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A Novel Approach to the Fuel Cell Technology

Mario Mitov[1], Rashko Rashkov[2], Stoyan Hrsitov[3], Anastasia Kaisheva[3]

1- Department of Chemistry, South-West University, Blagoevgrad, Bulgaria
2- Institute of Physical Chemistry – BAS, Sofia, Bulgaria 3- Institute of Electrochemistry and Energy Systems – BAS, Sofia, Bulgaria

***Abstract**: In this paper, results from implementation the first year program of a project "Metal Hydride – Air Cell" are presented and discussed. Conventional and newly synthesized materials have been studied as anode and cathode electrocatalysts for borohydride oxidation and oxygen reduction reactions, respectively. Initial tests with experimental fuel cell were also conducted. Based on analysis of results, some of studied materials are proposed for further investigations during next stages of the project.*

***Keywords:** metal hydride electrodes, alkaline borohydrides, electrooxidation, air gas-diffusion electrodes, Direct Borohydride Fuel Cell.*

1. INTRODUCTION

A new generation of devices and technologies aiming to overcome the disadvantages of existing energy system is under intensive research and development.

Among the most perspective technologies is that of fuel cells [1-3]. These are electrochemical devices that convert the energy of chemical reactions similar to combustion processes into electricity.

The mostly developed types are fuel cells using hydrogen as a fuel. However, various problems connected with technologies for hydrogen production, storage and transportation, as well as use of expensive electrocatalysts and, in some cases, electrolytes, exist and should be overcome for commercialization of the technology.

Although hydrogen is the fuel of choice, other hydrogen-rich compounds such as alkaline hydrides, borohydrides, alanates, etc. are also of interest [4,5].

Sodium borohydride is one of the most intensively investigated among other hydrides. Besides high hydrogen content among its advantages are it high solubility in water, easy stabilization by addition of alkaline base, controllable generation of hydrogen by catalyzed hydrolysis reaction:

(1) $$BH^-_4 + 2H_2O \rightarrow BO^-_2 + 4H_2$$

The formed borates are environmental safety and can be regenerated.

In addition, sodium borohydride can undergo electrochemical oxidation via following reaction:

(2) $$BH^-_4 + 8OH^- \rightarrow BO^-_2 + 6H_2O + 8e^-$$

The big number of participating electrons as well as highly negative potential of above reaction makes it very useful for practical application in electrochemical power sources. However, proper electrocatalysts are required for the effective borohydride oxidation.

Two important applications can be realized based on upper discussed reactions - hydrogen-on-demand (HOD) generators [6] and Direct Borohydride Fuel Cells (DBFC) [5,7].

Based on our previous experience in the fields of metal hydride and air gas-diffusion electrodes [8,9], we have started a project aiming at development of metal hydride – air fuel cell, using sodium borohydride as a fuel. In this paper, we summarize some of major results obtained during the first year of the project.

2. EXPERIMENTAL

2.1. Materials and reagents

Two types of materials have been principally studied as potential anode materials for direct borohydride oxidation – commercial metal hydride alloys and newly synthesized Co-based hydrogen-absorbing nanocomposite electrodeposits.

Except conventional Co-Ni and CoTMPP catalysts, other multicomponent systems (NiCoMnB, NiWTiOx, NiMoW) have been obtained by electrodeposition for testing as catalysts for air gas-diffusion electrodes.

Several plastics have been chosen for construction of experimental fuel cell – PVC, PMMA and polycarbonat Macrolon®. Chemical resistance in concentrated base solutions, wide temperature range operation (up to 80-100 ^oC), transperancy, etc. were among the leading criteria for chosing these materials.

Various separators and membranes as polyethylene separators DARAMIC®, plastic separators DARAK®, cellulose separators ARMORIB®, Nafion™ membranes, etc. have been tested for effective separation of the anolyte and catholyte in the experimental cell.

Sodium borohydride (purum p.a., Fluka) was used for preparation of the anolyte. Potassium or sodium hydroxide solutions were used as alkaline media.

2.2. Electrodes

Different technologies have been used for preparation of electrode samples.

Electrodes for borohydride electrooxidation were produced by following methods:

Pre-determined amount of a metal hydride alloy was mixed at various proportions with additives for increasing conductivity (nickel powder, graphite or VULCAN 72 hydrophobized carbon black) and binding agent (PTFE emulsion, PTFE paste or polyvinyl alcohol solution). After homogenization, the mixture was cold- or hot-pressed on Ni-foam.

Cobalt-based nanocomposites were directly electrodeposited on Ni-mesh or Ni-foam and pressed after that.

Air gas-diffusion cathodes were made in a following way:

Double layer tablets, comprising a porous hydrophobic gas layer made off a carbon material, modified by PTFE, and a catalytic layer made from a mixture of the same hydrophobic material and porous catalyst [10], were pressed on the both sides of Ni-mesh, used as a current collector, at 200 kg/cm^2 and 280^o C for 2 minutes.

2.3. Methods

A set of electrochemical methods has been used for characterization of electrode performance in borohydride solutions.

The tested electrodes were polarized anodically in base-stabilized sodium borohydride solutions at varying constant currents. Simultaneously, the kinetics of hydrogen evolution due to borohydride hydrolysis was monitored by means of water displacement method [11].

In other set of experiments, galvanostatic discharge curves were taken with the same electrodes in stabilized borohydride electrolytes and in 6M KOH electrolyte after overnight immersion of electrodes in borohydride – containing solution.

The electrochemical experiments were carried out in a specially constructed hermetic water-jacketed three-electrode cell with an outlet for generated gases. The tests were performed using PJT 35-2 potentiostat-galvanostat (Radiometer Tacussel) with IMT 101 electrochemical interface and Volta Master 2 software.

Steady-state polarization characteristics of investigated air gas-diffusion electrodes were obtained when operating with air or with pure oxygen in strong KOH electrolyte, using a half-cell arrangement. The potentials of air electrodes were measured against Zn reference electrode.

Volt-ampere characteristics of an experimental two-electrode metal hydride-air cell were taken using varying resistances. Metal hydride electrode prepared from commercial AB_5-type alloy and air gas-diffusion electrode with CoTMPP catalyst were used as an anode and a cathode, respectively. The geometric area of both electrodes was 6 cm^2. The anode and cathode compartments were separated by DARAMIC® separator, pre-treated with Nafion 117 (Fluka). Borohydride-containing 6M KOH electrolytes were used

as an anolyte and the cathode compartment was filled with 6M KOH solution.

3. RESULTS AND DISCUSSION

3.1. Studying of “metal hydride electrode – borohydride electrolyte” system

Anodic polarization curves, obtained with metal hydride electrodes in stabilized borohydride solution, are presented on figure 1:

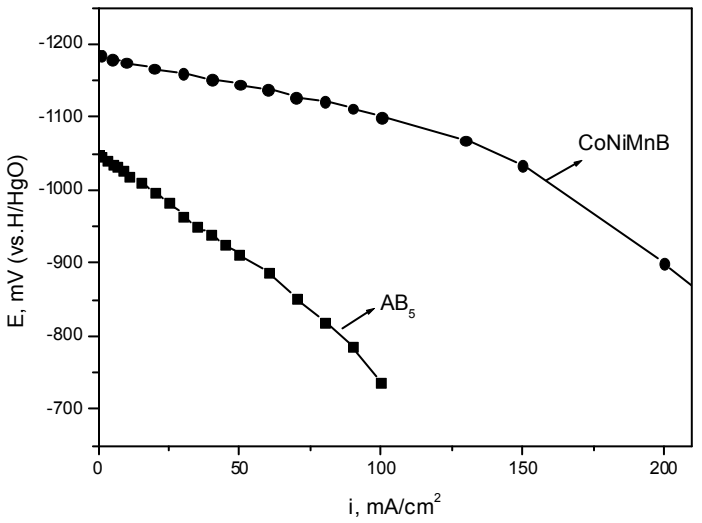

Fig. 1: Polarization curves obtained with studied electrodes.

Typically, the open circuit potentials (OCP) stabilized at more negative values than the equilibrium hydrogen potential in strong alkaline electrolytes (-0.926 V vs. Hg/HgO). In addition, the OCP shifted to more negative values with increasing borohydride concentration, which indicates its dependence on borohydride content.

Overpotentials fewer than 100 mV were observed with most of studied electrodes at current loadings up to 50 mA/cm^2, and even to 100 mA/cm^2 for some CoNiMnB compositions.

Over all electrode materials noticeable hydrogen evolution has been observed when the electrode sample was immersed in the borohydride electrolyte. At these conditions, hydrogen is generated by the borohydride hydrolysis reaction (1). The rate of hydrogen generation is highest on CoNiMnB nanocomposites (~6.5 ml/min) and lowest on AB_5 metal hydride electrodes (~1.5 ml/min).

When applying polarization, however, the rate of hydrogen generation decreases and tends to constant values at higher current densities - figure 2:

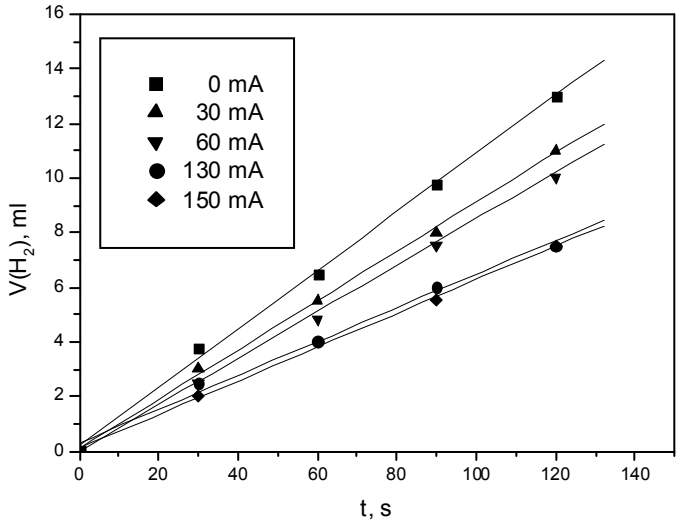

Fig. 2: Decrease of hydrogen evolution rate with increasing current loading.

The later result may be assigned to a competition between borohydride hydrolysis (1) and electrooxidation (2) reaction.

The observed decrease of hydrogen evolution rate is most significant for CoNiMnB electrodes, where the rate of hydrolysis reaction is highest at the absence of polarization.

Discharge curves, obtained with studied materials in stabilized borohydride electrolyte and in 6M KOH electrolyte after immersion in borohydride solution are shown on figure 3.

The curves, taken in 6M KOH after treatment in borohydride solution are rather similar to the characteristic discharge curves of metal hydride electrodes, obtained after electrochemical charging. Previously, a metal hydride formation as a result of immersion of AB_5-type alloy in borohydride solution was demonstrated by means of XRD [12]. Thus, the observed discharge in 6M KOH most probably takes place via electrochemical hydrogen desorption and the calculated discharge capacity may be used as a measure of absorbed hydrogen quantity.

Quite longer plateaus than those observed in strong alkaline solutions are visible on the discharge curves obtained in borohydride-containing electrolytes. Taking into account much higher discharge capacities and more negative potentials, at which these plateaus occur, the observed performance may be assigned to borohydride electrooxidation.

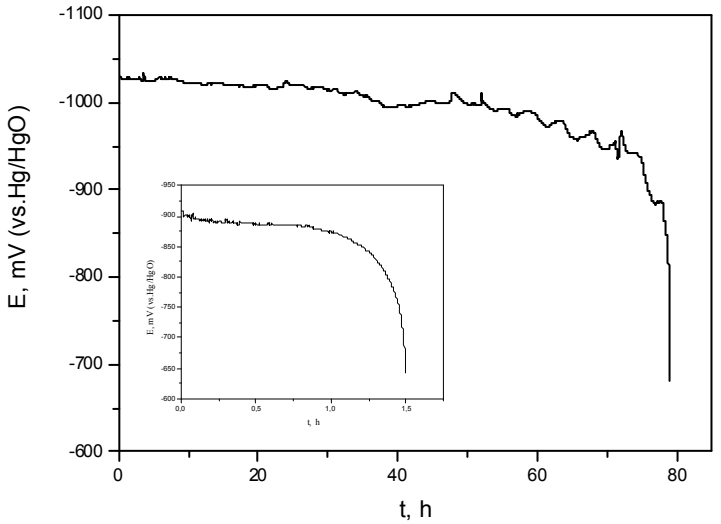

Fig.3: Discharge curves obtained with AB_5 electrode in 5% $NaBH_4$/KOH electrolyte ($I_{disch.}$=20 mA) and in 6M KOH ($I_{disch.}$=5 mA) after pre-treatment in sodium borohydride – inner graph.

The highest discharge times in borohydride solutions were obtained with AB_5 (~75 hours at 20 mA/cm^2) and CoNiMnB (~ 30 hours at 20 mA/cm^2) electrodes. The estimated discharge capacities from the curves, obtained in 6M KOH are ~300 mAh/g for AB_5 and ~150 mAh/g for CoNiMnB electrode.

3.2. Air gas-diffusion electrode investigation

Promising results, comparable with those of highly-performance CoTMPP and Co-Ni catalysts, were obtained with CoMnB electrodeposits for oxygen reduction reaction (ORR) [10]. However, when using air, significant polarization due to transport hindrances has been observed at current densities higher than 10 mA/cm^2.

Investigations with newly synthesized nanocomposites are in a progress.

3.3. Studies with experimental fuel cell

Initial results, obtained with the experimental fuel cell, are presented on figure 4.

Typically, with increasing of borohydride concentration the polarization becomes smaller at the same current loadings and the maximum power increases.

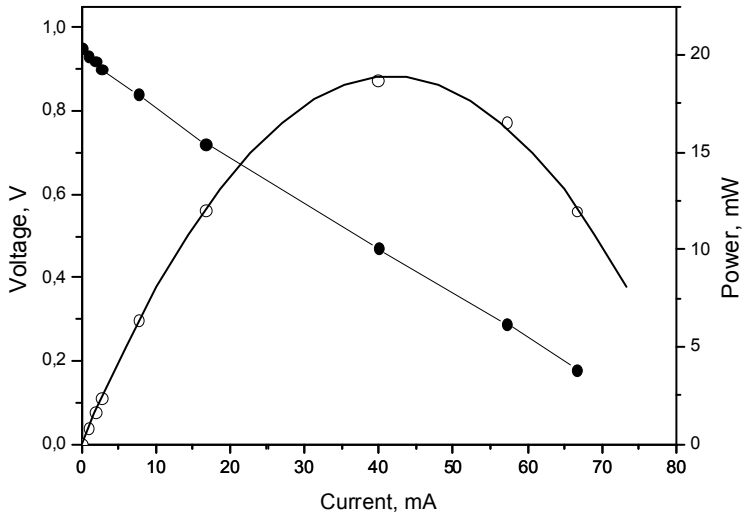

Fig. 4: Volt-ampere characteristic and power curve, obtained with the experimental fuel cell.

Further improvement of operational characteristics is required for practical application of this fuel cell.

4. CONCLUSIONS

The studied hydrogen-absorbing materials (mainly AB_5 metal hydride alloy and CoNiMnB electrodeposits) exhibit low overpotentials at relatively high current densities as well as long-term discharge capability, which makes them proper candidates for application as anodes in Direct Borohydride Fuel Cells.

Taking into account simultaneous hydrogen generation, especially on CoNiMnB nanocomposites, they can be also used in a hybrid fuel cell-hydrogen generator system.

Several new materials will be tested as anodic and cathodic electrocatalysts. Further investigations with newly designed cells will be also conducted.

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Cleavage Of 1,3-Dithianes via Acid-Catalyzed Hydrolysis of the Corresponding 1,3-Dithianemonooxides

Stephan Cludius-Brandt and Karsten Krohn
University of Paderborn, Warburger Straße 100, 33098 Paderborn

Abstract*: The hydrolysis of 1,3-dithianes to their parent carbonyl compounds via their corresponding monosulfoxides was systematically investigated. The oxidation of the 1,3-dithianes was carried out in high yields using tert-butyl hydroperoxide. Acid-catalyzed hydrolysis of the resulting 1,3-dithiane-1-oxides was then performed in excellent yields.*

Keywords: *1,3-dithianes, dithioacetals, 1,3-dithiane-1-oxides, cleavage, dethioacetalization*

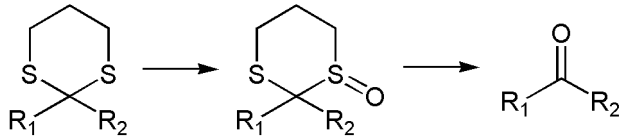
1. INTRODUCTION

Dithioacetals are useful protecting groups for carbonyl compounds due to their ease of formation and their stability under acidic and basic conditions.[1] In addition, they are also *umpolung* reagents[2] that play an increasing role in natural product synthesis. However, their deprotection often remains a problem in spite of the large number of published methods.[3] Many of these procedures have considerable drawbacks such as the use of toxic reagents, long reaction times, harsh reaction conditions, expensive catalysts, or the occurrence of undesired side reactions that are not compatible with functional groups present in the substrates. Thus, there is still a need for generally applicable and mild methods for the cleavage of dithioacetals to their parent carbonyls. In 1961, Kuhn et al. reported that the monosulfoxides of 1,3-dithianes undergo easy cleavage to the carbonyl compounds in acidic methanol under reflux.[4] However, this very convenient method did not find many applications and was not included in the latest review article on deprotecting methods for 1,3-dithianes.[3a] Therefore we initiated a systematic investigation with a representative number of 1,3-dithianes varying in steric demand and electronic properties in order to probe the scope and limitations of this dithiane cleavage methodology. The reaction pathway is shown in figure 1.

2. SYNTHESES OF THE SUBSTRATES

2-alkyl-1,3-dithianes (**1**) were synthesized using known methods by reaction of the corresponding carbonyl compounds with 1,3-propanedithiol[5]. As substrates we selected aromatic, olefinic and aliphatic aldehydes and ketones. The subsequent oxidation to the corresponding

monosulfoxides (**2**) was carried out using *tert*-butyl hydroperoxide (TBHP) in dichloromethane and catalytic amounts of camphorsulfonic acid (CSA). The yields in this transformation were nearly quantitative and the formation of higher oxidation products (sulfones or disulfoxides) was not observed. 2-(1-hydroxyalkyl)-1,3-dithianes were prepared by addition of lithiated 1,3-dithiane to aldehydes or ketones.



R_1 = Alkyl; R_2 = Alkyl, H

Fig. 1 Hydrolysis of 1,3-dithianes (**1**) via their monosulfoxides (**2**)

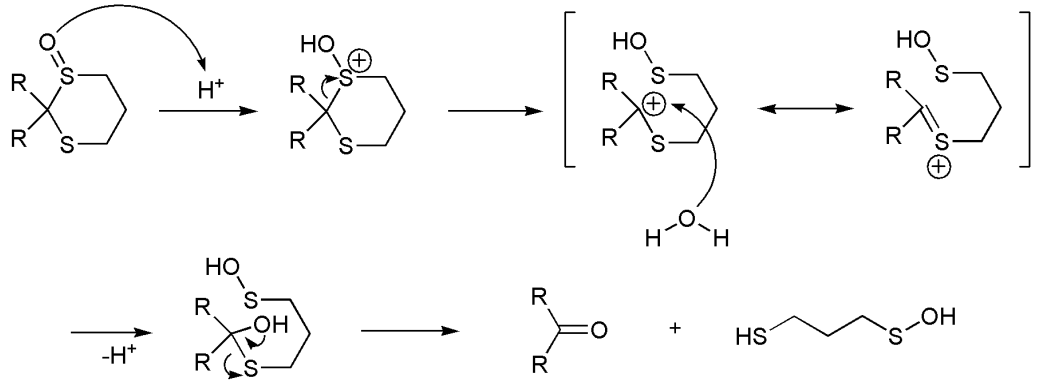


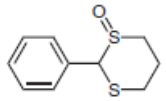
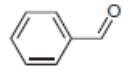
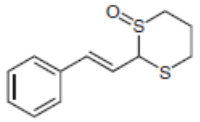
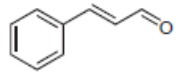
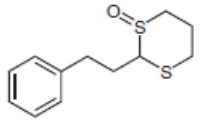
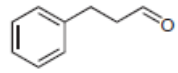
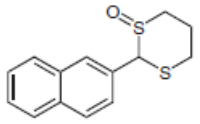
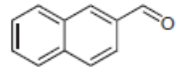
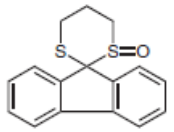
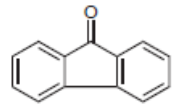
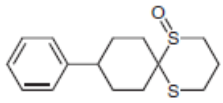
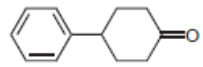
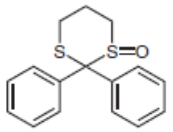
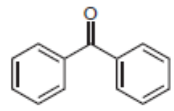
Fig. 2 Assumed mechanism for cleavage of 1,3-dithiane-1-oxides in acidic acetonitrile

3. RESULTS AND DISCUSSION

The acidic hydrolysis reactions of 1,3-dithiane-1-oxides (**2a**-**g**) (see table 1) were perfomed in acetonitrile (1 mmol substrate in 10 mL acetonitrile to which 0.3 mL of 6 N HCl was added) and conducted overnight for reasons of convenience and in order for the reactions to reach completion. Alternatively, complete conversion could be achieved by heating at 30-40 °C for several hours. The conversions were quantitative by TLC comparison and no side products were formed. The isolated yields were in a range of 83-95 %. Figure 2 shows the assumed mechanism for the cleavage reaction in acidic acetonitrile. In the first step, the addition of a proton to the oxygen atom of the sulfoxide leads to the formation of a sulfonium ion. Subsequent

ring-cleavage gives an open-chain sulfur-stabilized carbenium ion, which is then transformed into the corresponding carbonyl compound by nucleophilic attack by water.[6]

Tab. 1 Acidic cleavage of 1,3-dithiane-1-oxides in acidic acetonitrile

Substrate		Time (h)	Product		Yield (%)
	**2a**	38		**3a**	83
	**2b**	12		**3b**	94
	**2c**	12		**3c**	91
	**2d**	12		**3d**	95
	**2e**	12		**3e**	95
	**2f**	12		**3f**	86
	**2g**	8 min		**3g**	93

However, not only 2-alkyl-1,3-dithianes but rather the 2-(1-hydroxyalkyl)-1,3-dithianes, formed by addition of 1,3-dithianes to aldehydes and ketones are the most important intermediates in *umpolung* chemistry. While investigating these substrates we found some very interesting conversions which are currently under further investigation.

In summary, we have shown for a representative number of examples that this two step cleavage methodology for 1,3-dithianes via the corresponding monosulfoxides is a straightforward and high yielding process. The method does not seem to be restricted by electronic or steric effects and

can be considered as an economic and environmentally friendly alternative to existing methods.

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Obtaining of Active Silica from Rice Husk

Ranko Adziski, Emilija Fidancevska, Venceslav Vassilev

Faculty of Technology and Metallurgy, Rudjer Boskovic 16, Skopje, R. Macedonia
University for Chemical Technology and Metallurgy, Dept. of Semiconductors,
8 Kliment Ohridski Blvd., Sofia, Bulgaria

***Abstract**: Rice husk is an attractive abundant source for active silica production. Silica with 98.4 % purity was obtained by pretreatment with hydrochloric acid at 90±5 ^{0}C and combustion at 600 ^{0}C. This silica remained in amorphous form and possessed specific surface area of ~300 m^2/g. It is constituted by particles with indefinite geometry and expressed relief. The particle size ranged from 2 to 8 mm. An agglomerated silica powder with specific surface area of ~180 m^2/g was obtained by mechanical activation-wet milling for 3h. The agglomerates size ranged from 10-30 μm, and they were constituted by primary particles of ~20 nm.*

***Keywords:** rice husk, acid treatment, mechanical activation, active silica*

1. INTRODUCTION

Since 1934, Japanese scientists have observed that silicon is beneficial in the normal growth of rice. Lanning studied the silica content of various parts of the rice plant. He classified the silica in rice as biogenetic opal [1]. Depending of the variety, climate and geographic location, rice husk (RH) produces ash content by combusting, varying from 13-29 wt. % [2]. The ash is predominantly composed of silica (87-97%), with small amounts of inorganic compounds and unburned organic materials. Due to the high silica content, RH becomes a source for preparation of elementary silicon, oxide ceramic [3], SiN_3 [4], SiC [5] , high purity SiO_2 nanoparticles [6], active silica [7], low cost absorbents for absorption of various polar and no polar molecules from water solutions [8], photo catalysts [9], etc. Patel et al. [10] obtained SiO_2 by 99% purity at low temperature by acid leaching of the RH. Della et al. [7] showed that calcination of rice husk ash (RHA) at 700 ^{0}C for 6 h followed by milling for 80 min is an effective procedure for producing active silica. The elimination of metallic impurities in RH samples treated with 1 mol/dm^3 HCl at 60 ^{0}C for 4 h is reported in Ref [11]. By treating the RH with 3 mol/dm^3 HCl and combustion at 600-700 ^{0}C, the formation of black particles can be avoided [2]. SiO_2 with high purity (~99.5%) and high specific surface area (~260 m^2/g) can be produced by combustion of previously HCl treated RH at 600 ^{0}C [12]. A 99.9% SiO_2 with average particle size of

15 nm can be obtained from rice husk treated with lignocellulolytic enzymes [6].

Processing and characterization of pure active silica from RH are presented in this paper. The purity of the RHA silica was increased by acid pretreatment and the activity of the obtained silica was improved by mechanical activation.

2. EXPERIMENTAL PROCEDURE

The raw material used for the experiment was RH obtained from a local rice milling industry (Zrnovci, Kocani, Macedonia).

RH was treated in hydrochloric acid for 2 h at 90±5 ^{0}C. Acid concentrations of 0.5, 1, 5, and 10 wt% were used. The treated RHs were washed with deionized water and dried at 105 ^{0}C. Combustion was realized at 600 ^{0}C for 1 h in air atmosphere.

RH and RHA powder morphology were observed by Scanning Electron Microscope (SEM) (Leica S 440i) on samples covered with gold. Energy Dispersive X-Ray Spectroscopy (EDS) was used for quantitative analysis-chemical composition of the powders.

The phases present in the RHA sample were identified by X-ray diffraction (XRD) (Bruker D8 Discover). CuKα radiation at 40 kV and 40 mA was used. The 2θ interval was ranged from 15 to 65 ^{0}.

Mechanical activation-wet milling of the RHA was realized in attritor mill (Netzsch) for 1, 2, and 3h using circonia balls. The ball-to-powder weight ratio was 10:1, and the milling speed was at 1200 rpm. The milled suspensions were dried in porous plates at RT and 105 ^{0}C, followed by milling in agate mortar.

Specific surface area was measured using nitrogen gas adsorption (5 point BET method), (Gemini, Micrometritics USA).

Powder morphology of the mechanically activated RHA was followed by Transmition Electron Microscopy (TEM) (JEOL 3010).

3. RESULTS AND DISCUSSION

Spectral analysis-chemical composition of the inorganic part from different parts of RH is shown in Tab. 1. Silica was present all over the RH but is concentrated in protuberances and in hairs (trichomes) on the outer epidermis, Fig. 1b, and also in the inner epidermis, Fig. 1a. The inorganic impurities were mostly concentrated in the inner epidermis of the RH, Tab. 1.

Upon heating to 600 ^{0}C the non treated RH yielded ashes grey in color with considerable amount of black particles. The black particles were collected separately and analyzed through EDS, Table 2. An increased concentration of inorganic impurities, especially potassium oxide was noticed. The potassium must be accelerating the carbon fixation in RHA [11]. Potas-

sium oxide (K_2O), which dissociates upon heating at 347 ^{0}C, forms elemental potassium whose melting point is 63.8 ^{0}C.

Tab. 1: Spectral analysis-chemical composition from different parts of RH.

Spectral analysis	SiO_2	K_2O	MgO	SO_3
Spectar 1	84.12	7.33	4.00	4.56
Spectar 2 (hairs)	99.68	0.32		
Spectar 3 (protuberances)	100.00			

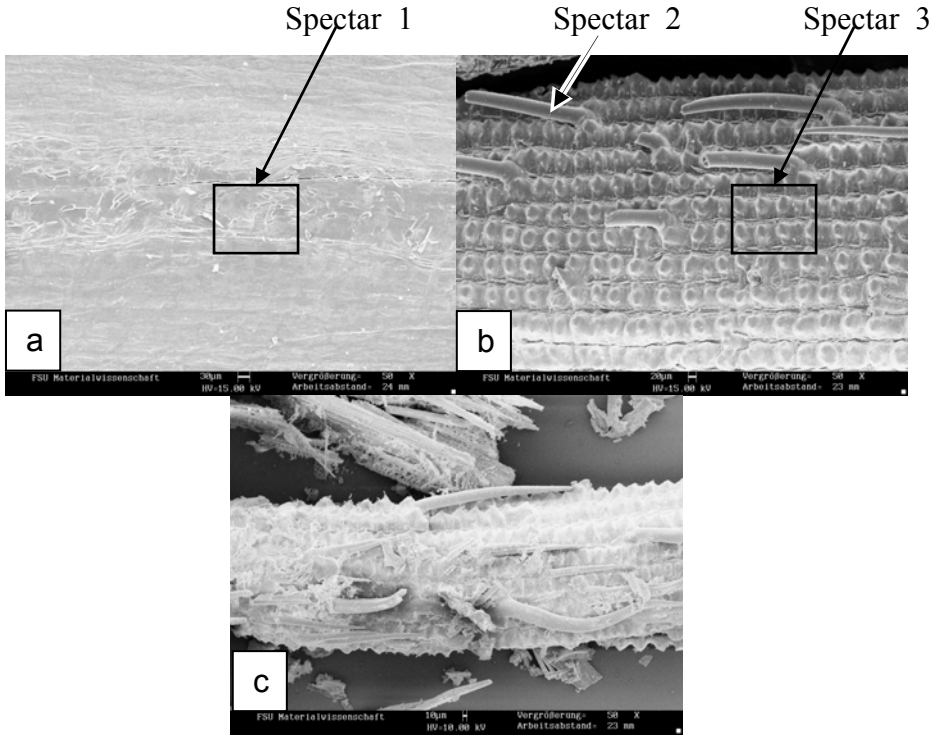

Fig. 1: SEM micrographs of the: a) inner epidermis of RH (x50), b) outer epidermis of the RH (x50) and RHA combusted at 600 ^{0}C (x50).

As the temperature raised, there is occurrence of simultaneous oxidation of carbon formed from decomposition of organic matter and dissociation of K_2O followed by surface melting. Once carbon is entrapped in the potassium rich melt, it cannot be oxidized as it is not in direct contact with air [2]. As the temperature of combustion increases, the tendency of carbon fixation increases. Therefore, a large number of black particles were observed in the RHA samples combusted at 700 and 800 ^{0}C.

Tab. 2: Spectral analysis-chemical composition of black residue and RHAs obtained at 600 ^{0}C

Material	SiO_2	K_2O	CaO	MgO	MnO	Na_2O	SO_3
Black particles	79.17	14.59	2.04	2.79		0.64	
RHA-0wt[1]	94.81	2.68	0.88	0.58	0.32		0.61
RHA-0.5wt	100.00						
RHA-1wt	100.00						
RHA-5wt	100.00						
RHA-10wt	100.00						

[1]*Awt* means the concentration of the hydrochloric acid (0, 0.5, 1, 5, 10 wt%) used for the pretreatment.

White coloured ashes were obtained by combustion of acid treated RHs at 600 ^{0}C. A slight gray hue was noticed in RHA pre-treated with 0.5 and 1 wt.% HCl. This was as a result of uncompleted combustion of organic materials [7]. The lost on ignition was ~1.60 wt.% for both ashes. Although the EDS results of these ashes showed no presence of inorganic impurities, Tab. 2, few black particles were detected. Complete white colour was obtained from all the acid treated RHs by increasing the temperature of combustion to 700 ^{0}C. With further increase of the temperature of combustion to 800 ^{0}C, the brightness of the white colour increased.

Patel et al. [10] reported that the temperature of combustion should be preferably below 700 ^{0}C to avoid any transformation of SiO_2 from amorphous to crystalline form.

Taking into account Patel’s conclusion and considering the spectral analysis-chemical composition, Tab. 2, RHA pre-treated by 1 wt.% HCl obtained at 600 ^{0}C (RHA-1/600) was chosen as a material for our further investigation.

XRD investigations of the RHA-1/600 showed that the SiO_2 remained in amorphous form.

From the SEM micrograph, Fig. 1c can be noticed that the RHA-1/600 was constituted by particles with indefinite geometry and expressed relief. The particle size was approximately 2 mm in tick and 8 mm in length. The RHA-1/600 possessed specific surface area of ~300 m^2/g. Real et al. [12] reported specific surface area of ~260 m^2/g for RHA obtained at similar conditions.

The specific surface area of the RHA-1/600 was 147 m^2/g after 1h of mechanical activation. Further, the specific surface area started to increase reaching maximum for 2 h of mechanical activation (184 m^2/g), and decreased to 177 m^2/g after 3 h of mechanical activation.

An agglomeration occurred in the mechanically activated RHA-1/600. As the time of mechanical activation increased, the agglomerate size increased too, probably because of increased surface energy of the particles. From the micrograph of the RHA-1/600 mechanically activated for 3h, Fig. 2., can be seen that the size of the agglomerates ranged from 10-30 μm. The agglomerates were constituted of nanosized primary particles (~20 nm) nearly spherical in shape, Fig. 3.

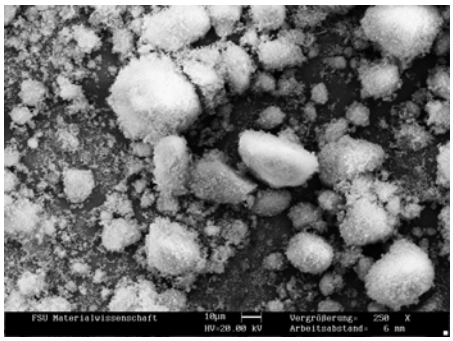

Fig. 2: SEM microphotograph of mechanically activated RHA-1/600 for 3h (bar 10 μm)

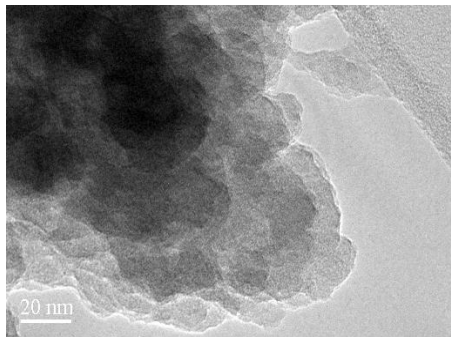

Fig. 3: TEM microphotograph of mechanically activated RHA-1/600 for 3h (bar 20 nm)

The RH represents a cheap source for active silica production. This active silica can be used in a wide range of applications, as well as production of porous silicate compacts, binder in refractory industry, catalysts supports, cheap absorbents, etc.

4. CONCLUSION

- RH is an abundant annual source for active silica production.
- The inorganic impurities in the RH were effectively removed after treatment with hydrochloric acid. White silica ash with specific surface area of ~300 m^2/g was obtained after combustion at 600 ^0C for 1h. The silica ash particles were with indefinite geometry, expressed relief and their size ranged from 2 to 8 mm.
- The thermal treatment of the RH at 600 ^0C does not affect the structure of its ash-silica, i.e. the silica remained in amorphous form.
- Ash silica powder in agglomerated form with specific surface area of ~180 m^2/g was obtained by mechanical activation-wet milling. The agglomerates size ranged from 10-30 μm, and they were constituted by primary particles of ~20 nm.

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PREPARATION AND CHARAKTERIZATION OF YTTRIUM-ALUMINIUM GARNET ($Y_3Al_5O_{12}$)

J. Ruzicka[1], J. Houzvicka[2], D. Niznansky[1], M.Nikl[3], R.Cerny[4]

[1] Charles University in Prague, Faculty of Natural Sciences, Department of Inorganic Chemistry, Albertov 6, 12843 Praha 2, Czech Republic,
E-mail: jakub_ruzicka@seznam.cz
[2] Crytur Turnov, Turnov Czech Republic
[3]FZU AV CR, Praha Czech Republic
[4]Universite de Geneve, Geneve Switzerland

Abstract. *This work deals with the preparation of powders and transparent yttrium aluminium garnet ($Y_3Al_5O_{12}$ - YAG) from nanopowders. Stoichiometric amounts of nanocrystalline Al_2O_3 and Y_2O_3 were mixed and chemically pretreated using different basic agents and using ultrasonic bath. Resulting mixture was dried, pressed and heated up to 1750°C. Final material was characterized by X-ray diffraction, DTA and optical and electron microscopy.*

1. INTRODUCTION

Yttrium aluminium garnet ($Y_3Al_5O_{12}$ - YAG) is the material, which is often used for the production of scintilation detektors and solid state lasers. In industry, it is produced by monocrystal drawing from melting (Czochralski method) and consecutive mechanical working (cutting, grinding, and polishing). However, this production process is very difficult due to high temperature of melting mixture (melting point of YAG = 1970°C) and need for resisting noble metal crucibles, which give the very high production costs.

The effort of research teams is now oriented in the direction of decreasing of production costs, i.e. decreasing of temperature needed for YAG preparation. The most simple and the cheapest method seems to be the preparation of transparent YAG ceramics from Al_2O_3 and Y_2O_3 nanopowders [1].

2. EXPERIMENTAL

The respective stoichiometric amounts of Al_2O_3 and Y_2O_3 were weighed out in beaker. Two basic agents were used for chemical pretreatment - 10% solution of tetramethylamonium hydroxide (TMAH) and amonium hydroxide respectively. In order to improve the transparency, the small amount of tetraethoxysilane (TEOS) (molar ratio YAG:SiO_2 = 1000:1) was added to this mixture. The suspensions were treated in ultrasonic bath

with high energetic ultrasonic power of about 50 W. Then, the samples were dried and thermally pretreated at 800°C. Resulting powder was pressed using cold or heat isostatic pressing and then heat treated in furnace at 1750°C.

Final samples were tested for transparency and characterized by X-ray diffraction, DTA and electron microscopy. X-ray patterns were measured at ambient temperature using a diffractometers Phillips and Bruker. Two type of scanning electron microscopes were used: electron microscope PHILIPS XL 30 CP for orientation observation and AQUASEM - (Tescan) - low-vacuum scanning electron microscope for detail observation of the samples.

3. RESULT AND DISCUSSION

All samples treated at maximal temperature of 1750°C prepared using both TMAH and amonia contained transparent crystals of 2 μm in diameter with defects. These transparent crystals were embedded in the YAG with poor crystallinity and for this reason the entire samples were not transparent.

The powder diffraction pattern revealed that the only phase present in the sample seems to be YAG (Figure 1). But the detailed view shows that the samples contained also some small amount of non-reacted alumina (inset in Figure 1).

Scanning electron microscope (SEM) images revealed that the structure contains the crystals of the size of several microns (Figure 2). These crystals are directly connected having gap smaller the 10 nm. This is favourable findings, because this size of pores does not raise the light diffusion and that samples are then transparent. But, unfortunately, at the same time we can observe the greater pores of the size of microns that have spurious effect to the sample transparency.

SEM images revealed that the main reason of the non-transparent aspect is porosity of the sample. This porosity can be due to the water adsorbed on the nanopowders surface or insufficient pressure during the isostatic pressing.

4. CONCLUSION

Small transparent crystals of the size of 2 μm were prepared using nanopowder Al_2O_3 and Y_2O_3, but these crystals were embedded in non-transparent phase. Other experiments with vacuum and heat pretreatment and using higher isostatic pressure must be done in order to avoid the large porosity and prepare transparent samples.

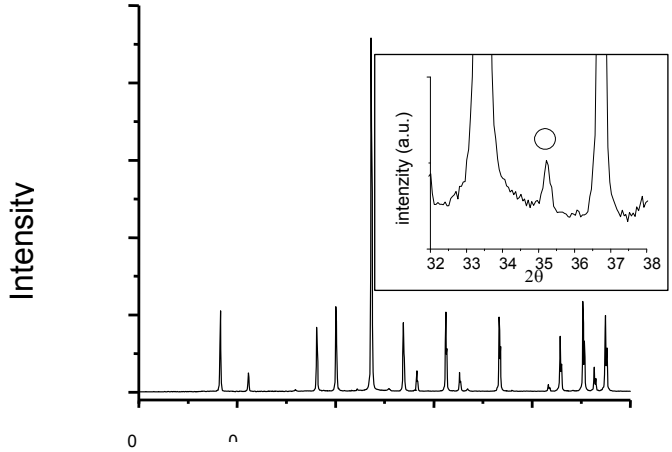

Figure 1. XRD pattern of the 1750°C heat treated sample. Inset represents detailed view (circle denote the most intensive peak of Al_2O_3).

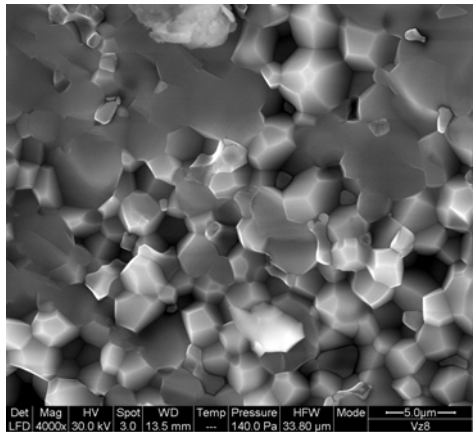

Figure 2. SEM image of the 1750°C heat treated sample.

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Biofuel Cells – Alternative Power Sources

Sofia Babanova[1], Yolina Hubenova[2], Mario Mitov[1,3]

[1]Department of Chemistry, South-West University “Neofit Rilski”, 66 Ivan Mihajlov Str., 2700 Blagoevgrad, Bulgaria
[2]Department of Biochemistry and Microbiology, “Paisii Hilendarski” University of Plovdiv, 24 Tzar Asen Str., 4000 Plovdiv, Bulgaria
[3]Institute of Electrochemistry and Energy Systems, Bulgarian Academy of Sciences, Acad. G.Bonchev Str., bl.10, 1113 Sofia, Bulgaria

***Abstract**: Energy generation from renewable sources and effective waste treatment are two key challenges for the sustainable development. Microbiological (or Bio-) Fuel Cells provide an elegant solution by linking both tasks. Biofuel cells, which can directly generate electricity from biodegradable substances, have rapidly gained increasing research attention. Widely available fuel sources and moderate operational conditions make them promising in renewable energy generation, wastewater treatment, power sources for remote devices, etc. This paper reviews the use of microorganisms as biocatalysts in microbiological fuel cells. The principle of biofuel cells and their construction elements are discussed.*

***Keywords:** alternative power sources, biofuel cells, biocatalysts.*

1. INTRODUCTION

The need of using alternative power sources, which can gradually replace the traditional energy fuels, is widely discussed. At the present, fossil fuels such as coal, oil, natural gas and their derivatives satisfy almost 85% of the energy demands. Unfortunately, the earth reserves of these fuels are limited. As a result of technical revolution and increasing people’s population, exploitation of these sources intensified, and for about one and a half century almost a half of the existing fossil fuels on our planet have been consumed. The conventional carbon fuels shortage combined with the rising content of greenhouse gases in the atmosphere, leading to global warming, enforce the necessity of new alternative energy sources utilization. From another hand, the increasing consumption of petrol products leads not only to energy crisis, but also to decrease of the raw materials for synthesis of carbon-containing products such as polymer materials, food, drugs, etc.

Biofuel cells, more popular as microbial fuel cells (MFCs), could be a potential solution of all these problems. MFCs possess a number of advantages over the currently used technologies for generating energy from organic matter [11]. The most important is that, they use substrates from renewable sources and have high conversion efficiency. The MFCs operate at

ambient temperatures and do not pollute the environment. This is the reason why they have the potential for application in locations lacking electrical infrastructure. Except for getting energy, in the same time, they can be used for wastewater treatment; powering marine devices with oxidation of sea sludge; as bio-batteries; in space crafts, etc.

For the progress of this innovative technology, which is most intensively developed in the last five years, the generalization of achievements is of a big importance. In this paper, the principles and construction elements of biofuel cells are reviewed and discussed.

2. *MFC BASIC PRINCIPLES*

*MFCs are devices that co*nvert the chemical energy of natural available organic substrates directly into electricity by using different microorganisms as bio-microreactors [9, 11]. The most investigated bacteria for application in biofuel cells are Escherichia coli [12, 13], Geobacter sulfurreducens [7, 12, 13], Pseudomonas aeruginosa [7, 12, 13], Rhodoferax ferrireducens [12, 13], Shewanella oneidenis, Shewanella putrefaciens [12, 13], Enterobacter cloacae [9, 13], etc.

In principle, biofuel cells can be divided into three major components: anaerobic anode chamber, cathode chamber and separator (fig. 1). In the anode compartment the organic matter is oxidized through the catabolic metabolism of the microorganisms and the gained electrons are then transferred to the electrode [12]. Abundant organic substances such as carbohydrates, organic acids, methanol, etc., can be used as substrates for the oxidation process [1, 2]. The electrons that reach the anode pass through the external load circuit to the cathode, where the electron acceptor is reduced. The protons diffuse from the anode through a separator to the cathode, where with oxygen, provided by air, produce water [6]. In most cases, the resulting products are carbon dioxide (at the anode) and water (at the cathode). Other oxidizers such as hydrogen peroxide, potassium ferricyanide, etc., can also serve as final electron acceptors.

The operational characteristics of biofuel cells, as other electrochemical power sources, depend on numerous factors including anode potential, cathode potential, internal cell resistance, etc.

The anode potential controls the liberation of electrons from different stages of metabolic pathways. Changing the anode potential we could varying the amount of electrons flow, produced *in vivo* in the processes of glycolysis, fermentation or respiration, to the electrode.

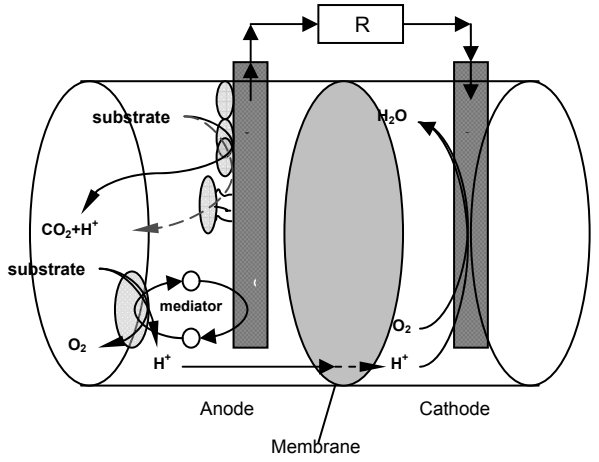

Fig. 1: The working principle of a two-chamber microbial fuel cell

The dependence of the anode potential upon material determines the type of material used. The anodic material of MFC must be conductive, biocompatible and chemically stable. The most appropriate one is the carbon. Graphite plates, rods, felt, cloth, paper, fibers are performed. The conduction characteristics of carbon electrodes are arranged in the ascending order: graphite plates and rods< carbon cloth< carbon foam< carbon felt, besides current density increase with the overall internal surface area [6]. It is supposed, that carbon felt has the best characteristics. Modifications including electrocatalysts performance such as Mn(IV), Fe(III), Pt, tungsten carbide, polyanilins/Pt composites, covalently linked mediators [6, 12] could increase the anode quality. However, difficulties concerning the biocompatibility of the electrocatalysts, chemical and electrochemical stability and cellular non toxicity are lowering their widely utilization.

From one hand, the choice of anode material, leading to suitable anode potential will increase the electrical current. The decrease of the anode potential forces the microorganisms to give electrons via taking part of complexes with low potentials. The aim is to apply such an anode potential by which the cells grow and develop normally, i.e. to use the electrons from the terminal stages of their metabolic pathways. However, for higher current density generation the electrochemical rules require lower anode potential in comparison with the cathode one [1, 12]. From the other hand, the composition of the anolyte is from crucial meaning. The select biocatalysts and substrates necessary for microorganisms’ development are of primary significance. The nutrition ingredients include sources of organic carbon, nitrogen, phosphorus, sulfur and metal ions. A lot of varying parameters such as medium components proportion, cell density, carbohydrate exhausting during cultivation, etc., influence the MFCs-performance. The maintaining of

suitable pH, once for the growth of microorganisms, and second for increasing the solution conductivity, requires a buffer solution usage. Neutral phosphate buffer (pH 7,0) is the most appropriate and commonly used for a two-chamber MFCs.

The choice of a proper cathode is also of big importance for the performance of MFCs. In general, for obtaining good operational characteristics, the cathode should possess high positive potential, which provides a high voltage of the power source. The oxygen is the most suitable electron acceptor for biofuel cells. It has high oxidation potential, availability, low cost and gives as end product water. To increase the rate of oxygen reduction, Pt catalysts could be applied. However, the high price of the product makes it inapplicable in the non labor production. [6]. Replacing Pt catalysts, the potassium ferricyanide acts as an oxidant [2, 10] and increases the power by 1.5 to 1.8 times compared to a Pt-catalyst cathode [6]. Using permanganate as the cathodic electron acceptor, a two-chamber MFC generate 4.5 and 11.3-folds higher maximum power density than that produced by using ferricyanide and oxygen, respectively [15]. The cathode reaction kinetics can be improved once, by choosing the suitable electrolyte and second, by electrode modifications incorporating metals, surfactants, organic substances or addition of mediators [10].

The separator is the third important component in MFC. It connects and at the same time physically separates the anode and cathode compartment while allowing protons to pass through to the cathode in order to sustain an electrical current. The major requirement to the separator is to allow the passing through only of the protons arresting other substances. Examples for separators most commonly used are the proton exchange membrane such as Nafion, the cation exchange membrane such as Ultrex or a simple salt bridge [2, 5, 6, 8].

Many different configurations are possible for MFCs. A widely used and inexpensive design is a traditional two-chamber MFC. It is constructed from two separate chambers, connected with a tube containing a separator or a salt bridge. The improved construction today leads to distribution of the single-chamber MFC with air-cathode. In this case the cathode is placed in direct contact with air, either in the presence or absence of membrane, so that the anode and the cathode are in the same compartment.

Other types of biofuel cells are those using enzymatic electrodes, the so-called enzymatic microbial fuel cells [4, 11]. The redox enzymes from the main metabolic pathways - oxidases, dehydrogenases, etc., can be isolated and purified from living cells and immobilized on the electrode surface. In such a manner the enzymes serve as biocatalysts rather than whole microbial cells.

Independently on the MFC type, the improvement of the electron transport efficiency takes an important part of investigations in the field. Three

mechanisms of electron transfer from living cells to the anode are possible [6, 12]: by artificial exogenous mediators; by using natural mediators produced by bacteria; direct electron transfer - by bacterial nanowires or respiratory enzymes. The oxidized and the reduced forms of the mediator should easy penetrate the cell membrane, should possess potential positive enough to pro-vide fast electron transfer and of course be non toxic [6, 12]. The most common used organic compounds as electron transport mediators are: thionine, methylene blue, neutral red, viologen, etc. [3, 4, 14]. Their concentration should not cause bacteria poisoning and apoptosis.

The examinations of natural mediators are in progress. Microorganisms such as Shewanella putrefaciens, Geobacter sulfurreducens, Geobacter metallireducens and Rhodoferax ferrireducens have active redox enzymes in their outer membrane, which can transfer electrons directly to the anode and because of that they do not require the use of exogenous mediators. These preferable biofuel cells are called mediatorless MFCs.

3. PERSPECTIVES FOR MFC APPLICATION

In principle, the current and power density output of MFCs is much lower than those of chemical fuel cells such as hydrogen-powered ones, so it is unrealistic to expect that they will have a large input in the future energy budget. However, the extremely increasing R&D in this field is indicative for its perspectives.

MFCs can potentially be used for different applications. The most realistic of them are as power sources for implantable devices within humans and as power supplies for use in remote areas. For large-scale applications such as wastewater treatment and remediation, development of inexpensive large surface area electrodes that resist fouling is needed.

A lot of further R&D, concerning improvement of current and power density output, cell design, long-life operation, etc., is required for the real commercial application of this innovative technology.

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Physicochemical properties of new As_2Se_3–Ag_4SSe–CdTe glasses

Lilia Aljihmani[1], Venceslav Vassilev[1], Temenuga Hristova-Vasileva[1], Emilija Fidancevska[2]

[1] Department of Non-Ferrous Metals and Semiconductor Technologies, University of Chemical Technology and Metallurgy, 8 Kl. Ohridski blvd., Sofia 1756, Bulgaria,
e-mail: l_aljihmani@abv.bg
[2] Faculty of Technology and Metallurgy, Rudjer Boskovic 16, Skopje, R. Makedonija

Abstract: *Chalcogenide glasses from the As_2Se_3–Ag_4SSe–CdTe system were synthesized. The basic physicochemical parameters such as density (d), microhardness (HV) and the temperatures glass transition T_g were measured.*

Compactness (C) and some thermomechanical characteristics such as volume (V_h) and formation energy (E_h) of micro-voids in the glassy network, as well as the module of elasticity (E) were calculated. A correlation between the composition and properties of the As_2Se_3–Ag_4SSe–CdTe glasses was established and comprehensively discussed.

Keywords: *chalcogenide glasses, density, microhardness, compactness, elasticity modulus, thermomechanical characteristics.*

1. INTRODUCTION

In the last two decades a new direction in the modern materials science is developing rapidly - physics and chemistry of disordered media. The chalcogenide glassy semiconductors excert significant influence on the development of the investigations in the field of disordered substances. This new class semiconductor materials unites the characteristic properties of both crystalline and glassy semiconductors. Furthermore, some of these substances depending on the synthesis method exist both in glassy and in crystalline state. This allows investigating fully the electronic processes objectives on one and the same objects in ordered, as well as in disordered state. The interest on the chalcogenide glassy semiconductors is also due to the fact, that they find more wider practical application, especially in the IR techniques, in the integral photoelectronics, as photosensitive elements of various photoelectrical systems for recording of optical images (photothermoplastic systems for optical images recording, electrophotography, optical windows and filters), as medium for holograms recording and creation of multifunctional elements for the integral optics, as materials for sensors, protective layers, switchers, electrochemical power supplies, etc.

The region of glass formation in the three-component system $(As_2Se_3)_x(Ag_4SSe)_y(CdTe)_z$, where x + y + z = 100 and m = y/(x+y), was outlined by us (Fig. 1) and is described in a previous work.

It is extended to the area rich of As_2Se_3 and lies on the faces As_2Se_3–Ag_4SSe (from 0 to 25 mol % Ag_4SSe) and As_2Se_3-CdTe (from 0 to 10 mol % CdTe) on the Gibbs' concentration triangle. The maximum solubility of CdTe in the glasses is 17.5 mol %.On the side Ag_4SSe–CdTe glasses were not obtained.

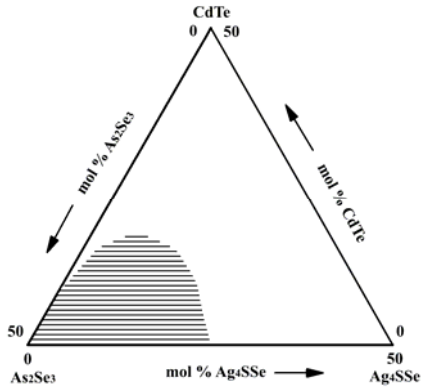

Fig. 1. Glass forming region in the As_2Se_3–Ag_4SSe–CdTe system.

The aim of the present work is to investigate the main physicochemical properties of chalcogenide glasses from the As_2Se_3–Ag_4SSe–CdTe system.

2. EXPERIMENTAL PROCEDURES

The source compounds and the glasses (4 g) from the $(As_2Se_3)_x(Ag_4SSe)_y(CdTe)_z$ system are produced via direct single temperature synthesis in vacuumed and sealed in vacuum 1.10^{-3} Pa quartz ampoules. The source materials used for the synthesis of As_2Se_3 and Ag_4SSe are Ag, S (4N-Fluka) and As, Se (5N-Fluka). CdTe produced by BALZERS with a purity "Coating material" is used. The characteristics of the syntheses (temperatures and the duration of the isothermal steps; the speed of heating between them) have been conformed by the physical and chemical features of the source components and the intermediary and final phases. The maximum temperature of the synthesis of the glasses within the investigated system is 950 ± 10 °C where, in the course of 2 hours a vibration agitation of the smelter is included. The last has been tempered at a temperature of 850 ± 10 °C and quenched in a mixture of water and ice with a cooling rate of 10–15 °C s^{-1}.

The density (d) of the samples have been measured by the hydrostatic method using toluene as immersion fluid and the microhardness (HV) – by the Vickers' method (a metallographic microscope MIM-7 with built in micro-hardnessmeter PMT-3 has been used at load of 20 g).

The elasticity module (E), the minimal volume of the micro-voids (V_h), the energy for their formation (E_h) and the compactness (C) were calculated by the Eqs. (1) – (2) [1]:

$$E = 15HV\ ,\ V_h = 5.04\frac{T_g}{HV}\ ,\ E_h = 30.729T_g \quad (1)$$

$$C = d\left\{\sum_{i=1}^{n}\frac{M_i x_i}{d_i} - \sum_{i=1}^{n}\frac{M_i x_i}{d}\right\}\left[\sum_{i=1}^{n} M_i x_i\right]^{-1} - 1 \quad (2)$$

where T_g is the temperature of glass transition and M_i and x_i are the molar weight and fraction of the i^{th} component, respectively.

3. RESULTS AND DISCUSSION

The microhardness of the glasses varies in the range 75–98 kgf/mm^2 and decreases with the increase of CdTe, as $HV_{Ag_4SSe} < HV_{CdTe} < HV_{As_2Se_3}$, respectively 24 [2], 60 [3] and 150 kgf/mm^2 [4] – Table 1. Despite the lower value of HV_{Ag_4SSe} with the increase of the Ag_4SSe content, the microhardness weakly increases. Most probably it is due to a congestion of the glasses' structure.

Table 1. Physical and thermomechanical properties of samples from the $(As_2Se_3)_x(Ag_4SSe)_y(CdTe)_z$ system.

Composition, mol %			m	HV, kgf/mm^2	d, g/cm^3	E, kgf/mm^2	E_h, kJ/mol	V_h, 10^{-3} Å^3	C
x	y	z							
90.25	4.75	5	0.05	75	4.86	1125	5070	11.09	-0.0087
85.5	9.5	5	0.1	98	4.94	1470	5070	8.49	-0.0161
76	19	5	0.2	98	5.15	1470	4179	6.99	-0.0211
85.5	4.5	10	0.05	77	4.91	1155	4456	9.49	-0.0055
81	9	10	0.1	95	5.00	1425	4333	7.48	-0.0103
76.5	8.5	15	0.1	94	5.06	1410	3718	6.49	-0.0050

The density of the glasses changes between 4.86 and 5.06 g/cm^3 and logically increases with the increase of the Ag_4SSe and CdTe content ($d_{As_2Se_3}$ = 4.75 g/cm^3 [5]; d_{Ag_4SSe} = 7.40 g/cm^3 [2]; d_{CdTe} = 6.20 g/cm^3 [5]) – Table 3.

The compactness of the investigated samples (Table 1) depends of the CdTe content (expressed by z at m=const), as well as of the proportion between As_2Se_3/Ag_4SSe (expressed by m = y/(x + y) at z = const).

The elasticity module (E) follows the course of HV and varies in the range 1125-1470 kgf/mm^2 and the energy for formation of micro-voids (E_h) is in the limits of 3718–5070 kJ/mol and repeats the course of T_g – Table 1.

The micro-voids volume (V_h) alters between $6.49.10^{-3}$ and $11.09.10^{-3}$ Å^3 (Table 3). V_h decreases with the increase of the Ag_4SSe content (z = const), as well as of the CdTe content (m = const).

The linear fragments of CdTe (–Cd–Te–) can build in the glass' network on two places: 1) tear the bonds between the trigonal pyramides $AsSe_{3/2}$ lying on one plane, build in between them and prolonging linearly the chains in one flat; 2) tear the bonds between the trigonal pyramids $AsSe_{3/2}$ lying on neighbor planes and build in between them. In both of the cases the micro-voids volume increases (mechanism I).

During the formation of the chalcogenide glass the Ag_4SSe decomposes on two linear fragments–S–Ag (–Se–Ag) and Ag–, which tear the network of the glass (in plane and between planes) and as a result the volume of micro-voids decreases (mechanism II).

When increasing the Ag_4SSe and CdTe content both of the mechanisms could be predominant. In the concrete case predominant is mechanism II (V_h decreases; C increases; HV and d increase). And in opposite, when increasing the As_2Se_3 content and decreasing the Ag_4SSe content, the mechanism I is determinative. When increasing the Ag_4SSe+CdTe content, with faster increase of CdTe, is possible to be predominant mechanism I.

4. CONCLUSIONS

Chalcogenide glasses from the As_2Se_3-Ag4SSe-CdTe system were synthesized.

A number of physicochemical (density, microhardness, compactness) and thermomechanical (elasticity module, micro-voids volume and energy for their formation) properties of the obtained glassy phases were studied. A correlation between these properties and the composition of the glasses from the investigated system was established and a method for its explanation has been proposed.

5. ACKNOWLEDGEMENTS

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Linear Calibration – Is It so Simple?

Diana Arsova[1], Sofia Babanova[1], Petko Mandjukov[1]
[1]Department of Chemistry, South-West University "Neofit Rilski", 66 Ivan Mihajlov Str., 2700 Blagoevgrad, Bulgaria

Abstract. *Calibration procedure is an important part of instrumental analysis. Usually it is not the major uncertainty source in whole analytical procedure. However, improper calibration might cause a significant bias of the analytical results from the real (certified) value. Standard Gaussian linear regression is the most frequently used mathematical approach for estimation of calibration function parameters. In the present article are discussed some not quite popular, but highly recommended in certain cases methods for parameter estimation, such as: weighted regression, orthogonal regression, robust regression, bracketing calibration etc. Some useful approximations are also presented. Special attention is paid to the statistical criteria which to be used for selection of proper calibration model.*

Standard UV-VIS spectrometric procedure for determination of phosphates in water was used as a practical example. Several different approaches for estimation of the contribution of calibration to the general uncertainty of the analytical result are presented and compared.

1. INTRODUCTION:

The analytical methods can be classified in two general groups: absolute and relative methods[1-3]. Most of the classical analytical methods (e.g. various gravimetric and volumetric methods) are absolute. They are based on simple measurement of quantity - mass of the sample or reagent volume and subsequent calculations based on fundamental relations. Most of the instrumental methods for analysis are relative. In such case the relation between analyte content and directly measured analytical signal is either complicate, or different from case to case, or dependent on factors which are impossible to control. Such methods required calibration. According to the official definition calibration is: "**Set of operations that establish under specified conditions the relationship between values of quantities indicated by the measuring instrument or measuring system, or values represented by a material measure or reference materials, and the corresponding values realized by standards.**"[4]. More simply said the calibration is a comparison between two quantities – analyte content and the analytical signal. The aim of this comparison is to evaluate parameters of empirical mathematical function, allowing estimation of the analyte content in unknown sample.

According to the temporary metrological requirements, all sources of uncertainty should be taken into account when the uncertainty of the final

analytical result is being estimated. Typical uncertainty sources for a relative method are presented graphically in Fig. 1.

Subject of the present work is the contribution of calibration procedure to the general uncertainty. Due to the complexity of the problem, only the simplest linear calibration model will be discussed.

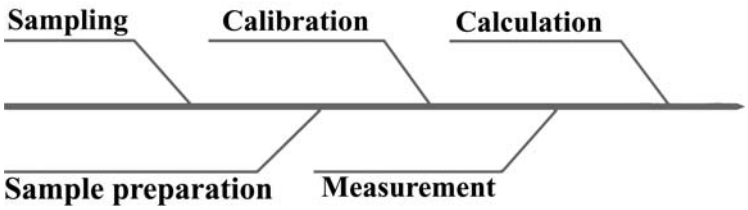

Fig. 1: “Fish bone” diagram presenting typical sources of uncertainty for relative analytical method.

2. USE AND ABUSE OF LINER REGRESSION

The most frequently used approach in calibration procedure is the well known linear (Gaussian) regression [5,6] using calibration function:

(1) $y = a_0 + a_1 x$

In most of the cases the response for concentration 0 is expected to be 0. Thus, the commonly used form of linear calibration function is:

(2) $y = a_1 x$

where: x is independent variable (analyte content), y is function of x (analytical signal).

Equation 2 should be used as a calibration model after proving the statistical insignificance of a_0.

Regression parameters a_0 and a_1 are evaluated using equations:

(3) $$a_1 = \frac{n\sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{n\sum_{i=1}^{n} x_i^{\,2} - \left(\sum_{i=1}^{n} x_i\right)^2}$$

(4) $$a_0 = \frac{\sum_{i=1}^{n} y_i - a_1 \sum_{i=1}^{n} x_i}{n}$$

Most popular and disputable characteristic of the quality of linear regression is the correlation coefficient R, calculated according to equation:

$$R = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i y_i}{\sqrt{\left[\sum_{i=1}^{n} x_i^{\,2} - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2\right]\left[\sum_{i=1}^{n} y_i - \frac{1}{n}\left(\sum_{i=1}^{n} y_i\right)^2\right]}} \tag{5}$$

However, this calibration approach implies fulfilling of number of requirements, which are not widely known and usually not tested (Fig. 2)[7-10]. Such detailed statistical analysis of the calibration function has to be done only during analytical method development and validation procedures. Once proved applicability of Gaussian regression, it can be applied in routine analysis without further tests. Alternative methods for linear calibration parameters calculation will be discussed in further.

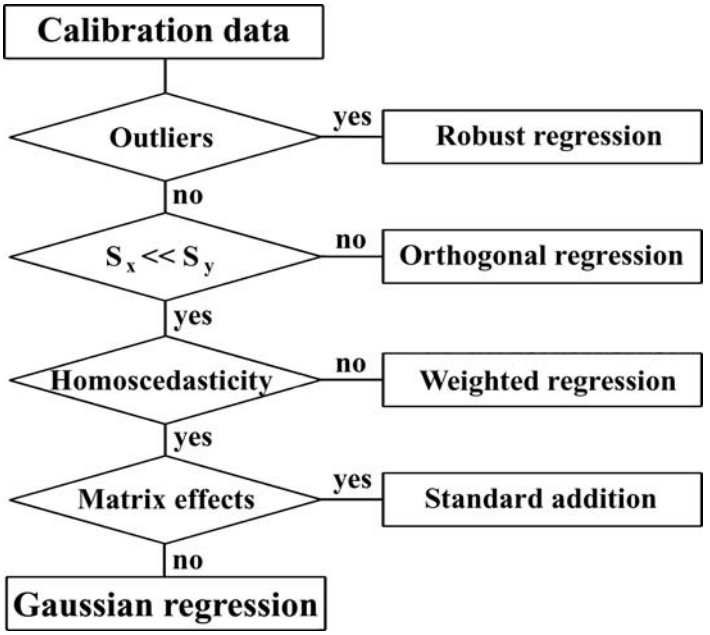

Fig. 2: Flow chart diagram presenting the requirements for proper application of standard linear regression procedure for calibration. Of course, all tests have to be done after proving linearity of the calibration function.

3. UNCERTAINTY ESTIMATION

Other unsolved problem remains the estimation of the uncertainty, introduced in the final result by the calibration procedure.

It should be noted that besides the regression procedure itself, the calibration standards preparation and measurements are also contributors to the uncertainty of calibration.

There are three different approximations most frequently to estimate calibration contribution to the uncertainty of the results.

4. APPROXIMATION 1 - GAUSSIAN STATISTICS.

This approach is based on suggestion that the only source of uncertainty is the spread of the experimental points around the calibration line.

Standard deviation of the regression (S_R) is a basic characteristic of the uncertainty introduced by the regression procedure. It might be estimated according to the equation:

$$S_R = \sqrt{\frac{\sum_{i=1}^{n}\left(y_i - \hat{y}_i\right)^2}{n-2}} \quad (6)$$

Where y_i are the measured analytical signals for standard solutions; $\hat{y}_i$ are the values calculated according to the calibration function for corresponding concentrations.

In case of good agreement between experimental points and calibration (regression) function the value of S_R is close to 0. The S_R value is essential for further steps in uncertainty estimation.

Uncertainty of the calibration procedure presented as standard deviation might be calculated according to equation:

$$S_x = \frac{S_R}{a_1}\sqrt{\frac{1}{m} + \frac{1}{n} + \frac{\left(y - y_{avg}\right)^2}{a_1{}^2 . \sum_{i=1}^{n}\left(x_i - x_{avg}\right)^2}} \quad (7)$$

Where: S_x is standard deviation of calculated concentration corresponding to analytical signal y; a_1 is the slope of the calibration line, y_{avg} and x_{avg} are the average values of analytical signals and concentrations of all calibration standards; x_i is the concentration of the standard i; n is number of standards and m is number of parallel measurements of the sample resulting the analytical signal y.

The confidence interval (Δx) of the obtained sample concentration, taking into account only S_x can be calculated using t-test of Student with

probability α; and degrees of freedom $\nu = n - c$ (n – number of standards; c- number of coefficients in the calibration equation):

(8) $$\Delta x = s_x t(\alpha; \nu)$$

The specified above confidence interval has a specific hyperbolic shape (Fig. 3, line 1) depending on the value of S_R and number of standards. It should be noted that the best, in terms of precision, is the middle part of working range.

5. APPROXIMATION 2 - SIMPLIFIED UNCERTAINTY PROPAGATION APPROACH

The standard deviation of the coefficient a_1 (S_{a_1}) can be calculated according to:

(9) $$S_{a_1} = S_R \sqrt{\frac{1}{\sum_{i=1}^{n} x_i^{\,2} - \left(\sum_{i=1}^{n} x_i\right)^2 / n}}$$

The uncertainty of sample concentration, presented in form of standard deviation, is calculated according to the uncertainty propagation law [1-3] using equation:

(10) $$S_x = x \sqrt{\left(\frac{S_y}{y}\right)^2 + \left(\frac{Sa_1}{a_1}\right)^2}$$

This equation corresponds to one coefficient calibration model (Eq. 2).

6. APPROXIMATION 3 - BRACKETING CALIBRATION APPROXIMATION

Bracketing itself is a simplified calibration method. The concentration of the sample is calculated according to Eq. 1 with slope and intercept estimated using only two closes neighbor standards. This method is especially useful when the analyte contents in many samples vary in a narrow concentration range. It is also applicable as approximation in case of complex nonlinear relation between concentration and analytical signal. Calibration using two standards makes easier application of the uncertainty propagation law and thus, to take into account the uncertainties of concentrations and

analytical signals for standards. Analyte concentration in the sample is calculated according to the equation:

$$x = x_{low} + \left(y - y_{low}\right)\frac{\left(x_{high} - x_{low}\right)}{\left(y_{high} - y_{low}\right)} \quad (11)$$

Where: x_{low} , y_{low} and x_{high} , y_{high} are the corresponding concentrations , analytical signals for the lower and higher standards.

4. Comparison between uncertainty estimation models

The comparison is based on standard UV-VIS method for determination of phosphates in water [11].

7. ANALYTICAL PROCEDURE

The method is based on a reaction of orthophosphate ions with acidified solution containing molibdate and antimony ions, forming an antimony phosphomolibdate complex. After reaction with ascorbic acid a blue colored molybdenum complex is formed. The quantification is carried out using spectrophotometer at wavelength 880 nm.

Six standard solutions are used for calibration covering concentration range from 0.05 to 2.50 mg/l calculated as phosphorus content. The uncertainty of concentration was calculated using uncertainty propagation law and precision data for the primary standard solution and all volumetric devices used. Uncertainties of analytical signals were estimated from six independent parallel measurements of each standard. Results are presented in Table 1.

In order to compare the different approaches, the calibration uncertainty was estimated for virtual samples covering the working range from absorbance 0.01 to 0.12 with increment 0.01. Uncertainty of absorbance was suggested as equal to 0.0004 (the average of corresponding values for measured standards). Results are presented in Figure 3.

The Approximation 1 shows quite even uncertainty distribution along the working range. Most probably the calculated values are underestimated since uncertainty of analytical signals and concentrations of the standards are not taken into account. On the other hand, this is the only approach demonstrating the typical for regression hyperbolic distribution of the uncertainty. This approach seems to be the best for cases with very good linearity (low value of S_r) and low values of concentration and analytical signal uncertainties for all standards.

Table 1: Concentrations, absorbance and corresponding uncertainties for 6 standard solutions used for calibration.

	Concentration / mg/l P (x_i)	*Uncertainty* (S_{x_i})	*Absorbance* (y_i)	*Uncertainty* (S_{y_i})
Standard 1	*0,05*	*0,01*	*0,0057*	*0,0004*
Standard 2	*0,12*	*0,02*	*0,0256*	*0,0003*
Standard 3	*0,25*	*0,04*	*0,0537*	*0,0005*
Standard 4	*0,50*	*0,06*	*0,1050*	*0,0002*
Standard 5	*1.00*	*0,08*	*0,2218*	*0,0008*
Standard 6	*2,50*	*0,10*	*0,4526*	*0,0005*

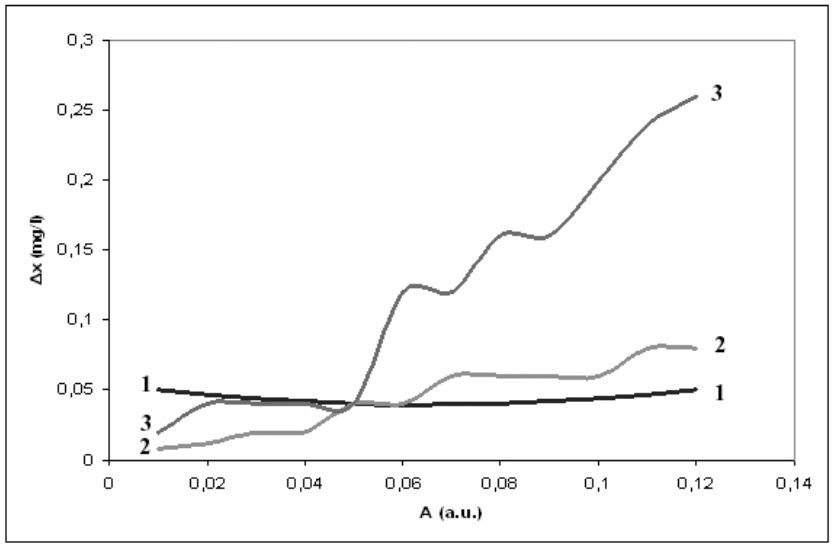

Fig. 3: Uncertainty of calibration, presented as a half width of the confidence interval, estimated using three different approaches:

1 - Approximation 1 – according to Equation 7.

2 - Approximation 2 – according to Equation 10.

3 - Approximation 3 – step by step uncertainty propagation approach for the uncertainty of x calculated by Equation 11.

In case of Approximations 2 and 3 there is a clear underestimation of the uncertainty in the lower part of the working range. The trend for increasing the width of the confidence interval wit increasing of concentration is also very clear. Approximation 3 shows inadequately high uncertainty values in the higher concentration/signal range of the calibration graphics. This

is also the approach which is most sensitive to any fluctuations in the standards because only two of the standards are used in calculations.

In order to achieve most precise uncertainty estimation is necessary to modify the Approximation 1 in order to implement in the model the uncertainties of concentrations and analytical signals of calibration standards. This will be a subject of further works.

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Synthesis and Antienteroviral Activity of Cinnamoyl and Hydroxicinnamoyl Amides

Lubomira Nikolaeva-Glomb[1], Maya Spasova[2], Angel Galbov[1], Tsenka Milkova[2]

[1]The Stephan Angeloff Institute of Microbiology, Bulgarian Academy of Sciences
[2]South-West University "Neofit Rilski"

1. INTRODUCTION

At present some 40 antiviral drugs have been licensed for use in humans, mostly for the treatment of infections with the immunodeficiency virus (HIV), hepatitis B virus (HBV), herpesviruses and influenza. Unfortunately, human enteroviruses comprising more than 200 medically important viruses in the family of picornaviruses, are not in the list. Despite the fact that enteroviruses are widely spread human pathogens associated with diverse morbidity, up to date there is no enterovirus-specific drug available. The need for development of new compounds which would be active against the replication of the numerous members of the enterovirus genus still exists. Natural products have inspired many research initiatives in organic chemistry leading to advances in synthetic methodologies and to the possibility of making analogues with improved properties. The beneficial effects of phenolic phytochemicals are long known and lay in the basis of many complementary and alternative medicinal prescriptions. Cinnamic acid derivatives exert a well documented antiviral [1, 2, 3], antimicrobial [4], antitumour [5], antioxidant [6] and anti-inflammatory [7] effects. The esters and amides of cinnamic acids are no exception. While cinnamoyl esters are abundant in the plant kingdom, cinnamoyl amides are more rarely found. Nevertheless N-substituted cinnamoyl amides are isolated form higher plants in different forms. The amides are considered to be protective agents against viral or other infections and against intoxication with ions of heavy metals. If compared to the ester group the amide group in either natural or synthetic cinnamoyl amides possesses a greater metabolic stability [8], which is an advantage from a pharmacological point of view. That is why there is an increased interest in the bio-medical properties of such compounds. The design of new cinnamoyl derivatives based on the presence of a stable amide group may be expected to result in compounds with better biomedical properties. The antiviral activity of cinnamoyl esters against the replication of picornaviruses in particular is a well proved fact [1, 2]. Relatively scarce data is available concerning the antiviral activity of cinnamoyl amides.

Aporphine alkaloids, on the other hand, also possess a wide variety of beneficial activities. Glaucine, the main alkaloid isolated from *Glaucium flavum* Crantz (yellow horn poppy) is an important representative of this group of compounds. Recently, the antienteroviral effect of glaucine and especially of its derivative oxoglaucine has been established [13]. Coupling cinnamoyl and glaucine moieties could be expected to result in an enhanced antiviral activity.

In this paper the synthesis and the antiviral effects against the enterovirus replication of cinnamoyl- and hydroxycinnamoyl amides of natural and fluorated aromatic amino acids, amides of substituted cinnamic acids with aliphatic monoamines, as well as cinnamoyl- and hydroxycinnamoyl amides of glaucine are described.

2. MATERIALS AND METHODS

Compounds

The new compounds were dissolved in ethanol to a concentration of 20 mM and kept as a stock solution at -20^{0}C. Stock solutions were *ex tempore* diluted to the necessary concentrations in the maintenance medium.

Cells and viruses

Poliovirus type 1 (LSc-2ab) (PV-1), coxsackievirus B1 (CV–B1) and echovirus 13 (EV-13) were grown in FL cells. Human rhinovirus 14 (HRV-14) was grown in HeLa Ohio-1 cells. PV-1, CV-B1 and EV-13 were grown at 37^{0}C and HRV-14 was grown at 33^{0}C.

Cytotoxicity test

Cells were seeded in 96-well plates. After formation of the cell monolayer, growth medium was discarded and 0.2 mL containing 0.5 lg concentrations of the tested compounds diluted in a maintenance medium was added, followed by further incubation of cells and monitoring the microscopic cytotoxic effect after 24 and 48 hours. The highest concentration, at which no visible cytotoxic effect had been recorded, was considered as the maximal tolerated concentration (MTC). After the microscopic evaluation cells underwent the neutral red uptake procedure and the 50% cytotoxic concentration (CC_{50}) was determined by regression analysis.

Cytopathic effect (CPE) inhibition test

Monolayer cells in 96-well plates were inoculated with 0.1 mL virus suspension containing 100 $CCID_{50}$. After an hour for virus adsorption (2 hours in the case of HRV-14), excessive virus was discarded and cells were inoculated with 0.2 ml of maintenance medium containing serial 0.5 lg dilutions of non-toxic concentrations of the compounds tested. The virus CPE was scored daily till the appearance of its maximum in the virus control wells (no compound in the maintenance medium). Then cells underwent the neutral red uptake procedure and the percentage of CPE inhibition was calculated by the following formula: $\%CPE = (OD_{test\ sample} - OD_{virus\ control})/(OD_{toxicity}$

$_{control}$ – $OD_{virus\ control}$). The concentration of the tested compound which inhibited 50% of the virus induced CPE was defined as the 50% inhibitory concentration (IC_{50}). The selectivity index was expressed as the ratio between CC_{50} and IC_{50} ($SI = CC_{50}/IC_{50}$). In the cases when IC_{50} could not be determined but nevertheless a minor inhibitory effect was observed, the antiviral activity was expressed as percentage of the inhibition of the virus CPE.

3. RESULTS AND DISCUSSION

The antiviral effects of all novel compounds were tested against two very important representatives of the enterovirus genus of the family of picornaviruses – PV-1 and CV-B1. Some of the compounds were additionally tested against two other enteroviruses – EV-13 and HRV-14. Results for the antiviral effects and the selectivity indices of the most promising newly synthesized compounds are presented on Table 1.

3.1. Antiviral effect of cinnamoyl- and hydroxycinnamoyl amides of fluorated aromatic amino acids.

N-substituted cinnamoyl-, feruloyl-, sinapoyl- and o- and p-coumaroyl amides of 3-fluorophenylalanine, 3-flurotyrosine and 6-fluorotryptopahan had been synthesized and tested for their antienteroviral activity against the replication of PV-1 and CV-B1. The newly synthesized cinnamic acid amides of fluorated amino acids revealed rather weak antiviral effect against the replication of both viruses, observed only at the maximal tolerated concentrations (MTCs) (data not shown).

3.2. Antiviral effects of cinnamoyl- and hydroxycinnamoyl amides of aliphatic monoamines.

N-substituted buthyl, hexyl or heptyl cinnamoyl, feruloyl and sinapoyl amides have been synthesized and tested for their antienteroviral effects. In general, the activity of the new cinnamoylamides of aliphatic monoamines against the replication of PV-1 (LSc-2ab) and CV-B1 is very weak. Only N-buthylcinnamoylamide could be considered as an exception. The compound inhibited the replication of PV-1 and the 50% inhibitory concentration (IC_{50}) was determined to be 86 μM. CV-B1 was inhibited to a lesser extent and the inhibitory effect was revealed only at MTC.

3.3. Antiviral effects of cinnamoyl- and hydroxycinnamoyl amides of amino acids.

The newly synthesized cinnamoylamides of amino acids possessed higher antienteroviral activity in comparison to the cinnamoylamides of aliphatic monoamines. PV-1 was more sensitive to the antiviral effect of the new compounds than CV-B1. The cinnamoyl amides of amino acids were endowed with though slight antiviral effect in contrast to the sinapoyl amides. The greatest attention deserved N-cinnamoyl-valine methyl ester. In

an experimental set-up which allowed the estimation of the effect against several different virus doses, IC_{50} against the replication of PV-1 was determined to be 70 μM and 276 μM against CV-B1. The greater sensitivity of PV-1 is noticeable. Having determined the 50% cytotoxic concentration for FL cells a selectivity ratio above 7 is established in the case of PV-1.

3.4. Antiviral effects of cinnamoyl- and hydroxycinnamoyl amides of glaucine.

The absence of an appropriate functional group in the molecule of glaucine for accomplishing linkage with cinnamic acids imposed the introduction of an amino group. The low reactivity of 3-aminoglaucine necessitated the synthesis of the more reactive 3-methylglaucine.

Tab. 1. Antienteroviral activity of the newly synthesized amides.

Compound	PV-1 (LSc-2ab)			CV-B1			EV-13			HRV-14		
	IC_{50}[a]	%[b]	SI[c]	IC_{50}	%	SI	IC_{50}	%	SI	IC_{50}	%	SI
N-buthyl-cinnamoyl-amide	86	n.a.[e]	**>4**	n.a.	>25	n.a.	n.d.[d]	n.a.	n.a.	n.d.	n.d.	-
N-cinnamoyl-valine methyl ester	70	n.a.	**8.2**	276	n.a.	**2**	n.d.[d]	n.a.	n.a.	n.d.	n.d.	-
Feruloylamide of 3-aminomethyl-glaucine	n.a.	0	n.a.	n.a.	0	n.a.	n.a.	≤25	n.a.	12	n.a.	**9.4**
Sinapoylamide of 3-aminomethyl-glaucine	n.a.	0	n.a.	n.a.	0	n.a.	n.a.	0	n.a.	28	n.a.	**4.5**
o-coumaroylamide of of 3-aminomethyl-glaucine	n.a.	≤25	n.a.	n.a.	0	n.a.	n.a.	0	n.a.	15	n.a.	**10.3**
p-coumaroylamide of of 3-aminomethyl-glaucine	n.a.	<50	n.a.	n.a.	0	n.a.	32	n.a.	5	13	n.a.	**11**
Oxoglaucine	1.2	n.a.	43.3	2.5	n.a.	21	0.5	n.a.	104	0.3	n.a.	170
Disoxaril	2	n.a.	12.5	2	n.a.	12.5	1.3	n.a.	19	1.5	n.a.	14

[a]50% inhibitory concentration values are expressed in μM and represent the mean values in two different experiments with 4 replicates in each experiment.
[b]Percentage of viral cytopathic inhibition as compared to the untreated virus control.
[c]$SI = CC_{50}/IC_{50}$
[d]n.d. – not done
[e]n.a. – not applicable

The latter was linked to ferulic, sinapic and o- and p-coumaric acids. The four newly synthesized amides were tested for their antienteroviral effects against PV-1, CV-B1, EV-13 and HRV-14. All new compounds demonstrated the highest antiviral activity against the replication of HRV-14. The best antirhinoviral effect was manifested by both o- and p-coumaroyl amides revealing a selectivity ratio above 10. Moderate antiviral activity against the replication of EV-13 was demonstrated by p-coumaroyl amide with a selec-

tivity index 5. The MTC of the compound (100 μM) had some minor effect against the replication of PV-1. CV-B1 was relatively resistant to the antiviral effect of p-coumaroyl amide. Minor inhibitory effect against PV-1 was detected also for o-coumaroyl amide. CV-B1 was insensitive to the activity of all the new amides from this group.

Nevertheless that none of the newly synthesized compounds exceeded in its antiviral activity the effects of the positive drug controls, several of the new cinnamoyl- and hydroxycinnamoyl amides revealed moderate antienteroviral effects. Given the promise of these results further directed synthesis of new compounds of this class with optimized chemotherapeutic characteristics is worth continuing.

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New Routes to Anthrapyrane Antibiotics

Hoang Trang Tran-Thien and Karsten Krohn

University of Paderborn, Warburger Straße 100, 33098 Paderborn

***Abstract**: The 4-H-anthra[1,2-b]pyranes are well known for their antibacterial and antitumoral activity. Their chemistry, biochemistry and biological activity was extensively reviewed. In most cases, the angulary condensed benzo[a]anthraquinone skeleton was constructed by a Diels-Alder reaction. It is anticipated that a series of Claisen condensations give molecules with β-polyketone functionalities (polyketides), whose intramolecular condensation and enolization generate aromatic nuclei such as naphthalenes, anthracenes, benz[a]-anthracene and anthrapyranes. Therefore we used the methodology of Yamaguchi to construct anthraquinones with ester functions in the side chain.*

***Keywords:** Total synthesis, Anthrapyrane antibiotics, y-Indomycinon, Baker-Venkataraman rearrangement, biomimetic dianion reactions.*

1. INTRODUCTION

γ-Indomycinon [1] is a member of the large family of anthrapyran antibiotics which mostly occur as the C-glycosides such as the pluramycines, hedamycines, riboflavines, altromycines and indomycines.[2, 3] These antibiotics found renewed interest in structural biology [4] due to their selective binding to DNA and their specific alkylation of guanine. [5, 6] In addition to the C-glycosides, a number of aglycones with the anthra[*b*]pyran skeleton are also found in nature. Some of these have a C-6 side chain at C-2 such as β-indomycinone(1)[7] and δ-indomycinone (2)[7,8] or or a C-4 side chain, exemplified by γ-indomycinone (3),[1] kidamycinone(4),[9] the antihepatitic antibiotic AH-1763 IIa (5),[10] and the neuroprotective espicufolin (6)[11] (Figure 1). The remarkable biological properties of some derivatives have aroused great interest, which recently resulted in several syntheses including those of premithramycinone,[12] espicufolin,[13,14] altromycinone and kidamycinone,[15] and AH-1763 IIa.[16] The recent publication of the synthesis of *ent*-γ-indomycinone by Tietze et al.[17] prompted us to disclose our alternative synthesis of rac-**3**. In the syntheses published to date, the construction of the appropriately substituted skeleton and the attachment of the C-2 side chain have found different solutions. Diels-Alder reactions[13,14, 16, 17] or biomimetic-type dianion condensations[12,15] were mainly used for the construction of the anthra[*b*]pyran skeleton. Carbanion methodology, not possible at the anthraquinone level, was often employed on naphthalene derivatives for the attachment of the side chains.[13-17] Alternatively, in our approach, we used an acyl transfer of the Baker-Venkataraman-type for chain elongation to

avoid the reduction and/ or oxidation steps connected with the organometallic reactions on the anthraquinone skeleton.[12,18]

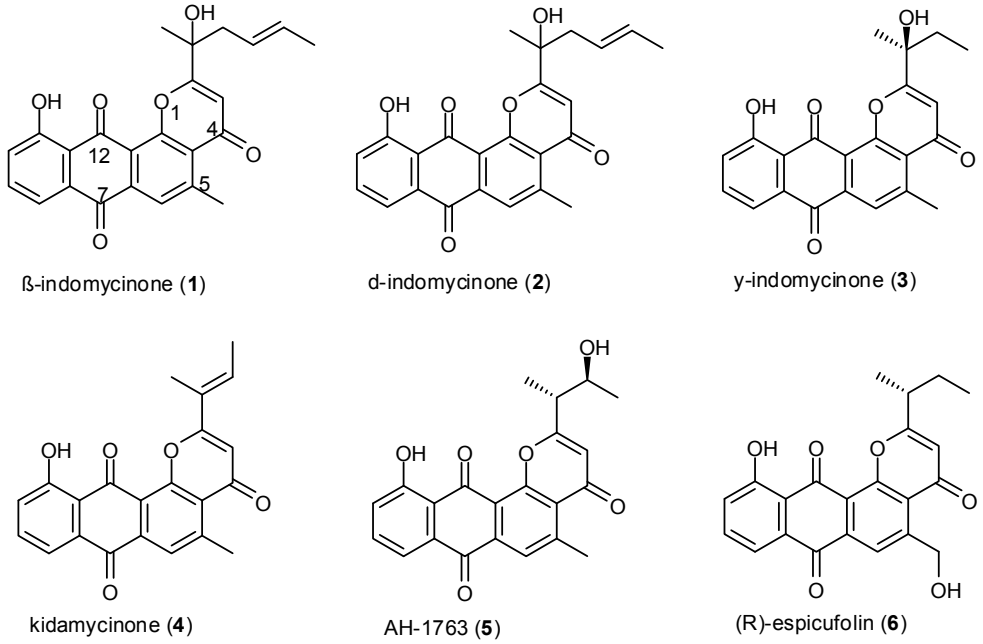

Fig. 1Representative anthrapyranone antibiotics with C-6 or C-4 side chains.

2. SYNTHESES OF THE SUBSTRATES

The total synthesis of racemic γ-indomycinone (*rac*-**3**) was achieved by Baker-Venkataraman rearrangement of ester 11 to the diketone 12, acid-catalyzed cyclization to the anthrapyranone 13, followed by methyl ether cleavage and acetylation to 16, selective bromination of the branched side chain with simultaneous S_N1-type hydroxyl substitution to 23 and transesterification to *rac*-**3**. The corresponding γ-indomycinone 11-methyl ether (*rac*-**20**) was prepared in asimilar reaction sequence.

3. RESULTS AND DISCUSSION

The synthesis of *rac*- γ-indomycinone started from the known 2-acetyl-1-hydroxy derivative 7, prepared in a biomimetic-type dianion reaction during the synthesis of aklanonic acid.[19] The first task was the saponification of the *tert*-butyl ester **7** in trifluoroacetic acid, followed by decarboxylation in dried DMF solutions to obtain the methyl group at C-5 as present in γ-indomycinone (**3**). The poor nucleophilicity of the strongly chelated phenolic hydroxyl group at C-1 in **9** in the esterification with the racemic a-branched acyl chloride 10 was overcome by addition of 4-(dimethylamino)pyridine (DMAP) to afford the ester 11 in 95% yield. The key step was the subse-

quent Baker-Venkataraman rearrangement induced by heating of the ester **11** under reflux with lithium hydride to afford the anthraquinone **12** with a branched β–diketo side chain in 97% yield. Simple solution in trifluoroacetic acid induced the transformation and the 2’-deoxy- γ-indomycinone methylester **13** was isolated in 75% yield. At this point, we wanted to test the cleavage of the methyl ether at C-11. Interestingly, using boron tribromide, the bromination product **15** (56%) was isolated in addition to the expected phenol **14** (34%). Acetylation of the phenol **14** afforded the acetate **16** in 95% yield, providing another molecule in addition to **13** for subsequent bromination experiments. A key feature of our synthesis was the exploiation of selective bromination of the side chains of 13 to introduce the missing hydroxyl groups. We expected that the tertiary position of the branched side chain at C-2’ would be attacked more rapidly than the C-5 methyl group. In fact, this assumption turned out to be true, in agreement with theory.

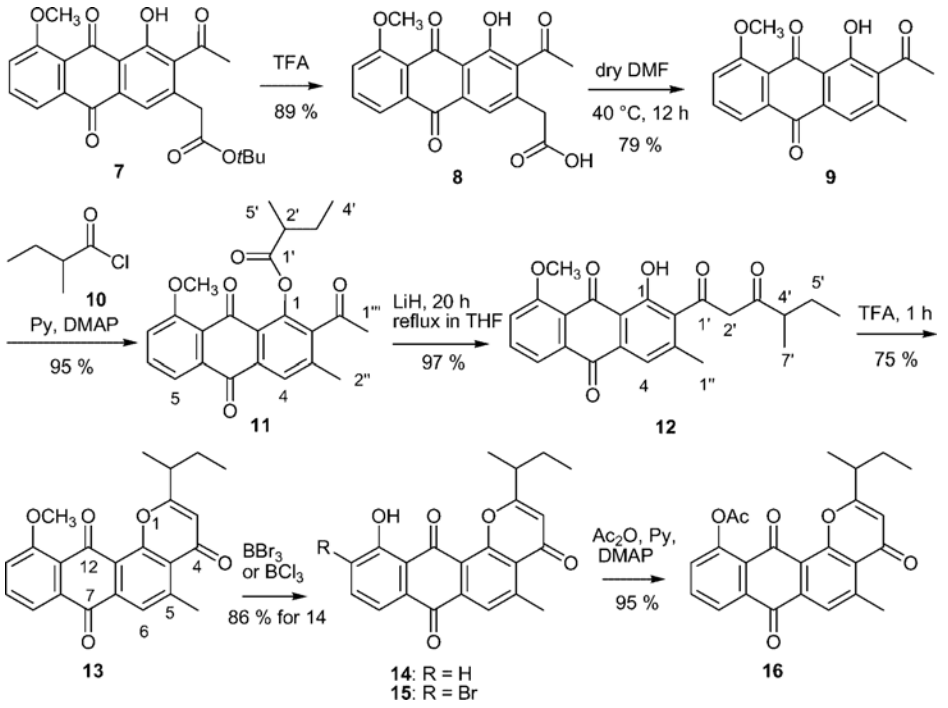

Fig. 2 Synthesis of the basic anthrapyranone skeletons **13**-**16** by Baker-Venkataraman rearrangement of **12**.

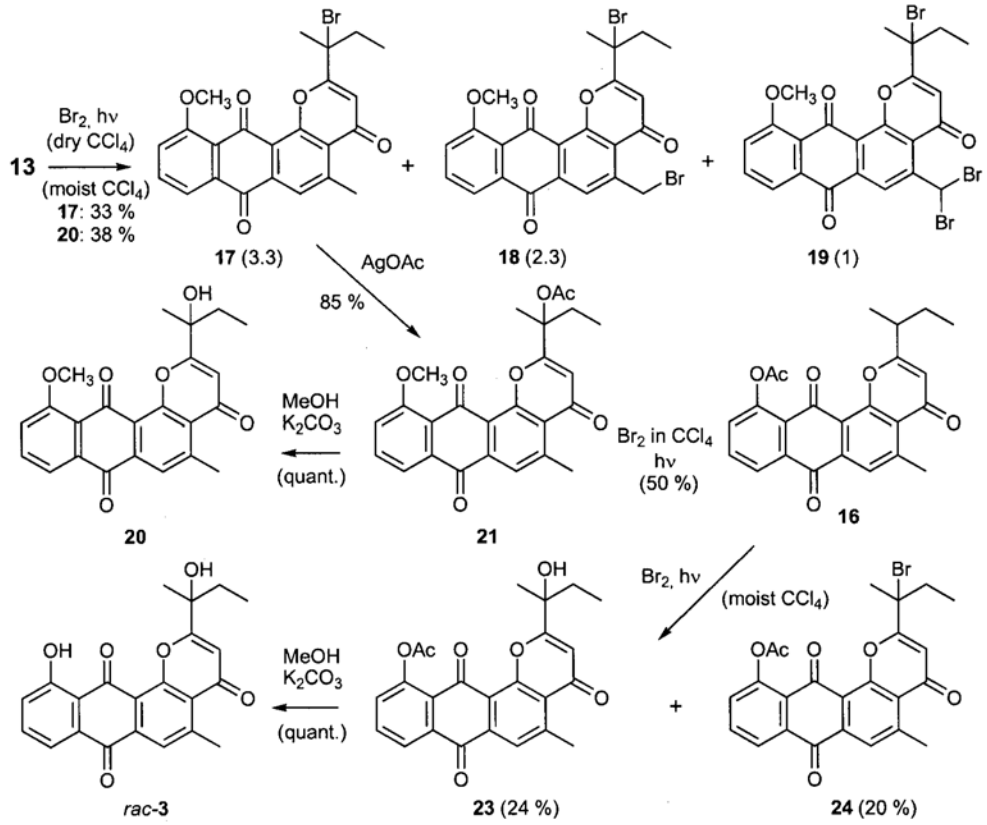

Fig. 3 Synthesis of *rac*-**20** and the natural product *rac*-**3** by transesterification in basic methanol of **21** and **23**.

We tried two different conditions for the bromination reactions. In the first experiments, rigorously dried terachloromethane and a sixfold excess of bromine was used in the light induced bromination. After consumption of the starting material, an approximate 3.3:2.3:1 ratio (45, 32, and 13% yield) of the monobromide **17**, the dibromide **18**, and the tribromide **19** was isolated (Fig. 3). In the second series of experiments, moist tetrachloromethane was used as a solvent, only a twofold excess of bromine was used, and the irradiation time was limited to ca. 90% of starting material conversion. Under these conditions, in addition to the expected monobromination product **17**, the γ-indomycinone methyl ether (**20**) was simultaneously formed (38%). An alternative exchange of the bromine atom in the monobromine **17** was realized by the two step procedure via the acetate **21**, formed by treating bromide **17** with silver acetate in DMF (85%)., followed by transesterification with basic methanol to yield γ-indomycinone methyl ether (**15**) quantitatively. Having established a route to the *rac*-γ-indomycinone methyl ether (**20**), the

final task was the methyl ether cleavage in **20** to yield the natural product *rac*-**3**.

In summary, using Yamaguchi-dianion reaction, Baker-Venkataraman rearrangement and radical bromination we have shown total synthesis of *rac*-γ-indomycinone in 19 steps.

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Spectroscopic and structural elucidation of codeinium violurate monohydrate

R. Bakalska[1], T. Kolev

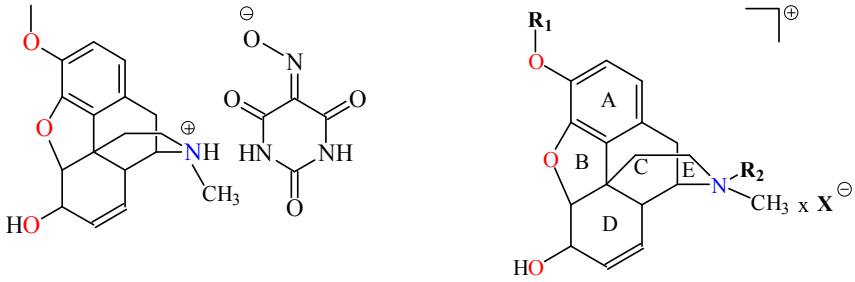
[1]University of Plovdiv "P. Hilendarski", Department of Organic Chemistry, Plovdiv 4000, Bulgaria

Abstract: *The structure and spectroscopic properties of codeinium violurate monohydrate (**1**) were studied, using methods of linear-polarized infrared (IR-LD) spectroscopy of oriented as suspension in nematic liquid crystal and UV-VIS spectroscopy, HPLC tandem mass spectrometry and thermal methods. Data obtained are compared with results of other codeine derivatives, where the absolute structures have been elucidated crystallographically.*

Keywords: *codeinium violurate monohydrate, UV- and IR-LD spectroscopy.*

1. INTRODUCTION

As a part of our systematic study of derivatives of codeine [1-4], we are presented the structural and spectroscopic elucidation of codeinium violurate (**1**), depicted in Scheme 1, using linear-polariz[1]ation IR-(IR-LD) spectroscopy of oriented colloids in nematic host, UV-spectroscopy, HPLC tandem mass spectrometry (HPLC ESI MS/MS) and thermal methods. The correlation structure-spectroscopic properties is elucidated comparing the spectroscopic data with the experimental crystallographic ones of other derivatives of codeine [5-14]. The structural investigations of codeine derivates are rare and every examination giving that kind of information is reasonable.



(**1**)

Scheme 1. Chemical diagram of (**1**)

[1] Corresponding author: Tel.: +032 261 348, E-mail: bakalska@uni-plovdiv.bg

2. EXPERIMENTAL

Synthese

To a solution of 1.0 g (3,3 mmol) of codeine in 6 ml water was added 5 ml violuric acid (0.3500 g (3.3 mmol) under continuously stirring at 40°C. The obtained violet solution was remaining 2 weeks at room temperature in the dark. The solvent was evaporated and the rest precipitate was filtered off, washed with methanol and dried on air. ($C_{22}H_{26}N_4O_7$ found: C, 55.71; H, 5.55; N, 11.84; calcd.: C, 55.69; H, 5.52; N, 11.81. The most intensive signal in the mass spectra of (**1**) is the peak at m/z 300.81, corresponding to the singly charged $[C_{18}H_{22}NO_3]^+$ ion with the as *m/z* value of 300.38. The thermal analysis of (**1**) in 200 – 500°C temperature range show a weight loss at 128°C, of 2.81 % corresponding to one water molecule included in (**1**). The enthalpy effect of 6.32 sack/mol is obtained.

3. MATERIALS AND METHODS

Conventional and polarized IR-spectra were measured on a Thermo Nicolet 6700 FTIR-spectrometer (4000 – 400 cm^{-1}, 2 cm^{-1} resolution, 200 scans) equipped with a Specac wire-grid polarizer. Non-polarized solid-state IR spectra were recorded using the KBr disk technique. The oriented samples were obtained as a colloid suspension in a nematic liquid crystal ZLI 1695. The theoretical approach, experimental technique for preparing the samples, procedures for polarized IR-spectra interpretation and the validation of this new linear-dichroic infrared (IR-LD) orientation solid-state method for accuracy and precision has been presented [15-18]. The *positive and negative ESI mass* spectra were recorded on a Fisons VG Autospec instrument employing 3-nitrobenzylalcohol (Sigma-Aldrich) as the matrix. *Ultraviolet (UV-) spectra* were recorded on Tecan Safire Absorbance/ Fluorescence XFluor 4 V 4.40 spectrophotometer operating between 190 and 900 nm, using solvent acetonitrile (Uvasol, Merck product) in concentration of $2.5.10^{-5}$ M, using 0.0921 cm quarz cells. The thermal analyses were performed in the 200 – 500°C region on a Differential Scanning Calorimeter Perkin-Elmer DSC-7, and a Differential Thermal Analyzer DTA/TG (Seiko Instrument, model TG/DTA 300). The experiments were carried out with scanning rate of 10K/min under an argon atmosphere. The *elemental analysis* was carried out according to the standard procedures for C and H (as CO_2, and H_2O) and N (by the Dumas method).

4. RESULTS AND DISCUSSION

The UV-spectrum of (**1**) in methanol, depicted in Fig. 1 is characterized with bands at 235 nm (= 10100 $l.mol^{-1}.cm^{-1}$), belonging to transitions of the aromatic fragment in the molecule. The observed violet colour of the (1) in solution and in solid-state is explain with the band at 551 nm (= 988 $l.mol^{-1}.cm^{-1}$), corresponding to n→* transition in the O=N- of the violurate

fragment, formed as a result of deprotonation of the acid and formation of the codeinium cation. These data are similar to other reported salts of violuric acid [19].

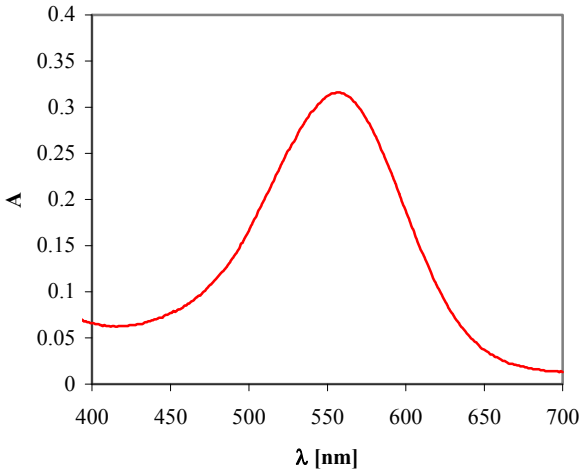


*Fig. 1. UV-spectrum of (**1**) in methanol*

The compound (**1**) is characterized with the underlined degree f macro-orientation of suspended particles [15-18] (Fig. 2), thus allowing a precise interpretation of the corresponding polarized IR-LD spectra. The IR-spectrum of (**1**) is characterized with an intensive doublet of bands at 3536 and 3485 cm^{-1} belonging to absorption maxima of the stretching vibration ($\nu_{(OH)}$) of the included solvent water molecule and the OH group of codeinium cation (Fig.2). The $\nu_{C=C}$ and 8a vibration is observed at 1614 cm^{-1}. The typical for other derivatives IR-bands about 1500 cm^{-1} (19a in-plane (A_1) phenyl modes) in the case of (**1**) is low intensive and practically undefinitived. To $\nu_{C=C}$ can be assigned the maximum at 1624 cm^{-1}

In the 1200 – 800 cm^{-1} region a series of in-plane peaks of 1,2,3,4-o-tetrasubstituted benzene about 1150 cm^{-1} and 1050 cm^{-1} are observed. Below than 1000 cm^{-1} intensive maxima at 783 and 756 cm^{-1} are observed, assigning to 17b and 11-ν_{CH} out-of-plane (o.p.) modes of aromatic fragment. A direct evidence of this assumption follows by the obtained the elimination of these maxima at equal dichroic ratio in corresponding polarized IR-LD spectra (Fig. 3). The discussed reduction leads to an appearance of the maxima for other different disposed molecules in the unit cell of (**1**). This phenomenon can be illustrated using the reduced IR-spectrum in Fig.3, where the elimination of the band of o.p. bending vibration at 756 cm^{-1} in the “inflex point” (Fig.2.2) is previously investigated [18] and confirmed of the

Davydov splitting effect as a result of the presence of different oriented molecules in the unit cell. As for example case of codeine-N-methyl iodide [4], crystallizing in orthorhombic space system and noncentrosymmetric $P2_12_12_1$ space group [4]. Unfortunately the polycrystalline character of the sample obtained from different solvents difficult the obtaining of the absolute structure of (**1**) by single crystal X-ray diffraction. Intensive IR-characteristic bands of the anion anionic violuric acid are at 1710 cm^{-1} and 1688 cm^{-1}, with the combination $\nu_{C=O}$ + ν_{N-H} vibrations [19].

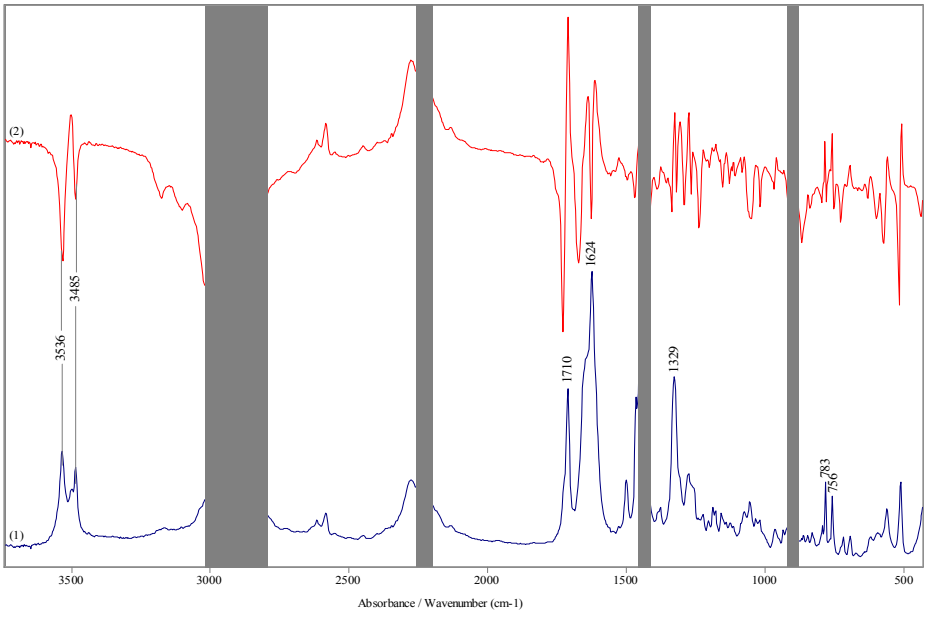


Fig.2. Non-polarized IR- (1) and difference IR-LD (2) spectra of (**1**) in nematic host; the self-absorption of the orientation medium is presented by gray rectangles

5. CONCLUSIONS

The correlation structure/spectroscopic properties of novel derivative of codeine, *i.e.* codeinium violurate monohydrate is elucidated by means of linear-polarized infrared spectroscopy of oriented as suspension in nematic host, UV-VIS spectroscopy, HPLC ESI MS/MS and thermal methods. The obtained data are compared with analogous one of other codeine derivatives, where the absolute structures have been elucidated by single crystal X-ray diffraction. Underlined Davydov resonance effect is observed in the solid-state IR-spectra. The phenomena are proved by polarization IR-spectroscopy, as far as the polycrystalline character of the sample avoid using an absolute method for determination of the structure.

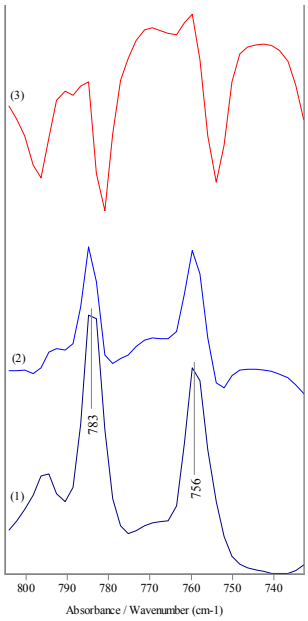


Fig.3. Non-polarized IR- (1) and reduced IR-LD spectra of (**1**) after consequently elimination of the sub-maxima (2) and (3) at the bands at 783 cm^{-1} and 756 cm^{-1}.

ACKNOWLEDGEMENTS

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QSAR Investigation on the Activity of Papain against Substrate Analogues

Georgi Hristov[1], Zhivko Velkov[1], Mikhail Kolev[2]

[1]Department of Chemistry, South-West University, Blagoevgrad, Bulgaria
[2]Department of Mathematics, South-West University, Blagoevgrad, Bulgaria

***Abstract**: Using the AM1 semiempirical quantum-chemical method some 3D and 2D descriptors were calculated for two series of papain substrate analogues - N-mesylglycine phenyl esters and N-benzoylglycine phenyl esters. Calculated energy of LUMO and the 2D parameter lipophilicity, log P, correlate well with the affinity of the compounds to the active site of the papain expressed by the logarithm of reciprocal values of Michaelis-Menten constants (Km).*

***Keywords:** quantum-chemical methods, LUMO, log P, QSAR, papain.*

1. INTRODUCTION

The construction of receptor/ligand interaction models is an actual challenge of the theoretical chemistry. The usage of computers with higher and higher computational resources allows fast improvement of quantum-chemical methods to be used for this purpose that increases substantially the reliability of the obtained results. The usefulness of the results obtained by the latter methods can be evaluated via their comparison with experimentally obtained data, for the affinity of ligands to receptors. The most convenient models for the investigation of the ligand/receptor interactions are those arised between enzymes and substrates (or inhibitors). Of important convenience in the process of study of ligand/receptor interactions is the fact that such kinetically measureable characteristic as the Michaelis constant shows directly the affinity of a given substance (substrate or substrate analogue) to the enzyme center.

Over the last years there are a lot of QSAR investigations using numerical kinetic descriptors of the ligands/enzymes interactions, obtained via quantum-chemical modeling. Usually a series of substrate analogues of a given enzyme are modeled [4].

Papain is a proteolytic sulfhydryl protease. Its molecule consist one polypeptide chain with 212 amino acid residues. The spatial structure of papain is folded into two domains with the active site in a groove between the domains [3]. Its catalytic triad is made up of 3 amino acids – cysteine-25, histidine-159, and asparagine-158. The function of papain is performed via nucleophile attack of cysteine sulfure to amide carbon. The polypeptide chain is oriented with its amino end towards the active center of papain. Asparagine-158 and histidine-159 are involved in spatial interactions and aid

the realization of reaction between enzyme and substrate. The interaction of the enzyme chain amino acids (receptor) and the amino acids of the hydrolysable protein chain (ligand) determines affinity between them and the effectiveness of the enzyme, which quantitative measure is the Michaelis constant.

The purpose of the present work is to look for relation between experimentally obtained values of the Michaelis constant and theoretically calculated descriptors of two series of papain inhibitors.

2. THEORY AND METHODS

In the present paper we are searching for a relation between the activity of papain against two groups of investigated compounds (Fig. 1) and its structural indices calculated quantum-chemically.

The optimal geometries of the investigated compounds were obtained by structure optimization employing the restricted Hartree–Fock theory at the semi-empirical AM1 level [5]. The AM1 method is chosen due to the size of the compounds under study and limited computing resources. Furthermore, AM1 is a method of choice in the articles of Raczynska and coworkers [6, 7] for calculation of microcharacteristics of compounds which are similar to those considered in this paper. The used software was MOPAC 2002 [11].

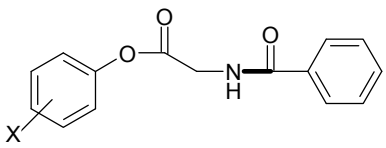
The investigated groups are: (i) compounds with amide bond (glycine X-phenyl ester amides) and (ii) compounds with amide-like bond (glycine X-phenyl ester sulfonamides), both differ with respect to the substituents in their phenyl ring.

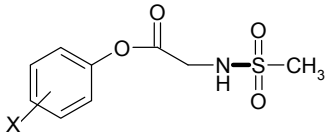
We have been looking for a relationship between the enzyme activity and several chosen descriptors, namely log P, the molecular refraction, LUMO, and the Hammet constant. The values of the activities ($\log {}^{1}\!/\!_{K_M}$), the molecular refraction (MR) and the parameter of Hammet (σ) are taken from [2].

The evaluation of log P is performed by the use of atomic parameters obtained by Ghose, Pritchett and Crippen [1] and extended later by Ghose and coworkers [9, 10].

3. RESULTS AND DISCUSSION

In Tab. 1 are presented the logarithms of reciprocal values of Michaelis constant ($\log {}^{1}\!/\!_{K_M}$) and the values of structural descriptors of compounds from the first group (i): with amide bond. The difference between compounds in both groups is in the substituent X in the phenyl rings.





I	ii
Substituent X	**Substituent X**
4-NH_2	4-OH
4-Me	4-OMe
H	4-Me
4-Cl	3-Me
4-F	H
3-NO_2	4-F
4-NO_2	3-OMe
	4-CHO
	4-Cl
	3-F
	0
	4-COMe
	1
	3-NO_2
	2
	4-NO_2
	3

Fig. 1: General structure of the investigated compounds

Tab. 1: Descriptors for the compounds from the subgroup (i).

	X	R	log1/Km	MR	σ	logP	LUMO
1	4-NH_2	COC_6H_5	3.58	0.54	-0.66	1.61	-0.183
2	4-Me	COC_6H_5	4.02	0.56	-0.17	2.85	-0.316
3	H	COC_6H_5	3.77	0.10	0.00	2.38	-0.306
4	4-Cl	COC_6H_5	4.00	0.60	-0.23	2.91	-0.636
5	4-F	COC_6H_5	3.69	0.09	0.06	2.52	-0.640
6	3-NO_2	COC_6H_5	4.74	0.74	0.71	-1.53	-1.567
7	4-NO_2	COC_6H_5	4.85	0.74	0.78	-1.53	-1.645
			|r| > 0.754	**0.714**	**0.892**	**- 0.867**	**- 0.940**

Significant linear correlation between seven values of independent and dependent variables at confident level of 95 % is observed when the sample

correlation coefficient is greater than its critical value of 0.754, i.e. when |r| > 0.754 [8]. Therefore, we have a significant linear correlation between the logarithm of the reciprocal value of the Michaelis constant and the σ-constant of Hammet, log P and LUMO energy.

For the sake of tightness graphical presentation of the correlation are missed.

The regression equations between the activity of the enzyme papain and the descriptors are:

$$\log {}^{1}\!/_{K_M} = -0.2203 \log \mathrm{P} + 4.3828$$

$$\log {}^{1}\!/_{K_M} = 0.8946\sigma + 3.9868$$

$$\log {}^{1}\!/_{K_M} = -0.7849\mathrm{LUMO} + 3.4994$$

It is obvious that, the decrease of log P increases the affinity to the enzyme active site. The more hydrophilic the compound is, the higher its affinity to the enzyme is. The observed linear dependence can be described by the narrow interval of values of log P of the investigated compounds. Certainly, with the decreasing of the hydrophobicity of the investigated compounds their affinity towards the enzyme increases. This relation is easy to be commented having in mind the polar medium in the active site of enzyme formed by the amino acids cysteine, asparagine and histidine.

We have obtained a linear correlation between the activity and the σ-parameters of the substituent in the aromatic ring of the ester group. With the increase of σ, the affinity to the active center of the enzyme increases. The increase of σ corresponds to the amplification of electron acceptor properties of the substituent X. From the correlation dependence it can be concluded that compounds with more than one electron acceptor group should have higher activity to the active center of papain. The distance between aromatic ring and hydrolysable amide function is large enough. It means that the correlation between Hammet constant and the affinity of the compounds to the enzyme active site is due to the stronger attraction between histidine nucleophylic atoms and electorphylicity of the ester carbon atom.

We have obtained a linear dependence with highest correlation coefficient between LUMO energy and the logarithm of the reciprocal value of the Michaelis constant. Interestingly, the value of the sample correlation coefficient $r > 0.940$ is sufficient to assure the significance of the linear correlation even on confidence level of 99 %. [8]. Moreover, with increasing of LUMO energy the affinity towards the enzyme increases as well. The LUMO energy shows the electrophilicity of the investigated compound. This correlation confirms the former one. The stronger electrophilic properties are, the higher affinity to the enzyme is.

The second group of compounds (ii) is the compounds with amide-like bond – sulfonamide group. Tab. 2 presents the values of $\log 1/K_M$ and the calculated descriptors for the second group. The compounds have amide-like bond and differ with respect to the substituent X in the phenyl ring.

Tab. 2 Descriptors for the second subgroups of compounds.

	X	R	log1/Km	MR	σ	logP	LUMO
1	4-OH	SO_2Me	2.05	0.28	-0.37	0.44	-0.829
2	4-OMe	SO_2Me	2.13	0.79	-0.27	0.47	-0.784
3	4-Me	SO_2Me	2.08	0.56	-0.17	1.19	-0.796
4	3-Me	SO_2Me	2.23	0.56	-0.07	1.19	-0.798
5	H	SO2Me	1.79	0.10	0.00	0.72	-0.817
6	4-F	SO_2Me	1.95	0.09	0.06	0.86	-0.897
7	3-OMe	SO_2Me	2.29	0.79	0.12	0.47	-0.822
8	4-CHO	SO_2Me	2.33	0.69	0.42	0.40	-1.069
9	4-Cl	SO_2Me	2.38	0.60	0.23	1.24	-0.890
10	3-F	SO_2Me	1.98	0.09	0.34	0.86	-0.905
11	4-COMe	SO_2Me	2.57	1.12	0.5	0.03	-0.995
12	3-NO_2	SO_2Me	2.53	0.74	0.71	-3.19	-1.497
13	4-NO_2	SO_2Me	2.71	0.74	0.78	-3.19	-1.442
			|r| > 0.553	**0.813**	**0.730**	**-0.677**	**-0.720**

The presented results show that there is a significant linear correlation between $\log 1/K_M$ and all of the investigated independent variables. The regression equations are as follows:

$$\log 1/K_M = -0.1208 \log P + 2.2462$$

$$\log 1/K_M = -0.8109 LUMO + 1.4500$$

$$\log 1/K_M = 0.5437\sigma + 2.1370$$

$$\log 1/K_M = 0.6834 MR + 1.8564$$

The values of the sample correlation coefficients allow the conclusion that there is significant linear correlation between log P of the investigated analogues of the substrates and the activity of the enzyme papain at confidence level of 95 % and between the activity and the LUMO energy, the Hammet parameter σ, and the molecular refraction even at confidence level of 99 %. [8]

The obtained correlations for the second subgroups of compounds (ii) support the correlations obtained for the first subgroup and can be interpreted by the same way.

There is a significant linear correlation between local descriptor of substitute (-X) influence and the receptor/substrate affinity, as far as between global parameter of electophylicity (energy of LUMO) and the affinity, besides there is a correlation of the affinity and molecular refractivity. All the

obtained relations are in excellent accordance with the relations obtained for the first subgroup.

The correlation of any biological answer with log P usually shows how the penetration through the biological membranes is connected to the biological activity of the compounds under consideration. When we look for the structural features of compounds responsible for affinity to enzymes, log P is demonstrative for the correspondence between enzyme active site polarity and the polarity of the substrate analogue. As better the correspondence is, as higher the affinity between them is. What was important for us in the present investigation is that there is a strong accordance between structural desctiptors obtained experimentally and descriptors obtained quantum-chemically, using semi-empirical quantum-chemical methods. This finding demonstrates the reliability of the used theoretical methods.

ACNOWLEDGMENTS

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Lipophilicity and Antiviral Activity of Acyclovir Analogues

Elitsa Hristova, Zhivko Velkov, Mikhail Kolev

Department of Chemistry and Department of Mathematics
South-West University “Neophit Rilski” Blagoevgrad, Bulgaria

***Abstract**: The low intestinal absorption and bioavailability with oral administration are important disadvantages of the contemporary antivirus agents. They come from their high polarity and hydrophilicity. In this paper we correlate the antiviral activity of the Acyclovir pro-drugs with the calculated index of hydrophobicity log P.*

***Keywords:** pro-drugs, QSAR, antivirus agents.*

1. INTRODUCTION

Computer-aided molecular modeling is among the methods that are successfully used in the search for new antivirus drugs over the latest years [5]. That way, a variety of physicochemical descriptors can be generated. These descriptors can be related quantitatively with the antiviral activity of the investigated compounds and such approach gives information about the structural elements that antiviral agents should possessed [1]. Moreover, the molecular models are a reliable source of information for predicting adsorbability, distribution, metabolism, excretion and toxicity (ADMET) of a given drug at a very early stage of screening the candidates for drug development and for the successful combinatorial library design [8], [10], [13], [18].

The most of the antiviral drugs are analogues of nucleotides/nucleosides and as such they act as inhibitors or substrates of virus polymerase. In the former case, a decrease in the virus replication is observed, while in the latter case the drugs prevent the process of viral DNA replication. The modified structures in nucleosides analogues include changes in the glycoside fragments as well as in the aglycone fragment. Via simplification of the ribose part, Acyclovir (ACV), bromovinyldeoxyuridine (BVDU), Ganciclovir (GCV), Penciclovir (PCV) and analogues of 2’-deoxyguanosine have been obtained [3].

Important properties of antiviral drugs like these are their low bioavailability after oral administration and their short plasma sojourn time [2], [3]. In order to increase the solubility of ACV in water, its esters have been synthesized. The initial esters turned out to be toxic [4], [12] but the ester of Acyclovir with the amino acid Valyne called Valaciclovir (VACV) proved to be a safe and efficacious drug.

Greater bioavailability of VACV may be explained by the specific peptide transporters (such as hPEP1) that accelerate the penetration of VACV into cells as well as by the fast enzyme hydrolysis to ACV via the hydrolysis of the ester group in the interior of cell [7]. The enzyme that could play the role of a "valaciclovirhydrolase" is a biphenylhydrolase-like peptide that has been cloned initially from human breast carcinoma cells and later on from Caco-2 cells [9].

After oral administration, Valacyclovir undergoes fast transformation to ACV and the irreplaceable amino acid valyn [11].

In the present paper we will look for the optimal values of log P for a group of derivatives of Acyclovir with esterically bound amino acids and peptides and we will search for a correlation between their lipophilicity and antiviral activity.

2. THEORY AND METHODS

The evaluation of log P is performed by the use of atomic parameters obtained by Ghose, Pritchett and Crippen [6] and extended later by Ghose and coworkers [16], [17].

The results for antiviral activity are taken from B. Anand, Y. Nashed, A Mitra, [2]; they show the concentration (in μM) of the respective drug needed for 50% inhibition of viral (Herpes Simplex Virus 1, HSV 1) cytopathogenesis.

The regression analysis was performed by using MS Excel program package.

In the present paper the following compounds have been investigated:

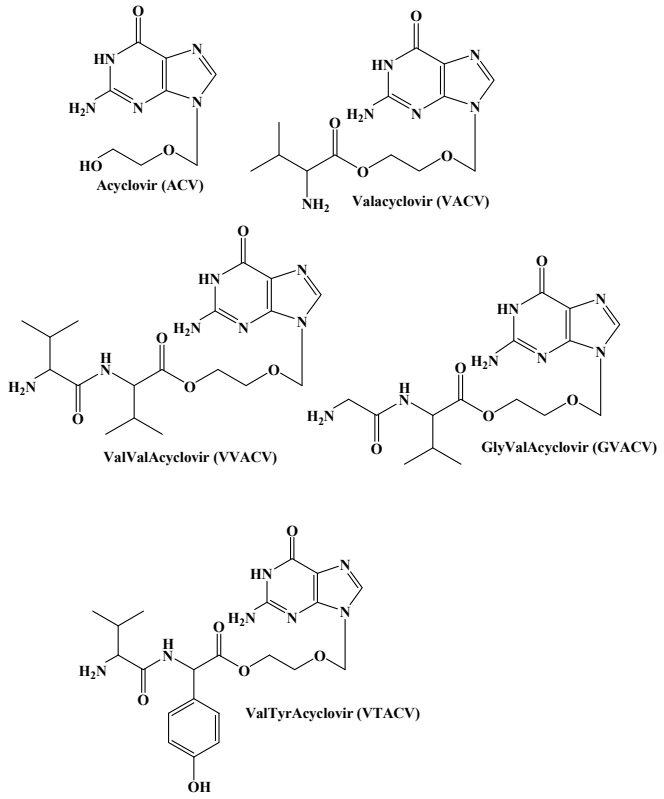

Fig. 1: Investigated Acyclovir pro-drugs.

3. RESULTS AND DISCUSSION

The values of the antiviral activity: concentration of the investigated compounds in μM that inhibits 50% of the viral infection, and the calculated values of log P are given in the Tab. 1.

Tab. 1: The values of the antiviral activity and the calculated values of log P of the investigated compounds.

Acyclovir and amino acid esters	EC50 against HSV-1 [μM]	log P
ACV	7.1	-1.05
VACV	9.10	-0.82
VVACV	6.14	-0.48
GVACV	12.60	-1.89
VTACV	4.80	0.05

The regression equation of the variables describing the antiviral activity and log P is:

(1) EC_{50}=-3.93*logP+4.65,

with sample correlation coefficient r = -0.932.

We obtained that, the value of the sample correlation coefficient r in Eq. (1) is higher than the critical value 0.878 for the set size of 5 compounds at 95% confidence level. Therefore, there exists a significant linear correlation between the antiviral activity (described by the concentration of the compounds required for the 50% reduction of the viral infection) and the lipophilicity index, log P [14]. The higher the lipophilicity is, the higher the antiviral activity of the compounds is.

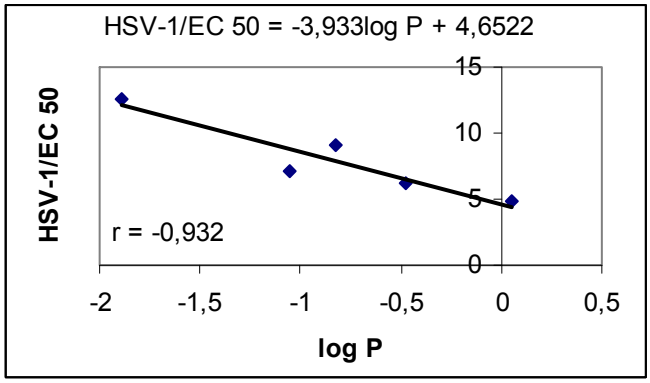

Fig. 2: The linear correlation between the biological activity of derivatives of Acyclovir and log P

In our previous investigations [15] we have obtained that the optimal values of the lipophilicity descriptor log P for 3′5′-esters of 5-bromo-2′-deoxyuridine with amino acids and peptides with respect to their antiviral activity is between -1.39 and -2.16. The compounds with higher lipophilicity and with lower lipophilicity show lower activity.

Such dependence of the antiviral activity on the lipophilicity is expected when the differences between the lipophilicity of the investigated compounds is enough large.

In our group the difference between the highest and the lowest lipophilicity is 1.94 units of the log P scale. This is not high enough in order to expect parabolic dependence.

The lower values of the lipophilicity than this of ACV are undesirable, while the increase in the lipophilicity leads to the increase of the antiviral activity. This means that the lipophilicity plays very important role for this group of compounds.

ACNOWLEDGMENTS

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Air Pollution with Gaseous Emissions and Methods for Their Removal

Venceslav Vassilev[1], Sylvia Boycheva[2], Emilija Fidancevska[3]

[1]University of Chemical Technology and Metallurgy, Department of Non-Ferrous Metals and Semiconductor Technologies, Sofia, Bulgaria;
[2]Technical University of Sofia, Department of Nuclear and Thermal Power Engineering, Sofia, Bulgaria;
[3]University st. Cyril and Methodius, Faculty of Technology and Metallurgy, Scopje, FYR Macedonia

***Abstract**: Information concerning gaseous pollutants generated in the atmosphere, as a result of fuel incineration processes in thermal power and industrial plants, was summarized. The main methods and technologies for flue gases purification from the most ecologically hazardous pollutants are comparatively discussed.*

***Keywords:** gaseous pollutants, aerosols, flue gas purification systems and technologies, air ecology control.*

1 INTRODUCTION

Recently, atmospheric pollution become of severe global ecological problem because of the expressed tendency in climate changes and the related subsequences. The atmospheric pollutants can be generated simultaneously from natural phenomena and anthropogenic activities. The discharge of enormous amounts of exhaust industrial gases with different gaseous contaminants in the atmosphere provokes the development of effective technologies and reduction in the normative allowed limits [1].

Taking into account the ecologically hot problems, the efforts have to be directed mainly on the reduction of greenhouse and acidic gases, cyclic organic compounds and heavy metal vapors emitted from fuel incineration in thermal and industrial plants. The category of pollutants includes each hazardous component which can be harmful for human health and has negative natural impact [1,2].

The purpose of the present communication is to summarize information about the mechanisms for gaseous emission generation at different industrial branches and the established reliable technologies for their removal and conversion in useful products.

2. ANTROPOGENIC SOURCES FOR AIR POLLUTANTS

2.1 Air pollutants from fuel incineration processes

Fossil fuels, which are widely used in the industrial and district heating systems, consist of organic (combustible) and mineral (ballast) part. In the case of coals, the main constituents of the organic compounds are carbon, hydrogen, oxygen, nitrogen, phosphorous, and sulfur, while the inorganic part includes: sulfates, sulfides, oxides, carbonates, halogenides, alumosilicates, etc. Natural gas is purified from the sulfuric constituents before its transportation for the pipeline corrosion prevention. The content of the sulfur in the different types of petrol and coals varies in wide limits from less than 1 to around 5 %. The all sulfur in the composition of the petrol is included in the organic compounds, while coals contain a significant amount of inorganic sulfuric compounds, such as FeS_2, $Fe(SO_4)_3$, $MgSO_4$, $CaSO_4$, etc. [3].

Carbon and hydrogen oxidation, which is accompanied by energy generation, takes part according to the following reactions in a case of full fuel incineration:

(1) $$C + O_2 \rightarrow CO_2 + 395\ MJ/mol$$

(2) $$H_2 + 1/2O_2 \rightarrow H_2O + 287\ MJ/mol$$

In a case that the oxygen concentration is not enough for the full carbon oxidation, reactions for CO formation take place:

(3) $$C + 1/2O_2 \rightarrow CO + 111\ MJ/mol$$

(4) $$C+CO_2 \rightarrow 2CO - 1722\ MJ/mol$$

Evidently, the generated energy simultaneously with the high levels of CO formation is significantly lower.

During the non-full fuel incineration, which more often performs at small municipal ovens, simultaneously with CO, volatile organic compounds (VOC) also appear. The concentration of VOC, which are formed in industrial and thermal incineration systems, is rather smaller because they incinerate entirely to CO_2 and H_2O setting on fire from the hot walls of the boiler.

Sulfur from the coals and petrol oxidizes to SO_2:

(5) $$S+O_2 \rightarrow SO_2.$$

SO_2 can be oxidized additionally, as follows:

(6) $$SO_2 + O^* \rightarrow SO_3,\ \text{or}$$

(7) $$SO_2 + 1/2\ O_2 \rightarrow SO_3 + 85\ MJ/mol$$

Generally, SO_3 percentage in SO_x does not exceed 1 % and it is higher in the flue gases from installations burning petrol than that with coals, because of the presence of vanadium oxide catalysts.

NO_x are also generated as incineration gaseous byproducts, as the main part from the nitrogen comes from the fuels and small concentrations – from the air.

Formation of NO is described by the help of Zeldovich’s chain reactions:

(8) $$N_2 + O^* \rightarrow NO + N^* - 315\ MJ/mol$$

(9) $$N^* + O_2 \rightarrow NO + O + 133\ MJ/mol$$

In the flame of the boiler systems, NO generation is stipulated from the thermally activated oxygen, hydroxide and nitrogen radicals:

(10) $$N^* + OH^* \rightarrow NO + H^* + 165\ MJ/mol.$$

At lower temperatures in the incineration systems and in the atmosphere by photochemical reactions, NO transforms to NO_2.

2.2 Air pollutants from industrial plants

The main industrial sources of atmospheric pollution are metallurgy, chemistry, petrol processing and food industries [3-6].

2.2.1 Non-Ferrous Metallurgy

The processing of the Cu, Pb and Zn sulfide ores is the second source for SO_2 emitting after the fuel incineration. The raw ore for copper production is preliminary subjected to oxidation for partially removing of the sulfur content, as the SO_2 concentration in the exhaust gases is about 8 vol. % (Fig. 1). The obtained mixture composed of Cu and Fe oxides and sulfides is melted in screen oven together with flux additives. The melt surface is covered with Cu and Fe sulfides, and the volatile gases contain 1-3 vol.% SO_2. The sulfide mixture obtained on the top of the melt is heated additionally in the converter, where oxidation of Fe and the residue S is occurred and the concentration of SO_2 in the exhaust gases is 3-5 vol. %.

In similar technologies, sulfide ores are also used for Pb and Zn production, such as PbS (galena), ZnS (galena false), etc. The ores are subjected to roasting in furnaces with movable grids or in pseudo-fluidized bed layer. The exhaust gases containing up to 6 % SO_2 are used for H_2SO_4 production. The main problem that occurs at this manner for SO_2 utilization is the presence of As_2O_3, HCl and HF in the roasting gases, which are catalytic poisons of SO_2 to SO_3 oxidation.

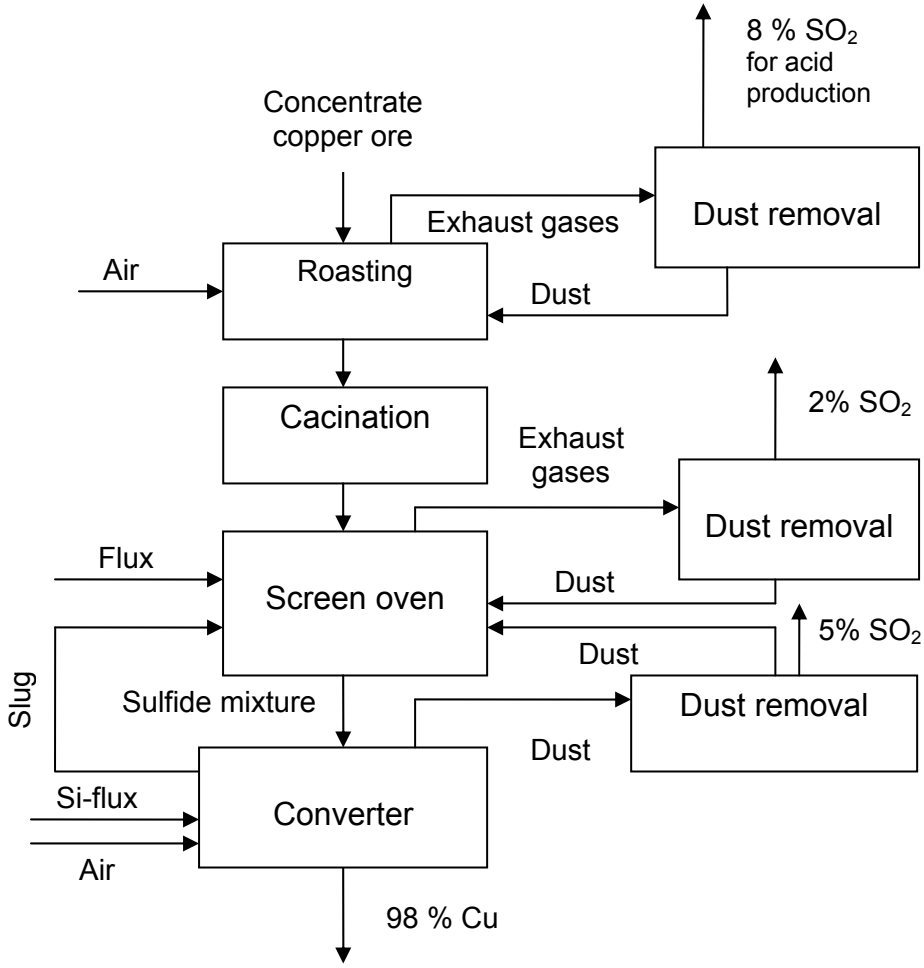

Fig. 1: Technological scheme of copper production as a source for SO_2 formation.

2.2.2 Ferrous metallurgy

High thermal reduction of the ferrous oxide ores leads to formation of Fe-C alloy with up to 6 % C. This process is carried out in ballast-furnaces which are simultaneously loaded with ore and coke. Various stills are produced from the obtained cast iron by the reduction of carbon concentration and blending. The mining, ore processing, agglomeration and loading of the ballast-furnaces create serious problems with dust pollutions in air. Moreover, the exhaust gases from the ballast-furnaces contain high concentration of CO. The cast iron is converted to still in converters which are scavenged by oxygen flows and the resulted gases contain high levels of CO and CO_2.

2.2.3 Petrol processing industry

Except of hydrocarbons the raw petrol contains alkaline and rare earth salts, different organic and inorganic sulfur–enriched compounds. Sulfur concentration in the raw petrol varies from 0.5 to ~5 %. The main pollutions during the petrol processing are generated from the incineration of petrol or its low-quality fractions for thermal supporting of distillation and rectification. High quantity of black carbon can be emitted during the cracking and regeneration of the catalysts.

2.2.4 Chemical industry

The mining of row materials (coals, sand, break stone, etc.) from earth womb uses different explosives which liberate in the atmosphere hazardous gases (CO, CO_2, SO_2). Glass industry utilizes as raw products soda, sand, limestone and old glass and the exhausted gases from their melting contain carbonates, fluorides, nitrates and chlorides, which are air pollutants.

The H_2SO_4 production is based on the catalytic oxidation of SO_2 to SO_3 in reactors at 450-600 °C. Despite of the reliable equipment about 2 % of SO_2 go into the atmosphere.

The synthesis of phosphorous fertilizers and electrolytic deposition of Al are accompanied by liberating of fluorine-containing gases, while the paper and cellulose industry is a potential source of H_2S and mercaptans.

3 METHODS AND TECHNOLOGIES FOR REMOVAL OF GASEOUS EMISSIONS

According to their aggregate state, the air pollutions can be divided in two main groups: (i) gases and vapors, and (ii) aerosols. The pollutants from the first group are characterized with molecular sizes and generally they form homogeneous solutions with air, while those from the second group are small in size particles from condensed matter (solid or liquid) with a diameter $\leq$100 μm.

3.1 Methods for aerosol removal

Gaseous flows are passed though cameras in order to remove the dispersed solids by the help of gravity, electrostatic, thermal, centrifugal or inertial forces [2,3,6]. The equipments for aerosols removal are schematically presented in Fig. 2.

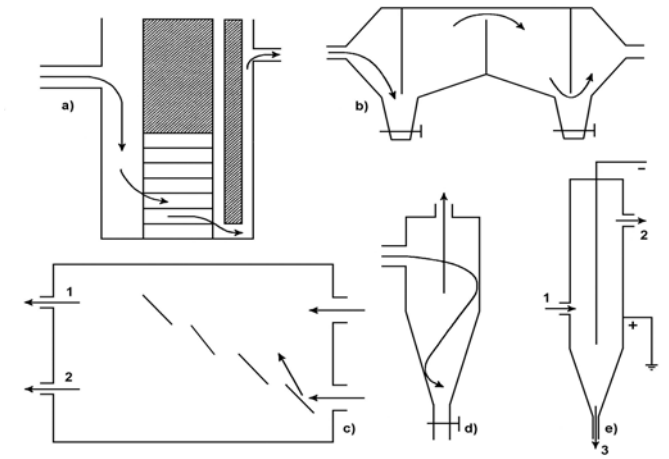

Fig.2.: Equipments for flue gases purification from aerosols : a) dust removal camera; b) inertial camera with vertical bafflers; c) sloping screen precipitant; d) cyclone;
d) electrostatic filter; 1-row gas; 2-clean gas; 3-dust products.

3.2 Methods for gaseous emissions removal

The gaseous pollutants removal from gas-carrier medium is based on the general aspects of the gas diffusion into the bulk or on the adsorbent surfaces. The pollutants are kept by adsorption on solid or liquid surface and thereafter they are catalytically transferred in less toxic or even commercial products. Another approach is the oxidation, dissociation or reduction of the emissions to harmless air components.

3.2.1 SO_2 removal

SO_2 has acidic reaction and low solubility in water, that is way for its removal alkaline solution or solid bases are used. The most used sorbents are limestone ($CaCO_3$), quick lime (CaO) or dolomite ($CaCO_3.MgCO_3$). The following chemical reaction can occur:

(10) $$CaO + SO_2 + 1/2O_2 \rightarrow CaSO_4$$

The obtained dry powder is separated from the gas flow by cyclones or filters, or in scrubbers like semidry product in a case of wet process. The effectiveness of the dray process is 40 – 70 %, while of the wet is over 90 %.

The rest middling slime from non-ferrous metals processing containing CaO and MgO is used for SO_2 removal:

(11) $$MgO + SO_2 \rightarrow MgSO_3$$

Gaseous NH_3 can be used as an effective reagent of SO_2 neutralization at 150 °C (USBM-process) [2,3]:

(12) $$2NH_3 + SO_2 + H_2O \rightarrow (NH_4)_2SO_3$$

(13) $$NH_3 + SO_2 + H_2O \rightarrow NH_4HSO_3$$

NH_3 can be regenerated by the help of NaOH, CaO or ZnO. The effectiveness of this process exceeds 95 %.

Pure water can also be a reagent for SO_2 capture followed by catalytic (coal, MnO, Na_2S) oxidation to sulfuric acid:

(14) $$SO_2 + H_2O \rightarrow H_2SO_3$$

(15) $$H_2SO_3 + 1/2O_2 \rightarrow H_2SO_4$$

Direct oxidation of SO_2 to SO_3 can be performed, which is well-known catalytic process in H_2SO_4 production. Full oxidation with high velocity is ensured at 450 – 600 °C.

Another technological possibility is SO_2 absorption with NH_3 followed by disproportion of the obtained NH_4NSO_3 and $(NH_4)_2S_2O_3$ under high pressure (1.4 MPa) and 170 °C [3]:

(16) $$2NH_4HSO_3 + (NH_4)_2S_2O_3 \rightarrow 2(NH_4)_2SO_4 + 2S + H_2O$$

The eutectic melts from carbonates can also be used for SO_2 chemical attachment:

(17) $$SO_3 + MeCO_3 \rightarrow Me_2SO_3 + CO_2 \ (Me=Li, Na, K),$$

followed by sulfite oxidation and reduction with carbon at 800 °C.

3.2.2 H_2S removal

H_2S is with acidic behavior and combines easily with NH_3, CH_3NH_2 and $C_2H_5NH_2$, and can be removed more effectively than SO_2. The used amines can be easily recovered with water vapors, and the captured H_2S is utilized for S production.

Fe_2O_3 is broadly used for reagent for gases purification from H_2S. Fe_2O_3 water suspension and flue gases are passed through absorber, reacting to ferrous sulfide:

(18) $$Fe_2O_3 + 3H_2S \rightarrow Fe_2S_3 + 3H_2O$$

Fe_2O_3 regeneration performs at 800 °C in air and the liberated SO_2 can be used in H_2SO_4 production.

3.2.3 NH_3, amines and pyridines removal

NH_3 and amines are well soluble in water and strong oxidation media giving ammonium and alkylammonium ions, but their solubility diminishes with temperature increase. Practically, two-stage purification of row gases is

applied, as during the first stage gases are cooled up to 30-50 °C in a heat-exchanger, and at the second – they are rinsed with water in a wet-scrubber.

Another technological decision includes pollutants dissolution in an absorber with injected water followed by crystallizer with injected H_2SO_4, at which ammonium sulfate crystallizes on the bottom. This method is broadly used for the removal of pyridine and its derivatives.

3.2.4 NO_x removal

NO_x transforms to inert N_2 by reduction with NH_3 and/or $(NH_4)_2CO_3$ under high temperature or over catalysts.

3.2.5 Fluorine and fluorides removal

HF can be easily absorbed by water in wet scrubbers, while in the presence of fluorine instead water 5-10 % NaOH solution is used:

(19) $$2F_2 + 4NaOH \rightarrow O_2 + 2H_2O + 4NaF$$

4 CONCLUSIONS

The most problematic and global air pollutants, such as SO_2, H_2S, NO_x, NH_3, amines, fluorides, pyridines, as well as their industrial generation sources are summarized. The established reliable technologies for gaseous emissions reduction are briefly discussed. The most effective and ecologically compatible are the technologies converting emissions in commercial and harmless products and those with sorbent recovery.

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Pyrazolone-derivatives and their tiosemicarbazones – spectrophotometric study and photochemical behavior

Atanas Chapkanov

South-West University “Neofit Rilski”, Department of Chemistry,
66 “I. Mihailov” str., 2700 Blagoevgrad, Bulgaria,
E-mail: chapkanov@swu.bg nasko50@yahoo.com

Abstract. *A series of β-diketone derivatives containing pyrazolone-ring were synthesized in order to interpret further spectroscopic characteristics and photochemical behavior. UV-spectral analysis of pyrazol-5-ones derivatives and their thio-semicarbazones in solution were carried out. The spectral characteristics of the different tautomers depending on the structure compounds, medium effects, inter- and intramolecular interactions it was established. The UV-light irradiation influence and protonation of the solutions on absorption bands and tautomeric forms stabiization it was elucidated. The protonation of the tiosemicarbasones derivatives in methanol solutions it was by addition of 5% HCl after next UV-light irradiation.*

Keywords*: pyrazol-5-one derivatives, thiosemicarbazones, UV- irradiation, protonation*

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Corresponding author: Tel:+359 73 831825; Fax:+35973885516;

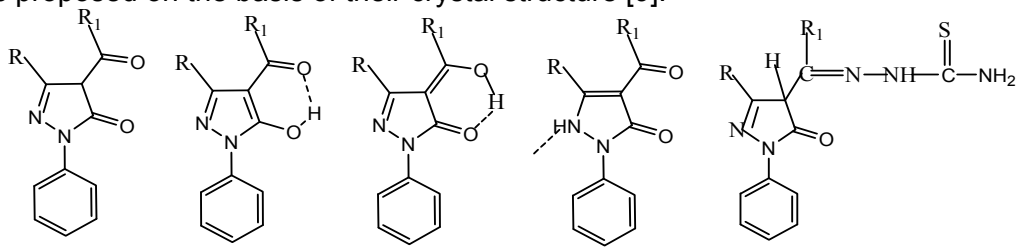
E-mail: chapkanov@swu.bg nasko50@yahoo.com

1. INTRODUCTION

Photochromism of material in solid state and solution has provoked much attention because of scientific interest and potential applications in the practice as a different photo switching devices or optical storage media with high density [1, 2]. On the other hand numerous compounds as spiropyrans, diarylethenes, Schiff bases and etc. have been extensively studied possessing photochromic properties [3, 4]. Derivatives of Schiff bases from salicylaldehyde are well-known examples which show either photo- or termochromism in solid state.

4-Acetyl (benzoyl)-1-phenyl-3-substituted pyrazol-5-ones (Scheme 1 a-d) has been extensively studied in the recent years, because of its metal extracting properties [5, 6]. On the other hand thiosemicarbazones and their derivatives are well known as compounds with a biological activity and practical application [7, 8]. Two new photochromic compounds on tiosemicarba-

zone have been synthesized, where intermolecular H-transfer mechanism was proposed on the basis of their crystal structure [9].



CH (a) **OH (b)** **OH (c)** **NH (d)** **(e)**

Scheme 1. Structure of tautomeric forms of 4-acetyl (benzoyl)-1, 3-substituted pyrazole-5-ones (a-d) and thiosemicarbazones (e); R = CH_3, C_6H_5, R_1 = CH_3, C_6H_5

The structure compounds study as of 4-acetyl-3-methyl-1-phenyl pyrazol-5-ones (**4-AcMPhP)**, 4-acetyl-1,3-diphenyl-pyrazol-5-one **(4-AcDPhP**), 4-benzoyl-3-methyl-1-phenyl pyrazol-5-ones (**4-BzMPhP**), 4-benzoyl-1, 3-diphenyl-pyrazol-5-one (**4-BzDPhP**) and corresponding thiosemicarbazones are shown in Scheme 1.

2. EXPERIMENTAL PART

The 4-acetyl (benzoyl)-substituted-pyrazol-5-ones and their tiosemicarbazones were synthesized according to the literature procedures in [14, 15]. The solvents used were Uvasol (Merck) products. The UV-absorption spectra of the compounds studied as $0.5.10^{-4}$ mol/l solutions (1-cm quartz cell) in n-hexane, THF and MeOH were recorded on a SPECORD UV-VIS (Carl Zeiss Jena - Germany) spectrometer with ± 3 nm resolution. The samples solution were irradiated from a distance of 15 cm using a medium pressure mercury vapour lamp and system of liquid filters (310 nm). The irradiation intensity was $1.29.10^{16}$ quanta/s.cm^3. The protonation was carried out by drop wise addition of 0.02 ml 5 % HCl and after that UV-light (λ=310 nm) irradiation.

3. RESULT AND DISCUTION

According to literature data 4-acyl (benzoyl)-1,3-substituted pyrazol-5-ones in polar solvents show exist as keto NH-form (see Scheme 1 (d)) with strong intermolecular hydrogen bonds, while in of non-polar solvent as CCl_4 they exist as two enolic forms (see Scheme 1 (b), (c)) with intra molecular hydrogen bonds [16, 17].

UV-spectral analysis

The spectral data of the parent β-diketones containing pyrazolone-ring in some organic solvents are given in Tab. 1.

Tab. 1. UV-spectral data of studied compounds in different solvents

Compound	n-Hexane (λ_{max})	THF (λ_{max})	MeOH (λ_{max})
4-Ac-MPhP	230-250sh, 273		230, 265
4-Ac-DPhP	255	255	250, 310 sh
4-Bz-MPhP	240, 285	245, 290	240, 275
4-Bz-DPhP	255, 290w	255, 290-310 sh	253, 280-315sh
4-Ac-DPhP tiosem.			250, 270sh, 330sh
4-Bz-MPhP tiosem			250, 310

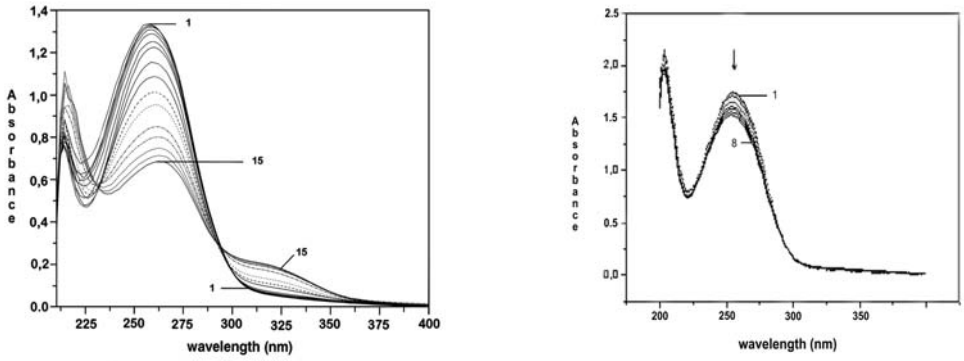
The benzoyl derivative of 1, 3-diphenyl-pyrazol-5-one in non-polar solvents posses only one intensive band at 255 nm and shoulder at 290-310 nm [19], while for 3-methyl-substituted is characterized with two absorption maxima at 240-245nm and 285- 290 nm (Table 1). This is one of the basic differences for compounds studied and is connected with their structure, but showing an insignificant influence of the solvent effect (see Figures 1 and 2).

In polar solvent (MeOH) the absorption maxima for acetyl and benzoyl MPhP derivatives are characterized with two absorption bands in the region 230-240 nm and 266-275 nm respectively. They should be assigned to dike-to NH-tautomer (Scheme 1d) like 1, 3-diphenyl pyrazol-5-ones and antipyrine [13]. Other two compounds posses maximum around 250-253 nm and shoulder at 280-310 nm characterizing NH-tautomeric form.

Irradiation and protonation of the compounds studied

The irradiation with UV-light (λ = 310 nm) of 4-Ac-DPhP in THF leads to batochromic shifted of maximum at 256 nm to 263 nm and peak intensity strongly decreased and new low intensive at 320 nm [Figure 1.1] which can be assigned to the excitation of the carbonyl group with CT origin [20]. The isobestic points available are appropriate spectral evidence. The UV-spectra in n-hexane (see Figure 1.2.) show no changes after irradiation. In the experimental conditions this should means a break up of the available intra molecular hydrogen bonds in the enolic forms, minor conversion to other tautomers or photodegradation.

The irradiation of 4-Bz-MPhP in THF showed (see Fig.2) however showed that absorption maximum at 290 nm hypsochromicaly shifted to 270 nm, while this at 245 nm is batochromicaly shifted to 256 nm with a significant intensity decreasing and forming a single absorption maximum.



(1) (2)

Fig. 1. UV-spectra of 4-Ac-DPhP in THF (**1**) and n-Hexane (**2**):
1- before irradiation, 2-15- after irradiation

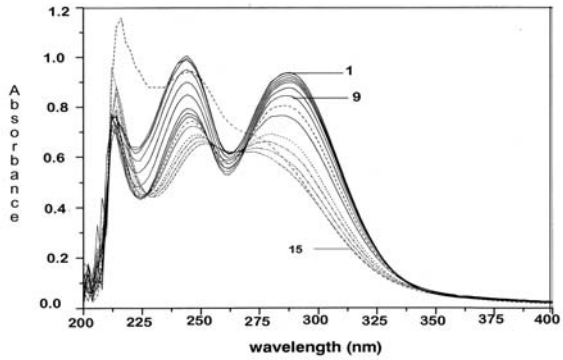
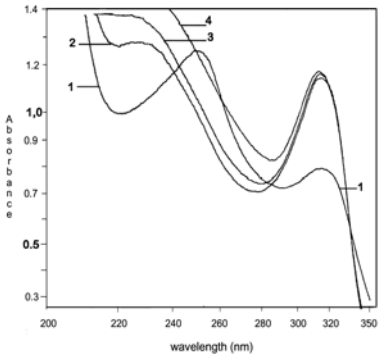


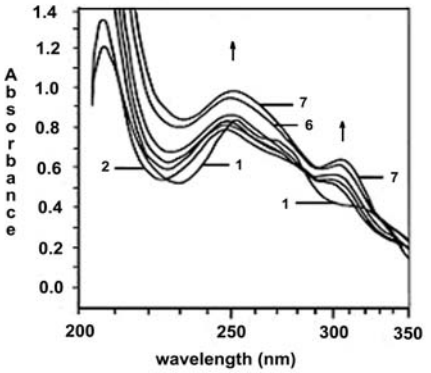
Fig. 2. UV-spectra of 4-Bz-MPhP in THF solution:
1- before irradiation, 2-15- after irradiation
2-

For 4-Bz-DPhP in the same solvent is at hand only hypochromic decreasing intensity of the peak at 255 nm. The obtained experimental results means, that the some non polar solvents are not appropriate for such kind investigations.

The experimental results for tiosemicarbazone derivative containing pyrazolone ring extend our investigations. We represent the results only for 4-Ac-DPhP and 4-Bz-MPhP and tiosemicarbazone in MeOH solution after protonation.

The protonation of tiosemicarbazone-pyrazolone derivatives was carried out by consecutively addition of 0.02 ml 5 % HCl.





(**1**) (**2**)

Fig. 3. UV– spectra of 4-Ac DPhP tiosemicarbazone (1) and 4-Bz-MPhP tiosemicarbazone (2) in MeOH: after protonation with 5 % HCI: 1 – without HCI; 2 -7 after addition of 0.02 ml 5 % HCI;

The spectrum of 4-AcDPhP tiosemicarbazone in MeOH before protonation maximum at 250 nm and two shoulders at about 270 nm and 330 nm (see Figure 3.1, curve 1) which is similar to those of 4-AcDPhP in MeOH with exception of a new shoulder at 270 nm and characterizing NH-tautomeric form (see Table 1). After protonation by 5% HCI a new band at 310-315 nm (Figure 3a) is appeared, maximum at 250 nm is characterized with increasing intensity and shoulders available disappeared. This result is a like to the photochemical behavior of 4-Ac-DPhP in THF. Such high value defies the assignment as n→π conjugated C=O group which is typical for a NH-form of 1, 3-disubstituted pyrazolones.

The spectral data for 4-Bz-MPhP tiosemicarbazone in methanol before protonation show two absorption maxima at 250 nm and 310 nm. They are batochromicaly shifted with 10-35 nm in comparison with parent β-diketone (4-Bz-MPhP) in the same solvent. That can be due to the presence of tiosemicarbazone part in the molecule structure in spite of tiosemicarbazone in MeOH possess single band at 245 nm and it is difficult to be distinguish. The protonation is accompanied with hypsochromicaly shifted of the band at 250nm to 230-240 nm and increasing intensity of the second maximum at 310 nm (Fig. 3.2). With growth of the amount 5% HCI added, the band at 230 nm disappeared, but no changes in the maximum at 310nm. One possible explanation of this spectral behavior probably is due to saturation of the

solution with HCI which provoke blocked of the N-nucleophilic centre in the chain-side. On the other hand, according to literature data [16] the bands at shorter wavelength in 1-substituted pyrazolones are attributed to pyrazolone ring and the protonation is occur initially in the thiosemicarbazone part of molecule.

4. CONCLUSION

The comparative UV-spectral analysis on the photochemical behavior of series of β-diketones and their thiosemicarbazones in different solvents and after protonation was carried out. The obtained experimental results showed that depending on the structure compounds, kind of solvent, time of UV-light irradiation and protonation, the investigated compounds investigated possess a different spectral characteristic.

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Изследване на виталността и преживяемостта на микрофлората в киселото мляко от търговската мрежа в гр. София in vitro при pH 1.5, 2.5 и 3.5.

Йорданка Щърбева и дбн Христо Чомаков

Химикотехнологичен и металургичен университет гр. София

Резюме. *Изследването има за цел да установи виталността и преживяемостта на микрофлората в киселото мляко от търговската мрежа в гр. София при ниско pH 1.5, 2.5 и 3.5 и наличие на пепсин. Налице са големи различия в състава на микрофлората в киселото мляко – липсва Lb. bulgaricus в някои от изследваните проби. Малка е издръжливостта на Lb. bulgaricus при ниско pH и наличие на пепсин. Висока е устойчивостта на кълбовидните форми- Str. thermophilus.*

1. ВЪВЕДЕНИЕ

Киселото мляко е най-старият пробиотик известен на човека. От дълбока древност се използва като храна, която укрепва здравето и осигурява дълголетие на човека (1). Млечнокиселата ферментация в киселото мляко се предизвиква от Lactobacillus delbrueckii subsp. bulgaricus (Lb. bulgaricus) и Streptococcus thermophilus. Броят им в доброкачественото кисело мляко е от 100 милиона до 1 милиард в грам продукт. Функционалността на продукта, способността му да оказва здравословно въздействие върху организма се обуславя от броя на бактериите, които достигат живи и в активно физиологично състояние в дебелото черво на човека (2). Преди да окажат въздействие върху организма бактериите трябва да преживяват в достатъчно количество при преминаване през стомашночревния тракт. Основното изискване по време на транзита през стомашночревния тракт е културите да издържат на ниското pH и наличието на пепсин в стомаха. Въпреки че pH-то в стомаха може да достигне до 6.0 и над 6.0 след приемането на храна, нормално то се движи в границите от 2.5 до 3.5 (3.4). По време на постене pH-то в стомаха може да достигне 1.5, което означава, че преживяването в силно кисела среда е едно от най-важните физиологични изисквания при културите след приемането на продукта (5). Виталността и преживяемостта на микрофлората в киселото мляко са важни особенности в оказването на здравословни ефекти върху организма.

Естествената устойчивост по време на транзита през стомашночревния тракт варира в широки граници при отделните млечнокиселi бактерии (6). Срещат се бактерии, които населяват чревния тракт и устояват на високата киселинност в стомаха и жлъчните соли в тънкото черво (7).

Проведените до сега изследвания се отнасят до устойчивостта на отделни щамове от определени видове под формата на монокултури. При консумиране на кисело мляко се приемат и двата вида - Lb. bulgaricus и Str. thermophilus. При тяхното съвместно развитие млякото се биотрансформира. Получават се биологично активни съставки, които оказват влияние върху виталността и преживяемостта на двата вида, а оттук и върху устойчивостта им в стомаха при ниско pH. Не следва да изключваме и синергизма между двата вида. В това отношение няма данни в литературата.

У нас Чомаков Хр. и Св. Бойчева (8) изследват преживяемостта на Lb. bulgaricus и Str. thermophilus под формата на заквaска за Българско кисело мляко чрез третиране със стомашен сок и жлъчка. Те установяват, че в продължение на 3 часа при 37˚C, не настъпват съществени промени в броя на Lb. bulgaricus и Str. thermophilus.

Няма данни в литературата за виталността и преживяемостта на Lb. bulgaricus и Str. thermophilus в киселото мляко от търговската мрежа при ниско pH в стомаха.

Настоящото изследване има за цел да установи виталността и преживяемостта на микрофлората в киселото мляко от търговската мрежа в гр. София при ниско pH и наличие на пепсин.

2. МАТЕРИАЛИ И МЕТОДИ

2.1. Проби кисело мляко за изследване

Кофички кисело мляко се вземат наслуки от магазини в търговската мрежа. Взетата кофичка кисело мляко се разклаща енергично в продължение на 5 минути. Отваря се стерилно и се извършва микробиологичния анализ.

След вземане на необходимото количество от съдържанието за микробиологично изследване се определя pH-то и киселинността по метода на Тьорнер (9).

2.2. Определяне издръжливостта на микрофлората на киселото мляко при ниско pH.

Течност подобна на стомашен сок се получава в съответствие с Американската фармакопея (10). Количеството на пепсина (Sigma) е 3.2g. на литър. Прибавя се под формата на стерилен разтвор, получен чрез филтриране през бактериален филтър. Течността е стерилна съставена от вода, 0.2g. готварска сол и солна киселина с pH 1.5, 2.5 и 3.5.

Изследването протича по следния начин. В стерилна епруветка с 9 ml от течността със съответното pH се прибавя 1 ml от киселото мляко и 0.1 ml от разтвора на пепсина. Епруветката се разклаща енергично и се поставя в термостат на 37˚C за 2h. През този период съдържанието в епруветката се разклаща няколкократно. След изтичане на времето се определя виталността и преживяемостта на бактериите.

2.3. Определяне на виталността

От киселото мляко в кофичката и от всяка епруветка със сместа от кисело мляко и изкуствения стомашен сок с pH 1.5, 2.5 и 3.5 след коагулирането се поставя по 0.2 ml в 10 ml стерилно мляко. Посетите епруветки се култивират в термостат на 37˚C. Отчита се времето за коагулиране на млякото. От коагулиралото мляко се приготвя препарат оцветен с метиленово синьо и се наблюдава микроскопската картина-наличие на пръчковидни форми- Lb. bulgaricus и кълбовидни форми- Str. thermophilus.

2.4. Установяване преживяемостта на микрофлората при ниско pH.

Определя се чрез броят на живите бактерии по метода на пределните разреждания в стерилно обезмаслено мляко (9).

3. РЕЗУЛТАТИ И ОБСЪЖДАНЕ

3.1. Виталност на микрофлората в изходното кисело мляко преди и след престояването му при ниско pH.

Данните за виталността на изследваните проби кисело мляко са отразени в табл. 1.

От данните в табл.1. се вижда, че в изходното кисело мляко виталността се движи от 2 h и 50 min. при проба 1 до 5 h при проба 5. В четири от изследваните проби 1, 2, 3 и 5 се наблюдават пръчковидни и коковидни бактерии, докато в проба 4 липсват пръчковидните форми. Киселото мляко не съдържа Lb. bulgaricus, а само Str. thermophilus, което намалява рязко биологичната стойност на продукта, а оттук и неговата функционалност. При престояване при pH 1.5 микрофлората в проби 4 и 5 загива, а при pH 2.5 и 3.5 се наблюдават само коковидни форми. Пръчковидни форми при pH 1.5 се установяват в две проби – 2 и 3.

С изключение на проба 2 и 5, стойностите за pH и киселинността по Тьорнер при останалите проби са в границите на доброкачественото кисело мляко.

Табл. 1. Влияние на pH 1.5, 2.5 и 3.5 върху виталността на микрофлората в киселото мляко в изкуствено приготвен стомашен сок след култивиране при 37˚C за 2 h.

Проба №	ph	Кисел инност по Тьорнер ˚T	Време за коагулиране на млякото часове и минути				Микроскопска картина			
			Изходно	при ph			Изходн	при ph		
				1.5	2.5	3.5		1.5	2.5	33.5
1	4.35	119	2h 50 min	20h	20h	20h	пк	к	пк	к
2	4.00	132	3h	19h	19h	19h	пк	пк	пк	к
3	4.63	99	4h 20 min	19h	19h	19h	пк	пк	пк	к
4	4.50	85	4h 30 min	нк	19h	19h	к	нк	к	к
5	4.11	119	5h	нк	19h	19h	пк	нк	к	к

п – пръчки, к – коки, нк-не е коагулирало

Данните за влиянието на pH върху преживяемостта на микрофлората – брой живи бактерии в киселото мляко в изкуствено приготвения стомашен сок са отразени в табл. 2.

Табл. 2. Влияние на pH върху преживяемостта на микрофлората – брой живи бактерии в киселото мляко в изкуствено пригитвен стомашен сок.

Проба №	ph	Киселинност по Тьорнер ˚T	Брой живи бактерии			
			Изходно	при ph		
				1.5	2.5	3.5
1	4.35	119	10^9к 10^6пк	10^1к п -	10^5к 10^4пк	10^7к 10^4пк
2	4.00	132	10^9п 10^5пк	10^3пк	10^5пк	10^7пк
3	4.63	99	10^9к 10^6п	10^4к 10^1п	10^8к 10^3п	10^9 к 10^5 п
4	4.50	85	10^9к п -	нк	10^7к п -	10^7к п -
5	4.11	119	10^8к п -	нк	10^6к п -	10^5 к п -

п – пръчки, к – коки, нк-не е коагулирало

Данните в табл. 2. показват, че изследваните проби 4 и 5 не съдържат живи пръчковидни бактерии. Тяхната микрофлора се състои единствено от кълбовидни форми- Str. thermophilus.

При pH 1.5 само в две проби 2 и 3 са останали живи пръчковидни форми в порядъка на 10^3 при проба 2 и 10^1 при проба 3. Тези количества от пръчковидни бактерии не могат да окажат здравословни ефекти,

за което е необходимо броят на живите бактерии, които достигат дебелото черво да бъде не по-нисък от 10^6/g. Рязко се увеличава броят на живите бактерии при pH 2.5 и най-висок е при pH 3.5. При това pH броят на Lb. bulgaricus е 10^7/g при проба 2 и 10^5/g в проба 3. Данните показват, че кълбовидните форми- Str. thermophilus са силно устойчиви на ниско pH, данни за което липсват в литературата.

ЗАКЛЮЧЕНИЕ

Данните от проведеното изследване показват големи различия в състава на микробната популация в киселото мляко в търговската мрежа. На лице е кисело мляко без Lb. bulgaricus, което рязко влошава биологичната и функционалната стойност на продукта. Много ниска е устойчивостта на Lb. bulgaricus на киселото мляко от търговската мрежа при pH 1.5. При pH 1.5 в две от изследваните проби- проба 2 и проба 3 се запазват живи и активни пръчковидни форми- Lb. bulgaricus, но броя им е под необходимото количество, което оказва здравословни ефекти върху организма. Данните дебело подчертават необходимостта от въвеждането на селекция при Lb. bulgaricus въз основа устойчивостта му при ниско pH. Това е необходимо условие да се повиши биологичната стойност и функционалността на киселото мляко. Особен интерес представлява установената устойчивост на кълбовидните форми- Str. thermophilus, при ниско pH, което се наблюдава за първи път.

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INFLUENCE OF MECHANICAL ACTIVATION ON THE PROPERTIES OF DENSE CERAMIC MATERIALS OBTAINED FROM FLY ASH

Biljana Angjusheva, Emilija Fidancevska, Ranko Adziski

Faculty of Technology and Metallurgy, University "St Cyril and Methodius" Rudjer Boskovic 16, Skopje, Republic of Macedonia

Abstract: *Dense ceramic compacts were fabricated utilizing fly ash class C from the power plant REK Bitola, Republic of Macedonia. By conventional sintering of fly ash (fraction with particle size lower than 63 μm) at temperatures of 950, 1050 and 1150^{0}C, the compacts with density of 1.4g/cm^3, bending strength of 10$\pm$1MPa and E-modulus of 5$\pm$0.8GPa were obtained. The effect of mechanical activation realized by milling of fly ash for 5h in ball mill showed the incensement of density up to 2.33 g/cm^3, bending strength of 71$\pm$2 MPa and E-modulus of 33$\pm$1GPa for the samples sintered at 1150^{0}C/1h. The obtained dense compacts were in thermal equilibrium and present potential ceramics to be considered as comparable to those of commercially produced engineering ceramics.*

Keywords: *fly ash, ceramics, sintering, bending strength, E-modulus.*

1 INTRODUCTION

Coal power plants are the main source of electricity in R. Macedonia. The large quantity of coal burned in these plants generates fly ash in quantity about 1.0 10^6 tons per year. This by-product is a result of burning of coal in the temperature range of 1100-1450^{0}C. Only a small quantity of the total fly ash generated is utilized in construction industry either for making bricks, concrete blocks or blending with cement [1-5]. Soon-Do Yoon et al. [6] pointed to advance technique for recycling fly ash to obtain glass -ceramic. There are many works of the other authors dealt with producing ceramic materials from fly ash. K.Primraksa et al.[7] dealt with obtaining of bricks of coal fly ash. They focus on treatments of fly ash by sieving and grinding and their influence on the properties of the fly ash bricks. Fly ash constructional materials with bending strength of 55 MPa were prepared by extrusion of 95 % Class C fly ash and other additives [8].

The aim of this paper is to obtain dense ceramic compacts by using only fly ash. Mechanical activation was used in order to increase the geometrical factor of activity of fly ash and the mechanical properties were increased as reflection of the activation.

2. EXPERIMENTAL PROCEDURE

The raw material was taken from the thermal power station REK Bitola from Macedonia. Two types of fly ashes were investigated: fraction of collection zone, particle size under 63 μm (FA1) and fraction of collection zone, particle size under 63 μm milled for 5 h (FA2). Chemical analysis of the investigated materials was carried out with ISP-OES VISTA-MPX spectrophotometer (Inducted Coupled Plasma Optical - Emission Spectrometry). By using a Philips X-ray diffraction unit (Model PV 105-1) operating at CuK_{α} - radiation X-ray diffraction (XRD) studies of the samples were realized.

The morphology of the fly ash and the microstructures of sintered samples were examined trough scanning electron microscopy (SEM- Leica S440i). The particle size distribution of the raw materials was determined by sieving analyses.

The densities of the powders were determined by immersion method. The specific surface area was obtained by BET nitrogen adsorption method (Gemini, Micrometritics USA). The wet milling of the powders was realized by ball mill with porcelain grinding media and milling time of 5 h. The ratio of fly ash to water and grinding media was 1 and 0,33, respectively.

Pressing of the powders, using water as binder, was performed by uniaxial press (Weber Pressen KIP 100) at P=30 MPa. The green bars were dried 24 h at room temperature and 24 h at 110 ^{0}C prior to sintering.

Sintering was realized in the chamber furnace in the air atmosphere at temperatures 950, 1050 and 1150^{0}C, using heating rate of 3^{0}C/min and isothermal treatment at the final temperature of 60 min. Bulk density of the sintered samples was determined by water displacement method according to EN-993.

Three point bending tester (Netzsch 401/3) with 30 mm span and 0,5 mm/min crosshead speed was used to determine mechanical properties of the dense specimens with dimensions 50x5x5mm^3, 8 pieces.

Linear thermal expansion of the dense materials was determined with a dilatometer Netzsch 402E in the air atmosphere and temperature interval RT-650-RT, with heating rate of 2^{0}C/min.

3. RESULTS AND DISCUSSION

The chemical composition of the investigated waste materials is given in Table 1.

It is evident that the silica content represents more than 50 wt.% in both ashes. The CaO content is higher than 10 % which characterized them as fly ash type C.

The phase composition of the investigated fly ash before mechanical activation was consisted of quartz, mullite, hematite, ilite, feldspar, anhydrite and glassy phase.

Tab. 1: Chemical composition of the fly ashes

Oxide	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	LOI	Σ
FA1 [wt%]	50.33	18.69	7.71	13.76	3.05	1.07	1.41	1.44	1.10	98.56
FA2 [wt%]	52.40	17.97	7.67	13.38	3.06	1.15	1.45	1.45	1.12	99.65

SEM micrograph of the fly ashes before and after mechanical activation are presented in Fig.1 and Fig.2

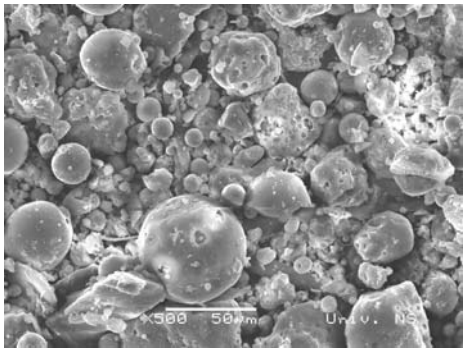

Fig. 1 SEM micrograph of fly ash before mechanical activation (bar 50μm)

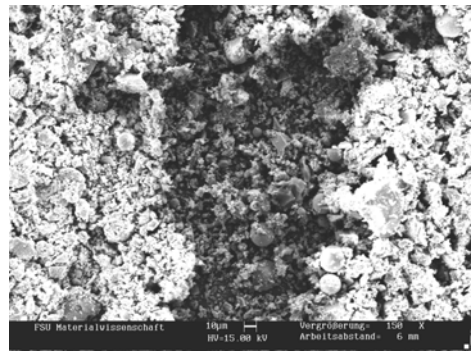

Fig. 2 SEM micrograph of fly ash after mechanical activation (bar 10μm)

Fig. 1 shows typical morphology of fly ash powders. In this SEM image spherical particles with a broad particle size distribution are observed. It is evident the presence of ceramics porous, vesicular and smooth cenospheres with dimensions from 60 to 10 μm. SEM micrograph (Fig 2) shows that particles of fly ash after mechanical activation are with smaller size (< 10 μm) and more uniform distribution.

Densities, specific surface area and average diameter of the fly ashes are presented in Table 2

Table 2 Density, specific surface area and average diameter of fly ash before and after mechanical activation

Fly ash	FA1	FA2
Density [g/cm^3]	2.27	2.38
Spec.sur.area[m^2/g]	3.09	4.75
d_p[μm]	37.63	20.97

As it is presented in Table 2, the specific surface area of fly ash after mechanical activation increased up to 4.75 m^2/g and the average particle diameter decreased to 20.97 μm. Mechanical activation clearly destroys the original fly ash particle structure and increases the available surface area.

Fig. 3 shows the density variation with firing temperature for fly ash compacts fabricated from non mechanically activated fly ash and mechanically activated (5h milled) fly ash.

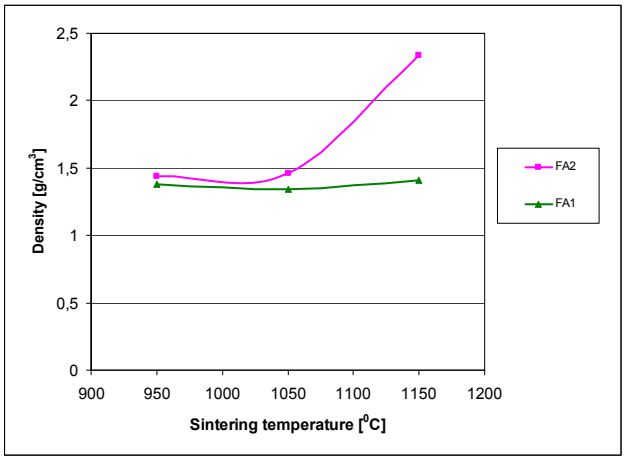

Fig.3 Effect of firing temperature on density of sintered samples

The mechanically activated fly ash samples had a maximal density of 2.33 g/cm^3 that was achieved by firing at 1150^{0}C for 1 h. The low density of the non mechanically activated fly ash samples demonstrate that these are not sintering effectively in the investigated temperature region. This is due to the poor particle packing in green compacts and reduced surface area compared to mechanically activated fly ash samples.

Mechanical properties (bending strength and E-modulus) of the sintered fly ash compacts in relation to the temperature are shown in Fig. 4 and Fig. 5.

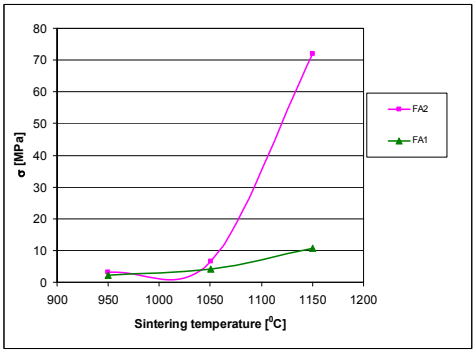

Fig. 4 Bending strength of fly ash

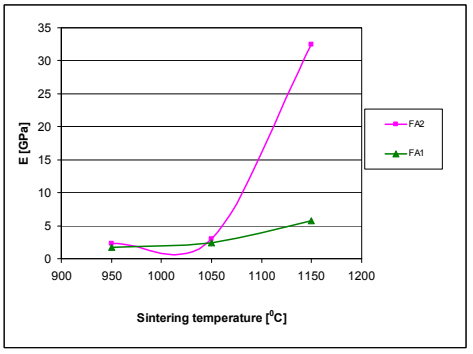

Fig. 5 E - modulus of fly ash

compacts in relation to firing temperature

compacts in relation to firing temperature

It is evident from Fig.4 and 5 that bending strength and E-modulus of fly ash compacts obtained after 5 h milling showed rapid increasment of the mechanical properties from temperature 1050 to 1150^{0}C. The bending strength of mechanically activated fly ash is 71.0 ±2 MPa for the firing temperature of 1150^{0}C, while for non activated fly ash samples it is only 10±1 MPa.

Thermal expansion investigation of the mechanically activated fly ash sintered at 1150^{0}C/1h showed absence of hysteresis which proved that the system is in thermal equilibrium. Technical coefficient of thermal expansion is α_{tech} =7,4·10^{-6}/^{0}C.The temperature variation of the physical coefficient of thermal expansion in the interval of RT-650-RT is presented as II order polynomial form (1):

(1) $$\partial(\Delta L/L_0)/\partial T = 0{,}0099\text{-}2\cdot10^{-5}T\text{-}3\cdot10^{-8}T^2$$

SEM micrographs of the fractured surfaces of mechanically activated fly ash sintered at 1150^{0}C/1h is shown in Fig.6

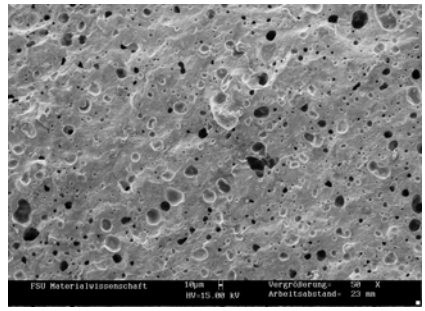

Fig. 6 SEM micrograph of fracture surface of mechanically activated fly ash samples sintered at 1150 ^{o}C/1h (bar 10 μm)

SEM micrograph presents smooth fractured surface which is result of high density and good sinterability. The presence of open pores with dimensions from 10 to 30μm and close pores with the same dimensions are evident.

4. CONCLUSIONS

Dense ceramic materials were fabricated by conventional route of processing using mechanical activation and consolidation. Ceramics with density of 2,33 g/cm^3, bending strength of 71±2 MPa and E-modulus of 33±1GPa was fabricated from fly ash fraction less than 63 μm mechanically activated for 5h and sintered at 1150^{0}C/1h. According to the density and

mechanical properties the fabricated ceramics can be potentially considered to those of commercially produced engineering ceramics.

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BIOMASS ENERGY UTILISATION - ECOLOGICAL AND ECONOMIC ASPECTS

Assoc. Prof. Plamen Gramatikov, Ph.D.

Department of Physics, South-Western University "Neofit Rilsky";
2700-Blagoevgrad, Bulgaria

***Abstract**: Biomass is the world's fourth largest energy source today and it represents about 35 % of the primary energy supply in developing countries. Biomass is a versatile source of energy in that it can produce electricity, heat, transport fuel and it can be stored. The problems (technical, economic, etc.) which have to be solved by treatment of biomass are discussed in this work. The average quantities of biomass resources of some European countries are presented and the structure, percentage of products and their calorific values are estimated.*

***Keywords:** Biomass Energy Potential, Ecological & Economic Aspects.*

1. INTRODUCTION

The beginning of the third millennium coincided with important challenges for the energy sector. Environmental concerns are gaining ground mostly on economic considerations, but above all, decisions makers are now facing critical long-term energy policy choices. The on-going liberalisation of the gas and electricity markets is profoundly changing the structure and dynamics of energy markets in Europe. Furthermore, world markets are becoming more fluid, and decisions affecting one country necessarily affect others. In the years to come, investments in energy, both to replace existing resources and to meet increasing energy requirements, will obligate economies to arbitrate among energy options taking into account environmental concerns. The opportunity should be seized to promote viable environmental and energy policies at the global level.

The environment has always provided a variety of options for alternative and renewable energy sources. Some alternatives have been used for years and others are still being developed. Biomass energy that has been used in developing countries is becoming increasingly common in industrialised countries.

2. BIOMASS AS RENEWABLE ENERGY SOURCES

An increasingly important source of fuel is biomass, which can include such diverse sources as agricultural crop waste, forestry waste, animal waste, sewage, municipal waste, and sea-weed. Definition of Biomass – it is biodegradable fraction of products, waste, residues from agriculture.

Energy from biomass can be obtained in processes of direct combustion of solid biofuels or after processing into liquid and gaseous fuels (Fig. 1).

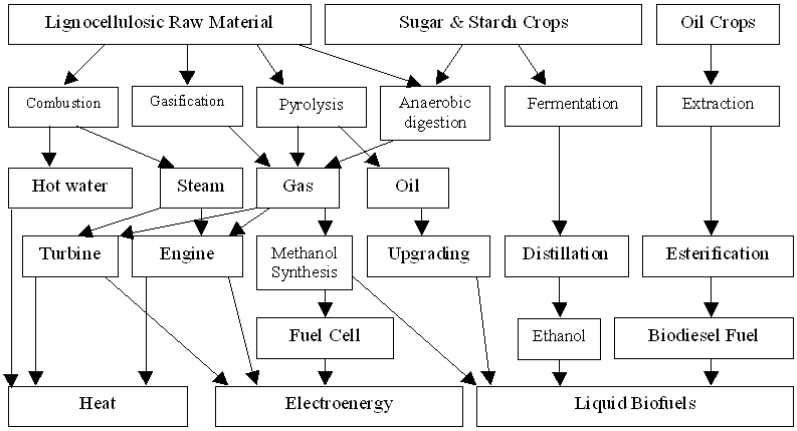

Fig. 1: Possible converting of biomass to end-products.

The common raw material are often defined as “waste materials”, e.g. human excreta, animal manure, sewage sludge, and vegetable crop residues, all of which are rich in nutrients suitable for the growth of anaerobic bacteria. Although some of these materials can be used directly as fuels and fertilisers, they could be used for biogas production to gain some additional heat value while the other benefits are still retained (Table 1).

Tab. 1: Definition of “renewable” and “waste” fuel sources in common use.

Renewable, sustainable biomass fuel sources	“Waste” fuel sources
Sugar cane waste	Sewage digester gas
Timbermill waste or sawdust	Landfill gas
Forestry and agricultural residues	Mines gas
Short-rotation forestry	Coke-oven gas
Straw	Refinery /process plant flare gas/ off-gas
Rice husks and coffee husks	Stripped crude gas
Peanut and other nut shells	Municipal solid waste incineration
Palm oil and coconut residues	Hazardous and chemical waste incineration
Meat and bone meal	Sewage sludge incineration
Poultry litter	Hospital and clinical waste incineration
Livestock slurry	Vehicle tyre incineration

Wood, straw, sewage sediments and other solid organic materials can be used to produce energy in processes of direct burning. Biomass can also be processed into liquid fuels (rape methyl ester - RME, alcohol, pyrolysis

gasoline) or gaseous (farm biogas, biogas from purification plants or from refuse dumps, etc.).

Based on the value of the biogas (4,500 – 6,300 kcal/m^3), it is estimated [1] that on complete combustion 1 m^3 of biogas is sufficient to:

1. Run a 1 horsepower engine for 2 h.
2. Provide 1.25 kWh of electricity.
3. Provide heat for cooking three meals a day for five people.
4. Provide 6 h. of light equivalent to a 60 W bulb.
5. Run a refrigerator of 1 m^3 capacity for 1 h.
6. Run an incubator of 1 m^3 capacity for 0.5 h.

Therefore 1 m^3 of biogas is equivalent to 0.4 kg of diesel oil, 0.6 kg petrol, or 0.8 kg of coal. The biogas can be used to drive a turbine or internal combustion engine as well as to be used in boilers to produce heat [2]. Biomass as material for direct combustion, if not processed into briquettes or pellets can only be used in a local scale because of its low volumetric mass. In general, the production of biomass for energy will enable better use of land, labour and capital on farms.

3. CURRENT SITUATION IN EUROPE

Biomass production in 2001 was 56 Mtoe. To achieve 12 % by 2010 estimations show a need of more 74 Mtoe of biomass energy. The Directive 2003/30/EC promote of the use of biofuels for transport through:

• The Directive sets a minimum percentage of biofuels to replace diesel or gasoline for transport purposes in each Member State.

• Member States shall ensure by end of 2005 a 2 % minimum proportion of biofuels of all gasoline and diesel fuels sold on their market – by end of 2010 a 5.75 % minimum proportion.

In the frame of the Common Agricultural Policy (CAP) reform is estimated the impact of biofuels to increase through better opportunities for farmers to adapt production to increasing demand for biomass and by additional incentives:

- New energy crop premium
- Growing energy crops on set-aside land continued
- Premium of € 45 per hectare in addition to decoupled payments granted according to reference area
- Maximum guaranteed area of 1.5 million hectares
- All crops (except sugar beet) eligible for support, including some multiannual
- Processing contract required, if not processed on farm.

Share of biomass in energy production of the EU countries is shown on Fig. 2.

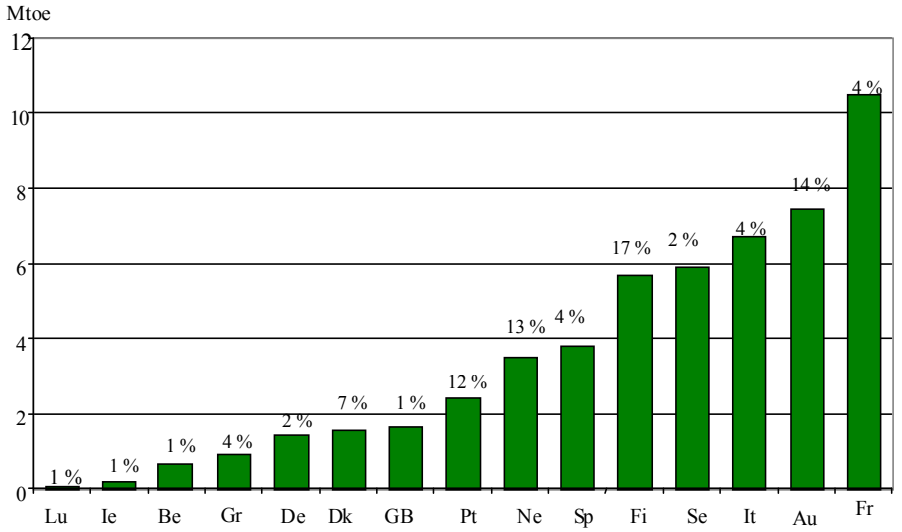

Fig. 2: Share of biomass in energy production of the EU countries during 1997 [3].

It can be seen that the greatest absolute amount of biomass produce France, although as a relative share Finland is the first in use of biomass for energy production.

Tab. 2: Current situation - Energy production from biofuels.

Energy production from biofuels, Mtoe			
Field	2001	Additional estimated amounts needed 2010	Total by 2010
Electricity	13	32	45
Heat	42	24	66
Transport	1	18	19
Total	56	74	130

To reinforce the effective use of biomass for energy purposes, in May 2004, the European Commission (EC) has announced a co-ordinated Biomass Action Plan with clear approach to securing adequate supplies of biomass through European, national and regional/local action. The plan will have to ensure effective co-ordination of Community policies in Energy, Agriculture and forestry, industry, rural development, environment and industry. Parts of the plan would be the following actions:

• Twinning actions of biomass energy generation under the existing directives and buildings including an efficient use of wood for energy.

• Landfill gas recovery and anaerobic digestion, which does not replace waste prevention and recycling.

• Fossil fuel substitution in coal plants and co-firing.

4. ENERGY FROM BIOMASS AND THE ENVIRONMENT

One of the main goals of the modern agricultural engineering is the environment conservation [4]. This fact should be taken into consideration in strategies of development of the agriculture and rural areas in general as well as in the energy policy.

Among different sources of pollution connected with agricultural production there are harmful products emitted during the combustion of coal and petrol fuels. Since the predominant production of the electric energy in Bulgaria is based mainly on the coal, therefore also using this kind of energy is bound indirectly with environment degradation.

More wide use of renewable energy sources, including biomass, would be favourable for environmental conservation. However, high unitary costs of production of energy from these sources are the main factor hampering their use.

5. CURRENT SITUATION AND BARRIERS IMPEDING THE BIOENERGY USE IN BULGARIA

It is estimated [5] that the total energy equivalent of plant and animal residues and wastes in Bulgaria is about 2 Mtoe/yr (Table 4). This value amount 22 % of the primary energy needs of Bulgaria for a year.

Tab. 3: Available resources of biomass in Bulgaria.

Type of biomass	Total yield, t	Yield, t/1000 ha
Primary yield of plant production	11 324 104	1 024
Ten most important crops		
Wheat	3 070 667	278
Clover	2 000 000	181
Maize	1 112 000	101
Oats	719 333	65
Forage maize	616 485	56
Potato	471 333	43
Sunflower	446 333	40
Tomato	408 667	37
Grapes	405 691	37
Meadow grass	310 000	28
Stock-breeding	Number	Number/1000 ha
Cattle	676 500	61
Birds	15 324 000	1 386
Pigs	1 616 500	146
Equivalent animal units	1 476 340	134
Wood industry	m^3	m^3/1000 ha
Firewood and wooden coals	1 607 000	145
Timber residuals	2 000	0

In spite of ecological, economic and social advantages, the use of biomass for energy is not enough widespread in Bulgaria. There are several barriers of economic and organisation nature as well as some technological problems that impede using the biomass for energy:

- Large range of water contents (up to 60 %) making the preparation of biomass for energy use difficult.
- Rather low calorific value as related to the mass or volume.
- Low density of biofuels causing their transportation, storing and dosage difficult.
- High diversification of processing of biomass into energy carries.

Multitude and diversity of problems linked with the use of biomass for energy hampers the improvement and implementation of appropriate technologies. Only well-prepared biomass fuel with reduced humidity can ensure the performance over 70-80% in modern stoves.

6. CONCLUSIONS AND FUTURE DEVELOPMENT

1. Existing potential of land, labour and technologies enables significant increase in production of biomass in Bulgaria. There are also potentialities to produce RME.
2. Biomass energy production has positive effects on development of rural areas.
3. The local renewable energy industry offers possibilities to develop the infrastructure in rural areas and to create new jobs, and therefore enable professional activation of personnel leaving the agriculture without problems related to the mitigation. Creation of new jobs in rural areas may stimulate the positive changes in farm size structure.
4. The use of potential renewable energy from agricultural by-products (animal and municipal wastes for biogas) could contribute in an increase of the share of gaseous fuels and in decreasing the use of solid fuels. It also brings about the diminution of soil and water pollution problems connected with the use of slurry. Finally, the use of biomass for energy instead of the mineral fuels, is friendly to the environment.

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Dissociation of relativistic ^{8}B nuclei in peripheral collisions

R. Zh. Stanoeva[1,2], J. N. Stamenov[1], P. I. Zarubin[2]

[1]Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2]Joint Institute for Nuclear Research, Dubna, Russia

***Abstract**: The BECQUEREL Project at the JINR Nuclotron is devoted systematic exploration of clustering features of light stable and radioactive nuclei. The technique of nuclear track emulsions is used to explore the fragmentation of light relativistic nuclei down to the most peripheral interactions - nuclear "white" stars. The analysis of the relativistic fragmentation of neutron-deficient isotopes has special advantages owing to a larger fraction of observable nucleons. A complete pattern of the relativistic dissociation of a ^{8}B nucleus with target fragment accompaniment is presented. The important role of the electromagnetic dissociation on heavy nuclei with respect to break-ups on target protons is demonstrated.*

***Keywords:** relativistic nuclei, fragment, emulsion, peripheral dissociation.*

1. INTRODUCTION

Among all variety of the nuclear interactions the peripheral dissociation bears uniquely complete information about the excited nucleus states above particle decay thresholds. The peripheral dissociation is revealed as a narrow jet of relativistic fragments the summary charge of which is close to the charge of the primary nucleus. In spite of the relativistic velocity of fragment motion in a laboratory system the internal velocities inside the jet are non-relativistic [1]. In principle, information about the generation of such fragment ensembles can be used in nuclear astrophysics (indirect approaches), as well as in developments of nucleosynthesis scenarios on the basis of few-particle fusion. To utilize this novel possibility it is necessary to provide the completeness in the observation of relativistic fragments.

The emulsion composition provides a special convenience to explore just peripheral interactions. It includes the Br, Ag and H nuclei in comparable concentrations and allows one to compare fragmentation patterns of various origins. Under the same conditions it is possible to observe the very peripheral break-up in the electromagnetic field on a heavy target nucleus (EM dissociation; fig. 1) as well as in collisions with target protons.

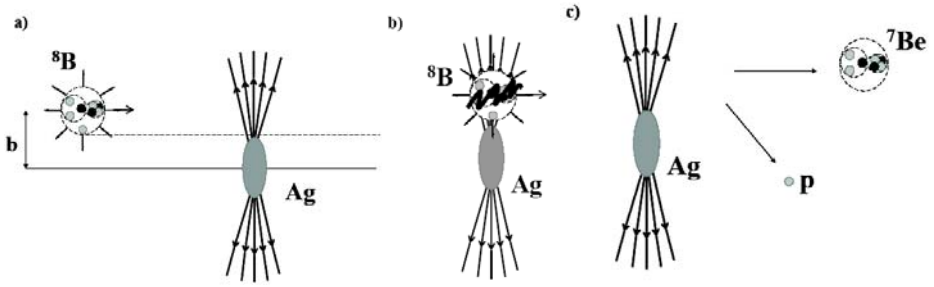

Fig. 1: Diagram of peripheral dissociation of relativistic ^{8}B nucleus in EM field of Ag nucleus: nearer approach of the nuclei with an impact parameter (a), absorption of quasireal photon by ^{8}B nucleus (b), ^{8}B dissociation on fragment pair - p and ^{7}Be (c).

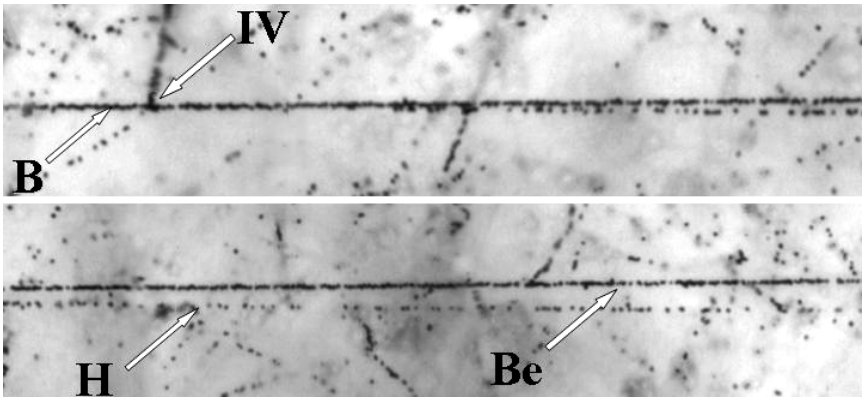

Fig. 2: Example of peripheral interaction of a 1.2 A GeV ^{8}B→^{7}Be+p in a nuclear track emulsion (event with target fragment n_b=1). The interaction vertex (indicated as **IV**) and nuclear fragment tracks (**H** and **Be**) in a narrow angular cone are seen on the upper and bottom microphotograph.

The emulsion response is described by the multiplicities of heavily ionizing fragments n_b including α particles and slow protons and n_g corresponding to non-relativistic protons. Besides, the reactions are characterized by the multiplicity of produced mesons n_s. The events in which there are no tracks of target nucleus fragmentation belong to electromagnetic or diffractive dissociation and are named “white” stars (n_b = 0, n_g = 0, n_s = 0). Dissociation on a proton must lead to the appearance of its track, that is, n_b = 0, n_g = 1, and n_s = 0.

The presence in the interaction vertex of strongly ionizing particle (n_b>0) tracks (example is shown in Fig.2) or relativistic particle (n_s>0) tracks outside the fragmentation cone makes it possible to define the interaction as

the one which occurred with an overlap of the densities of colliding nuclei or with C, N and O nuclei in the cases of extremely short tracks of recoil nuclei. In principle, mutual excitation and simultaneous fragmentation of both colliding nuclei are possible. The discussion of these events is outside the scope of the present paper and their statistics is given for the sake of illustration.

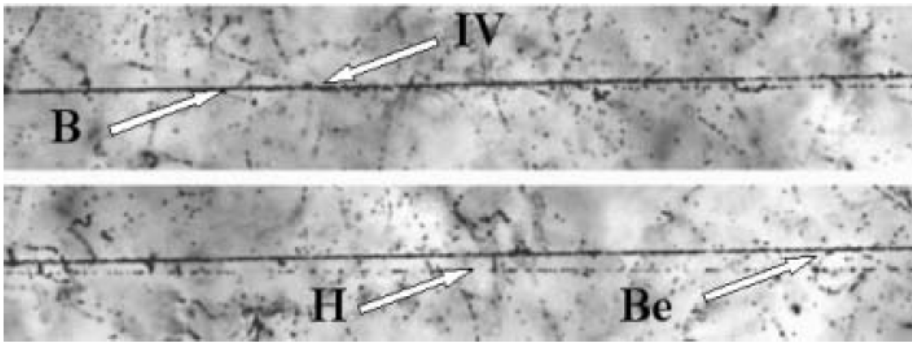

Fig. 3: Example of peripheral interaction of a 1.2 A GeV $^{8}B \rightarrow ^{7}Be+p$ in a nuclear track emulsion ("white" star). The interaction vertex (indicated as **IV**) and nuclear fragment tracks (**H** and **Be**) in a narrow angular cone are seen on the upper and bottom microphotograph.

2. EXPERIMENT

Nuclear emulsions were exposed to relativistic ^{8}B nuclei at the JINR Nuclotron. The beam of relativistic ^{8}B nuclei was obtained in the $^{10}B \rightarrow ^{8}B$ fragmentation reaction using a polyethylene target [2]. Data were obtained at a beam energy of 1.2 A GeV. Events were sought by microscope scanning over the emulsion plates. A leading contribution of the "white" stars $^{8}B \rightarrow ^{7}Be+p$ (50% or 25 events) having the lowest energy threshold was revealed. Due to the loosely bound proton the ^{8}B nucleus appears to be a very sensitive probe of the EM interactions proceeding at the lowest momentum transfers even. Information about a relative probability of ^{8}B dissociation modes with larger multiplicity has been obtained. The ^{7}Be core dissociation in ^{8}B is found to be similar to that of the free ^{7}Be nucleus [8]. Emulsions provide the best spatial resolution (about 0.5 mm). Irradiation details and a special analysis of interactions in the BR-2 emulsion are presented in refs. [3, 4]. We have no chance to present here a full description of all experimental procedures [2–5].

3. RESULTS

The study of the events with a total relativistic fragment charge of $\Sigma Z_{fr}=5$ in an emulsion exposed to ^{8}B nuclei enabled one to establish the leading contribution of the "white" stars $^{8}B \rightarrow ^{7}Be+p$ as compared with the stars con-

taining the target fragments [4,6]. This conclusion is a qualitative distinction from ^{10}B case for which 3-prong “white” stars 2He+H are predominant [7].

Tab. 1: The distribution of the peripheral interactions with ΣZ_{fr}=5 and 6 obtained in an emulsion exposed to a ^{8}B enriched secondary beam versus target fragment numbers n_b and n_g.

n_b	0	0	1	2	3	4	5
n_g	0	1	0	0	0	0	0
He+3H	12	6	3	3	2	3	-
2He+H	14	3	8	2	4	-	1
Be+H	25	1	3	3	1	-	-

A detailed distribution of the ^{8}B dissociation over the fragment configurations $\sum Z_{fr}$ and the numbers of the target fragments n_b and n_g is given in Table 1. First of all, the predominance of “white” stars $^{8}B \rightarrow {}^{7}Be+p$ should be noted (example is shown in Fig.3). In this channel, there is practically no dissociation on protons n_g=1. The difference is due to a rapid increase in the EM dissociation cross section with increasing target nucleus charge (like Z^2). Half a number of “white” stars is just associated with 3- and 4- particle dissociation modes having much higher thresholds. This implies that the multiple fragmentations can be initiated by an EM excitation of one of the He clusters. It may also be noted that in the 2He+H (example is shown in Fig.4) and He+3H channels the fraction of the events on protons (n_g=1) and the events with target fragments (n_b>0) with respect to the ^{7}Be+p channel becomes the major one and increases by a factor of 5 as compared with the case of “white” stars (n_b=0, n_g=0). It is obvious that such a tendency is connected with an increase of direct proton-nucleon collisions.

4. CONCLUSIONS

The presented observations serve as an illustration of prospects of realtivistic nuclear beams for nuclear astrophysics. The results of an exclusive study of the interactions of relativistic ^{8}B nuclei in nuclear emulsion lead to the conclusion that the known features of their structure are clearly manifested in very peripheral dissociations. In spite of an extraordinarily large distinction from the nuclear excitation energy the relativistic scale does not impede investigations of nuclear interactions in energy scale typical for nuclear astrophysics, but on the contrary gives also new methodical advantages.

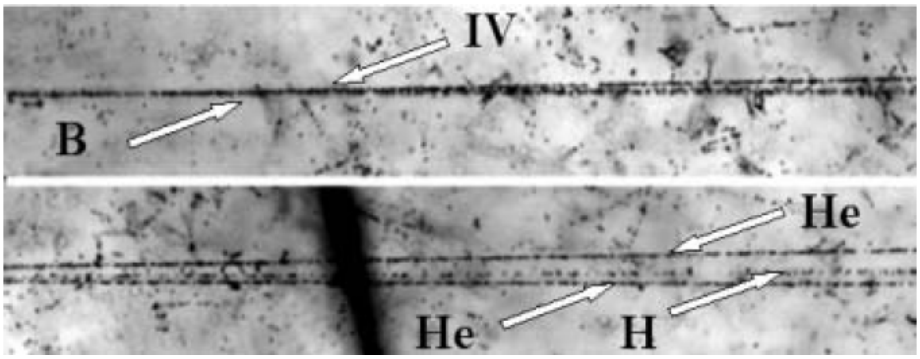

Fig. 4: Example of peripheral interaction of a 1.2 A GeV $^{8}B \rightarrow 2He+H$ in a nuclear track emulsion ("white" star). The interaction vertex (indicated as IV) and nuclear fragment tracks (H and He) in a narrow angular cone are seen on the upper microphotograph. Following the direction of the fragment jet, it is possible to distinguish 1 singly (the central track) and 2 doubly charged fragments on the bottom microphotograph.

Due to a record space resolution the emulsion technique provides unique entirety in studying of light nuclei, especially, neutron-deficient ones. Providing the 3D-observation of narrow dissociation vertices these classical technique gives novel possibilities of moving toward more and more complicated nuclear systems. Therefore this technique deserves upgrade, without changes in its detection basics, with the aim to speed up the microscope scanning for rather rare events of peripheral dissociation of relativistic nuclei.

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Diurnal and 27 day variations of cosmic rays as registered with the muon telescopes at SWU and BEO – Moussala

Ivo Angelov

South West University "N. Rilski"

***Abstract**: The results from the periodic analysis of the muon telescopes data at South West University and BEO - Moussala are presented. The diurnal and the 27-day variations are clearly visible..*

***Keywords:** cosmic rays, muon telescopes, periodic variations*

1. INTRODUCTION.

The intensity of the cosmic rays (CR) changes continuously with time. The CR intensity variations can be divided in two main groups: variations of terrestrial origin and variations of extra terrestrial origin.

Seasonal and diurnal variations, due to changes in the atmosphere temperature profile belong to the first group and are significant for the muon component of CR. Small diurnal variation of the CR intensity due to small diurnal change of the local geomagnetic cut-off also exist because of the asymmetric shape of the Earth’s magnetosphere[1],[2].

The extraterrestrial variations of CR are two groups periodic and sporadic.

The ground level enhancements (GLE) and the Forbush decreases have solar origin and belong to the sporadic CR variations. (See [3], [4], [5] for details.)

The observed extraterrestrial periodic variations are 22 year, 11 year, 27 day and solar diurnal variation. They are connected with solar modulation effects on CR.

The 22 year variation is connected with the solar magnetic fields reversal. The 11 year variation is connected with the solar activity cycles and has largest amplitude, a example plot is shown on fig. 1. [6].

A 25-26 day periodicity (sidereal period) is observed in large number quasi-periodic variations of the different solar activity parameters and the solar wind because of the 25-26 day rotation of the sun (for the solar equatorial and near equatorial regions, for solar polar regions the period of rotation is about 35 days). For an observer on the Earth, this periodicity is 27-28 days (sinodical period). The periodic CR variation, connected with the solar rotation is called 27-days variation [8].

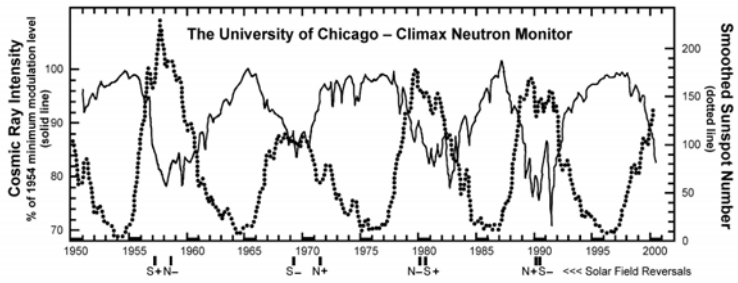

Fig. 1: The 11 year variation of CR and its anti-correlation with the solar activity [6].

The CR particles corotate with the interplanetary magnetic field (IMF). At distance 1 AU the speed of corotation is about 400 km/s and the direction is in the direction of the Earth orbital movement (fig. 2). This effect leads to an anisotropy of CR and a diurnal variation which should have maximum about 18:00 local time [6]. In fact the maximum is shifted towards earlier hours because of the bending of the trajectory of primary CR particles by the Earth's magnetic field.

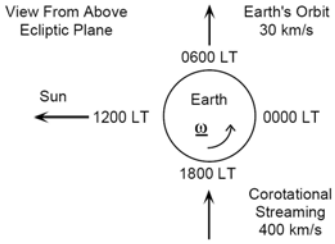

Fig. 2: Corotation of CR particles with IMF [6].

The variations of CR are studied with neutron monitors and muon telescopes [1], [7]. In this paper we analyzed data from the muon telescopes (MT) at South West University (SWU) and Basic Environmental Observatory – Moussala (BEO). Details for the instruments can be found in [9], [10], [11].

2. EXPERIMENTAL DATA, PROCESSING AND ANALYSYS

We have analyzed data from the time period November 2007 – May 2008 for the SWU MT and for the period August 2006 – June 2008 for the BEO MT. The relative intensities of the CR muons are pressure corrected. For the SWU MT we take the data records averaged for 15 minutes (by the data logger software). We used the 15 seconds raw data from the BEO MT, the data are pressure corrected and averaged for 15 minutes by custom soft-

ware. The 15 min. data were smoothened using digital filters. The data processing was done with MatLab 7.1

2.1. The diurnal variation

The method of superimposed epochs was used to obtain the diurnal variation. The obtained results are plot on fig. 3a, 3c.

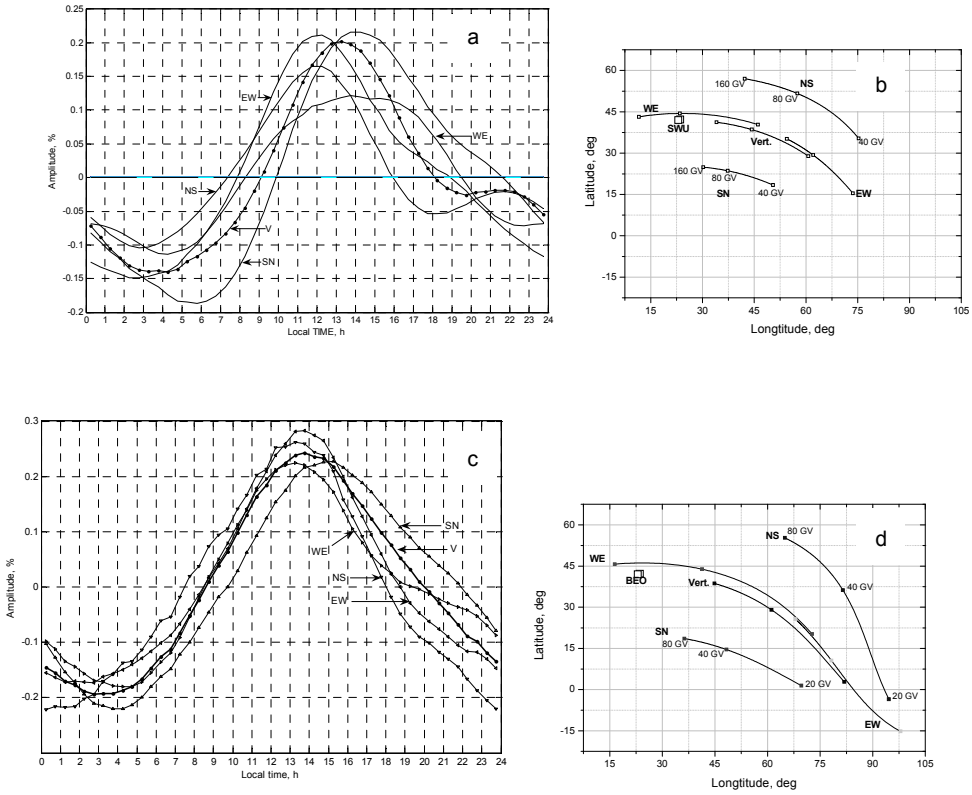

Fig. 3: Diurnal variations of CR muons and asymptotic directions of the telescopes:
a) MT SWU variation ; b) asymptotic directions of SWU MT ;
c) MT BEO variation, data from August 2006 to December 2006;
d) asymptotic directions of BEO MT.

As expected the shape of the diurnal variation is near sinusoidal.

For SWU MT, vertical direction (fig. 3a, line V), the maximum is at 13:15 local time (LT), the minimum is at 03:45 LT. The peak to peak (p-p) amplitude is ~0.35%. A weak second maximum is noticed at 22:00 LT.

For the BEO MT, vertical direction (fig. 3c, line V) the maximum is at 13:45 LT, the minimum at 3:15 LT, the amplitude is ~0.45% p-p.

2.2. The 27-days variation

We have analyzed only the data from the BEO MT for 27 days periodicity, since we have long enough period only for this telescope. The adjacent averaging smoothed over 6 points hour data are plot on fig 4., the dashed line. For 27 days variation we used additional smoothing by digital filtering of these data. A digital recurrent band pass filter with cut off frequencies 2.10^{-2} cycles/day and 10^{-1} cycles/ day (corresponding to periods 50 days and 10 days) was used. To avoid phase distortions the filter is applied once in forward and once in backward direction. The filtered data are plot on fig. 4 – the solid line.

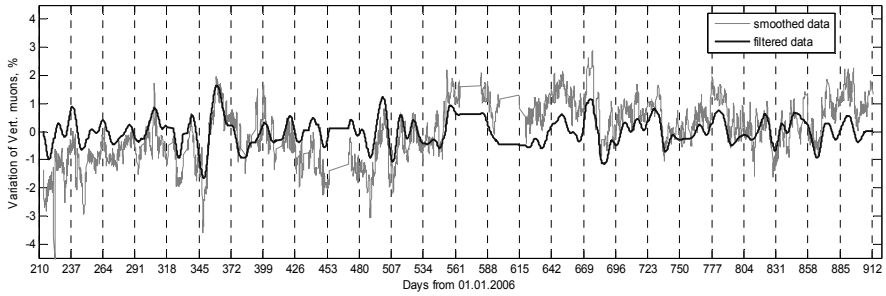

Fig. 4: 27 days variations of CR muons

3. DISCUSSIONS AND CONCLUSIONS.

Since the primary CR are charged particles, (mainly protons) their trajectories are distorted by the Earth's magnetic field and the vertical CR, detected by a telescope, are not coming along the Earth's radius, but from another direction. The direction at which a particle enters the Earth's magnetosphere can be calculated if we know its energy and the direction at which it comes to the detectors using "the method of backward trajectories" [12]. These directions are calculated for primary particles with different rigidities (in the energy range of the instrument), entering the atmosphere above the detectors vertically at 20 km altitude and are called asymptotic directions for the instrument. The asymptotic directions allow to estimate from which direction of the interplanetary space are coming the particles detected at given directions on the ground.

The asymptotic directions for the two telescopes are calculated using MAGNETOCOSMICS software code [12] and are plot in geographical coordinates on fig. 3b, 3d [11].

As mentioned before, the solar diurnal variation due to the corotational streaming should have maximum at about 18:00 LT, if the particles trajectory bending is not taken into account. We have maximums at 13:15 and

13:45 LT (fig.3a, 3c), approximately 4.5 hours before 18:00, which corresponds to ≈67.5° longitude shift. At this moment, the LT is 18:00 at ≈90°E. (The angular speed of Earth is 15°/h, the telescopes are situated at ≈23°E)

For the vertical channels of the telescopes, according to the calculations, from asymptotic viewing longitude ≈90°E come particles with rigidities ≈16 GV for BEO MT. From asymptotic viewing direction with longitude ≈80°E come particles with rigidity ≈21 GV.

The SWU MT is sensitive mainly to primaries with rigidities 20-160 GV and the BEO MT is sensitive to primaries with rigidities 10-80 GV (fig. 5).

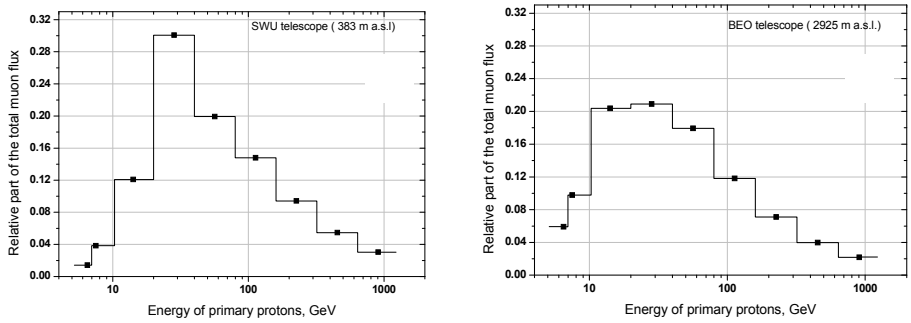

Fig 5. Response to primary protons: a) SWU MT ; b) BEO MT. [11]

The maximum of the registered diurnal variation corresponds to corotational streaming anisotropy of CR. The time of maximum and the phase differences between the directions are in logical agreement with the calculated asymptotic directions.

The phase differences, for the BEO MT, between the different directions are smaller, because it is more wide angle, and with lower rigidity response than the SWU MT.

The second small maximum at about 22:00 – 23:00 LT is probably due to Earth’s magnetosphere asymmetry.

The observed 27-days variation is not constant and with small amplitude, which is usual for data near minimum solar activity period.

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Non-linear Optical Method For Measurement of Fibre Parameters

Luben Mihov Ivanov

South West University, Blagoevgrad, Bulgaria
and
Institute of Electronics, Bulgarian Academy of Science, Sofia, Bulgaria

Abstract*: We demonstrate the possibility of determining simultaneously the parameters of optical fibers, using stimulated four-photon mixing. This is the first non-linear optical method, which allows obtaining the important fiber parameter. The method is without the requirement of considering the particular refractive profile. The most suitable modal combinations, which minimize the error of neglecting the refractive index profile, are found depending on the V parameter value. Experimental results, which verify the accuracy of the proposed method, are given too.*

Keywords: *Fiber optics, non-linear optics, four photon mixing, optical communications.*

1. INTRODUCTION

At present most of developed methods for d control of optical fiber parameters determine only one of the fiber parameters [1]. We propose method based on nonlinear optical processes when measuring the frequencies shifts between new components and pump wave at stimulated four-wave mixing (FWM). As a result practically important fiber parameters are simultaneously determined such as: the core radius a_{cor}, the core cladding refractive index difference Δn, the cut-off wavelength λ_c, and the fiber V parameter.

2. METHOD

As it is well known, the stimulated FWM is a non linear process, when two pump photons of frequency ν_p are transformed in Stokes and anti-Stokes pair of frequency respectively ν_s and ν_a, which obey the energy balance $\nu_p - \nu_s = \nu_a - \nu_p$. The process is efficient if the phase matching condition $\Delta k = k(\nu_s) + k(\nu_a) - 2k(\nu_p) = 0$ is fulfilled. Perfect phase-matching can not be achieved in optical glasses because in the normal (anomalous) dispersion region Δk is always greater (less) than zero. Exact

phase-matching is possible in optical fibers, when the material is compensated by the modal dispersion for a suitable combination of the modes, i.e.

(1) $\Delta\beta = \beta_{p1} + \beta_{p2} - \beta_a - \beta_s = 0$,

where β_{p1}, β_{p2}, β_a and β_s are the propagation constants of the waves in the respective waveguide modes.

The frequencies ν_a and ν_s generated by a FWM process can be accurately predicted, if the parameters of the fiber, including the refractive index profile, are precisely known. For a fixed modal combination, they can be calculated by varying frequency shift $\Delta\nu = \nu_p - \nu_s = \nu_a - \nu_p$, and looking for a $\Delta\nu$, at the phase-matching condition, expressed by eq.1.

At the same time, the solving of the inverse problem – to fine the fiber parameters from the fibers from the given FMW frequencies – have to deal with difficulties, connected mainly with the influence of the refractive index profile. Most of the fibers produced by the MCVD technique have a central dip in the profile. The shape and the depth of this central dip substantially modify the dispersion properties of the fiber and, as a result, the frequency shifts of various modal combinations.

In this work we demonstrate the possibility for substantial reduction of the error, associated with the FWM method. Our investigations demonstrate, that we can achieve the same results when using the direct measurement of the differential modes delay for a fiber parameters determination, and the error due to the influence of the refractive index profile, is minimize too.

For the case of weakly guided fibers [2] in a divided pump process (that is the Stokes and one of the pump wave propagate in one fiber mode, while the anti-Stokes and other pump wave propagate in another fiber mode) the frequency shift $\Delta\nu$ is determinate by Δn, V, $2a$, and n_{cor} as it follows [3,4]:

(2) $$\Delta\nu\lambda_p D(\lambda_p) = \Delta n\left[\frac{d(B_s V)}{dV} - \frac{d(B_{as} V)}{dV}\right],$$

where

(3) $$V = \frac{2\pi a}{\lambda}\sqrt{2n_{cor}\Delta n}$$

is the normalized frequency, λ_p is the pump wavelength, $D(\lambda) = \lambda^2\left(\frac{d^2 n}{d\lambda^2}\right)$ is the core material dispersion and $\frac{d(BV)}{dV}$ are differential mode delays of the propagating Stokes and anti-Stokes waves. These modal delays depend only on the V parameter and on the real profile of the

refractive index of the waveguide core. They do not depend, however on whatsoever material parameters. distinct combinations of modes) the following characteristic equation for the parameter V can be written [5].

$$(4)\ \frac{\Delta\nu^{(1)}}{\Delta\nu^{(2)}} = \frac{\dfrac{d(B_s^{(1)}V)}{dV} - \dfrac{d(B_{as}^{(1)}V)}{dV}}{\dfrac{d(B_s^{(2)}{}_sV)}{dV} - \dfrac{d(B_{as}^{(2)}V)}{dV}} = R(V).$$

In eq.4 indices 1 and 2 denote the first and the second modal combination respectively. If the refractive index profile is already known, the right side of the eq.4 depends only on the V parameter. This fact established the possibility to obtain V parameter, and after that – the other fiber parameters.

However, the various refractive index profiles yield different value for the normalized group delays [6], and therefore substantially different function $R(V)$. As a result, the error of the obtained V parameter can be quite large. In order to find the conditions for minimizing this error we investigated the $R(V)$ function for various refractive index profile and modal combinations.

The main concept of our approach is straightforward. The central dip of the refractive index profile influences substantially on the normalized group delays of the axially symmetrical only (the LP_{lp} modes with first index $l = 0$) [6]. The latter is a consequence of the fact that the intensity maximum of these modes, for the fiber without a dip must lay in the center of the fiber. Hence, the presence of the dip changes radial field distribution and the group velocity of the wave. The influence of the refractive index profile on the axially anti-symmetrical modes (the first index $l > 0$) is much less pronounced, because their intensity at the center of the fiber is zero.

Fig. 1 shows the dependencies $R(V)$ for the rectangular refractive index profile and the rather extreme case when the radius of the rectangular central dip is 15% of the core radius and the refractive index in the center of the fiber equals to the refractive index of the cladding. The dependencies $R(V)$ are show for three different combinations of the pump wave modes, including respectively 0,1 and 2 axially symmetrical modes. Curve 1 correspond to $\Delta\nu^{(1)}$ obtained with the pair $LP_{31} - LP_{21}$ and to $\Delta\nu^{(2)}$ obtained with $LP_{21} - LP_{11}$, curve 2 to $\Delta\nu^{(1)}$ obtained with $LP_{21} - LP_{11}$ and $\Delta\nu^{(2)}$ obtained with $LP_{11} - LP_{01}$, curve 3 to $\Delta\nu^{(1)}$ obtained with $LP_{02} - LP_{11}$ and $\Delta\nu^{(2)}$ obtained with $LP_{11} - LP_{01}$. It is interesting to mention that these are

combinations of the lowest order modes. From fig.1 it is seen that $R(V)$ has zeros for certain values of V. Consequently, for those values of V the normalized group delays participating in numerator of eq.4 are equal. The negative value of $R(V)$ correspond to the case when the anti-Stokes wave of the modal combination in the numerator of eq.4 propagate in the higher mode, that the Stokes wave. The positive values correspond respectively to the case when the Stokes wave is in the higher mode.

As it seen from the given curves, if only axially anti-symmetrical modes are used, the function $R(V)$ for the cases of rectangular refractive index profile and profile with a central dip almost completely coincide. Hence, using such modal contribution, the value of the V parameter can be determined with remarkable precision without considering the type of profile. In the case of only one symmetrical mode participating in the process, an interval of V value, where the two curves coincide enough precisely, can be found too.

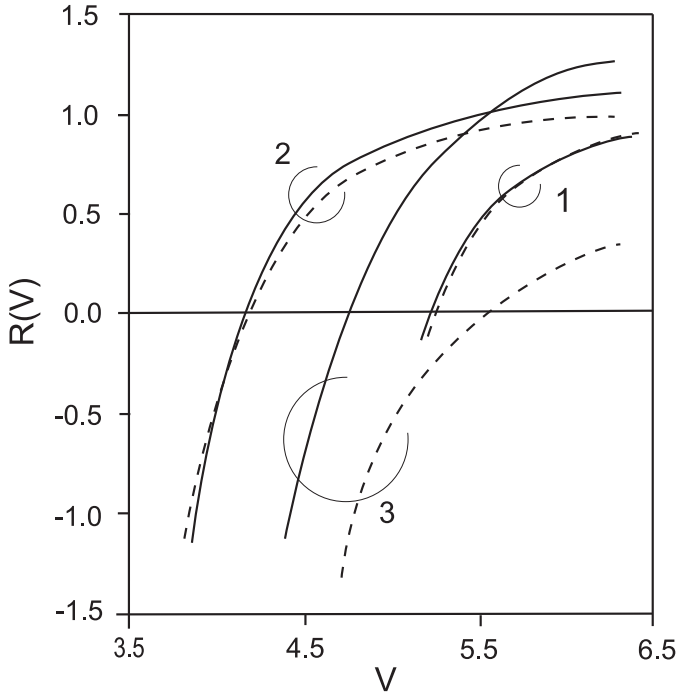

Fig 1. The dependence $R(V)$ of different modal combinations and for rectangular index profile (continuous line) and for a profile with a central dip (dotted line).

This is the interval around the point where the function $R(V)$ becomes zero. For the concrete case when the first frequency is obtained for LP_{21}

and LP_{11} fiber modes, while the other – for LP_{11} and LP_{01} modes in the interval $3.9 < V < 4.3$ the error of the obtained value of V is less than 1%. However, for larger values of V the error becomes considerable. Suitable interval of V values does not exist in the case of two axially symmetrical modes, so such modal combination is not preferable to be use in determining of the V parameter.

If the V parameter is already known, the determination of the other parameters (core radius a_{cor} and the core cladding refractive index difference Δn) requires information about the dopant composition of the fiber, or equivalently, about refractive index $n(\lambda)$ and the dispersion $D(\lambda)$. We will show below in this paper, that in the case of optical waveguide dopand by only one element, we can determinate the concentration of this element ($n(\lambda)$ and $D(\lambda)$ respectively), using the recurrent procedure. If the core is dopand by more than one element, this procedure is not applicable. Using the data for the pure fused quartz in this case we can obtain good accuracy of such approximation [7]. The error due to this exchange is especially negligible, if λ_p is far from the point of zero material dispersion of the fused silica. After that, the derivation of Δn and a_{cor} is straightforward.

3. EXPERIMENTAL RESULTS.

In order to prove experimentally the feasibility of determining the fiber parameter using FWM process with one axially symmetrical mode, we studied a fiber with known V parameter, which was approximately 3.9 for $\lambda_p = 532nm$. An experimental set up, which is widely used for studying non-linear phenomena in optical fibers, was employed for obtaining the stimulated FWM spectra. The fiber was pumped by the second harmonic of a Q-switched and mode-locked CW Nd:YAG laser. The fiber had been produced by the MCVD technique and had pure silica cladding and Ge-doped cores with different molar concentration.

In the experiments the excitation of the different groups of modes was accomplished by varying the launching conditions for the pump beam. The modal structure of the generated radiation were identified visually, after splitting a fraction of the fiber output with a grating. FWM were recorded by OMA.

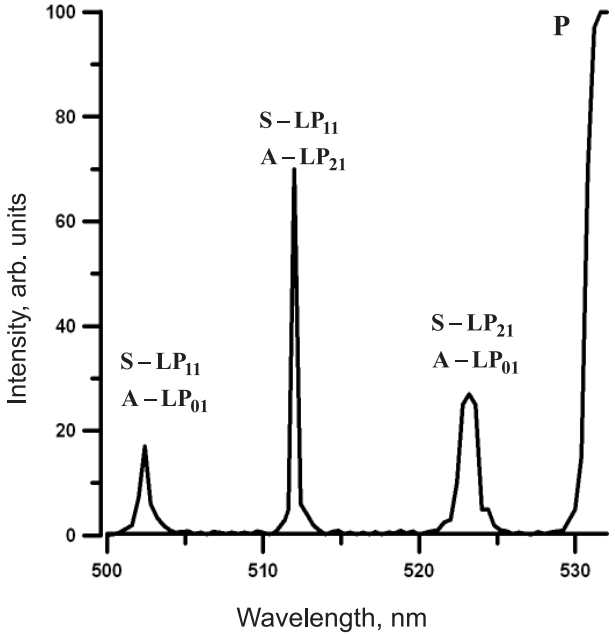

Fig.2 The anti-Stokes components of the FEM spectrum.

In Fig.2 the anti-Stokes sides of the FMW spectra is shown For this fiber the refractive index profile differ substantially from rectangular one. Fig.2 show also the modal combination of the Stokes and anti-Stokes components for the respective frequency. The Stokes sector of the spectra. Expect the symmetrical Stokes frequency, contains also the stimulated Raman scattering (SRS) line with frequency shift 440 cm^{-1} from the pump. It complicates the spectra and increases the uncertainty of the adjacent FWM frequencies. For this sample we used $\Delta\nu^{(1)} = 722cm^{1}$ obtained with $LP_{21} - LP_{11}$ and $\Delta\nu^{(2)} = 1089cm^{-1}$ with $LP_{11} - LP_{01}$. The frequency shift $\Delta\nu^{(1)} = 722cm^{1}$ was obtained when anti-Stokes component was in the higher mode. That's why we take this value as a negative. Via eq. 4 we find out the V value for the pump wavelength used 3.96.

Using this value, the parameters of the fiber were easily calculated. The standard optical fibers are made from SiO_2 with Ge-doped core. But the doping concentration weakly effects to core refractive index n_{cor}, core material dispersion $D(\lambda) = \lambda^2\left(\frac{d^2n}{d\lambda^2}\right)$ and differential mode delays $\frac{d(BV)}{dV}$ [7]. Then if we use the data for pure silica the error will be negligible. Solv-

ing eq.2 we obtain for the core-cladding refractive index difference $\Delta n = 3{,}04.10^{-2}$. From eq.2 we find out for the core diameter $2a = 2.25\mu m$ when. We have to mention that the passport data are correspondingly $\Delta n = 3.2.10^{-2}$ and $2a = 2.2\mu m$.

4. CONCLUSION.

In conclusion, non-linear optical frequency-resolved method is proposed to determine simultaneously most of the important fiber parameter, without accounting for the specific refractive index profile, which were experimentally demonstrated. The accuracy of the obtained data is satisfactory. The largest deviation from the certificate parameters is 5%, and in addition, it is a sum of the errors associate with the standard methods and with our measurement.

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ASSESMENT OF THE MOST REFINED FRACTION IN AEROSOL SYSTEMS WITH LIMITED VOLUME VIA MEASURING THEIR CINEMATIC VISCOSITY

Krasimir Damov* , Anton Antonov**

**Mathematics and Natural Sciences Faculty, South-West University "Neofit Rilsky", 66 Ivan Mihailov Str., BG-2700, Blagoevgrad, Bulgaria E-mail: krasi_damov@abv.bg*

***Institute of Nuclear Research and Nuclear Energy Bulgarian Academy of Sciences, 72 Tsarigradsko chausee Blvd., BG-1784, Sofia, Bulgaria E-mail: asantonov@abv.bg*

Abstract. *The mass and the size of the particles of most refined fraction in aerosol systems with limited volume are determined via measuring the cinematic viscosity. The measurements of latter have been performed when the system is left to stay after forming for a period of time, called delay time. The results for different aerosol volumes have been extrapolated at delay time tending to infinity, when there are left only the finest in size particles of the aerosol. They are interpretive as Aitken's nuclei of condensation in the atmosphere.*

Keywords: *aerosol with limited volume, cinematic viscosity, Aitken's nuclei.*

1.INTRODUCTION

In some previous papers of ours [1,2] we discussed a method of measuring the cinematic viscosity of aerosol systems with limited volume possessing properties analogous to those of liquids. The method is based on, investigating the decrease of the aerosol boundary in case of outflow resulting from the action of its own hydrostatic pressure. In [3] we specified that it is due to extra pressure created by the aerosol phase.

2.METHODS

The aerosol is formed in a cylindrical vessel with cross section S and flows out through a horizontal tube (L is length and R is radius) near the bottom of the vessel. Assuming that the outflow is laminar and follows Poiseuille law we deduce the expression below for the cinematic viscosity

(1) $$\nu = \eta / \rho = B / [\, d(\ln H) / dt \,] \quad ,$$

where η is the dynamic viscosity, ρ is the density of the aerosol phase $B = \pi R^4 g / 8 L S$, g is the gravity acceleration, H is the height of the free aerosol boundary above the outflow tube.

The changes in H – the height of the aerosol boundary, are registered by photodetectors which receive a signal of the dispersed light of a laser beam scanning the aerosol in a direction perpendicular to its horizontal free boundary.

In [2,3] expression (1) is modified as follows:

(2) $$\nu = \frac{\eta}{\rho} = B \frac{\overline{H}}{\Delta H} \Delta t \quad ,$$

where Δt is the time need to decrease the free aerosol boundary by discreet step ΔH around the height $\overline{H}$. ρ is the mean density of the aerosol phase in aerosol volume $V = S \overline{H}$.

If after the aerosol formation and before measuring its cinematic viscosity it is left to stay for a period of time τ, called in [1] evolution time (delay time), then in the aerosol system, which is a typically unbalanced system occurs a decrease in the density ρ and a respective increase in the viscosity ν as a result from the processes of sedimentation and precipitation on the walls of the vessel. This leads to a change in the time Δt of outflow between two successive photodetectors corresponding to the height $\overline{H}$.

From (2) we obtain the following expression for the outflow time Δt of an aerosol with a volume $\Delta V = S \Delta H$

(3) $$\Delta t = -c \nu / \overline{H} \quad ,$$

where $c = 8 S \Delta H L / \pi R^4 g$.

Time Δt can be treated as a new characteristic of aerodispersion systems with limited volume. It depends on the cinematic viscosity ν, the height of the aerosol boundary $\overline{H}$ and the evolution time τ, via ν.

We experimentally defined the quantity Δt for 7 different heights of the aerosol boundary (aerosol volumes) in case of 11 evolution times.

The experiments were conducted with an aerodispersion system model, namely smoke from 3 cigarette brands, the aerosol being formed in a cylindrical measurement chamber with a diameter of 0.030 m and a height of 0.450 m. The outflow tube was with a diameter of 0.008 m and a length of 0.030 m.

The experimental results indicate that the time Δt depends approximately linearly on the evolution time τ as the angular coefficient of the obtained straight lines increases with the decrease of the aerosol boundary, i.e.

(4) $\Delta t = \alpha(\overline{H})\,\tau + \beta(\overline{H})$.

The linearized dependences of Δt as a function of τ are illustrated in Fig.1.

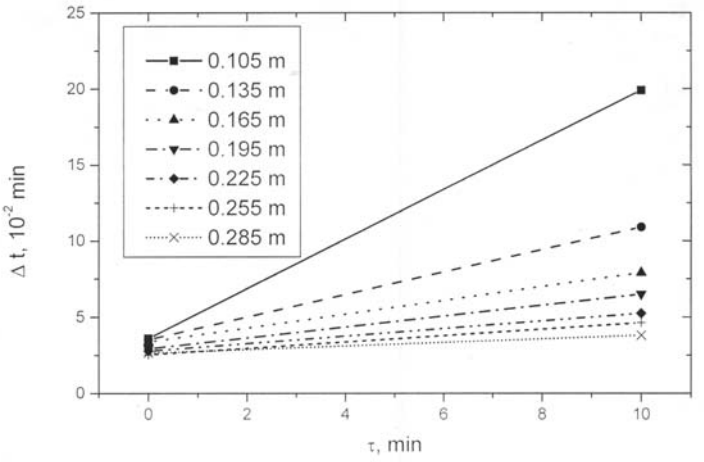

Fig. 1. Linearized dependence of outflow time of aerosol Δt on evolution time τ at 7 different heights $\overline{H}$ (aerosol volumes). The aerosol is smoke from Arda cigarettes

Let us divide the two sides of equation (4) by τ. We obtain

(5) $$\frac{\Delta t}{\tau} = \alpha(\overline{H}) + \frac{\beta(\overline{H})}{\tau}$$.

The quantities in the right-hand part of the above equation depend, as it can be seen from fig.1, on the height $\overline{H}$.

In equation (5) we can perform approximation $\tau \to \infty$, when there remains only the most refined fraction of the aerosol. Then $\frac{\Delta t}{\tau} \to \alpha$, i.e. the quantity $\alpha(\overline{H})$ appears as a characteristic of the most refined fraction of the aerosol.

Fig.2 represents the dependence of $\Delta t / \tau$ on $1/\tau$ for different heights of the same aerosol.

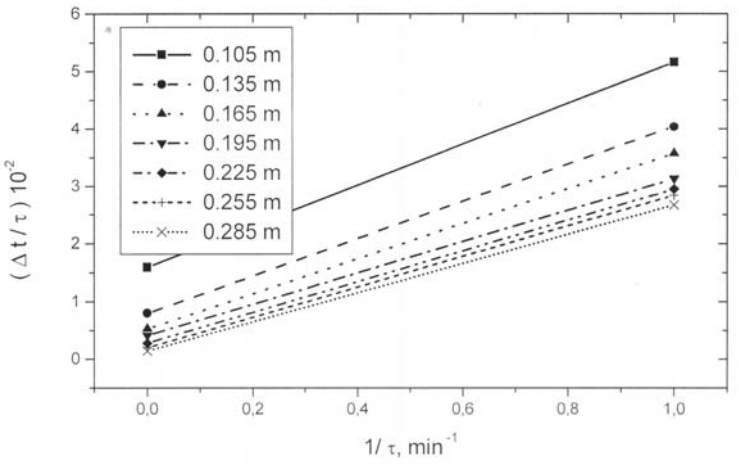

Fig. 2. Dependence of $\Delta t/\tau$ on $1/\tau$ in case of seven different heights $\overline{H}$.

The values of $\alpha(\overline{H})$ are defined by the cross points of the straight lines with the ordinate axis (for convenience the zero abscises axis, when $1/\tau = 0$, is removed a little to the right).

Fig.3 represents the dependence of $\alpha(\overline{H})$ on $\overline{H}$. The points designate the values of $\alpha(\overline{H})$, defined by Fig.2, and the uninterrupted line presents the approximation with exponential function.

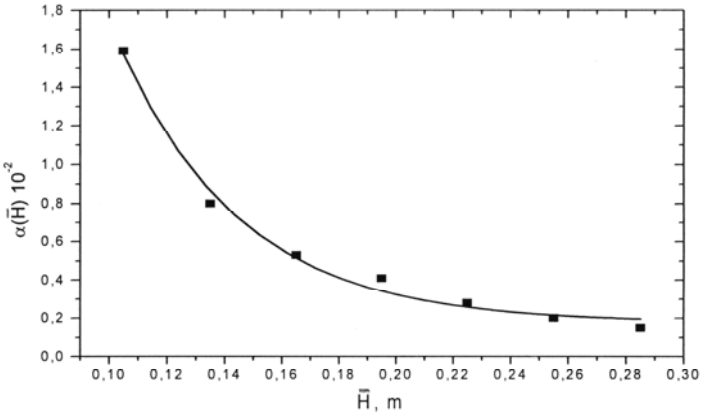

Fig. 3. Dependence of $\alpha(\overline{H})$ on $\overline{H}$ for the investigated aerosol (with points) and approximation with exponential function (the uninterrupted line).

Fit exponential function :
$y = y_0 + A_1 \, EXP[-(x - x_0)/t_1]$
$y_0 = 0.175 \pm 0.043$
$x_0 = 0.105 \pm 0$
$A_1 = 1.395 \pm 0.063$
$t_1 = 0.042 \pm 0.005$

As it can be seen from Fig.3, $\alpha(\overline{H})$ can be expressed well enough via the exponent. We obtained analogous results for other aerosols, too, smoke from different cigarette brands. Fig. 4 represents the experimentally obtained dependences of $\ln\alpha(\overline{H})$ on $\overline{H}$ for tree kinds of aerosols (with points) and their approximations with straight lines.

The results from Fig.3 and Fig.4 give us the right to formulate:

(6) $\alpha = \alpha_0 \exp(-b\overline{H})$.

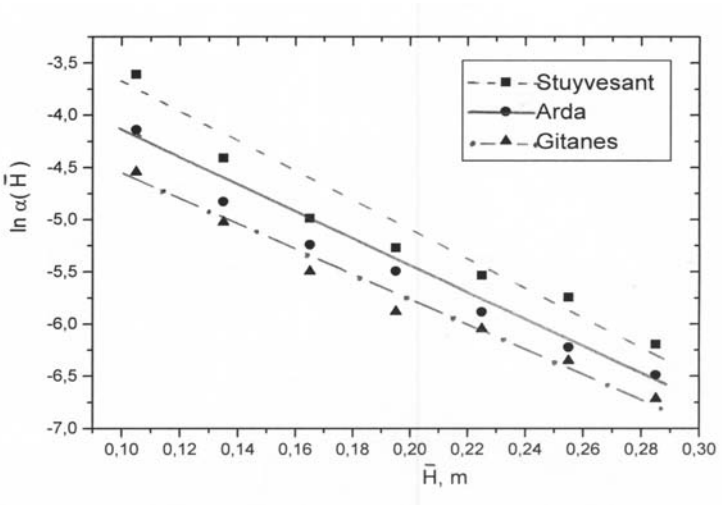

Fig. 4. Dependence of $\ln\alpha(\overline{H})$ on $\overline{H}$ for tree kinds of aerosols.

The above dependence resembles the dependence of the concentration n, of a system of particles with mass m, on the height H, in the earth gravity field

(7) $n = n_0 \exp(-mgH/kT)$,

where g is the gravity acceleration, k is Bolzman's constant, T is the absolute temperature.

On the basis of this analogy we can deduce that the dimensionless quantity α is proportional to the concentration of the most refined fraction of

the investigated aerosols. If we take a natural logarithm from (6) and differentiate according to $\overline{H}$ we will obtain:

(8) $$b = \frac{d\ \ln(\alpha)}{d\overline{H}} \quad .$$

On analogy with (7) we can deduce

(9) $$b = \frac{m_a\, g}{k\, T} \quad ,$$

where m_a is the mass of the most refined particles of the aerosol (we assume that the aerosol is monodispersive).

From formula (9) through experimentally defining the quantity b (from Fig.4 u (8)), we can calculate the mass m_a, of the particles of the most refined fraction

(10) $$m_a = \frac{b\, k\, T}{g} \quad .$$

On assumption that the particles are spherical with radius r, their mass expressed via the volume V and the density ρ_a of the substance of the aerosol particles will be

(11) $$m_a = \frac{4}{3}\pi\, r^3 \rho_a \quad .$$

Replacing m_a from (10) in (11) we will obtain for the radius of the particles:

(12) $$r = \sqrt[3]{\frac{3\, b\, k\, T}{4\, \pi\, g\, \rho_a}} \quad .$$

3.RESULTS AND DISCUSSION

Assuming an approximate value for $\rho_a = 4 \times 10^3\, , kg/m^3$ (about the mean density of the earth crust), T=293K, k=1.381x10^{-23} J/K, then for the mass and the size of the particles of the most refined fraction of the aerosol phase, for three kinds of aerosol – smoke from cigarettes, we obtain the following values.

Аерозол	**Stuyvesant**	**Arda**	**Gitanes**
m_a,10^{-21}kg	5.4±0.6	5.1±0.3	4.8±0.3
r,10^{-9}m	6.8±0.2	6.8±0.2	6.6±0.1

As it can be seen, the values of m and r of the particles of the three kinds of aerosols are close to each other. Because of this fact and because

of the physics sense of $\alpha(H)$ (it characterizes the most refined particles which remain during the aerosol evolution) we assume that these particles appear as centers of condensation in the atmosphere. In [5] such centers are designated as Aitken's nuclei. They have inorganic origin which gives us ground to deduce that ρ_a equals the mean density of the Earth's crust.

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RADIATION DOSES FOR X-ray DIAGNOSIS TEETH IN DENTAL MEDICINE

Lyubomir Direkov

South Western University “Neofit Rilski” – Blagoevgrad / Bulgaria

Abstract: *X-rays are the first ionizing radiation, which are applied in medicine for diagnostic radiology and X-ray therapy. While in the beginning they are mainly used for X-ray photos of the chest / lungs and in severe fractures of the limbs, then in recent years they are widely applied in diagnostics of teeth in dental medicine. Considering that caries is a widespread disease, both in children and adults, and it requires repeated x-ray photographs of the damaged teeth for the individual, the total radiation doses, which reflect on people from the X-rays are at high values.*
In order to reduce external exposure to other organs /mainly thyroid gland/ by X-ray pictures of teeth, it should be used with special lead aprons with large coefficient of reduction.

Keywords*: doses of radiation, X-ray machines, dental, x-ray pictures of teeth, protection sources.*

INTRODUCTION

In 1895 German physicist Wilhelm Ryontgen discovered X - rays, i.e. cathode rays, which represent the flow of electrons. Later, these rays were named in his honor X-rays / Ro /. These rays emerge spontaneously in the electronic transitions in artificial substances and by altering the speed / delay, suspension / of electric charged particles circulating in a given volume. X-rays represent flow of electromagnetic quantum, which have speed of movement and range - beams / approximately 300,000 km/sec, but their energy is substantially lower - from 10 KeV to 150 KeV. The most widely distributed sources of X-rays are X-ray mechanisms, which are electro vacuum double electrodes devices, where the cathode emits electrons, and then they speed up in an electric field and purposefully fall on the other covered electrode / anode. In a sharp reduction of the speed and stopping of electrons on the anode, so called braking X-ray radiation occurs, which consists of X-ray quantum.

X-rays have great penetrating power, because the X-ray quantum do not have electric charge form. These rays ionize the air, biological tissues and other environments and pass through them in an indirect way. X-rays are the first ionizing radiation, applied in medicine for diagnostic radiology and X-ray therapy.
The main methods of radiological diagnosis are three types: radiography, radioscopy, computed tomography.

In radiography the image on the film represents the distribution in one plain of the darkening of the film due to its exposure to the substance passed from the X-ray radiation.
Radioscopy image is observed on the monitor screen by X-ray electro optical converter and tv camera.
In computed tomography detailed image with cross-cutting form of the body is obtained using a computer, that handles a large array of data passed through the intensity of X-rays in tissue.

EXPOSE

The purpose of this study is to measure the doses of external radiation that people receive in diagnostic radiology used in dentistry, to analyze the risks and benefits of this diagnostic and basic requirements to protect patients in these examinations.

There are two main types of X-ray apparatus used in dentistry: sectional, ie. kugels - 1,2, 3 and panoramic X-ray – 4.

1 2 3 4

Fig.1: X-ray machines in dentistry

Registered devices of both types of X-ray apparatuses are X-ray films or electronic sensors. Apparatuses with electronic sensors are more advanced, where the information goes directly into the computer, the image can be increased or another processing can be applied. Furthermore, they are more sensitive and capable of reducing the exposure time, and thus the absorbed radiation dose.

X-rays are absorbed in variable amount by different organs and tissues of the human body.For example, organs that contain much larger quantities of calcium CA - bones and teeth absorb them in larger amount than the soft tissues. In X-ray pictures of teeth one part absorbs the X rays and the other goes through them and causes exposure on the X Ray film. Thus the result is a negative image of the teeth in which, areas that less absorbed X-rays are lighter and those who absorb more are darker.

Radiation doses that people receive in the radiological diagnosis of teeth, depend on the sample of X-ray apparatus, remedies and methods of diagnosis – if this is graphs / photos / or gelt / highlight. Gelt is distinguished by high doses of radiation and is not always necessary.

Tests were conducted in the laboratory for dental X-ray diagnostics in the region of Blagoevgrad with sectional X-ray / kugel / type EndosAC.

In the first experiment patient No.1 who was sent from a dentist to make an X-ray picture of teeth, no protective equipment was used and the dose of radiation was measured using a portable digital monitor "Berthold"

Fig.2: Digital portable monitor

Monitor was placed around the neck of the patient and after making the picture he showed 13,6 µSv / h.

The experiment with patient № 2 – was made with protective apron with lead collar. Monitor was placed again around the neck, just below the collar of the protective apron. After the image was made the display monitor accounts dose of radiation in the range of 6,2 µSv / h. That means that the

patient without a protective apron received 7,4 μSv more doses of radiation from X-rays, i.e. about 2 times higher dose.

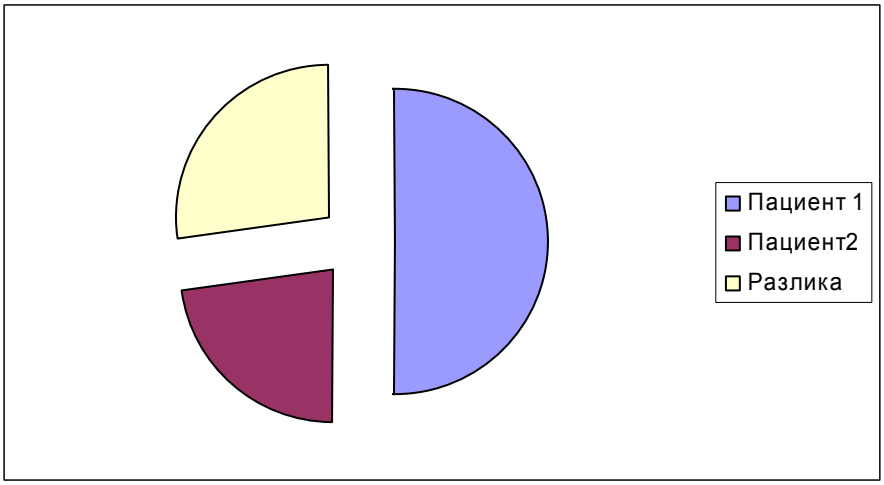

Fig.3: Distribution of radiation doses

The main factors that determine the load of rays in the human organism over time are the amount of radiation dose for each radiograph of the teeth and the frequency of exposure for one year. Up to 2008 Bulgaria is among the first 10 countries in Europe by the number of X-ray examinations. In researches conducted by the World Health Organization was found that in developed countries the main source of X-ray exposure of people are medical and dental X-ray procedures. However low doses of X-ray exposures that occur in images of teeth, can cause more lasting damage than the high doses of radiation to other organs and systems with lower average frequency.

CONCLUSIONS

1.The exposure of human body to X-ray exams with greater frequency can cause certain damage to organs resulted from distracted X-rays. To reduce the risk of damage to the human organism in the X-ray pictures of teeth,the principle of equal distribution of the absorbed dose of radiation over time should be applied.

2.For the protection of other organs in X-ray pictures of teeth, such as the lungs and thyroid, the patients should wear lead/gum aprons. This is very important for children and people with impaired thyroid function and cardio-vascular diseases.

3.Optic lens is extremely sensitive to ionizing radiation. It is determined that the optic lens accumulate impairment for long time at comparatively low levels of exposure to X-ray and other radiation. This can cause partial or complete loss of eyesight.For the eye protection in x-ray pictures of teeth,they should be made with special protective leaded glass.

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Device and method for assessing possible effects of 900 MHz EMF and geomagnetic activity on heart rate variability

Ivo Angelov[1,2] Svetla Dimitrova[3]

[1]South West University "N. Rilski", Blagoevgrad, Bulgaria
[2]Institute for Nuclear Research and Nuclear Energy – Bulgarian Academy of Sciences, Sofia, Bulgaria
[3]Solar-Terrestrial Influences Institute at the Bulgarian Academy of Sciences, Sofia, Bulgaria

***Abstract**: The rapid development of mobile communications has led to public concerns about possible health effects. To examine the level of personal exposure and possible correlations with heart rate variability a cost optimized personal devices, estimating the intensity of the 900 MHz EMF in arbitrary units, combined with one-channel electrocardiogram (ECG) monitor have been developed. Two prototypes were made and tested. Two volunteers carried them all the time and recorded 5-minutes morning and evening ECGs for several months. These pilot results show that probably EMF at 900 MHz and geomagnetic activity effect cardio-vascular health state and expanded study with large group of volunteers for a long period of time should be performed.*

***Keywords:** cardio-vascular health state, mobile phones and stations, geomagnetic storms*

1. INTRODUCTION

As a part of the environment, the electromagnetic fields (EMF) are in close relationship with biological processes and human physiological state. Different investigations indicate that geomagnetic activity (GMA) affects on functional systems and in particular cardio-vascular system [1, 2, 3]. The fast development of new technologies for personal communication and wireless networks in the last years has led to significant concern about the increased EMF exposure of the people and possible adverse health effects. The studies carried out by now [4, 5, 6, 7] have not produced clear results, but they indicate that the radiation of the mobile phones and base stations may be responsible for various biological effects. It is essential to find out whether these effects may affect human health.

The methods used by now to study the association between health symptoms and mobile phone radiation such as self-reported mobile phone use or operator data, lateral distance of the residence to the next base station and spot measurements have a lot of limitations.

Having in mind these facts we have developed personal devices to assess the average personal exposure on 900 MHz EMF and method to esti-

mate the possible exposure correlations and GMA variations with heart rate variability (HRV).

HRV is the oscillation of the intervals between consecutive heart beats (R-R intervals) in the electrocardiogram (ECG). It is an important marker of the autonomic nervous system and can also be used to study the heart activity for different functional and pathological states [8]. The analysis of HRV is a relatively new, non-invasive, easily applicable and very informative method. Measuring HRV, the relationship between lethal arrhythmias on one hand and increased sympathetic activity or decreased activity of parasympathetic nervous system on the other hand is already a proven fact. Reduced HRV is a negative prognostic factor, often preceding and/or accompanying various cardiovascular diseases, including fatal diseases as well as cases of sudden cardiac death [8].

2. METHOD

A cost optimized devices, estimating the intensity of the 900 MHz in arbitrary units, combined with one-channel ECG monitor have been developed. Two prototypes were made and tested. Two volunteers used them - the first one for about 10 months and the second one for 8 months. The devices were carried in the pocket or in the bag of the persons, continuously recording the 900 MHz EMF signal strength. The volunteers recorded two 5 minutes ECGs every day – in the morning after awakening and in the evening before falling asleep.

The HRV indices (both in spectral and time domain) were derived from the recorded ECG using custom software and statistical analysis was performed to assess the possible effects of GMA and recorded 900 MHz EMF levels on HRV parameters.

3. DESCRIPTION OF THE INSTRUMENT

The block-scheme of the tested prototypes is shown on Fig. 1.

A quarter wave printed circuit board (PCB) slot antenna was used to measure the signal strength in the 900 MHz band. The antenna is connected to a logarithmic amplifier through a LC-matching circuit. The circuit provides certain selectivity for the 900 MHz band and $\approx$9 dB voltage gain. Because of the frequency band and the needed high sensitivity and dynamic range, the logarithmic amplifier AD8313 (Analog Devices) was chosen. The device gives the possibility of exact transfer of the modulated RF signal applied to its differential input, to an equivalent logarithmic (proportional in dB) scale at its DC output.

The output of AD8313 is connected to the input of the internal 12-bit ADC of the microcontroller (MCU). The signal is digitized continuously with 64 kHz sampling rate. The MCU averages each 16384 samples (2^{14}), and the voltage value is stored as 2-byte word in the RAM of the MCU. Every

1.024 second 4 values are stored. Every 64.5 seconds the results are recorded on a 512 bytes sector of the SD-card. The sector contains 252 values and the current time and date from the real time clock.

The measured values can be recorded also in ASCII files and monitored in real time on a personal computer screen, using the developed application software for visualization and the built-in USB interface.

The averaged values of the signal strength in dB, calculated from the recorded values of the output voltage according to the transfer characteristic of AD8313, are used. The data are read from the SD-card with a standard card-reader and developed custom application software, which recalculates the voltage values into dB and averages the data for different time periods (Fig. 2).

When the patient cable is connected, the instrument switches to “ECG-monitor” mode. The ECG-monitor is designed on the basis of the publications [9, 10].

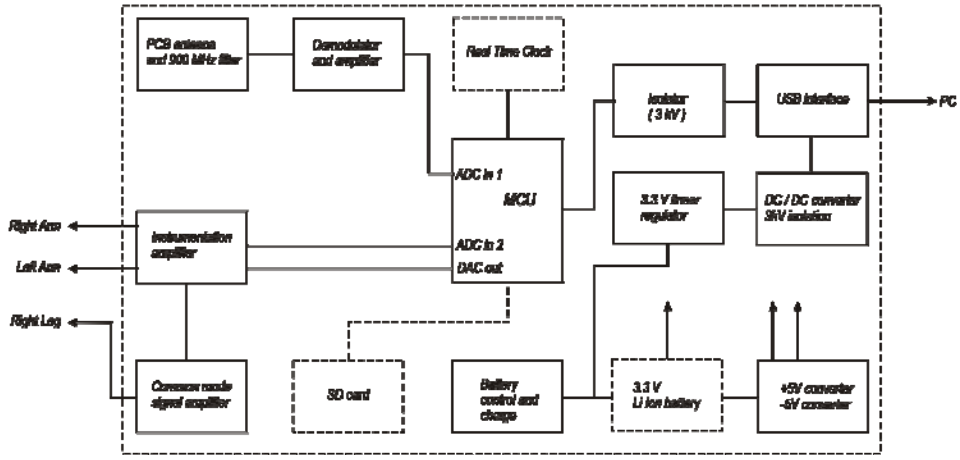

Fig. 1. Block-scheme of the tested prototypes.

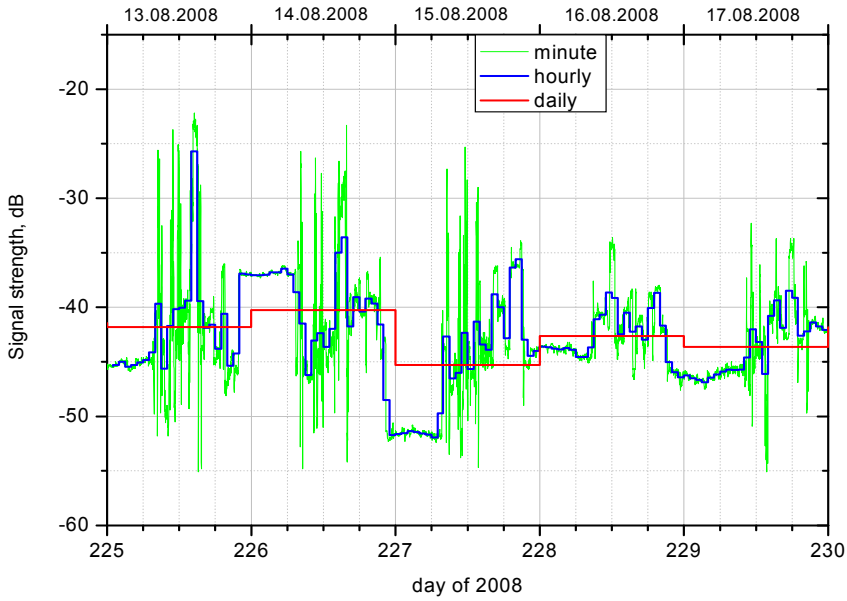

Fig. 2. Values of the signal strength, registered with one of the prototypes for the period 13 – 17 August 2008

The input stage of the ECG-monitor is designed with a standard instrumentation operational amplifier. The common mode amplifier (Rigth leg driver) is realized with a precision operational amplifier.

The internal 12-bit ADC of the MCU is used for digitizing the amplified ECG signal. To increase the resolution of the ADC the method described in [11, 12] is used. The needed sampling frequency for the ECG signal is 500 Hz, but each of the values is a result of the sum of 128 consequent samples (actual sampling frequency 64 kHz, oversampling), divided by 8 (decimation). The result for each of the 500 samples is a 16-bit word, and practically the ADC resolution is increased to 15 bit.

To facilitate the tests, the prototype was designed with USB interface to PC, and can be powered with + 5V provided via USB. To ensure safety, the power is galvanically separated from the PC ground using DC/DC converter with 3 kV isolation and the data transfer from the MCU to the PC is via 3 kV digital isolator (type i-coupler, Analog Device).

No digital filtering of the ECG signal is implemented in the current version of the embedded software. Each of the digital values is sent directly to the PC via the USB interface. The custom application software visualizes the ECG and records the digital values in ASCII file (Fig. 3).

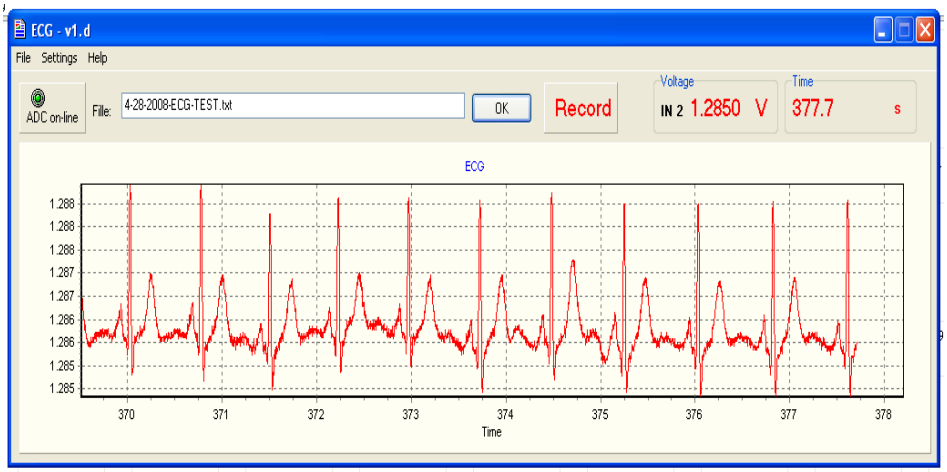

Fig. 3. The window of the application software for ECG visualization and recording.

4. SOFTWARE FOR R-R INTERVALS DETECTION AND HRV ESTIMATION

For processing of the recorded ECG (filtering, QRS detection, R-R intervals calculation, rejection of values not within the criteria, spectral analysis and other), software with graphical user interface, developed in MATLAB programming environment is used. A simplified block diagram of the program algorithm is presented on Fig. 4.

The bandwidth of the recorded ECG is limited in the 0.5-150 Hz range. A digital Butterworth band pass filter of 4^{th} order is used for that purpose, and for the 50 Hz broom rejection a digital Butterworth stop band filter of 8^{th} order is used. The built in MatLab function *filtfilt* is used, which provides digital filtering without phase change by processing the input data once in right and then in reversed order.

For QRS complexes detection an algorithm based on the one described in [13] is applied. The R-peaks are separated by 17 Hz band-pass filter. The separated signal is differentiated and squared. The values are consequently integrated in given limits (moving integrator) and a flying threshold, averaging the integrated values for given time interval is calculated. The time of the maximums of the R-peaks is determined by finding the local maximum in the filtered ECG for each of the time ranges, in which the integrated signal exceeds the threshold.

To remove ectopic beats and artifacts from the R-R intervals sequence, those which have time duration lower than 0.8 or higher than 1.2 of the duration of the previous interval are deleted [14, 15].

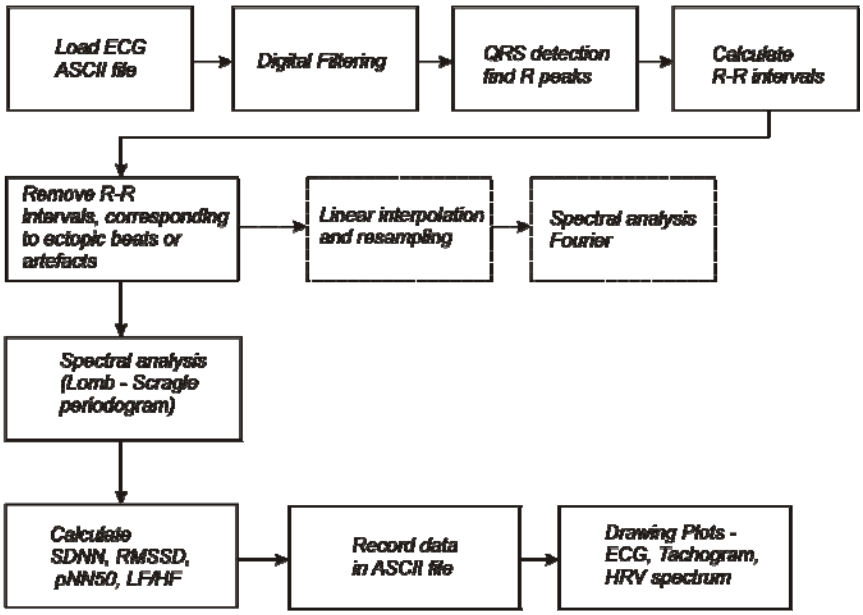

Fig.4. Block diagram of the program for ECG analysis.

The spectral analysis of the time dependence of the R-R intervals, RR(t) is performed using the LS-periodograms method [16, 17], which gives the possibility for analysis of unevenly sampled data and the distortion of the spectrum is minimal if there are missing R-R intervals (removed ectopic beats or artifacts). Just for comparison the program makes also interpolation of the RR(t) time dependence and a resampling in even time intervals after that. Then the data are analyzed using discrete Fourier transforms.

The program calculates the HRV indices in the time domain – SDNN (standard deviation of normal sinus R-R intervals), RMSSD (the square root of the mean squared differences of successive R-R intervals), pNN50 (percentage of adjacent R-R intervals that vary by more than 50 ms), R-R average, R-R minimum, R- R maximum, and also in the frequency domain - the ratio between the powers in the low-frequency (0.04-0.15 Hz) and high-frequency ranges (0.15-0.4 Hz) of the spectrum (LF/HF). For each ECG, these values are recorded in formatted ASCII file, together with the date, hour of the ECG record and the name of the participant in the registration.

Additionally for visual control the filtered ECG with the found R peaks, tachogram, and power spectrum (LS-periodogram) are plotted on the screen and can be viewed in details or printed on paper.

5. RESULTS, DISCUSSION AND CONCLUSION

This method and developed devices give the possibility to study the personal exposure to 900 MHz EMF and possible variations of heart rate variability.

The results from the personal monitoring of the two volunteers are presented in [18]. They indicate that although heart rate decreased, HRV parameters were worsened after the exposure at increased signal strength at 900 MHz. The results about the increased GMA effects were similar but heart rate increased with GMA increment.

The results showed a shift in LF/HF ratio towards a sympathetic dominance in the autonomous nervous system under increased signal strength at 900 MHz and increased GMA.

These pilot results are consistent with other results performed by other researchers at different experiment settings and show that probably EMF at 900 MHz and GMA effect cardio-vascular health state and expanded study with a large group of volunteers for a long period of time would be useful to be performed by the proposed method using personal exposimetry and heart rate variability parameters.

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DNA double-strand break and apoptosis induction in human lymphocytes in different cycle cell phases by ^{60}Co gamma rays and Bragg peak protons of a medical beam

A.A. Khachenkova, A.V. Boreyko, A.V. Mozhaeva, V.N. Chausov, I.I. Ravnachka, I.Amov, S.I. Tiunchik

Joint Institute for Nuclear Research

Abstract. *A comparative analysis is made of the regularities in the formation of DNA double-strand break and apoptosis induction in peripheral human blood lymphocytes in different cell cycle phases after ^{60}Co gamma and extended Bragg peak proton irradiation. It is shown that the formation of apoptotic cells in a lymphocyte population increases linearly in all the cell cycle stages after proton irradiation. The maximal DNA double-strand break and apoptosis yield in lymphocytes is observed in the S phase of the cell cycle.*

INTRODUCTION

As is known, apoptosis is a basic mechanism of the regulation of the tissue level of living system organization and plays an important role in preventing living cell malignization, which is especially important for evaluating radiation influence on the organism.

It is shown that the formation of DNA double-strand breaks (DNA DSB) is the molecular event initiating programmed cell death – apoptosis. As the DNA DSB quantity and quality depends on the physical properties of ionizing radiation influencing cells, it can be assumed that the regularities in apoptotic cell formation will also depend on the quality of radiation.

The aim of this work was to study the regularities in the induction of apoptosis and DNA DSB as the main initiating events in apoptotic cell death under ionizing radiation with different physical characteristics.

MATERIALS AND METHODS

As the research objects, peripheral human blood lymphocytes were used. Lymphocytes isolated from donor blood /V.A. Tronov, 1996/ in a concentration of $2 \cdot 10^6$ cells/ml were irradiated with ^{60}Co gamma rays and 250 MeV-protons in the doses of 1 – 5 Gy.

DNA DSB induction was studied using a neutral DNA comet method. The analysis of apoptotic cell death was based on morphological indicators; it was done using a fluorescent microscope after staining lymphocytes with a mix of stains.

RESULTS AND DISCUSSION

Fig.1 shows DNA DSB induction in lymphocytes after proton irradiation in different cell cycle phases. It was found that the maximal DNA DSB yield is observed in the S phase of the cell cycle. Fig.2 shows apoptosis induction in lymphocytes after proton irradiation in different cell cycle phases. It was found that apoptotic cell formation in a lymphocyte population increases in all the cell cycle stages for all the proton doses up to 5 Gy. With respect to this measure, the most sensitive cells are those in the G2 and S phases of the cell cycle.

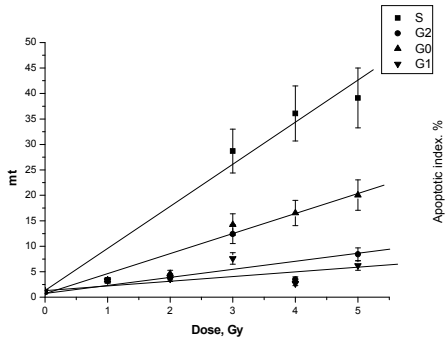

Fig. 1. DNA DSB induction in lymphocytes after proton irradiation in different cell cycle phases.

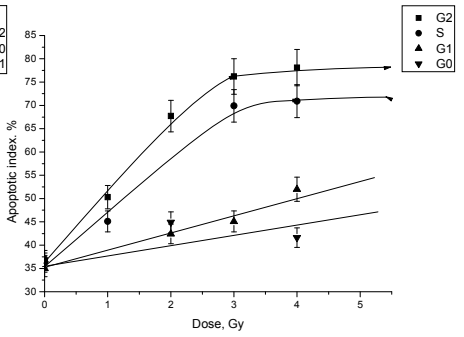

Fig.2. Apoptosis induction in lymphocytes after proton irradiation in different cell cycle phases.

DNA DSB induction was studied after ^{60}Co gamma-irradiation (Fig. 3). A quantitative analysis of DNA damages was performed at different times after irradiation (0, 24, 48,72, and 96 h). As is seen in Fig. 3, the number of DNA DSB in cells decreases with time, which is caused by intensive DNA repair processes in cells. The kinetics of DNA DSB repair in lymphocytes in different times after irradiation is shown in Fig. 4. It was found that the number of DNA DSB decreases exponentially during the post-irradiation period. The reference level of DNA DSB was observed by 24 h after irradiation. This level kept up to 96 h.

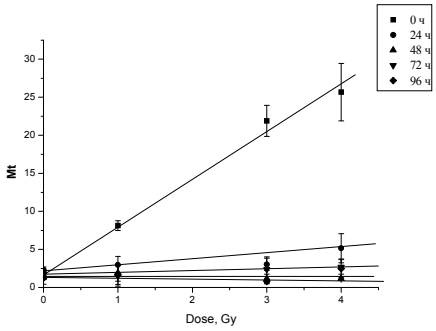

Fig. 3. DNA DSB induction in human lymphocytes after ^{60}Co gamma-irradiation

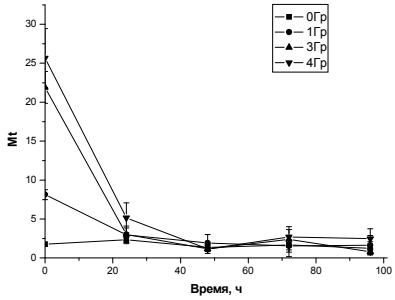

Fig. 4. Kinetics of DNA DSB repair in human lymphocytes after ^{60}Co gamma-irradiation

Electron spin influence on eigenmode dispersion in relativistic plasma

N. E. Rusakova, P. A. Polyakov, M. A. Tassev, I. D. Gyudjenov

Moscow State University, Moscow, Russia

South-West University ‘Neofit Rilski’, Blagoevgrad, Bulgaria

***Abstract**: In the paper the wave propagation in plasma at relativistic temperature in a strong electromagnetic field taking spin into account is investigated. An expression for the ponderomotive force related to the influence of intrinsic magnetic moment of electrons is proposed. Dispersion equations for waves propagating in the plasma medium along the external magnetic field is derived.*

***Key words:** relativistic plasma, spin, intrinsic magnetic moment, dispersion equation.*

1. INTRODUCTION

Collective phenomena in plasma systems are of great interest for fundamental physics as well as for numerous applications. Nearly all investigations of plasma simulation are carried out like those of non-relativistic gas systems i.e. the charged particle motion is considered as the motion of charged point particles with non-zero mass that move by external electromagnetic field and microscopic electromagnetic field generated by all particles of plasma medium. The most common model of self-consistent field account is the well-known Vlasov model (0,0). The particle motion can be modeled in frame of the hydrodynamic theory or the kinetic one (in the last case the Vlasov kinetic equation 0 is used in most of models). Such consideration is correct from the classic standpoint but an electron as a quantum object has a degree of freedom due to its intrinsic magnetic moment (spin) in addition to classic characteristics such as coordinate, velocity, charge and mass.

The account of intrinsic magnetic moment influence on collective phenomena in relativistic plasma compared with non-relativistic case is the much more complicated problem. The ponderomotive force effected by electron spin is a function of both magnetic and electric field in the relativistic case 0. Using non-relativistic plasma analogy one can expect that some estimations can be obtained by consideration of a special case of wave propagation along the external magnetic field since in the case the spin-effected ponderomotive force components are absent (since the value is determined with an expression of the order of $\left(\vec{I}_0\vec{H}\right)=\frac{c}{\omega}\left(\vec{I}_0\ \left[\vec{k}\vec{E}\right]\right)$).

3. THE INITIAL SET OF EQUATIONS

Lets consider an electron-ion plasma medium in a strong external magnetic field. According to living theoretical concepts and experimental data such plasma system is generated by a high-power femtosecond laser pulse interaction with a solid-state target. Let us neglect thermal dispersion in a direction transverse to an external magnetic field and model the transverse macroscopic plasma movement on the basis of the hydrodynamic theory. Along the external magnetic field, we consider plasma dynamics using the kinetic theory. Mathematically, it means that the electron distribution function can be presented in the following form:

(1) $$f_a'(t,\vec{r},\vec{u}) = f_a(t,\vec{r},u^z)\delta(\tau_x - u_x)\delta(\tau_y - u_y),$$

where $\vec{u}$ is a spatial part of a velocity 4-vector 0, related to the 3D velocity by the following:

(2) $$\vec{u} = u_0\vec{v}/c, \quad u_0 = \left(1 - v^2/c^2\right)^{-1/2},$$

$\delta(\tau_x - u_x)$ is the Dirac delta function, τ_x and τ_y are the components of a hydrodynamic 4-velocity:

(3) $$\tau^\alpha = \int u^\alpha f_e c^3 d^3u \Big/ \int f_e c^3 d^3u$$

To describe plasma medium, we use the self-consistent covariant Vlasov — Maxwell system of equations 0, 0:

(4) $$\frac{\partial F^{ik}}{\partial x^k} = -\frac{4\pi}{c}\left(J^i + J_s^i\right), \qquad \frac{\partial F^{ik}}{\partial x^l} + \frac{\partial F^{kl}}{\partial x^i} + \frac{\partial F^{li}}{\partial x^k} = 0,$$

(5) $$\frac{u^i}{u_0}\frac{\partial f_a'}{\partial x^i} + \frac{1}{m_a c}\frac{\partial}{\partial u^\alpha}\left(\frac{e_a}{c}F^{\alpha i}u_i\frac{f_a'}{u_0}\right) = 0.$$

Here the summation index a numbers a particle type (electrons and ions), other Latin indices take on values (0, 1, 2, 3), Greek indices take on values (1, 2, 3); F^{ij} is the electromagnetic field tensor 0, $J^i = (c\rho,\vec{j})$ is the 4 vector of the current density ($\rho = \sum_a e_a \int f_a' c^3 \frac{d^3u}{u_0}$ is the charge density, $\vec{j} = \sum_a e_a \int \vec{u} f_a' c^3 \frac{d^3u}{u_0}$ is the current density), $J_s^i = \left(0, \vec{j}_s\right)$ is the spin current density:

The distribution function is has the following norm:

(6) $$\int f_a c^3 d^3u = n_a$$

$n_a = N_a / V$, где Na is the number of particles of “a” type and V is the system’s volume.

(7) $\vec{j}_s = c\,\mathrm{rot}\left(\frac{2\mu}{\hbar} n_e \left\langle \vec{\zeta} \right\rangle_{\vec{v}} \right)$,

(8) $\left\langle \vec{\zeta} \right\rangle_{\vec{v}} = \int \vec{\zeta}_{\vec{u}} f_e c^3 d^3 u \Big/ \int f_e c^3 d^3 u$, is the velocity-averaged electron spin value, $\vec{\zeta}_{\vec{u}}$ is the average value of the spin operator on the quasi-classical wave packet state and on all the particles with the velocity $\vec{u}$. It is determined with the Bargmann-Michel-Telegdi equation.

(9) $\frac{d\vec{\zeta}}{dt} = \left[\vec{\Omega}^p \vec{\zeta} \right]$,

where

(10) $\vec{\Omega}^p = \frac{e}{m} \left\{ \frac{g\vec{H}}{2\gamma} - \left(\frac{g}{2} - \frac{\gamma}{1+\gamma} \right) \left[\vec{\beta} \vec{E} \right] - \frac{g-2}{2} \frac{\gamma}{1+\gamma} \left[\vec{\beta} \left[\vec{\beta} \vec{H} \right] \right] \right\}$,

$g \approx 1 + \frac{\alpha}{2\pi} - 0{,}328 \frac{\alpha^2}{\pi^2} + 1{,}49 \frac{\alpha^3}{\pi^3}$ is the Lande splitting factor, $\alpha = \frac{e^2}{\hbar c} \approx 1/137{,}04$ is the fine structure constant.

Without loss of generality let us consider the coordinate system where $\vec{H}_{(0)} = \{0,0,H_0\}$ and $\vec{k} = \left\{ k^1, 0, k^3 \right\}$. The equilibrium electric-field strength is assumed to be zero: $\vec{E}_{(0)} = 0$.

The permittivity tensor of the plasma medium can be represented as following

(11) $\varepsilon_{\alpha\beta} = \varepsilon_{\alpha\beta}^{(\vec{j})} + \varepsilon_{\alpha\beta}^{(\vec{s})}$,

where $\varepsilon_{\alpha\beta}^{(\vec{j})}$ are the permittivity tensor components generated by the electron conduction current, $\varepsilon_{\alpha\beta}^{(\vec{s})}$ are the permittivity tensor components generated by the electron intrinsic magnetic moment.

4. THE DISPERSION EQUATION FOR THE WAVES PROPAGATING ALONG THE EXTERNAL MAGNETIC FIELD

Taking account of the 1D velocity distribution of electrons (1), we obtain the following expressions for permittivity tensor components after Fourier transformation and linearization of system (4)–(9) assuming that ion component influence is small and an equilibrium electron velocity distribution function is Maxwellian ($f_{(0)} = \frac{e^{-\alpha u_0}}{2K_1(\alpha)} \frac{n_e}{c^3}$, $\alpha = mc^2 / k_B T$) 0:

The permittivity tensor components generated by the conduction current are the following:

$$\varepsilon_{11}^{(\vec{j})} = 1 - \frac{\omega_p^2}{\omega^2 K_1(\alpha)} \left(K_0(\alpha) - \frac{\Omega}{(a_1 - a_2)(\omega^2 - k^2 c^2)} \cdot \right. \\ \left. \cdot \left((\Omega + \omega a_1) J_-(a_1) - (\Omega + \omega a_2) J_-(a_2) \right) \right), \tag{12}$$

$$\varepsilon_{12}^{(\vec{j})} = -i \frac{\omega_p^2}{\omega^2 K_1(\alpha)} \frac{\Omega}{(a_1 - a_2)(\omega^2 - k^2 c^2)} \times \\ \times \left((\Omega + \omega a_1) J_+(a_1) - (\Omega + \omega a_2) J_+(a_2) \right), \tag{13}$$

$$\varepsilon_{33}^{(\vec{j})} = 1 + \frac{\omega_p^2}{\omega^2 K_1(\alpha)} \alpha \left(1 - a^2 \right) \left(\left(1 - a^2 \right) J_+(a) - K_1(\alpha) \right), \tag{14}$$

$$a_{1,2} = \frac{\omega\Omega \pm kc\sqrt{k^2 c^2 + \Omega^2 - \omega^2}}{k^2 c^2 - \omega^2}, \; a = \frac{kc}{\sqrt{k^2 c^2 - \omega^2}}. \tag{15}$$

The permittivity tensor components generated by the electron intrinsic magnetic moment:

$$\varepsilon_{11}^{(s)} = -\frac{g}{2} \frac{g-2}{2} \frac{k^2 c^2}{\omega^2} \frac{\Omega_\mu \Omega}{\omega^2} \frac{1}{K_1(\alpha)} \left(K_0(\alpha) + \frac{\tilde{\Omega}}{\omega} J_- \left(\frac{\tilde{\Omega}}{\omega} \right) \right), \tag{16}$$

$$\varepsilon_{12}^{(s)} = -i \frac{g-2}{2} \frac{k^2 c^2}{\omega^2} \frac{\Omega_\mu}{\omega} \frac{1}{K_1(\alpha)} \left(K_1(\alpha) + \left(\frac{\tilde{\Omega}}{\omega} \right)^2 J_+ \left(\frac{\tilde{\Omega}}{\omega} \right) \right), \tag{17}$$

$$(18)\quad J_{-}(b)=b\int_{1}^{\infty}\frac{e^{-\alpha\gamma}}{\left(\gamma^{2}-b^{2}\right)\sqrt{\gamma^{2}-1}}d\gamma,\ J_{+}(b)=\int_{1}^{\infty}\frac{\gamma e^{-\alpha\gamma}}{\left(\gamma^{2}-b^{2}\right)\sqrt{\gamma^{2}-1}}d\gamma.$$

where $\Omega_{l}=8\pi e\mu n\zeta_{0}/\hbar mc$, $k=k^{3}$.

The wave propagation along the external magnetic field is described with the following dispersion equations:

$$(19)\quad \varepsilon_{11}^{(\vec{j})}\pm i\varepsilon_{12}^{(\vec{j})}+\frac{k^{2}c^{2}}{\omega^{2}}\left(\bar{\varepsilon}_{11}^{(s)}\pm i\bar{\varepsilon}_{12}^{(s)}-1\right)=0.$$

One can show that at least in the ultrarelativistic temperature limit the functions $J_{\pm}(b)$ in (18) are bounded on the whole complex plane except for the essentially singular point $b=1$. Since the real modes contain damping (collisional or Landau one) the point $b=1$ is nonphysical and one can obtain $\varepsilon_{11}^{(\vec{j})}\pm i\varepsilon_{12}^{(\vec{j})}\gtrsim\frac{k^{2}c^{2}}{\omega^{2}}\left(\bar{\varepsilon}_{11}^{(s)}\pm i\bar{\varepsilon}_{12}^{(s)}-1\right)$ at sufficiently small k values, so the spin contribution appears to be of an adjustment order related to the conduction current contribution.

As a result the correction generated with the spin component vanishes in the ultrarelativistic limit when $mc^{2}/\theta\to 0$ and the corresponding spin modes 0 degenerate.

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Domain structure screening of a local magnetic inhomogeneity

Mikhail L. Akimov, Peter A. Polyakov, M. Tassev

Faculty of Physics, M.V. Lomonosov Moscow State University, Vorobiovy gory, Moscow 119992, Russia

Faculty of Mathematics and Natural Science (South-West University), Blagoevgrad, BULGARIA

***Abstract**. A phenomenon of magnetic screening of external and intrinsic magnetostatic fields with a magnetic sample is revealed. An efficiency of magnetic screening of magnetostatic field of a cylinder-shaped magnetic inhomogeneity with a stripe domain structure in a magnetic film is analyzed.*

***Keywords**: stripe domain stricture; magnetic thin films.*

A magnetic domain ordering is known to occur in ferromagnetic materials and to promote decrease of the sample's magnetostatic energy [1]. This phenomenon can be considered as screening external and intrinsic magnetic fields by the magnetic sample. In this paper, an efficiency of screening a magnetic field of a cylinder-shaped magnetic inhomogeneity by a stripe domain structure is analyzed.

We used a magnetic film of composition $(Bi_{0.7}Lu_{0.3})_3(Fe_{0.8}Ga_{0.2})_5O_{12}$ with orientation *(210)* to obtain a static domain configuration experimentally. The parameters of the selected sample were the following: $h \cong 13\ \mu m$ is the thickness of the film, $\theta \cong 30°$ is the inclination of the easy direction, $4\pi M_s \cong 60\ Gs$ is the saturation magnetization, $\alpha \cong 0.01$ is the dimensionless Hilbert damping parameter determined from the FMR line width, $H_k \cong 1400\ Oe$ is the field of the orthorhombic anisotropy.

A photo of an obtained domain structure is presented at fig. 1. The width of a stripe domain (the dark one at fig. 1) containing a bubble domain equals 16 μm. The width of adjacent stripe domains (light ones) equals 10 μm. The mean radius of the bubble domain is 6.75 μm.

Let us consider a stripe domain of width $w = 2a$ in presence of a cylinder-shaped inhomogeneity of radius *R* on a side of it. The origin of coordinates is in the center of the inhomogeneity. The stripe domain is located along the *x* coordinate axis in an infinite film of thickness *h*. The *z* coordinate axis is directed perpendicularly to the film's plane, and the *y* coordinate axis is directed perpendicularly to the stripe domain walls. A magnetostatic stray field of the inhomogeneity distorts the stripe domain's shape and leads to a dependence of its width on *x* coordinate.

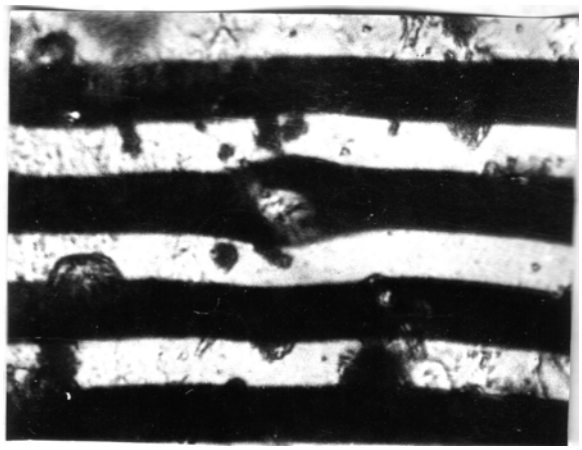

Fig. 1. A bubble domain in a stripe domain structure.

Assume that functions $y_1(x)$ and $y_2(x)$ determine the domain walls' curves. After calculating variational derivatives of a magnetostatic energy functional $\delta W/\delta y_1(x)$ and $\delta W/\delta y_2(x)$, we yield a system of integral equations with respect to functions $y_1(x)$ and $y_2(x)$. The equations can be linearized for comparatively small deformations of domain walls. Expressing functions $y_1(x)$ and $y_2(x)$ in terms in the range of integration, we yield a system of linear integral equations of a convolution kind which can be solved with a Fourier transformation method. After Fourier transformations, we obtain the following expressions for distortion shapes of domain walls of the stripe domain [2]:

$$y_1(x) = c + \sqrt{\frac{2}{\pi}} \int_0^\infty \frac{[A_2(y)A(y) + A_1(y)B(y)]\cos(xy)dy}{D_1(y)A_2(y) - A_1(y)D_2(y)}, \quad (1)$$

$$y_2(x) = c + w + \sqrt{\frac{2}{\pi}} \int_0^\infty \frac{[D_1(y)B(y) - D_2(y)A(y)]\cos(xy)dy}{D_1(y)A_2(y) - A_1(y)D_2(y)}, \quad (2)$$

$$A_1(y) = -K_0(y(b-c-w)) + K_0\left(y\sqrt{(b-c-w)^2 + h^2}\right), \quad (3)$$

$$A_2(y) = f + K_0(y(d-c-w)) - K_0\left(y\sqrt{(d-c-w)^2+h^2}\right), \quad (4)$$

$$D_1(y) = f + K_0(y(b-c)) - K_0\left(y\sqrt{(b-c)^2+h^2}\right), \quad (5)$$

$$D_2(y) = -K_0(y(d-c)) + K_0\left(y\sqrt{(d-c)^2+h^2}\right), \quad (6)$$

$$f = 2\ln\left(1+\frac{h^2}{4a^2}\right), \quad (7)$$

$$A(y) = \int_0^\infty dx' \int_{-R}^{R} dx_1 \int_{-\sqrt{R^2-x_1^2}}^{\sqrt{R^2-x_1^2}} dx_2 \cos(x'y) \times \left[\frac{1}{\sqrt{(x'-x_1)^2+(c-x_2)^2}} - \frac{1}{\sqrt{(x'-x_1)^2+(c-x_2)^2+h^2}}\right], \quad (8)$$

$$B(y) = \int_0^\infty dx' \int_{-R}^{R} dx_1 \int_{-\sqrt{R^2-x_1^2}}^{\sqrt{R^2-x_1^2}} dx_2 \cos(x'y) \times \left[\frac{1}{\sqrt{(x'-x_1)^2+(w+c-x_2)^2}} - \frac{1}{\sqrt{(x'-x_1)^2+(w+c-x_2)^2+h^2}}\right]. \quad (9)$$

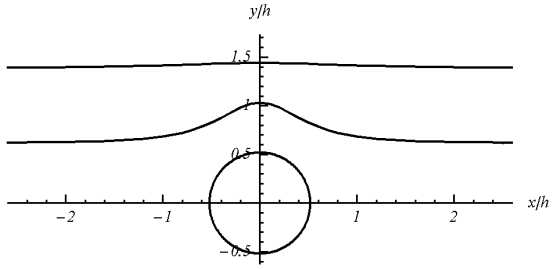

Fig. 2. Domain walls computed by formulas (1)–(9).

Based on expressions (1)–(9), we plotted theoretical curves which describe the distortion shape of domain walls of a stripe domain in the presence of a cylinder-shaped magnetic inhomogeneity of radius R = 6.75 μm on a side of it (fig. 2).

The theoretical computation of a maximum domain wall bend by formulas (1)–(9) (fig. 2) for parameters which fit the experimental data (w = 10 μm is the width of the stripe domain, h = 13 μm is the film’s thickness, R = 6.75 μm is the mean radius of the bubble domain, c = 8 μm is the distance between the center of the bubble domain and the nearest stripe domain wall) gives values 5.44 μm and 0.71 μm. The maximum stripe domain wall bend values obtained experimentally for the above parameters are 3.9 μm and 1.1 μm. Therefore, the values calculated by formulas (1)–(9) conform the experimentally obtained stripe domain wall bend values.

It follows from the obtained results and graphs shown at fig. 1 and 2 that the field of the cylinder-shaped inhomogeneity influences significantly upon the nearest domain wall only. The next one curves much smaller. Physically, it means that the magnetic field of the inhomogeneity is almost totally screened by a magnetic charge induced by the curvature of the nearest domain wall (see fig. 1). This phenomenon was also observed experimentally in [3]–[5]. Thus the presented research shows that a stripe domain in a magnetic film can effectively screen a magnetostatic field of a magnetic inhomogeneity with a slight distortion of the domain’s shape.

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APPLICATION OF SOLAR RADIATION FOR HEATING AND PREPARATION OF WARM WATER IN AN INDIVIDUAL HOUSE

Tadeeusz Kozak, Anna Majchrzycka

West Pomeranian University of Technology, Szczecin
The Faculty of Mechanical Engineering and Mechatronics
70-310, Szczecin, Piastów 19, Poland

***Abstract**: The paper is aimed at analysis of application of the solar collectors array for preparing of warm water and space heating in an individual house.*

***Keywords:** application of solar radiation, preparation of warm water, heating,*

1. INTRODUCTION

According to the environmental policy Poland is obliged to reduce CO_2 emission and increase the share of energy produced from renewable energy sources in gross final energy consumption [1]. The share of energy consumption in Polish households is as follows: 77% energy for heating, 11% energy for electricity, cooking and 12% for preparing of hot water. The growing energy requirements, pollution of environment and the higher costs of energy cause that there is an interest in implementation of renewable energy sources also in households. In Poland, where an average annual global solar radiation density is about 930–1163 kWh/m^{2}a, there are four zones of the different solar radiation density. West Pomeranian zone of Poland is limited with the isoline 950 kWh/m^2·a [2,3], therefore it is essential to analyse the possibility and profitability of the solar collectors application for producing energy for the household purposes [2,3,4]. The paper is aimed at analysis of the solar collectors array application as energy source for preparing of warm water and space heating of an individual house. Analysis will be performed for two cases: where the solar collectors are used as an independent energy source and combined with gas fuelled boiler.

2. ENERGY FOR PREPARATION OF THE WARM WATER

Analysis will be performed for one floor detached individual house with the loft. The house is covered with the gable roof of the slope 45°, area of the southern roof is of 35,2 m^2. The total area of the house is of 188 m^2 and the usable area is of 111,5 m^2. The solar collectors installation will be placed on the roof. It is assumed that the solar installation consisting of 10

modules (2 rows each of 5 modules) of the flat plate solar collectors. It was assumed that the flat plate solar collectors type KS-2000 (Hewalex), dimensions $102 \times 590 \times 2030$ mm, with the selective absorber of the surface area A_1=1,8m^2 will be used for preparing of warm water. The total surface area is of A=21 m^2. Energy obtained from n=10 solar modules installed on the roof is calculated from the following equation:

(1) $$Q_{coll} = I \cdot \eta \cdot F$$

where:

Q_{coll} - energy obtained from solar collectors, [kWh]

I - monthly solar radiation

η - installation efficiency [%], = 45%;

F - surface of the solar collectors , F=18 m^2.

Energy obtained from the solar collectors arrays assembled on the roof was determined for each month based on data from actinometer station [2]. Twenty-four hours demand for energy necessary for preparing of the warm water is calculated from the following equation:

(2) $$q_{cwu} = \frac{G_{cwu} \cdot C_{cwu} \cdot (t_{cw} - t_{zw})}{3600}$$

where:

q_{cwu} - twenty-four hours demand for energy necessary for preparing of the warm water, $\left[\frac{kWh}{d}\right]$

C_{cwu} - specific heat of water $[\frac{kJ}{kgK}]$

t_{cw} - the temperature of the warm water, [ºC]

t_{zw} - the temperature of the cold water, [ºC]

G_{cwu} - twenty-four hours water consumption, [kg]

Water consumption in twenty-four hours is determined from equation:

(3) $$G_{cwu} = n \cdot g_{cwu}$$

where:

g_{cwu} – mean twenty-four hours water demand per capita , [kg]

G_{cwu} – water consumption in 24-hours, [kg]

n - the number of inhabitants,

Monthly energy demand for preparation of warm water was determined at the following assumptions: n=4 inhabitants, mean twenty-four hours water

demand per capita g_{cwu}=60 [kg/capita], the temperature of the warm water, t_{cw} = 45 ºC, the temperature of the cold water, t_{zw} = 10 ºC.
Monthly energy requirement for preparation of the warm water is calculated from the equation:

$$Q_{cwu} = N \cdot g_{cwu} \tag{4}$$

where:

N- number of the days in month

Fig.1 shows comparison of monthly energy requirement for preparation of the warm water and energy monthly obtained from the array of the installed solar collectors.

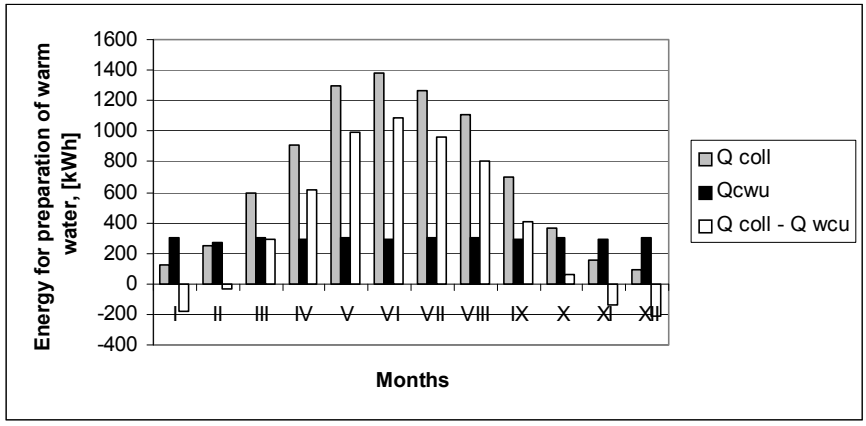

Fig.1: Comparison of energy requirement for preparation of the warm water with energy delivered by the installed solar collectors.

As it follows from analysis energy obtained from the solar collectors is sufficient to provide energy for preparation of the warm water in the period between March and October. Between November and February energy obtained from the solar collectors covers only 54% of energy requirement. The missing energy necessary for preparation of warm water should be produced by conventional source i.e. gas hot water boiler. At the assumption that maximal energy demand for preparation of the warm water is of 303KWh and minimal solar radiation in December is of 0,37kWh/m^2 it was determined that to cover energy requirement for preparation of warm water during all seasons it is necessary to install the solar collectors array consisting of 33 modules of the total surface area 59 m^2.

3. ENERGY REQUIREMENT FOR SPACE HEATING

Energy requirement for house heating was determined according to Polish Standards [5,6] from the following equation:

$$Q_d = \frac{Q \cdot St \cdot 24}{t_e - t_i} \tag{4}$$

where:

Q_d heating requirement, [kWh/a],
Q thermal power demand [kW]
St the number of heating -degree days
t_e the mean internal temperature, [^oC].

The number of heating - days was calculated from the following equation:

$$St = \sum_{i=1}^{n} x \cdot (t_e - t_i) \tag{5}$$

x number of days when heating is required
t_e mean internal temperature , [^{o} C]
t_i mean outer temperature , [^{o} C]

Energy requirement for the house space heating in all seasons is shown in Fig.2. As it follows from calculations energy delivered from solar collectors array of 18 m^2 is not sufficient enough to cover energy requirement of the house. Energy delivered from the solar array covers 85% of energy demand for preparation of the warm water and 8 % of energy required for space heating of the house. Between December and January it is recommended to install an additional energy source - gas boiler, that will be switched on and work with the maximal thermal power. Beyond that period gas boiler will operate with thermal power lowered by energy obtained from the solar collectors installed on the roof of the house. Energy released in combustion of natural gas Gz-50 of net calorific value Q_i=34.430 kJ/nm^3 was calculated at assumption that efficiency of installation is $\eta = 0{,}85$ and the amount of gas consumed was determined from equation:

$$B = \frac{(Q_d \cdot 3600)}{\eta Q_i} \tag{6}$$

where:
Q_d the total energy requirement for house purposes, [kWh],
Q_i net calorific value of natural gas, [kJ/nm^3]

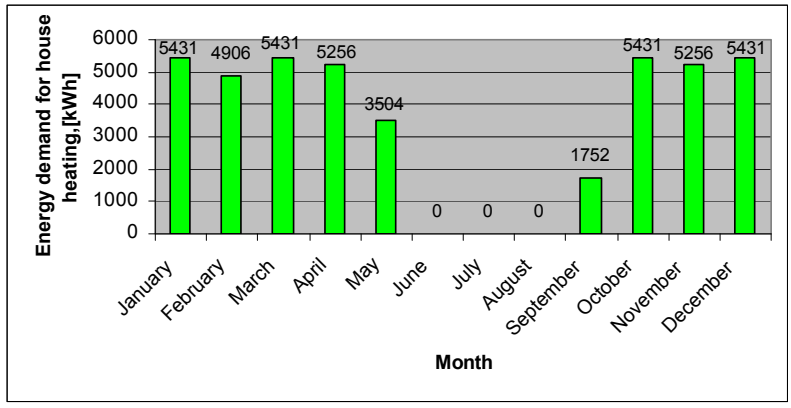

Fig. 2: Energy requirements for the house space heating in all seasons.

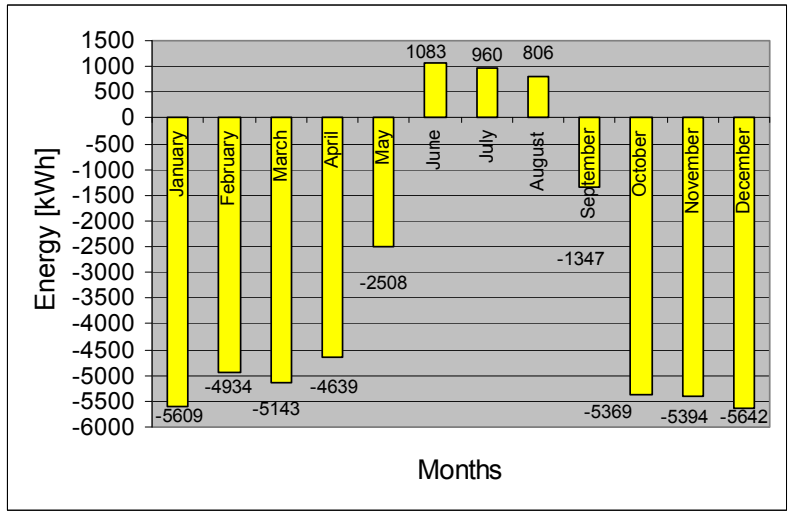

Fig. 3: Energy delivered for preparation of warm water and space heating from gas boiler combined with the solar collectors array.

Figure 3 shows energy that is to be delivered from gas boiler to cover the total monthly energy requirement of the house in case of not sufficient amount of energy delivered from the solar collectors (negative values in Fig.3) and in case of energy exceed delivered from the solar collectors (positive values in Fig.3).

4. CONCLUSIONS

- In relation to solar radiation conditions in West Pomeranian Region of Poland, it is recommended to apply the solar collector array for preparation of warm water between March –October, whereas between November and February, energy obtained from the solar collectors covers only 54% of energy requirement for preparation of warm water,
- Application of the solar collectors array as the main source of energy for preparation of warm water and space heating is not recommended in West Pomeranian Region of Poland, as energy delivered from the solar array yearly covers yearly about 85% of energy required for preparation of the warm water and 8 % of energy required for space heating of the house.
- Because of solar radiation conditions of zone in question it is recommended to apply the solar collectors combined with gas boiler or heat pump.

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Wind energy potential in Bulgaria

Stanko Vl. Shtrakov

South - West University "Neofit Rilski",
66 Ivan Mihailov Str., 2700 - Blagoevgrad, BULGARIA,

Abstract*: In this study, wind characteristic and wind energy potential in Bulgaria were analyzed using the wind speed data. The wind energy potential at different sites in Bulgaria has been investigated by compiling data from different sources and analyzing it using a software tool. The wind speed distribution curves were obtained by using the Weibull and Rayleigh probability density functions. The results relating to wind energy potential are given in terms of the monthly average wind speed, wind speed probability density function (PDF), wind speed cumulative density function (CDF), and wind speed duration curve. A technical and economic assessment has been made of electricity generation from three wind turbines having capacity of (60, 200, and 500 kW). The yearly energy output capacity factor and the electrical energy cost of kWh produced by the three different turbines were calculated*

1. INTRODUCTION

The utilization of wind energy has been increasing at an accelerating pace. However, the development of new wind projects continues to be hampered by the lack of reliable and accurate wind resource data in many parts of the world. Such data are needed to determine the priority that should be given to wind energy utilization and to identify potential areas that might be suitable for development. The distribution of wind speeds is important for the design of wind farms and power generators.

Bulgaria has a large potential for renewable energies. One of the very effective renewable energy sources for Bulgaria is wind energy. The previous technical research proves that some parts of Bulgaria are endowed with strong wind conditions. Particularly, some parts of the coastal region of Black Sea and locations with rugged mountains are especially promising regions.

In the last decade, a lot of studies related to the wind characteristics and wind power potential have been made in many countries worldwide [1–24]. For proper and beneficial development of wind power at any location, wind data analysis and accurate wind energy potential assessment are the key requirements.

The annual average wind speed for Bulgaria ranged from 3.7 to 9.5 m/s and a mean wind power density from 80 to 167 W/m^2 at standard height of 10 m. There are determined the optimum configuration of a stand-alone

wind power system and wind farms by using long-term wind potential theoretical investigations for several regions in Bulgaria.

2. THEORY

Before the installation of any wind turbine, it is necessary to estimate the expected power output in order to assess the economic viability of the project. It is usually based on wind statistics measured over a period of at least 2 year.

Wind energy projects are generally more financially viable in “windy” areas. This is due to the fact that the power potential in the wind is related to the cube of the wind speed. However, the power production performance of a practical wind turbine is typically more proportional to the square of the average wind speed. The difference is accounted for by the aerodynamic, mechanical and electrical conversion characteristics and efficiencies of the wind turbines. This means that the energy that may be produced by a wind turbine will increase by about 20% for each 10% increase in wind speed. Wind energy project sitting is critical to a financially viable venture. It is important to note that since the human sensory perception of the wind is usually based on short-term observations of climatic extremes such as wind storms and wind chill impressions, either of these “wind speeds” might be wrongly interpreted as representative of a windy site. Proper wind resource assessment is a standard and important component for most wind energy project developments.

Wind power density (wpd, Wm^{-2}) can be calculated according to

$$wpd = \frac{1}{2}(\rho C_{PR} C_T) V^3$$

where ***r*** is the air density (kg/m^3) and ***V*** is the wind speed (m/s). Pressure and temperature correction terms (CPR and CT, respectively) are applied to account for deviations from standard atmospheric density (1.225 kg/m^3) due to differences from standard sea level pressure (1013.25 hPa) and temperature (288.15 K). The correction factors are computed as

$$C_{PR} = \frac{P_a}{1013.25}; \quad C_T = \frac{288.15}{T_a}$$

where $\boldsymbol{P_{a}}_{\text{abs}}$ is the sea level pressure (hPa) and ***Ta*** is the air temperature (K) at the site.

It is important to know the number of hours per month or per year during which the given wind speeds occurred, i.e. the frequency distribution of the wind speeds.

Simple knowledge of the mean wind speed is not sufficient for the computational demands of the available regional wind potential. Additionally, thorough information is needed for the probability distribution of the appearance of several wind speed values in the course of time, with an emphasis

on recording the stillness intervals and the intervals of the appearance of very strong winds [10].

It is important to determine the theoretical model, which fits the real wind data in Bulgaria most accurately. It can be used the two- parameter Weibull probability model, the lognormal, gamma and Rayleigh models [3,5,6]. Practice and investigations show, that the Weibull probability distribution function is found to fit the monthly frequency distribution of wind speed measurements. This means that, most wind speed distribution characteristics at any site can be described by two parameters: the shape parameter ***K***, and the scale parameter ***C***. The fraction of time duration that the wind blows at speed ***V*** is thus determined by

$$f(V)=\frac{K}{C}\cdot\left[\frac{V}{C}\right]^{K-1}\exp(-\left[\frac{V}{C}\right]^{K}$$

This expression is valid for ***K*** >1, ***V*** ≥ 0, and **C** > 0. The shape factor will typically range from 1 to 3. For a given average wind speed, a lower shape factor indicates a relatively wide distribution of wind speeds around the average while a higher shape factor indicates a relatively narrow distribution of wind speeds around the average. A lower shape factor will normally lead to a higher energy production for a given average wind speed. ***C*** is the scale factor, which is calculated from the following equation (Hiester and Pennell, 1981):

$$C=\frac{\overline{V}}{\Gamma(1+\frac{1}{K})}$$

where $\overline{V}$ is the average wind speed value and ***Γ*** is the gamma function.

In order to estimate Weibull ***K*** and ***C*** parameters, numerous methods have been proposed over last few years. In this study, the two parameters of Weibull are determined by using mean wind speed-standard deviation method [7].

The input parameters required for the software have been calculated and/or estimated as follows: The shape parameter ***K***, which is an indication of the breadth of the distribution of wind speeds, is calculated by applying equation proposed in [1] and also by repeatedly running the program, by way of trial and error, checking the results against the measured data. The value that fits best for K is found to be

$$K=(\frac{\sigma}{\overline{U}})^{-1.086}$$

where, $\overline{U}$ is the mean wind speed and σ is the standard deviation.

Typical example for the Weibull probability distribution function is given on fig. 1 – region Kaliakra (near the Black Sea)

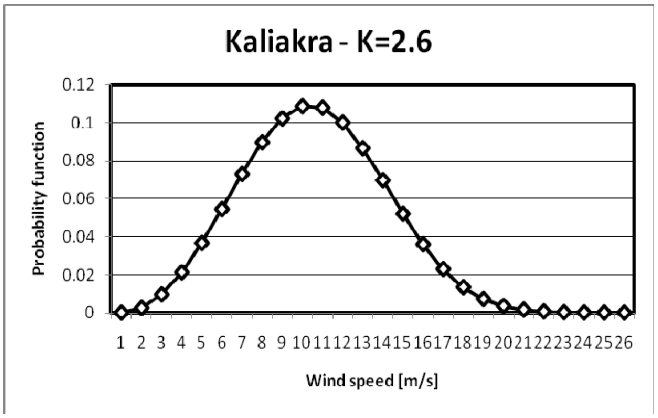

Fig. 1 Weibull probability distribution function

Energy curve

The energy curve data is the total amount of energy a wind turbine produces over a range of annual or monthly average wind speeds. In fig.1, the energy curves for Atlantic Orient Corporation AOC 15/50 - 60 kW wind turbine (rotor diameter - 15 m) and Vestas V47-600kW - 600 kW (rotor diameter – 47 m) are specified over the range of 3 to 25 m/s average wind speed, and are displayed graphically.

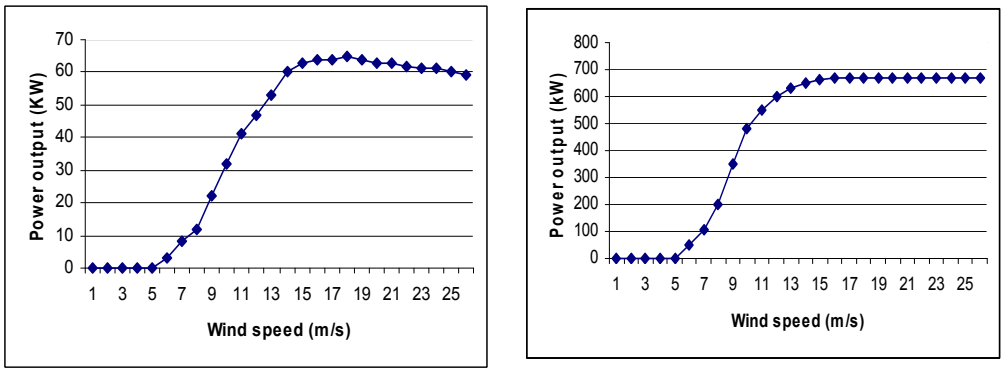

Fig.1 Energy curves for 60 KW and 600 kW wind turbines

The user specifies the wind turbine power curve as a function of wind speed in increments of 1 m/s, from 0 m/s to 25 m/s. Each point on the energy curve, ***Ev*** , is then calculated as:

$$E_{\overline{V}} = T \sum_{i=1}^{25} P_i \cdot p(i)$$

where v is the mean wind speed considered, P_i is the turbine power at wind speed i, and p(i) is the Weibull probability density function for wind speed i,calculated for an average wind speed v .
Gross energy production is the total annual energy produced by the wind energy equipment,before any losses, at the wind speed, atmospheric pressure and temperature conditions at the site.

WIND_ENERGY Software

Wind_Energy is a computer program that provides a gross energy production of wind energy. It uses a monthly and yearly mean wind speed and Weibull probability model for assessment of wind speed distribution.
WINDOWS environment for the Wind_Energy Delphi program provides for user friendly input of data, processing and viewing of the results.
Data input is interactive (mouse driven) via WINDOWS dialogue boxes, selection lists drop down lists and entry fields on a series of screens running through general Project information to individual space data and for all the building services plant, capacities, operating schedules, etc. Buttons on the toolbar and special keys allow the user to copy individual values, columns of data or complete screens from space to space or system to system and there is a facility for making global changes.

Wind Energy potential in Bulgaria

Calculations for many places in Bulgaria have been made with the software program with two wind turbines. Result for gross energy production was presented as a energy for unit 'swept' area of wind turbine rotor – kWh/m^2. This information was summarized and graphically presented by geographical map – fig.2. From this map can be seen, that in Bulgaria are some places with very good energy potential, but very big part of territory is not suitable for wind energy utilization.

3. CONCLUSION

New technologies in planning, design and operation for wind energy utilization often require the use of computers, and with the developing of desktop computing, building energy simulation is expected to grow in importance. A new energy performance standard is being proposed for use in European countries so as to achieve higher efficiency levels and greater energy savings. We demonstrated engineering compliance software, **CDLoad**, tailored for use by professionals to perform calculations aimed at achieving energy efficiency in buildings and compliance of energy performance standards. Software is approved in CHAMBER OF ENGINEERS IN THE INVESTMENT DESIGN and is adopted as official design software for *HVAC (Heating, Ventilating, and Air Conditioning) projects.*

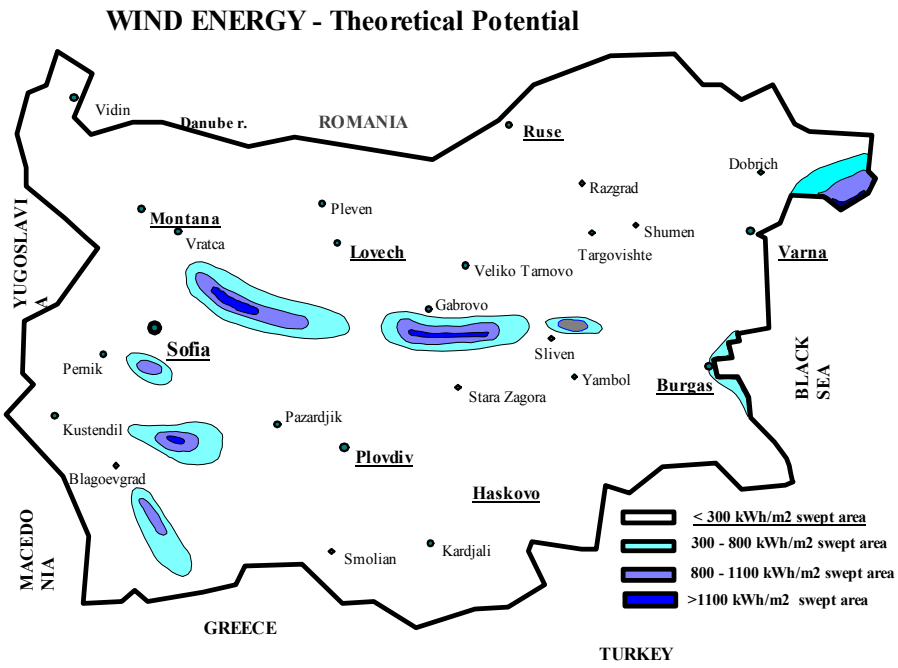

Fig. 2. Main screen of the program CDLoad

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Investigation of Metal Hydride Electrodes for Application in Direct Borohydride Fuel Cells

Georgi Hristov, Elitsa Hristova, Mario Mitov

Department of Chemistry, South-West University, Blagoevgrad, Bulgaria

***Abstract**: The commercialization of fuel cell technology is going to solve the global problem with satisfying rising energy demands as well as those of environmental pollution and global warming. The use of hydrogen-rich compounds, such as alkaline borohydrides, is a possible solution of the problem connected with safety hydrogen storage and transportation. Alkaline borohydrides can also undergo direct electrooxidation. The purpose of this study is to determine the share of possible processes taking place in the complex system AB_5 metal hydride electrode/sodium borohydride electrolyte. The obtained results allow selecting the appropriate conditions for application in direct borohydride fuel cells or hydrogen-on-demand systems.*

***Keywords:** metal hydride electrodes, borohydride electrooxidation, direct borohydride fuel cells, hydrogen-on-demand systems.*

1. INTRODUCTION

Fuel cells are innovative devices, which generate electricity using predominantly hydrogen as a fuel. Hydrogen is about three times more caloric than oil derivatives such as petrol and diesel [11]. Its combustion does not emit carbon monoxide and carbon dioxide, nitrogen oxides, but only produces water. The commercialization of the fuel cell technology is going to solve the global problem with satisfying rising energy demands as well as those of environmental pollution and global warming. The main problems of using hydrogen as a fuel are connected with its storage and transportation [13]. The common methods for gas storage are under high pressure or as cryogenic liquid. When these methods are applied to hydrogen they become unprofitable and dangerous. The researchers are looking for new materials containing enough hydrogen to play the role of safety hydrogen tanks, such as metal hydride alloys or carbon nanotubes [3, 5, 6]. A possible solution of the problem with safety hydrogen storage and transportation is to use hydrogen-rich compounds, such as alkaline borohydrides or alanates, which can easily undergo hydrolysis or thermal decomposition with a big yield of hydrogen [1, 2]. New types of hydrogen-on-demand (HOD) generators, operating on the principle of controlled catalytic hydrolysis or thermal decomposition, are under research and development [2, 7, 9]. An advantage of alkaline borohydrides is there ability for direct electrooxidation, which makes them potential fuel in the so-called direct borohydride fuel cells (DBFC) [1, 12].

Recently, we have investigated the performance of system consisting of a metal hydride electrode, such as those in Ni-MH batteries, and sodium borohydride electrolyte as anode half-cell of electrochemical power source. In such system, three processes are possible - electrooxidation of $NaBH_4$, hydrolysis of $NaBH_4$ and absorption of hydrogen in the metal hydride material [10].

The purpose of this study is to determine the share of possible processes taking place in the complex system AB_5 metal hydride electrode/sodium borohydride electrolyte. The obtained results allow selecting the appropriate conditions for application in DBFC or HOD systems.

2. EXPERIMENTAL

Commercial AB_5-type metal hydride alloy AKL-86 (Triebacher, Germany) was used for preparation of button-shaped electrodes. A mixture of metal hydride, hydrophobized carbon VULCAN 72 and PTFE-paste (Carl Roth GmbH+Co) in weight ratio 90:5:5 was hot pressed (p=100-200 $kg.cm^{-2}$, t=280 ^oC) on RCM-Ni-2733.03 nickel foam (RECEMAT) with geometric area 1 cm^2.

Sodium borohydride (Merck) was used for preparation of stabilized solutions by dissolving in 6M KOH.

The studies were performed in a hermetically sealed three-electrode cell with separate compartments for the working and the counter electrode. The tested metal hydride electrode was connected as a working electrode and a Pt-mesh with geometric area 5 cm^2 was used as a counter electrode. The potentials were measured against Hg/HgO reference electrode. Solution of 5% (w/v) $NaBH_4$/6 M KOH was used as a working electrolyte. The electrolyte temperature was maintained within the range of the set value ±0.2 ^oC using a thermostat. The electrochemical experiments were performed using PJT 35-2 potentiostat–galvanostat (Radiometer-Tacussel) with IMT 101 electrochemical interface and Volta Master 2 software.

A complex methodology, which enables to assess the part of each of the possible processes – electrooxidatoin of borohydride, its hydrolysis and absorption of hydrogen in the electrode material, taking place in the system metal hydride electrode / alkaline borohyride electrolyte, has been developed and applied.

After overnight treatment in sodium borohydride solution, the metal hydride electrodes were anodically polarized at constant current in 6M KOH electrolyte. In this case, the occurring discharge process corresponds with the electrooxidation of formed metal hydride and the estimated discharge capacity value can be used as a measure for the hydrogen-storage capacity of the alloy.

In a subsequent experiment, the same electrodes were galvanostatically discharged but in 5% (w/v) $NaBH_4$/6 M KOH electrolyte and the corres-

ponding discharge capacity was estimated. Simultaneously, the kinetics of hydrogen release due to catalyzed borohydride hydrolysis was monitored by means of water displacement method [10]. The volume of generated hydrogen was recalculated to normal conditions and plotted versus time. The hydrogen generation rate at different stages of the discharge progress was estimated from the obtained kinetic curves. In parallel, the change of sodium borohydride total concentration was controlled by using linear voltammetry method, described in [4]. Samples of 2 ml borohydride-containing solution were diluted 250 folds and linear voltammetry with Au-indicator electrode was carried out. The intensity of anodic peak, observed at -30 mV (vs.Hg / HgO) in the voltammograms, was used as an analytical response. Borohydride concentration was determined from the obtained linear dependence of peak current with concentration at the range 1 - 12 mM $NaBH_4$ (correlation coefficient R^2 = 0.9953), used as a calibration curve.

3. RESULTS AND DISCUSSION

Under anodic polarization, it is expected that in the complex system metal hydride electrode/sodium borohydride electrolyte the dissolved borohydride undergoes predominantly a direct electrooxidation. However, many transition metals and their compounds catalyze borohydride hydrolysis, so this reaction could occur simultaneously with electrooxidation, thus exhausting “non-productively” borohydride content in the electrolyte. As previously reported [3], as a result of treatment with sodium borohydride solution AB_5-type alloys form metal hydrides as those obtainable by electrochemical charge in Ni-MH batteries. The results of this study give quantitative data about the share of those three reactions in the case of AKL-86 alloy used as electrode material.

Typical discharge curve, obtained with AKL-86 electrode in 6M KOH electrolyte, is shown on Fig. 1.

The obtained open circuit potential (OCP) and discharge time are characteristic for this type of metal hydride electrodes [3]. The estimated specific discharge capacity value 250 mAh/g corresponds to 1.30 mmol-at absorbed hydrogen.

Discharge curve obtained with the same electrode in 5% $NaBH_4$/6M KOH is presented on Fig. 1. In this case, the curve starts at more negative potential than the typical one for the hydrogen reaction and the discharge capacity (Q = 1500 mAh) is several times bigger than the theoretical specific capacity of this type alloys. Both results are indication that the overall electrochemical process is connected with direct electrooxidation of dissolved sodium borohydride.

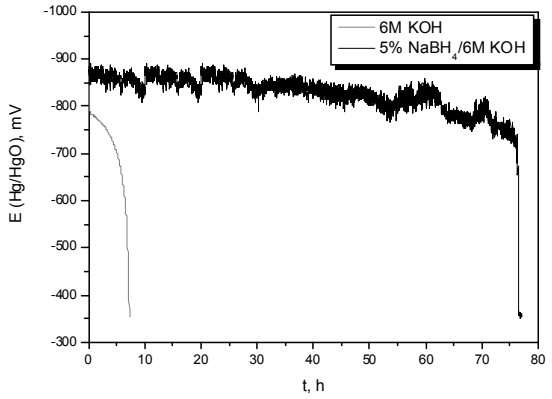

Fig. 1: Discharge curve obtained with AKL-86 electrode in 6M KOH ($I_{disch.}$=5 mA) after pre-treatment in sodium borohydride solution and discharge curve obtained with AB_5 electrode in 5% $NaBH_4$/6M KOH electrolyte ($I_{disch.}$=20 mA).

Kinetics of hydrogen release as a product of catalytic borohydride hydrolysis was measured at different stages of discharge experiment. As in previous studies [10], the resulting kinetic curves are linear and the hydrogen generation rate can be directly calculated from the line slope. As seen from Fig. 2, the rate of hydrogen release decreases non-linearly within discharge progress. This could be explained with an exhausting of borohydride due to both competitive processes – hydrolysis and electrooxidation.

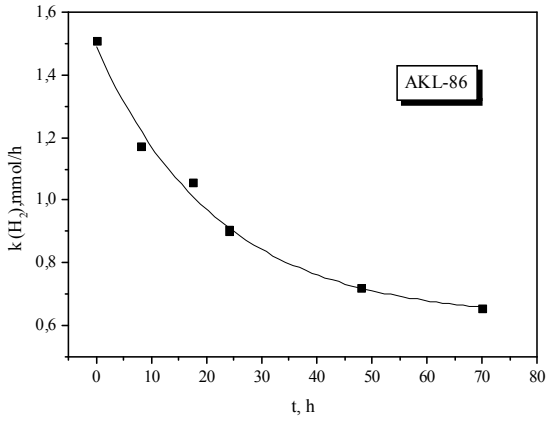

Fig. 2: Change of hydrogen release rate constant, k, during galvanostatic discharge (I=20 mA) of AKL-86 electrode in 5% $NaBH_4$/6M KOH electrolyte.

The analytically determined change of borohydride concentration within discharge progress, presented on Fig. 3, confirms the above statement. It could be seen that the amount of $NaBH_4$ in the working electrolyte was half-exhausted for about 25 hours, and at the end of discharge it became 7 times lower than the initial one.

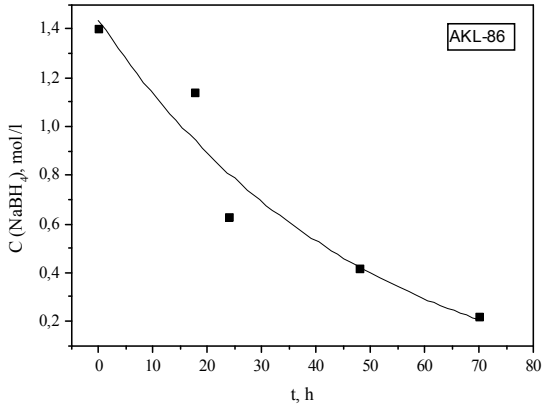

Fig. 3: Change of sodium borohydride concentration during galvanostatic discharge (I=20 mA) of AKL-86 electrode in 5% $NaBH_4$/6M KOH electrolyte.

The relative share of sodium borohydride consumed via electrooxidation, hydrolysis and metal hydride formation is compared with the total depletion of its concentration on Fig. 4. Hypotheses for participation of 8, 4 or 2 electrons in the process of borohydride electrooxidation were verified. The best fit with the experimental results was obtained for the case of 2 electron reaction.

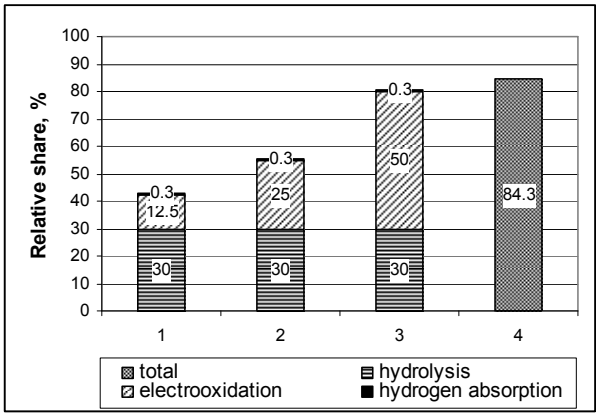

Fig. 4: Relative share of borohydride electrooxidation, borohydride hydrolysis and hydrogen absorption/hydride formation processes in the system AKL-86 electrode /

$NaBH_4$ electrolyte at hypotheses for: 1 – 8-electron; 2 - 4-electron; 3 - 2-electron participation in borohydride electrooxidation compared with: 4 – analytically determined total sodium borohydride depletion.

4. CONCLUSIONS

The relative share of possible processes taking place in the complex system AKL-86 metal hydride electrode/sodium borohydride electrolyte was determined by using a set of electrochemical and volumetric methods. Hypothesis of three possible mechanisms for sodium borohydride electrooxidation were assumed. The best fit between the analytically determined depletion of sodium borohydride and the summary share of borohydride electrooxidation and hydrolysis corresponds to the hypothesis of two-electron electrooxidation process. The share of hydrogen absorption/metal hydride formation process is negligible in compare with those of other two processes.

The obtained results prove the possibility for application of studied AKL-86 alloy as anode material in DBFC. Investigations in metal hydride – air cell are in a progress.

Acknowledgements: This study was supported by the National Science Fund of the Ministry of Education and Science of Bulgaria through contract d01-368/2006.

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Solar Electricity Power Station Building. A Preliminary Project Investigation for “PIRIN TEX LTD.” – Gotze Delchgev Using

Boyko Kolev, Vanja Todorieva

South-West University, Faculty of Natural Sciences and Mathematics, Geography, Ecology and Environment Protection, Blagoevgrad, Bulgaria

***Abstract**: The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (EJ=10^{18} J) per year. In 2005, this was more energy in one hour than the world used in one year. Photosynthesis captures approximately 3,000 EJ per year in biomass. The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined.*

Natural gas crisis such as this from January 2009 in Bulgaria turn into the best investments the development of technology for renewable energy sources using especially solar energy using for electricity production and water heating.

The aims of this article are:

To develop a preliminary project for solar electricity power station building;

To estimate the profits of solar energy used for electricity production and water heating.

***Keywords:** renewable energy sources, solar energy accumulation, solar electricity power station, natural gas crisis.*

1. INTRODUCTION

The Earth receives 174 petawatts (PW[2]) of incoming solar radiation (insolation[3]) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the

[2] petawatt (10^{15} watts).

[3] **Insolation** is a measure of solar radiation energy received on a given surface area in a given time. It is commonly expressed as average irradiance in watts per square meter (W/m^2) or kilowatt-hours per square meter per day ($kW \cdot h/(m^2 \cdot day)$) (or hours/day). In the case of photovoltaics it is commonly measured as $kWh/(kW_p \cdot y)$ (kilowatt hours per year per kilowatt peak rating).

visible[4] and near-infrared ranges with a small part in the near-ultraviolet. Solar radiation budget is presented in Figure 1.

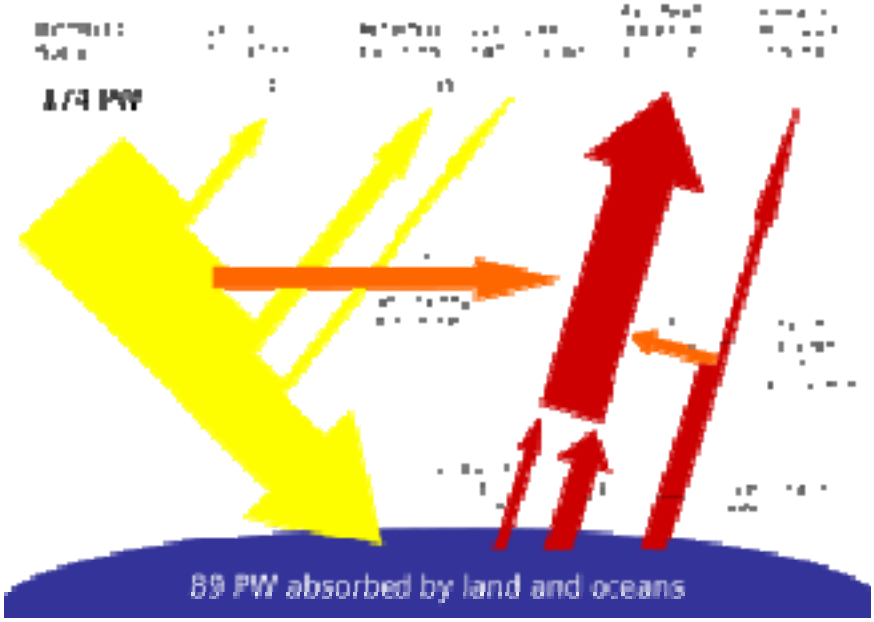


Fig. 1: Solar radiation budget.

Earth's land surface, oceans and atmosphere absorb solar radiation, and this raises their temperature. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapour condenses into clouds, which rain onto the Earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection, producing atmospheric phenomena such as wind, cyclones and anti-cyclones. Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of 14 °C. By photosynthesis green plants convert solar energy into chemical energy, which produces food, wood and the biomass from which fossil fuels are derived. Yearly Solar fluxes and human energy consumption are presented in Table1.

From the table of resources it would appear that solar, wind or biomass would be sufficient to supply all of our energy needs, however, the increased use of biomass has had a negative effect on global warming and dramatically increased food prices by diverting forests and crops into biofuel production. As intermittent resources, solar, biomass and wind raise other issues.

Tab. 1: Yearly Solar fluxes and Human Energy Consumption.

[4] From about 380 to 750 nm.

Yearly Solar fluxes & Human Energy Consumption	
Solar	3,850,000 EJ
Wind	2,250 EJ
Biomass	3,000 EJ
Primary energy use (2005)	487 EJ
Electricity (2005)	56.7 EJ

Natural gas crisis such as this from January 2009 in Bulgaria turn into the best investments the development of technology for renewable energy sources using especially solar energy using for electricity production and water heating.

The aims of this study are:

To develop a preliminary project for solar electricity power station building.

To estimate the profits of solar energy used for electricity production and water heating.

2. OBJECT AND METHODS

2.1 Object

The region of Gotze Delchev (an area of about 1367 km^2) is located in southwest Bulgaria and borrows most south border territories with Greece. It includes the municipalities Gotze Delchev, Hadgidimovo, Garmen and Satofcha and includes 58 settlements and two cities (Gotze Delchev and Hadgidimovo with population of 83339 by data from 1995). This region is situated on the one of the most picturesque nature tessellation: of parts of Pirin, western Rodopi, Slavjanka and Stargach, the valley of middle Struma and Gotze Delchev valley.

The Gotse Delchev municipality encompasses an area of 315.8 km^2 in the southwest part of Bulgaria. It borders the municipalities of Hajidimovo, Garmen, Bansko and Sandanski.

The town of Gotse Delchev is situated in the Gotse Delchev Hollow, at the southwest foot of the Middle Pirin Mountain, along both banks of the Nevrokopska (Gradska) River - a tributary to the Mesta River, which flows 3 km west of the town.

The general view of the Pirin Tex Ltd. is presented on Figure 2. Its activities included production and sale of men's clothes with the company's own trademark - Rollman Fashion.

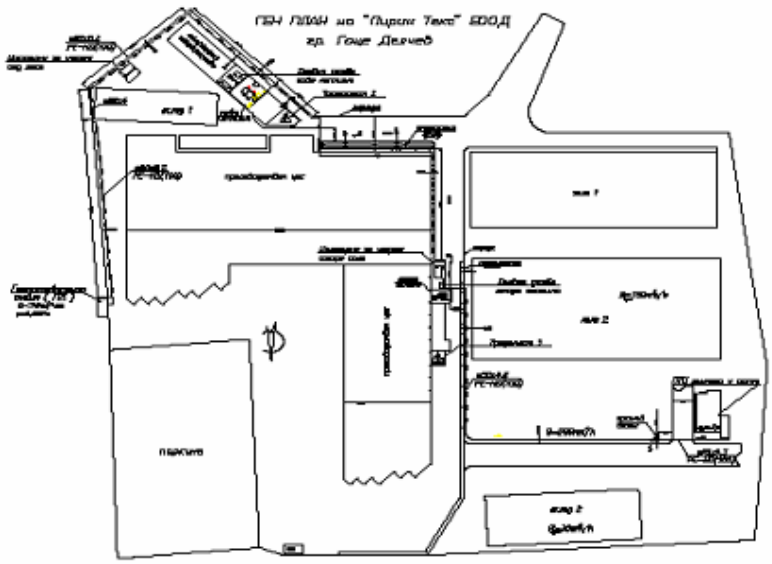


Fig. 2. PIRIN TEX LTD. - the general view.

2.2 Methods

The radiative energy from the Sun that keeps our planet warm exceeds by far the current primary energy supply used by mankind for its comfort, leisure and economic activities - [3], [4]. It also exceeds vastly other energy sources at ground level such as geothermic or tidal energy, nuclear power and fossil fuel burning. Sunrays also drive hydraulics, wind and wave power and biomass growth.

Solar technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight [1]. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the Sun. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies - [2]. The theoretical potential of Bulgarian solar resources is presented in Figure 3.

3 RESULTS AND DISCUSSIONS

3.1 Project development

We offer two standard modules with different electric power and working on 16.5 and 35 volts for solar electricity power station building - [5].

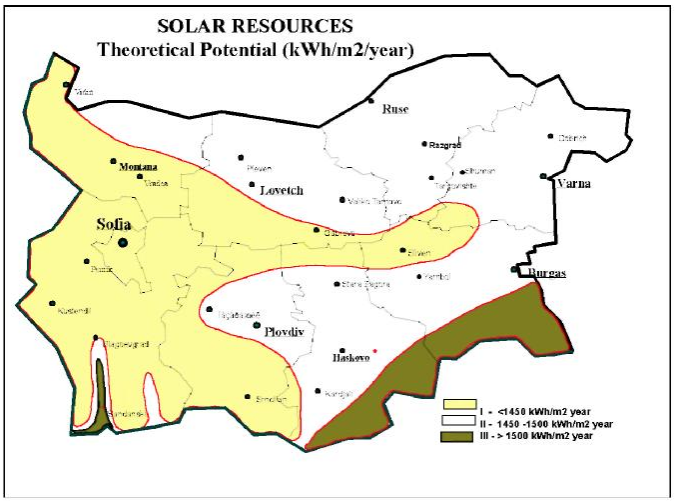


Fig. 3. Bulgarian solar resources (theoretical potential).

Tab. 2: Characteristics of the first type of modules.

Model	WSK0001	WSK0039	WSK0019	WSK0020	WSK0021
Power, W	5.5	12.0	23.0	35.0	55,0
Working voltage, V	16.5	16.5	16.5	16.5	16,5
Working current, A	0,33	0,73	1.39	2.12	3,33
Width, mm	205	405	405	605	605
Height, mm	305	305	605	605	905
Thickness with the frame, mm	31	31	31	31	35
Weight, kg	1,32	2,41	4.51	6.54	9,74

Tab. 3: Characteristics of the second type of modules.

Model	WSG0036E70	WSG0036E75	WSG0036E8
Power, W	70,0	75,0	80,0
Working voltage, V	33,0	34,0	35,
Working current, A	2.12	2.21	2.29
Width, mm	605	605	605
Height, mm	1205	1205	1205
Thickness with the frame, mm	35	35	35
Weight, kg	12.71	12.71	12,71

3.1.1 Mono-phase and Three-phase transformers – series solar-STAR

We offer two types standard set transformers – mono-phase (A series) and three-phase (X series) with different power supplies. Two examples of transformers connection are presented in Figure 4.

3.1.2 Circuit-breakers

We offer two Circuit-breakers: DC Circuit breaker MC4 and DC Disconnect. Their characteristics are presented in Table 4 and connection - Figure 5:

3.1.3 Commutators

For bigger solar parks building in is necessary to connect many strings of solar modules. So it is necessary to use commutators that grouping the generating energy and transmiced it by smallest number of cables with biggest Ø. The most important characteristics of them are presented in Table 5 and connection - Figure 6:

Tab. 4: Characteristics of Circuit-breakers.

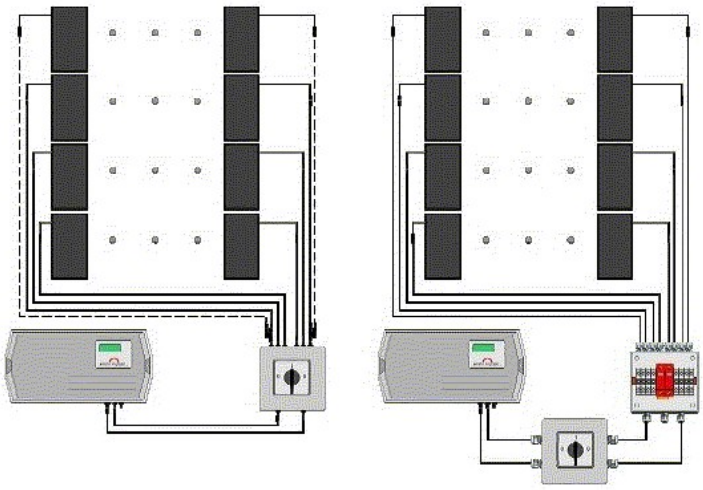
Model	DC Cirquit breaker MC4	DC Disconnect
Maximum voltage, Vdc	900	600
Maximum current, Adc	25	25
Section of the input cable, mm	4	6
Section of the output cable, mm	6	6
Numbers of inlets	3	4
Numbers of outlets	2	1

Würth Solergy offered 2 standard modules STARcheck AX and STARcheck PRO. Very often it is offered AX series, because they have a possibility to monitor up to 100 modules.

Manufacturer of GeneCIS solar modules and supplier of customized complete solar installations. Because applies also with Photovoltaic plants: each chain is only as strong, as your weakest member – Figure 7.

For solar electricity plants on trade objects you can use special financing and depreciation possibilities as well as tax benefits, which are naturally dependent on their personal starting situation. Inform is worthwhile oneself!

a - direct connection



b – protected connection

Fig. 4. Transformers connection

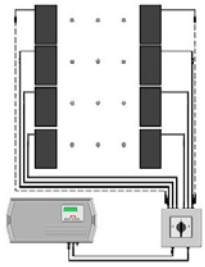


Fig. 5. Circuit-breakers connection

Tab. 5: Characteristics of commutators.

Model	**STARconnect 12**	**STARconnect 16**
Maximum voltage, Vdc	900	900
Maximum current, Adc	120	160
Section of the input cable, mm	6	6
Section of the output cable, mm	50	150
Numbers of inlets	12	16

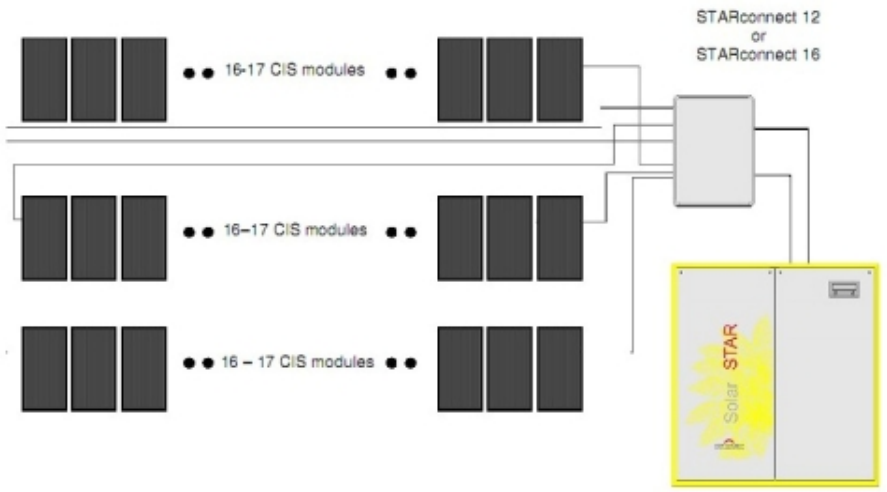


Fig. 6. Commutators connection together with inventor X-series.

Fig. 7. Photovoltaic plant.

4 CONCLUSIONS

The preliminary project for solar electricity power station was build.

The profits of solar energy used for electricity production and water heating are in preferential conditions for stimulating photovoltaic development in Bulgaria include but not limited to special government guaranteed sell prices of power generating by PVf or 25 years as follows:

- 400 euro per MWh generated by PV up to 5 kW power.
- 367 euro per MWh generated by PV as high as 5 kW power.

The conclusion of this study is that, depending on the location, rooftop-mounted PV systems produce the amount of energy so as to recover their energy content from manufacturing and recycling in the range of 1.6 to 3.3 years and produce during their energy production period or service life between 17.9 and 8 times their initial energy content. Once they have reimbursed their initial energy input, rooftop-mounted PV systems can avoid, during their lifetime, the emission of up to 40 tons of CO_2 depending on their location and on the local electricity mix available.

Results for PV facades are logically slightly worse than for roof-top PV systems since they produce less energy for the same installed power. They produce the amount of energy to recover their energy content from manufacturing and recycling in the range of 2,7 to 4,7 years and produce during their service life between 10,1 and 5,4 times their initial energy content. Their contribution to CO_2 emissions mitigation can be up to 23 tons of CO_2 per kWp installed.

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Application of biogas for combined heat and power production in the rural region

Kozak T., Majchrzycka A.

West Pomeranian University of Technology, Szczecin
The Faculty of Mechanical Engineering and Mechatronics
70-310, Szczecin, Piastów 19, Poland

***Abstract**: The paper discusses combined production of heat and power (CHP) from biogas in a small-scale power plant placed in the rural region. Based on power and heat demands of the rural region and biomass supply, the CHP system was selected.*

***Keywords:** biogas, cogeneration*

1. INTRODUCTION

Combined production of heat and power (CHP) is one of the methods leading to improvement of production cost-effectiveness. Compared do separated production of heat and energy, CHP enables better utilisation of the chemical energy contained in the fuel, reduce fuel consumption and emission of pollutants. CHP systems are the most effective, when energy and power produced cover local energy and power requirements in a region as in such case energy transmission costs are relatively low. Increasing interest in biomass utilisation and development of CHP systems follows from EU and the Polish energy policy that is aimed at increasing share of energy from renewable sources. The target is for energy produced from renewable sources to account for 7,5% of total energy consumption by 2010, and for 14% in 2020 [0]. Therefore, Polish legislation and EU directives support all activities concerning application of renewable energy sources [0], particularly combined heat and power production [0,0,0].There are many different means of combined heat and power production from biomass. One of them can be realised by production of biogas and application of genset, where biogas is combusted then in combustion engine with recovery system coupled with electric generator. Because of large biomass potential, new energy policy regarding CHP and financial problems in a rural regions it is essential to analyse possibility of biogas production and its use as fuel in CHP systems.

Presented paper is aimed at analysis of biogas production and its application as the fuel in CHP system that will produce energy and power to cover energy and power requirements in the region.

2. PRODUCTION OF BIOGAS

Natural organic components of biomass containing cellulose, proteins, carbohydrates and starch are transformed into biogas in the process of anaerobic digestion. Anaerobic digestion is the process, whereby bacteria break down organic material without air, yielding a biogas and a solid residue. In the rural regions biogas is mainly produced from manure and dunghill, however plants obtained from short rotation plantations or waste biomass are used in biogas manufacturing process as well. A solid residue that is similar to compost and a liquid liquor in biogas manufacturing process can be used as a fertilizers. Composition of biogas depends upon substrates and parameters of manufacturing process. Factors influencing biogas manufacturing process are as follows: process temperature, composition of substrates, retention time, load of digestion chamber, mixing of biomass, toxic substances.. There are the following stages of biogas manufacturing process influenced by the temperature:

- psychrophilic digestion takes place in the temperature range t=10-25^{o}C,
- mesophilic digestion takes place in the temperature range t=30-40^{o}C and can take a month or two to complete,
- thermophilic digestion takes place in the temperature range t=50-65 ^{o}C and is faster as the bacteria are more sensitive. Choice of the process temperature depends upon the individual parameters of biogas plant. Biogas consists mainly of CH_4 and CO_2, however small contents of CO, N_2,H2, H_2S and traces of O_2 can occur.

3. BIOGAS FUELLED CHP SYSTEM

An example of the biogas application for combined heat and power generation will be presented here. It was assumed, that energy produced in CHP system will cover energy and power requirements of the rural region of area1900 ha neighbouring to the small town. At present, electric energy is delivered to the region from the power grid. Most of the buildings in the region are heat supplied from the small local boiler houses but mainly from an individual coal/coke/wood fired stoves. The region in question is of very high natural value and the large biomass resources, therefore biomass deployment for combined heat and power production will lead to positive environmental benefits, particularly reduction of pollutants emissions. The other advantages of the biomass use in the region are as follows: reduction of energy manufacturing costs, development of small scale commodity production and tourism, decreasing unemployment and finally, improvement of the living standard in the region. The total energy requirement and the characteristics of energy recipients and their demands are the main factors deciding about the choice of the suitable combined heat and power technology. The total efficiency of heat and power generating plant is related to the bio-

mass conversion technology, the kind of biofuel, conversion efficiency and costs-effectiveness indicators.

Energy and power requirements for the rural region in question are as follows: power E_{el}=0,8 MW_e, heat E_t=1MW_{th}. Biogas potential in the region $\dot{V}_n = 3.000.000 \frac{nm^3}{a}$, therefore it is possible to apply CHP consisting of genset supplied biogas of net calorific value Q_l=22 MJ/nm^3. Selected CHP system, genset of type HE – PG 393 – B 0 will be applied for energy and power production to cover requirements of biogas plant and region in question. The system consists of two digestion chambers for biogas production, biogasholder, gas filter, compressor, combustion engine that drives an electrical generator, heat exchangers: hot water-cooling water, exhaust gas-water. Genset type HE – PG 393 – B of rate power 392,5 kW will be supplied with biogas of molar fractions: x_{CH4}= 0,6 ; x_{CO2} = 0,40. Biogas will be combusted (fuel consumption 3,126 nm^3/min) in four-stroke spark ignition, water cooled engine manufactured by PERKINS0, exhaust gas temperature in exhaust manifold is t= 463 °C.

There are three heat exchangers in an analysed system:

- WC1 (water –water)- engine cooling water gives up the heat to circulating water, therefore water is heated up from the temperature t=50 °C to t=75°C,

- WC2 (exhaust gas -water)-exhaust gas gives up the heat to circulating water therefore water is heated up from the temperature t=75 °C to t=90°C and exhaust gas cooled from the temperature t=460°C to t=100°C,

- WC3 (exhaust gas -water) exhaust gas gives up the heat water that heats up charge in digestion chamber, exhaust gas is cooled from the temperature t=100°C to t=70°C, whereas water is heated up from the temperature t=50°C to t = 75°C.

Due to hot water requirement heat exchangers can work in series or parallel connections. Fig.1 shows the scheme of CHP system fuelled with biogas

4. ENGINE THERMAL BALANCE

Thermal balance of combustion engine is as follows:

$$\dot{Q} = \dot{Q}_e + \dot{Q}_{ch} + \dot{Q}_w + \dot{Q}_{sp} + \dot{Q}_r \quad (1)$$

where:

$\dot{Q}$ stream of heat supplied to the engine, [kW]

$\dot{Q}_e$ stream of heat converted into work, [kW]

$\dot{Q}_{ch}$ stream of heat recovered from engine cooling water, [kW]

$\dot{Q}_w$ stream of heat removed by exhaust gas to environment , [kW]

$\dot{Q}_{sp}$ stream of heat recovered from exhaust gas , [kW]

$\dot{Q}_r$ thermal balance closure, [kW]

.

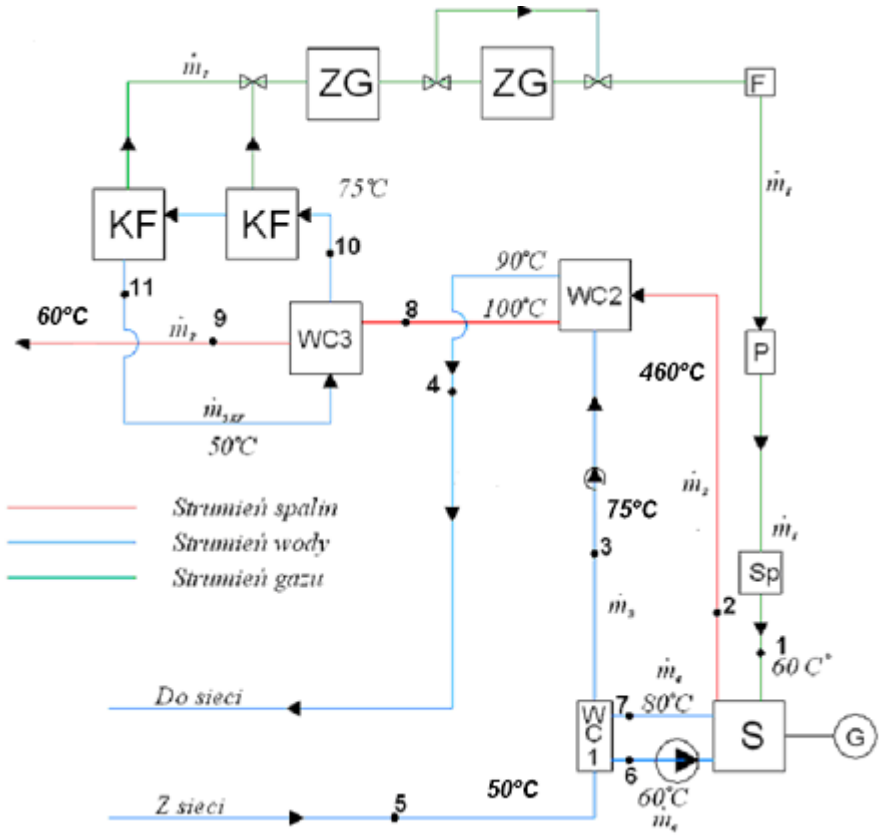

Fig.1:Scheme of biogas CHP system

KF- digestion chamber, ZG -biogasholder , F-gas filter, P- air supplied to combustion process, Sp- compressor, S- combustion engine, WC1- heat exchanger hot water-water, WC2, WC3- heat exchangers : flue gas-water.

Heat released in combustion process equals $\dot{Q}$ = 1144 kW. At assumption that watt-hour efficiency is of 0,9, stream of heat converted into mechanical work equals $\dot{Q}_e$ = 436,1 kW. Stream of heat recovered from ex-

haust gas–water heat exchangers was determined from amount and specific enthalpy of exhaust gas at the fiducial temperature t=0°C. Closure of thermal balance consists of radiation and transmission heat streams from engine. Share of combustion engine thermal balance is as follows:

$\dot{Q}$ = 1144 kW (100%), $\dot{Q}_e$ = 436,1 kW (38,1%), $\dot{Q}_{ch}$ = 320,8 kW (28,0%)

$\dot{Q}_w$ = 16,0 kW (1,4%), $\dot{Q}_{sp}$ = 219,2 kW (19,2%), $\dot{Q}_r$ = 151,9 kW(13,3%).

Detailed thermal balance of combustion engine is shown in Fig.2.

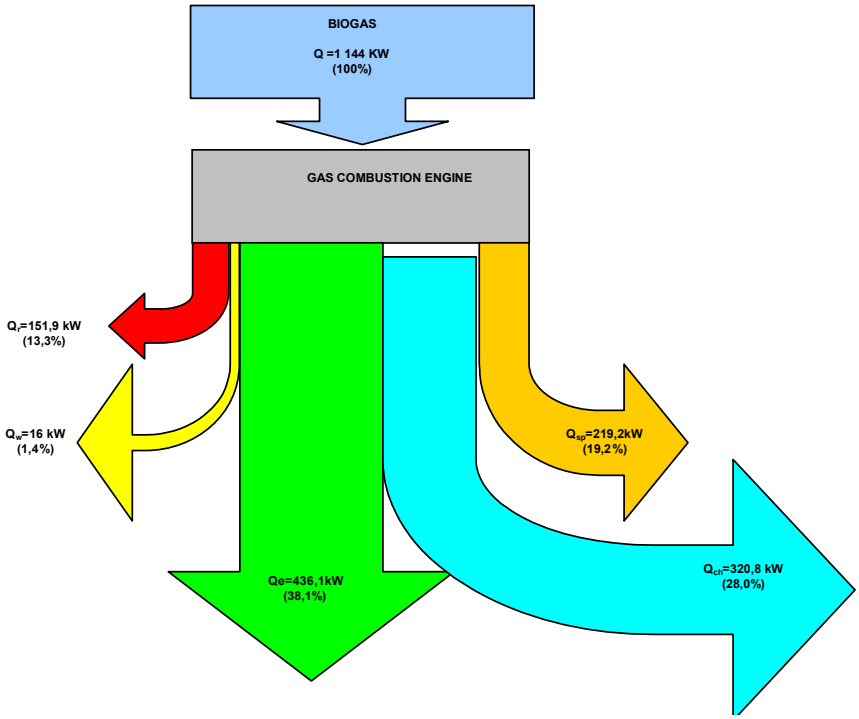

Fig.2: Thermal balance of combustion engine

5. CONCLUSIONS

Biogas manufactured in the small rural biogas plants can be used as the fuel in combustion engines,

Combined heat and power (CHP) system equipped with combustion engine enables to produce electricity and heat by recovery from combustion process in the heat exchangers emboded into cooling and exhaust systems.

Water heated in heat exchangers can be applied as heat source in central heating system or used for preheating of the charge in the digestion chamber,

In case of higher electricity requirement and biogas oversupply, it is possible to increase power of the system by embody of additional CHP module,

For CHP system in question, the total efficiency of combined heat and power production is of 81,5 %, watt-hour efficiency of 34,3 % and thermal efficiency of 47,2 % of energy supplied.

Production of energy in biogas fuelled CHP will contribute to meet the requirement of reducing air pollution.

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APPLIED PHOTOTOVOLTAICS AS A PRACTICAL EDUCATION IN RENEWABLE ENERGY TECHNOLOGIES

Mitko Stoev

Solar Energy Centre, Faculty of Mathematics and Natural Sciences, South-West University "N. Rilski", Blagoevgrad

***Abstract**: The optional course „Applied Photovoltaic" for MEng students specializing in Electronics at the Faculty of Electronics and Automation, TU-Plovdiv is presented. The main topics of the advanced PV course as a modern sustainable energetic based on the photovoltaic effect and energy from Sun as a renewable energy source; materials and technologies in photovoltaic; design of solar cells and PV modules and PV generators up to 100 kWp; BIPV and CIPV systems; hybrid PV systems; PV mounting; monitoring of PV systems and EC regulations for PV systems connected to the utility grid are discussed. The advanced teaching method by online e-platform with virtual resources is presented.*

Key words: PV education, PV technologies, applied photovoltaic, e-platform

1. INTRODUCTION

The modern energetic of 21st century is based on a broad utilization of energy from renewable energy sources[1]. The electricity is a high-tech energy from RES and in the particle case photovoltaic conversion of a solar energy into a "clean" energy is one attractive way to cover the energy needs of the society. The density of solar energy is low and high-tech RES technologies in photovoltaic are used to utilize this energy by solar cells, PV modules, inverters, controllers, electronics etc. The RES university courses are covering mainly the general aspects of RES technologies and the broad background knowledge is the aim of this education process. In any cases the RES education is limited from strong requirements from education in departments of natural sciences and the right way for the teacher to solve the problem is to offer the modern optional PV course for batcher and master degree students. The nature of the course has to be oriented to the students which have a background on specific education in the field of natural sciences for example in chemistry the optional course is "Chemistry of solar cells", in physics the optional course is "Photovoltaic effect, materials and systems" in electrical engineering the optional course is "Applied photovoltaic". The modern PV education is discussed abroad during the EC RES summer university[2] and PV education workshops[3].

The goal of the paper is to present the advanced course “Applied photovoltaics” for a master degree students from electrical engineering, electronics and automatic which are involved in design of PV cells, PV modules, electronics, PV systems and PV centrals.

2. DESCRIPTION OF THE COURSE

The ”Applied Photovoltaics” course is a part from university courses uploaded on DOX e-platform. The courses are superstructural in character. The students start batcher university education with three compulsory courses as Inorganic Chemistry I (General) and they study the lows in chemistry, Inorganic Chemistry II (Elements) is oriented to elements and theirs compounds, Inorganic Chemistry III (Preparative)) is a preparative inorganic chemistry. The students from Dept. of Chemistry have a choice to select the optional course as Solid State Chemistry and Chemistry of Solar Cells depending from theirs orientations to the next master degree level in material sciences and application of materials in the new energetic of 21st century. The courses in Dept. of Chemistry are oriented to the students in the field of natural sciences. The optional course “Applied Photovoltaic” is oriented to the engineering master degree students from technical universities and representatives from engineering departments from privately firms which are involving in PV business. The offering lecture courses for batcher and master degree students on DOX e-platform are presented in Fig. 1.

2.1 Lectures

The course is designed for Bulgarian and ERASMUS students in Bulgarian and English languages. It is oriented to applications of the modern PV technologies for “clean” electricity production from solar energy. The background of solar engineering is based on the calculation of the predicted solar potential by application of software as METEONORM[4], PVGYS[5], NASA[6] and PVSYST[7] focusing on the design of PV systems for solar energy conversion by advanced high-tech technologies. The basic of photovoltaic effect is discussed by application of the animation model for electricity generation. The main futures of photovoltaic conversion of energy are explained. The technologies for production of materials for PV industry are briefly discussed.

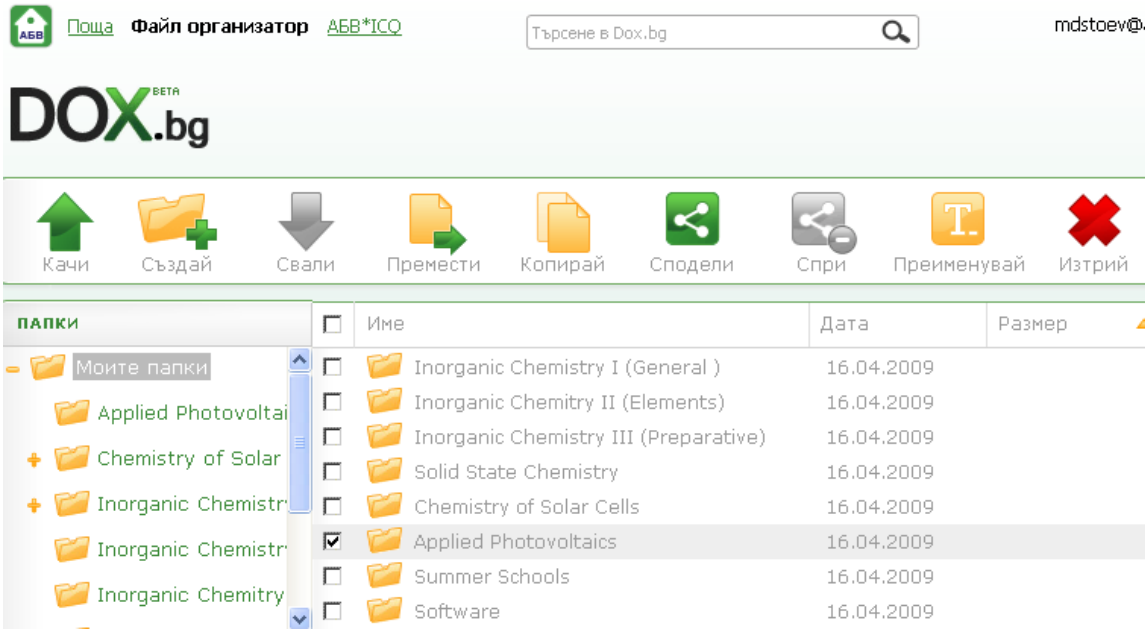

Fig. 1 The lecture courses for batcher and master degree students uploaded on DOX e-platform.

The design of solar cells as c-Si, mc-Si, a-Si, thin films solar cells and the new advanced solar cells are discussed. The focus of the course is on the design of PV modules and electrical connections in PV area. The inverters, electronic regulators and there characteristics for specific PV applications are discussed. The battery package for PV systems and specific characteristic of the solar batteries and chargers are presented. The design of 1.5 kWp PV generator in grid-connected and autonomous regimes is presented. The integration of PV generator into the structure of a family house as a BIPV is discussed. The design and applications of autonomous PV systems in isolated regions is one of the topics of the course. The 350 Wp PV emergency system is discussed. The grid-connected 5 kWp PV and 100 kWp PV centrals are studied in details. The main aspects of a building integrated PV (BIPV) and a car integrated PV (CIPV) are presented. The combined solar systems as PV&T and PV&W are studied. The monitoring system for PV centrals and normative requirements of EC for installation and the grid-connection of PV centrals are presented. The structure of the course 'Applied Photovoltaic" is shown in Fig. 2. The course is presenting by 30 hrs lectures using advantage of Power Point and e-resources as e-books, specialized software and Internet.

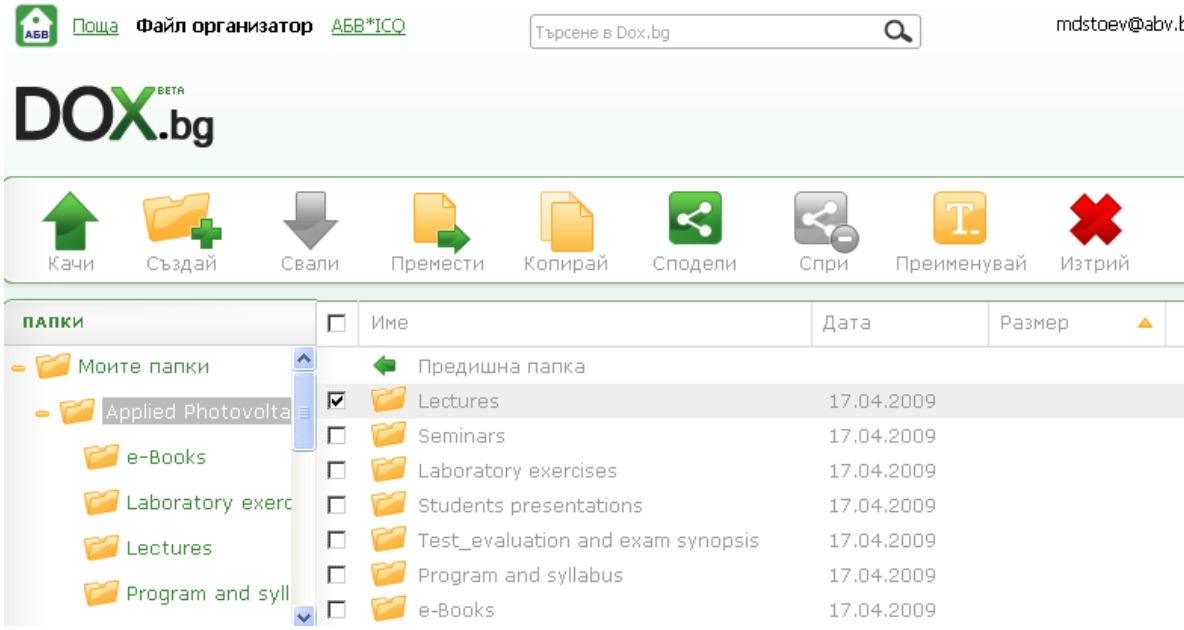

Fig. 2 The structure of the course “Applied Photovoltaic”.

2.2 Seminars

The seminars are 15 hrs and the students are using software for solar engineering as MapSource, NASA, PVGYS, METEONORM, Sunny Design, Sunways Sundim and PVSYST to find the position of PV system, to calculate the solar resource, to design the PV system and to predict the yield of electricity from PV system. The design of mobile autonomous 140 Wp CIPV is one of the goal of the students. They have to draw a principle scheme of PV systems and they have to select the efficiency loads for application of the system. The next project is connected with PV applications in emergency cases and 350 Wp PV system has to be designed from the students. The system has to cover the first needs with electricity in the case of a natural disaster and fires when the utility grid is destroyed. The 1.5 kWp grid-connected BIPV for a quality supply of the loads in the end point of the utility grid is discussed. The students have to design 100 kWp grid-connected PV central during the seminar training.

2.3 Laboratory exercises

The laboratory exercises are 15 hrs practical training. The students have to design 350 W PV system and after that to mount the PV rack. This exercise is shown in Fig. 3.

Fig. 3 The laboratory exercise “Mountaing the PV rack”.

The next step of the practical training is installation of PV modules presented in Fig. 4 and PV welding shown in Fig.5.

Fig. 4 The laboratory exercise “Installation of PV modules”.

Fig. 5 PV welding exercise in the solar camp.

2.4 PV summer school

` The students after the course “Applied photovoltaic” have a possibility deeply to study the main topics of solar engineering in the PV summer schools for example in EC RES Summer university in Patra, Greece. After the PV training in TU of Plovdiv and T.E.I. of Patra the students have choice to develop practical skills to install and to live with 350 Wp PV system in the camp. This practical PV training is shown in Fig. 6 during the traditional Black Sea Solar Camp in Bulgaria.

3. CONCLUSIONS

The applied photovoltaic is a modern optional course for the students which have interest in high-tech renewable energy technologies. The course is presented by advanced e-platform with e-resources in Internet and Power Point presentations of the lectures. The lecture course is connected with EC RES summer educational courses where students have a possibility deeply to study the main topics in RES technologies. The practical training in applied photovoltaic is advantage for the students which are oriented to design and to install PV systems in Solar engineering departments of the firms.

Fig. 6 The stand-alone 350 W PV system during BLACK SEA SOLAR CAMP

ACKNOWLEDGEMENTS

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THE METHODOLOGICAL APPROACH APPLIED IN STUDIES OF DEMOGRAPHIC PROCESSES FOR SPATIAL PLANNING AT different LEVELS

Maria Shishmanova,

South-West University “Neofit Rilski”, Blagoevgrad, Bulgaria

Abstract*: Subject of the paper is the methodological approach in research and planning of demographic processes at different spatial levels of administrative units and unofficial settlement formations. Certain requirements are formulated on the grounds of the Regional Development Act and the Spatial Planning Act, as well as the subsequent Rules and Regulations on their enforcement. Further to the above, specific requirements for each recognized or unofficial spatial unit are proposed in response to the specific and individual character of the forecast entity, taking account of European statistical indicators.*

Keywords: *methodological approach, demography, processes, forecast, indicators, Eurostat*

1. INTRODUCTION

Core to the study is the methodological approach applied in the research and planning of demographic processes at the various territorial levels of administrative units and unofficial settlements. Certain requirements are formulated on the basis of the Regional Development Act, the Spatial Development Act and subsequent rules and regulations. Furthermore, specific requirements have been drawn up on each formally recognized or unofficial territory with the purpose of providing specific and individual description of the forecast object, taking account of European statistical indicators as well.

2. RESULTS, DISCUSSIONS, CONCLUSIONS

The present paper has taken into consideration and been developed in accordance with the specific requirements on the scope and subject matter of demographic processes studies in spatial planning at various territorial levels [1], [2], [3]. A number of reference documents have been consulted, among them:

- “Interrelations between the generations and sexes”, Bulgarian Academy of Sciences, Co-ordinating Research Council on social Development and Social Eurointegration, Sofia, 2004

- "Demographic Development of the Republic of Bulgaria", National Council for Cooperation on Ethnic and Demographic Issues at the Council of Ministers, the Bulgarian Academy of Sciences, National Statistical Institute, United Nations Population Fund, Sofia, 2005
- "Children, young people and sport", Programme of the Government of the Republic of Bulgaria
- A report from a sociological study of the Faculty of Primary and Preschool Education of Sofia University 'St. Clement of Ohrida' on the Rate of Literacy, 2003
- The European Social Charter (revised), 1991
- The European Charter of Local Self-Government, Strasbourg, 1985
- Concluding Declaration, EU Education Ministers Meeting with Youth Ministers, joint session on 'The Discomforts of Youth and School Leavers', 2003, San Patrignano
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- “Overcoming poverty”, Ministry of Labour and Social Policy Programme
- “Better Health for a Better Future for Bulgaria”, Ministry of Health
- “Social Policy and Labour Market”, Programme of the Government of the Republic of Bulgaria
- Social Risk Groups Sociological polls
- “ Municipality of Plovdiv Ethnic Minorities Integration Strategy for the period 2004-2007, Plovdiv
- “ Municipality of Plovdiv Ethnic Minorities Integration Strategy for the period 2004-2007, Plovdiv
- “Strategy for the Development of the Secondary Education System in the Republic of Bulgaria”
- “Joint Evaluation Report on the Employment Policy Priorities of the Republic of Bulgaria”
- The European Urban Charter, Congress of the Local and Regional Authorities of the Council of Europe, Strasbourg, 1992
- The Leipzig Charter of Sustainable European Cities, Leipzig, 2007
- Other subject-related specific documents

These relate to urban development requirements and mainly to the European Urban Charter, the Leipzig Charter of Sustainable European Cities and the European Declaration of Urban Rights. Urban European citizens enjoy a wide variety of rights, incl. right to employment, unlimited mobility and freedom of travel, intercultural integration (to enable communities of differing cultural, ethnic and religious nature to co-exist in peace), personal fulfillment and equality irrespective of sex, age, origin, faith, social, economic and political status. Such studies must account for and incorporate the following:

- the requirements of the development programmes of the Government of the Republic of Bulgaria, the strategies elaborated by the Bulgarian ministries for the development of individual public spheres and the respective action plans thereto, the regulations relating to spatial and settlement network development and other reference documents.

- each spatial development level, recognized or unofficial unit bears the peculiarities of the respective level of detailed description. The 'conch' of the level of detailed description widens from the top downwards.
- the respective documents (plans, strategies, etc.) relating to the development of a planning region, district, municipality and municipal urban centre.

Information on the demographic development of the city has been obtained from the following sources: National Statistical Institute, Regional Urban Statistical Offices (for instance for the city of Plovdiv), National Directorate Civil Registers and Administrative Services, Institute of Sociology to the

Bulgarian Academy of Sciences, the National Employment Agency, Regional Employment Directorate in Plovdiv, Local Employment Office "Puldin' and 'Trakia', sociological research and polls.

Different demographic development elements for certain periods are analyzed, depending on the exhibited dynamics and trends.

The structure of the study must conform to the structural requirements assignment. For instance:

- Administrative and spatial development changes having an impact on the number and development dynamics of the population;
- Population dynamics: historical review and demographic development in five-year periods, for ex. 2001-2005, 2005- 2009;
- Population structure – age, active population;
- Ethnic composition – data from population censuses and surveys;
- Development potentials – education, employment, unemployment figures;
- Employed population – by sectors and economic branches;
- Quality of life;
- Groups in social risk.

The information in text must be enhanced by means of graphs and tables. When research on the lowest level, for example a settlement or a town, is carried out, it is necessary to provide a retrospective survey of its demographic development trends, which usually results in clear-cut periods. As an example, in the case of the city of Plovdiv in "Demographic Development - Diagnosis 2005, Trends" the basic periods are three in number [4]:

- I – 1978-1985-1991, characterized by population growth. It has been correctly pointed out that the highest population growth was registered for the period 1956-1975, mainly accounted for by purely mechanical growth, following which the growth rate gradually diminishes.
- II – 1991-2001. During this period the population decreased, accounted for by a decrease in the male population, whereas the female population actually increased.
- III – 2001-2004 – Flat rate and slight increase of the population in the last 2 years.

Studied are basic population subdivisions: by age and sex in both distribution groups in compliance with the adopted Bulgarian classification: under, at and above economically active age and in accordance with European classification: 0-14, 15-64, 65 years and above).

Economically active population, families and households data are also analyzed. Special attention is to be devoted to the economically active population contingents if their share is found to be high, as they are the main supply base on which labour force figures depend.

The demographic development potential is examined in respect of education, employment and unemployment figures, as well as various aspects

of the quality of life such as income, expenditure and human development index.

Furthermore, the demographic development of a given city (Plovdiv) is characterized both successively in time and by areas, detailing their specifics [4].

The main city population development trends are clearly delineated and relate to the overall city development.

This research needs to use a wealth of statistical data, sociological research findings, legislative documents and developments relating to the demographic development of the city, region, state and the European urban centres.

Comparative analyses are carried out and demographic parallels are drawn between cities and other settlements in the country, found to be similar in their demographic development characteristics.

Thus the comparative analyses conduce to the elucidation of the specifics of a city or town on a level of comparison.

Conclusions of high precision level are aimed at to provide an accurate and objective analysis of the population development potential of the city and municipality.

Special attention is to be devoted to the economic activities and employment data of the population, as well as unemployment levels, as these characteristics may in a certain degree lead to upgrading of the capacity of industrial areas and activities relating to tertiary sector development.

The major role of the city for the development of the suburban area, targeted for special measures – for instance the district of Plovdiv, the South Central Planning Region and the state.

Of particular interest is the examination of the income and expenditure data of the population and its structure on municipal/urban level. These indicators are monitored by the National Statistical Institute (NSI) and other institutions (trade unions, the Institute of Sociology to the Bulgarian Academy of Sciences) on a district level only. Thus it is currently impossible to undertake any concrete measurements and draw conclusions.

Thus the analysis of demographic development and the deductions drawn clearly delineate the processes that have previously taken place as well as the ones currently underway in the urban or municipal areas. They provide an excellent basis to found a population development forecast which is to then serve a General city spatial development plan or a municipal development plan.

The conclusions drawn and the provision of demographic development models by city districts focuses the attention upon the specific nature of each of them, which would help to a great extent to correctly estimate the area of the respective areas for joint social use territories, landscape and residential development and others by city districts.

Priorities aid specialists to positively react to and utilize demographic processes by means of spatial development. An important aspect of the paper is the highlighting of various factors and trends, which helps avoid certain risks in time; moreover, their exposure provides for an adequate solution.

With the demographic processes taking place in the peri-urbanisation zone (the space where the city finds its functions overflowing into the rural areas), which is the area, targeted for special measures, it is logical that this territory is to be administered and managed jointly [6].

The paper must include a lot of graphic material, such as graphs, tables and diagrams, to be able to fulfill its main purpose: development of the General spatial Development Plan and the Municipal Development Plan.

Of interest is the research paper on the groups in social risk entitled “Social and economic problems of the groups in social risk in the General Spatial Development Plan, for instance Plovdiv, until 2025”. [5]

A study must also shed light on the general socio-economic, demographic and localization characteristics of disadvantaged social groups.

Three social groups of significance to urban development must fall under scrutiny: these are ethnic minority communities, the population above economically active age and citizens supported by various social care programmes.

The paper incorporates the social principle of enhancement of the quality of life and welfare of all Bulgarian citizens, guarantees the right to adequate development of every person, irrespective of origin, ethnic or religious affiliations and/or other differences.

The examination of ethnic minority communities has been carried out on the basis of National Statistical Institute data (population censuses), sociological studies, surveys and polls.

Analysis of population data based on permanent and current address is vital for correct adjustment of all subsystems in the development of a General Spatial Development Plan, especially in respect of habitation data.

Detailed population analysis in respect of ethnic minorities residential concentrations has been carried out which ensures an individual approach to the spatial development of these centers and other areas, such as spatial development zones, needed to cater to their specific needs, finding expression in spatial elements, sites and measures.

The residential units themselves are analyzed in detail by residential quarters and the findings yield valuable information on the demographic composition and character of the city.

Highlighted are the problems of the ethnic minority communities in the respective residential quarters (in the city of Plovdiv), which relate to restricted access to quality health care, low educational qualifications, low

school enrolment and graduation rate, low employment and high unemployment rate, low income levels.

Account has been taken of migration processes, which are sporadic and seasonal, for which reason this population does not appear in local statistical registers and data, as these population figures are not planned or expected.

The reasons for the low educational qualifications are brought under scrutiny which reveals that they do not stem from spatial distribution, but are of various nature. Segregation in schools as a problem area also comes under the spotlight and is found to be of organizational nature. School enrolment rate and graduation educational levels are also subjected to a detailed analysis.

Studied are characteristic family and household structures, their average size and structuring, marriage or cohabitation characteristic peculiarities, as they are very informative on the estimates of residential dimensioning. The factors for all of these also receive due attention. The relations within the family and among families are considered and evaluated as they help study the movements of this population in the urban environment.

The employment rate, unemployment level and its breakup by sex, age, education, and qualifications brings further colour to the diversity of problems, experienced by disadvantaged social groups.

A forecast for the development of ethnic minorities risk groups in the city has been elaborated in several versions. For the city of Plovdiv for example two versions have been prepared, based on the number of the ethnic minority groups population, the one yielded by the 2001 census (appr. 30 000 people) and the other based on the results of a sociological study (55 000 people). The submitted forecast evaluations include numbers of ethnic minorities’ population, distribution by sex and age groups (women in fertile age, economically active population and pre-school and school-age population numbers - from 0 to 18 years), economic activities.

The forecast takes account of the various requirements of the legislative framework in the social sphere, cited above.

The favorable reproduction trends will maintain significant numbers of school-age population during the next decades. This in its turn spells out a need for the construction of new and maintenance of the existing educational infrastructure.

In respect of the population above economically active age it is necessary to objectively consider the situation so as to avoid the emergence of ‘lifeless’ urban structures of low reproduction potential and excessive ageing of the population. For example, within the national data the city of Plovdiv is highly likely to remain an area of relatively constant reproductive age population rate, but of relatively low fertility rate.

The age structure of the population is not homogeneous in certain parts of the city of Plovdiv. The old central residential quarters of the municipality of Plovdiv are the most affected by the ageing of the populaton. The age structure, however, is of the 'progressive' type in the new residential areas and parts where ethnic minorities are concentrated. This should define the politics to be pursued in urban management by means of the various 'spatial development zones, sites and measures'. This is valid for and typical of all big cities.

In implementing social assistance schemes for the citizens of a given city, no direct or indirect discrimination is to be allowed, based on sex, citizenship, political or other affiliations, religion, handicaps, age, marital status, origin or others, as is called for by the Constitution of the Republic of Bulgaria, the European Convention on Human Rights and the International Pact on Economic, Social and Cultural Rights (the European Convention for the Protection of Human Rights and Fundamental Freedoms and the International Covenant on Economic, Social and Cultural Rights).

Social assistance in a given settlement, city or municipality in the form of benefits and services, must be allocated in a manner that does not offend the dignity of the citizens receiving these as monthly allowances. For the city of Plovdiv for example appr. 2% of the population has been granted social assistance and benefits. The analysis of the monthly social benefits shows that the number of families in need of such benefits is continuously on the increase and an ever greater number of people fall within the scope of those that comply with the requirements for social benefits.

The implementation of a number of programmes and projects focused primarily on citizens in need of social care, such as "'Opportunity for everyone' (for social and economic cohesion of vulnerable groups), projects aiming at enhancement of the access of ethnic minority youths to education, employment rate enhancement projects for provision of income and overcoming of poverty among ethnic minority groups in the city of Plovdiv and elsewhere partially supports providing solutions to these problems with other means apart from the tools of management of the urban territory from the General Spatial Development Plan.

The analyses must draw on statistical data, sociological research, regulations and studies relating to disadvantaged social groups.

Analyses and conclusions must accurately reflect the objective problem area of the urban social groups, that are subject of the study. They will support a correct decision-making in any delay of the final spatial development planning process in the territory of a certain city.

The paper must include a wide variety of graphic material, tables and diagrams.

Research of such a broad scope has to purposefully also undertake concrete studies of the mentioned social groups and their problems as they

are important for the dimensioning of the General Spatial Development Plans.

Risk groups may be termed disadvantaged social groups, so as to harmonize Bulgarian and European terminology.

This kind of paper may be considered good practice prior to the elaboration of a General Spatial Development Plan.

The concrete examinations of demographic processes on municipal, district and planning region levels have been carried out in accordance with the methodological instructions on the elaboration of development plans for these spatial units, enriched with some of the demographic indicators appearing here. [1], [2], [3].

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Surface Analysis Functions in GIS environment

Penka Kastreva

South West University "Neofit Rilski" , Blagoevgrad, Bulgaria

Abstract: *Topographic surfaces can be represented with the computer, both in raster and in vector form. Grid DEMs are numerical representations of the topographic surface are the most used for a GIS analysis. The coordinate grid data are used to estimate the necessary partial derivatives for points of the topographic surface. They are in the base of the surface interpolation methods and functions for topographic surface analysis. Quality of data and the accuracy of the DEM are discussed.*

Keywords: *Grid DEM, GIS analysis, topographic surface, surface analysis functions.*

1. BASIC METHODS FOR REPRESENTING A TOPOGRAPHIC SURFACE WHICH PROVIDE DATA FOR SURFACE ANALYSIS

Topographic surfaces are features which contain height values called Z values distributed throughout an area defined by set of X and Y coordinate pairs. When the coordinate x and y are planimetric, height values are called elevation and noted with H. Now we have sample data points, we next need to decide how a surface could be represented with the computer, both in raster and in vector form.

When mapping the Earth's topography, a variety of symbolization techniques are possible but the most of them involve manipulating contour lines. The presentation of the topographic surface is based on the assumption of a continuous distribution of enumeration height values recorded at point location. In order to portray the surface of the tree-dimensional data hypothetical horizontal planes, with given "z" value relative to a fixed datum, intersect with the surface. When these lines of intersection are projected onto the map they represent all data points with equal "z" value above, or below the employed datum. Normally the parallel planes intersect the surface at easily calculated intervals such as 10, 50 or 100, and the distance between them is termed the contour interval. The lines are constructed by interpolation, an analytical method of calculating a given "z" value by comparing the distance to all known neighbouring data points.

Slope-breaks defined by high profile curvature value and inflexion lines separating convex and concave areas are very important parameters in geomorphology. In GIS software these inflexion lines are called breaklines, for example lines following streams, ridge crests, or cliff edge; roads often used as 'breaklines' in urban areas.

Elevation data are sometimes provided as a triangulated irregular network (TIN), which is based on the triangulation approach. The TIN model is the basic vector data structure for representing surfaces in the computer. TIN models consist of a series of non-overlapping triangles. Each vertex of the triangle is encoded with its location and has a height associated with it.

A TIN model is one of methods of storing height information, creating group of products collectively called digital elevation models or DEMs. Very often DEMs data are most commonly provided in a square gridded (raster) network. Image models are created in two general types: those on points and those on lines. Each grid cell contains a single absolute elevation value. In order represent elevation in raster more accurately we have to select a relatively small grid cell size. For analyses it is equally important to decide where within the grid cell area the actual elevation point to be located: at the center of the cell or in one of the four corners.

By definition, Digital Terrain Models (DTM) are “ordered arrays of numbers that represent the spatial distribution of terrain attributes, and digital elevation model (DEM) is defined as an ordered array of numbers that represent the spatial distribution of elevations above some arbitrary datum in a landscape”. (Moore et al.1991). DEMs are the most basic type of DTMs. Therefore, the general term Digital Terrain Model (DTM) may be used to refer to any of the above surface representations. Some people also use DEM as synonymous with DTM.

Digital terrain analysis is implemented on digital elevation models in order to derive digital terrain models of various terrain attributes. Topographic attributes, such as slope and aspect can be derived from contour, TIN DEMs and grid DEMs, however, the most efficient DEM structure for the estimation and analysis of topographic attributes is generally the grid-based method. Surface analyses in GIS include: creation of contours; slope and aspect creation; hillshade creation; viewshed and visibility analysis; area and volume statistics.

2. SURFACE ANALYSIS FUNCTIONS

Digital elevation models (DEMs) are an important part of many GIS datasets and equally important are the parameters calculated from these DEMs. The surface analysis functions provide additional information which can be derived by producing new data and identifying patterns in existing surfaces. Some basic characteristics of tree-dimensional surfaces are commonly used for characterizing relief:

- Steepness of slope and azimuth or orientation of aspect

The general method of calculating is to compute a surface that best fits trough neighboring points and measure the change in elevation per unit distance. Raster and vector model a surface’s slope and aspect in different ways. In vector a TIN model is used and each triangle defines a plane with a

slope and aspect. To determine slope, the software simply compares the horizontal distance between vertices of the TIN facets with the respective horizontal coordinates. In a raster, slope and aspect are calculated for each cell by fitting a plane to the z-values of each cell and its eight surrounding neighbors. Raster GIS software may also allow nonlinear interpolation methods as kriging or others surface-fitting processes. Slope and aspect maps are often used as layers within a GIS and can be displayed as a new raster.

- Viewshed

This function is useful when we want to know which land area is seen from a specified point. This process is called visibility (viewshed) and intervisibility analysis. In vector, the simplest method to create line-of-sight is to connect an observer location to each possible target point and look for elevations that are higher than observer point. Visibility analysis performed in vector requires the use of a TIN data model in which surface is defined by the triangular vertices. Raster methods of intervisibility operate in the same way. The process begins by defining a viewer cell and the software compares the elevation values of each grid cell with the elevation values of the viewer grid cell.

- Hillshade

The hillshade function calculates the reflective ability of a surface by determining illumination values for each elevation grid cell, given the slope and aspect of the data and the sun angle.

- Volume and Area

Surface area is measured along the slope of a surface, taking height into consideration. The calculated area will always be greater than the area measured by simply using the 2D planimetric extent of a model. The volume is the space between the surface and a reference plane and we can calculate the volume above the plane or below it (for example hill or lake).

- Cut and Fill

Cut and Fill functions are essentially the same for calculations of volumes. The calculation of volume is very simple in either vector or raster. First, we separate the region into portions and calculate the area of each portion. For each slice of the volume we simply multiply the area attribute value by the depth value. Cut and Fill analysis determines how much material has been lost or gained in a study area by comparing two surface models of the area -one before a change and one after that.

- Cross –sectional profile

A profile is a result from the intersection of a plane to the x, y datum and the topographic surface. Raster GIS use method that creates a raster coverage by comparing a central target cell to two of its immediate neighbor cells. We can select orientation of this search to be able to characterize a set of profiles for grid cells.

- Surface Water Flow (run-off) and Water (among other things) flows downhill

The hydrologic modeling functions provide methods for describing the hydrologic characteristics of surface. Using elevations from DEM as input, it is possible to model where water will flow. From DEM we can provide other hydrologic characteristics for instance to create watersheds and stream lines.

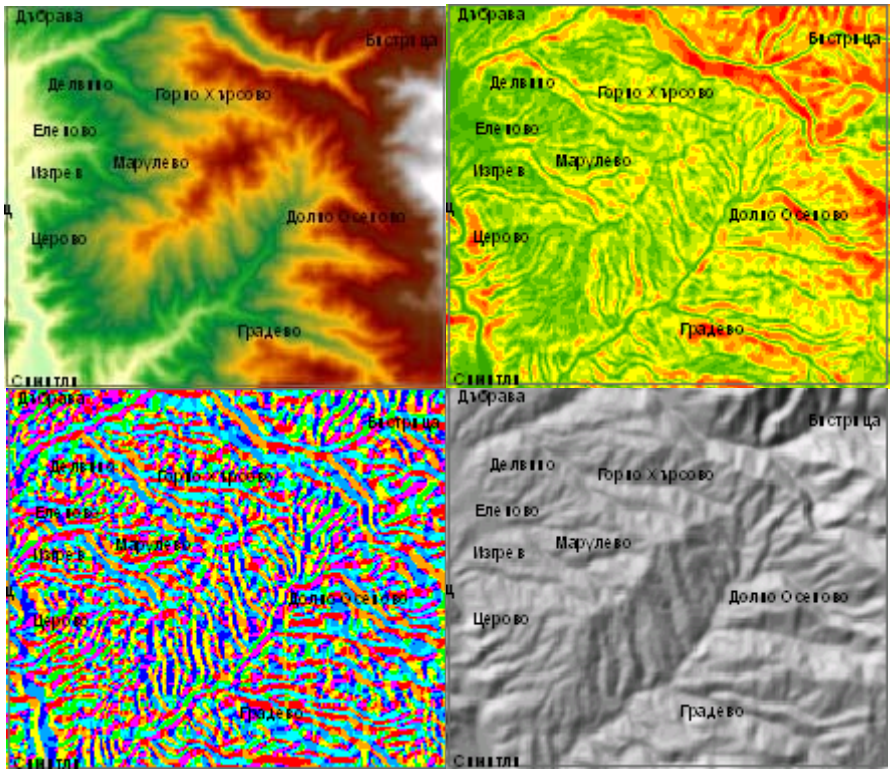

Fig. 1. Exemples: DEM, slope, aspect and hillshad

3. CONCLUSIONS

DEM models are created in two general types: those on points and those on lines. If elevation data are available only through topographic paper maps, DEMs can be created by scanning the maps and interpolating the elevation values of all pixels located in between the contour lines.

There are many interpolation methods that can be used in digital terrain modelling and their derivative raster models (slope, aspect and hillshad). The interpolation is generally controlled by a set of parameters that enable

the modification of the behaviour of the mathematical function so that a resulting surface meets the criteria of specific applications.

The interpolation accuracy can be measured by different methods. The most straightforward is to evaluate deviations between interpolated surface and the input points. The overall error, measured e.g. by Root Mean Squared Error (RMSE) then characterises the interpolation accuracy in the given points.

Florinsky (1998) analytically derived RMSE errors of various gradient methods and concluded that (1) RMSEs in slope, aspect and curvatures are directly proportional to elevation RMSE, (2) these RMSE values increase with decreasing grid spacing, (3) gradient RMSEs increase with decreasing slope, (4) curvature RMSEs are more sensitive to grid spacing.

The above lead to the following conclusions. First, before implementing gradient and derivative calculations by computer, it is worth knowing which method is used by the applied software. Skidmore (1989) concludes that the eight-point finite difference methods are more accurate in calculating slope and aspect because all grid points adjacent to the centre grid contribute to the calculation.

Second, it is good to understand the original DEM surface and find the geometrically most suitable gradient filter. For example the topographic surface can be generated from a TIN or generalization contour lines.

Contour data source impacts accuracy of topographic gradient calculation. Linear interpolation methods, such as TIN offer good results for contour source data. DEMs derived from contour data often display systematic error towards contour elevations (Carrara et al. 1997). Since the problem is related to contour line spacing of the original data, cells larger than the average contour line spacing might treat the problem. Grid DEMs obtained from TIN-interpolated random points of orthophoto heights can also display systematic errors.

Carter (1992) proves that the use of gradient methods with smoothing effect can reduce systematic error in aspect. The aspect should be calculated also from TIN DEM instead of grid DEM. Because of their smoothing effect eight-point finite difference methods yield the best approximation of gradient in this case

Third, the interpolation accuracy depends on the size of grid cells. According to Chang and Tsai (1991); Guth (1995) and Hodgson (1995) grid spacing also has variable influence on slope and aspect calculations depending on the numerical algorithm. The largest differences in gradients calculated with various methods occur at pits, peaks, ridges and valleys, therefore algorithms tend to provide similar results when changing grid scale by smoothing.

Quality of data used in the GIS is a critical issue. The accuracy is a property of DEM determining outputs of the GIS systems that are designed

for example for assessment of renewable energy resources, flood forecasting, disaster and security management. Similarly, suitability analysis, calculating of environmental indicators and water quality monitoring within the catchments are based on the use of DEM and the his characteristics. Thus, a prerequisite for full exploitation of the potential of DEMs is to make them available at sufficient accuracy and detail for a variety of applications.

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Some Possibilities for Soil Fertility Regenerating and Increasing in Pazardjik District

Boyko Kolev, Nevena Miteva, Maria Kirkova

South-West University, Faculty of Natural Sciences and Mathematics, Geography, Ecology and Environment Protection, Blagoevgrad, Bulgaria
Soil Resources Agency, Sofia, Bulgaria

***Abstract**: A lot of attempts were done for estimation of human activities effecting on soil properties change. These attempts give some empirical relations but could not be applied for all soil cases. By now the estimation of human activity as a factor that could change soil properties is very approximate.*

The aim of this study is taking some soil samples in the same place where the previous soil studies were done. These samples are analyzed by meaning of soil texture, soil chemical properties and heavy metals in ploughing soil horizons. These analytical data were compared with the previous data and the results of human activities for this period could be established. The research work shows that the soils in Pazardjik District are appropriate for applying the compost technology to increase the soil fertility.

***Keywords:** soil properties, soil texture, soil chemical properties, heavy metals, human activities, compost technology.*

1. INTRODUCTION

Soil is a three-phase system made up of solids, liquids and gases. The solid phase or soil matrix contains mineral and organic materials. The organic part of soil matrix is a mix of organic residuals (predominantly plant residuals) is in the different part of their transformation. It is finding that some of osculate organic products formed by oxidation, condensation and polymerization yield a new specific organic matter with dark color and high stability for continued decomposition. This specific organic matter is called “humus” [3]. Humus plays very significant role in soil formation and soil fertility increasing in plough horizon.

The main role of compost technology is to increase organic matter in soils with very low and low humus content with the aim of increasing soil fertility. Of course it is only possible the soil organic matter increasing. Soil humus content increasing is very slow process and takes thousands of years. The question is how to find the most successful compost technology for this purpose. The right answer could be finding by estimating the risky factors for soil contamination by heavy metals and metalloids, using several different compost materials in compost technology. The background values

of these an organic substances in Bulgarian soils vary as follow: Cd – 0.4 mg/kg; Pb – 26 mg/kg; Cu – 34 mg/kg; Zn – 88 mg/kg; As – 10 mg/kg - [1]. According to Bulgarian soil protecting policy - [5], the content of these elements after compost technology applying, should be low, or at least equal to their “precautionary values (pv)” (limit values) - [2].

2. OBJECT AND METHODS

Pasardjik district is situated almost in the central part of the South Bulgarian soil area, which includes the territory of South Bulgaria up to 750-800 m. altitudes. Some parts of the district area are situated higher than these altitudes. The Southern Bulgaria embraces Thracian Valley, bordering to the Southwest with the mountains Rhodopes, Pirin and Rila, and with the Black Sea to the east. The climate of the district is formed as continental climate and with the increasing of the altitude above sea level. The mean annual temperatures vary between 11,5 and 12,5 °C. The mean annual precipitation for plain part of the district vary between 500 and 600 mm, but for the uplands (the territories higher than 850 m) reach up to 1200 mm. Mainly two types of plants present the natural vegetation:

- Deciduous and coniferous trees and shrubs, which can form complete or particle to complete canopy.
- Grasses presented by tall, steppe and short grasses, which create meadow and steppe grass ecosystems.

Agroecolopgical areas of the object are sown on Fig. 1.

Human activities play important, sometimes – decisive role in the district soil forming processes mainly through deforestation, intensive agriculture, irrigation, reclamation etc. In the last years approximately all existing soil data were organized into a computerized geographic information system of soil resources (GISoSR), containing information on:

- Basic topographic information;
- Point information;
- Territorial information in 1:10 000 scale and soil physical and hydrological properties;
- Data about local climate;
- Data about current land use pattern of the soils – Fig. 2.

It was analyzed 15 samples of the plough horizons from typical soils from south to north starting above Batak and finished above Panaguriste. Eight soils with low and very low humus content from them are finding adequate for compost technology applying. The analytical results are already present in [4]. In addition to this data an analytical data from hard civil waste products, sediments, excrements are presented. All samples were taken in September 2001. The following analytical methods are used:

Organic carbon is determined following Turin method, modified by Nikitin in spectrophotometer.

Humus following Turin according to equation:

(1) $$H = 1.724 * C$$

where: C is organic carbon content (%) and H is humus content (%).

pH – with pH-meter in water suspension in the ratio of 1 part of sample to 2,5 parts of water.

Heavy metals and metalloids – by ICP and AAS methods.

Soil horizons are classified for humus content and pH according to [3].

Hard civil waste products, sediments and waste from canning works:

Organic carbon is determined following Turin method, modified by Nikitin in spectrophotometer;

pH – with pH-meter in water suspension in the ratio of 1 part of sample to 2,5 parts of water;

Heavy metals and metalloids – by ICP and AAS methods.

Excrements from birds, pigs, sheep and cows.

pH – with pH-meter in water suspension;

Heavy metals and metalloids – by ICP and AAS methods.

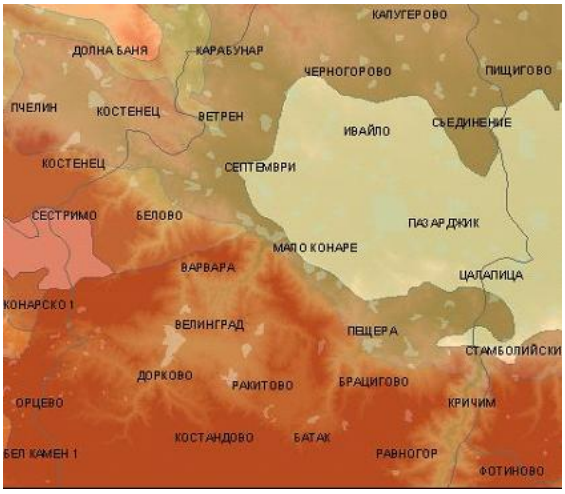

Fig. 1: Agroecological areas of the object

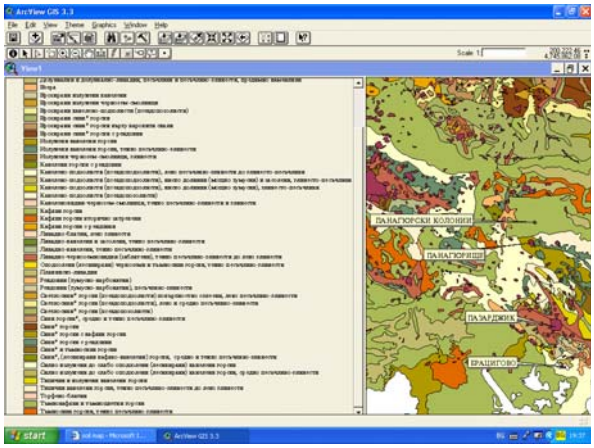

Fig. 2: General view of the object

3. RESULTS AND DISCUSSION

Analytical results for 8 of 15 soil samples (more than 50 %) are sown in Table 1 and for waste end excrements samples – in Table 2. The studied soil horizons are as follow:

#1. A1A2l pl. hor. of Cinnamonic podzolic (pseudopodzolic) forest soil near Pestera town.

#2. A1l pl. hor. of Cinnamonic forest soil near Pestera town.

#5. A/1к layer pl. of Alluvial-Deluvial meadow soil near to Captain Dimitrievo village.

#8. A1A2l pl. hor. of Cinnamonic podzolic (pseudopodzolic) forest soil near Sarja village.

#9. A1f pl. hor. of Cinnamonic forest soil (undeveloped) near Sbor village.

#11. A1l pl. hor. of leached Cinnamonic forest soil near Dolno Levsky village.

#12. A1f turf of leached Cinnamonic forest soil (shallow) near Buta village.

#13. A1f pl. hor. Cinnamonic forest soil (undeveloped) near Panaguriste town.

There are any suspicions of Cd, Pb, Cu and Zn contamination in horizons analyzed. Some contamination by means of As exist in samples #1, #12 and # 13 with 15,3 %, 63 % and 2 % respectively.

There are any suspicions of Cd (Cadmium), Cu (copper) and As (Arsenic) contamination in analysed samples. Some contamination by means of Pb (Lead) – sediments of about 4 % and Zn (Zinc) exist in samples CWP 2 and C&DE of about 41 and 30 % respectively.

It is necessary to point out that using same compost techniques should be very careful. If, for example it is using some mixture of CWP 1, CWP 2, S

and WCW in equal quantity it yields about 12 mg/kg As. This means that all soils might be contaminated by As. The same might happened if in a compost technology from the same compost components yield contamination by Cd, Pb, Zn and Cu.

Almost the same might happened if as a compost materials are used a mixture of C&DE, PE, SE and CE, or mixing all studied potential compost materials. Every one could calculate how many times would be jumped over the precautionary values for studied heavy metals and metalloids.

4. CONCLUSIONS

As result of analyzed soil, waste, sediments and excrements it might conclude that there are same adequate soils for compost technology applying for organic matter increasing only in Pazardjik district territory.

Is should be notified that such kind of techniques might be done very carefully because of very high dangerous of soil contamination by heavy metals and metalloids.

Very hard analytical work by means of soils, waste, sediments and excrements should be done, before taking any decisions about right compost technology developing.

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Table 1. Humus content estimation and precautionary values of heavy metals and metalloids for studied soil horizons.

Sample number	Horizon Depth (cm)	Humus content (%)	Estimation	pH in H_2O	Heavy metals & metalloids content (mg/kg)									
					Cd	Cd pv	Pb	Pb pv	Cu	Cu pv	Zn	Zn pv	As	As pv
1	A_1A_2l pl. 0-26	0,44	Very low	5,4	0,23	2.0	15,88	70	33,15	60	50,64	95	32,65	25
2	A_1l pl. 0-28	0,93	Very low	6,7	0,47	2.5	29,00	80	98,50	260	99,00	340	17,66	25
5	$A/_{1к.}$ pl. 0-26	0,78	Very low	8,1	0,20	3.0	16,86	80	34,65	280	61,20	370	19,26	25
8	A_1f pl	1.94	Low	6.3	0,20	2.5	22,70	80	31,81	260	98,79	340	17,40	25
9	A_1f pl. 0-22	1,03	Low	6,9	0,30	2.5	23,50	80	67,75	60	58,76	340	15,17	25
11	A_1l pl. 0-26	1,43	Low	5,6	0,24	2.0	24,28	70	34,86	260	39,90	200	17,50	25
12	A_1f 0-19	1,96	Low	5,9	0,23	2.0	24,08	70	24,08	120	37,38	200	40,73	25
13	A_1f pl. 0-23	0,90	Low	5,4	0,20	2.0	21,18	70	27,51	120	36,27	95	25,6	25

Table 2. Analytical results of hard civil waste products (CWP), sediments (S), waste from canning works (WCW) and chicken and ducks (C&DE), pigs (PE), sheep (SE) and cows (CE) excrements.

Samples	OM content estimation	pH in H_2O	Heavy metals & metalloids content (mg/kg)									
			Cd	Cd pv	Pb	Pb pv	Cu	Cu pv	Zn	Zn pv	As	As pv
CWP 1	Very high	6.8	0.70	2.5	40.4	80	43.9	260	153	340	4.49	25
CWP 2	Very high	6.3	0.75	2.5	13.8	80	59.2	260	480	340	<2.0	25
S	Very high	7.3	1.60	3.0	83.0	80	119.0	280	344	370	3.37	25
WCW	Very high	6.4	0.44	2.5	56.0	80	40.1	260	186	340	2.53	25
C&DE	Very high	6.0	0.48	2.0	56.9	70			260	200		
PE	Very high	6.4	0.17	2.5	6.4	80			226	340		
SE	Very high	7.6	0.11	3.0	14.6	80			160	370		
CE	Very high	7.4	0.28	3.0	8.4	80			129	370		

FORECASTING OF THE SOCIAL AND ECONOMIC DEVELOPMENT OF FORMALLY RECOGNIZED AND UNOFFICIAL SPATIAL UNITS on the bAsis of spatial factors

Maria Shishmanova,

South-West University “Neofit Rilski”, Blagoevgrad, Bulgaria

Abstract: *The paper illustrates a methodological approach for the correct localisation of economic, social services and environmental objects in the territory of recognized or unofficial spatial planning units, based on spatial factors and various rules and regulations. Alongside defining these units' future development, a description of the direct and reverse connections between the different levels is provided, seen as a basis for the correct management of processes, phenomena and the spatial areas themselves. The attainment of sustainable development in a certain spatial area would require the correlation and compatibility of the regulatory framework at the different levels, as well as consideration of the available long-term tangible assets, natural heritage and cultural and historical background.*

Keywords: *methodological approach, social and economic development, sustainable development, management*

1. INTRODUCTION

The paper illustrates a methodological approach for the correct localisation of economic, social service and environmental objects in the territory of recognized or unofficial spatial planning units, based on spatial factors and various rules and regulations. Alongside determining these units' future development, a description of the direct and reverse connections between the different levels is provided, seen as a basis for the correct management of processes, phenomena and the spatial areas themselves. The attainment of sustainable development in a certain spatial area would require the correlation and compatibility of the regulatory framework at different levels, as well as consideration of the available long-term tangible assets, natural heritage and cultural and historical background.

2. RESULTS, DISCUSSIONS, CONCLUSIONS

Following a period of complete rejection of all forms of regional and spatial development planning, planning and forecasting methods have to a great extent regained their significance. An important factor in this process was Bulgaria's accession to the EU and the adoption of a system of regional social and economic planning, harmonized with the relevant European leg-

islature and practice. However, despite strenuous efforts towards compliance with EU requirements we are yet far from a positive assessment of our achievements. Whereas regional, district and municipal development plans are in place and a National Strategic Reference Framework, National Regional Development Plan, National Strategy on Regional Development, National Operational Programme, entitled 'Regional Development', have all been elaborated, spatial development planning, even though it experienced a certain 'renaissance', has not yet started functioning satisfactorily (Fig.1). Amendments are usually introduced one or two years after the adoption of a Municipal Development Plan, whereas developments are partial amendments that continue to be adopted as in the past. Very few municipalities have prepared their Municipal Spatial Development Plans and very few cities have new General Spatial Development Plans. It is barely now that spatial development planning of district centers and some larger towns, as well as of settlements within agglomeration areas, starts. Regional planning, on the other hand, owing to its inclusion in a number of important documents under signature, was able, at relatively short notice, to produce a multitude of documents, strategies and plans, which covered the country on a municipal, district and planning region level.

A certain inconsistency between spatial development and regional planning emerges on careful examination, with clear evidence for a lag-behind in spatial development planning, which is a cause of disruption to the sustainability of the territories.

The regional, district and municipal development plans merit a discussion on the extent of their effectiveness in providing a solution to the challenges of the social and economic process currently underway, but national spatial development planning clearly does not function properly, despite its revival. The reason is that planning in the new market economy conditions is quite different from planning as implemented by the planned economy system. We have now been convinced that even the free market cannot do without planning, especially in the field of spatial development. It must be understood that for planning to be efficient today it needs to function in harmony with the market. Otherwise plans simply fail.

Synchronization between planning and the market has been never been easy to achieve and has not yet been mastered even in countries of market economy age-long traditions. Alain Bertaud (World Bank expert) has spoken on the tragic discrepancy between half-a-century experience based fundamental market research carried out by economists and the total lack of interest in these problems on the part of urban planners, who are exactly the specialists, making the decisions and actually shaping urban development. In his Beijing lectures Bertaud voiced the opinion that it is exactly the insufficient knowledge of market tools that has led to the failures in spatial planning in the 20th century on a world scale. However, any failures of planning

as practiced in developed market economies do not automatically spell out appreciation of our practices in the 1990s when some of our country’s most beautiful natural heritage estates were sold out and destroyed.

The interdependence among planning, market and nature is a problem area that must receive due attention. The failures of our spatial development planning have resulted in unsupervised destruction of invaluable natural resources. Society blames construction developers, but in the end they just provide what consumers demand. If demand calls for recreation facilities and holiday apartments, construction entrepreneurs will undoubtedly produce them. The actual problem is whether profits are realized by means of sustainable or anti-sustainable forms of spatial development, which in its turn is determined by the rules of the spatial development system.

There is a close connection between all the above and the regulatory framework issue. Right now there is flagrant discrepancy between plans and their objectives, of the one part, and the spatial planning regulatory framework, of the other part. More or less successfully, municipal development plans aim to implement certain publicly significant objectives, but in a market economy spatial development rules and standards have much greater precedence. In our country they literally sabotage and undermine these objectives. What other comment can Ordinance No. 7 of the Ministry of Regional Development and Public Works on rules and regulations on the spatial development of various types of territories and spatial development zones possibly elicit with its provision for an intensiveness of development coefficient of 1.5 for the recreation zones, whereas the Agricultural Land Preservation Act has one of the most simplified procedures in the world for transformation of agricultural land into regulated estates, i.e. urbanized territories [2]. When we so lightly change the intended use of spaces and create regulated land estates of such a high intensive construction coefficient we must surely recognize (Kint) [2] that we thus cut up and parcel our invaluable environmental and natural resources. We should not be surprised that each of these cuts and parcels may generate significant interests. The enormous values of these natural resources and of the intensive construction coefficient engender huge economic interests. Therefore it would be better to analyze the situation and introduce more sensible and nature-friendly rules into this market game.

The other side of this issue relates to the strengths and weaknesses of planning and the market. One of the strengths of planning in a market economy is that with the help of relatively low, but well invested financial resources it can generate a hundred- or even thousand-fold more powerful market reaction. Such an effective tool is, for example, investment in infrastructure. The municipality of Bansko succeeded in putting together and investing over 4 million EUR in its infrastructure with the purpose of providing an incentive to the development of tourism [4]. Whether this objective was well-grounded and properly considered is another matter, but the objective

itself was achieved. Providing a solution to the greater part of the infrastructure problems of this small town was one of the decisive factors for later attracting millions of EUR as foreign investments, which was a hundred times more than the planning authority could raise, i.e. the municipality. In fact, this is just one of many hundreds of real-life positive or negative examples of the cardinal value of the link between planning and the market [3]. In general, the expertise we have now gained in the sphere of regional and spatial development planning in a market-driven environment is now more than sufficient, but regrettably, far from positive. Is Bulgarian spatial planning successful and effective? It is especially important to assess planning in the tourism sector (recreation zones), where developments have been stormy. An especially apt example is provided by the tourism and recreation zones [6]. Over the last five years public opinion of them is so negative that they have become examples for anti-environment-friendly, anti-sustainable, even anti-recreational spatial development forms.

What is the role of spatial development plans? Another example is provided by the selection of the 27 industrial zones, which are being developed prematurely, with no clarity as to any possible investors at this critical point in time for both the economy and the financial sphere, when moreover, some countries have now found themselves in recession. Industrial zones and their spatial development determine the level of industrial development in a certain territory to a very large extent [5].

Another example of the new speculative business ventures in a negative sense is the development of the 'green current' areas. 'The green current' was a headline in the economic section of the *Black Sea Lighthouse* newspaper, quoted by the *Focus* news agency. After the construction sector was badly hit by the crisis, speculators began looking for cheap land to build wind farms and photovoltaic stations. Most are now buying low-priced plots of 20 to 30 thou.sq.m., prepare and submit a project for a single generator and attempt to find investors. Because of expected high returns and European requirements to increase the share of the 'green current', projects have become more 'expensive': their value has changed from 110 000 to 160 000 EURO.

As mentioned above, one of the basic factors for the resuscitation of planning in the 1990s was Bulgaria's accession to the EU and harmonization of Bulgarian legislature in line with European criteria. The newly developed Regional Development Act adopted in 1999, became the basis for the National Regional Development Plan 2000-2006. The national regional development plans and strategies, operational programmes and sectoral strategies define the major objectives in the development of tourism and recreation zones as acceleration of development processes, achievement of a positive overall effect for the economy and providing financial stability, solutions to the social problems in disadvantaged regions, conservation of the natural and cultural heritage and enhancement of the quality of the tourism

product [3].

Against the background of the above-mentioned ‘dark ages’ in the sphere of spatial development of, for example, recreation zones, one can counterbalance the regional spatial development scheme for the Black Sea coast and the spatial development plans of the Bulgarian Black Sea municipalities as an important large-scale exception, which were financed by the World Bank (1995 and 1997-98 respectively). Regrettably, despite their high level of development, these plans (with some minor exceptions) were too rapidly abandoned.

Conversely, after the 1990s when spatial planning processes started to gain impetus all over the country, these processes in the recreation zones and resort towns fell behind. The first half of the new decade saw too few examples of any new plans being developed. The development of general spatial development plans did start for a number of towns and resorts along the Black Sea coast between 2004 and 2008, but planning still remains a slow and difficult process.

In general, the slow-down in spatial development planning is due to the extremely difficult adjustment of the enormous and sharpened interests of the various market participants (these are land estate owners, investors, ordinary citizens, ecologists and others). Indeed, the construction of new industrial zones as a ‘green field’ investment is a much more profitable and a prompter process, compared with the conversion and adaptation of existing industrial estates. The former receive no mention and are a blank spot in spatial development. They increase in number and size. The population is on the decrease but each new general spatial development plan widens the urban boundaries and bases its calculations on optimal population numbers. Should Bulgaria’s population be summed up on this basis, it would appear to be growing, whereas in actual fact it is drastically diminishing.

The following have been established:

- Discrepancies between regional and spatial development planning;
- Discrepancies between planning objectives and spatial development regulations;
- Discrepancies between spatial development and the market;
- Imperfect planning tools to modify the market.

On the other hand, as the system of regional social and economic planning has been adjusted to the EU planning system, it sets very strict criteria on conformity of aims, objectives, priorities, measures, actions, tools, indicators, etc. Therefore, despite certain weaknesses (as certain unnecessary complications and even disparity between a number of planning documents and strategies), the generally accepted assessment is that of consistency and internal conformity between the aims and the means to implement them.

Actually, it is the lack of ‘external’ conformity that poses the greatest

problem. The European system of regional planning is a tool for the distribution of European funds, aiming solely at deriving the maximum effect from the use of financial resources. This is its primary positive role, but also the root of many failures, because overestimation of this function makes one lose sight of the complete picture. Effective use of funds is actually only a means and not an end in itself. There are activities and factors whose effect on accelerating local development is difficult to assess, but even so they are of the utmost importance, which is even more meaningful than European financing.

It is for this reason exactly (the function of a tool to distribute funds) that social and economic planning loses sight of spatial development. District and municipal plans and strategies are needed to ensure European financing, but it looks as though that spatial development plans show no relation to financing local development. To summarize, social and economic regional planning relies on spatial development only as regards infrastructure projects. Regional and spatial development planning must run parallel and form a unity of both kinds of planning, whereas social and economic planning must indicate as its output the objectives of spatial development. In practice however social and economic planning does not concern itself with the development trends, major objectives, measures, concrete actions and parameters of the natural and urban environments. Even when they pinpoint the problem areas of tourism, related to excessive construction development of our resort complexes, the strategies (the National Regional Development Strategy, the Bulgarian Tourism Development Strategy) never formulate measures and actions to counteract negative trends in spatial development (such as population density, excessive construction development, free space).

The legal and regulatory framework is another and more important factor of regional development systems, unaccounted for by the strategies and plans because they focus too narrowly on the function of distribution of European funds.

Despite the importance of European funds for the Bulgarian economy, the significance of the legislative and regulatory framework is several times greater. Regrettably, planning documents rarely take adequate account of this framework, and even if they do, it is superficially, by simply enumerating related parliamentary Acts, rules and regulations, without studying their impact on process developments. This has been particularly acutely felt in spatial development planning. If we analyze spatial development processes that have taken place in our cities and territories during the last decade we shall find out that it is exactly the rules and standards as elements of planning that are functioning. Practices in recent years have shown that while spatial development plans aim in a given direction (on principle the correct one), spatial development rules and standards most often work in another

direction, but it is these two last (rules and standards) that exert an impact on actual development. A spatial development plan, functioning in disharmony with spatial development rules (universal, national or specially prepared for its implementation) is to no effect [3].

Actually, the market system of urban spatial development has not yet been considered extensively by a single planning document. Bulgarian planning practices barely recognize the fact that it is the market today that boosts spatial development and that the market can and would better be regulated and that there is no other alternative for a plan to be implemented but by means of market mechanisms. The points of the triangle regional planning – spatial development planning - market mechanisms must be synchronized on the basis of sustainable ecological development.

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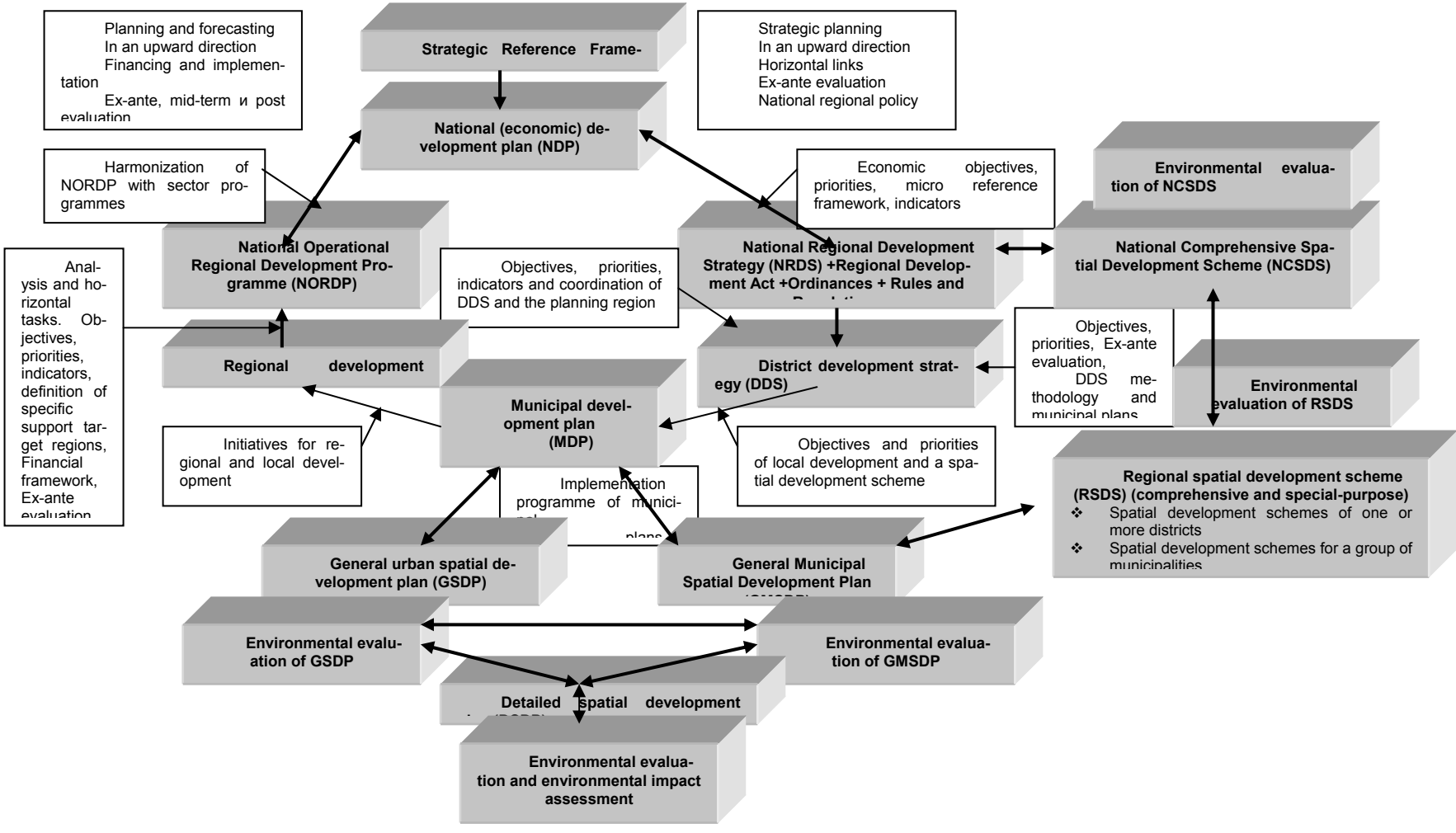

Fig. 1: Inter-relations regional and spatial development planning.

Late Quaternary glaciation in the valley of Musalenska Bistrica (Rila mountains, Bulgaria)

Emil Gachev

Southwestern University “Neofit Rilski”, Blagoevgrad, Bulgaria
Institute of Geography – BAS, Sofia, Bulgaria

Abstract. *This study is about the history of deglaciation in the valley of Musalenska Bistrica river (Rila mountains, Bulgaria) after the Last Glacial Maximum (LGM - the coldest phase of the Wurmian), which took place between 23,000 and 19,000 years BP. Relict glacial features found on the field suggest that the post-LGM warming has occurred on several stages that were interrupted by phases of cooling, to which traces from several glacier advances are related. Geomorphic analyzes and comparisons with other mountains in the region show that these phases are to considerable extent synchronous with those registered in central Europe and the Mediterranean. The last cold stage was the Little Ice Age (15^{th} – 19^{th} c. AD), when probably the last glacier (or microglacier) still existed in the uppermost part of Musala cirque.*

Keywords: glaciation, glacier retreat stages, Musala cirque, equilibrium line altitude (ELA), moraines

1. INTRODUCTION

Global climate change has recently been one of the mostly debated scientific issues. A useful instrument to estimate the regional and local effects of such changes is to reconstruct environmental conditions of different past periods. Among the most evident field indicators of such conditions in Bulgaria are the traces of glaciations left during the cold phases of the Quaternary, which are found in the highest mountains Rila and Pirin. They are presented as specific landforms which can be recognized on the field. Through their analysis and dating it is possible to suggest the basic climatic conditions in the past and by comparing them with the present climatic setting to elaborate models for possible regional climate changes in the future. Although most authors suggest at least two Pleistocene glaciations in highest Bulgarian mountains (Riss and Würm), clear evidence exist only from the last glacial stage (Würmian) and from the glacier retreat during the Late Würmian and the Holocene. The present study is focused on the analysis of glaciation history in a representative part of Rila mountain during the last 21,000 years.

2. GEOGRAPHICAL SETTING OF RESEARCH AREA

The catchment of Musalenska Bistrica river is situated along the northern slopes of Rila mountain in their central section (fig. 1) and in general has a northerly aspect. To the south it reaches Musala peak - the highest point of Rila and all the Balkan Peninsula and to the north it ends at the town of Samokov where Bistrica flows into Iskar River.

The area of interest includes the upper part of the catchment situated within the slopes of Rila massif above Borovec resort, with an altitude ranging from 2925 m a. s. l. (Musala peak) to 1350 m a. s. l. (Borovec). The uppermost part of this area is occupied by the staircased Musala cirque, which has three main levels (bottoms at 2700, 2550 and 2390 m a. s. l.).

The study area has a uniform bedrock setting - premesosoic granitoides. The classical relict glacial landform complex includes cirques, rigels, carlings, U-shaped valleys, moraines, roche moutonnée etc. Cryogenic processes are typical for present morphogenesis at altitudes above 1900 m a. s. l., (especially active in the areas above 2600 m. a. s. l.), while erosion processes dominate in the lower section of the valley. The area is abundant with traces of relict and recent paraglacial activity - rock glaciers, rockfalls, talus cones, avalanche gullies, boulder fields etc. Cirque bottoms are filled by 7 lakes (the Musala lakes), which form two groups – upper lakes: Ledeno (2709 m a. s. l.), Bezimenno (2576 m a. s. l.), Alekovo (2544 m a. s. l.) and a small lake at 2486 m a. s. l.; and lower lakes – Karakashevo (2394 m a. s. l.), Dolno Musalensko (2386 m a. s.l.) and a small lake at 2391 m a. s. l.

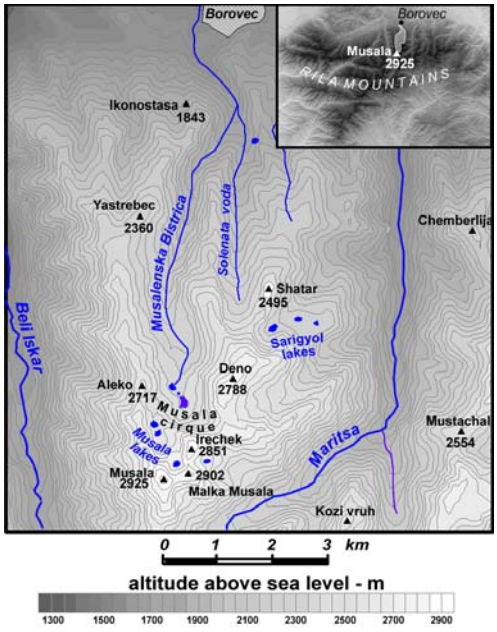

Fig. 1. Location of the catchment of Musalenska Bistrica

Present climate conditions: average annual air temperatures for the period 1931-1970 [1] are as follows: Musala peak (2925 m a. s. l.): -3°C; Musala cottage (2389 m): +0,5°C; Sitnjakovo (1742 m): +4,2°C; Borovec (1350 m): +5,5°C. Temperature at Musala peak show a tendency of warming +0,2°C for the last 30 years and +0,7°C for the last five years [2]. For the period 1931-1985 annual precipitation range between 670 mm/y (Samokov at 1029 m a. s. l.) and 964 mm/y at Musala peak [3]. A serious decrease of precipitation has been registered for Musala peak for the last two decades,

precipitation presently ranging from 830 to 900 mm/y. Present climatic conditions define presence of a forest belt up to 2050 m a. s. l., (Picea abies, Pinus peuce), a subalpine belt up to 2500 m a. s. l. (Pinus mugo, Juniperus sibirica), and a belt of alpine grasses in the highest areas.

3. MORAINE FEATURES AND GLACIAL MORPHOSCULPTURE

According to the maps of the previous researchers [4,5] as well as in result of author’s fieldwork observations, in the cathcment of Musalenska Bistrica are found several terminal moraine ridges that mark out consequent stages of glacier retreat. As the present study does not include results of absolute dating of moraine features (samples for cosmogenic nuclide dating with ^{10}Be that were taken in 2007 are still in processing), suggestions about the depositional ages are made on the basis of a valley-to-valley correlation, geomorphic analyses and parallels with similar mountain massifs in the region where such datings are available.

For each of the glacial stages revealed on the field a spatial reconstruction of former ice extent was made on the basis of GIS supported analysis of slope tilts, cirque shoulders and trimlines, and also in verification with presently glaciated mountain catchments (Hintereisferner glacier in the Alps and others). On the basis of former ice margins the equilibrium line altitudes (ELA) for the consequent glacial stages were calculated following the accumulation-ablation ratio (AAR) method [6,7], which relies on the statement that surface areas of accumulation and ablation zones of a mountain glacier are in a relatively constant proportion, dependant on glacier hypsometry and catchment morphology (normal error ±50 m). For present estimations an AAR ratio of 0.67 was used, which is accepted as average for Alpine glaciers [8]. Obtained values of former ELAs are used for estimations of past temperature conditions accepting a normal temperature lapse rate of 0.6°C/100 m altitude.

4. RESULTS

The lowermost moraine found in the valley of Musalenska Bistrica is located at valley outlet from the mountain slopes just above Borovec resort (1360 m a. s. l.). An outcrop of this moraine is seen at the road from Borovec to Beli Iskar near the palace Tsarska Bistrica (the palace itself lies partially on this moraine). No traces of older moraines were found in the valley below. Correlation with the adjacent valley of Beli Iskar river shows that these deposits have same age as those, found just above the village of Beli Iskar. A dating result has already been obtained for the latter, confirming that moraine accumulation occurred during the Last Glacial Maximum (LGM) – 23 to 19 ka BP [8]. This indicates that the maximum Würmian glacier extent in the valley of Musalenska Bistrica and in Rila as a whole occurred simultaneously with that in the Alps and Tatra mountains and sug-

gests that other glacier retreat stages can also be correlated to those observed in central Europe. According to calculations the ELA of Musala glacier during the LGM was at about 2155 m a. s. l. [8]. This matches to great extent the opinions of most of the previous authors that during the late Würmian the lower position of snow line in Rila was at about 2200 m a. s. l. (fig. 2). The next moraines upvalley are found in the forest at altitudes 1650 and 1740 m a. s. l. This is a mixture of terminal and lateral moraine ridges of age probably related to Gschintz stadial of the Alpine scheme (ca 12–13 ka BP).

A well outlined stadial moraine is located just at the lower end of Musala cirque at 2390 m a. s. l. This flat and wide ridge forms the northeastern rim of Dolno Muisalensko lake and is partly cut by the shallow incision of Bistrica river, which flows out of the lake. Calculations for this stage show an ELA of about 2490 m a. s. l. Further up terminal moraines shape the northern rim of Alekovo lake at 2550 m a. s. l., outlining a retreat glacial stage with ELA at about 2645 m a. s. l. A moraine made of three parallel ridges border also Ledeno lake at 2700 – 2710 m a. s. l., indicating a small cirque glacier with ELA at about 2740 m a. s. l. (fig. 3). As a result of the bathymetry mapping done by [9] a young crescent-shaped ridge was found and mapped on the bottom of the lake at the shallow SW side.

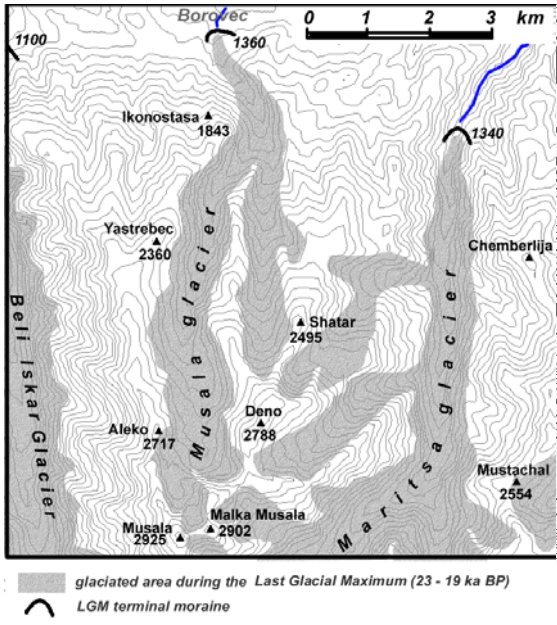

Fig. 2. Glacier extent in Musala area during the LGM (23 – 19 ka BP)

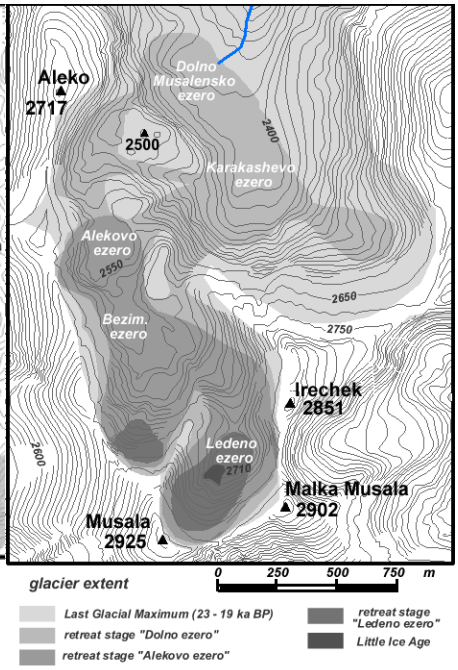

Fig. 3. Late Pleistocene and Holocene glacier retreat stages in Musala cirque

This might be the youngest moraine in Musala cirque, dating probably from the Little Ice Age – the cooler period which lasted from 15th to 19th century AD). Such a hypothesis is supported by documentary records ([10] wrote about “a patch of snow that never disappears at the very foot of Musala peak”, and [11] reported about 11 “small glaciers” in Rila mountain) and also by the current presence of microglaciers in Pirin. Althoigh they are considered to exist at lower altitudes due to the specific topography and lithology in the marble part of Northern Pirin [12], their presence is by no doubt an indicator that the present snow line is not very high above the highest mountain peaks.

5. DISCUSSION

The Last glacial maximum occurred simultaneously in the mountains of Central and Eastern Europe. This should mean that glacier retreat stages in the mountains of the region should also be correlated. For this sake past and present environmental conditions in Rila (the valley of Musalenska Bistrica) are compared to two other sites with similar conditions – Bâlea valley in Făgăraş mountains (Southern Carpathians, Romania) and Suha woda valley in High Tatra mountains (Poland) (fig. 4). They all have similar hypsometry, aspect (to the north) and lithology (slicate crystalline rocks). According to regional studies [7,13] the present average annual temperature in Rila is about 2°C

Fig. 4. Location of comparative areas – Rila, Făgăraş, High Tatra

higher than in Fâgâraş mts. and about 2.9°C higher than in Tatra mts. at same altitude. In vertical expression this equals to altitude differences of 330 and 480 m (of the levels with same values of temperature). When comparing the estimated altitudes of LGM ELA for Musalenska Bistrica (2155 m), Balea valley (1800 m by [14]), and Sucha woda valley (1620 m – own calculations based on the data of [15]) it is evident that differences between the values are quite close to the present setting (355 m and 535 m accordingly with estimated error of ±50m. This means that three sites underwent similar decrease of temperature during the LGM (about 6.5°C), and probably close changes in precipitation. Thus such analogies can be searched also when analyzing retreat stages. In Suha woda valley a moraine ridge at 1545 m a. s. l. was dated at 12 550±450 years BP [16], which equals to ELA at about 1940 m. Similar age was obtained by [14] for a moraine at 1850 m a. s. l. in Bâlea area (Făgăraş) indicating an ELA of 2050 m. This level corresponds to ELA at about

2400 m a. s. l. in Musala area, which probably addresses the moraine at 1740 m a. s. l. A good match is present at the next set of stadial moraines up the three valleys – the moraine at 1850 m a. s. l. is addressed to the Egesen stadial (10.7 – 10.2 ka BP), ELA estimate about 2040 m a. s. l. Following the scheme this should correspond to the uppermost moraines in Bâlea valley (ELA 2250 m), and to the stadial moraine at Dolno Musalensko ezero in Rila (ELA about 2490 m). Depositional age of moraines at Alekovo and Ledeno lakes cannot be estimated in this case because there do not have representative analogs in the other two analyzed sites. They can probably be addressed to Kromer stadial (around 8.2 ka BP). On the basis of the correlations revealed by the moraine levels an estimate is made about main retreat stages and temperature drop in the three selected valleys, calculated under a standart lapse rate of 0.6°C/100 m altitude (tab. 1).

Tab. 1. Comparative data about glaciation in selected valleys of Rila, Fâgâraş and High Tatra

Glacial Stage (Alpine scheme)	Age ka BP	Mus. Bistrica Rila		Bâlea Făgăraş		Suha woda High Tatra		Temp. drop ºC compared to present
		Alt.of moraines	ELA	Alt.of moraines	ELA	Alt.of moraines	ELA	
Present	0	-	3230**	-	2900	-	2750	
LIA	0.5–0.2	2710*	2980**	-	2650**	-	2500**	1.5
Kromer	8.2	2710	2740	-	2330**	1950	2070*	3.7
Egesen	0.7-10.2	2500	2645	2150*	2250*	1840	2040	4.3
Gschintz	12,5	2390	2500	1950	2050	1600	1940	4.9
Bühl	16 – 15	1780**	2400	1670	1950	1260	1730	5.9
LGM	23 - 18	1360	2155	1450	1800	1130	1620	6.6

*related to highest small cirques **suggestible

6. CONCLUSIONS

According to the position and dating of terminal moraines in Rila mountain late Pleistocene glaciers had their largest extent during the LGM stage (23 – 19 ka BP). This glacial advance occurred synchronously in the mountains of Central and Eastern Europe. According to climate reconstructions, despite the overall cooling relations between average temperatures (and probably precipitation) during the LGM in Rila, Southern Carpathians and the High Tatras were quite much like at present, at least concerning northern slopes. This allows for analogies to be used for revealing the time of glacial retreat stages these three mountains. Traces for at least five such stages are found in the valley of Musalenska Bistrica, but the exact dating of some of them is still quite uncertain. For revealing the Post-glacial evolution of the valley in more details a further research is needed. It should be fo-

cused on absolute dating of moraine deposits, sampling of lake sediments and correlations with other mountain areas.

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Changes in forest fragmentation in the period 1990 - 2006 based on CORINE Land Cover

Monika Kopecká, Jozef Nováček,

Institute of Geography, Štefánikova 49, Bratislava, Slovakia

Abstract*: Concerns about forest fragmentation and its conservation implications have motivated many studies that focused on the dynamics of the forest landscape pattern. This paper presents an assessment of forest fragmentation on the example of the Tatra region, Slovakia. CORINE Land Cover (CLC) data layers for three time horizons (CLC90, CLC 2000 and CLC 2006) are used as input data for classifying changes in forest patterns. Results are based on the quantity of the following fragmentation components: core, patch, edge and perforated.*

Keywords: *CORINE Land Cover, forest fragmentation, Tatra region*

1. INTRODUCTION

Forest fragmentation results in both quantitative and qualitative loss of habitat for species originally dependent on forest. As a consequence, the abundance and diversity of species originally present often decline. Forest fragmentation not only reduces the area of available habitat but also can isolate populations and increase edge effects. Understanding possible consequences of forest fragmentation has become of great concern to conservation biologists and landscape ecologists since almost all natural habitats have become fragmented at some scale.

According to habitat types of matrix, Faaborg et al. (1993) recognize permanent and temporary fragmentation. Permanent fragmentation results in islands of forest surrounded by dissimilar habitat types (eg. urban areas). Temporary fragmentation occurs for example through timber harvest practices, which create holes of young forest within a matrix of mature forest.

Although effects of temporary fragmentation are generally less severe than permanent fragmentation, detrimental effects still exist. From this point of view, the actual and reliable information about the land cover and its changes are important input data for forest fragmentation assessment.

In the early 90-ties of the last century, the CORINE Land Cover project (CLC90) was implemented in the most of the EC countries as well as in PHARE partner countries from Central and Eastern Europe. This database became an essential source of information for many national and European projects and applications, for the policy and decision makers, local administration, scientists and NGOs. Standard methodology and nomenclature of 44 classes were applied for mapping and database creation in 1:100 000 scale using the 25 ha minimal mapping unit. Soon after CLC 90 came to

use, the need for an updated database became the impulse for realization of IMAGE&CLC2000 project. The aim of the project was to produce the CLC2000 data layer and information in general about land cover changes between the first CLC inventory and the year 2000 (Feranec et al. 2007). In the years 2007-2008, 38 European countries participated in the CLC2006 Project. All participating countries used a standardized technology and nomenclature to ensure the compatibility of results for the environmental analysis, landscape evaluation and changes.

The aim of this contribution is to present an assessment of forest fragmentation changes using the CLC data in 3 time horizons: 1990, 2000 and 2006 and to describe the main driving forces that affected these changes in the study area.

2. FOREST FRAGMENTATION ASSESSMENT

2.1 Study area

The studied area is situated in the north of Slovakia and includes four administrative districts: Tvrdošín, Liptovský Mikuláš, Poprad and Kežmarok. Total studied area is 3,764 km^2 and it covers 7.7 % of the national territory.

Fig. 1. - Location of study area

Among fourteen orographic units that differentiate the relief are the High Tatras the tallest mountains. The most elevated parts of the High Tatras and also Low Tatras represent the alpine landscape with areas of dwarf pine-woods, alpine meadows with sparse vegetation and bare rocks. The largest part of the territory is situated in the basin Podtatranská kotlina - a deep depression with fluvial plains and terraced flysch hill land in the foreland of the High Tatras. Prevailingly flysch mountain ranges and depressions alternate in the district of Tvrdošín in the northwest of the region. Mountain ranges Oravská Magura and Skorušinské vrchy are mostly forested while the upland of Oravská vrchovina is also agriculturally used. Forested flysch

mountain ranges Spišská Magura and Levočské vrchy cover the major part of district Kežmarok in the northeast of the region.

The biggest town of the region and an important transport node with an airport is Poprad. Numerous protected territories in two National Parks (TANAP a NAPANT) enhance the importance of the region in terms of travel and tourism.

2.2 Methodology

Fragmentation of forest was assessed using the fragmentation indices proposed by Riitters et al. (2002) who introduced a model to quantify fragmentation from raster land-cover maps (Kopecka, Novacek in print). The indices are based on two measures: forest proportion (Pf) and forest connectivity (Cf). Pf is the percentage of forest in a landscape window. To calculate Cf, the number of true edges (edges between pixels of the target land cover type and other land cover types, e.g. forest – non-forest edges) and the number of interior edges (edges between pixels of target land cover type e. g. forest-forest) were first determined. Cf is the sum of interior forest edges divided by the sum of true edges and interior edges in a selected landscape window. In order to apply this method, it was necessary to convert the vector CLC data into a raster land cover map (25m x 25m pixels). Land cover classes were aggregated to focus on the pattern of forest versus non-forest land cover. Three forest CLC classes (311 Broad-leaved forest, 312 Coniferous forests and 313 Mixed forest) were grouped into one forest class and the remaining classes were grouped into one non-forest-class. Statistical analysis was carried out using landscape windows 5x5 pixels (125m x 125m).

Comparison of P_f and C_f values facilitates classification of the observed raster window into one of four defined fragmentation components:

- Core, if $Cf = P_f = 1$
- Edge if $1 > P_f \geq 0{,}6$ and $P_f \leq C_f$
- Perforated if $1 > P_f \geq 0{,}6$ and $P_f > C_f$
- Patch if $P_f < 0{,}6$

2.3 Changes in forest fragmentation in 1990 - 2006

In the period 1990 – 2006, a remarkable decrease of forest land on the study area was recorded. Table 1 demonstrates the decrease of the compact forest areas both in 2000 and 2006. On the other side, increased percentage of disrupted forest areas was observed. Pursuing the applied methodology, these areas were classified into Perforated forest, Forest patches and Forest edge fragmentation components.

	1990		2000		2006		Change 1990-2006	
Fragmentation component	km²	% SA	km²	% SA	km²	% SA	km²	% SA
Forest core	1540,4	40,92	1530,05	40,64	1352,75	35,93	-187,65	-4,99
Perforated forest	59,71	1,59	57,17	1,52	59,23	1,57	-0,48	-0,02
Forest patches	287,44	7,64	275,44	7,32	289,88	7,7	2,44	0,06
Forest edge	145,75	3,87	150,78	4,01	154,81	4,11	9,06	0,24
Total	2033,31	54,01	2013,44	53,48	1856,67	49,32	-176,64	-4,69

SA –study area

The crucial driving forces of the forest landscape changes in the period 1990 – 2000 were of anthropogenic origin and they were connected with the change of the forest into woodland scrub caused by logging (Kopecka et al. 2008). Comparison of forest fragmentation maps from the year 1990 and 2000 documented the most intensive changes in the regions of Levočske vrchy, Spišska Magura and Low Tatras. The most stable region in that period was the territory of Tatra National Park. In November 2004 a calamity windfall in Tatras destroyed around 12 000 ha of forest at altitudes between 700m to 1350 m above sea level. The storm did not only affected the very susceptible spruce monocultures, but also damaged to some extent mixed forests, including close-to-nature stands believed to have higher resistance against wind damage. In the year 2005 large fires increased environmental problems of the territory affected by the windfall. These facts were the main reasons of dramatic forest fragmentation in Tatra National Park in the period 2000 – 2006.

Decrease of the area of the CLC forest classes (classes 311, 312 and 313) on the land cover maps from 2000 and 2006 was connected with an increased number of transitional woodland/shrubs polygons (CLC class 324). This land cover type is represented by the young wood species that are planted after clear-cuts or after calamities of any origin, forest nurseries and stages of natural development of forest (Feranec and Otahel 2001). The change of forest into transitional woodland indicates a temporary fragmentation with possible forest regeneration. On the other hand, forest destruction in the National Park facilitated the development of travel and tourism (new hotels, ski parks, etc.). Consequently, an urban sprawl associated with a permanent forest fragmentation is also expected in future.

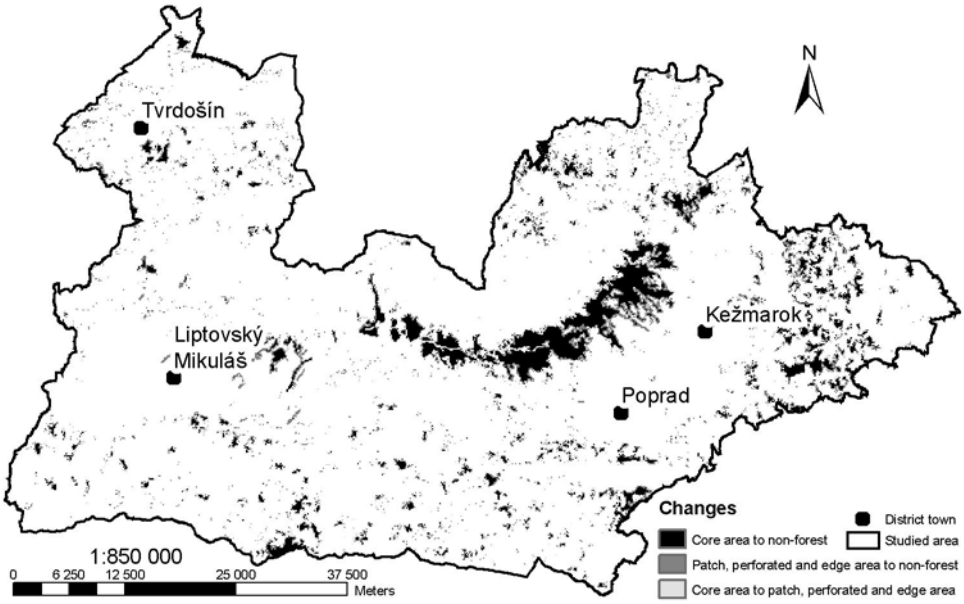

Fig. 2. Changes in forest fragmentation in 1990 - 2006

3 CONCLUSION

The use of the CORINE land cover maps for the analysis of forest fragmentation offers a great potential for the integration of spatial pattern information in the management processes, but also requires understanding of the limitations and correct interpretation of results. Significant changes in forest landscape were observed in the study area. The applied methodological procedure makes it possible not only to quantify the scope of forest diminishment in a selected study area but also to detect qualitative changes in forest biotopes that survive in the territory in question. Anthropogenic changes in the forest landscape structure as well as those caused by natural disasters led to the prevailingly temporary fragmentation. With regard to effects on species composition, special eco-stabilizing measures are needed to ensure the ecological stability of the Tatra region.

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TOURIST REGIONALIZATION IN REPUBLIC OF MACEDONIA AND IT'S IMPACT ON TOURIST DEVELOPMENT

Igor Andreeski

DASS Ohrid

***Abstract**: Republic of Macedonia has many regions with more or less homogenised structure of elements which contain tourist values. The tourism is directly connected with the area in the surrounding. In that area are appearing the needs for tourist movements which are taking place in the boundaries of one area and also their problems are being solved there. We are going to point out the importance and the meaning of tourism for the Macedonian economy through analysis of the tourist region.*

Valorization of the natural and anthropogenic tourist resources has enormous contribution for the development of tourism. It is necessary to canalize the attention of all subjects and use this motivation values.

Tourist regions in Republic of Macedonia will be divided on the base of their containing values and functional characteristics. That will allow accented autonomy of the regions in that way that they will provide autonomy in the development, attendance in the tourist market and mutual compatibility.

The comparison of the economic, social and demographic parameters will lead to the conclusion that Republic of Macedonia from tourist aspect is a small country. But we must insinuate that on this areas are scattered important natural and anthropogenic tourist resources. That means that here exist attractive possibilities for tourist development and with their exploration we can make better the picture of tourist industry of Republic of Macedonia.

***Keywords:** regionalization, tourist regions, tourism in Republic of Macedonia, tourist valuables.*

1. INTRODUCTION

Tourism is the most powerful global industry in the modern society. Today, every year number of tourists in the global world is increasing. That's why this industry needs more attention. Republic of Macedonia is a transition country and economy has significant priority. There for we should pay attention in the tourism industry as it can provide significant influence in other commercial and non-commercial industries.

By organizing and defining the regions (tourist locality, tourist zone and tourist region) we can determine which region has better opportunities for tourism development. That organization need to be treated from the aspect

of tourism development and influence of the tourism over the society, economy and tourist regions.

2. TOURIST REGIONALIZATION IN REPUBLIC OF MACEDONIA

Republic of Macedonia has very important natural and anthropogenic tourist values. Tourism is connected with the natural characteristics of the areas. Also there are a lot of anthropogenic valuables for tourism development. The main reason is that Macedonia has very good geographic position and very rich cultural and historic life which was present in these areas.

All tourist regions in Macedonia have more or less attractive elements, and it need to be determined their level of progress and their functional characteristics.

Regionalization is secure and objective way for adequate valorization for all attractive tourist valuables. Also with that regionalization we can implement effective tourism policy for urban and architectural solutions, and to all micro-local activities and organizational designation.

Protection of natural and cultural valuables is more than necessary, and we can approach more organize to solve this problems with tourist regionalization. With correct tourist regionalization we will have better perception for all separate localities, zones and regions, and we can decide priorities to direct investments, organizational and labor policy.

The tourist regions determine the places which are in priority for development of tourism. Also they are building the principles about their usage and manipulation. Republic of Macedonia has tourist regions which are enriched with significant natural and anthropogenic tourist values. On the other hand, the region which doesn't have any important tourist values must see their development in the other economical branches.

3. NATURAL TOURIST VALUABLES

Natural tourist valuables are basic for tourism development. Macedonian fund of natural attractions is very big, various and qualitative. These valuables enable complementary development of different types of tourism. Character of natural factor is great specification, authenticity and originality.

Republic of Macedonia has attractive places in which the tourist activity can be performed. In order to have better approach in studying of the tourist values on these places it is necessary to have tourist regions on the territory of Macedonia.

To become one phenomenon or object attractive for tourist visits, it need to have at least one of the following attributes: recreate characteristic, curiosity, aesthetic or place of importance.[5]

[5] Zivadin Jovicic “Tourist Geography” Science book, Belgrade, 1971.

If the tourist place doesn't have this attributes, it has no qualities that will satisfy the tourist needs. From all this quality depends if that place will be visited by tourists, what season will be that tourist activity and how important are economic effects from tourism in that region.

Natural potentials in Republic of Macedonia are very common. In contents of natural tourist valuables, basic component are this factors:[6]

- Geomorphologic tourist valuables;
- Climate tourist valuables;
- Hydrographic tourist valuables;
- Bio-geographical tourist valuables;
- Landscape tourist valuables;

4. ANTHROPOGENIC TOURIST VALUABLES

The anthropogenic tourist valuables are significant factor for tourism development of one region. They fit perfectly together with the natural valuables and they enrich site attractiveness to attract attention of the potential tourists. That means that natural factors are complemented with those factors created by the human as a result of their physical and mental activities. This is why we need to analyze anthropogenic tourist valuables and their valorization. If one place has natural attractive factors, and at the same time there are no anthropogenic valuables, then tourist offer for that place is not complex.

Anthropogenic tourist valuables can be divided into:[7]

- Ethnography and social motives;
- Cultural-historic motives;
- Manifestation motives;

5. METHODOLOGICAL ASPECTS OF THE REGIONALIZATION

Economic activities are performed inside boundaries of one geographic place. We can't research all activities separately for each smaller territory space, but we can do that in multiple defined sites – economic regions.

Main reason for economic regionalization in one country is to arrange rationally product forces in all territory and to fulfill reciprocal connection between the regions. With that regionalization we can have equal economic and social development in all territory and higher growth rate for a longer period of time. That's why we need to pay attention in both economical and regional aspects and they need to be one functional entirety.

[6] Naume Marinoski "Tourist geography of Republic of Macedonia" Ohrid 1998, page 48.

[7] Naume Marinoski "Tourist geography of Republic of Macedonia" Ohrid 1998, page 197.

Regional aspect long time was disregard in the economic theory. Later on, social and economic problems became more strength. Some regions faced serious consequences like unemployment and asocial phenomenon, and other regions had significant economical effects. Therefore a lot of countries took some measures to harmonize and establish equal economic development in all economic activities. Regionalization includes system of organized activities in social, economic and political plan to accomplish separate interests between the territorial localities in circled entireties. That is a basic step to get better level of the entire economy in one country.

When we need to determine tourism regions in Republic of Macedonia, during the methodological action it need to predict the following models: model based on the natural factor, economic regionalization model, model for functional spacious gravitation, development model, gravitation model and model for administrative-territorial classification.

From methodological aspect are considered the spacious characteristics of tourism, conditions for better tourist development and the needs for this complex socio-economical and spacious phenomenon.

6. CRITERION FOR TOURIST REGIONALIZATION

Tourist turnover is under massive influence from huge population that is involved in the tourism as one of the most expanded social and economical phenomenon. Also relation between one region and the major tourist recruit countries, most important transit lines, and other concurrent tourist regions are very important attributes that can determine development potential of one tourist region.

It is necessary to define what kind of tourism can be developed in the tourist regions. There for all the factors which determine the tourist development must be considered in order to achieve some optimal efficiency in the valorization of conditions for development. Through analysis of the places and define the natural and anthropogenic tourist values, the activities that have priority which must be done for the development of any kind of tourism will be separated.

During the defining the criterions, it is crucial to pay attention to the dynamic character for the specified tourist region, how did tourism influence the natural factors, social end economic development of that region. The most important criterions that need to be developed and worked out are the following: natural social and economic intact, criterion of integrity, type of traffic, criterion for optimal tourist valorization and capacity of the spaces.

7. CONCLUSIONS

The complexity of tourist regions in Republic of Macedonia is very important for tourist development. When we define the problems, and explain the regional aspects of tourism, we can make some conclusions. The mod-

ern conditions of living are pointing out the meaning of tourism as a significant factor from which we can provide important economical results. For the existence of the tourist development in some places, his basic directions must be determined. With their determination, the infrastructural development of the tourist region is identified and so are the places which must be protected for the tourist needs in some region.

Evaluation of the tourist potentials of the smaller spacious units in the tourist regions must be made and with their grouping to form a bigger unit. The smallest spacious unit is the tourist place which is with at least one attractive element for the tourist development. The tourist place is a homogeny tourist spacious unit which is developing under the influence of the higher spacious units. That higher unit is the tourist zone, which represents a group of many tourist places. The tourist zone is mutually connected with other zones and it can not have individual development. The biggest spacious unit is the tourist region which is formed of many tourist zones. This kind of spacious, natural and economical units are making the possibilities for an individual tourist development.

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The Reconstitution of the Morphohydrographic Evolution of the Jiu – the Danube Confluence Area on the Basis of Cartographic Documents

Gheorghe Curcan, Sandu Boengiu, Mihaela Licurici

University of Craiova, Geography Department, Craiova, Romania

Abstract: *In time, the Danubian rivers transmitted to the conterminous area the different shaping imposed by the Danube, with all the corresponding forms. At the same time, the particular features of the basins of the Danube's tributaries enter the landscape of the collecting river course with characteristics that are proper to the situation.*

The confluence of the Jiu river with the Danube brings about the most interesting issues, not so much concerning the present morphological aspect, but more regarding the paleogeomorphological evolution. As the historic documents show, the confluence of the Jiu river with the Danube occurred, at that time, near the settlement of Bechet. After the extraordinary flash flood that took place in 1879, the Jiu river abandoned its old course, as well as the old confluence point and moved 15 kilometres westwards. Nevertheless, the present confluence is neither the same, nor that represented on the Map of the Pliocene of Oltenia, scale 1:500,000, realised by I. P. Ionescu – Argetoaia (1918). At present, the Jiu debouches into the Danube 2 kilometers downstream, after describing a double bend on the last 2 – 3 kilometres, and its mouth has a slightly oblique position, exactly in front of the downstream edge of the Copanița Holm.

Keywords: *the Jiu, the Danube, paleogeomorphological evolution, morphohydrographic features, cartographic documents.*

1. GENERAL CHARACTERISTICS

The drainage basin of the Jiu river is located in south-western Romania, between 43°45' - 45º30' N and 22º34' - 24º10' E. Within these limits, it covers a surface of 10,080 sq. km, is about 260 km long and is characterised by an average width of about 60 km in the upper part and 20 km in the lower part. One of the particular features of this drainage basin is its elongated shape. The drainage basins of the 232 coded tributaries keep the same high degree of elongation. The hydrographical network is 3,876 km long and its density is 0.34 km/sq. km. The average altitude of the Jiu drainage basin varies between 1,649 meters in the northern part and 24.1 meters in the confluence area. The average slope of the basin is 5 ‰. Having its sources in the Carpathians, the Jiu has a north - south flowing direction; after passing out the Southern Carpathians, the river successively crosses the Getic

Sub-Carpathians, the Getic Piedmont and the Oltenian Plain (the western sub-unit of the Romanian Plain) and it debouches into the Danube near the settlement of Bechet.

Notes with hydrographical and toponymic character concerning the Danube Valley and the Jiu - the Danube confluence area appear in the ancient Greek literature dating before Christ; these notes were occasioned by the expansions of the Greek merchants and they were recorded by the historians of the time, Herodot (5th century B.C.), Aristotel (4th century B.C.), Eratostene (3rd – 2nd century B.C.) etc. Evidences regarding the hydronims of the Jiu river appear later, i.e. during the Roman occupation (the first centuries after Christ), namely Rhabou.

Important data concerning the land and rivers in this part of the country offers the historian and geographer Strabon, in the 1st century after Christ, in his "Geographica", while Pomponius Mela noted the cartographical results of the Roman Empire during the reign of Augustus.

The first cartographic document in which the course of the Rhabon river (the Jiu) is sketched belongs to Claudius Ptolemeus from Alexandria (about 150 after Christ). The map of the Lower Danube, reproduced by C. Brătescu (1924) and Ptolemeus' entire work remain the most important documents until the Renascence period, respectively the 15th century (Simion Mehedinți, *Dacia pontică şi Dacia carpatică*, The Bulletin of the Geographical Society XLVII, 1938).

The first map of high cartographical value, on which the river has its present name, is that of the High Stewart Cantacuzino; it was published in 1700, in Padova. On this map, the Jiu river has a cartographical representation that is very similar to the present one. Another important map on which the Jiu river and other rivers in Oltenia appear, is that realised by the Austrian Schwartz during the occupation of Oltenia (1718-1739) by the Austrians; the title of this map is *Tabula Valachiae Cisalutanae* (1724).

Turning to good use all the previous cartographic documents, there appears the first Atlas of Romania, in 1865 (Fig. 1), under the guidance of Gh. Asachi; here, the Jiu river is represented with high precision. Other very important information was left by the engineer C. Achim (the 19th century). He noted valuable data on some very high flash floods occurred in 1864, 1879, 1881, and 1893, on the Jiu and on other rivers within the southern part of the country. Records with morphometric and hydrographical character were left by the same author. Thus, it is recorded that after the 1879 flash flood, the confluence between the Jiu and the Danube changed from a point located near Bechet to a point that is close to the present river mouth (Fig. 2).

Fig. 1 The Jiu - the Danube confluence on the Atlas of Romania, 1865

Fig. 2 The Jiu - the Danube confluence on the Atlas of Romania, 1903

2. MORPHOHYDROGRAPHICAL CHARACTERISTICS

The numerous studies on the Quaternary in Oltenia (S. Ştefănescu, 1896; Ionescu-Argetoaia, 1918, 1923; Popescu Voinescu, 1932, 1935,1936; P. Coteț, 1957; T. Baudrabur, 1957, 1968, 1971) and the interpretation of the results obtained through recent geological drilling (The Institute for studies, projecting and land improvement - Bucharest, The Drilling and water supply enterprise - Bucharest, S.T.M.H. - Craiova) performed in the Jiu floodplain, confirm the fact that at the end of the Levantine, the Pliocene lake completely withdrew from the region of the Lower Jiu.

The climatic conditions, together with the movements of the crust (Al Roşu, 1956, 1964; P. Coteț, 1957; C. Savin 1973) played a determining role in the evolution of the river course and of its deflection, in the formation of the terraces and influenced the lithological character of the Quaternary deposits (P. Coteț, 1957; Al. Roşu, 1964). The paleogeographical evolution of the Jiu river starts with the Quaternary.

The youngest deposits in the Jiu floodplain are those that make up the alluvial stratum of this unit, as well as the sand of the dunes that cover the floodplain, the terraces and the fields.

The above-mentioned studies certify, on the basis of evidences, that the Wűrm or Riss age, allotted by some researchers to the aeolian sands (B. Ionescu, 1923, P. Coteț, 1957) is not justified, as they are deposed on all morphological units, starting with the floodplain and ending with the high field.

These sands were attributed to the superior part of the Upper Holocene. According to the paleoclimatic criterion, only the terrace deposits belonged to the Quaterary. The research conducted by Liteanu and Bandrabur, 1957, based on the fossil mammals criterion, led to the conclusion that the deposits of the terraces, as well as the sediments with loess character are attributed to the stratigraphic interval Middle Pleistocene – Upper Pleistocene,

while the accumulations of the floodplain and the Aeolian sands belong to the Holocene.

On the geological map, scale 1:200,000 (1966), the alluvial deposits of the low terrace (t1) of the Danube, made up of gravels, blocks and sands, characterized by thickness of 5 – 10 meters, are attributed to the "Lower Holocene", position which is accepted lately by almost all researchers that have studied the terraces.

Through the geomorphologic analysis (parallelism and connecting to the mouth of the Jiu river), we consider that this age must be attributed also to the low terrace (t4) of the Jiu (after C. Savin). On the basis of the same analysis, we reach the conclusion that we need to attribute the deposits of the floodplain, the dunes deposits and the marsh deposits to the immediately superior sub-stage of the „Upper Holocene".

Although not many authors accept the idea of this age for the most recent deposits in the Jiu floodplain, we support this new opinion on the basis of the detailed mapping realised in the field, in the area where the Danube floodplain is connected to the Jiu floodplain (C. Savin, 2003). The existence of certain clear morphogenetical differences between the low terrace of the Danube and of the Jiu, on the one hand, and the new floodplain formation, on the other hand, logically imposes the acceptance of an age differentiation between the two morphologic units, the last one continuing its evolution up to our days.

3. THE ISSUE REGARDING THE OLD COURSE OF THE JIU RIVER

An attentive look at a morpho-hydrographical map of the Jiu valley shows that downstream of the settlement of Murta, on the left side of the floodplain, there is another watercourse, parallel to the Jiu and having its bed moulded in the same alluvial deposit (Fig. 3, Fig. 4).

Although on the hydrographical maps this river appears as a first order tributary of the Danube, having a drainage basin independent of that of the Jiu, we consider this water course and the afferent reception basin to be a component of an organic ensemble, represented by the Jiu drainage basin; taking into account the hydrological aspect, it could be considered an independent river, but following the morphological, geological, hydrogeological and paleogeomorphological aspects, it cannot be set apart from the general evolution of the Jiu valley, whose component it is.

In the present case, there is no doubt that the Jieț flows through a valley that exclusively belongs to the Jiu river, from the genetic and evolutional viewpoint. Thus, the only explanation is that the the Jieț is not an independent river, with its own paleo-geo-hydromorphology, but it represents the rest of a river that once flowed on this track: the Jiu river.

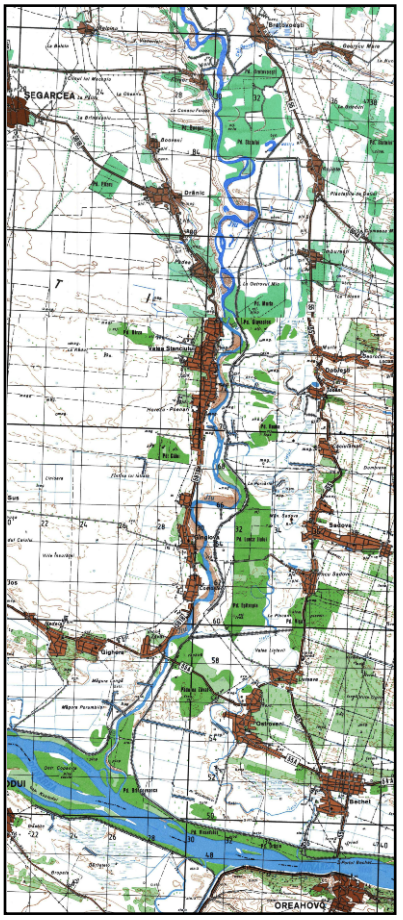

Fig. 3 Fragment of the topographical map, scale 1:100,000, 2000 edition

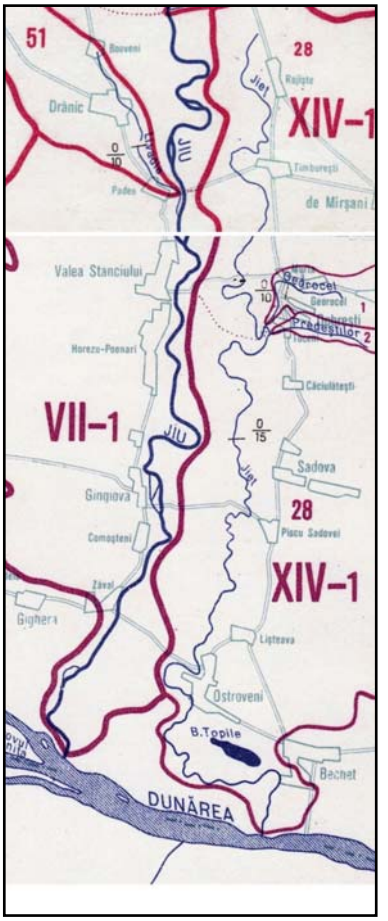

Fig. 4 Fragment of the Atlas of the drying of the rivers, scale 1:200,000, 1974 edition

In other words, the present course of the Jieț is inherited from the Jiu, which once was flowing on the left side of the present floodplain and had its mouth near the present settlement of Bechet. The present course of the Jieț is an abandoned course, partially clogged in time, due to the overflowing of the Jiu or to a complex of causes and processes (the deposition of sands transported by the wind, the contribution of the tributaries on the left, slope processes), in which the Jiu played, nevertheless, an important role.

Furthermore, highly significant historical evidences, such as the notes left from the engineer C. Chiru, ascertain the fact that until the exceptional flash flood occurred in 1879, the Jiu river was flowing into the Danube near the Bechet; subsequently, it changed its course with about 15 km westwards. This testimonial is highly significant, the change of the Jiu course on

the present track being of extremely recent historical date. Among other evidences that ascertain this movement of the course, we mention:

- besides the flowing bed, the Jieț presents numerous abandoned meanders that, taking into account their dimensions and the low flow of the river, cannot be the result of certain natural corrections imposed by the Jieț, but they are inherited from the Jiu and constituted one of the causes that led to the abandonment of this track;
- most of the erosion forms (the present and abandoned meanders) of the Jieț are developed in the upper part of this course, where the Jieț barely gathers its water and it does not have the necessary strength to create such erosion forms in the minor river bed. Most of the rivers are exposed to such processes in the middle and lower course, where their flows are higher and the divagation is stronger. Thus, these erosion forms are inherited from a stronger river, characterised by erosion, transportation and accumulation activity that is highly superior to the Jieț;
- the granulometric analyses of the alluvia from the two horizons of the floodplain alluvial stratum confirm a perfect petrographical unity on its whole width and their mineralogical nature is obvious Carpathian; the transporting agent is the Jiu river;
- the present aspect of the Jieț riverbed is that of an old river course, while the present sector of the Jiu, located between Padea and the confluence - with no meanders - seems that of a much younger river. It cannot be admitted that the Jieț is an older modelling factor than the Jiu, as the last one represents the morphogenetic agent that led to the formation of the slope terraces and of the Jiu floodplain along the entire river.

All these arguments, to which the tectonic factor can be added, as it facilitated the deviation of the Jiu course towards the right slope, are convincing enough to make us consider the present course of the Jieț as being, in fact, a riverbed abandoned by the Jiu river.

So, the main causes of this important stage in the historic evolution of the Jiu river course are, in fact, two: the tectonic one, which facilitated the divagation of the course towards the left of the floodplain and the hydrological one, which finished this change of direction and of riverbed.

The above-mentioned elements lead to the important conclusion that during the whole evolution of the floodplain and up to its present form, the Jiu river changed the flowing direction many times and the one analysed above is the most recent and of historic age. The data obtained from drillings support this statement; it shows that the alluvia of the floodplain is made up of a succession of strata, whose width and disposition in longitudinal and transversal profile suggest an evolution with numerous and pronounced deviations in horizontal plan and oscillations in vertical plan. All these leaps in the evolution of the course and of the floodplain of the Jiu river were the result of the climatic variations rebounded in the hydrological

regime of the Jiu, to which the influence of the tectonic movements was associated.

In the light of the past, there can be anticipated that such leaps in the evolution of the river within the limits of the present floodplain are also possible in the future, especially if we take into account the fact that the Jiu is presently in a stage of strong alluviation. This is proven by the data obtained from the topographical survey, showing that on certain portions, the elevation of the riverbed is more important than broad surfaces of the floodplain, at least in the lower course of the river.

The confluence of the Jiu river with the Danube brings about the most interesting issues, not so much concerning the present morphological aspect, but more regarding the paleogeomorphological evolution.

Concerning the graphical representation of the Jiu river mouth on the historical maps, it is to be noticed the fact that these differ a lot in precision, not only from a century to another, but also on maps drawn at a few years interval. Thus, on the maps drawn during the 17th century, the Jiu is represented schematically, usually through a short, slightly winding line, on the northwest-southeast direction; the river debouches into the Danube eastwards than the present confluence, as it is shown by the Map of J. Hondius, published in 1606 (Fig. 5), where the Jiu river mouth is located near a settlement, probably Bechet; another map is that realised by J. Blaeu in 1666 (Fig. 6), showing a very pronounced diversion of the Jiu on the northwest-southeast direction. Only in 1699, on the Transylvanian Map, Homann places correctly both the course of the Jiu and its confluence with the Danube (Fig. 7). In the next year, 1700, there appears in Padova the Map of the High Stewart C. Cantacuzino and on this cartographic document the Jiu valley is more precisely drawn (Fig. 8).

The first map to represent the Jiu river as exactly as on the modern maps is that realised by Schwantz, in 1722 (Fig. 9), but it indicated the fact that the Jiu debouched into the Danube through two mouths that enclose a relatively large triangular surface, the bifurcation of the course occurring at the entrance in the Danube Floodplain, near the settlement of Potrojani, namely the present-day Ostroveni.

In 1790, there appears the Specht Map (Fig. 10), on which the Jiu debouches into the Danube through only one branch. Comparing these two last maps, one can believe that the Jiu river mouth moved 15 km eastwards in about 70 years. Although it is rich of details, this map does not concord with the reality concerning the confluence, as in 1791, there is published the Map of F. von Reilly (Fig. 11), in which there appears the same bifurcation as 70 years before.

Fig. 5 The Confluence of the Jiu on the Map of J. Hondius (1609)

Fig. 6 The Confluence of the Jiu on the Map of J. Blaeu (1666)

Fig. 7 Fragment of the Map of Homann (1699)

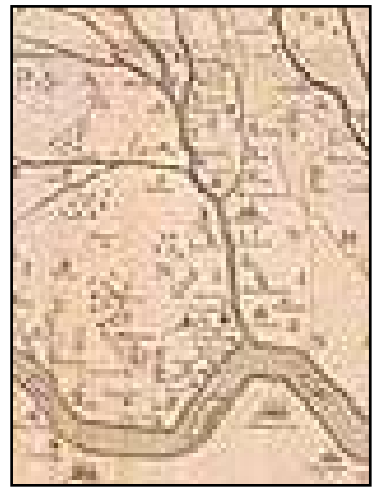

Fig. 8 Fragment of the Map of C. Cantacuzino (1700)

Starting with the 19th century, on the published cartographical materials, the Jiu river appears with only one mouth, but with a series of branches that start to appear north of Ostroveni (Fig. 12).

As the documents left from the 19th century show, the confluence of the Jiu river with the Danube occurred, at that time, near the settlement of Bechet. After the extraordinary flash flood that took place in 1879 (C. Chiru), the Jiu river abandoned its old course, as well as the old confluence point and moved 15 km westwards. Nevertheless, the present confluence is neither that indicated by C. Chiru, nor that represented on the Map of the Pliocene of Oltenia, scale 1:500,000, realised by I. P. Ionescu – Argetoaia (1918).

Fig. 9 Fragment of the Map of Schwantz (1722)

Fig. 10 Fragment of the Map of Specht (1790)

Fig.11 Fragment of the Map of Von Reilly (1791)

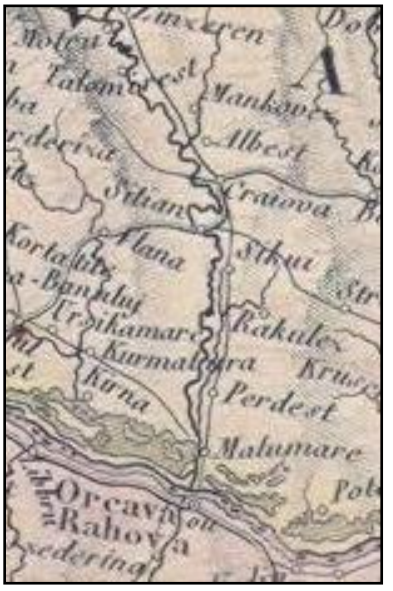

Fig.12 Fragment of the Plan of the Brâncoveanu Hospital Estate (1838)

At present, the Jiu debouches into the Danube 2 km downstream, after describing a double bend on the last 2 – 3 kilometres, and its mouth has a

slightly oblique position, exactly in front of the downstream edge of the Copanița Holm (Fig. 13, Fig. 14).

Fig. 13 The confluence of the Jiu with the Danube, after the Austrian Map, 1912 edition

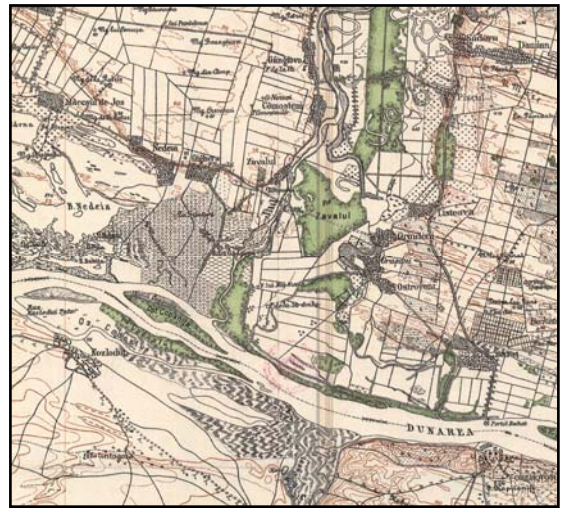

Fig. 14 The confluence of the Jiu with the Danube (Sketch after the topographical map, scale 1:100,000, 1929 edition)

We cannot think that the map of the reputed geologist lacked the necessary precision and would have indicated in an approximate manner a confluence that was perpendicular on the Danube, while the dimensions and the form of the Copanița Holm would have been represented arbitrarily. If we compare the detailed aspect of the confluence shown on the above-mentioned map with that of the present confluence, we notice sensible differences. Among these, there are to be mentioned:

- according to the respective map, after the settlement of Zăval, the Jiu river course has a slight deviation towards west and the confluence was perpendicular; at present, on the last km, the course of the Jiu presents a slight bending, then a double bend and subsequently debouches into the Danube in a relatively oblique position;
- in the quoted map, the Copanița Holm was characterised by other shape and dimensions while, at present, it is nicely elongated along the Danube, being characterised by a much more regular shape. It is possible that the alluvia transported by the Danube contributed to the completion of its dimensions and shape, up to the present configuration;
- at that time, between the Copanița Holm and the Jiu mouth there was no other holm; at present, the maps indicate the presence of a small holm, located in an oblique position, both on the flow direction of the Danube and that of the Jiu river in the above mentioned period (1918); the

shape and position of this small holm demonstrate that it is the common result of the fight between the alluvia deposed by the Jiu and the Danube’s tendency to wash them. This small holm, whose genesis must be connected to the solid flow of the Jiu river, could have caused, in an anterior stage, the closing up of the Jiu river mouth and the movement of its confluence with 1 – 2 kilometers downstream, in a position that facilitates the much easier discharging of the tributary’s solid flow into the Danube. All these recent changes of the Jiu – the Danube confluence can be considered real if we take into account the fact that the Jiu river is characterised by a solid flow of up to 144 kg/s (C. Savin, 1973) in the confluence sector.

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Directions and Possibilities for Capitalizing the Touristic Potential of the Relief within Oltenia, Romania

Popescu Liliana, Negreanu Stefan, Vaduva Iulica

Abstract*: Oltenia, situated in the south-western part of Romania, covering an area of approximately 30,000 sqkm, is a region with a great geographical personality, as a result of the presence of mountainous, hilly and plain relief, that gradually descend from north to south, with different lithological strata, differently modeled by exogenous agents. Consequently, there are various categories of touristic objectives found throughout the region, which includes the first two touristic areas of the country from the touristic potential value point of view. The paper aims at analyzing the main attraction points and at suggesting the main possibilities for a better capitalization of the touristic potential within the region*.

Keywords: *touristic potential of the relief, touristic zones, capitalization, Oltenia.*

1. INTRODUCTION

Tourism, as a form of capitalizing the natural environment and the man-maid patrimony, transforms, spontaneously or following the decision of the public administration, the geography of numerous countries [5, p. 311].

The touristic attraction is generated by some natural or man-made potential, with a permanent or only conjectural action. The natural touristic potential is a fundamental premise for promoting a region and for stimulating the touristic flows. It is the fundamental factor that has led to the initiation of touristic capitalization of some components, representing the primary touristic offer from the economic point of view [3, p. 25].

Among the natural elements, relief plays a great attraction since it greatly influences the characteristics of any landscape. The relief is important for tourism first of all due to its numerous forms, both individually and associated, as well as to the diversity of the attractions and its role in unfolding the touristic activities [4, p. 63].

2. THE TOURISTIC POTENTIAL OF THE RELIEF WITHIN OLTENIA

2.1 Geographical location and relief characteristics of the region

Oltenia is one of the historical provinces of Romania, situated in the south-western part of the country, covering an area of approximately 30,000 sqkm. It stretches from the peaks of the Southern Carpathians in the north to the Danube valley in the south.

From the touristic point of view, a great potential is found throughout the entire mountainous area, situated in the north and north-western part of the region, which includes the southern massifs from the Fagaras, Parang and Retezat-Godeanu, and the much lower Almaj Mountains, as well as in the Mehedinti Plateau and in the Subcarpathians (Fig. 1).

Fig. 1 Geographical location and relief within Oltenia region

2.2 The relief forms with touristic potential

The touristic potential of the relief is largely the result of the different landscapes that vary from one place to another depending on the lithological strata shaped by endogenous and exogenous agents, altitude and natural biomes. The relief forms found within limestone areas, the glacial forms, the gorges in the Carpathians and the sand dunes in the Romanian plain are the most prominent touristic attributes of the natural environment within the region.

2.2.1 Relief forms on limestone

Limestones are predominant in the Capatani, Valcan and Mehedinti Mountains, as well as in the Mehedinti Plateau, extending on hundreds of kilometers on a west-east direction, with impressive karst formations. The presence of thick limestone strata, high degree of tectonization, the lack of a protective layer and the large quantity of precipitation lead to the territorial

variety of the karst relief in the area [7, p. 169]. It is worth mentioning here some of Romania's most important caves, lapies fields, karstic springs, very picturesque gorges and escarpments.

There are hundreds of caves in Oltenia, approximately 300 only in the Cerna basin [7, p. 170], but only very few are fitted out for visitors – i.e. Polovragi, within the Oltet basin, and Muierii – the first cave in Romania that had electricity. Topolnita and Epuran in the Mehedinti Plateau are among the most impressive caves in Romania. All the important caves are protected by law since they were declared natural protected areas and the access of the public is very strict, requiring special approval. Moreover, other beautiful caves are administrated by amateur speleologist clubs, with gates at the entrance, so that the access is somehow restricted. Although it is very necessary to protect the caves and to reduce the human impact to the minimum, some of the small caves should be opened for the public, having proper guiding and following very strict rules.

The shallow karst forms are the most representative for the landscape of the low and medium mountains in the north and north-western part of Oltenia. There are large lapies fields, in different stages of evolution, such as those in the Mehedinti Mountains and Plateau (Poiana Mare, Stan Peak, Ponoare), doline, locally known as crov, the most representative being Crovul Madvedului – the biggest in the country, 170 m deep and 1 km in diameter [7, p. 170], the karstic valleys found throughout the Cerna and Cosustea hydrographic basins, karst springs (Izbucul Cernei, Izbucul Jalesului – protected area).

There are also very picturesque gorges, such as Tesna, Corcoaiei, Cosustea, Sohodol and Oltet gorges, and steep escarpments formed on lime stones, sought by the alpinism club members, with various levels of difficulty.

2.2.2 Glacial relief forms

The landscape of the high mountains testify for the glacier erosion during the Pleistocene, leading to glacial cirques and lakes, comb-like ridges appreciated by some tourist seeking the adventure, such as the Parang main ridge, 10 km long, that unfolds between Parangul mare and Mohoru Peaks [3, p. 36]. Almost all the touristic routes in the high mountains cross the sectors with the most significant and accessible glacial relief forms [6, p. 40]. The peaks are the essential objectives and destinations for hiking and climbing, offering a large view towards the entire mountainous area.

3 EVALUATION OF THE TOURISTIC POTENTIAL

In order to evaluate and hierarchy the territorial units, the Ministry of Regional Development and Housing, together with specialist from universities and state institutions, used the analysis tree method, based on

criteria and subcriteria, resulting in a total of maximum 100 points, of which, for the natural touristic resources there were given maximum 25 points (natural environment 10 points, therapeutic natural factors 10 points and natural protected areas 5 points).

According to the Spatial Planning of the National Territory elaborated by the Ministry of Regional Development and Housing, the highest potential of the relief is found in the three counties situated in the north of the region –where there are many territorial administrative units considered to have the best natural environment, with a total of 10 points out of ten for this criterion. It is worth mentioning Pades in Gorj county (Domogled-the Cerna Valley National Park, Piatra Closanilor, Closani and Cioaca cu brebenei caves, Corcoaia gorge, Mount Oslea), Balta, Ciresu (Mehedinti Geopark, Topolnita and Epuran caves), Ponoarele (the karst complex, including a natural bridge, cave, lake and lapies).

There are 20 caves, 6 gorges, over 20 peaks, escarpments and slopes, which were declared natural protected areas, 11 fossil points, all of them declared natural protected areas. On the whole, the Iron-Gates – the Cerna valley (Mehedinti county) is ranked the first for the value of the touristic potential, and Gorj follows on the 14th place in the national hierarchy.

4 POSSIBILITIES FOR CAPITALIZING THE TOURISTIC POTENTIAL

The main objective for the touristic promotion of the region should be a much better capitalization of the touristic potential by developing all forms of tourism that may unfold within this territory and by drawing tourists from the other regions of the country as well.

In order to make it possible, the local authorities should bear in mind that accessibility is often a key point in the development of any touristic point. Pades, Balta, Ciresu, Dubova, Obarsia Closani etc., all with great natural potential must deal with technical infrastructure issues, since there is no direct access to a national road, and, moreover, the existing roads are in a very bad condition.

The accommodation possibilities in the area are also very poor. The very same settlements with numerous natural protected areas and spectacular relief forms have hardly any chalet or guest houses. For instance, there is no public place to accommodate at Balta, Ciresu or Obarsia Closani, although here are some of the most representative karst landscapes and objectives. It is very important to increase the number of accommodations in these territorial units, and, most of all, to make sure that they are not a discordant element of the landscape. The traditional architecture is the most appropriate for this and numerous peasant houses could serve as accommodation places. But for that, settlements should have a good edilitary infrastructure (running water, sewage system). Although all

the villages have such projects, financed by the European Union, the progress is very slow.

The chalets and refuge places in the mountains should not be neglected. They are very necessary for the tourist that go hiking and camping in the mountains in bad weather.

The landscapes and relief forms in Oltenia favor the development of the recreation tourism and educational tourism.

4.1 Recreation tourism

The recreation tourism attracts the urban population, that wants to escape the towns, no matter the age. The nature of the three northern counties of the region is very suitable for:

- Mountainous itinerant tourism – at altitudes exceeding 1500 m in the Parang, the Capatani and Valcan mountains. The marks on the touristic paths and forest roads should be repainted periodically.
- Hiking – favoured by the landscape value of the mountains, both in the limestone massifs (the Capatanii, Buila Vanturarita, Mehedinti and Cerna Mountains) as well on the alpine summits.
- Mountaineering – along the Cerna valley and Mountains, on the limestone cliffs and escarpments.

Most townsmen flee the cities, especially in the hot summer days, as well as during the spring, in search for a quieter, greener, cooler place for the week-end. It is the case of people from the three large towns in the north – Ramnicu-Valcea (along the Olt and the Lotru valleys), Drobeta Turnu-Severin (towards Orsova and the Danube defile), and Targu-Jiu (Sohodol gorges). As accommodation is scarce, most of them do not camp in the mountains, but return home in the evening. The rivers springing from the Carpathians and the foothills of the mountains could attract tourist from the southern counties as well, since the landscape in Dolj and Olt is rather dull, being dominated by plains and low hills, if there were places to stay for the night. The camping sites should be well organized, with fireplaces and garbage disposal points.

4.2 Educational tourism

The educational tourism includes all the touristic activities the purpose of which is the education, particularly of the young generation (pupils or students). In this respect, the local authorities should largely promote some of the main attraction points, emphasizing the uniqueness or specificity of the county: the sarsen stones at Costesti, the Land Pyramids at Slatioara and Valea Stancioului and the paleonthological reserve at Golesti in Valcea county; the Jales karst spring, Corcoaiei and Sohodol gorges, fossil places in Gorj county or Ponoare complex in Mehedinti county.

5 CONCLUSIONS

The relief, due to different geology and variety of landscapes, attracts many categories of tourists, with different interests and needs; thus, the touristic activities must include more objectives and sightseeing points. From the touristic point of view, any region, regardless of the natural background potential and beautiful scenery, is important only when there is an appropriate technical endowment, which allows it to be integrated in the touristic circuit. Only then the natural and man-made resources may be properly capitalized.

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The impact of tourism activities on rural space in Romania

Liliana Guran-Nica, Narcizia Ştefan

Spiru Haret University, Bucharest, Romania

Abstract: *After a long transition period, characterised by important difficulties, Romania experienced, in the last several years, a true economic progress. However, this advance was significantly reduced because of the Global Economic Crisis. In these conditions, the Romanian rural space was and continues to be the most affected as agriculture is its main activity, and consequently it does not have enough resources to overcome the crisis. A possible answer to these problems that have already been discussed at the political level is the development of tourism and agrotourism activities. A good example is Rucăr-Bran Passage placed in the Southern Carpatians, where the phenomenon took a special turn in the last decades.*

Key words*: tourism, agrotourism, rural space, Romania*

1. THE CHARACTERISTICS OF ROMANIAN RURAL TOURISM

Romania is a south-eastern European country that, like other states in the region, has known an intense process of political and socio-economic change after 1989, a unique process through its peculiar complexity and long time extent. In the decade following the historical events of 1989, the economy experienced a downfall followed by a relatively slow recovery that affected the Romanian society. In the view of the economic analysts, following a 3 years downfall (16% per total), in 1999 this country experienced economic recovery, although it was no more than 1.8%. Eventually, “the GDP grew by 2.1 and continued to grow by significant values in the following years, the negative growth from the ’90s not being experienced anymore” [8].

In this less favorable context, the Romanian rural space, dominated by agricultural activities, was strongly affected. An important structural and financial crisis has brought the above mentioned space to a state of deep underdevelopment. Nevertheless, there is hope to revitalize it by implementing special programs to modernize the agricultural activities and develop the tourism ones. Tourism proves to be a viable alternative in a Europe that wishes to protect and sustain the sustainable development of natural and traditional landscapes.

Romanian rural space has an important tourist potential, consisting of diverse natural and anthropic resources. *The attractiveness level* is determined by the existence of unique natural landscapes containing numerous protected areas, the diversity of architectonic and traditional cultural ele-

ments, the presence of tourist resorts, etc. The analysis of their spatial distribution underlines the concentration of the most valuable ones in approximately 20% of the total rural settlements. These are grouped in five large tourist areas of notable importance: the Eastern Carpathians, the Southern Carpathians, the Banat Mountains, the Apuseni Mountains, the Black Sea Littoral an the Danube Delta [4].

Among the numerous types of tourist activities viable for the rural space, agro-tourism proved to be a real chance for the development of the local economy [3]. However, agro-tourism and the socio-economic development of rural settlements are vital to each other [1], The first one influences the environment in which it evolves, leaving a print on the general level of development of the region.

Nevertheless, although rural tourism activities can offer important resources to the individual and communitarian income, in Romania they have not overcome the crisis. The tourism is even now less developed compared to the existing natural and cultural potential.

This situation is confirmed by the state of the accommodation capacity expressed in number beds per commune. The analysis done underlines the fact that most rural settlements (95%) have no accommodation units (huts, pensions, motels, hotels, etc.), excepting some small areas from the Carpathians and the Danube Delta. At the same time, the level of comfort is considered unsatisfactory by tourists willing to spend free-time at the countryside [4].

In the above mentioned areas, the agro-tourism is starting to make up for the lack of other forms of rural tourism, although the experience of the population in this direction is poor and the transport and municipal infrastructure are deficient.

2. BRAN–RUCĂR PASSAGE – A TRADITIONAL SPACE FOR RURAL TOURISM

Bran–Rucăr Passage, placed in the Southern Carpathians, is a very important touristic area. In this space called by Maria Banuş “open gate between Transylvania and Wallachia, a pass for transhumance, a meeting place for Romanians all over the country, where people speak a clear, smooth, plane language as a rock from a mountain river, a language as a nest for the literary one” there is the cradle of the rural tourism. Bran commune, together with the settlements around it, is the place where the development of the Romanian rural tourism started. Lying in the northern opening of the Bran–Rucăr Passage, through which an old commercial and strategic road between Tara Bârsei and Wallachia is passing, this settlement is appreciated for its natural and cultural beauties. A heath resort of local importance at the beginning, developing in a space never touched by the cooperativization process, Bran was an economically prosperous village at the

beginning of the last decade of the XXth century. This was an opportunity to the entire area to highly evolve and to become the national centre of rural, ecologic and cultural tourism, being now one of the most coveted in Romania.

2.1. Physical and socio-economic characteristics

The geographical position of Bran–Rucăr Passage is in the Southern Carpathians. Its highest altitude is in Giuvala Pass (1232 m) on the territory of Fundata commune. From the geomorphological point of view in this geographical unit there are two structural entities. One is the mountainous area characterised by individualised massifs, deeply fractured, dominating the depression by 1000 ms, covered with mixed forests of resinous trees, beech and Quercus species and alpine grasslands. The second structural unit is the depression like passage dominated by levelled surfaces 1000 m high (fig. 1).

The temperate climate, specific to the mountainous depressions, is characterised by cool summers and cold winters, being attractive from the tourism point of view. The annual mean temperature is 5^o C, rising above 25^o in summer and falling below –10^o in winter. Along the passage winds are permanently blowing with a speed of 3–5 m/s.

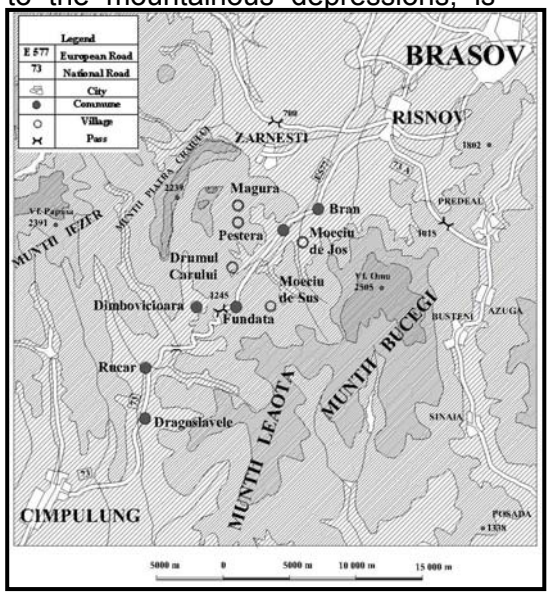

Fig. 1: Bran-Rucăr Passage – geo-

The hydrographic network is well developed and consists of two main rivers: Bârsa in the northern sector and Dâmbovița in the southern one.

The Bran–Rucăr Passage is crossed by DN 73, this road being connected in the north to E 60, one of the most important national highways that link Bucharest, the capital of the country, with Western Europe. In the south the road goes to Râşnov and than to Piteşti, another strategic transport node. This network offers the studied area a good accessibility to the two main regions of Romania, Transylvania and Muntenia and, further more, to the two extremities of Europe, the western and the south-eastern.

The 12 villages of the Bran touristic zone are spread on the mountain slopes and in the valleys. They are grouped in 3 communes: Bran (5573 inh.), Moeciu (5514 inh) şi Fundata (1000 inh.), occupying the largest part of the passage. Although tourism is the most important for these settlements,

there are other economic activities as commerce, transport, constructions, finance and forestry that contribute to the local budget.

2.2. The tourist potential (natural and cultural)

The natural potential is the result of the combination of various factors as the complex relief forms (high mountains picks and plateaus, abrupt slopes, hilly depressions), fractured by a dense river network, a favourable climate and an abundant vegetation.

Very attractive relief forms are those developed in karst (gorges, dolines, dry valleys, polje, caves) as Moeciu Cave and Waterfalls, Brusturet Gorges, Dâmbovicioara Gorges, Bats Cave, Bears Cave, and many others placed in Piatra Craiului National Park and Bucegi National Park. The mild climate, the pure air, the atmospheric calm, the fresh water and the forest are also important for the tourist activity. On the mountain picks of Bucegi and Piatra Craiului one can see the chamois (Rupicapra rupicapra), considered a natural monument for Romania, and many other wild animals living in the two national parks. Unique vegetation species live in these mountains Dianthus Callizonus, Leontopodium alpinum and Gentiana lutea being some of them.

The region has also a rich and various cultural potential altogether with a specific hospitality. The most important of all is Bran Castle, lying high up on a big cliff, like an old soldier from immemorial times watching the passage between the two countries, Transylvania and Wallachia. It is an architectonic monument of inestimable historical and cultural value, the origin of the fascinating Dracula legend. Its fame changed it in “the brand” of Romania. At the bottom of the cliff there lies Queen Mary’s hart, the symbol of her deep love for Romania, for Bran and its population. Another historical monument of a great touristic importance is Râşnov’s Peasant Fortress, built up in the XIV-th century, being illustrative for the medieval architecture of Romania.

Fig. 2: Bran Castle

There are also other interesting places that can be visited by the tourists coming in this region: The Ethnographic Museum from Bran and The Custom-house Museum. Among the religious sanctuaries the most attractive is Adormirea Maicii Domnului Church (Assumption of the Virgin), built up in the XIX-th century.

2.3. Development level of the tourism facilities in present

The high potential of Bran-Rucăr Passage sustains all forms of tourism, practiced along the entire year. Not many years ago agriculture was the main economic activity in this region, and especially the animal raising. Touristic unregistered activities were present, too.

This economic branch was officially borne only in 1994, when the old tourist establishments were registered. The tourist profiled rural households were the first homologated in Romania (January 18th, 1996), receiving the specific classifying certificate for rural tourist boarding houses. In the last few years agrotourism has highly developed, and is going to be the main economic activity in the region. This is the result of the general economic development, the population growth, the rise in budget, more free time, the development of transport facilities, infrastructure and telecommunication networks, etc.

In present, a much larger number of households in Bran-Moeciu area is profiled on tourism activities. Compared to 1997 when there were only 69 touristic boarding houses and villas with a total of 376 places[8], "in 2001 the number of the tourist and agrotourist boarding houses in Bran region exceeded 220, being homologated by the Ministry of Tourism and rated one to four daisies" as Marilena Stoian, the President of ANTREC[9] underlines [11]. Until 2007 many other accommodation units were built (383 in the last 3 years only in Moeciu), some rated 5 daisies, each having up to 20 rooms [2]. Among them only 85 were registered in The Tourist Boarding Houses Guide, as many owners tried to elude paying the burdensome taxes imposed by the state.

The majority of the accommodation units are placed in Bran and Moeciu communes. This is the motive for "those who build up boarding houses to avoid Bran, as it is already crowded, many of them do not prefer that, there are jams in weekends", Marilena Stoian says [2].

The number of tourists in Bran region was more than 7.300 in 1997[10], and exceeded 42.000 (5 times more) in 2007, 24.485 Romanians and 17.659 foreigners[11]. The overnight stays grew also from 13.727 in 1997 to 103.732 in 2007[12], tourists preferring more Bran (44.180) and Moeciu (46.683), and less Fundata (2.869). The sojourn average duration diminished in the same period of time from 3.19 days to 2.46 days, meaning either that the tourists are more interest of week-end trips or they prefer external destinations for longer excursions. "The president of ANTREC affirms that during the working days only 10–15% of the total accommodation facili-

[8] Source: Bran – Imex, 2001.
[9] National Agency for Rural, Ecologic and Cultural Tourism
[10] Source: ANTREC, 2001.
[11] Source: INS (Institutul Național de Statistică), 2007.
[12] Source: INS (Institutul Național de Statistică), 2007.

ties are covered, while beginning with Fridays the occupancy level is up to 50%” [11].

3. CONCLUSIONS

The Romanian rural space is struggling with many difficulties even after 20 years of market economy experience. Nevertheless, a hope still exists in tourism. The plenty natural and cultural resources that one can find in the villages are attractive not only for Romanian tourists but also for the foreign ones. Therefore, the experience of some areas fully developed in this direction is inestimable. The Bran-Rucăr Passage is one of them and is offering precious information that encourage the authorities of other rural settlements to use this example for more efficient development programs.

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Analysis of the Threats and Damages from Natural Disasters in the Simitli Municipality

Krasimir Stoyanov

SWU "N. Rilski, Blagoevgrad, Bulgaria

***Abstract**: The aim of this paper is to investigate the space- and time characteristics of the natural risk processes in the Simitli municipality. The risk analysis considers unfavorable events (threats) and their consequences, which are subject to preliminary quantitative and/or qualitative evaluation. Information about the threat frequency (probability) and intensity as well as the size of damages (losses) is available. The municipality is considered as a complex system of interconnected and interdependent elements. The expected losses are directly and/or indirectly connected with life quality deterioration.*

***Keywords:** natural risk processes, threat, frequency, municipality.*

1. INTRODUCTION

The tendency in the last decades is towards increasing influence of natural disasters and technogene damages over living environment and people's quality of life. The natural disaster is a phenomenon and process in the nature that is beyond the control of human beings and is of geophysical, geological, atmospheric or biosphere origin. It is characterized by a sudden disturbance in the vital process of people, damages, destruction of material values and causalities among the population. Typical examples of natural disasters are the volcano eruptions, earthquakes, floods, landslides or avalanches, tropical cyclones and etc. This means, these are natural phenomena and processes that threaten the health, life and activity of people by causing material damages and various unfavorable changes in the environment.

It is possible that one disaster leads to another. A number of processes can generate or cause another types of catastrophic in their character natural disasters.

2. OUTPUT DATA AND METHODS

Natural disasters can be classified according to different indications. One of the most frequently used is the genetic principle. Natural disasters can be caused by three groups of processes and phenomena – predominantly geological ones in the lithosphere (earthquakes, volcanoes, landslides, etc.), meteorological in the atmosphere (hurricanes, hailstorms, snowstorms, dry spells, etc), hydrological in the hydrosphere (floods, tsunamis, mud flows, etc.). [4]. This classification is relative in its character, for

an instance, an earthquake can cause more damages and destructions by after-phenomena like tsunamis. This is illustrated by the earthquake near Sumatra on 26.12.2004.

Other classifying criteria for natural disasters are the disaster’s frequency, range, duration, intensity. Classifications according to form and plan also exist, for an instance, linear, planning, spot, etc. [4].

The notions of *“risk”, “danger”,”vulnerability”, “management of risk”* are used when considering the influences that natural processes have over human activity. These notions are defined in the books [3][4][5][6][7].

The aim of this paper is to investigate *the space- and time characteristics of the natural risk processes in the Simitli municipality* and to determine their intensity and frequency on the territory of the municipality by means of perfecting existing methods also [3].

The main dangerous natural processes on the territory of the municipality are the following (Table 1):

Table 1: List of natural disasters used in method guides

N	Disaster	Basic criteria	Striking factor and consequences
	Geological processes		
1	Earthquakes	Force or intensity – up to Magnitude 12	Soil dislocation, cracks, landslides, fires, destructions, human casualties
2	Landslides, landslips	Mass, speed of flow	Masses of rocks, material losses
3	Mud-rock flows (seli)	Mass, speed of flow	Mud-rock flow, material losses
	Hydrological processes and phenomena		
1	Floods	Increase river levels	Flooded riverside areas, material losses, human casualties
2	Dry spells	High temperatures and low humidity	Agricultural damages, decreased soil fertility, fires
3	Snow flows and glaciations	Over 20 mm rainfall for 12 hours	Snowdrifts – complications in the road
	Meteorological processes and phenomena		
1	Strong wind	Speed over 15m/s	Material losses
2	Tornado phenomena	Speed over 30m/s	Material losses
3	Dust storms	High temperatures, low humidity, dust	Agricultural damages, decreased soil fertility, fires
4	Hailstorms	Size of ice grains, intensity	Agricultural damages
5	Wet snow	Amount and moisture content of snow	Damages over forests, fruit gardens, electro conductive network
6	Fog	Horizontal vision -	Transport, air purity

		below 500 m	
7	Silver thaw	Intensity	Transport, Agriculture
	Fires	Temperature	Thermal impacts, material losses, biosphere and soil damages

Some disasters have ecological effects under favorable conditions and combinations. These effects greatly vary and practically cover all aspects of human's vital activity. Ecological disasters fall into four basic groups according to their character:

- change in the land conditions: soil degradation, erosion, deserting;
- change in the characteristics of air environment – climate, shortage of oxygen, harmful substances, acid rains, break of the ozone layer, etc;
- change in the hydrosphere conditions – pollution of water environment;
- change in the biosphere conditions.

Natural disasters' basic characteristics are given in Table 2.

Table 1: Basic characteristics of natural disasters

N	Disaster	CND (min)	CA	CE
	Geological processes			
1	Earthquakes	10^{-1}-10^{1}	10^{6}- 10^{11}	REG- GLO
2	Landslides, landslips	10^{0} - 10^{3}	10^{3}- 10^{6}	LOC- REG
3	Mud-rock flows (seli)	10^{0} – 10^{1}	10^{3}- 10^{6}	LOC- REG
	Hydrological phenomena and processes			
1	Floods	10^{2} – 10^{4}	10^{4} – 10^{8}	LOC- REG
2	Dry spells	10^{4} – 10^{5}	>10^{8}	REG- GLO
3	Snow flows and glaciations	10^{2} – 10^{4}	10^{6}- 10^{8}	LOC- REG
	Meteorological phenomena and processes			
1	Strong wind	10^{2} – 10^{4}	10^{5}- 10^{8}	LOC- REG
2	Tornado phenomena	10^{0} – 10^{2}	10^{3}- 10^{6}	LOC
3	Dust storms	10^{2} – 10^{4}	10^{6}- 10^{8}	LOC- REG
4	Hailstorms	10^{0} – 10^{1}	10^{3}- 10^{6}	LOC
5	Wet snow	10^{2} – 10^{4}	10^{6}- 10^{8}	LOC- REG
6	Fog	10^{2} – 10^{4}	10^{6}- 10^{7}	LOC- REG
7	Silver thaw	10^{2} – 10^{4}	10^{6}- 10^{8}	LOC- REG
	Fires	10^{1} – 10^{4}	10^{4}- 10^{5}	LOC- REG

CND – continuance of the natural disaster – min;
CA – cover area of the natural disaster – m^2
CE – coverage evaluation – LOC (local) , REG (regional)GLO (global)

Disasters’ intensity is evaluated according to the basic characteristics, the striking factor and the consequences. Parameters of quantity are used for these characteristics. A relative scale from 0 to 10 has been introduced for the level of intensity (0 – insignificant level; 10 – maximum level), as follows: low-intensity disaster – 0-2; middle-intensity – 3-4; high-intensity – 5-7 and catastrophic-intensity – 8-10.

The frequency of event is evaluated on a one-year basis. Basically, it tells the chance a given event occurs. Thus, these two characteristics help evaluating the threat from a given natural disaster as a rating value for the whole socio-economic life and specific business and infrastructural sites in the municipality.

3. DATA AND INFORMATION FOR THE MUNICIPALITY

A great part in the threat evaluation plays the geographic position, the typical climate conditions in the municipality and the overall description of the economy there. They define to a greater extent the chance natural disasters happen and their expected intensity.

The municipality of Simitli lies on 533 km^2 in the north-west part of the Blagoevgrad region. The center of the municipality is the town of Simitli, which extends over the both banks of the Struma River in the foothills of Vlahina Mountain. It is 110 km south-west from the capital Sofia and 14 km from the Regional center Blagoevgrad.

The total number of the population in the municipality as of December, 2005 is 15804.

The lay varies and has significant displacements. The central area is occupied by a part of the Struma valley. Within the boundaries of the municipality fall the Zheleznishko Defile in the north and part of the Kresnensko Defile in the south. The Simitliyska Hollow is formed between them. The eastern wall of the hollow is the low foothills of south-western Rila and northern Pirin (up to 2597 m). It reaches the steep, faulty sides of Vlahina Mountain in the west, and the Krupnishki hills of the Maleshevska Mountain in the south-west.

Morphometric peculiarities of its lay clearly reflect the tectonic structure of the region. The vertical segmentation of the lay varies from 20 m/km^2 to 40 m/km^2 in the lower and flat south part of the Similiyska Hollow and reaches up to 450 m/km^2 at the bottom of the hill from the Krupnishki hills. These sharp differences in the vertical segmentation reflect the faulty tectonics and especially the active Krupnishki fault. The vertical segmentation in the high part of Rila and Vlahina is up to 400-500 m/km^2 and above these levels in Pirin. The horizontal lay segmentation is predominantly due to external earth forces. The significant gradients, shallow soil coverage, denuded slopes and Mediterranean rainfalls all favor the formation of a dense river-valley network. It is 2 – 2.5 km/km^2 within the range of the wall slopes

and decreases to about 2 km/km^2 at the hollow bed. Middle and significant slopes gradients dominate – up to 15 – 20^o and up to 1 -5^o at the hollow bed.

Risk processes. They are connected to the formation of a great number of landslides, predominantly small- and middle-size ones. They are mainly situated at the foothills of the slopes, in the diluvial-prolluvial deposits on the periphery of the Simitliyska kettle. There are several active landslips in the Struma defiles. They mainly influence the road infrastructure.

Geological – tectonic structure and seismic activity. They are distributed by magma, sediment and metamorphic cliffs at different age. The Simitliyska kettle is covered in alluvial, diluvial and proluvial neogenic deposits, where intensive erosion processes are developing. Paleogenic deposits fill the Brezhanska hollow. The wall mountain areas are mainly characterized by Cambrian and pre-Cambrian metamorphic cliffs. Pirin is an exception. Its northern part consists of evenly-grained biotitic Cretaceous granites – (Northern Pirin plutonic). The same cliffs constitute the part of the Kresnensko defile that falls within the range of the municipality.

The region is known for its very high levels of seismic activity. The most active one is the seismic center of Krupnik, which generates earthquakes in the Krupnishki fault, directed south-west and north-east. Around 2000 earthquakes have been localized for the period 1990 – 2003 alone in the region of the seismic center of Krupnik with magnitude between 1.5 and 4.1 [2]. About 65 – 70 of them are felt. On 4th of April, 1904 one of the powerful earthquakes in Europe took place, the epicenter of which was the region of the Kresnensko defile. The magnitude of the shock at 27 past 12 o'clock was registered 7,8. The local seismic activity also influences the movement of the active faults in the region [1]. These seismic activities, together with the instrument-registered low-amplitude seismic activity in the region, are beyond any doubts related to the complicated morpho-tectonic structure in this part of the valley of Sredna Struma River.

According to its climate, the hollow occupies an area with transitional climate, which is harsher in the mountains due to the influence of the altitude and the exposition. The average annual temperature in the hollow is 12,5-13º. The topographic peculiarities are a prerequisite for some unfavorable characteristics of the climate. A low dispersing level of the atmosphere contaminators can be observed at the times when there is no wind and especially if fogs come down.

The sum of the rainfalls in the Simitliyska kettle is 650 – 700 mm(Table 3). A transitional regime is observed in the distribution of the rains – maximum levels in the late spring and summer – May-June and minimal levels in February.

Table 3: Middle month and year sum of the rainfalls [9]

№	Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Sum
1	Suhostrel	65,3	60,9	63,8	61,4	88,2	81,8	59,2	49,0	*47,6*	62,1	77,8	62,0	779,1
2	Krupnik	66,4	58,5	47,9	50,9	64,2	62,2	51,1	*32,4*	35,4	52,2	69,8	60,8	651,8
3	Gradevo	67,2	55,5	53,6	63,0	80,2	74,9	52,4	*44,2*	50,0	57,9	86,5	70,3	755,7
4	Predela	75,4	61,8	59,1	62,9	92,7	78,3	57,0	*44,2*	54,8	74,9	82,2	84,9	828,2

The possible upper rainfalls for a twenty-four-hour period and a month are an important characteristic. This index places the region under the average level for the country. The great slopes, unstable rocky substrate, lack of flora are all prerequisites for formation of mud-rock flows. Such can be observed at the Zheleznishko defile and at other place, as well. Dry spells are possible in August and September.

The snow cover does not stay for long. There are no snowstorms and snow drifts. North-western winds dominate in the region. They are low-speeded.

Water resources. The waters on the territory of the municipality of Simitli flow into the Struma River. Left flows from Rila and Pirin are the rivers Brezhanska, Senokoska and Gradevska, and right flows from Vlahina and Maleshevska mountains are the rivers Stara, Sushichka, Potoka, Breznishka.

Soils. The dominant soils are the maroon forest skeleton ones, which are mainly strongly eroded. Alluvial soils have developed in the Simitliyska hollow.

Vegetation. The significantly denuded from forests lands in the low-mountain belt increase the erosion of the soil.

There are 18 towns and villages altogether on the territory of the municipality.

Infrastructure. Transportation system. The international transportation corridor No. 4 Vidin – Sofia – Kulata crosses the municipality and renders a road connection with Greece and Romania.

A railway directing north – south crosses the municipality and within its boundaries serves the town of Simitli and the village of Cherniche.

The municipality of Simitli is bordered on the west by the Republic of Macedonia, but they are not connected by a functioning direct transportation network.

Two of the most important roads in the South Bulgaria cross the territory of the municipality. Road I-1 (E-79) Vidin – Sofia – Kulata is a part of the Trans-European international transport corridor (MTK) No. 4 – Vidin/Lom – Sofia – Blagoevgrad – Kulata – Thessalonica. This direction is the shortest distance between the harbors of Vidin and Lom on the Danube River and the harbor of Thessalonica in Greece. The section of the road that goes through the municipality is 28 km long and runs along the riverside of Struma River.

Another road of strategic significance for the municipality is Road II-19 Simitli – Razlog – G. Delchev – Koprivlen – Border Checkpoint Ilinden. It makes the connection with the others municipalities in the Region of Blagoevgrad, which lie along the riverside of Mesta River. The section of Road II-19 that goes through the municipality is 22 km long. The roads that connect the other towns and villages in the municipality, apart from the enumerated ones, are IV class and municipal ones. 33,5 km of them are in good condition and 33,4 km – in bad [10].

The territory of the Simitli municipality is crossed by a main railway V (CE-855) Sofia – Kulata. There are two active railway stations – Simitli and Cherniche, which are used by passengers and for loading.

Thirty-nine water sources are exploited on the territory of the municipality – 35 drainages and catchment, 2 river water-intakes and 2 shaft wells [10].

The municipality of Simitli is supplied with electricity by SS "Simitli" 110/20 sq 2 x 25 sq through WEP by SS 110/20 sq "Blagoevgrad", "Razlog" and "Sandanski". The total length of the distributing network is 25 km overhead and covers 14 towns and villages [10].

The transnational gas pipeline for Greece crosses the territory of the municipality.

4. RESULTS AND DISCUSSION

On the grounds of the two basic criteria for evaluation of natural disasters a table, which reflects the intensity and frequency of natural disasters on the territory of the municipality of Simitli, was made (Table 4). The threats caused by earthquakes are of primary significance. They are of regional and global character and represent a serious danger to the neighbor municipalities and partly to southwestern Bulgaria and east Macedonia. One of the most active earthquake epicenters are 20 km far away from Blagoevgrad. The earthquake force on such a distance is only 1-2 levels lower than this in its epicenter (on MSK6).

The highly indented topography, unstable rock basis, denuded of forests areas and earthquake shocks predefine the great threat of landslides and landslips in the municipality. They seriously endanger the roads, including the main ones - E-79 in the region of the defiles and Road II-19 from the village of Gradevo to Predel.

Mud-rock flows are typical phenomena for the municipality, which are due either to the abovementioned reasons or rare, but intensive rainfalls.

Other natural processes that carry a risk for the municipality are the floods. Almost all of the towns and villages are located near rivers, which more or less makes them vulnerable to floods. Particularly dangerous are rivers with denuded catchments and big inclines, which have developed at weathered and easily-crumbling cliffs. In this case high waters are com-

bined with flow of ample rock material and thus they become mud-rock flows. In this regard, the villages of Zheleznitsa, Polena, Sushitsa, Cherniche and Dolno Osenovo are the most endangered ones.

The rest of the natural processes and phenomena (Table 4) are less intense and frequent.

What also matters is the vulnerability of the technical infrastructure to natural disasters. A number of critical sectors are not presented in the municipality of Simitli, for an instance, nuclear power engineering, aero-cosmic industry, facilities for scientific researches.

Critical objects are those of the road infrastructure, the gas pipeline for Greece and the mining companies, where exploding substances are used.

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10. Simitli – Municipal Development Plan 2007-2013.

Table 4. Intensity and frequency of natural disasters in the municipality of Simitli

N	Classification of Disasters	Disaster intensity											
		Low intensity			Middle intensity			High intensity			Catastrophic intensity		
		Probable cause	Consequences	frequency per year	Probable cause	Consequences	frequency per year	Probable cause	Consequences	frequency per year	Probable cause	Consequences	frequency per year
	Natural disasters												
	Disaster intensity		0=2			3=4			5=7			8=10	
	Geological processes												
1	Earthquakes		4th -5th degree on EMS98 scale, felt by people in and out of buildings	$>10^{0}$		6th - 7th degree on EMS98 scale, light objects fall, cracks on the walls of buildings, slightly damaged chimneys	10^{-1}		8th - 9th degree on EMS98 scale, chimneys fall, wide cracks on the buildings, some of them are partially demolished, supports and pillars are twisting	$5x10^{-1}$		10th - 12th degree on EMS98 scale, massive buildings collapsed, cracks on the earth surface	10^{-2}
2	Landslides and landslips	up to 30mm rainfalls, weathering and denudation	Area: up to 10^{2} m^{2}, covering grounds without infrastructures and buildings	$>10^{1}$	Rainfalls: 30-50 mm	Area: up to 10^{2} m^{2}, covering grounds together with infrastructures and buildings	10^{0}-10^{1}	Rainfalls: 50-100 mm	Area: 10^{3}-10^{6} m^{2}, covers roads and buildings (no destructions)	$5x10^{-1}$-10^{0}	Rainfalls: over 100 -120 mm	Area: over 10^{6} m^{2}, great damages on the infrastructure, demolished buildings	$>5x10^{-2}$
3	Mud-rock flows (seli)	up to 30mm rainfalls, weathering and denudation	Area: up to 10^{3} m^{2}, covering grounds without infrastructures and buildings	$>10^{1}$	Rainfalls: 30-50 mm	Area: up to 10^{3} m^{2}, covering grounds together with infrastructures and buildings	10^{0}-10^{1}	Rainfalls: 50-100 mm	Area:10^{3}-10^{6} m^{2}, covers roads and buildings (no destructions)	$5x10^{-1}$-10^{0}	Rainfalls: over 100 -120 mm	Area: over 10^{6} m^{2}, great damages on the infrastructure, demolished buildings	$>5x10^{-2}$
	Hyrdological processes and phenomena												
1	Floods	30-50 mm rainfall intensity according to the season, snowmelting	Flood of Struma around the flooding terrace and the flows at their mouth	$>10^{0}$	Rainfalls of about 50-100 mm intensity	Flood of Struma around the flooding terrace and the flows mainly at the exit, in the hollow - Potoka River and Sushitsa River at the village of Polena, Stara reka	$5x10^{-1}$ - 10^{0}	Rainfalls of about 100 - 150 mm intensity	Flood of Struma River, the flows Potoka and Sushitsa at the village of Polena, Stara reka River at Zheleznitsa, gullies in the defiles. Flood in the villages of Polena, Chernichе, Sushitsa, Zheleznitsa	$2x10^{-1}$	Rainfalls of about 100-150mm intensity	Flood of Struma and its flows, in combination with mud-rock flows at the periphery and in the defiles	$>5x10^{-2}$
2	Dry spells	Temeperature above 25 degrees, 3 weeks of no rainfalls	up to 30% loss of autumn crops	$>10^{0}$	Temperature: over 30 degrees, six weeks of no rainfalls	up to 50% loss of autumn crops	10^{-1}-10^{0}	18 weeks of no rainfalls	up to100% loss of autumn crops	$2x10^{-2}$ - $5x10^{-2}$	No favorable conditions		
3	Snow flows and glaciations	2 weeks of temperatures below the zero and 20 cm snow cover	difficult transport connections	$>10^{0}$	2 weeks of temperatures below 10 degrees and up to 40 cm snow cover	troubled transport, power and water breakdowns	10^{-1}-10^{0}	No favorable conditions			No favorable conditions		
	Meteorological processes and												
1	Strong wind (avergae speed for 2 min.)	Speed: 15-24m/s	broken windows, isolated light injuries of people caused by falling objects	$>10^{0}$	Speed: 24-29m/s	damaged buildings, falling chimneys and boughs, injuries of people caused by falling objects	10^{-1}.	Speed: over 30 m/s	brings down light buildings, rips off roofs, uproots trees	$2x10^{-2}$ - $5x10^{-2}$	No favorable conditions		
2	Tornado phenomena	No favorable conditions											

N	Classification of Disasters	Disaster intensity											
		Low intensity			Middle intensity			High intensity			Catastrophic intensity		
		Probable cause	Consequences	frequency per year	Probable cause	Consequences	frequency per year	Probable cause	Consequences	frequency per year	Probable cause	Consequences	frequency per year
3	Dust storms	wind: 11-15 m/s, Vision: below 1000 m, Duration: over 3 hours	crops damages, erosion	$>10^{0}$	over 15 m/s wind, Vision: below 1000 m, Duration: over 12 hours	crops damages, erosion	10^{-1}-	No favorable conditions			No favorable conditions		
4	Hailstorms	Diameter: 6-19 mm	20 decares of crops	10^{0}-10^{1}	Diameter: over 20 mm	50 decares of crops and up to 50% damages	10^{-1}-10^{0}	Diameter: over 20 mm	over 1square kilometer and 100 % crop damages, damaged transportation vehicles and building stock	$<10^{-1}$	No favorable conditions		
5	Accumulation of wet snow	10-30 mm	broken tree boughs, bgr broken air communications	$>10^{0}$	over 30 mm	broken big tree boughs, cut highway transmission lines,	10^{-1}-	No favorable conditions			No favorable conditions		
6	Reduced horizontal vision (fog)	anticyclone and inversion situation during the cold six months	Vision: below 500m, 1-5 days and nights	$>10^{0}$	anticyclone and inversion situation during the cold six months	Vision: below 50 m, over 5 days and nights	10^{-1}-	No favorable conditions			No favorable conditions		
7	Silver thaw		difficult automobile transportation, broken tree boughs, broken air communications	$<10^{0}$		Unabled movement of transport vehicles	10^{-1}-	No favorable conditions			No favorable conditions		
	Fires												
1	from intentional actions and non-intentional actions of the human factor	the villages and the area around them	local fire	$>10^{0}$	the villages and the area around them	the fire covers over над $1km^{2}$	10^{-1}-	No favorable conditions			No favorable conditions		
		Main roads E79 and Simitli - Predela	local fire	$>10^{0}$	Main roads E79 and Simitli - Predela	the fire covers over над $1km^{2}$	10^{-1}-	No favorable conditions			No favorable conditions		
		path of the gas pipeline for Greece	fire in one room	$<10^{-1}$	No favorable conditions			No favorable conditions			No favorable conditions		
		mining companies	fire in one room	$<10^{-1}$	No favorable conditions			No favorable conditions			No favorable conditions		

About some anomalies in precipitation regime in Bulgaria

Ivan Drenovski, Krasimir Stoyanov

SWU "Neofit Rilski", Blagoevgrad, Bulgaria

***Abstract**: An attempt for analysis on the precipitation regime in the part of territory of Bulgaria in last 14 years is made. As a base a data published in monthly hydro-meteorological bulletins from 1995 till now are used. Some anomalies in annual trade of precipitation are revealed. Some suggestions about their causes are expressed.*

***Keywords:** Precipitations, Anomalies, September, Period of 14 years.*

1. INITIAL DATA

Data about month's precipitations for 16 stations in Bulgaria for the period of 14 years (1995-2008) are used. Most of them (for 14 stations) are gathered from national month's hydro-meteorological bulletins[3]. For 2 stations data are obtained through internet. Unfortunately there are no more available and reliable comparative data for other stations in Bulgaria. The entire period of published data in national month's hydro-meteorological bulletins cover 17 years – from 1992 to 2008. But the first three years (1992, 1993, 1994) are omitted in analysis, because they are abnormally dry. According [6][7] these three years are ones of driest from the beginning of meteorological observation in Bulgaria. The probability of occurrence of two contiguous extremely dry years as 1993 and 1994 is estimated to 0.1%.

2. REGIME OF PRECIPITATIONS IN BULGARIA

All climatologists, dealing with annual distribution of precipitation in Bulgaria [1],[4],[5],[6],[7] record that two main regime types are observed. First of them is called tempered-continental with maximum in May-June and minimum in February (rarely in September). The second one – continental-Mediterranean is known by maximum in November-December (rarely in January) and minimum in August (rarely in September). Considerable part of Bulgarian territory has transitional regime with two maximums and two minimums. The main maximum and minimum are respectively in May-June and August-September and the secondary ones – in November-December and February-March [4].

3. RESULTS

Some different and considerable changes occurred in precipitation regime in the most of examined stations.

1. In all 16 stations amazingly big increase of rainfall in September is observed (Tab. 1).

Tab. 1: Absolute and relative increase of September rainfalls for 1995-2008 period in comparison with 1931-1985 period

Station	Precipitation in mm 1931-1985	Precipitation in mm 1995-2008	Increase of September rainfalls		Change of annual rainfalls (%)
			mm	(%)	
Varna	28.0	77.1	49.1	175.4	+ 0.8
Dobrich	32.0 (1	83.0	51	159.4	+ 8.8
Razgrad	33.0	77.6	44.6	135.2	
Sliven	32.0	74.6	42.6	133.1	- 8.2
Russe	37.0	84.6	47.6	128.6	+ 6.3
V.Tarnovo	41.0	89.5	48.5	118.3	+ 0.7
Blagoevgrad	26.4 (2	54.9	28.5	108.0	+ 20.5
Pleven	38.0	70.8	32.8	86.3	+1.8
Vidin	36.0	66.0	30	83.3	- 4.8
Kardzhali	32.0	54.8	22.8	71.3	- 11.2
Burgas	36.0	59.5	23.6	65.3	+ 1.0
Plovdiv	35.0	54.3	19.3	55.1	- 2.2
Sandanski	30.0	45.2	15.2	50.7	- 7.3
Vratsa	59.0	85.2	26.2	44.4	- 5.8
Sofia	44.0	63.3	19.3	43.9	- 1.4
Kyustendil	38.0	49.9	11.9	31.3	- 10.2

(1 The data are for 1916-1955 period
(2 The data are for 1946-1981 period

The most considerable increase of September precipitations, between 2,2 and 2,75 times, is observed in six station located mainly in eastern and northeastern part of the country. Absolute values of rainfalls growth is between 43 and 51 mm.

In the central and western part of Northern Bulgaria, as in the Blagoevgrad the increase is from 83 to 108%. In absolute values growth 28-33 mm is recorded. In these stations (excluding Pleven and Blagoevgrad) the annual rainfall maximum is moved in September (Fig.1). To this group of sta-

tions should be included Vratsa station with more than 26 mm absolute growth. The relative increase in this case is deceitful small, due to the very high background value of September rainfalls – 59 mm.

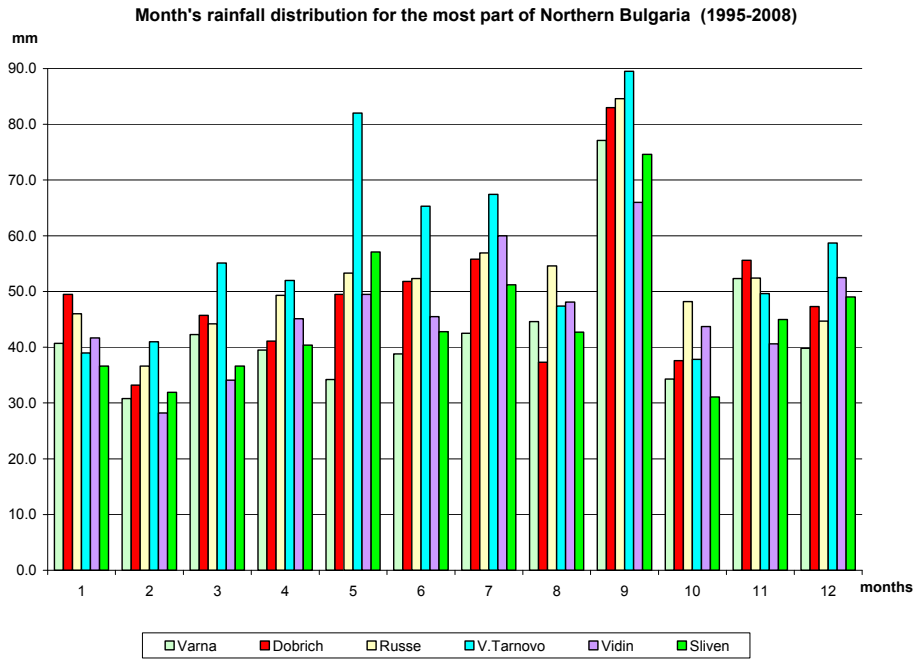

Fig. 1: Month's rainfall distribution for the most part of Northern Bulgaria (1995-2008)

Least of all is the increase of September precipitations in South Bulgaria – between 31 and 71%. Absolute growth of rainfalls here is from 12 to 23 mm. But in some stations the amount of September rainfalls becomes the second big in the year (Fig.2).

Based on these two diagrams a considerable growth of rainfall in July and August can be revealed too. It regards to some stations in Northern Bulgaria. Relative increase is about 15-25%, but in some cases can reach up to 30%. This increase leads to tendency the sum of precipitation in July to become maximum or the second big in the year in tree stations - Pleven, Vidin, Dobrich. In Russe it is due to the decrease of May and June rainfalls.

2. As just have been mentioned, conversely in some months of the year significant decrease of precipitations take place (Table 2).

Unfortunately it happened mainly when the maximum of rainfalls to the specific climate zone in Bulgaria supposed to be. In continental-Mediterranean zone in South Bulgaria these are the months from November to January.

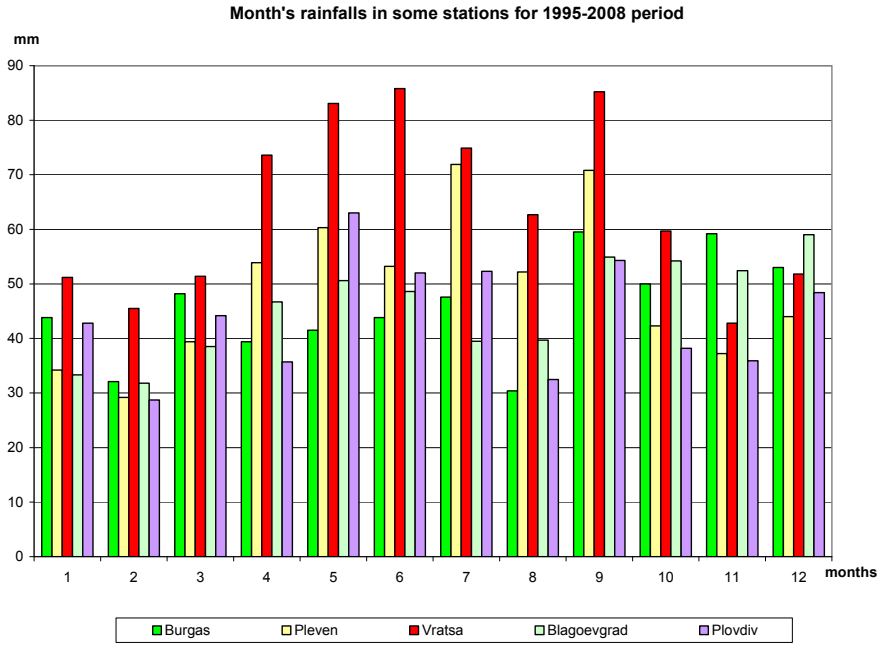

Fig. 2: Month’s rainfall in some stations for 1995-2008 period

Tab. 2: Relatively decrease (in %) of precipitations in chosen months for 1995-2008 period

Station/ months	January	April	May	June	November
Kurdzhali	29.7	20.5		46.4	15.8
Sandanski	22.9	12.5	15.6		34.2
Kyustendil	27.3	22.1	18.8		25.0
Sliven		19.2	14.8	35.2	26.3
Burgas		10.5	13.5	21.8	
Vidin		11.5	21.0	34.1	27.5
Vratsa			25.8	20.1	
Pleven				34.3	
V. Tarnovo	18.7	17.5		24.1	
Russe				34.6	
Varna			18.6	26.8	
Plovdiv		20.7		17.5	

Average value of rainfall reduction in November and January is about 25%. In fact in December in some stations relative increase is recorded, but it can’t balance winter decrease of precipitations. In tempered-continental climate zone the biggest decrease is recorded in June (average 25-30%). If

the decrease in April and May (average 15-20%) would be given in account, a very disturbing reduction of spring rainfalls promises to become. In transitional-continental climate zone both of pointed tendencies are revealed. Cartographic interpretation is done on Fig.3.

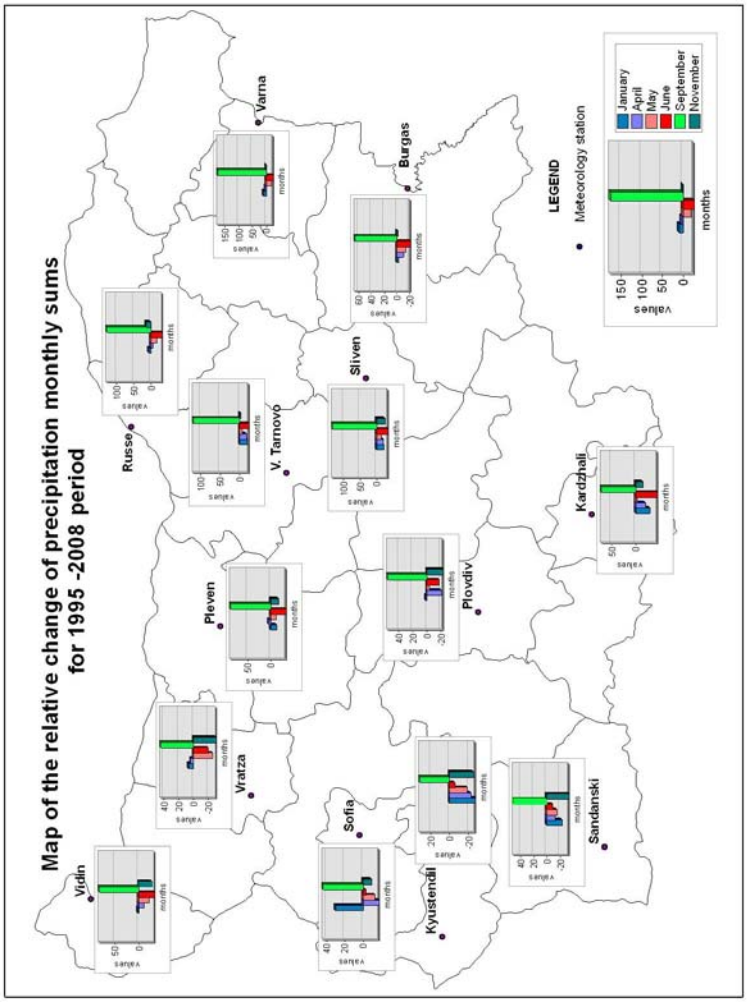

Fig.3. Relative change of precipitation monthly sums for 1995-2008 period

4. COMMENTS

Most likely the main reason for pointed changes in precipitation regime in Bulgaria is connected with changes in atmosphere circulation in our region, as [7] and [4] presume. There is no statistical evidence for increase of

rainfall synoptic situations in September. Years with intense cyclonic activity alternate ones with almost no occasions of cyclones in September. And what is more – the number of passed cyclones is not in a direct ratio to rainfall amount. In some cases in one and only situation in September fallen rain amount can be more than a monthly norm. Typically such situations arise when a movement of Mediterranean depression from south-west is prevented by an anticyclone lying northerly or north-easterly from Bulgaria. Usually such combination is most common in the winter. A numerous other reasons are enumerated in specific paper [2].

As matter to precipitation decrease in November and January, most probably it is related with the reduced number of Mediterranean cyclones in winter, as earlier was observed by [7]. A rainfall reduction in June and May probably may be explained with smaller number of Atlantic depressions in the spring. This assumption need to be proved further.

5. CONCLUSIONS

Taking in account the relatively short period of observation (14 years) no definite conclusions can be done. Very likely all these anomalies in precipitation regime in Bulgaria are associated with global climate change. The question whether is this stable tendency or casual climate fluctuation remains opened.

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Application of Remote Sensing Data to Assess the Big Fire in the Rila Mountain of September 2008

Alexander Gikov[1], Nadejda Nikolova[2]

[1]Space Research Institute – Bulgarian Academy of Sciences, Sofia
e-mail:gikov@space.bas.bg
[2]South-West University"Neofit Rilski", Blagoevgrad, Bulgaria

***Abstract**: The various capabilities of current satellite sensors for observing and mapping of fires are overviewed. RGB combinations with pseudo colours for best visualization of bands are shown. For mapping and area assessment of fire-scar, a KOMPSAT-2 image with 1 m resolution is used. In GIS environment, the fire-scar is delineated. Both plan area and surface area are calculated.*

***Keywords:** Wildfire, Remote sensing, Rila Mountain*

1. INTRODUCTION

Wild fires are a natural element of landscape development and an important part of the successive change of its vegetation cover. Nevertheless, they are considered an extremely adverse event on Bulgarian territory. After 1990, substantial increase of both fire number (Fig. 1) and the area affected by them have been observed.

Since 2000, only on the territory of the *Rila* National Park, several fires have occurred, of which the one with the greatest area (nearly 400 ha) and significance occurred in the region of the Malyovitsa hut in September 2000, while the last great one occurred in the Rila Mountain in the beginning of September 2008.

This last fire started on September 3, 2008, along the southern slope of the Arizmanitsa summit above the *Bodrost* relaxation site. It is believed that it was caused by a lightning. The meteorological circumstances in the end of summer facilitate the easy emerging and propagation of wild fires. Fig.2 shows that, after a brief slight temperature lowering about September 1, during the first half of the month the weather was still characterized by summer daily temperatures. Actually, for more than a month (August 11 – September 14), the weather stayed dry, with almost no precipitation, which increased the risk of fire occurrence and propagation.

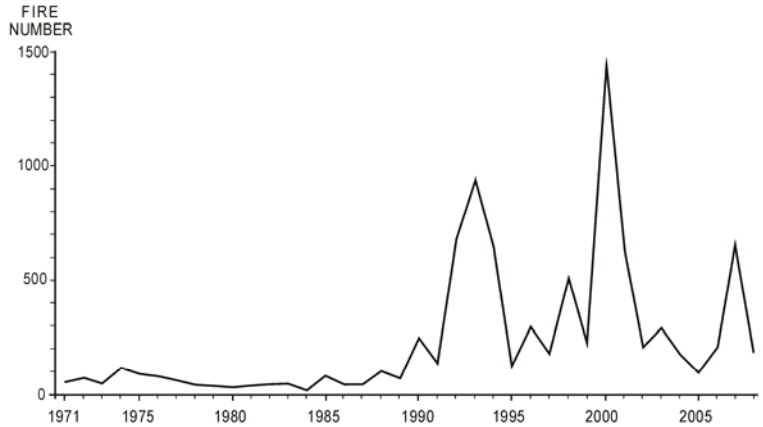

Fig. 1: Wild fires during the period 1971-2008 [12]

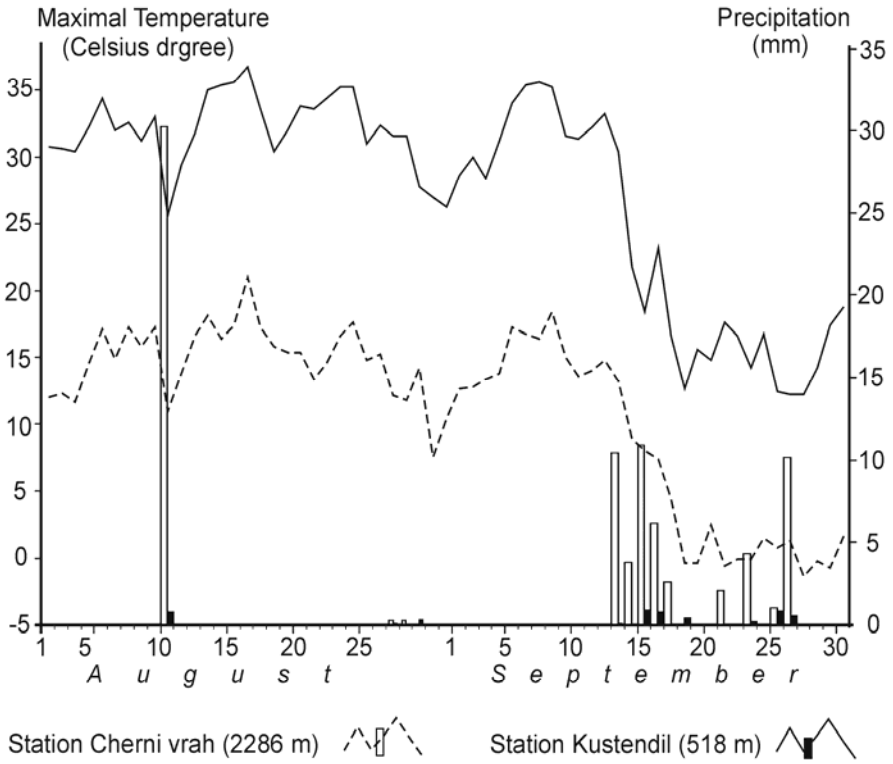

Fig. 2: Maximal temperatures and precipitations for August and September 2008 for the *Cherni Vruh* and *Kustendil* stations [11]

2. SATELLITE INSTRUMENTS FOR FIRE OBSERVATION

Remote sensing methods have been adopted worldwide as a reliable instrument for wild fire identification and assessment of the damages caused thereby. Currently, many sensors are orbiting, featuring various spatial and spectral resolutions. There is a reverse proportional relationship between time and spatial resolution, i.e. the greater the spatial resolution, the smaller the time resolution and vice versa.

2.1. MODIS Data

MODIS (Moderate-resolution Imaging Spectroradiometer) is an instrument launched into orbit by NASA in 1999 on board the Terra Satellite, and in 2002 on board the Aqua satellite. The instruments capture data in 36 spectral bands ranging in wavelength from 0,4 μm to 14,4 μm and at varying spatial resolutions (2 bands at 250 m, 5 bands at 500 m and 29 bands at 1 km). They are designed to provide measurements in large-scale global dynamics including changes in Earth's cloud cover, radiation budget and processes occurring in the oceans, on land, and in the lower atmosphere. The width of swath is 2330 km [9].

MODIS data are used to identify wild fires by accounting for thermal anomalies. There are various web-sites presenting global- and regional-scale wild fire maps. On them, fires are indicated by dots, marking the centre of a pixel sized 1 km. These maps usually cover a time interval of 8-10 days, or a month. One can download freely from the web-site of processed MODIS data [8] the products MYD14 and MYD14A1, which represent classified and georeferenced raster layers in HDF format, where the pixels having the size and value of 7,8 and 9 represent wild fires. The increase of this figure shows increase of fire intensity. Somewhat more detailed images with resolution of 250 m and nearly on-line are accessible on the sub-sites of the MODIS Rapid Response System, whereas nearly the whole territory of Bulgaria in included in the AERONET_Thessaloniki Subsets [10]. On the real- and pseudo-coloured images with resolution of 250 m, fires are distinguished by their smoke trains. The data may be downloaded in GeoTIFF format, which provides for their easy integration into GIS.

During the first 3 days, on account of the cloud cover above Rila, the fire could not be identified on the MODIS images. But, on the real-coloured image acquired by the Terra satellite on September 6, before noon, the fire smoke and the smoke train, directed to south-west, are clearly visible. On the afternoon image acquired by the Aqua satellite, there are clouds over the mountain ridge, but the smoke train is bigger, reaching the valley of the Strouma River. During the next days, the fire could not be identified clearly because of the clouds, except for the scene from September 8, 2008.

The priority use of MODIS data is intended for global monitoring and identification of fire-devastated areas, not for their assessment or mapping.

For the latter two purposes, satellite images with higher spatial resolution are used.

2.2. Landsat data

The Landsat program is the longest running enterprise for acquisition of imagery of Earth from space. The first Landsat satellite was launched in 1972; the most recent, Landsat 7, was launched in 1999 [5]. On May 31, 2003 the Scan Line Corrector (SLC) in the ETM+ instrument failed. Because of this defect, in the end of the received scenes, there were strips with data gap, which prevented both the images visual interpretation, as well as their automatic classification. For this reason, it was resolved to let Landsat data for free downloading on the Internet [6, 7]. Now, even the archive images from the older Landsat missions 1-5 are accessible on the web-sites of USGS Global Visualization Viewer [4] Earth Explorer [2].

The ETM+ sensor has 7 spectral bands, 6 of them with resolution of 30 m, and the seventh, thermal one, with resolution of 60 m. Apart from them, ETM+ also has a panchromatic channel with spatial resolution of 15 m [3] and time resolution of 16 days. The spatial resolution provides to identify several degrees of fire impact on the Landsat images.

It is a good chance that there is an available cloudless Landsat scene acquired during the fire on September 6, 2008. The bad luck is that it is captured by the damaged Landsat 7 sensor, ETM+. Nevertheless, the fire is clearly visible on it. Using an RGB combination of the bands (3-2-1) in the visible part of the spectrum provides to see the white smoke above the valley of the Blagoevgradska Bistritsa River. Using the terminal channel as a red one, the fifth, infrared channel as a green one, and the third, red channel as a blue one (RGB 6-5-3), a contrast pseudo-coloured image was obtained, on which the smoke’s disguising effect was greatly reduced. Using the thermal channel as a red one allows to see clearly the area (which is shown in bright red) of the fire centers active at the time.

2.3. ASTER VNIR data

ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) is an imaging instrument flying on Terra, a satellite launched in December 1999 as part of NASA's Earth Observing System (EOS). ASTER provides high-resolution images of the Earth in 14 different bands of the electromagnetic spectrum, ranging from visible to thermal infrared spectrum. The ASTER instrument consists of three separate instrument subsystems. Each subsystem operates in a different spectral region and has different spatial resolution. ASTER's three subsystems are: the Visible and Near Infrared (VNIR), the Shortwave Infrared (SWIR), and the Thermal Infrared (TIR). The resolution of images ranges between 15 to 90 meters [1].

To assess the damages and map the burned area, a VNIR image from ASTER with resolution of 15 m was used. It was acquired on October 24,

2008. The change is identified through comparison with an older ASTER scene captured on August 21, 2008. Both VNIR scenes were visualized in RGB combination 3-2-1. On the pseudo coloured image, survived vegetation is shown in red and the fire-scar is grey. This spatial resolution allows separating the areas with survived trees inside the fire-scar. They appear in red color in the pseudo coloured image. If a very high resolution (VHR) image of the fire-scar had not been found, this ASTER image would have been the basic one.

2.4. VHR imagery – KOMPSAT-2 data

KOMPSAT-2 (KOrea Multi-Purpose SATellite-2) is a South Korean very-high-resolution Earth-imaging satellite. It was launched on 28 July 2006. The mean altitude of orbit is 685 km. The sensor has a single PAN spectral band between 500 - 900 nm and 4 spectral bands between 450-900 nm. PAN imaging and MS imaging operate simultaneously during mission operations. The spatial resolution is similar to IKONOS – 1 m of panchromatic band and 4 m of spectral bands [13].

The archive of KOMPSAT imagery has two scenes acquired after the fire. The first one is taken on 6 November and the second on 11 November 2009. We preferred the second scene because the first one has thin snow cover which could embarrass visual interpretation. Using software ENVI 4.6, the following image processing steps were applied:

- Layer stacking of spectral bands.
- Pan-sharpening applying the Gram-Schmidt spectral model.
- Orthorectification using RPC file with GCP (7 points) and DEM with 30 m sell size is made.

For precise orthorectification, 7 points are not quite sufficient, but since the area is mountainous only GCPs in the valleys were available. Because of the low sun elevation, the north-western steep slopes were shaded and some GCPs were not recognizable, which decreased additionally their number.

In GIS environment, the fire-scar was delineated and the area was calculated. The total burned plan area is 117.2 ha. The real surface area is larger because the region is mountainous and part of the fire-scar occupies a steep slope. To calculate the surface area, DEM with cell size of 30 m was used. It is equal to 135.1 ha, i.e. by 13% larger than the plan area.

Fig. 3: Fragment of KOMPSAT-2 image acquired on November 11, 2008, two months after the fire. Burned areas are shown in dark grey. On the B&W image, only the upper fire-scar border is clearly visible. At the top center of the picture, the fire restricting ditch can be seen.

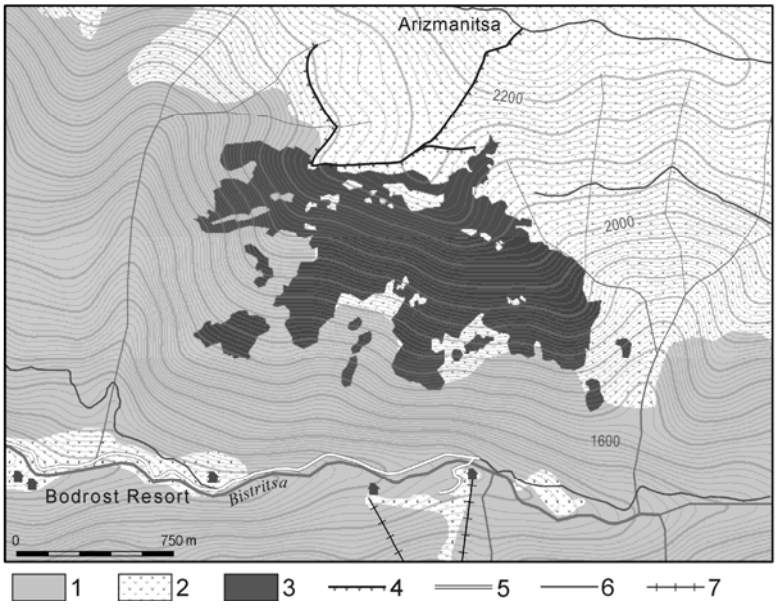

Fig. 4: Burned area delineated on KOMPSAT-2 satellite image

1 forest; 2 grassland; 3 burned area; 4 ditch restricting fire spread; 5 paved road; 6 unpaved road; 7 ski lift

The delineated burned area may differ to some extent from the real one. Where the fire was low, the grass and the bushes were affected, but the canopy remained intact. But it is mainly the tree heads that are pictured on the image. The fact that there are large areas with intact forest is very comforting, giving rise to hope for relatively quick restoration of the forest landscape.

3. CONCLUSION

Thanks to the quick intervention of the employees of the Rila National Park and the Fire Safety Service and especially, thanks to the use of dedicated wild fire extinguishing aircraft, the fire's propagation was restricted and the setting to fire and burning of many trees on the fire-affected slope was prevented. This conclusion is confirmed by the comparison of the ultimate fire-affected area and the active fire centres, outlined by Landsat's thermal band on September 6. During the next days, the fire's area expanded insignificantly to the west, in the direction of the Kartalsko gully.

However, the fire was completely extinguished only after the weather's change in the middle of the September, as seen from climatic data. Accounting for the fact that the damages caused by this fire were smaller than those caused by the great fire of 2000 at the Malyovitsa hut, it may be assumed that if they had used aircraft at the time, the sub-Alpine landscapes would not have suffered such great damages.

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Structure of sectors and branches of agriculture and livestock breeding in the rural areas of Blagoevgrad district

Emilia Patarchanova

SWU ” Neofit Rilski ”, Blagoevgrad, Bulgaria

Abstract: *In the report is outlined the modern sector-sectoral structure of rural Blagoevgrad region, through analysis of some economic indicators. There are strengths and weaknesses, identified are appropriate opportunities and potential threats to their development.*

Keywords: *structure of sectors and branches, rural areas*

1. ANALYSIS OF THE ECONOMIC SECTORS AND BRANCHES IN THE RURAL DISTRICTS

In order to determine the contemporary branch structure of the agricultural economy, analysis has been made according to three indicators: division of the employment in the economic sectors and branches, number of the economic subjects in the economic sectors and branches, and gross production of the economic sectors and branches.

The division of the employment in the economic sectors in the studied theory is 3.1 : 56.2 : 40.8. It differs from the average state of the employment in the country which is 26.7 : 26.5 : 46.9. Extremely low is the number of those who take part in the primary sector – that indicator approximates the one in the most developed countries in Europe. Here, however, it is not a result of a modernly developed agricultural economy the way it is in those countries. Here the hidden employment in that sector is very high and much results from the way in which the land reform is being made. Indeed, it granted land to almost every owner or their heirs but that lead to a great fragmentation of the cultivable land.

The established model of the employment in the district is: main employment in the secondary or in the tertiary sector, while in the “free time” – in the rural economy (the owners work mostly parts of their land, breed one animal or a few birds). The production is being used for personal needs - a small quantity of “everything” is being grown, which means there’s no specialization of the produce and no market orientation of the economy. The landowner and the members of his family engage themselves in this activity but this is being registered nowhere as employment, neither as income. That is why the employment in the primary sector of the agricultural economy is that low (according to personal investigation).

The high share of employees in the secondary sector of the rural economy (twice above the average in the country) is being explained with:

- The lower employment in the primary sector;
- The structural changes of the industry in the district, which took place with less damage than other places, due to the fact that here have been no huge industrial giants.
- The change in the branch structure is not big – except for the machine-building industry;
- This area has never been completely dependent on the agriculture in the economical meaning (even the valley of Sandanski and Petrich), coming from the fact that there have been workshops and small firms in many of the settlements on this territory.

The employment in the tertiary sector in the studied area is lower than the average in the country. Even though the difference is not quite big, it can be accepted that the development of the service sector here lags behind compared with the rest of the country. The lower number of the employees in this sector has another explanation – the hidden unregistered activity in the family firms. This structure of the employment is typical of almost all rural regions in the area. Some exceptions though are determined.

The distribution of the economy subjects (firms) in sectors in the rural regions of the studied territory shows the lowest share of the firms in the primary economy sector and highest in the tertiary one in the area as much as in all rural regions. The share of the firms in the primary sector is in between 1 % and 10 %. Even in Petrich and Sandanski, which have highest producing potential and possibilities for developing in agriculture, the same share is in between 1 % and 1.2 %. The development of the sector in the new market conditions lags behind significantly compared with the others. The reasons for that are complicated. The agricultural sector hasn't yet surmounted the crisis and if the land reform has finished, the structural reform still goes on. The rural economies have no market orientation and work to content personal needs. The landowners have no motivation (the period of 2001 – 2004) to register as subjects of agricultural activity. For many of them farming is an additional but not a general source of income, most often by paying in kind (by products), which makes such registration pointless. The limited share and fragmentariness of the cultivable land also reduce the possibilities of developing modern rural economy.

The subjects in the secondary sector form 20 % – 25 % of the small business establishments in the rural regions. This share is lower in Garmen and Simitly. Garmen is undeveloped rural region with entirely peasant population, more isolated in terms of geography and transportation, which explains the lower industrial development on its territory. The situation with Simitly is different. Here is a solid specialization in the mining industry

(coals), which lasted in the new market conditions, in spite of the reduced production.

The distribution of the business subjects (firms) in the sectors of the economy shows a sharp domination of the tertiary sector (62% - 86%) in all the rural regions unexceptionally**.** It is widely known that to establish a firm and start a business in the service sphere it is financially more favorable rather than in the manufacture industry. In a time of transition and establishment of the private property, when the population still hasn’t accumulated enough capital, but yet there are men willing of enterprise, and the banks, however grant loans reluctantly, firms are being established namely in the tertiary sector. Consequently, the economical conjuncture in the country determines this direction of business development and the rural regions in the studied territory make no difference. It is positive in terms of the tendencies in the economical development of the European rural regions and the policy of the EU for the growth of the tertiary sector and creating a large range of services for their population. The largest is the number of firms in the field of trade and repairs (G) 40 % - 50%, followed by hotels and restaurants (H). In territorial aspect, the number of firms in both fields of economy sharply stands out in the developed rural regions such as Petrich, Sandanski, Gotse Delchev and Razlog. As for transport and communications (I), the territorial concentrations of the firms is salient in Sandanski and Petrich (in number) and in Simitly as a percentage because of the favorable transport and geographical lay. The division of the economic subjects in sectors proves an already started process of economical diversification in the rural regions.

Tab. 1 Sector and branch structure of the rural regions

Rural regions	Branches and sectors of economy
Bansko	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H – Hotels and restaurants 4. A, N – Primary sector; health and social activity
Belitsa	1. D - Manufacture industry 2. A - Primary sector 3. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 4. H, N - Hotels and restaurants; health and social activity
Gotse Delchev	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H, F - Hotels and restaurants; building 4. A, I, N - Primary sector; transport and communication; health and social activity
Garmen	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles,

	personal goods and devices 3. A - Primary sector 4. H, I, N - Hotels and restaurants; transport and communication; health and social activity
Kresna	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H, E, A - Hotels and restaurants; production and distribution of electricity; primary sector 4. F - building
Petrich	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H, I - Hotels and restaurants; transport and communication 4. N, F - Health and social activity; building
Razlog	1. D – Manufacture industry 2. F – Building 3. G - Trade, repairs, technical maintenance of automobiles, personal goods and devices 4. I, N - Transport and communication; health and social activity 5. A - Primary sector
Sandanski	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H - Hotels and restaurants 4. I - Transport and communication 5. N - Health and social activity 6. F - Building
Satovcha	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. A - Primary sector 4. H, F - Hotels and restaurants; building 5. N - Health and social activity
Simitly	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H, I, A - Hotels and restaurants; transport and communication; primary sector
Strumyany	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. F – Building 4. H, N - Hotels and restaurants; health and social activity 5. A - Primary sector
Hadjidimo-	1. D – Manufacture industry

vo	2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. H, F - Hotels and restaurants; building 4. N - Health and social activity; transport and communication
Yako-ruda	1. D – Manufacture industry 2. G – Trade, repairs, technical maintenance of automobiles, personal goods and devices 3. A - Primary sector 4. H, N - Hotels and restaurants; health and social activity

The highest share of the gross production belongs to the manufacture industry (D). This share varies from 50 % in the undeveloped rustic regions like Belitsa and Garmen, to over 80 % in the more developed ones Bansko and Gotse Delchev. The manufacture industry stands lower share in Razlog because of the high percentage share of building and construction in the same sector. Higher than the expected is the share of the manufacture industry in Satovcha and Hadjidimovo. The percentage of the building industry in the gross production is low – 2% - 6% due to the fact that the huge construction sites and commissions are being assigned to firms, registered outside of the studied territory. Razlog is the only exception from this tendency.

According to the share of the primary sector in the gross production of the regions may be concluded the following tendencies: very low share (0.5% - 3.2%) in half of the regions, which once again shows the lack of market - orientated economic subjects, specialized in the growing and breeding particular crops and stock; a lack of integration between agricultural producers and firms from the light and food industry; in other rustic regions this share is slightly higher (4.3% - 10.7%), which is a result from the slower growth of the other branches and sectors of the economy (Garmen, Satovcha, Yakoruda) or from more favorable conditions for agriculture (Petrich); very high share of the primary sector in Belitsa, resulting from the forestry enterprise (two boards) and firms dealing with lumbering due to the limited possibilities for developing other fields of production.

2. SECTOR AND BRANCH STRUCTURE OF THE RURAL REGIONS.

The analysis of the sectors and branches made in the rural regions in the studied area according to the three indicators showed their structure (tab. 1). It is characterized by the following features:

- The manufacture industry is the leading one everywhere. The share of manufacturing dominates in the gross production and employment but lags behind in terms of economic subjects;
- Trade and repairs (G) is on second place in almost every rural region (except for Razlog and Belitsa). It is the leading one ac-

cording to percentage of economic subjects and in some regions – according to gross production as well;

- The primary sector is on third place in the undeveloped rustic regions, which shows a stronger dependency of their economy on it. In other rustic regions on third place is standing a branch of the tertiary sector (most often hotels and restaurants (H);
- In well developed rural regions and those with favorable geographical and transport allocation (Simitly, Hadjidimovo) the fourth place takes a branch such as transport and communications (I);
- The place of the building industry in the structure of the rural regions is not that simple. In Razlog it takes second place, in Gotse Delchev, Strumyany, Hadjidimovo – third place, in a few more rural regions it's on fourth place. There are regions in the structure of which it does not find place due to various reasons. In Bansko, for example, firms which perform building and constructing activity are registered in settlements outside of the studied area and that is why they are not part of the statistics here.

3. SWOT ANALYSIS OF THE RURAL REGIONS IN BLAGOEVGRAD DISTRICT.

The analysis of the demographic resources, the structure of branches and sectors of the economy, of agriculture, of small and medial business and of the infrastructure of the rural regions in Blagoevgrad district allowed to identify the strong and weak characteristics of there regions, along with determining the favorable opportunities and potential obstacles for their development.

Tab. 2 SWOT analysis of the rural regions in Blagoevgrad district

Strengths	rating	Opportunities	rating
- Favorable border biographical position;	9	- Development of external economical relationships with neighboring countries;	9
- Transport objects of national and international importance;	9	- Use of the mineral water potential;	7
- Diversity of nature conditions and resources;	10	- Good ecological characteristics on the territory;	8
- Considerable amount of water resources (underground rivers, lakes, thermal springs);	8	- Improving the level of mechanization in agriculture;	10
- Good demographic potential in most of the rural regions;	9	- Improving the producing process of biological products;	8
- Low level of unem-	9	- Involving new technologies in agriculture and development of multifunctional agriculture;	8
		- Improving the competitive	

ployment and increasing share of employment;		qualities of small and medial firms and agriculture;	8
- Low level of urbanization;	7	- Speeding up of the economical diversification in the rural regions;	9
- Well developed economical sectors: manufacture, building and services;	8	- Development of regional fields in manufacture industry (foods and drinks), textile fabrics and clothing, agriculture, tourism, transport;	8
- Establishment of considerably developed sector of small and medial firms;	9	- Development of telecommunications and making the access to information easier;	8
- Usage of the hydroenergetic resources on the territory;	9	- Establishment and development of free economic zone in tourism;	8
- Considerable experience and tradition in some of the agriculture industries;	8	- Rehabilitation and modernizing of the technical infrastructure;	7
- Produce of new for he territory crops breeding of untraditional animals;	7	- Investments in human resources for professional education improving the level of qualification during lifetime;	8
- Development of diverse forms of tourism (ecological, rural, cultural, spa-tourism)	9	- Wider access to the EU markets for more of the Bulgarian producers;	5
- Basic net of technical infrastructure – roads, water supply, communications, garbage disposal, distribution of electricity;	8	- Closer connections between the local business and the professional schools;	6
- Settlements with good housing capacity;	6	- Increasing the level of attractiveness of rural regions not only for rest and recuperation but for living as well.	10
- Preserved rural communities along with their lifestyle, folklore, traditions, etc;	9		
- Rich cultural and historical heritage (museums, monuments of culture, folklore, architectural sights, festivals, etc.)	10		
Total rating	**141**	**Total rating**	**127**
Weaknesses	**rating**	**Threats**	**rating**
- Significant fragmentariness of the sources of agricultural products and cultivable land;	9	- Widening range of the depopulation process;	10
- Insufficient specialization and market orientation of most of the farms;	10	- Increasing level of illiteracy among the population, especially the roma population;	6
		- Too slight interest for cooperation between farmers;	8

- Small share of cultivable land;	8	- Delay of the technological progress and innovations in the economy;	9
- Small share of firms in agriculture;	8	- Limited number of market orientated farms;	8
- Insufficient share of investments in the economy;	7	- Increase in the percentage of uncultivable land;	7
- Domination of micro–firms in services;	5	- Loss of the competitive advantages due to high cost of labor and land along with increase of the prime cost of agricultural production;	7
- High share of municipal class roads and lower share of the state road net;	6	- Low level of integration between the farming producers and manufacture firms;	10
- Not fully built or old infrastructural systems: water-supply and canalization, illegal dung-hills;	7	- Growing of the internal differences in the regions on the territory.	7
- Deteriorating condition of social infrastructure (dilapidating buildings of health cares and schools, abolishment of schools)	8		
- Low percentage of population with high degrees of education;	8		
Total rating	**76**	**Total rating**	**72**

This SWOT analysis provides information to distinguish two strategies for development of the rural regions in Blagoevgrad district. At first, the main one should be the recovering strategy due to the predominant relation between strong characteristics and obstacles. When putting it into practice, most of the efforts should be towards stopping the influence of external negative factors and taking advantage from usefull internal features. The second stage, due to the good combination between strong characteristics and opportunities, would be concentrating on developing the aggressive strategy which would work for efficient and stable usage of the unique local conditions and resources.

Process of economical diversification of rural areas

Emilia Patarchanova

SWU ” Neofit Rilski ”, Blagoevgrad, Bulgaria

Abstract: *The, defined as a model o contemporary development of rural regions. It is defined by the term **diversification** and reveals itself in the increasing diversity of economical activities in the secondary and thirdly sectors of rural economics. Creation of stable sectors, presented by diverse production activities mark the contemporary socio-economic development of these territories.Present is the place of economical diversification in the politics for development of rural areas in EU and Bulgaria.*

It is analyzing in process of economical diversification in chosen rural areas from the country. In this base is created example model for diversification of rural economic, according to specialties of specific area.

Keywords: *economical diversification, rural areas*

1. MEANING AND BEGINING OF THE PROCESS OF ECONOMIC DIVERSIFICATION IN RURAL REGIONS.

Researchers of European rural regions identify two models in the development of these territories. The first model is related to a policy of subsidizing rural production, the main aim being a growth in its quantity and quality. Investments have been used mainly for the opening of branch companies, moving of firms to rural regions and development of their infrastructure. Some services are also moved from urban to rural regions. As these investments are made from other regions or from abroad this model of development is called exogenic. The second (endogenic) model of development combines rural employment with employment in other spheres – tourism, services, agrobusiness, etc.; it introduces forms of local development, which are less dependent on external funds; it is characterized by a high concentration of specialized small and middle-sized companies. Development of rural regions is focused on the encouragement of local enterprises, increase of the local potential, local initiatives and economical diversification.

The contemporary socio-economic tendencies in rural regions development in EU indicate of the 90`s are:

» Increase of their population with a higher tempo than that of the urban regions;

» Agriculture is an important branch in rural economics, but the weight and importance of non-agricultural activities rise, i.e. a process of economical diversification is carried out;

» Differences in the branch structure of employment between rural and urban regions in European countries are going to decrease;

» A new model of employment emerges, which is shown in the decrease of agricultural employment and increase of servicing employment;

The strong points of rural regions (proximity to nature, quality of living environment, etc.) make them capable of attracting investments and labour power.

The undevelopement of agriculture in an economical sense and according to the number of people employed was identified as a basic tendency in rural regions development. Meanwhile another tendency develops, defined as a model of contemporary development of rural regions. It is defined by the term diversification and reveals itself in the increasing diversity of economical activities in the secondary and thirdly sectors of rural economics. Creation of stable sectors, presented by diverse production activities mark the contemporary socio-economic development of these territories. Diversification is identified by the growth of employment in industry and the servicing sector, which compensate for the decrease of employment in agriculture. The bigger part of rural regions, which have chosen this way of development have registered an increase of their population.

Therefore old conditions are related to traditional development of the agricultural sector, rural experience of farmers and industrial workers. New conditions concern vital values as rural idyllic, natural quality, returning to land and a cheaper way of life, which the “newly come” identify with rural regions. Wishes and expectations of new-comers challenge the rural regions themselves. In these conditions, development of rural regions depends on complicated economical, social and political processes. In all these rural regions, however, a transformation takes place, during which monofunctional enterprises are displaced by new polyfunctional enterprises. They produce and deliver new products and services as protection of local natural land shafts, creation of new high-quality regionally specific products, develop rural tourism and organic farming, reclaim renewable natural resources and aim to develop themselves at new markets. That way a diversification of rural economy is achieved.

2. ECONOMIC DIVERSIFICATION IN THE EU’S POLICY FOR THE DEVELOPMENT OF RURAL REGIONS.

The idea for economic diversification of rural areas is also part of a territorial approach, used in the defining of rural areas.

The territorial approach.

The territorial approach rejects the strong interaction between rural regions and agriculture and focuses on economic diversification of rural regions. According to territorial approach space is divided to territorial units, in which economical activities take place. Every unit includes agricultural, industrial and servicing activities and consists of one or more centers and open space (Saraceno, 1994).

Stimulation of the process of economic diversification can be traced back to the EU transition program period (2000-2006). In the Council Regulation of the Union, one of the main aims of the second base of this policy for the development of rural areas is „Development of secondary and alternative activities, which must secure a workplace, aiming to slow the process of depopulation and strengthening the economic and social situation in these regions” (Council Regulation of the EU 1257/1999).

This is followed by a reformation in the CAP in which it’s main objectives are defined: increasing the competetive qualities of agriculture through restructuring; development of landscaping and natural surroundigs through management of natural resources; raising the standard of life in rural regions and encouraging the diversification of economic activites via actions carried out in farms and other economic subjects in rural regions.

The relative weight of every one of the groups in the planned European Agricultural Guidance and Guarantee Fund (EAGGF) agenda for the period of 2000-2006 (EU-15) is 38% for „competetive quality”, 52% for the „natural surroundigs” and 10% for the precautions aimed at diversifying economic activities in rural areas.

In addition to the rural area development policy the LEADER+ initiative has been active through the community. The areas, on which the program will concentrate are alternative agriculture, rural tourism, ecological protection, culture and renovation of villages, small business initiatives within and outside food production and reinstatement of technical and social infrastructure in rural settlements. The initiative is financed by EAGGF.

During the current program period (2007-2013) the EU has allowed an independent policy on developing rural areas (IPDRA). One of the three main objectives is the development of economic diversification:

1. Increasing the competition in the agricultural and forest sector through funding restructuring (minimum 15% of the country’s budget, selected for rural development).
2. Improvement of natural and rural surroundings through financing land management (minimum 25% of the budget).
3. Diversification of rural economy and life-standard improvement (minimum 15% of the budget).

An independent european agricultural fund has been established for the development of rural areas. This way all funds, allocated for these regions are accumulated in the newly formed fund and are not part of structural funding.

Following the agenda for stable development, CAP and IPDRA work together in order to reach economic, social and ecological solutions in rural regions. They help with the successful integration of rural areas and diversification of their economy. They aid to the solving of problems such as the stable management of natural resources, achieving economical and social unification in these regions, diminishing differences between them, and sustaining equality in their development capabilities.

3. DEFINING (CALCULATING) ECONOMIC DIVERSIFICATION (ED).

Usually you use the number of employees in the three sectors of the economy, quantity of production in the gross produce, division of economic subjects in the economic sectors.

Our proposition is to add another indicator, called index of undertaking activity of the population.

Calculating the undertaking activity can be reached through this equation:

$$K_a = \frac{F}{P} 1000 \quad , \tag{1}$$

whereas: K_a – coeficient of undertaking activity;

F – number of small and medium-sized businesses in the rural region;

P – number of economically active population.

In choosing an indicator we have tried to achieve the following: To have available data via the LAU-I, to simplify its use in the analysis of rural regions, development of small and medium-sized businesses as one of the mechanisms defined for the acomplishment of integrated development of rural regions; creating a signified sector in the small and medium-sized businesses is a key factor in defining it as a market economy; small and medium-sized businesses are very useful for the rural regions, because they have proven their advantages – flexibility in terms of quantity and quality, quick assimilation of new productions, they also achieve economic diversification.

The small and medium-sized businesses analysis, conducted in the rural areas of the Blagoevgrad region shows, that the dispersion of small and middle-sized businesses depends on the size of the rural area, defined by the index of economically active population. The corellation coefficient between the small and medium-sized businesses and the economically active population in rural regions is 0.961. It is close to 1 hence the dependency is strong and proportional. The correlation analysis states, that if the economically active population increases, the number of small and medium-sized businesses is raised as well. The capable active workforce tends to affect the creation of small and medium-sized businesses in a positive way. The determinative coefficient between the small and medium-sized businesses number and the economically active population is 92%, which shows, that the economically active population is a major factor in increasing the number of small and medium-sized businesses. We therefore have a reason to think that the indicator is adequate.

The key reasons to use this indicator are:

- stimulation of endogenic development of rural areas based on local resources. The population is well acquainted with these resources, and it itself is a very important resource;

- New aims in the IPDRA, connected with the LEADER+ initiative, which after 2007 has become one of the main stalwarts of this policy. The goal is to stimulate the active population towards strategic planning and realization of local development, and making important decisions concerning the areas in which they work and live;

- The newly formed businesses are always connected with activity realization which is a product of an important decision. In reaching such a decision people are strongly motivated to succeed in its realization. They often have the necessary education, qualification and experience in the business (personal enquiry);

- The successful realization of a single decision (to start a business) can also have a multiplying effect (new workplaces, manufacturing or new services, new taxes in the municipality, stimulated development of other businesses etc.). The uses in developing initiatives of this sort are connected straight to the undertaker, but also affect the settlement in which the business is situated.

4. REALIZATION POSSIBILITIES FOR BULGARIAN RURAL AREAS (BASED ON RURAL AREAS IN THE BLAGOEVGRAD DISTRICT (TAB.1).

The conducted research of rural areas’ economic sector structure have shown, that there is a process of economic diversification underway in the Blagoevgrad municipal area (Patarchanova, 2007). There rural areas, unlike most others in this country (Agricultural report, 2001) are not entirely economically dependant on agriculture (tab. 2). In the current definitive structure the manufacturing industry is dominant as well as a few branches of the third economic sector (Patarchanova, 2007).

Tab. 1 Model for the economic diversification of rural areas

Economic diversification of rural areas:	
1. Production of food;	*6.* Absorption of renewable natural resources;
2. Reinstating local jobs;	*7.* Production of biological products;
3. Infrastructural development;	*8.* Production of specific regional products;
4. Activies meant for preserving natural resources;	*9.* Development of small and medium-sized businesses in commersial service;
5. Development of rural, agricultural and ecological tourism;	*10.* Guarantee for raw materials for the industry;

Tab. 2 Agriculture firms in Blagoevgrad district performing non-agricultural activities

Type of activity	Number of firms	Percentage of firms in the South-eastern region
Mechanized services	942	51.8
Manufacture of agriculture products	1298	47.7
Manufacture of wood	22	68.8
Rural tourism	34	60
Crafts	17	70.3
Fishing and aquatic cultivating	34	12.3
Producing of electricity	4	33.3
Other activities	179	33

Source: agritultural firms count in Bulgaria in 2003. MSG, Agrostatistics, 2005 and independent calculations.

1. Development of small and medial business.

The correlation analysis of small and medial firms has shown that the establishment of stable sector of small and medial business can't be made without investment in human resources. The policy for development of human resources in the rural regions should be directed towards:

- Development of consulting services in the rural regions.
- Creating closer connections between the professional schools in the rural regions and the local business.
- Encouragement of the enterprising thought and skills through education, establishment of better law and administrative environment for starting business, providing administrative services through internet, consolidation of the technological capacity of small firms; improvement of the access to financial services are important premises for encouraging the people in their ambition to start a business of their own.

To provide possibilities for development of small and medial firms in the rural regions is required also:

o Registration of the firms in the regions where their activity takes place.

o The creating of strategies for development of small and medial firms should be coordinated with the characteristics and specific needs of the particular rural region. They should reflect the views of the locals for the future of the region.

o Capitalizing of the border geographical position of the rural regions. The establishment of free trading zones, common labor markets, realization of investments in the economic activities and infrastructure can stabilize the economical and demographical situation of a significant number of villages.

In the process of economical diversification the manufacture industry is leading. It dominates over the other sectors and branches in terms of gross production and employment and in some rural regions also in terms of economical subjects. Firms in the rural regions are of rather local and rarely regional importance. Many of them before and after the economical reform are small departments and micro-firms in the sphere of manufacture and food industry.

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Hydrological specific of Pirin Mountain

Nelly Hristova

Sofia, Bulgaria

Abstract*: There are some likeness and differences of river regime in Pirin Mountain with other high mountains in Bulgaria (especially Rila Mountain). The likenesses include periods with high water and low water. The differences are finned in the maximum and minimum of flow..*

Keywords: *river regime, high water, low water, maximum of flow, minimum of flow*

1. INTRODUCTION

Hydrological point of view of Pirin Mountain shows two differences with other mountains. The first is the hydrographic structure. The river network is very close-meshed. It includes rivers, which flow away in contrary direction and which are elements of two main rivers in Bulgaria – Struma River and Mesta River. The second special feature is the flow regime – with two periods of high water and two periods of low water.

2. RESULTS, DISCUSSIONS, CONCLUSIONS

2.1. Classification of rivers.

The river network is asymmetric – the tributaries of Struma River are longer and bigger by surface area then tributaries of Mesta River (Table 1). The most rivers with flow to Mesta are small by length (between 10 and 20 km) and watershed (from 20 till 100 km). Only two rivers are middle by this index – Belishka River and Matnitsa River. Exception is Breznishka reka, which is small by length and middle by watershed. The tributaries of Struma River – Vlahina reka and Sandanska Bistritsa are middle, Melnishka reka – small, Pirinska Bistritsa – middle big by this classification (Sarafska, 2000). The reason for this difference is that southwestern, western and northern slopes are longer then northwest and eastern slopes. So, Pirin Mountain is local center of divergence. It's interesting that there haven't a lot of exceptions, which are typical for karst region. Only Melnishka reka doesn't give good correlation with other rivers (Figure 1). This river hasn't constantly flow in its river bad. The coefficient $D = lnF/lnL$ (where F is area of watershed, L is length of the river) is between 1,13 (Bezbozka reka) and 1,57 (Belishka reka). It proves that rivers run on steep slopes.

Tab. 1: Rivers of Pirin Mountain

	River	L (km)	F (km^2)	Classification	
				By length	By watershed
Mesta	Belishka reka	22.6	134.4	middle	middle
	Votrachka	17.8	68.2	small	small
	Bela reka	18.9	80.7	small	small
	Jazo	5.2	5.8	very small	very small
	Iztok	16.5	41.0	small	small
	Glazne	24.6	118.9	middle	middle
	Demjanitsa	13.4	36.9	small	small
	Razdavitsa	12.0	21.0	small	small
	Dobrinishka	20.8	57.0	small	small
	Bezbozka	16.0	23.2	small	small
	Retidze	19.0	44.4	small	small
	Lakenska	13.9	25.2	small	small
	Kmenitsa	17.4	31.4	small	small
	Kostena	15.7	25.2	small	small
	Breznishka (Tufcha)	26.6	122.8	small	middle
	Kornishka	14.4	53.5	small	small
	Nevrokopska	18.5	53.9	small	small
	Matnitsa	31.0	145.8	middle	middle
	Djavolska reka	26.9	133.2	middle	middle
Struma	Vlahinska-Vlahi	27.0	108.0	middle	middle
	Sandanska Bistritsa	33.0	139.0	middle	middle
	Melnishka	30.0	97.0	small	small
	Pirinska Bistritsa	53.0	507	middle big	middle big

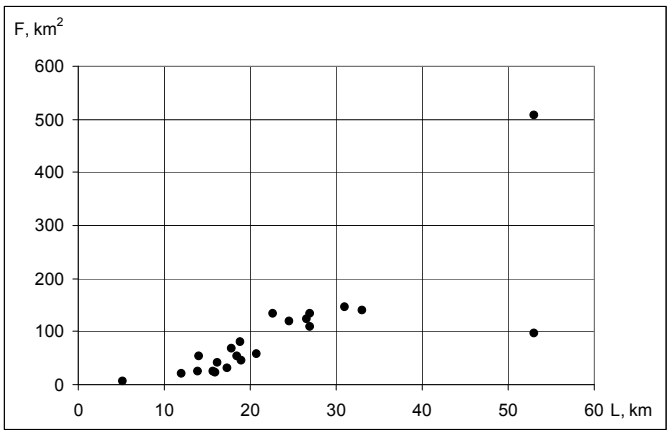


Fig. 1: Classification of rivers by length and area

2.2. Flow regime

The river’s regime was calculated on monthly flow. There are ten gauges for Pirin Mountain, which have got good dates for calculate (Table 2). The

other gauges had functioned for some year (two or three) and that's why they didn't include in this investigate.

Tab. 2: Stream-gauging in Pirin Mountain

River	F (km^2)	H (m)	Period	
			years	n
Belishka reka - Belitsa	63.0	1791	1948/49-1982/83	35
Votrachka - Belitsa	68	1490	1951/52-1982/83	32
Bela reka - Razlog	71,4	1367	1957/58-1982/83	26
Demjanitsa-Bansko	35,7		1953/54-1982/83	30
Iztok - Razlog	55,4	1388	1959/60-1966/67	8
Iztok - Banja	61,0		1968/69-1982/83	15
Breznishka - Breznitsa	39,48	1597	1958/59-1982/83	25
Vlahinska - Vlahi	91,6	1838	1959/60-1982/83	25
Sandanska Bistritsa - Liljanovo	116,6	1838	1950/51-1982/83	33
Pirinska Bistritsa - Spanchevo	131,9	1527	1951/52-1982/83	32

The hydrological year in Bulgaria begins in November. What about for hydrological year in Pirin? All rivers finish water balance in September (Table 3). It is reason to tell that hydrological year in Pirin begins in October. It's very important for analysis of water regime. The comparison between hydrographs proves that (Figure 2).

The hydrographs of river flow show that

All rivers have high water from April till June or just three months (Table 3, Figure 3).The exceptions are Iztok River-Razlog and Demjanitsa River-Bansko. Iztok River-Razlog is under anthropogenic impact. The watershed of Demjanitsa is more then 2000 meters above sea-level and that's why high-water is only two months. The volume of runoff in period with high-water is between 44,9 % (Retige River) and 60,9 % (Belishka reka).

There is a second period with rising flow in Pirin Mountain. It begins in October and includes three (Sandanska Bistritsa River) – five (Vlahinska reka) months. The runoff during in this period is lower then annual flow. It almost the same flow of summer law-water. The second raising of runoff for tributaries of Mesta River begins in October and continues till December (for Bjala reka and Demjanitsa Rive) or till January (for Belishka reka and Votrachka reka) (Figure 3). It's longer for tributaries of Struma River, especially for Vlahinska River and Pirinska Bistritsa River (Figure 4). During winter high-water appear the second monthly maximum of flow, but it shows up for Votrachka reka, Demjanitsa River and Sandanska Bistritsa River.

The period of law-water begins July and finish September. Then appear the first minimum of flow, which is in September for all rivers. Exceptions are Bela reka and Demjanitsa River (Table 3, Figure 3 and 4). The second period with law-water is very short – one month (February) or two months (February – March). It is three months (January – March) for Demjanitsa River

and Bjala reka. In February appears the first monthly minimum of runoff for these rivers (Table 3, Figure 3 and 4).

Tab. 3: Monthly distribution (%) of river flow in Pirin Mountain

River	months											
	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X
Belishka reka-Belitsa	5,1	5,3	4,7	3,3	4,2	13,2	29,3	18,4	6,8	3,0	2,8	3,9
Votrachka-Belitsa	5.0	5,7	4,5	4,2	6,4	16,4	28	15,5	6.0	2,6	2,3	3,4
Iztok-Razlog	8,3	10,2	8,5	8,5	10,5	7,3	9,1	11,5	8,4	5,9	5,7	6,0
Iztok-Banja	5,1	5,8	6,2	7	9,5	12,0	19,0	13,7	6,4	3,6	4,3	7,0
Bela reka-Razlog	4,9	3,5	2,4	1,7	1,7	4,9	24,7	29,3	13,3	5,7	3,8	4,1
Dem-janitsa-Bansko	6,3	3,4	2,6	2,2	2,4	7,3	26,8	26,1	9,9	4,4	3,9	4,7
Breznishka -Breznitsa	6,0	6,7	7,1	6,5	6,5	10,3	21,8	16,8	8,3	3,7	2,8	3,5
Vlahinska-Vlahi	7,1	7,5	7,7	7,5	6,6	9,3	22,5	17,1	5,2	2,4	2,5	4,6
Sandanska Bistritsa-Liljanovo	6,7	4,9	4,6	4,4	4,9	7,9	22.0	20,9	9,2	5,5	4,3	4,7
Pirinska Bistritsa - Spanchevo	6,1	6,2	5,9	6,2	7,3	12,8	18,5	17,2	8,1	5,3	4,7	5,1

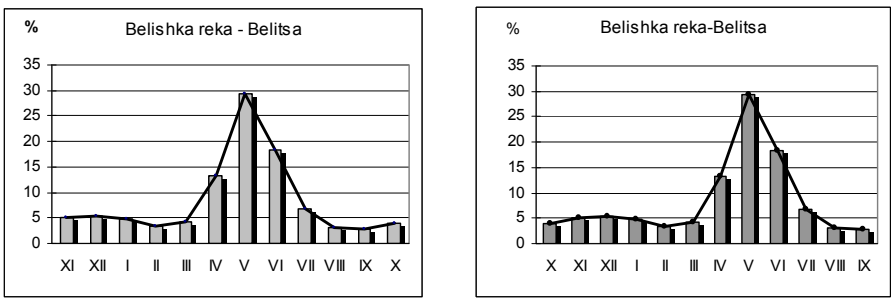
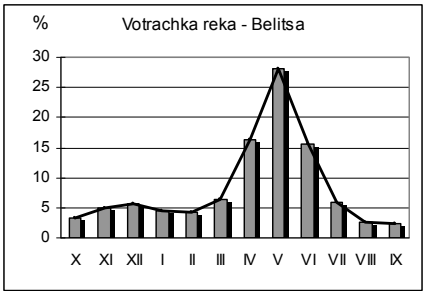


Fig. 2: Comparison between hydrographs of Belishka reka-Belitsa for different beginning of hydrological year



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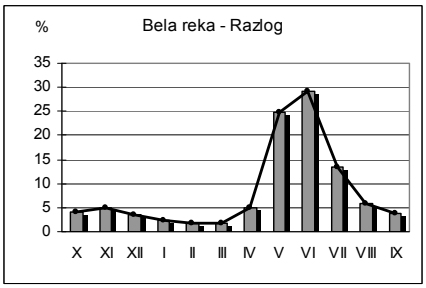

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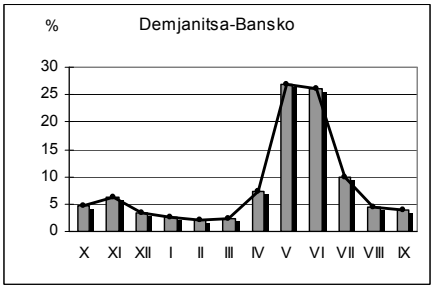

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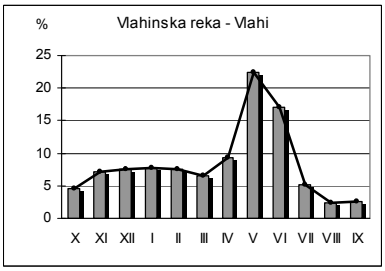
Fig. 3: Flow regime of the rivers from Mesta River network



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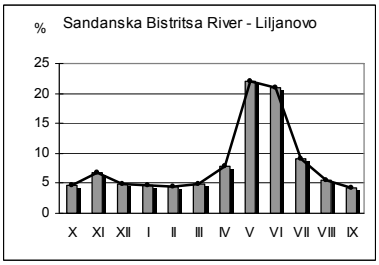

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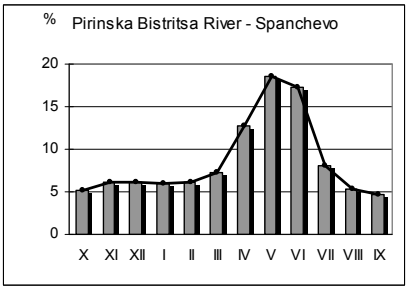

c)

Fig. 4: Flow regime of the rivers from Mesta river network

The hydrological specific of Pirin Mountain is determined by climate, lakes and karst. There is big deference between alpines zones and lower

courses of river in the watersheds by these futures. Glazne River (flowing under this name after the spot where Banderishka and Demjanitsa River merge their waters), Retize River and Vlahinska River start at the lakes. Bela Reka and Iztok collect the greater part of the underground waters of the karst ridge. All rivers gather their waters from snow in the alpine zones and from precipitations in lower part of watershed. That’s\s why their regime is similar and different in the same time.

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An Approach for a Complex Assessment of the Geo-ecological Risk from Natural Disasters in a Geographic Region

[1]Plamena Zlateva, [2]Krasimir Stoyanov

[1]Institute of control and system research – BAS, Sofia, Bulgaria,
[2]SWU "N. Rilski, Blagoevgrad, Bulgaria

***Abstract**:The paper proposes an approach for a complex assessment of the geo-ecological risk of a certain geographic region on the basis of quantitative and qualitative datum about the potential natural disasters. A fuzzy logic model is designed. The type of the threats, consequences and interdependencies between infrastructure objects are taken into account. The geographic region is considered as a complex system of interconnected and mutually influencing elements. The expected damages are directly and/or indirectly connected with life quality deterioration.*

***Keywords:** Risk, Geo-ecological risk, Damages, Threats, Vulnerabilities, Natural disasters*

INTRODUCTION

The analysis and assessment of the geo-ecological risk from natural disasters in a particular geographic region could bring to the avoiding or reduction of the consequences from the negative impact of different threat types [2].

The risk is an expected damage from the occurrence of a particular dangerous phenomenon (event or process) due to its intensity, time and place, as well as in correspondence with the vulnerability level of that place [1].

The geo-ecological risk for a given geographic region is bound to the possibility of oversetting its normal condition (damage, annihilation, disrupted functioning, capacity reduction, etc.) due to the occurrence of critical natural disasters.

In this paper, the complex assessment of the geo-ecological risk is taken as an integral measure for the level of negative impact of the natural disasters over the geographic region. Because of that the assessment of the geo-ecological risk is presented as a functional relationship between "Damages" and "Probability".

The damages, that are related to the geo-ecological risk, depend on the vulnerability level of the geographic region and the threat strength, predetermined by the intensity of the natural disaster, i.e. Damages=F(Vulnerability, Threat).

The vulnerability reflects the natural capacity of the given geographic region to withstand any natural disaster.

The threat reflects the potential danger for a possible occurrence of a natural disaster with a given intensity.

The threat occurrence probability takes into account the occurrence frequency of a given natural disaster for a fixed time period in the investigated threat geographic region.

In the risk assessment, the consequences from the threats are subjected to a preliminary quantitative and/or qualitative assessment. It is assumed that there is information for the threat frequency (probability) and intensity, as well as for the strength of the damages.

It is necessary to emphasize, that the geo-ecological risk assessment of the geographic region is done under subjective and uncertain conditions. This justifies the usefulness of applied intelligent assessment methods with fuzzy logic [3].

The purpose of the paper is to propose an approach for a complex assessment for a geo-ecological risk of a certain geographic region on the basis of quantitative and qualitative information for potential natural disasters. The approach is based on fuzzy logic, by which the subjectivity in the expert knowledge and indefiniteness of quantitative data.

A FUZZY LOGIC APPROACH FOR A COMPLEX ASSESSMENT OF THE GEO-ECOLOGICAL RISK

The proposed approach for a complex assessment of the geo-ecological risk in a given geographic region comprises several stages.

Vulnerability Determination of the Geographic region

Vulnerability determination of a given geographic region is performed. It is assumed that the vulnerability depends on the peculiarities of the geographic region that in the greatest extend influence the damages from a natural disaster.

Most frequently the following geographic peculiarities are analyzed: geological structures, rock and soil moisture, level of underground waters, landslides, mud-rock flows, swamps, deforest, etc.

Threat Definition for a Geographic region

Threat (dangers) definition for the given geographic region is performed, that are related with damages with determined intensity. The natural disasters directly affect the condition of the natural environment.

The most common natural disasters over the territory of our country are presented in the following table.

N	Disaster	Basic criteria	Striking factor and conse-

			quences
	Geological processes		
1	Earthquakes	Force or intensity – up to Magnitude 12	Soil dislocation, cracks, landslides, fires, destructions, human casualties
2	Landslides, landslips	Mass, speed of flow	Masses of rocks, material losses
3	Mud-rock flows (seli)	Mass, speed of flow	Mud-rock flow, material losses
	Hydrological processes and phenomena		
1	Floods	Increase river levels	Flooded riverside areas, material losses, human casualties
2	Dry spells	High temperatures and low humidity	Agricultural damages, decreased soil fertility, fires
3	Snow flows and glaciations	Over 20 mm rainfall for 12 hours	Snowdrifts – complications in the road
	Meteorological processes and phenomena		
1	Strong wind	Speed over 15m/s	Material losses
2	Tornado phenomena	Speed over 30m/s	Material losses
3	Dust storms	High temperatures, low humidity, dust	Agricultural damages, decreased soil fertility, fires
4	Hailstorms	Size of ice grains, intensity	Agricultural damages
5	Wet snow	Amount and moisture content of snow	Damages over forests, fruit gardens, electro conductive network
6	Fog	Horizontal vision - below 500 m	Transport, air purity
7	Silver thaw	Intensity	Transport, Agriculture
	Fires	Temperature	Thermal impacts, material losses, biosphere and soil damages

Criteria exist for each natural disaster type, with which the damage intensity is determined, that is used for characterization of the expected threat.

Most frequently the strength of the natural disasters is classified as a *Small*, *Medium*, *Large* and *Catastrophic* intensity.

Damage assessment for a geographic region from a natural disaster

A damage assessment for the analyzed geographic region with a determined vulnerability level is performed when a natural disaster with a different intensity occurs.

The D_1, D_2, D_3 and D_4 variables are introduced, which describe the potential damages when a natural disaster occurs, correspondingly with a small, medium, large and catastrophic intensity.

It is assumed that the values of the variables D_i, $i = 1,...,4$ vary from zero to ten in order to achieve an uniformity and comparability between the expert assessments of the potential damages due to different natural disasters.

Probability calculation for the natural disaster occurrence with a defined intensity

The probability calculation for a natural disaster occurrence with a given intensity is performed.

The accumulated quantitative information (a priori and a posteriori) and expert knowledge for threat types with different intensity is used.

It is proposed the probability assessments to reflect the possibility for the occurrence of different natural disasters within one year period.

The P_1, P_2, P_3 and P_4 variables are introduced which represent the occurrence probability for a given natural disaster, correspondingly with a small, medium, large and catastrophic intensity.

Determined assessment of the geo-ecological risk

A variable GER is introduced which represents a complex assessment of the geo-ecological risk of the observed geographic region from natural disasters with different intensities.

The determined complex assessment of the geo-ecological risk, GER, is calculated as follows:

(1) $$GER = P_1.D_1 + P_2.D_2 + P_3.D_3 + P_4.D_4$$

It is important to emphasize that the calculation of the geo-ecological risk for a given geographic region is performed in the conditions of subjectivity and incomplete definiteness.

The assessment of the potential damages, D_i as result of the occurrence of a certain natural disaster is based on an incomplete quantitative information and subjective knowledge of the experts regarding the region vulnerability and the intensity of the observed threat.

The intensity assessments themselves for a certain natural disaster are also represented with linguistic variables (*Small*, *Medium*, *Large* and *Catastrophic* intensity), which are by themselves qualitative, rather than quantitative variables.

The indicated peculiarities for the assessment of the geo-ecological risk quite naturally lead to the idea for the inclusion of the fuzzy logic approach, which accounts for the subjectivity and indeterminateness.

Fuzzy logic assessment of the geo-ecological risk

The idea is to develop a fuzzy logic model that describes quite well the subjectivity in the assessments of different experts regarding the size of the potential damages for a geographic region with a various intensity of the natural disaster.

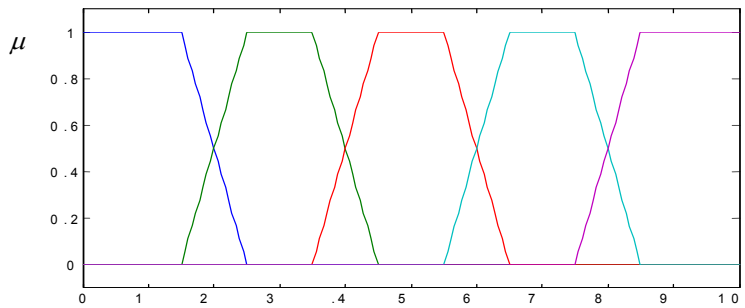
In fact the proposed fuzzy model should be taken as a complex assessment for the level of the geo-ecological risk from natural disasters in a given geographic region.

In the current paper the fuzzy logic model is established on the basis of a determined functional dependency (1), in which the potential damages of D_i, $i = 1,...,4$ and the complex assessment of the geo-ecological risk GER are defined as linguistic variables.

Five values for the linguistic variables D_i, $i = 1,...,4$ are introduced to reflect five levels for each of the four types of damages.

The proposed five levels of damages are set with five fuzzy subsets, correspondingly: *Very small*, *Small*, *Medium*, *Large* and *Very large*.

All linguistic variables vary in the [0, 10] interval and they are set with a trapezoid member functions (see Figure).



A node point vector $\alpha = (\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5,)$ is introduced, which in the particular case has the following form: $\alpha = (1,3,5,7,9)$.

Each D_i, $i = 1,...,4$ variable has a corresponding membership function μ_{ij}, $j = 1,...,5$ to the five fuzzy subsets.

The membership function μ_{ij} are defined with the following formulae:

$$\mu_{i1} = \begin{cases} 1, 0 \le D_i < 1.5 \\ 10(2.5 - D_i), 1.5 \le D_i < 2.5 \\ 0, \ 2.5 \le D_i \le 10 \end{cases}; \qquad \mu_{i2} = \begin{cases} 0, 0 \le D_i < 1.5 \\ 10(D_i - 2.5), 1.5 \le D_i < 2.5 \\ 1, \ 2.5 \le D_i < 3.5 \\ 10(4.5 - D_i), 3.5 \le D_i < 4.5 \\ 0, 4.5 \le D_i \le 10 \end{cases};$$

$$(2)\qquad \mu_{i3}=\begin{cases}0, 0\le D_i<3.5\\ 10(D_i-3.5), 3.5\le D_i<4.5\\ 1,\ 4.5\le D_i<5.5\\ 10(6.5-D_i), 5.5\le D_i<6.5\\ 0, 6.5\le D_i\le 1\end{cases};$$

$$\mu_{i4}=\begin{cases}0, 0\le D_i<5.5\\ 10(D_i-5.5), 5.5\le D_i<6.5\\ 1,\ 6.5\le D_i<7.5\\ 10(8.5-D_i), 7.5\le D_i<8.5\\ 0, 8.5\le D_i\le 1\end{cases};\qquad \mu_{i5}=\begin{cases}0, 0\le D_i<7.5\\ 10(D_i-7.5), 7.5\le D_i<8.5\\ 1,\ 8.5\le D_i\le 1\end{cases}$$

For the linguistic variable – complex assessment of the geo-ecological risk GER, five levels are introduced too, as shown in the following Table

GER intervals	Levels of the geo-ecological risk
$8<GER\le 10$	“*Very large geo-ecological risk*”.
$6<GER\le 8$	“*Large geo-ecological risk*”
$4<GER\le 6$	“*Medium geo-ecological risk*”
$2<GER\le 4$	“*Small geo-ecological risk*”
$0<GER\le 2$	“*Very small geo-ecological risk*”

The complex assessment of the geo-ecological risk on the basis of the proposed fuzzy logic model is calculated as follows:

$$(3)\qquad GER=\sum_{i=1}^{4}P_i\sum_{j=1}^{5}\alpha_j\mu_{ij}.$$

The obtained value for GER shows the level of the geo-ecological risk in the observed geographic region.

CONCLUSIONS

The proposed fuzzy logic model produces a complex assessment for the geo-ecological risk that is comparative to the corresponding summary assessment of the experts (geologists, hydrologists, meteorologists, financiers, ecologists, etc.).

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Treatment of Hazardous Wastes from the Town of Kyustendil Emergency Department and Its Branches

Stefka Cekova, Lidia Sakelarieva, Maria Stoyanova

South-West University, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihailov Str., 2700 Blagoevgrad, Bulgaria

***Abstract**: Technical guidelines on the environmentally sound management of biomedical and healthcare wastes were adopted at the sixth meeting of the Conference of the parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal held in December 2002. As a country accepted the Basel Convention the Republic of Bulgaria has adapted the Technical guidelines for the local conditions. Technical guidelines on the management of installations for healthcare wastes were adopted in 2003. Consistent implementation of the measures set in the Guidelines and in the National waste management programmme has started since then.*

An example of the treatment of hazardous waste from the Emergency department in the town of Kyustendil and its six branches located in the district of Kyustendil has been considered in the report.

***Kewords**: biomedical and healthcare wastes, treatment of hazardous wastes, Emergency department, district of Kyustendil.*

1. INTRODUCTION

The safety management of biomedical and healthcare wastes has been one of the problems which have to be sold by the Bulgarian legislation. The National waste management programmme for the period 2009 – 2013 [3] has set ten strategic goals which to a certain degree concern also the healthcare wastes. One of them has been connected with the development of stable systems for management of specific waste flows which include the hazardous wastes from the medical and healthcare institutions.

The purpose of the present study was to make an attempt for an assessment of the established system for management of hazardous wastes generated by the town of Kyustendil Emergency department (ED) and its branches and to give some recommendations for the improvement of that activity.

2. MATERIAL AND METHODS

The Emergency department in the town of Kyustendil was established on the grounds of government decree 195/1995 and was structured for work in the territory of the Kyustendil district. About 154 470 inhabitants in area of

3037 km^2 have been served by the 6 branches of the ED located in the towns of Kyustendil, Dupnitsa, Bobov dol, Rila, Sapareva banya, and in the village of Nevestino (Fig. 1).

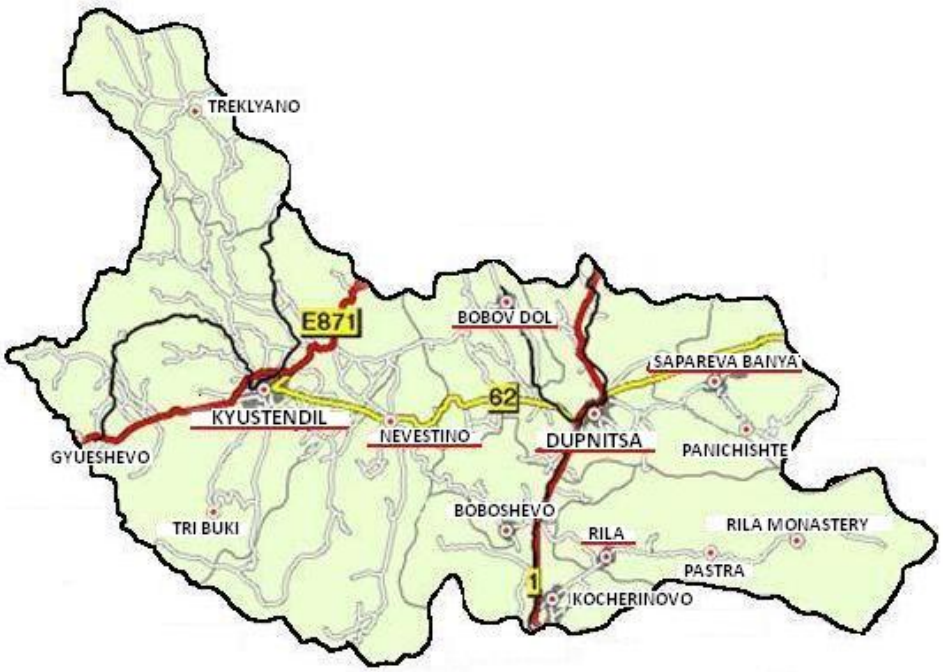

Fig. 1: The area of the Kyustendil district

Information about the generated hazardous wastes, their dynamics and the treatment methods used was gathered for a three year period (2005 – 2007). The supplements of Ordinance No 9 [2], the transportation maps, the annual reports, the planned and realized measures for improvement of the activities set in the Programme of the ED for the period 2006 – 2011 were used. Our own studies were also conducted.

3. RESULTS AND DISCUSSION

Different kinds of wastes are generated by the town of Kyustendil ED and its branches. They could be combined in two large categories – hazardous and non-hazardous. The wastes which collection and treatment are subjects of special requirements, according to Ordinance No 3 [1], are included in:

Code: 18.01.03 - used sharp objects (needles and syringes from used vaccines, edges of scalps, razors and safety razors and laboratory glass-ware); used and broken laboratory glass-ware as well as used surgical instruments; pathologo-anatomical wastes (amputated extremities, polluted

consummatives for one-time use and materials polluted with physiological and pathological secretions, bacterial cultures etc.); plaster casts, working clothes polluted with physiological and pathological secretions etc.

Code: 21.01.21 – thermometers, luminescent lamps, batteries etc.

The generated waste with non-hazardous properties is included in:

Code: 18.01.04 – waste which collection and treatment are not subjects of special requirements in order to avoid infections – linen, one-time clothing etc.

Code: 20.03.11 – mixed waste – paper and plastic packaging, paper from the administrative offices, consulting and hospital rooms, waste from the cleaning of the area of the ED and its branches.

The non-hazardous wastes have been thrown away daily in containers owned by the ED and have decomposed at the town of Kyustendil landfill. The hazardous wastes from all branches have been transported to premises for temporarily storage located at the area of the town of Kyustendil ED and then sent and burned in the insenerator of the Alexandrovska hospital (Sofia). The quantity of hazardous healthcare waste generated by the ED and its branches has been registered monthly on the basis of the transportation maps accompanying the load.

The dynamics of hazardous waste (Code: 18.01.03) generated by the ED and its branches for the period 2005 – 2007 (fig. 2, 3, 4, 5, 6 and 7) shows that:

1. The monthly values of hazardous wastes quantities varied from about 1kg (August 2005 and 2006, the village of Nevestino ED branch) to about 27kg (May 2006, the town of Bobov dol ED branch and August 2007, the town of Sapareva banya ED branch). However the average values in the three studied years changed from about 10kg to 16kg per month with the exception of the village of Nevestino ED branch where the average quantity of waste was about 4kg. The quantity of hazardous waste generated in the town of Kyustendil ED branch in 2007 was comparatively higher with an average monthly value about 20kg.

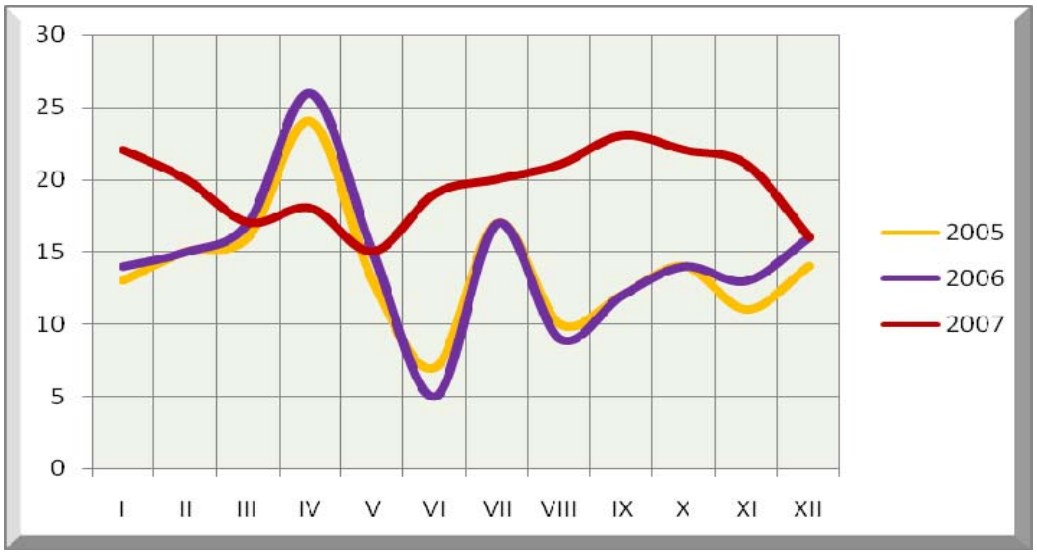

Fig. 2: Dynamics of hazardous waste generated in the town of Kyustendil ED branch

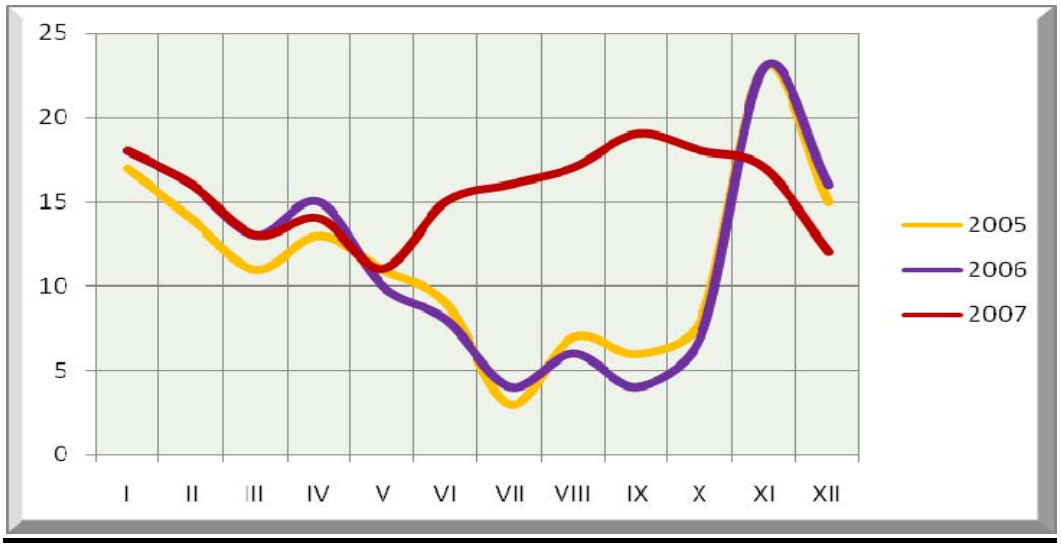

Fig. 3: Dynamics of hazardous waste generated in the town of Dupnitsa ED branch

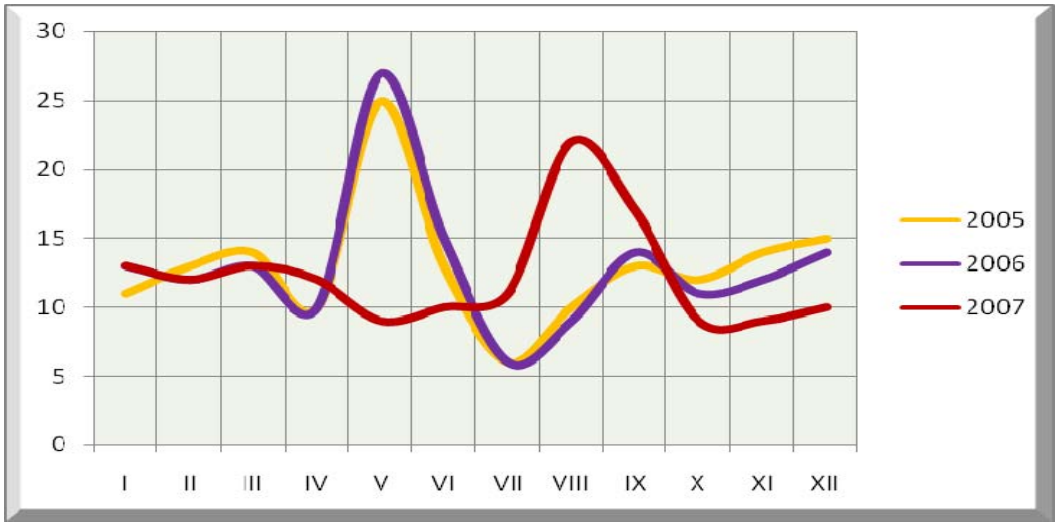

Fig. 4: Dynamics of hazardous waste generated in the town of Bobov dol ED branch

2. The dynamics of hazardous wastes quantities generated in 2005 and 2006 was similar in each of the ED branches except in the village of Nevestino ED branch (fig. 7) where the quantity of waste in the second three months of 2005 was comparatively higher.
3. In some cases (fig. 5, 6, 7) the dynamics of hazardous wastes quantities generated in 2007 followed those in the previous two years.
4. The higher quantities of wastes in August of the three studied years in the town of Sapareva banya ED branch could be explained with the increased number of visitors to the town in that month.

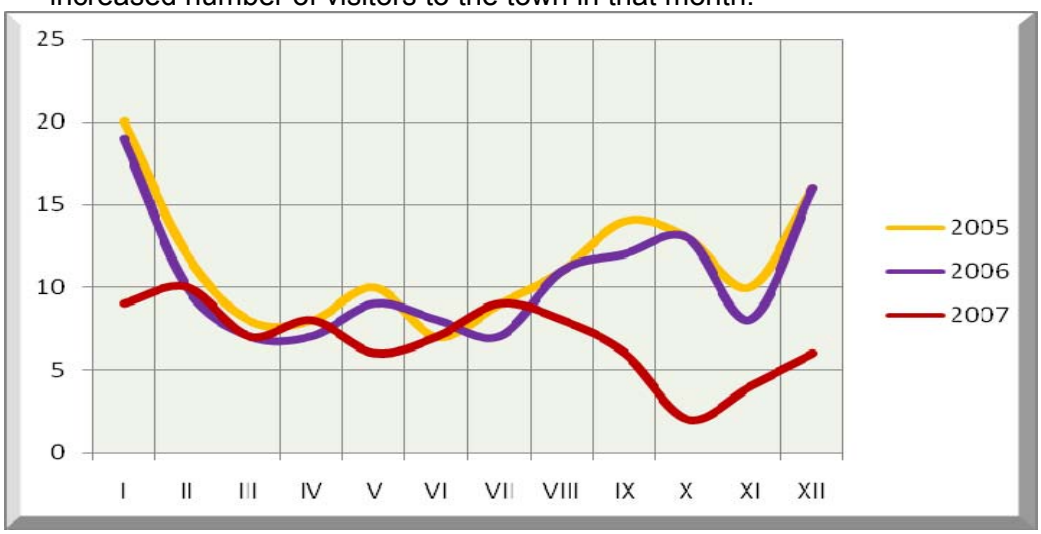

Fig. 5: Dynamics of hazardous waste generated in the town of Rila ED branch

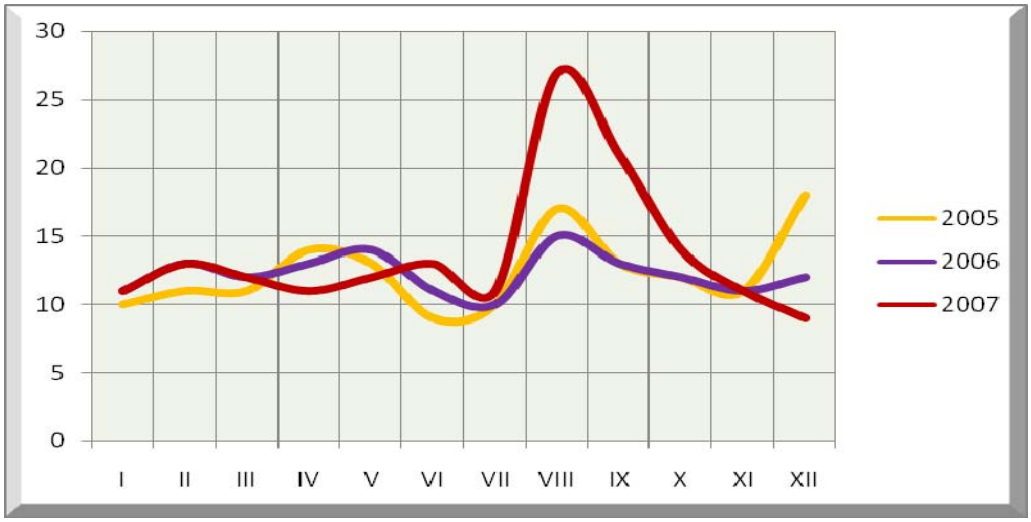

Fig. 6: Dynamics of hazardous waste generated in the town of Sapareva banya ED branch

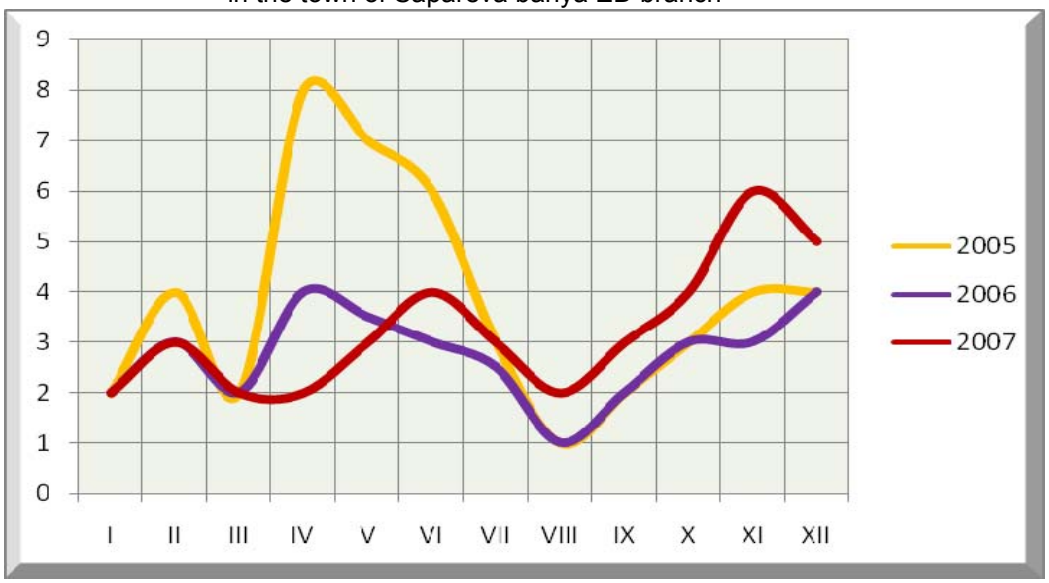

Fig. 7: Dynamics of hazardous waste generated in the village of Nevestino ED branch

The hazardous healthcare wastes transported for burning in the insenerator of the Alexandrovska hospital (Sofia) in 2007 were approximately 849 kg - 236 kg from the town of Kyustendil ED branch, 186 kg from the town of Dupnitsa ED branch, 164 kg from the town of Sapareva banya ED branch, 148 kg from the town of Bobov dol ED branch, 80 kg from the town of Rila ED branch, 35 kg from the village of Nevestino ED branch respectively.

4. CONCLUSIONS

- Measures for the consecutive implementation of the requirements set in the Waste management Act and the corresponding normative acts have been adopted in the town of Kyustendil Emergency department and its branches. The long transportation distances and the expenses connected with them impose a new policy of hazardous healthcare waste management. It has to be directed to waste minimization and treatment at the place of their formation by using autoclave or microwave installations.
- The preparation and realization of a programme for management of the old luminescent and other lamps containing mercury, thermometers, medicines with expired term of use, batteries, accumulators etc. is expedient.

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Observations of Amphibians (Amphibia) within the Territory of the Blagoevgrad Municipality

Alexander Pulev, Lidia Sakelarieva

South-West University, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihailov Str., 2700 Blagoevgrad, Bulgaria

***Abstract**: A great number of the amphibian and reptile species, distributed in Bulgaria, are sensitive to anthropogenic impacts. Therefore they are protected by the Low of biological diversity and are included in the new edition of the Bulgarian Red Data Book. The present observations of the herpetofauna within the territory of the Blagoevgrad municipality have been carried out since 1988. The aim has been to update, supplement and summarize the available information about the taxonomy, distribution and ecology of the amphibians and reptiles in this region. The results about the amphibians are presented and discussed in this report. Eleven amphibian species, out of 18 for the whole country, have been recorded. One subspecies, concrete habitats, as well as some aspects of the ecology of certain species are reported for the first time.*

***Kewords**: amphibians, distribution, ecology, Blagoevgrad municipality*

1. INTRODUCTION

Although the researches of the herpetofauna in Bulgaria started in the beginning of XX century there are no publications which summarize the available information about the species composition and distribution of the amphibians and reptiles within the territory of the Blagoevgrad municipality. Some data are found in the works of Buresh and Tsonkov [1, 2, 3, 4, 5] as well as in the collection of the Regional Historical Museum in the city of Blagoevgrad (RHM - Blagoebgrad).

The aim of the present observations of the herpetofauna within the territory of the Blagoevgrad municipality has been to update, supplement and summarize the available information about the taxonomy, distribution and ecology of the amphibian and reptile species in this region. The results about the amphibians are presented and discussed in this report.

2.MATERIAL AND METHODS

The Blagoevgrad municipality (Fig. 1) is located in the South-West Bulgaria and covers a part of the middle stream of the Struma River. It includes the Blagoevgrad valley, the Blagoevgradska Bistritsa River basin and the Eastern slopes of the Vlahina Mountains with the small Padesh valley. The average altitude is 959.8 m. The lowest point is the Struma River valley - 310 m, and the highest one – the mount Golyam Mechi Vrah, South-West Rila

Mountains – 2617 m. The river system is comparatively dense. The climate is transitional with two maximums of precipitation – June and November, and two minimums – February and August. The mountain climatic influence is felt especially in the Eastern part of the municipality.

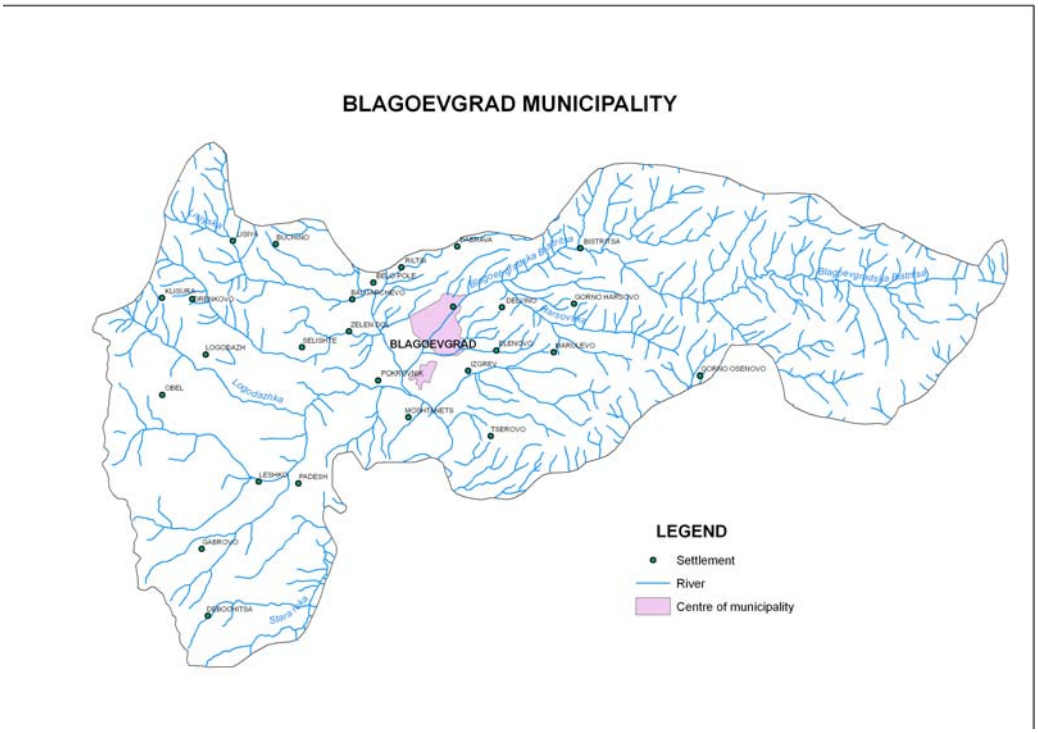

Fig. 1: Map of the Blagoevgrad municipality

The observations of the amphibians have been carried out since 1988. The data were gathered during day field trips. Some localities were reported by other biologists. The available information about the species distributed in the studied area was summarized.

3. RESULTS AND DISCUSSION

Eleven amphibian species (3 tailed and 8 tailless), out of 18 for the whole country have been recorded for the territory of the Blagoevgrad municipality:

***Salamandra salamandra* (Linnaeus, 1758)**

Localities: Parangalitsa reserve [4]; one specimen, the village of Pokrovnik, 03.1974, RHM - Blagoevgrad, K. Iliev collect.; one specimen, same locality, 10.02.1978, RHM - Blagoevgrad, Kr. Mopov collect.; one specimen, the village of Obel, under a rotted tree, G. Manolev observ.; several larvae, between the villages Dolno Tserovo and Tserovo, 13.05.1990; two specimens and several larvae, SE of the village of Izgrev, in a large gully; one specimen, the city of Blagoevgrad, Varosha residential area, 18.04.2002;

one specimen, between Blagoevgrad and the village of Delvino, in a ditch; one specimen, between Blagoevgrad and Bachinovo place; several specimens, Bachinovo, in a ditch along the alley, 05.10.1996, 14.03.1998, 16.05.2000; several larvae, between the villages of Bistritsa and Gorno Harsovo, in the Mishovets stream; several larvae, Gorno Harsovo, in a small marsh; one trampled specimen, on the road after the fork to Gorno Harsovo; several trampled specimens, on the road between Bachinovo and Bistritsa; one trampled specimen, on the road in the Slavovo place, 17.08.1997; one specimen, on the road between Slavovo and the Bodrost resort, 26.11.2006; 4 specimens on the road between Bistritsa and Slavovo, 19.04.2009; the Bodrost resort.

Remarks: The fire salamander is widely distributed in the territory of the Blagoevgrad municipality. It is the most common tailed amphibian species in the region and is comparatively abundant if suitable wet habitats are available. Quite a lot of such habitats are found within the Blagoevgradska Bistritsa River basin. It is interesting to note the late observation on November 26, 2006 (before the Bodrost resort) in mixed forest, at 4.30 pm, sunny and cold weather (6° C). The localities indicated supplement considerably the available information about the distribution of the salamander in this part of the country.

***Triturus vulgaris* (Linnaeus, 1758)**

Localities: one specimen, floods of the Blagoevgradska Bistritsa River between Blagoevgrad and Bachinovo, G. Manolev observ.

Remarks: In spite of the only locality at our disposal probably the smooth newt is much more widely distributed within the territory of the Blagoevgrad municipality.

***Triturus* superspecies *cristatus* (Laurenti, 1768)**

Localities: one specimen, Pkrovnik, 04.1984, RHM - Blagoevgrad, K. Iliev collect.; one specimen, the Kaimenska chuka height, south of Blagoevgrad; one specimen, Blagoevgrad, between Elenovo and Strumsko residential areas, in a ditch along the road, 24.05.2003; two specimens, Bachinovo, in a ditch along the road, 11.07.2000; several larvae, in a flood on the Struma River right bank, near the village of Balgarchevo, 07.07.1998; several hibernated under the ice specimens, Obel, in a marsh along the road, 24.01.1990;

Remarks: The crested newt is to be found comparatively often within the studied territory. It is of interest the hibernation of 5 - 6 specimens in semi-numbed state right under the ice in a large marsh (Obel) on 24.01.1990. The species has not been reported for the Vlahina Mountains yet.

***Bombina variegata* (Linnaeus, 1758)**

Remarks: The yellow-bellied toad is one of the common amphibians in the studied region. Its abundance is high and it is found in puddles, canals, marshes, tubs, small streams, floods of large rivers.

***Rana ridibunda* Pallas, 1771**

Remarks: The marsh frog is the most common and often met amphibian species within the territory of the Blagoevgrad municipality. It is very abundant in and along streams, marshes, puddles, dams, canals, tubs etc.

***Rana dalmatina* Bonaparte, 1839**

Localities: one specimen, Kaimenska chuka, south of Blagoevgrad; one specimen, Blagoevgrad, Strumsko residential area, in a ditch along the road; one specimen, the Blagoevgradska Bistritsa River in Blagoevgrad, 06.04.1999; one specimen, South-East of Blagoevgrad, in a gully, 04.1990; several specimens, Bachinovo, in a ditch along the road, 16.05.2000, 11.07.2000; one specimen, the Blagoevgradska Bistritsa River at the influx of the Mishovets stream, 16.05.2000; one specimen, the village of Dabrava, in a gully; one specimen, Obel, G. Manolev, observ.

Remarks: The spring frog has been found at several localities, almost always single specimens. The species has not been reported for the Vlahina Mountains yet.

***Rana graeca* Boulenger, 1891**

Localities: several specimens, between Dolno Tserovo and Tserovo, 13.05.1990; one specimen, Bachinovo, 11.08.2001; several specimens, in a shallow flood and on the bank of the Blagoevgradska Bistritsa River at the influx of the Mishovets stream, 14.03.1998, 16.05.2000; several specimens, in the Mishovets stream, between Bistritsa and Gorno Harsovo; one specimen, the Harsovska River, West of Gorno Harsovo, in a small pool, 30.08.1998; two specimens, the Harsovska River, 2 km East of Gorno Harsovo, 03.08.1998; two specimens, the village of Drenkovo, in a tub, 23.03.2001; several specimens, Obel, G. Manolev, observ.

Remarks: The Balkan stream frog is widely distributed within the territory of the Blagoevgrad municipality. It is found in all suitable for it habitats, usually in low numbers. The localities reported supplement considerably the knowledge about the species distribution in this part of the country.

***Rana temporaria* Linnaeus, 1758**

Localities: the Blagoevgradska Bistritsa River at Parangalitsa reserve [5]; Parangalitsa reserve, RHM - Blagoevgrad, K. Iliev collect.; Makedonia hut, 24.07.1978, RHM - Blagoevgrad, E. Andreeva collect.; several specimens, the Blagoevgradska Bistritsa River, at Kartala place, 11.08.1996 and in the beginning of Parangalitsa reserve.

Remarks: The common frog is distributed only in the highest Eastern part of the Blagoevgrad municipality, in the Rila Mountains. It is not expected the species to be found in other parts of the municipality.

***Bufo bufo* (Linnaeus, 1758)**

Localities: Blagoevgrad [5]; one specimen, Kaimenska chuka, south of Blagoevgrad; several specmens, Blagoevgrad, Strumsko residential area, in a ditch along the road and under stones; one trampled specimen *Bufo bufo*

spinosus, Bachinovo, 08.06.2005; two specimens *Bufo bufo bufo*, Drenkovo, in an irrigation canal, 13.03.2001; several specimens including a copulating couple *B. b. bufo*, Drenkovo, in a pool, 23.03.2001; one specimen *B. b. bufo*, Pokrovnik, beneath a tile, 08.10.2003; one specimen *B. b. bufo, same locality,* in fallen leaves, 02.11.2007; one specimen, *B. b. spinosus*, same locality, under a particle board, 08.04.2005.

Remarks: The common toad is less abundant than the green one in the Blagoevgrad municipality territory. It is found in settlements as well as in natural habitats. It was observed early in the spring on March 13 (2 male specimens) and late in the autumn on November 2 (1 female specimen). The subspecies B.b. spinosus is reported for the first time for the region (2 localities). It helps to throw light upon the Northern distribution of that Mediterranean subspecies within the Struma River basin.

***Bufo viridis* Laurenti, 1768**

Remarks: The green toad is widely distributed in the region in settlements and in natural habitats.

***Hyla arborea* (Linnaeus, 1758)**

Localities: one specimen, the surroundings of Blagoevgrad, 28.07.1974, RHM - Blagoevgrad, E. Andreeva collect.; one specimen, Blagoevgrad, Strumsko residential area, near the road; one specimen, Bachinovo, on a tree next to the pond; one specimen, Stoikovtsi reservoir, in the grass on the shore, 24.04.2002.

Remarks: The common tree frog is a common species for the whole country. The few localities recorded were probably due to its hidden way of living. It could be expected much wider distribution of the species within the whole region. It is reported for the first time for the Vlahina Mountains.

4. CONCLUSIONS

- Eleven amphibians or 61% of the amphibian species distributed in Bulgaria inhabit the territory of the Blagoevgrad municipality although it represents only 0.56% of the territory of the country. In spite of the small area the species diversity of amphibians is rather high because of the diverse relief, the considerable difference in altitude, comparatively dense river system, favourable climatic conditions various habitats and unpolluted environment. Especially suitable living conditions are found within the Blagoevgradska Bistritsa River basin, the Eastern part of which is sparsely populated and is included in the Rila National Park boundaries. All eleven amphibian species were registered there, some of them very abundant. An increase in species composition within the territory of the Blagoevgrad municipality as a result of future observations has not been expected.
- The localities reported supplement to a great extent the known distribution of the amphibian species in the studied area.

- The Southern subspecies of the common toad *Bufo bufo spinosus* has been recorded for the first time in the territory of the Blagoevgrad municipality. The two localities reported limit the Northern distribution of the subspecies within the Struma River basin.
- Three amphibian species - *Triturus cristatus*, *Rana dalmatina* and *Hyla arborea* have been recorded for the first time in the Vlahina Mountains.
- Three amphibian species - *Bombina variegata, Rana ridibunda* and *Bufo viridis* are widely distributed in large numbers within the studied area.

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The spiritual value of forests and sustainable forest management

William A. Clark

American University in Bulgaria

Abstract. *People value forests for a wide variety of reasons. Traditionally, the consumptive and utilitarian values of forests have predominated in the practice of forestry and in the academic literature. In more recent decades greater attention has been given to non-utilitarian forest values, including the spiritual value of forests. However, the concept of spiritual values associated with forests has not been clearly defined or fully developed. A review of the academic literature combined with a survey of forest related websites shows awareness, but an overall lack of definition of spiritual values of forests. The spiritual value people place on forests can be broken down into four broad categories: intrinsic sacredness; spiritual value associated with significant religious people, places, or events; forests as a reflection of a Creator; and forests as a place to experience a connection with God or transcendence.*

1. INTRODUCTION

People value forests for a wide variety of reasons and receive numerous benefits, both tangible and intangible from forests. Sustainable forest management should therefore include protection of the whole spectrum of these goods, services, and values (Ritter and Dauksta 2006, Fabbio et al. 2003, Wiersum 1995). Successful sustainable management of forests is facilitated by an accurate understanding of the complete set of values people place on forests (Bengston 1994; Brown and Harris 1992; Tarrant and Cordell 2002). In addition, understanding how diverse stakeholders value forests, and clarifying the nature of these values, will help enable forest managers to weight competing demands, address potential conflicts, and develop management plans in harmony with society's values (Tarrant and Cordell 2002).

Most recent research on forest values points to the less tangible values as being more important to the public than the more traditional values of wood production and ecological services. As a result, there have been calls for a more careful consideration of these less tangible values. For example, Ritter and Dauksta (2006) write,

> *We suggest that the cultural and spiritual needs of people have to be considered more consciously in the context of forestry and that this would help to achieve a sustainable use of forests resources together with a positive development of human society.*

This article looks specifically at the spiritual values of forests and seeks to expand and clarify the nature of these values.

2. GROWING INTEREST IN SPIRITUAL VALUES OF FORESTS:

A review of current literature on forest values shows much interest in the spiritual value of forests, but little attempt to clarify what the term means. Spiritual values are often lumped together with other values. Tarrant and Cordell (2002), following Xu & Bengston (1997) and Rolston & Coufal (1991), identify the spiritual values of forests as a sub-set of non-commodity and non-utilitarian values and treat them as essentially equal to cultural or heritage values. The FAO combines cultural, spiritual and aesthetic values into a single category of indirect use values, distinguishing them from direct use, option, and existence and bequest values (Kengen 1997). Ritter and Dauksta (2006) discuss cultural and spiritual values of forests as a single concept. They assert that understanding these values is important for sustainability; however, they fail to clearly define what is meant by a spiritual value. Hagvar (1999), following Callicott (1997), speaks of the psyco-spiritual value of nature labeling it a “third generation” value; in other words, a value of nature benefiting the human mind and spirit. Edwards (2006 p.5) writes:

> *Intangible SCVs (social-cultural values) are also often hard or impossible to separate from each other, and tend to be referred to by undifferentiated labels such as ‘cultural and spiritual values’ or ‘cultural heritage’. Yet they are undeniably important and often rank higher in stakeholder consultations carried out for forest planning and policy-making than the traditional timber benefits.*

Some authors attempt to provide more detailed definitions of spiritual values. Schroeder (1992 p. 25) states:

> *“Spiritual” refers to the experience of being related to an “other” that transcends one’s individual sense of self and gives meaning to one’s life at a deeper than intellectual level.”*

However, the spiritual values of forests are generally seen as abstract and difficult to define.

> *The cultural and spiritual functions of forest are comprised of traditional or special values that are connected to places or trees and the spiritual bonds and history that link human culture and religion to forest and trees. While cultural functions are easily linked to ‘special’ places, the spiritual function is a more abstract human value that is often held subconsciously or consciously expressed in a different way e.g. by showing emotional to forestry issues. The cultural and spiritual functions are rarely mentioned in comparison to the other forest functions. This is partly because they are more intangible, but also because it is difficult to express these values in monetary terms…* (Ritter & Dauksta 2006 p. 427).

Scientists and professional foresters are often uncomfortable talking about spiritual, and fail to respect the spiritual values others hold toward forests (Schroeder 1992). And yet, if these values are ignored or not respected, it can lead to conflicts and misunderstandings with local communities and hinder good management (Koch 1997).
Measuring spiritual values, which are clearly non-market in nature, in a way allowing comparison with other values has been difficult. It is widely considered unacceptable or controversial to use conventional environmental economic techniques (e.g. contingent valuation or hedonic pricing) to reduce spiritual values to monetary terms (Kumar & Kant 2007; Edwards 2006). Nevertheless, spiritual values related to forests have been studied using various survey instruments.

3. FORESTS AND SPIRITUALITY ON THE WEB

Many non-academic websites promote the idea that forests have a unique spiritual value, but the exact nature of this value is not clearly defined or explained. In a review of approximately 100 forest related websites, several phrases and themes were frequently repeated, forest:

-- provide spiritual refreshment
-- give spiritual joy
-- contribute to spiritual health
-- are linked to a community's spiritual values
-- are a source of spiritual wellbeing
-- are essential to a community's spiritual survival
-- provide spiritual renewal
-- have spiritual benefits
-- may be sacred places
-- are a source of spiritual welfare
-- may serve as a spiritual sanctuary
-- make available spiritual fulfillment
-- fulfill spiritual needs
-- can provide a spiritual setting
-- give spiritual enrichment
-- provide a place for spiritual experiences
-- are an integral part of some spiritual traditions
-- form a part of our common spiritual heritage

4. CLARIFYING THE SPIRITUAL VALUE OF FORESTS

It is obvious the term "spiritual value" has a broad range of meaning. From a review of the academic literature, along with a consideration of internet websites and other sources of popular culture, it appears the spiritual im-

portance of forests falls into four broad categories. Forests have spiritual value because:

- They are intrinsically sacred
- They are associated with special places of worship, historical events or people of religious significance
- Are a reflection of a Creator
- Provide an environment allowing a connection with the Divine

These four categories capture the broad range of meaning connected with what various researchers refer to as the spiritual value of forests. A given individual may hold more than one of these and there also may be a degree of overlap between them.

4.1. Forests as intrinsically sacred places

Some cultures and traditions view certain forests as intrinsically sacred because they are believed to be the abode of gods, or the habitation of various spirits, including the spirits of departed ancestors (e.g. Altman 2000). This view of forests is most often found among traditional cultures or indigenous groups living among a dominate culture, such as aboriginal Australians or certain Native American tribes. This view is particularly true of animist groups or cultures which view forests or individual trees as the dwelling place of various spirits. The persistence of such beliefs in parts of Asia and Africa has significantly contributed to the preservation of remnants of ancient forests and the protection of biodiversity. For example, Anh & Pham (2005 p. 1) write:

“Ceremonial forests, however, can still be found in every Thai village with an average size of five to ten ha. It is the place to bury the dead. According to Thai beliefs, the souls of the dead live in this forest, so therefore no villagers dare to damage it. To this day, the ceremonial forests are still being maintained and preserve many valuable species.”

In India, certain groves of tress are viewed as inherently sacred because they are believed to be permeated by local deities. These groves are still found in many villages and hamlets, although their numbers and sizes have been greatly reduced. These groves have preserved remnants of the ancient Indian forests. Due to respect for their sacredness, they have been spared the destruction and degradation of surrounding forests and contain significantly greater biodiversity. (Ramakrishnan 1992, Subash Chandran & Gadgil 1998).

Sacred forests continue to play an important role in some African territorial religions. In a case study exploring the link between sacred forests and conservation in Zimbabwe, Byers et al. (2001) report the sacredness of certain forested areas is tied to the belief that ancestral spirits reside in the wild

animals living there. Such a belief naturally promotes the protection of these areas as wildlife habitat. Their study found a significant correlation between forest conservation and local belief in the sacredness of given forest patches. In the context of their study area, local religious leaders and elders were largely responsible for determining which areas were sacred and what activities and access are allowed

The idea of forests being intrinsically sacred is now a minority view in much of the world, especially in North America and Europe; although certain "New Age" and neo-pagan groups may still adhere to this view. Ritter and Dauksta (2006 p.430) contend that although the ancient, pre-Christian, tree-worshipping traditions of European tribes have vanished and are largely forgotten, they have left an unconscious imprint on modern societies in terms of a special connection with forests.

4.2. Forests as the loci of significant spiritual history or culture

Forests hold spiritual value for some people because they are closely associated with either current or past places of worship, or are the loci of historic events of spiritual importance. This aspect of spiritual value corresponds with what other authors have labeled cultural or historic forest values. Forests surrounding churches, monasteries, or temples are often considered to possess a spiritual quality (e.g. Votrin 2005) and can serve as important conservation areas. Some church or monastery forests form the core of nature preserves and other protected areas (e.g. Virtanen 2002; Madeweya et al. 2004; Salick et al. 2007). In Ethiopia, one of the few places where indigenous trees and forests can be found is on land own and controlled by the Orthodox Church (Votrin 2003). In Russia, many of the National Parks and nature reserves are former monastery forests (Votrin 2003).

Another example of a "sacred forest" in this context is Ouadi Qadisha (the Holy Valley) and the Forest of the Cedars of God (Horsh Arz el-Rab) site in Lebanon. Several ancient monasteries are located there and it contains a remnant of the ancient cedar forests of Lebanon mentioned in the Bible. Due to the presence of these ancient monasteries and its association with the ancient cedars, this site holds spiritual significance for many people. The site was originally nominated as a World Heritage natural property but failed to be included due to serious integrity issues. However, when re-submitted as a cultural site it won inclusion on the United Nation's World Heritage List because of its spiritual significance (Rössler 2005). This provides an example of the important interplay between spiritual and cultural values and the natural environment.

4.3. Forests as a reflection of God as Creator

The previous two categories of spiritual values of forests have limited application to most people living in North America, Europe, and Australia. In contexts with a Judeo-Christian heritage, forests are likely to hold spiritual value for people for different reasons. People in western, secularized socie-

ties are unlikely to consider forests as the abode of deities or spirits of the departed, but they may still place spiritual value on them for other reasons. Many people see nature in general and forests in particular as reflections of a Creator. This idea is captured by the mission statement of SacredForests.org (undated):

> *All forests are sacred gifts of God. We, the children of God, have a moral and ethical obligation to insure the protection and preservation of every acre of God's forests that have not yet been plundered and despoiled… We must demand that the tiny remnants of forests that remain untrammeled by humans be treated as sacred wilderness cathedrals dedicated to the glory of God.*

In this view, forests have value because they are an expression of God’s creativity and beauty. To damage or despoil a forest is to mar the handiwork of God. For some people, forests have spiritual value not because they are intrinsically sacred, or imbued with sacredness due to their history, but because they orient the mind and emotions toward God.
The words of the popular hymn, *How Great Thou Art*, expresses this idea,

When through the woods and forest glades I wander,
And hear the birds sing sweetly in the trees;
When I look down, from lofty mountain grandeur,
And hear the brook, and feel the gentle breeze;
Then sings my soul, my Savior God to Thee,
How great Thou art, how great Thou art…

People with this mindset are committed to protecting forests and other natural landscapes since they view themselves as stewards of God’s creation. This position is exemplified by a declaration published by The Religious Campaign for Forest Conservation (RCFC) in 2000:

> *Creation reflects the handiwork of the Creator. Just as Beauty is an aspect of the Lord who infuses Creation with magnificence and wonder, so every tree embodies the glory of God and every forest manifests the wisdom of its Maker. We should therefore intuit in forests the Great Architect of life and respect that Superior Wisdom which manifests in its incredible diversity, intricacy, beauty and fruitfulness* (Kruger 2001 p. 3).

4.4. Forests as a place to commune with God and/or experience transcendence

Forests have long served as places for finding solitude and escape from the burdens of modern life. For many people, the tranquility and solitude of forests provide an ideal environment for establishing or strengthening a spiritual dimension in their lives, and to connect with God.

Donald Swearer (1998), director of the Center for the Study of World Religions of Harvard Divinity School, notes that although early Buddhism was not inherently biocentric, forests have been a preferred environment for spiritual practices and that historically in Asia, and currently in the West, Buddhists often locate their learning centers in forests.
Even secular people seek the sense of renewal and invigoration that can come from spending time in the forest. Again quoting from the RCFC's declaration, "Preserving our Forest Heritage:"

> *People who have access to intact forests also have access to peace, quiet, renewal and the regeneration that native forest land offers. Wild forests have important therapeutic values for the human spirit which are only now becoming understood. Through the forests, people connect to principles of life, death and regeneration that are important for a whole perspective on our own life, death, and the responsibility to provide for future generations.* (Kruger 2001 p. 4)

Henryk Skolimowski, a founding father of eco-philosophy, states:

> *Forests and spirituality are intimately connected. Ancient people knew about this connection and cherished and cultivated it. Their spirit was nourished because their wisdom told them where the true sources of nourishment lay* (Skolimowski undated p. 4)… *(Forest) are important as human sanctuaries, as places of spiritual, biological and psychological renewal. As the chariot of progress which is the demon of ecological destruction moves on, we wipe out more and more sanctuaries. They disappear under the axe of man, are polluted by plastic environments, are turned into Disneylands* (Skolimowski undated p. 7).

Trigger and Mulcock (2005) link the spiritual value of forests with sense of place and maintain that for a place to have spiritual value implies it has significant "personal and cultural meaning" (p. 308). In extensive interviews with various stakeholders in the controversial Western Australian Regional Forestry Agreement of 1999, they discovered parties on all sides of the dispute agreed that forests have spiritual value. Both pro-logging and anti-logging interviewees saw forests as a place to meet with God or to experience transcendence. Brown and Raymond (2007) also highlight the connection between place attachment and spiritual values. They assert:

> *"…it is the individual's willingness to associate spiritual value with a landscape that best predicts the psychological state of place attachment. Although respondents are least likely to identify spiritual landscape values, these mapped landscape values are most important in identifying respondent attachment to place*" (p. 108).

Forests provide spiritual or transcendent experiences for both religious and non-religious people. Worth (2006) argues that increasing numbers of people in southwestern Australia without any formal religious affiliation are seeking to have their spiritual needs met in the aesthetic qualities of the natural environment of the forest. As more people see forests as a place to connect with God, find quietness, experience transcendence, or to mediate and experience inner peace, this will have implications for forestry and forest policy.

Often, when people talk about the spiritual value of forests (especially in western, secularized societies, it is this aspect (of being alone in a quiet, natural place where they can connect to something or someone larger than themselves) that they have in mind

3. SUMMARY

Forests are important to people for a wide variety of reasons, with spiritual benefits being a significant aspect. I have attempted to clarify what people mean when they talk about the spiritual value of forest by subdividing the value into the four broad categories described above.

People who value forests for spiritual reasons may embrace more than one of these values and may have difficulty expressing exactly why they attach spiritual significance to forests. Which value dominates will likely depend on multiple factors such as a person’s cultural heritage and spiritual beliefs, the particular forest in question, and the perceived needs of the individual. Spiritual values are often very personal and can be difficult to describe. Further research is needed to clarify more precisely what people mean when they speak of the spiritual value of forests, and to differentiate these values from other indirect-use values. However, understanding the spiritual importance of forests for people will facilitate better forest management and sustainable protection of the aspects of forests which enhance these values.

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Model calculations of the quanitities of landfill gas, emitted from the landfill for solid domestic waste in Blagoevgrad (village of Buchino)

Stefka Tzekova[13], Ivailo Ganev[2], Boyan Dimitrov[14]

***Abstract**: The biogas released from the landfills has got a noxious effect. It also creates the most serious environmental problems after the landfills closing. The gas releases actively for more than 25 years. That is why extremely high requirements for its utilization have been set today. The first step in this direction is the determination of its amounts. A prognosis for the quantities of gas released from the landfill at the village of Buchino has been made in the present report. The used mathematical model of prognosis has been adapted for the conditions in Bulgaria on the basis of the authors' experience gained during their observations and research of a number of landfills in the country*

Keywords: landfill gas, biogas, RES

INTRODUCTION

Closing of most of the landfills for domestic waste in our country which do not meet the contemporary requirements for construction of this kind of facilities is scheduled in the current and in the next year. In fact, these are landfills of municipalities (excluding those of the biggest towns), established long time before the actual standards for construction of landfills for domestic waste have been determined. However, closing of these landfills does not solve the problems with the emissions of harmful substances from them. The main problem from the environmental point of view is the emitted from the landfills for domestic waste landfill biogas. The landfill gas has been emitted actively for more than 25 years after the disposal of the waste. For this reason extremely high requirements are set for its disposal.

Objectis

The landfill in the village of Buchino, servicing the municipality of Blagoevgrad, is a typical landfill, for the closing of which particular measures are taken. The objective of this report is to present an approach for determination of the quantity of landfill gas, emitted from the landfill.

One of the important conditions for the determination of the method of extraction of the landfill gas and selection of a technology for its disposal is to have available data about the expected quantities of emitted gas.

13 South West University, Blagoevgrad, Bulgaria

14 Technical University – Sofia, Bulgaria

For this type of landfills for domestic waste and in particular the one in the village of Buchino, there are no monitoring and carried out experiments for determination of landfill gas emissions. The available data refer mainly to summarized quantitative values, without morphological structure studies, etc. When speaking about quantities, the established standard of accumulation of waste per resident should be taken into account. Based on the studies carried out by us, we have established the following accumulation rate (for the towns, where there is a relatively precise measurement of the disposed waste) – fig. 1. In other words, it can be reckoned in general for the estimation of the quantity of the emitted landfill gas, that the accumulation rate is 1 kg/day/resident.

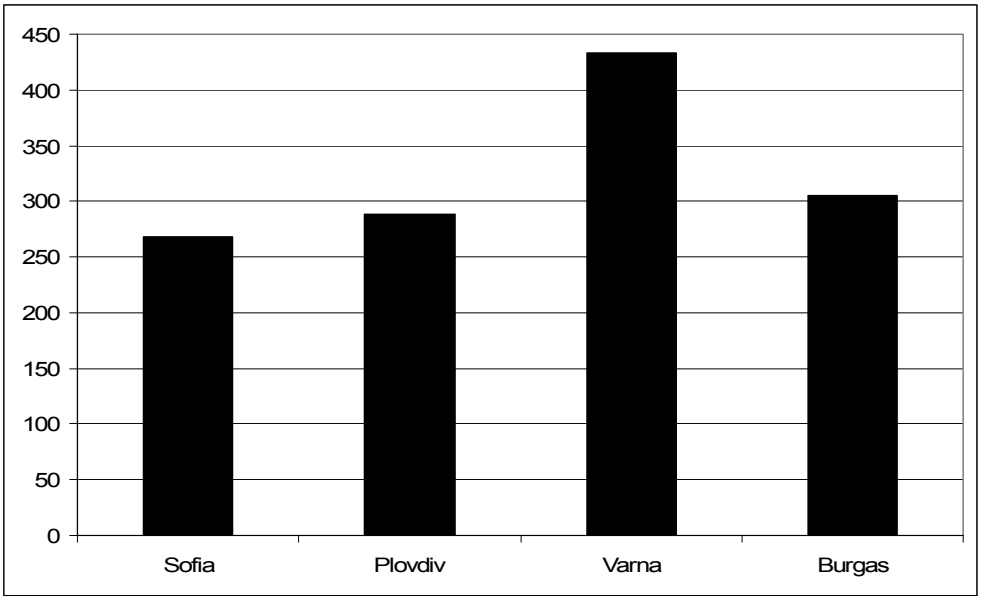

Fig.1 Accumulation rate is 1 kg/day/resident to Sofia, Plovdiv, Varna and Bourgas

These deductions are proven also for the municipality of Blagoevgrad, based on the landfill volume, the density of the disposed waste and the filing level.

For estimation purposes of the quantity of emitted landfill gas it can be supposed that annually the landfill in the village of Buchino receives approximately 30.000 tones of waste.

We have made our estimations using the so called first-order model. In this model the dynamic of emissions of landfill gas is a falling exponent and is shown on fig. 2.

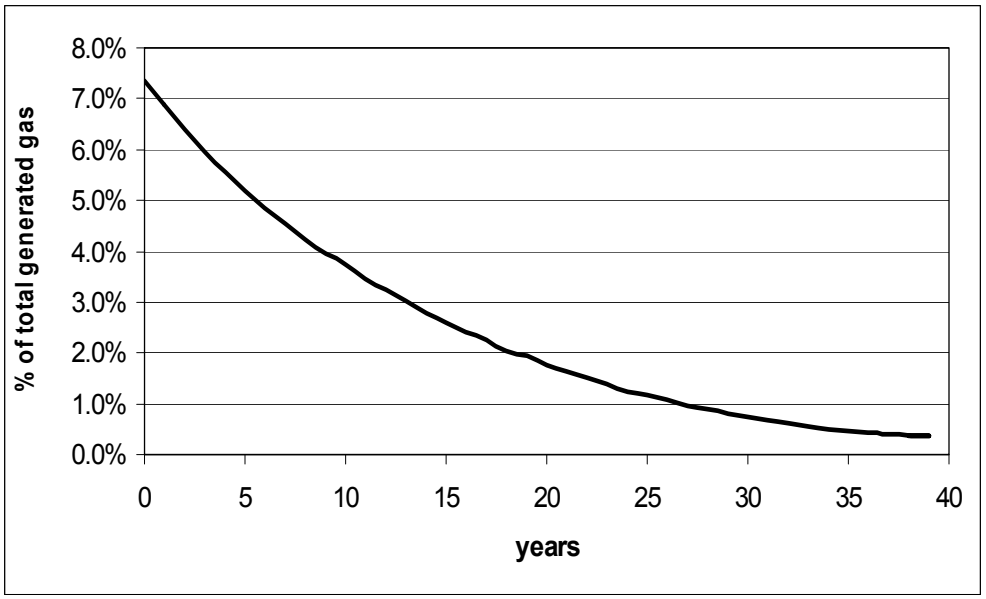

Fig.2 Intensity of gas generation

REZULTS

For the landfill in the village of Buchino it may be supposed that from 1 ton of waste the landfill gas, which may be caught, amounts to 40 m3. This relatively law amount is accepted because of occurring self-ignition of the landfill.

According to these data the following estimations of the emitted quantities of landfill gas are calculated – Fig. 3

In terms of opportunities of landfill gas recovery the energy, which may be generated by it is of interest. The fuel component in the landfill gas is methane. For methane content of about 50% the fuel value of the landfill gas is shown on Fig. 4.

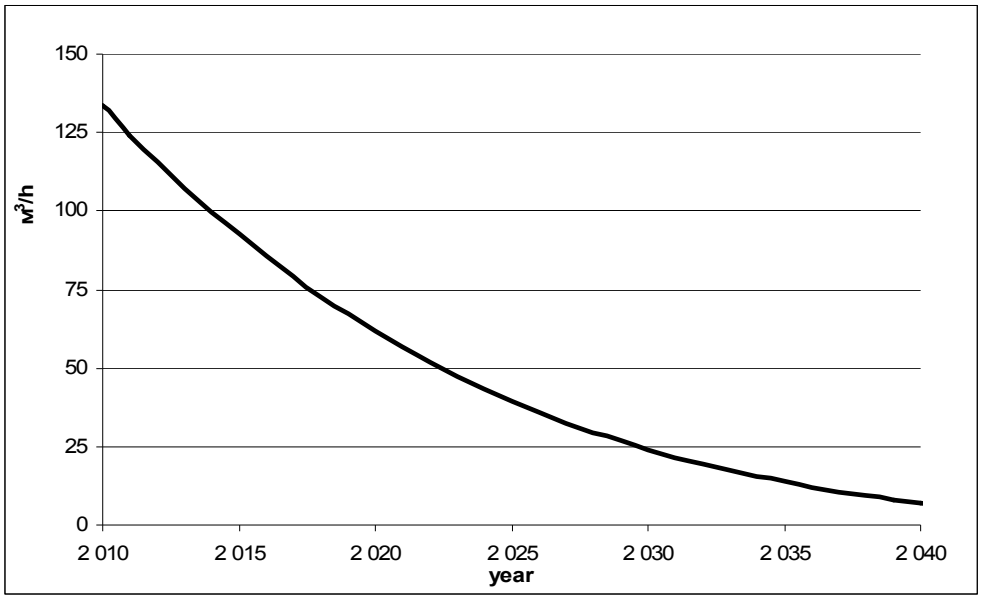

Fig.3 Landfill gas flow

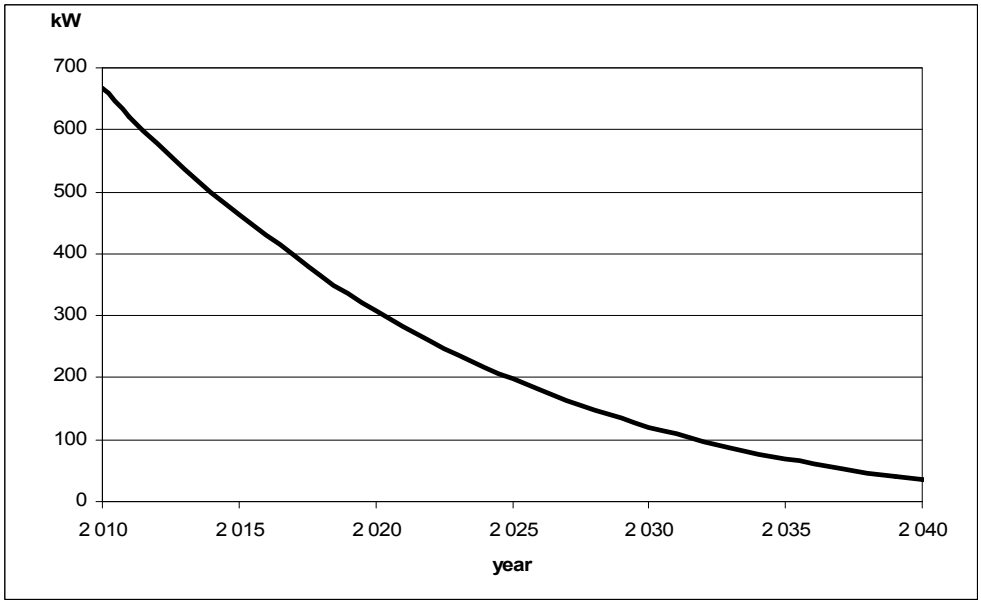

Fig.4 Energy potential

CONCLUSIONS

Although the expectations provide a relatively limited flow rate of landfill gas from the landfill in the village of Buchino, the gas emission should be controlled through construction of gas wells and its forced extraction and disposal must be organized. After having gas wells constructed an analysis of the quantity and the quality of the emitted landfill gas with relevant accuracy will be possible.

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GIS and remote sensing for environmental modelling

Penka Kastreva

South West University”Neofit Rilski”, Blagoevgrad, Bulgaria

Abstract: *This paper aims to explain how spatial information may be used for environmental modeling and management in Geographic information system (GIS) media. Another important point in this work explains how to obtain geographical information from remote sensing methods. A classification of GIS environmental models has been presented. This classification gives a review to very different models, which helps in transferring knowledge between different application areas of the environmental sciences. There are also examples from various application fields in the environmental sciences.*

Keywords*: GIS, remote sensing, environmental modeling,*

1. THE CHALLENGE IN THE WORLD

The environment is the key to sustaining human economic activity and well-being. Sustainable human development is a term for notation of paradox “Economic growth versus the progress i.e. that attempts to balance the often conflicting ideas of economic growth while maintaining environmental quality and viability. [Wainwright et al, 2004]. In any definition of sustainability, a key element is the change. Some authors define sustainability as maintaining components (such as biological diversity, water quality, preventing soil degradation) of the natural environment over time. A broader definition of sustainability includes the persistence of all components of the biosphere. Other definitions emphasize increasing the welfare of people while minimizing environmental damage. Goodland and Ledec (1987) underline that renewable resources should be used in a way which does not degrade them and those non-renewable resources should be used so that they allow an orderly societal transition to renewable energy sources. These changes continually occur at many spatial (e.g. global, continental, regional, local) and temporal (e.g. ice ages, deforestation, fire) scales.

The main components of the environment are: the air, the water, the soil, the landscapes and the nature (ecosystems, flora and fauna), the urban environment area, the population, the production and the consumption, the exploiting of natural resources, the emission in the atmosphere, waters and soils, the refuse, the noise and the radiation, the chemical and the genetic modified organisms; the natural and the technological risks; the power production, the industry, the transport, the agricultural and the forestry enterprise, the fishing, the tourism and there influence over environment and so on. These elements require the provision of timely, accurate and detailed in-

formation on land resources as well as changes in the land resources. Environmental changes that have to be mapped are: climate changes, ozone depletion in the stratosphere, luck of biodiversity, disasters; the tropospheric ozone; the forest degradation, coast guard; coordination of waste, urbane stress; chemical risk ect.

2. TYPES OF MODEL IN THE SPATIAL SCIENCES

A model is an abstraction of reality [Robinson et al, 1995]. The best model is always that which achieves the greatest realism. Environmental scientists have used spatial models of topographic surface, populations, environments, infrastructures in the form of maps and drawings. Maps and drawings are abstractions of the form of nature in the same way that models are usually abstractions of the process of nature. Mathematical models have been developed since the origin of mathematics, but there was a significant increase in modelling activity since the development of calculus by Newton and Leibniz working independently in the second half of the seventeenth century. Models can be classified hierarchically. The two model types are the mathematical models and the physical or hardware models. Mathematical models are much more common and represent states and rates of change according to mathematical rules. Mathematical models can range from simple equations through to complex software codes applying many equations and rules. There are no universally accepted typologies of mathematical models. Nevertheless, it is useful to understand the properties according to which models may be classified. In short the potential mathematical models are next: Conceptual type: empirical, conceptual, physically based or mixed; Integration type: analytical, numerical or mixed; Mathematical type: process models (deterministic or stochastic or mixed); Spatial type: lumped, semi-distributed, distributed, 1D, 2D, 3D (within the context of a GIS) or mixed; Temporal type: static, dynamic or mixed. Using terminology found in the environmental literature, models are characterized as 'models of logic' (inductive and deductive), and 'models based on processing method'. (deterministic and stochastic). The last belong to mathematical models. Most of the deterministic models are derived empirically from field measurements. They may be inductive or deductive. Further the mathematical models can be separated also into empirical, conceptual or physically types. Empirical models describe observed behaviour between variables. In other words, they have been confirmed by actual experience. They are usually the simplest mathematical function, which adequately fits the observed relationship between variables. Empirical models are also known as statistical or numerical data models. This type of model is derived from data. Normally in the science the model is usually developed using statistical tools for example, regression. Conceptual models are built on the basis of preconceived notions of how the system works. They add the parameter values, which describe the observed relationship between the variables. Physically models should be derived from established physical principles and produce results that are

consistent with observations. There are models that fall broadly under the heading of physically based. They include some level of empirical generalization in order to fill gaps where the physics is not known. Process models (deterministic and stochastic) emphasize the importance of the processes transforming input to output data. Physically based models are characterized with this that they often do not agree with observations. Models can be further subdivided according to how the equations are integrated. The either way is analytically solving of the model equations as differential equations or numerically solving them within a computer as difference equations. Models are of different spatial types. They are classified as interrupted models, which simulate a spatially heterogeneous environment as a single value. Semi-distributed models may have multiple values representing clearly identifiable units. Distributed models break space into discrete units, usually square cells (rasters) or triangular irregular networks (TINs) or irregular objects. The space of a model may be one-dimensional, two-dimensional sometimes three-dimensional. Most of the models are still mixtures of many of these types. Both inductive and deductive methods have been used for environmental modelling. However, inductive models dominate spatial data handling in GIS and remote sensing in the environmental sciences.

3. THE NATURE OF ENVIRONMENTAL MODELLING WITH GIS AND REMOTE SENSING

Modelling in environmental sciences is described as an art because it involves experience, intuition and mathematical skills. In science modelling supports the development of experiments in which hypotheses can be tested and outcomes predicted. A model is presented as a system of mathematical equations explaining the function of environmental processes in the station. The cartographical meaning of the concept model unlike the map consists of the database contents. The digital map contains only graphical database, while the cartographical model has as well attribute database which is related with the graphic. Both, the digital map and the model, are founded of the mathematical model. The models may also allow prediction and simulation of future conditions, both in space and time. The goal of building models is to understand the phenomenon and finally to build a sustainable system for its management. Mapping and environmental modelling of ecosystem’s changes with GIS and remote sensing support natural phenomena and disaster processes management. GIS is being more and more used for making decisions, planning and environmental management. GIS models may vary in space, time and state variables. Environmental models are being developed and used in a wide range of disciplines, at scales ranging from a few meters to the whole earth, as well as for purposes including management of resources, solving environmental problems and developing policies. GIS and remote sensing are necessary tools for sustainable development. The spatial data in GIS databases are predominately generated from remote sensing through the direct are import of images but also through the generation of

conventional topographic maps using photogrammetry. Remote sensing data, such as satellite images and aerial photos allow us to map the variation in terrain properties, such as vegetation, water, and geology, both in space and time. Satellite images provide very useful environmental information for a wide range of scales, from entire continents to details of a metre. Thus remote sensing is an integral part of GIS, and GIS is impossible without remote sensing. GIS and remote sensing have been combined with environmental models for many applications. These models are used for: monitoring of deforestation, agro-ecological zonation, ozone layer depletion, early warning systems, monitoring of large atmospheric-oceanic anomalies, climate and weather prediction, ocean mapping and monitoring, wetland degradation, vegetation mapping, soil mapping, natural disaster and hazard assessment and mapping, and land cover maps for input to global climate models.

4. EXAMPLES OF GIS AND REMOTE SENSING APPLICATIONS FOR ENVIRONMENTAL MODELLING

Geographic environmental data can be use for:

- Land – atmosphere interaction modelling

Climate models incorporate a greater quantity and higher quality of terrestrial data compared to a decade ago. Both general models that are used to estimate global climates under specific conditions are meteorological and land surface model. The meteorological model, uses of land cover data to set parameters (moisture, energy, and so on) for land-atmosphere interactions. Land surface process models were developed to describe the effects of the environmental state on these parameters.

- Ecosystems process modelling

These models ensure the relationship between atmospheric process modelling and ecosystems processes and functions. In biogeochemical modelling, it is important to include land cover attributes describing community composition or vegetation types. Some models (CENTURY, BIOME-BGC) have been used to evaluate the equilibrium response of ecosystems to doubled atmospheric $C0_2$ and associated climate change.

- Hydrologic modelling

Elevation, elevation derivatives (e.g. slope, aspect, drainage flow direction) and land cover data are required for modelling the physical processes of the hydrologic cycle ecosystems. One of the most important developments is the use of remotely sensed data for land surface and parameters that can serve as input data to models. Coupling of SVAT (Soil Vegetation Atmosphere Transfer) models with distributed hydrological process models and biological production models can be used to assess the effects of land cover changes on the regional hydrological cycle. One thing we are confident about is that modelling in a GIS environment, with a strong link to remote sensing is a promising way to go.

- Vegetation mapping and monitoring

Vegetation is a fundamental attribute of landscapes which influences a whole host of environmental processes. Mapping of vegetation via remote sensing is providing information on vegetation properties for large parts of the world in sufficient spatial detail to aid environmental modelling. Vegetation mapping at local to regional scales is currently dominated by imagery from the Landsat and SPOT satellites.

- Wildlife mapping and modelling

Wildlife conservation has been achieved with creation of parks and reserves in different parts of the world. These areas protect individual plant and animal species, or groups of them. Successful wildlife management requires appropriate spatial and temporal data on the distribution of wildlife populations. Remote sensing and GIS techniques are increasingly being used in the collection and analysis of these data as well as the monitoring and overall management of wildlife. Most commonly, distribution is derived from observations in the field of the animal species or aerial and satellite survey methods. GIS is increasingly used for mapping wildlife density and distribution.

- Biodiversity mapping and modelling

Biodiversity mapping and modelling is becoming increasingly important not only to the governments and intergovernmental agencies and programmes. BIOCLIM is one example of a tool that uses environmental parameters, in this case climate, to estimate species (animal or plant) distributions, that is influenced by climate. Predicted distributions are based on the similarity of climates at points on some geographic grid to the climate profile. BIOCLIM can also reconstruct palaeohistoric distributions and predict the potential impacts of climate change.

- Natural disaster management

Disasters are extreme events within the Earth's system that result in death or injury of humans, and damage or loss of valuable goods. Disasters can be classified in the next way: natural disasters which are caused by purely natural phenomena and bring damage to human societies such as earthquakes, volcanic eruptions, hurricanes, tsunami; disasters which are caused by human activities such as atmospheric pollution, industrial chemical accidents, major armed contlicts, nuclear accidents, oil spills; and mixed natural disasters which are accelerated by human influence such as landslides, erosion, greenhouse effect. Natural disaster management requires a large amount of temporal spatial data. Satellite remote sensing is the ideal tool for disaster management, since it offers information over large areas, and at short time intervals. In practice remote sensing is mostly used for warning and monitoring. It can be utilized as well in the various phases of disaster management, such as prevention, preparedness, and reconstruction. The use of remote sensing data is not possible without a proper tool to handle the large amounts of data and combine it with data coming from other sources, such as maps or measurement stations. Therefore, together with

the growth of the remote sensing applications, GIS have become important for disaster management. Remote sensing and GIS provide a historical database from which hazard maps may be generated, indicating which areas are potentially dangerous. As many types of disasters, such as floods, drought, cyclones and volcanic eruptions will have certain precursors, satellite remote sensing may detect the early stages of these events as anomalies in a time-series. Simultaneously, GIS may be used to plan evacuation routes, design centres for emergency operations, and integrate satellite data with other relevant data. GIS may model various hazard and risk scenarios for the future development of an area.

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Spot analysis of thermal comfort in some open urban spaces of Craiova city

Ioan Eustatiu Marinescu[15], Sorin Avram[1], Gheorghe Clota[16], Mihai Radu Costescu[17]

Abstract:*The paper deals with the application of a methodology designed to analyze the relationship between outdoor climatic conditions and the perception of bioclimatic comfort. The experiment consisted of conducting simultaneous questionnaire surveys and weather measurements during summer time. Is was carried out along a pedestrian urban area in Craiova with pre-established measuring points.*

The results showed that under normal outdoor conditions, thermal comfort is strongly influenced by the different types of urban habitat. The perception of air temperature is difficult to separate from the perception of the thermal environment and is modified by other parameters particularly wind, solar radiation, related to the intensity of fluxes from various directions (i.e. falling upon both vertical and horizontal surfaces), weighted by the coefficients of incidence upon the human body.

The analysis proved that this methodology is well-suited to achieving a good perspective over improving urban design and that it may be applied in other cities areas and in other seasons.

INTRODUCTION

Urbanization has led to substantial changes in land use, vegetation cover and other environmental parameters, and to the introduction of new elements and materials that can alter local surface–atmosphere energetic fluxes, thus disturbing regional climatic patterns.

The thermal climate of cities depends on their location in a specific climate zone as well as topographic and orographic factors. These background condition are modified by energetic and dynamic characteristics of cities, which lead to an elevated thermal level. Compared to the rural surroundings, it is well known as urban heat island UHI. This typical phenomenon of the urban climate is analysed by numerous investigations worldwide (e.g.Arnfield, 2003; Oke, 2006; Emmanule and Fernando, 2007).

However, there are only a few studies focussed on the assessment of the thermal component of the urban climate related to people in cities, i.e. in a human-biometeorologically significant way, although thermal comfort strongly controls their efficiency, well-being and health (Mayer, 1999 b;

[15] University of Craiova, Geography Department
[16] University of Craiova, CCMVDR (Center for Environmental Research and Sustainable Valuing of Resources)
[17] University of Craiova, Informatics Department

Mertens, 1999; Höppe, 2002; Thorsson et al., 2004; Ali-Toudert et al., 2005; Knez and Thorsson, 2006; Ali-Toudert and Mayer, 2006, 2007a, 2007b).

Outdoor public spaces contribute to the quality of life in cities and have an important role in the outdoor activities of urban dwellers (Thorsson et al. 2004) and contribute to strengthening social interactions between citizens (Nikolopoulou and Steemers 2003). Outdoor public spaces are considered areas accessible to the general public, such as *streets*, *plazas*, *squares* or *parks*, where people perform recreational and outdoor activities.

These areas can exhibit great differences with regard both to the level of usage and to the types of activity performed (Cervera 1999; Zacharias et al. 2001). Recent research has shown that microclimatic conditions have a big effect on the usage of open spaces, partly because of their influence on levels of thermal and mechanical comfort (Nikolopoulou et al. 2001; Givoni et al. 2003).

Thermal comfort is defined by Ashrae (1966) as "***the condition of mind in which satisfaction is expressed with the thermal environment***".

STUDY AREA

The city of Craiova is situated in the middle of Oltenia (one of the Southern regions of Romania), on the Jiu Valley and is located at approximately equal distances from the Southern Carpathians (north) and the Danube (south).

The climate is temperate continental with strong Mediterranean influences, characterised by mild, wet winters and dry, hot summers, which partly explains why its population frequently engages in outdoor activities, especially during spring and summer. Studies of Craiova's urban climate have been undertaken since 2004 at the Center of Environmental Research and Sustainable Valorification of Resources (CCMVDR) of the University of Craiova and have focused on Urban Heat Island (Marinescu, I., 2006), Urban Green Typology (Marinescu, I., Patroescu Maria, 2003), on the consequences of city growth upon ventilation conditions (Marinescu, I., 2006).

Fig. 1 – Study area – Unirii Street/Mihai Viteazu Plaza

Craiova has a wide range of outdoor public spaces, ranging from green areas to green walk sideways, squares and parks, which have different environmental characteristics and microclimatic conditions.

Mihai Viteazu Plaza and the northern end of Unirii Street were selected for the pilot study **(fig. 1)**. They stretch out in the central inhabitated area between busy traffic roads mainly on east-westward direction. The sector covers an area of approximately 10.000 squere meters. Within its limits the area is made up of paved sideways for walking, bordered by meadows biotopes, trees and constructed structures. This open space is used by the inhabitants of the city mainly for everyday promenading because of its central location and transit function for people. The orientation of urban morphology represents an important factor for the selection of measuring points.

METHOD

The methodology was focussed on two main directions. A one day experiment in the study area for the measuring of the meteorological values in the course of the day at the four preestablished measuring points. The second direction was focussed on a 11 weeks survey from April to June 2008 in order to study the behaviour of people in the studied area (open space) in connection to thermal comfort conditions. An important inffluence over the local situation within the study area is the presence of heat island with reduced ventilation and general orientation of built up area.

Fig. 2 - Preestablished measuring points in the study area

The overal study deals with periods of heat stress and reduced cooling during the investigation period of June. The thermal conditions were used to calibrate thermal sensations by an observation of the behaviour of people using the open

spaces near the walk sideways and stationary areas along the four points of observation **(fig. 2)** acoording to different types of activities **(table 1).**

The field data collection included questionnaire surveys and the measurement of weather parameters during the measurement period that lasted form 08:00 a.m. to 09:00 p.m.. There were also been taken fotographs of the study area in order to monitor any behaviour of users within it's limits indicating adaptation to urban bioclimatic conditions.

The field studies were carried out in late winter and spring, specifically beginning with the **15th of March till the end of June.** The weather conditions were characterized by partly cloudy sky and temperatures above the monthly average. Wind speed conditions were characterized by an average of 0.6. m s.

WEATHER MEASUREMENTS

The weather parameters measured in order to characterize the general weather conditions in the study area (*localscale)* and the thermal environment in which individuals move (*micro scale*) were air temperature (Ta), relative humidity (RH), wind speed (v) and mean radiant temperature (ºC). With the purpose of assessing the changes in the thermal environment during the questionnaire session, a Tinytag 433–7841 thermo-hygrometer (Gemini Data-loggers, Chichester, UK) was placed on a lamppost at a height of 2 m in the green area togheter with an automatic weather station (Multilog Pro-Fourier) **(fig. 3)**, facing north and sheltered from solar radiation, which recorded Ta and RH every 10 min.

Fig. 3 – MultiPro Fourier automatic

The thermological and physical processes based on heat balances of man are described by Fanger (1970) and Höppe (1999) to get the Predicted Mean Vote (PMV) of the Physiological Equivalent Temperature (PET). This parameter is strongly influenced by wind velocity, long and short wave radiation, humidity and air temerature.

The Physiological Equivalent Temperature (PET) is based on the Munich Energy-balance model for individuals (MEMI). PET is defined as air temperature at which in a tipical indoor setting (without wind and solar radiation) the heat budget of human body is balanced with the same core and skin temperature as under the complex outdoor conditions to be assessed.

This way PET enables a lay person to compare the integral effects of complex thermal conditions outside with his/her own experience indoors. On hot summers days, for example, with direct solar irradiation the PET value may be more than 6ºC higher than air temperature, on a windy day in winter up to 4ºC lower.

The calculation of the Predicted Mean Vote (PMV) and Predicted Percentage Dissatisfied according to ISO 7730 **(fig. 4)**, offers the possibility to evaluate the thermal comfort by the inputs of air temperature, mean radiant temperature, relative humidity, air velocity, clothing thermal resistance and metabolic rate recorded with the mobile weather station. Built in calculators are included to assist in determing clothing thermal resistance and metabolic rate. Optimisation routines are provided for determining required air temperature or mean radiant temperature for good thermal comfort

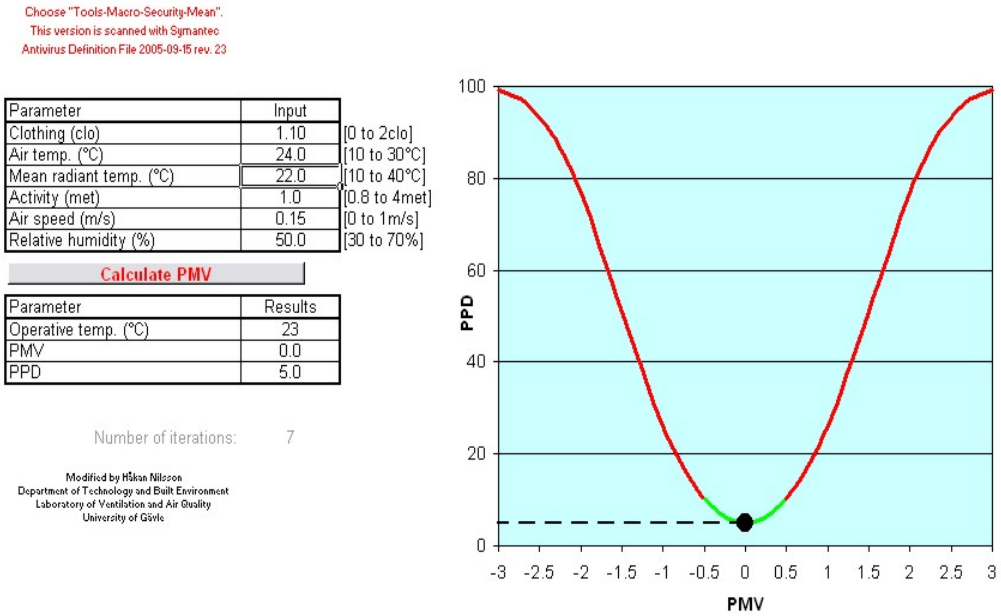

Fig. 4 – Calculation of PMV and PPD thermal comfort indicators

The effect of thermal comfort by open space design using shadow was easily calculated by comparison to the four measuring points, taking into account the physiological equivalent temperature (PET) dependency with sun radiation and air temperature (fig. 5).

One can notice the constant gap of nearly 6.1ºC between the PET values in measurement point 2, 4 in sun and 1, 3 in shadow independently form air temperature.

Table 1 - Thermal sensation and needed thermal conditions for different types of urban activities (Katzschner, 2002)

PMV	PET ^{O} C	thermal sensation
		Very cold
- 3,5	4	
		Cold
- 2,5	8	
		Cool
- 1,5	12	
		Slightly cool
- 0,5	16	
	20	Neutral
0,5	24	

activities	needed thermal conditions for use of open spaces	PET ^{O} C
sitting	warm	30
calm activities	warm moderate	26-32
children play	warm moderate	24-26
recreation	neutral	16-24
light movement	neutral	16-26
shopping	warm moderate	26-32
movement	lightly cool	14-24
strong movement	cool to cold	12-24
garden activities	lightly cool	12-24
work outside	neutral to cold	16-22

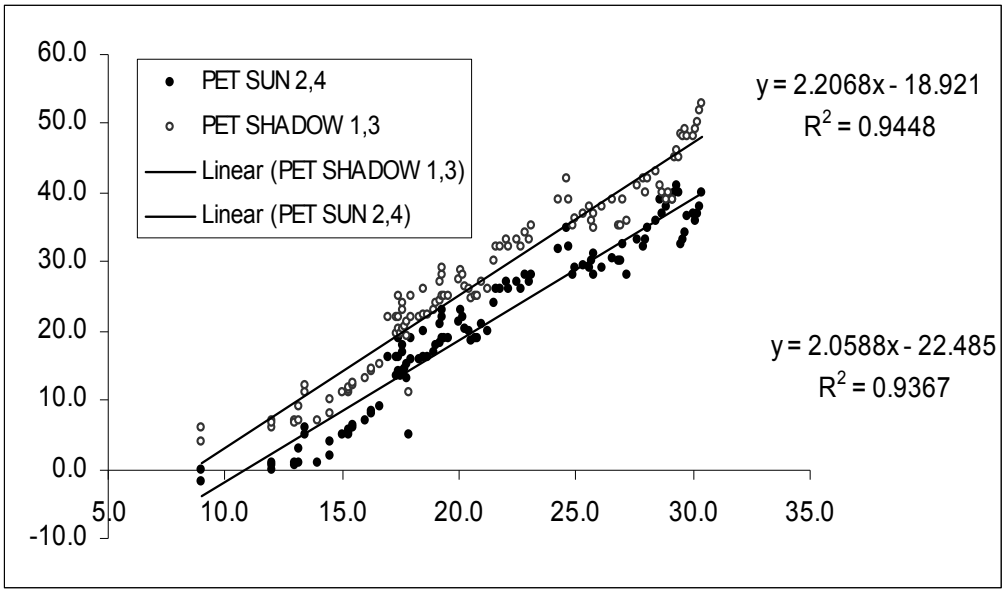

Fig. 5 – Relation between air temperature and the thermal comfort index PET in sun and shadow during measurements in Craiova (2,4;1,3 form 8 a.m. to 1 p.m.)

Another influencing factor which is to be considered in thermal comfort evaluation is thermal sensation and the **physiological stress level (fig. 7)**.

The investigations focused on the periods of heat stress and reduced colling during the investigation period in June. The destination of thermal condition was used to calibrate thermal sensations by observation of the behaviour of people using the open space within the study area. Thsese measurements were recorded with parallel interviews. The mean radiation temperature and globe temperature measurement results are used with correction factors in dependence of radiation and wind.

The questionnaire was applied to randomly selected people passing by on the sidewalk or sitting on the benches in Mihai Viteazu Plaza (fig. 6). In order to ensure that the sample was reasonably homogeneous, only young

people and adults engaged in low or moderate physical activity were approached. The youngest interviewee was 17 years old. The questionnaire was designed using concise and plain language in a short-answer format and could be completed in about 2 min.

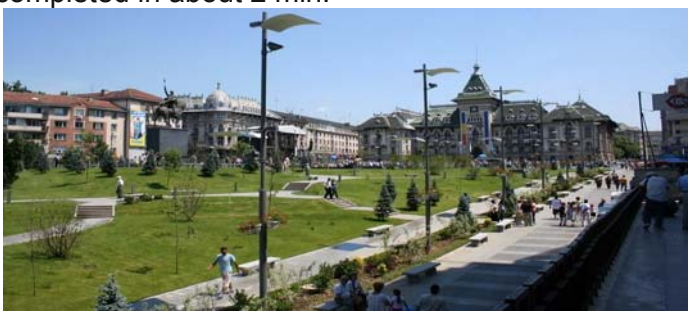

Fig. 6 - Mihai Viteazu Plaza

It was divided into two parts: the first part comprised the personal characteristics of the interviewees, while the second addressed the perception of comfort by the interviewees in relation to the weather parameters.

The selection and structure of the questions were based on previous studies (Nikolopoulou and Steemers 2003; Stathopoulos et al. 2004; Knes and Thorsson 2006) that had demonstrated the importance of a person’s individual characteristics and inherent psychological factors in the perception of comfort. The questionnaire is described in further detail in the following section

RESULTS

he one day experimental measurements **(fig. 8)** points out that the globe temperatures react very similar from sunny to shadowed areas. Globe thermometers were slowly reacting against the change of global radiation, thermal conditions (PMV, PDD) being strongly influenced by wind and radiation values **(fig. 8,9,10)**. The course of air temperatures, surface temperatures and globe temperature reveal great differenced in acoording to PET values at the measuring points.

Table 1 Physiologically Equivalent Temperature (PET) for different grades of thermal sensation and physiological stress on human beings (during standard conditions: heat transfer resistance of clothing: 0.9 clo internal heat production: 80 W) (*Matzarakis and Mayer*, 1996)

PET (°C)	Thermal sensation	Physiological stress level
	very cold	extreme cold stress
4	.....	.....
	cold	strong cold stress
8	.....	.....
	cool	moderate cold stress
13	.....	.....
	slightly cool	slight cold stress
18	.....	.....
	comfortable	no thermal stress
23	.....	.....
	slightly warm	slight heat stress
29	.....	.....
	warm	moderate heat stress
35	.....	.....
	hot	strong heat stress
41	.....	.....
	very hot	extreme heat stress

Fig. 7 - Physiologically Equivalent Temperature (PET) for different grades of thermal sensation and physiological stress on human beings (during standard condi-

tions: heat transfer, resistance of clothing: 0.9 clo internal heat production: 80 W) (Matzarakis and Mayer, 1996)

The one day measurement were carried out on 25th of June in the sudy area at the four indicated points **(fig. 8,9,10,11).** The recorded meteorological parameters in the investigation site were global radiation Rg [W/m^2], air termperature Ta [ºC], surface temperatures Ts [ºC], wind speed v [m/s], globe temperature big and small TGb and TGs and the correspondent PET values in [ºC].

The results are shown in the figures below. It was noticed that the globe temperatures react very similar, with a slight faster reaction time of the small instrument being conditioned by the wind speed . Globe thermometers react quite slowly against the change of global radiation, which is not the case of PET value which is directly influenced by wind and radiation values (fig. 12).

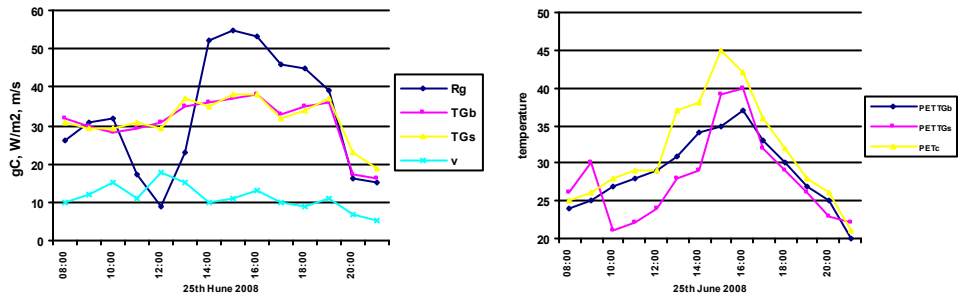

Fig. 8 - One day measurements of radiation Rg in W/m^{2}x10, wind speed v in m/s and two glob temperatures TGb TGs ºC (left) and three different PET values in ºC (right)

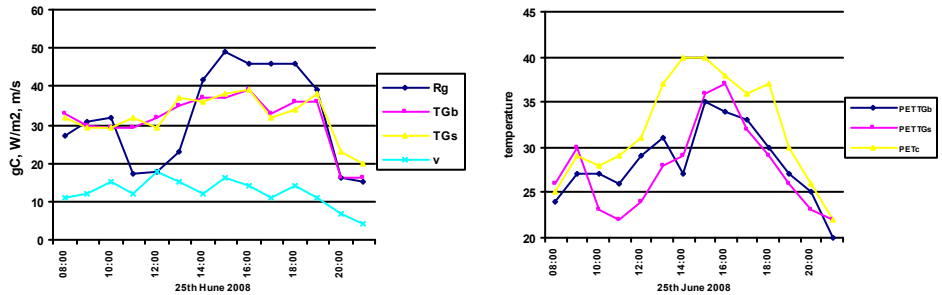

Fig. 9 - One day measurements of radiation Rg in W/m^{2}x10, wind speed v in m/s and two glob temperatures TGb TGs ºC (left) and three different PET values in ºC (right)

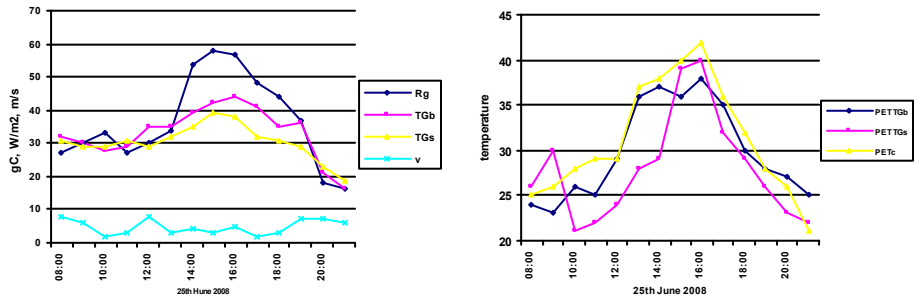

Fig. 10 - One day measurements of radiation Rg in W/m^{2}x10, wind speed v in m/s and two glob temperatures TGb TGs ºC (left) and three different PET values in ºC (right)

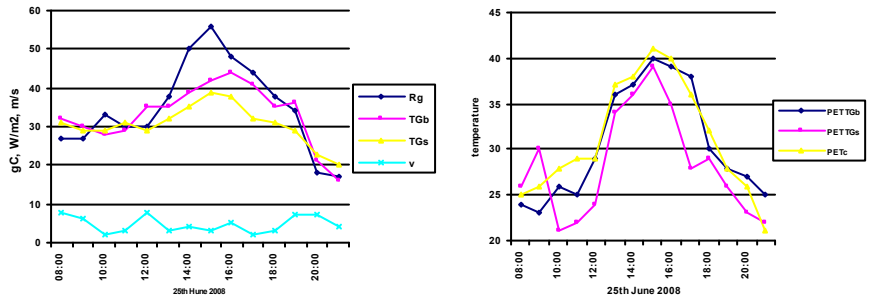

Fig. 11 - One day measurements of radiation Rg in W/m^{2}x10, wind speed v in m/s and two glob temperatures TGb TGs ºC (left) and three different PET values in ºC (right)

In (fig. 12) we observed the course of air temperatures, surface temperatures and globe temperature in connection to the calculation of PET. Here the daily course represent only a trend line but not changes on short term. A good understanding of the thermal situation is given by the surface temperatures.

Focusing on the hourly averages, there were developed wighting factor in order to get the mean radiation temperature. Taking into account the mean radiation temperature from globe or air temperatures PET easily can be calculated as all other parameters can be taken directly form measuring point.

Even if there was only a one day experiment in the study area the results are very interesting as they show big differences in terms of PMV, PPD and PET due to different orientation of sidewalks, green ratio and shadow zones.

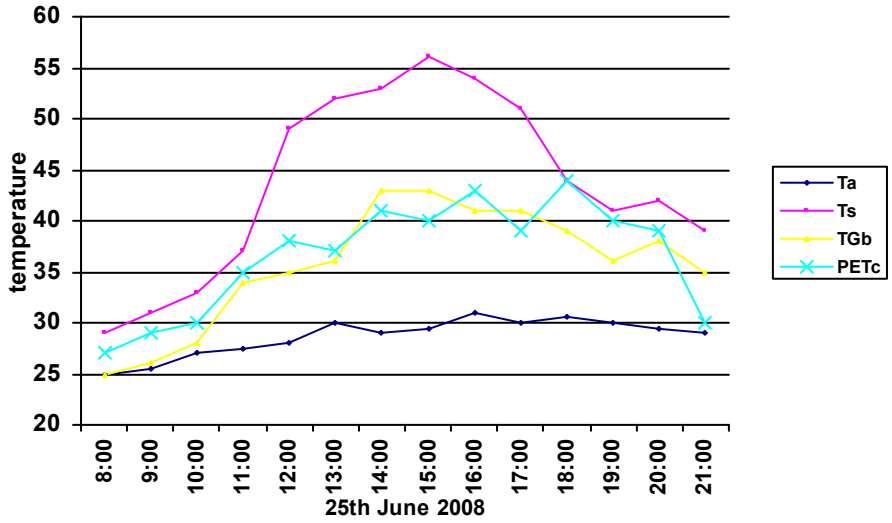

Fig. 12 – Daily variation of air temperature (Ta), surface temperature (Ts), globe temperature (TGb) and PET (PETc) al in ºC

Use of open spaces according with thermal comfort conditions

Thermal comfort was calculated on the basis of previous data and observation of how people react and behave on thermal comfort in the study area. There was taken as index for thermal comfort the PET. During the analysis period of 11 weeks there were counted all people that used to stay for longer in the study area. There were correlated the frequency of people and PET values.

In fig. 13 are one can see the weekly averages of PET in all measurement units as well as wind speed and absolute number of people using the area.

First observation is that people like sitting in the area 1 and 2 with increasing PET values. The study area benefits of a moderate but urban climate and heat stress occurs with more than 24ºC, which can be considered as neutral. A small percentage of people seek for warm thermal conditions. The discomfort situation was generated by the windy conditions that occurred 7th week.

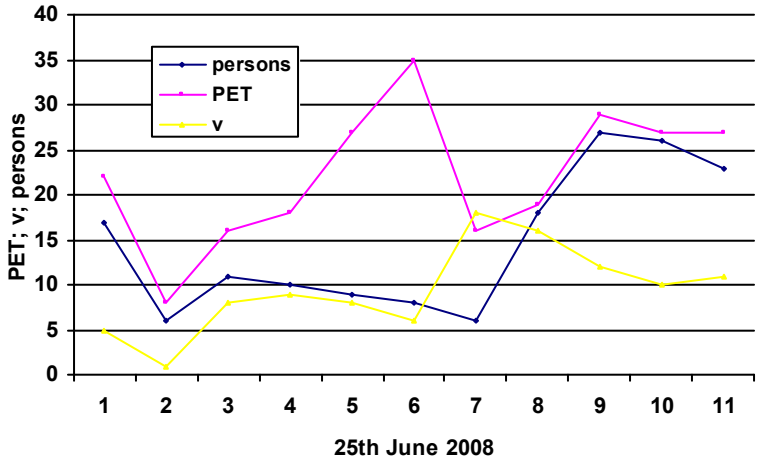

Fig. 13 – Thermal comfort, wind speed and frequency use of open spaces cumulation 1-4 measuring point

The observations pointed out that even during a warm summer day, with PET values above 24ºC not all people look for shadowed and greened places such are 1 and 3 which are much cooler than, but wat to be in the open space with warm or even heet stress conditions. This behaviour is very much in accordance to the espectation of the usual warm summer. Discomfort conditions are mainly prevailing according to the activity shortly before and a thermal compensation is dominating

Warm sensation is correlated very much with high solar radiation and low wind speed. During the 11 week’s investigation period from April to June the normal behaviour was an increasing open space use with increasing of PET. The two exception weeks were combined with rain and higher wind speeds. One can see the absolute values of PET often exceed neutral conditions but still people are looking for sunny open space with good ventilation with a correlation of clo index. There was identified a significant correlation between PPD and the daily evolution of PMV.

CONLUSIONS

The shows the people’s behaviour is very much dependent on the evolution of PMV in close relation with the functionl role of open space and different types of activities.

The description of thermal conditions have to be easily understood and also easily to get. In terms of this evaluation of the thermal condtions it seems possible to use simple assumption to classify thermal sensations. People react on climte objectively in accordance with the calculated thermal indices, but their thermal sensations are correlated with individual expectations. Especially as the results are used in an open space design the accuracy must be fit to that perspective and the accuracy showed in this paper

represent a starting point into assessing and analyzing the potential impact of thermal comfort on open space using and valorification.

Moreover a characterization and assessment of different city structures as well as climatic and urban patterns can be derived.

Thus, understanding the reachness of microclimatic characteristics in outdoor urban spaces, and the comfort implications for the people using them, opens up new possibilities for the development of urban spaces in Craiova.

The thermal bioclimatic conditions in Craiova city are described for the first time into an assessment method based on people perception of bio-climatic characterstics of the urban ecosystem.

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Water quality, physico-chemical and ecological status of the Struma river*

Assoc.prof. eng. Michail As. Michailov, PhD
South-West University „Neofit Rilski“ - Blagoevgrad, Bulgaria

Abstract. *There are a lot of interpretations about river water quality in the literature. Many of them are debatable. This article presents an analysis of some reasons and ideas for correction and for improvement of the positions about the significance of the hydro-morphological, the physico-chemical and the biological parameters as a tool for the Struma river* water quality and status assessment.*

INTRODUCTION

There are a lot of interpretations about river water quality in the literature. Many publications have presented data and information for:

- different parameters of the quality state in various river reaches;
- the specific requirements concerning water quality for different uses (for potable, domestic and industrial needs; irrigation; recreation, etc.);
- tools and methods for measurement of the water quality parameters, for determination of the water pollution degree and for the environmental status assessment, etc.

It is clear there are many possibilities for registration, evaluation and presentation the dynamic and the changes of the river water quality state. In any case their choice depends on the strategies and the goals of the management (global, regional or local).

An example as specific action for unification of the different tools for the water quality interpretation is EU Directive (2000/60/EC), establishing a framework for Community action in the field of water policy (WFD) [2].

DATA AND METHODS

The main purpose of this article is an analysis of data and information for water quality of the Struma river* basin and the results about ecological status for separated river reaches (water bodies), concerning of the WFD principle implementation.

It is well known, one of the aims of the Water Framework Directive (WFD) is to achieve “good ecological status in all surface water bodies (EU)

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* - on the territory of Bulgaria

by 2015 and also to prevent deterioration in the status of these water bodies” [2]. The “good ecological status” is determined by hydro-morphological, physical, chemical and biological quality criteria that should guarantee

functioning of the aquatic ecosystem and good water quality for different users [2].

The main task was to compare and to evaluate the data from national ecological monitoring system about hydro-morphological conditions, physico-chemical and biological parameters for every type of water body in Struma river* basin.

Many of data, results and requirements are debatable. So, the main WFD requirements as a type of definitions are well made. But it is arisen a lot of additional questions. For example:

- what are mean “natural conditions” and what kind of tools are necessary to measure them?
- what kind of parameters are needs to explain and to assess the human alteration?
- where are the borders between the requirements for the naturals or for the heavily modified conditions?
- what kinds of indicators are needed to present the changes in the natural conditions of the river basins and are these indicators universal? and etc.

At first sight these kinds of questions are useless in view of the fact that we have a new legislative document - The Water Framework Directive (WFD) – with a general aim to ensure sustainable water management and to reach good water quality by 2015 in the European Union (EU).

Unfortunately these are common explanations. It is not enough to report on different steps of the WFD implementation as the characterisation of the river basins, water types and bodies, or the identification of anthropogenic pressures and impacts, etc.

The assessment of the ecological status for different river basins is more than an administrative procedure.

It is important to note:

- there is a specific normative document (as WFD), concerning the water quality and the rivers ecological status problems and policy, from one side, and
- there are specific conditions of the different river basin in Bulgaria, from the other side,

and it is necessary to find the representative tools for the ecological statement assessments of each river in Bulgaria, in our case for Struma river*.

RESULTS AND DISCUSSIONS

Under the WFD requirements the classification of the ecological status of a surface water body is based on [2]: biological elements and hydro-morphological, physico-chemical and chemical elements, supporting these biological elements. The water bodies are classified in five quality classes (high, good, moderate, poor, bad) depended on the Ecological Quality Ratio

[3], which is a ratio between reference conditions and measured status of the biological quality elements.

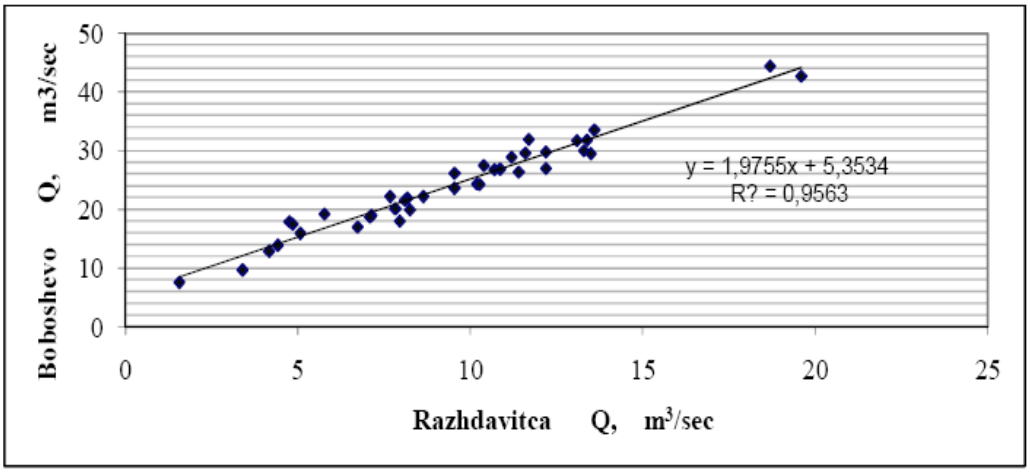
These normative criteria, described in the WFD, need to be made more operational as practical tools for surface water management. Our results confirm this necessity.

In view of the specific structure of the Struma river basin it was more important to understand and to represent:

- the peculiarities of the Struma river tributaries – first of all significant slopes, high river flow velocities, a rich nutrient sources, et.;
- the places of the each part of the Struma river length, according to the human activities assessments;
- the correct decision making position for the different type of reaches (water bodies), etc.

For example, there are a lot of additional questions about the significance of the hydro-morphological data. It is not enough to explain the river depth and width variation or the altitude, the latitude and the longitude position of the river reaches, etc. As it is shown on fig.1, fig. 2 and table 1 there are close relations between river flows in the different reaches of Struma river (according to the data for long term period from 1950 till 2000).

It is an impression toward the high level of the relations between the common hydrological parameters for the different parts of Struma river*. There aren’t any indicative differences in the natural regime and mean hydrologic parameters of the river.



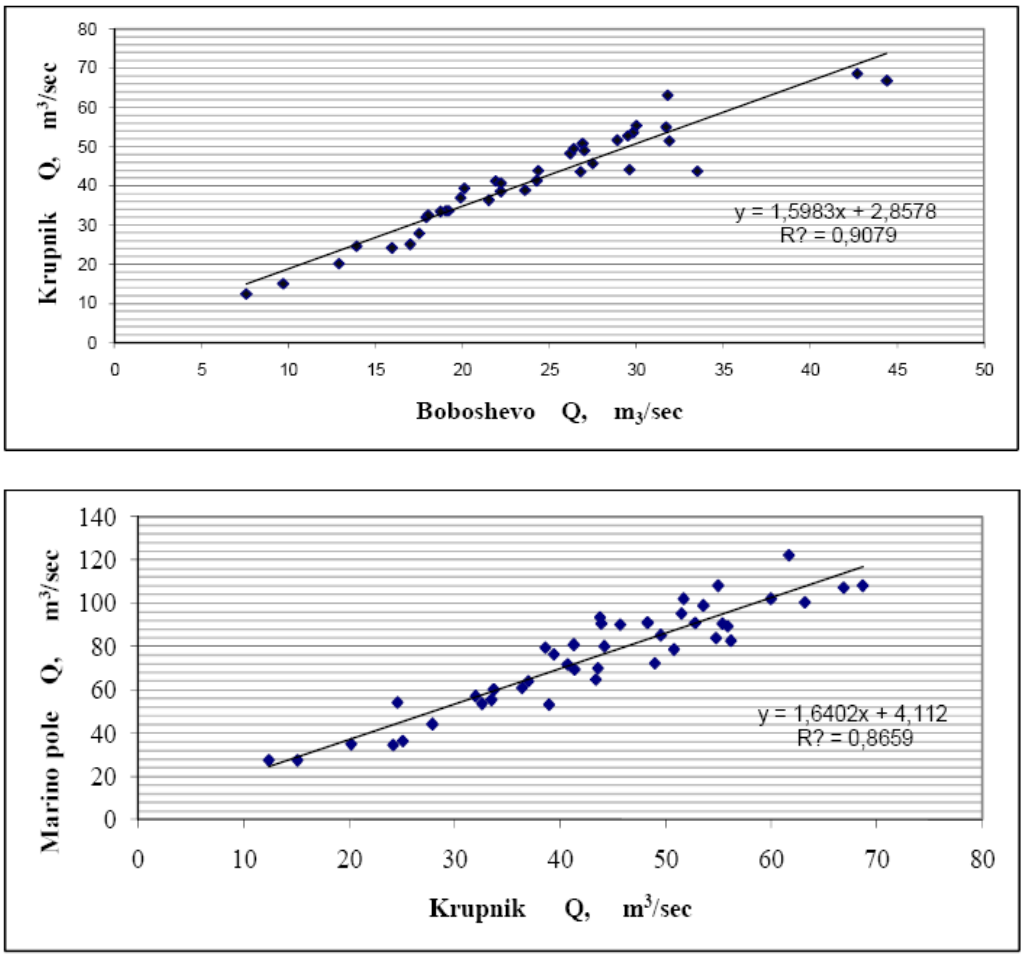


Fig. 1 Relation between the river flows at different HMS of the Struma river

Table 1
Correlative coefficients between average monthly flows for different reaches of Struma river*

Struma river reaches / months	Razhdavitsa - Boboshevo	Boboshevo - Krupnik	Krupnik - Marino pole	Razhdavitsa - Krupnik	Razhdavitsa - Marino pole	Boboshevo - Marino pole
I	0,960	0,976	0,961	0,922	0,838	0,887
II	0,985	0,988	0,941	0,973	0,815	0,958
III	0,974	0,983	0,936	0,952	0,873	0,925
IV	0,986	0,967	0,923	0,918	0,915	0,921
V	0,964	0,924	0,921	0,873	0,789	0,887
VI	0,939	0,894	0,944	0,823	0,843	0,857
VII	0,950	0,941	0,922	0,859	**0,717**	0,891
VIII	**0,740**	0,960	0,929	**0,694**	**0,666**	0,908
IX	0,842	**0,887**	**0,879**	**0,693**	**0,587**	**0,694**
X	0,970	0,979	0,959	0,942	0,921	0,952
XI	0,922	0,975	0,929	0,905	0,835	0,897
XII	0,947	0,964	0,954	0,903	0,866	0,893
year avg.	0,978	0,953	0,931	0,883	0,879	0,897

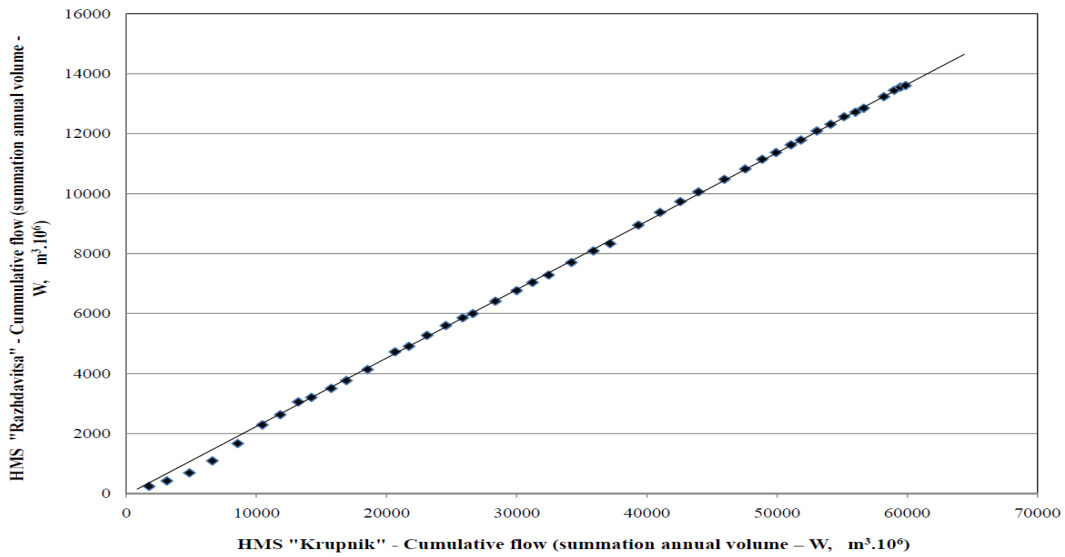


Fig.2 Relation between cumulative flow at HMS “Razhdavitsa” and HMS “Krupnik”

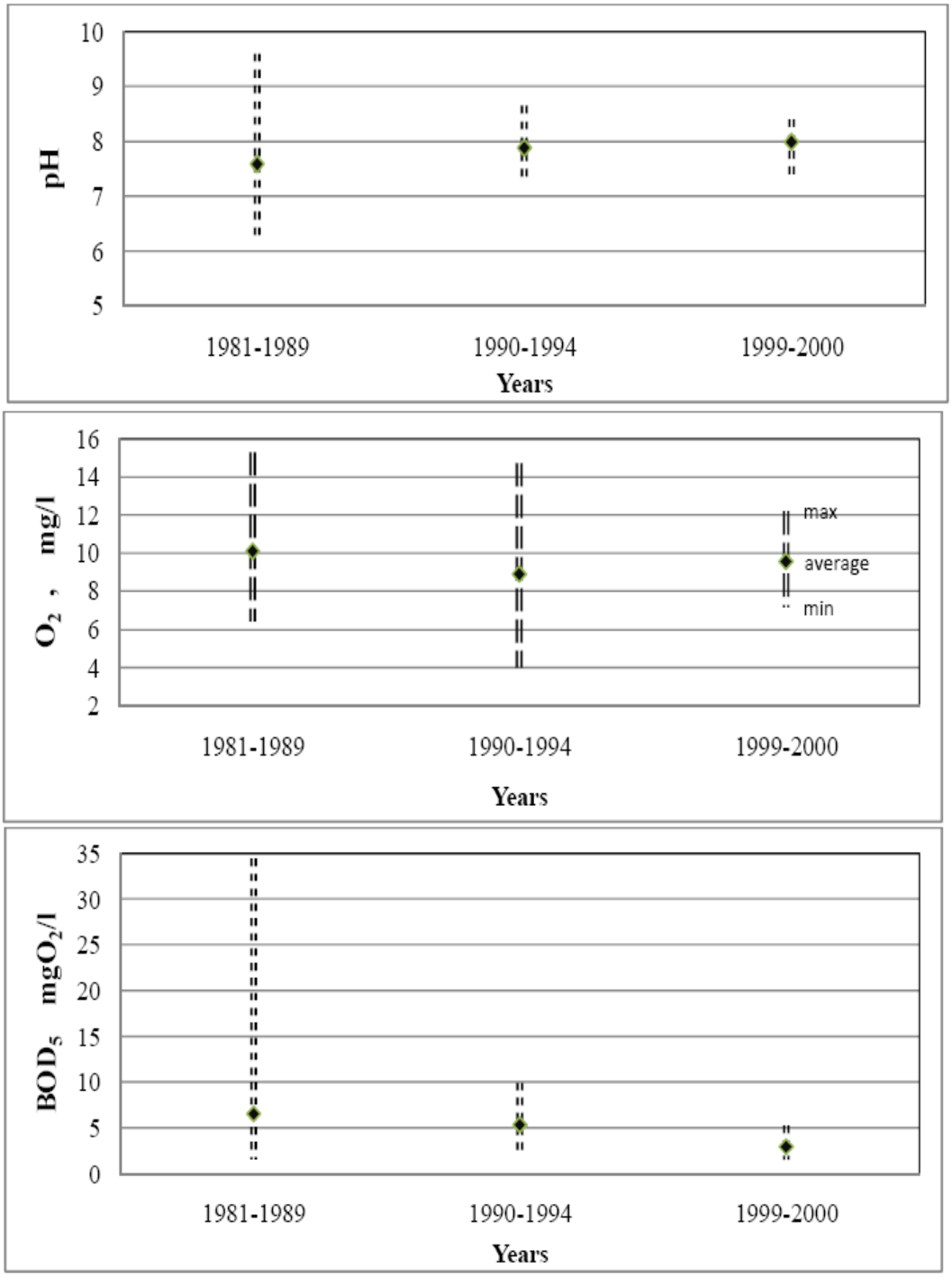


Fig.3 pH, O_2 and BOD_5 dynamic of the Struma river – HMS “Krupnik”

A downward tendency for the common chemical parameters is established. As it is shown of fig. 3 there are significant distinctions between main water quality parameters at hydrometric station (HMS) “Krupnik”.

It is well known there is a big (almost drastic toward the socio-economic activities) difference between the first part of this 20-years period (1980-1989) and the second part (after 1990).

The range of parameters distribution for first period is 2-3 (pH or “Dissolved oxygen”) till 7 (BOD_5) times bigger than the second period (especially after 1998).

A lot of interesting data, as biological indicators, are collected, used and published in Project PHARE CBC 9904-04.02. [4] The results are impressible, but the more important is their interpretation.

In this connection *Soufi at all.* [5] has made an important conclusion, noted as “The Struma river maintained a stable and balanced **β**-mesosaprobic state, with two exceptions (downstream the towns of Pernik and Blagoevgrad) – an **α**-mesosaprobity” [5].

Here is done an additional investigation of the relation between these biological indicators and hydrological parameters for Struma river*. On fig.4 are shown results for hydrometric station (HMS) “Krupnik”. It is useful to note that the range of the biological indicators (as example for SPUB) is rather small (1,5 – 2,5) in comparison with the range of the hydrological parameters (4 – 200 m^3/sec).

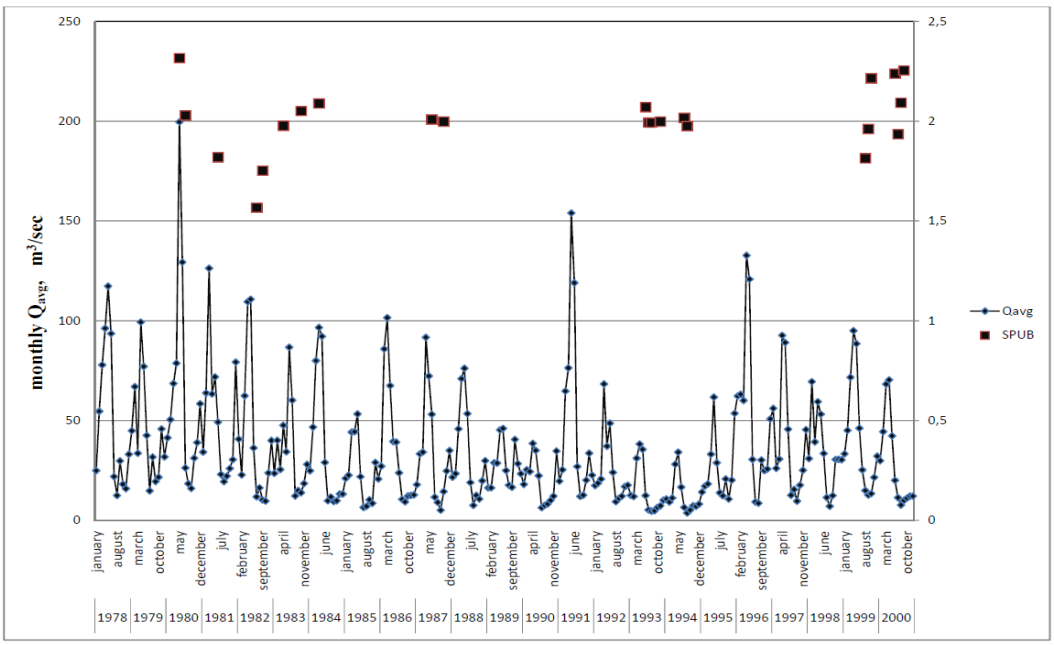
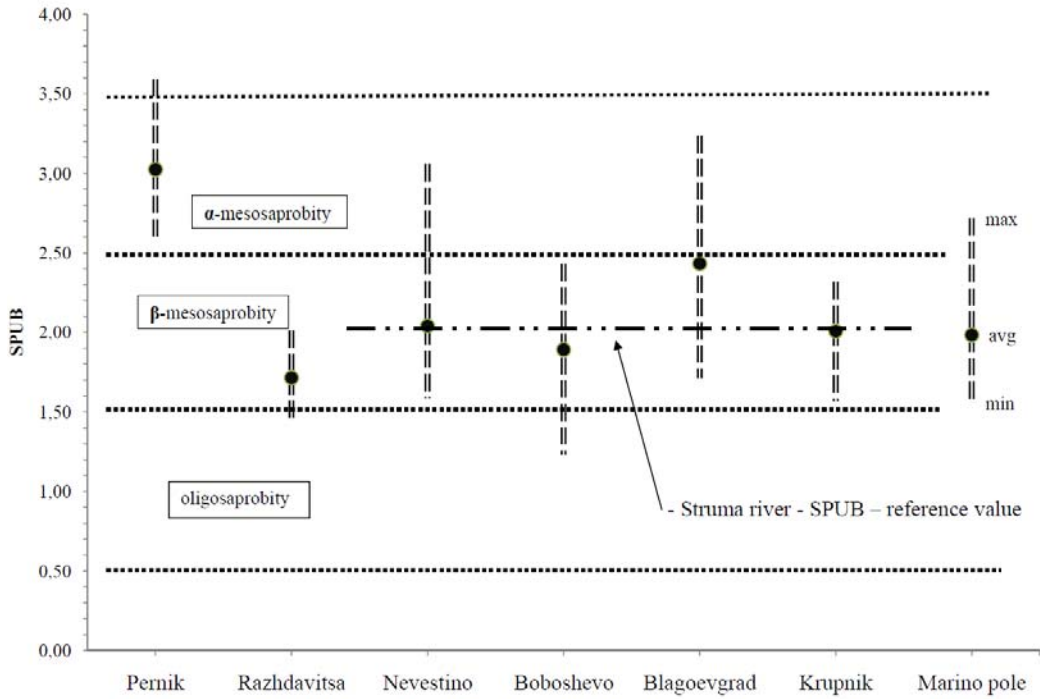


Fig. 4 Relation between SPUB and Struma river flow (monthly Q_{avg}) at HMS “Krupnik” for a long period (1978 – 2000)

So, it is time to note, it is practical meaningless to try to discover a direct relation between river flow and biological indicators of the water quality.

Beside the analysis and the assessments of the published results [4,5] there are possibilities for additional comparison and comments. As example for SPUB it would be interesting to explain that:

- a tendency for decreasing of the SPUB from the first (1980-1987) till the third (1999-2000) period is registered for the stations “Pernik” and “Nevestino”;
- the SPUB mean value, at station “Blagoevgrad”, for the first period (1980-1987) is smaller than for the second (1987-1994) and the third (1999-2000) periods;
- the results at HMS “Krupnik” are practically the same for the three periods;
- the biggest are differences between the SPUB mean values for all periods at stations “Pernik” and “Marino pole”, etc.



Source: Project PHARE CBC 9904-04.02 [4]

Fig. 5 The dynamic of the SPUB at main stations of Struma river for the whole long-term period (1980 - 2000)

For recent article, as an example, are used these data for Pantle and Buck’s saprobic index (SPUB). On fig. 5 it is shown the dynamic of the SPUB for all stations (Pernik, Razhdavitsa, Nevestino, Boboshevo, Blagoevgrad, Krupnik and Marino pole) during the whole long-term period (1980 - 2000). The data needs more specific analysis:

- first of all the most of the mean SPUB value are in the **β**-mesosaprobity borders, as *Soufi at all.* has noted [5];
- more careful study and assessment is necessary for HMS “Pernik”, as a region with industrial human activities for a long-term period (more than 100 years);
- the range of the results for Nevestino, Blagoevgrad and Marino Pole up to **α**-mesosaprobity depends on the sources and the specificity of the local conditions;
- very impressive and important are the results for HMS “Krupnik”, which needs special attention;
- independently of the human activities in Pernik, the conditions around HMS “Razhdavitsa” are more naturally predetermined;
- it is useful to propose a mean value for SPUB = 2 as a reference value for ecological quality ratio (EQR) determination in “middle Struma” reach (before and after HMS “Krupnik”).

It is clear that the current methodological tools about water quality management have had a lot of debatable formulations. It is not enough to announce the leading position of the biological parameters in the field of the water quality assessments. We have a strong reasons to reflect some specific positions about the attention of the different hydro-morphological, physical, chemical and biological parameters as indicators of the water quality (respectively ecological) status assessments. It is not useful enough to oppose any of these parameters (for example chemical to biological) as a more representative indicator.

As a direction of the Struma river basin investigation it is important to remember a complicated structure, including the main river and a lot of tributaries. So, it is usefully to note it would be a mistake to ignore the significance of the small tributaries. As a source of nutrients each tributary have had a place in this structure, especially when we try to give a proof of a new type of tools for ecological assessments. For a long-term period we have need a more complex approach.

The differences and the peculiarities between the rivers habitats and their conditions are nature properties. So, the aspiration for preparing a human-made classification scheme toward the **reference values** (according to the requirements of the FWD[2]) presentation is more unreasonable than useful. To present the ecological status as “high”, “good” or “bad” is an example of mixing different tasks – from one side to define the impact of the human activities, and from the other – to assess the natural processes. Obviously, it is common to register high level of the dissolved oxygen concentration (DO – mgO_2/l) and low level of the total dissolved solids (TDS) in the

upper (predominantly mountain) parts of the rivers or - low level of the dissolved oxygen concentration (DO – mgO_2/l) and high level of the total dissolved solids (TDS) in the lower (predominantly plain) parts of the rivers. Is it correct to present these natural conditions as “high”, “good” or “bad” status?

It is clear that the reference ecological status must be presented as the numerical value of one or another indicator (indicators) for the natural conditions in the rivers (or separate part of them), without any quality qualification (“high”, “good”, “bad”, etc.).

The more complicate is the situation about “bad water quality”. It is not quite original to use this term as a classification tool for the river reaches (water bodies) assessment. That is a wrong point of view. If there are monitoring data for the unallowable values of chemical components and any level of the water contamination we **must** correct the management, first of all to change the polluted water discharging. This kind of sources is not a reason enough to blame a river reaches (water bodies) for the rough intervention over the natural processes in Struma river, usually called “heavily modifed”.

On the other hand, if it is the reality of the processes in the river there is other task. The water is rather **unusable** for any needs than with “bad water quality”.

The “bad water quality” is not correct as a tool for ecological status assessment. The identification of these kind of problems is based on the assessments of the risk that known alterations to the river reaches (toward the hydromorphological characteristics [2]) were likely to be substantial enough to prevent the achievement of good ecological status.

It is necessary to note that the degree of the alteration (or changes of the natural conditions as results of the human impact) depends on many factors, independently of the feeling that in any cases the natural states are a sign of equality with the high quality of the ecological status (the blue color of the graphic presentation [2,3]).

So, an interesting question comes into the discussion – how to present the ecological status of the rivers:

- according to the common implementation of the WFD requirements [2], or

- as comparison between the natural or the modification states, according to the real degree of the human activities in the different parts of river basin areas.

There are some mixture between these two groups in the WFD, including some positions from earlier water quality classification schemes and some ideas for human activities pressure and assessments.

It is useful to remind some of the classic notions for the state or the results of the human impact. Without any doubt there are two general states of the river basin environments: natural and unnatural – affected by human activities.

CONCLUSIONS

There is a high level of the relations between the common hydrological parameters for the different parts of Struma river. There aren’t any indicative differences in the natural regime and mean hydrologic parameters of the river.

It is correct to note that the SPUB results for HMS “Krupnik” [4,5] are very indicative. It is useful to propose a mean value for SPUB = 2 as a reference value for ecological quality ratio (EQR) determination in “middle Struma” reach (before and after HMS “Krupnik”).

The results, discussed above, are very interesting not only as biological indicators of water quality for Struma river, as a specific long term database, which is rather provocative and needs more complex analysis and assessment.

Without any doubt there is necessity to find a practically correct way for presentation of the Struma river* ecological status: from one side according to the common implementation of the WFD requirements [2], or from the other - as comparison between the natural or the modification states, according to the real degree of the human activities in the different parts of river basin areas [1,4,6].

It is required a lot of knowledge of the specific characteristics of the Struma river reaches if we try to assess the ecological status especially for a long-term period.

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LAY AND VEGETATION COVER — FACTORS IN FOREST FIRES (FOLLOWING THE EXAMPLE OF BLAGOEVGRADSKA BISTRITSA)

Lyben Elenkov, Tsanko Tsankov
SWU "Neofit Rilsky", Blagoevgrad, Bulgaria

Abstract*: The relief and soil cover have very important meaning about forest fire development and spread. As basic and constant parameter which has influence over forest fires we analyze the relief, vegetation and ligneous cover.*

Keywords: *Forest fires, lay, vegetation cover*

1. INTRODUCTION

Peculiarities of the lay and vegetation cover in alpine regions play a significant role in forest fires. The article describes the basic determinative features of these two risky factors in the sharply broken alpine lay of the southwestern Bulgaria (fig. 1). The river basin of Blagoevgradska Bistritsa (fig. 2 and 3) is used to illustrate this. Similar morpho-hydrographic peculiarities have the river basins of the other big left feeders of Struma River on the western slopes of Rila- Rilska River and Vlahina River (fig. 2 and 3).

2. FORMULATION OF THE TASK. PURPOSE AND TASKS OF THE RESEARCH

The present analysis aims at giving the most complete valuation of the role the abovementioned natural factors play in the occurrence and spreading of fires in the harsh alpine conditions.

The principle model of the topographic cut of the sharply broken mountain lay of the river basin of Blagoevgradska Bistritsa (fig. 4) distinguishes the following basic elements:

1/river valley with low and high overflow river ledge;

2/ slope foot, covered in delluvial and prolluvial deposits and remains from high bended ledges:

3/ relatively steep mountain slopes and

4/inclined ridge zones with rocky massifs of tops

The rocky fundament (fig. 5) of the local lay is predominantly consisting of crystalline pre-Cambrian rocks and Phanerozoic granitoids. They show too similar physical and mechanical indices as a result of the weathering processes they are exposed to. Therefore, the rocky plinth of the river basin of Blagoevgradska Bistritsa can be described as monolithic as far as forest fires are concerned.

The same rocky structure and parameters of weathering favors the formation of spatially similar weathering products (fig. 7):

1/formation of side, quick spatially wedge-shaping, lenticular bodies of different thickness by weathering crust;

2/ low-powered elluvial deposits, predominantly situated on the foots of ridges and the highest part of the slopes

3/typical delluvial deposits on the slopes; they are getting thicker towards the foots of slopes;

4/ delluvial and prolluvial deposits on the foots of slopes; they form torrential cones and delluvial and prolluvial trains

5/ alluvial deposits on the low (overflow) and high (non-overflow, inclined) river ledges in the lower part of the foots of slopes and the river valley

Soils are represented by (fig. 7):

1/alpine meadow soils in ridges;

2/ grey wood soils over the slopes;

3/ maroon wood soils in the lower parts of slopes;

4/ delluvially - prolluvial soils in the foots of slopes;

5/ alluvial soils in the river valley

Vegetation cover also varies (fig.):

1/grass and fruticose overgrowth over the alluvial soils of the river valley and lower parts of the foot of slope;

2/ tendency towards gradual increase in the number of shrubs at the expense of the grasses and growth of single tufts (groups) of trees towards the higher parts of the foot of slope;

3/ abrupt transition from fruticose vegetation and grasses towards tall wood (broad-leaved) vegetation at the foot of slopes

Most of slopes are covered with wood massifs of broad-leaved and coniferous (in higher parts) trees

4/ distinctively quick transition from wood massifs to meadow grasses and tufts of shrubs in ridges

The deeply cut alpine lay of the river basin of Blagoevgradska Bistritsa is known for frequent and significant changes in the inclination of land surface (fig.7):

1/horizontal to sub-horizontal in the area of river bed and overflow ledges:

2/ inclinations from 12° to 15° in the area of foot terraces (inclined river ledges, delluvially — prolluvial trains and alluvial cones);

3/ relatively steep inclinations (about 400**)** on slopes

In many cases, however, inclination changes several times because of the terraced structure of the slopes’ lay (see below, morpho-structural peculiarities and fig. 8);

4/small (about 5-l0^0) inclinations on ridges (except for the rocky massifs of tops)

River basin of Blagoevgradska Bistritsa is covered with thick fault network (fig. 6). It predominantly consists of steep sinking normal faults and slanting listric breaks (faults). Many of them were active during the quaternary or are active now. Movements caused formation of gradually decreas-

ing towards the river valley series of listric prisms on them (fig. 8). They contribute to the terraced character of part of slopes and influence the local distribution of wood or grass and shrubs cover (fig. 8).

Tessellar block structure of lay has influenced the occurrence of relatively well-cropping minor hills with their own ridges, slopes and foots of slopes (fig. 5). These natural phenomena make the lay of lands we describe more complicated.

The lay model proposed, as well as its adjoining vegetation cover of the river basin of Blagoevgradska Bistritsa, is not complete and the same in every part:

1/no distinctively formed ridge areas in some places;

2/foots of slopes are not developed in all parts:

3/slopes change their appearance according to the presence or absence of terraced structure on them;

4/ river valley changes along its length its width and character of alluvial formations

5/ vegetation type and character are frequently changing according to the local land shapes.

3. CONCLUSIONS

Analysis made show that the influence of both of the described natural factors on fires in alpine deeply broken wood lay is to a greater extent different from the analogous cases of hazardous processes in low-mountain hilly and hilly-flat regions. These differences require adoption of different approaches when prognosticating and preparing to fight the raging flame. This requires a specific algorithm of fire-extinguishing in the regions of steep alpine wood slopes. The specific character of the southwest mountain lay is to be taken into consideration for its significance and is to be put in its proper place when organizing tire-fighting events of local, regional and national extent.

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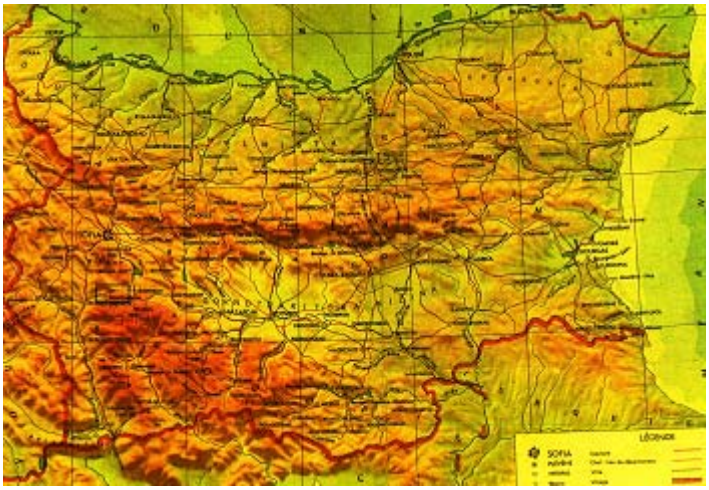


Fig. 1. Review map of the alpine lay of southwestern Bulgaria

Fig. 2. Review orohydrographic map of middle and western parts of Rila

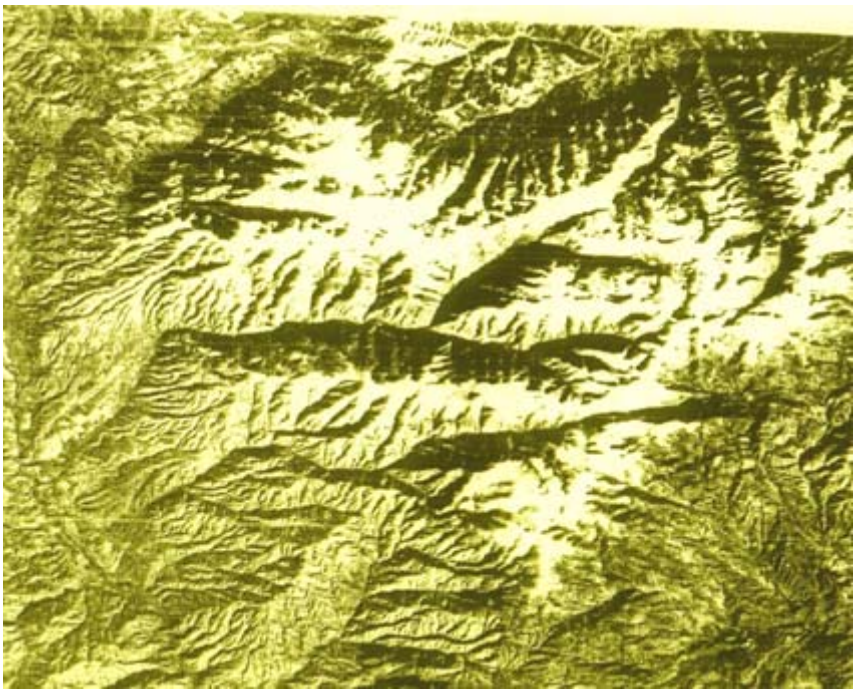


Fig. 3 Review space photornosaic (by Landsad photos) of middle and western parts of Rila

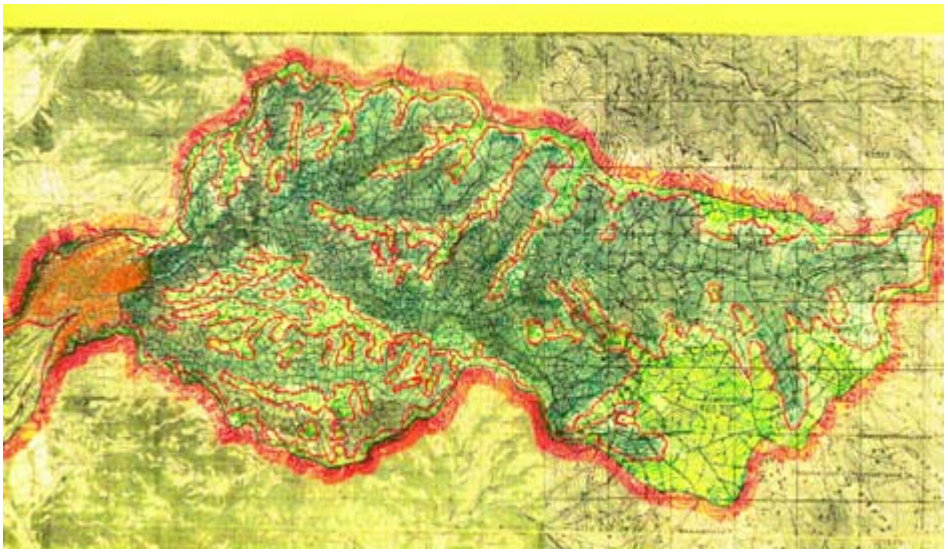


Fig. 4 Review map of basic orohydrographic elements of the river basin lay of Blagoevgradska Bistritsa

Fig.5. Review map of geological structure of the river basin of Blagoevgradska Bistritsa

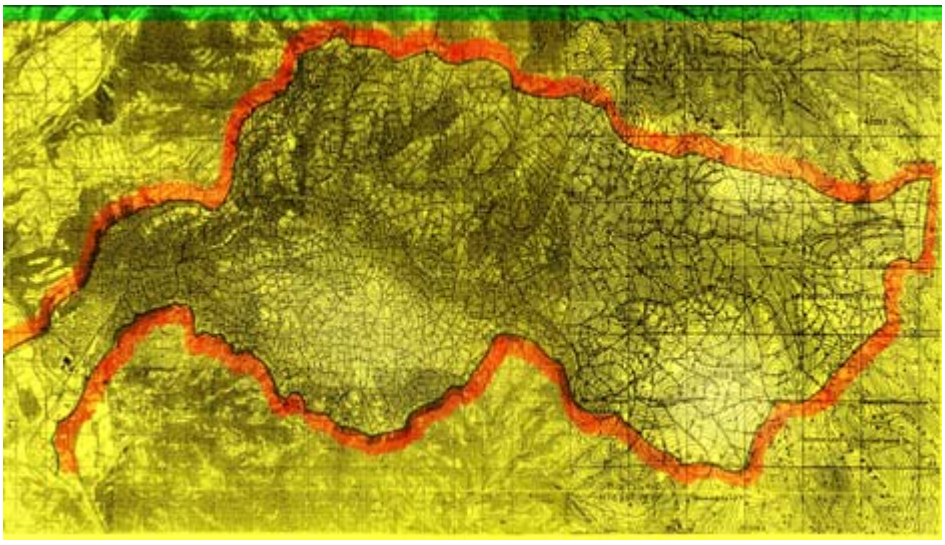


Fig. 6 Review map of fault network of the river basin of Blagoevgradska Bistritsa

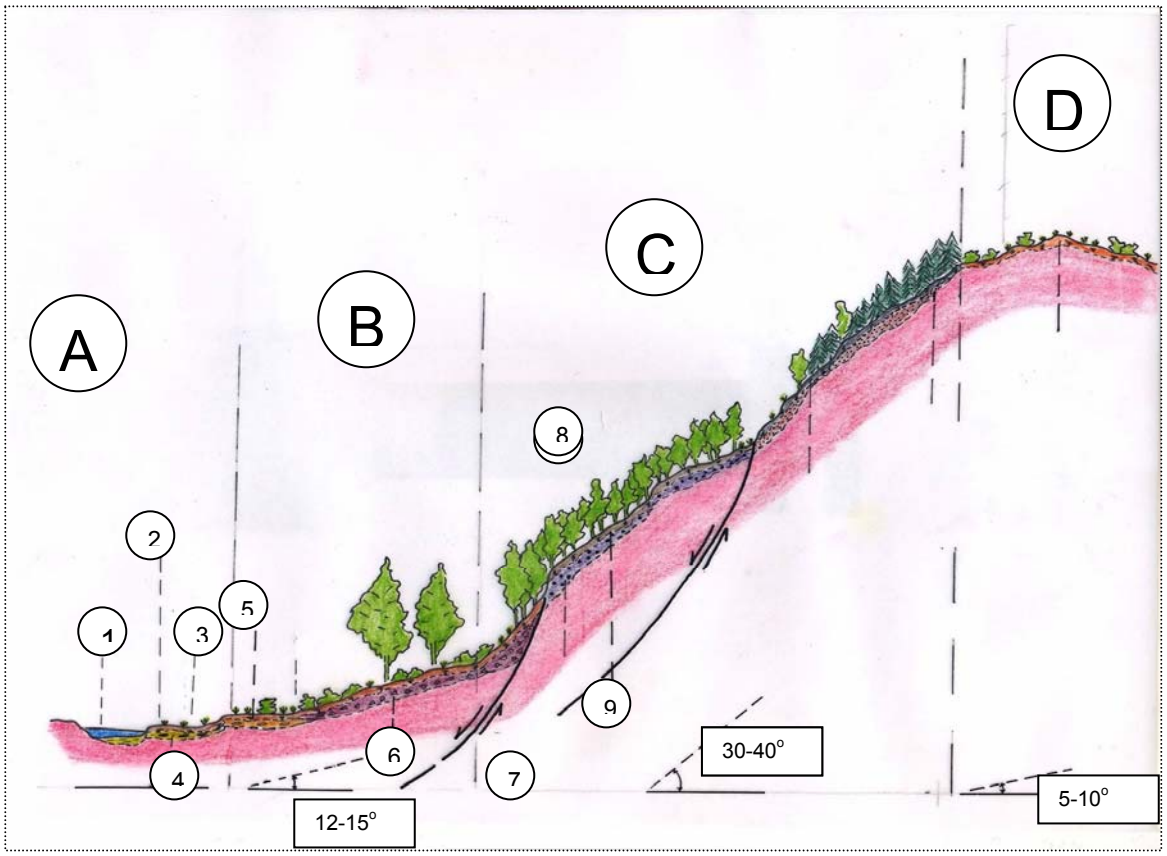


Fig. 7 Cross-sectional general exemplary model of river basin lay of Blagoevgradska Bistritsa

A — river valley: 1 — low overflow river terrace, 2 — high overflow river terrace, 3. — grasses, 4 — alluvial deposits;

B — foot level (inclined non-overflow river terrace): 5—grasses, shrubs, single trees or wood tufts. 6— alluvial deposits, 7— prolluvial desposits;

C — slopes: 8 — trees, 9 — delluvial deposits;

D — ridge (aquiferous zone): meadow vegetation, peats, low shrubs

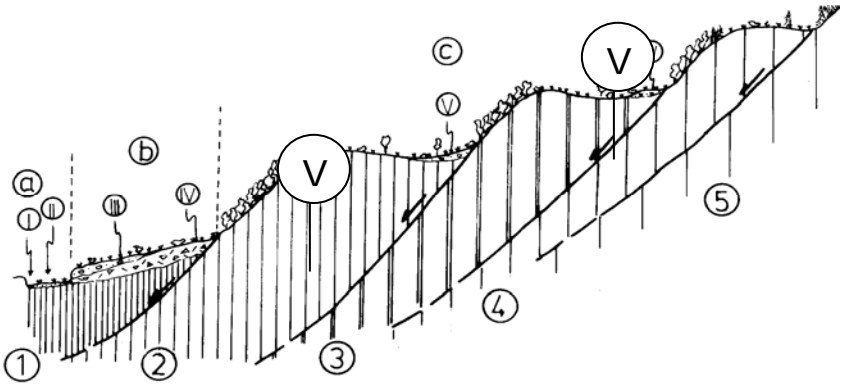


Fig. 8 General exemplary model of terraced lay on the slopes of the river basin of Blagoevgradska Bistritsa

a — river valley: I — river-bed, II — overflow river terrace;

b— foot level: III—high non-overflow river terrace, IV — delluvial and prolluvial deposits;

c — slope: V — trees, VI — grasses with separate trees and wood tufts 1, 2, 3, 4. 5— listric prisms

More researches on the occurrence and spreading of forest fires*

Lyuben Elenkov, Veselina Stoyanova, *Margarita Todorova*
SWU "Neofit Rilsky", Blagoevgrad, Bulgaria

Abstract*: The works describes the experimental researches on the spreading of forest fire with different initial hot spot area and with more than one hot spots having the same diameter. The behavior of the fire is followed when two fires merge, overlap. Estimation of fire intensity in different situations possible.*

Keywords: Forest fires, fire area, occurrence, spreading, merge of two hot spots.

1. INTRODUCTION

Wood stock, being remote from villages and in particular from special equipment, requires preliminary organization to be saved. The late discovering of the fire and the insufficient knowledge on the objective Jaws governing its development, leads to serious damages and complications in fire-extinguishing. It has been established that unless extinguishing being organized within half an hour, fire becomes conflagration. That is why a profound research and study of the parameters that activate the development of forest fires are needed to be made. Studying the experience of such fires, applying practical and theoretical skills in controlling the element helps in taking practical decisions at this hazardous situation.

Each forest fire starts with initial local occurrence. The cause might be neglect, carelessness, incompetence or intention. Statistics shows that 98°/o of fires depend on anthropogenic factor. Well-known is the fact that wood flammable materials can be fall into three levels — grasses, bushes and tall vegetation, which are mutually connected. We won't mention the damages, either material or human casualties, that forest fires caused in Bulgaria, Europe and the world, as they are well-known due to the media — they are our everyday.

2. FORMULATION OF THE TASK. PURPOSE AND TASKS OF THE RESEARCH

Wood massifs are special for their flammable materials. Susceptibility to inflammation of vegetation is characterized by two indices — level (height) of ignitability of flammable materials and combustibility index — pines, breeches, oaks, bushes, and grass. During the spring, summer until late in

* Gratitude. The present work is financed under project No. НИД-Н9/Ф-4 of SWU "Neofit Risky"

the autumn they are inhabited with tourists, forest workers, shepherds, etc. All these are a prerequisite for occurrence of fires, which have always happened and will happen in the future. They cannot be banned and stopped. The question is how to discover and localize them in time.

Forest fires have to be thoroughly analyzed, as the experience from the practical work and research activity has to be taken into consideration. It involves rules that are constantly to be extended (gathering experience from the research of each particular situation), finding the objective laws governing the occurrence and spreading of forest fires. Provided based on a regular fundament, every scientific research and initiative for hazard fighting gives birth to a new idea, more plausible solution. [2, 3]

Each second is of significant importance for the early extinguishing of the fire, or otherwise becomes a hazardous, random and uncontrollable event that is to be seized by means of many resources, by introducing live force and equipment.

The worldwide significance of the problem with forest fires clearly shows that a general explanation is to be sought, starting from institutions on a regional level, scientific institutes and those, either in Bulgaria or on an international level, who study forest fires.

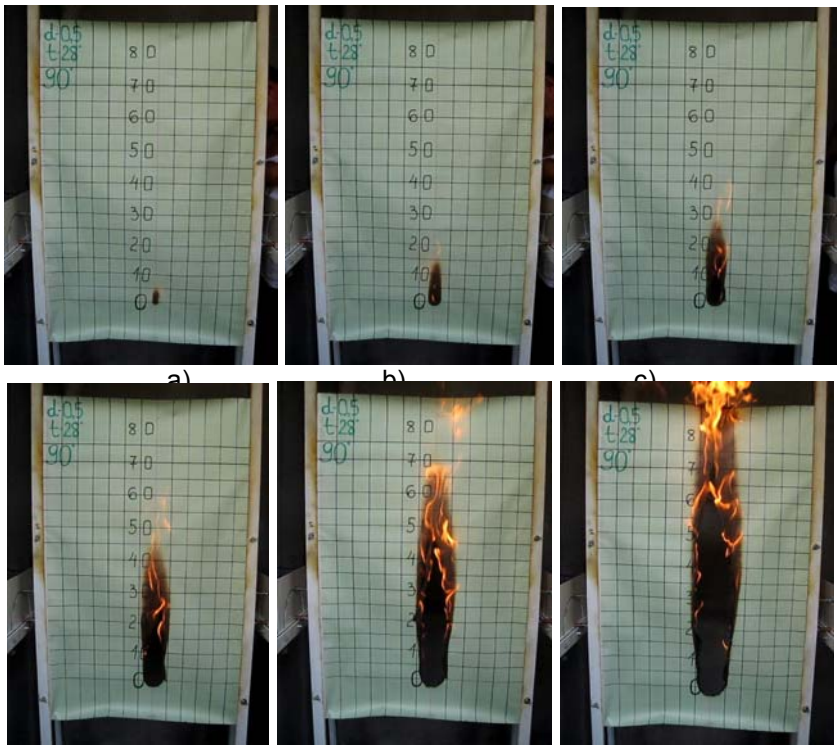
The purpose of the present report is to study the occurrence and spreading of forest fires due to carelessness as well as the cases of intentional fire-staring, which have become more frequent these days. This requires experiments with 1, 2, 3 and more hot spots. Practice proves that in cases of big fires, what takes place is a launch of elevating power of coals, brands to a greater height, which are conveyed by ground winds to great distances, which leads to formation of new local hot spots. [1].

The task before us is to follow the behavior of the fire in such a complicated environment by means of experiments and observations and to draw the respective conclusions. This requires experimental researches in order to establish how would the area of the initial hot spot, the number of local fires, the place of occurrence, which is grass, bushes or tall trees, influence the occurrence and spreading of the fire.

3. CARRYING OUT EXPERIMENTS

On a specially designed stand, by means of which we simulate different slopes of the terrain, we place a panel — flammable, unbroken paper material, which imitates combusting load in a wood massif. The panel has been preliminarily divided into columns, so that we can read the linear and mass speed of the fire. We randomly choose a slope, by means of which we imitate the lay of the area; the diameter of the hot spot R in the first case is 0, 5 sm^2 and 2, 5 sm^2 in the second case; after that we read the linear speed of the front development.

In order to establish the intensity (linear speed) of the fire development at different area of the initial hot spot on a randomly chosen place, but on the same level, we start a local fire and read the results (fig. 1 and fig. 2).



a) b) c)

d) e) f)

Fig. 1 Fire development at hot spot diameter 0, 5 sm^2

Both regimes are carried out in one and the same conditions. What strikes from the very beginning is that the linear speed of development of the local fire with greater diameter (fig. 2) is more intensively increasing.

From the experiment shown on fig. 2, it is clear that the intensity (the mass and linear speed) of the front development is greater as compared to the experiment in fig. 1. What impresses is that the fire shape is one and the same in fig.1 and 2.

Tab. 1 Intensity of development along the front at a different diameter of the hot spot

Intensity of development		
T(seconds)	d_2=5sm	d_2=25sm
2	5	15
4	15	25
6	25	45
8	40	65
10	70	95
12	90	110

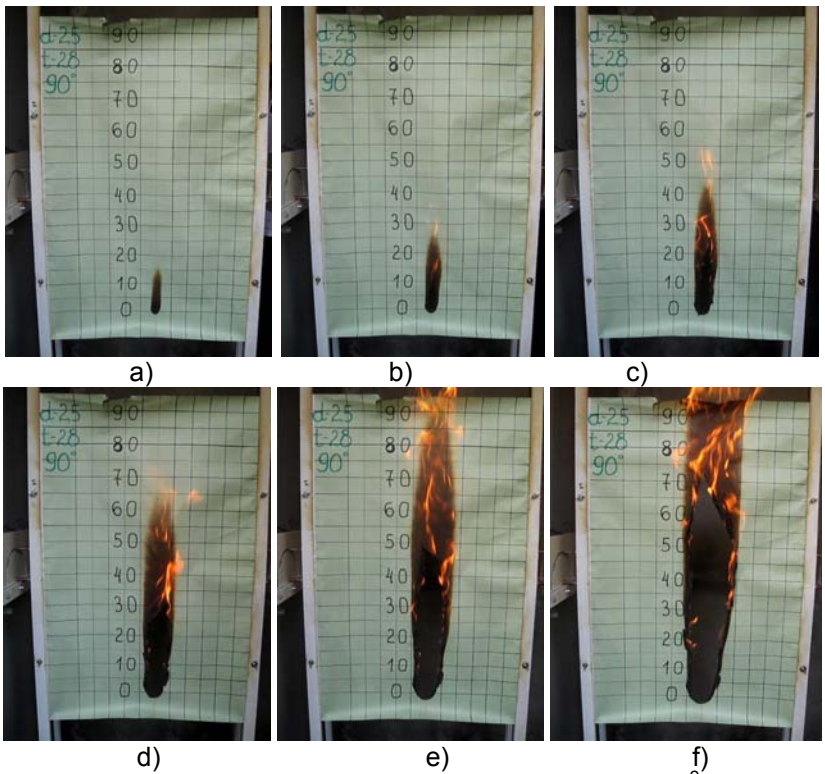


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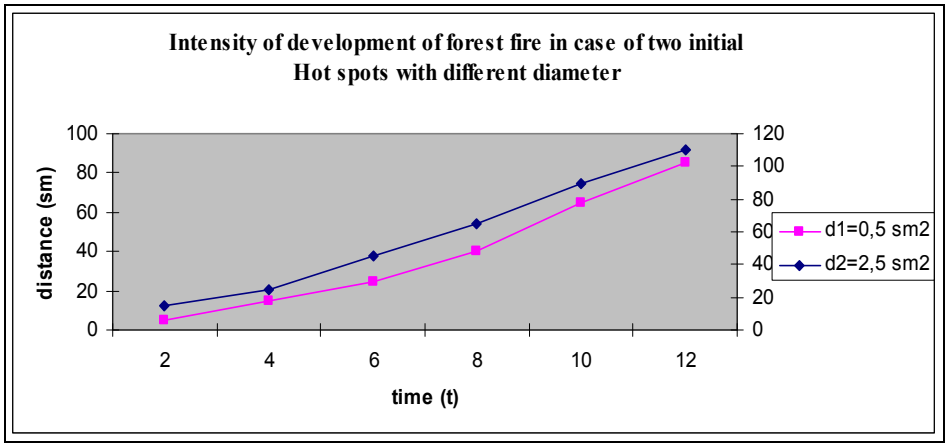
Fig. 2 Fire development at hot spot diameter 2, 5 sm^2

From the table we draw graphics 1, which describes the influence of the area of the hot spot in the spreading of the fire.



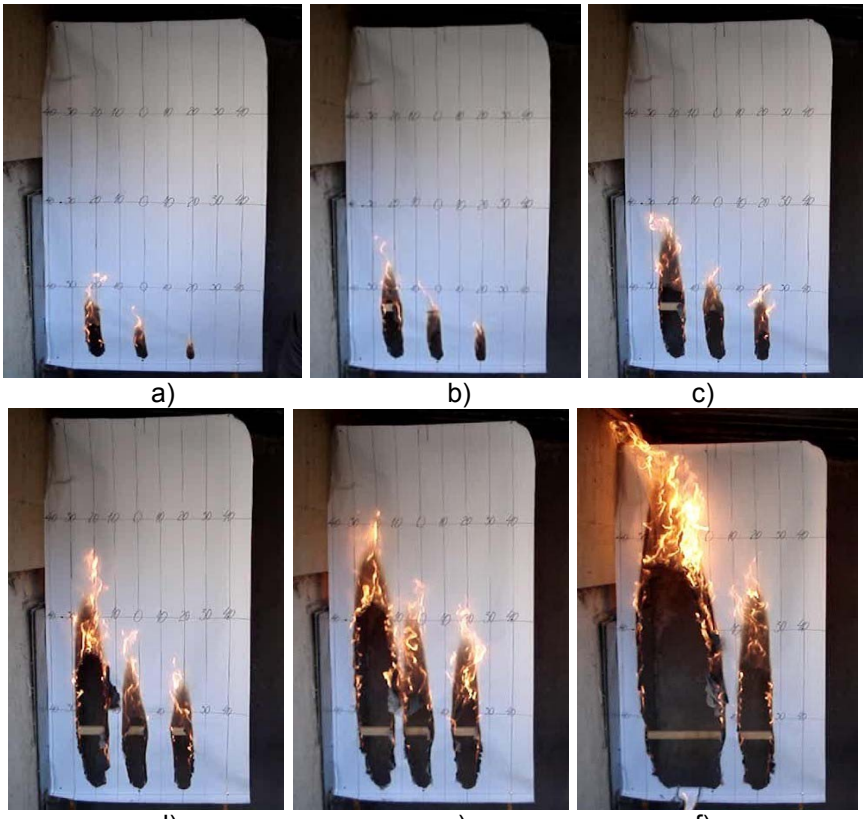
Graphics 1 Linear speed of the fire along the front in case of two initial Hot spots with different diameter

Tab. 2 Spreading of a fire with two hot spots

Intensity of development			
T (seconds)	d_1=5mm^2	d_2=5mm^2	d3=5mm^2
2	5	0	0
4	15	5	0
6	25	15	5
8	40	25	15
10	60	40	25
12	85	60	40
14	120		60
16	170		120

In figure 3 we can see the development of the fire with two and three hot spots present~ we determine the influence of the elevating power and intensity, when at a given time fires (first and second hot spot) become united (merge) in one (fig. 3e), as well as its behavior. The third hot spot is observed for its intensity to be compared.

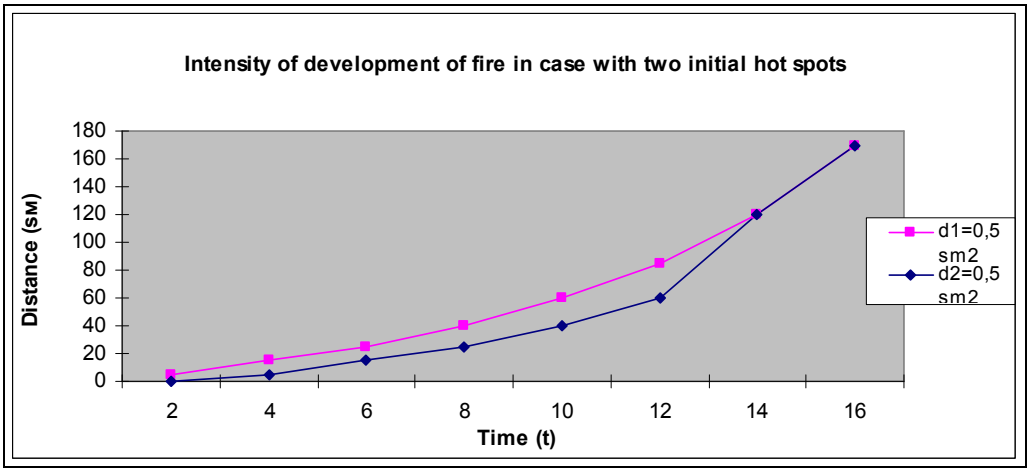
In Graphics 3 we can follow the behavior of the single hot spot of fire development, comparing it to the above-shown development of a fire with two hot spots (graphics 2) at the time their burning through merges and easily seen is a sharp increase in the intensity of the linear speed that is due to greater burning through area.



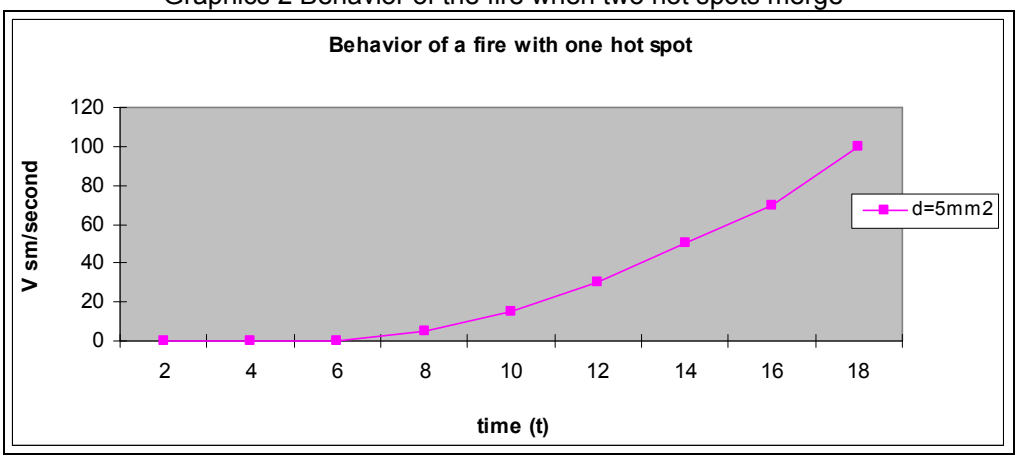
a) b) c)

d) e) f)

Fig. 3 Development of a fire with three hot spots, started at a different time



Graphics 2 Behavior of the fire when two hot spots merge



Graphics 3 Behavior of a fire with one hot spot

4. CONCLUSIONS

1. The greater the area the initial forest fire occupies, the powerful the convector flows, the more resistant the fire, the greater the linear speed.
2. When two or more hot spots overlap, the fire suddenly speeds up and extends the area it occupies — the linear and mass speed of burning is increasing.
3. In cases of more than three hot spots, the fire forms its front as its heat, energy and power are concentrating in the middle of the fire, e.g. flanks redirect their energy to the centred.

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Modern methods for monitoring of the Black Sea level in the context of global climate change

Lyubka Pashova

Central Laboratory of Geodesy, Bulgarian Academy of Science, Sofia, Bulgaria

Abstract*: Paper discusses issues related to the monitoring of the Black Sea level in the context of global climate change. A comparative analysis of the trend estimates for the mean sea level change obtained from tide gauge, satellite altimetry, and space gravimetry observations, is done. Long-term monitoring of mean sea level changes requires an integrated approach to the collection, storage, processing and analysis of in situ and space observations. The need for establishing a network of geodetic stations is motivated, as part of the observation systems and development of scientific infrastructure in the region.*

Keywords: *sea level, global climate changes, geodetic observations, Black Sea.*

1. INTRODUCTION

Over the last three decades global monitoring has emerged as a prerequisite for understanding the impact of mankind on the Earth system and to devise actions to mitigate the predicted global changes. One of the environmental variables important for studying climate processes is mean sea level (MSL). During the last century MSL rise with ~15 cm, mainly due to the thermal expansion of ocean waters and increase in the ocean mass from melting of the alpine glaciers and the polar ice sheets (IPCC, 2007). Because of ocean circulation and gravity effects, sea-level rise is not uniform but varies across European seas (Joint EEA-JRC-WHO report, 2008). Projections suggest that sea level and sea surface temperature of some European seas could rise more than the global average. The apparent acceleration of sea level rising observed by satellite altimetry in recent decades will have great impacts of human society and low-land coastal regions. It increases the likelihood of extreme sea level events, enforces landward intrusion of salt water and endangers coastal ecosystems and wetlands.

Sea level variations are now currently studied using *in situ* measurements and space geodetic techniques. Geo-information, obtained by these methods has direct applications in monitoring and understanding environmental change. The data and services can help national governments to react to climate change and respond to natural disasters.

The paper briefly presents the modern geodetic methods applied for sea level variations studies in the Black Sea region in the context of global climate change. The sea level trends obtained by tide gauge data and satellite

altimetry are compared. Some unresolved problems, limitations and future perspectives are outlined.

2. MODERN METHODS FOR SEA LEVEL STUDIES

Global Geodetic Observing System (GGOS) (www.iag-ggos.org) provides the meteorological basis for all Earth observations maintaining highly accurate reference frames as a backbone for all other observational systems (Fig. 1). The reference frames comprising global *in situ* networks of several space-geodetic techniques (VLBI, SLR/LLR, GNSS, DORIS, InSAR), increasingly dedicated satellite altimetry (ERS1/2,T/P, Jason1, Envisat), gradiometry and gravimetry missions (CHAMP, GRACE, GOCE). GGOS contributes to the scientific and infrastructure basis for all global change research in Earth sciences, and ensures important contributions to the increasing monitoring capacity of natural disasters in order to reduce the impact of these events. Maintaining a terrestrial reference frame at the level that allows, for example, the determination of global sea level changes at the sub-millimeter per year level requires a comprehensive Earth system approach (Plag and Pearlmen, 2008).

Crucial information required improving the understanding of sea level and ice sheet changes and to set up future sea level scenarios comes from Earth observation systems. Satellite altimeters, satellite gravity missions,

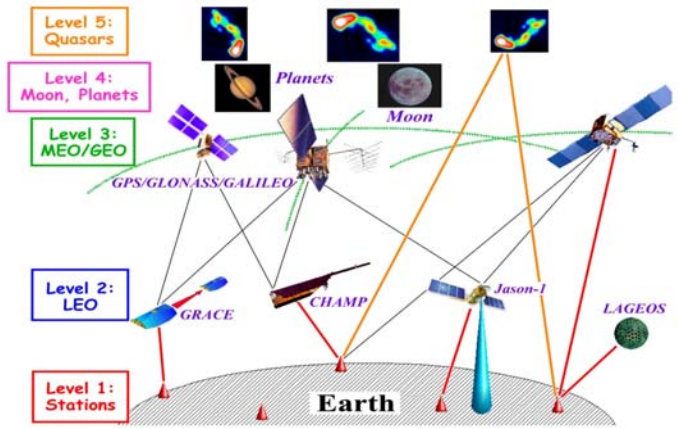

Fig. 1: Five levels of GGOS and their interactions with observations of various types

GNSS satellites, tide gauges and other *in situ* techniques are all necessary components of the “sea level observing system”. Without well-defined and stable global reference frame, past and present ice sheet and sea level changes cannot sufficiently be quantified and understood, and plausible future scenarios of regional and local sea level cannot be provided to the society as a basis for informed planning. Understanding sea level change and crustal dynamics requires a mul-

ti-decadal reference frame with and accuracy of 1.0 mm and stability better than 0.1 mm/yr (Plag&Pearlmen, 2008).

There are primarily two methods of determining the long term sea level changes - tide gauge measurements and satellite altimetry. Over the last two centuries, the global sea level rise has been estimated mainly from tide gauge measurements (IPCC, 2007). For the 20th century the estimated rate of global sea level from tide gauge measurements by long-term averaging is in the range of 1-3 mm/yr with average value 1.6±0.4 mm/yr (Kuo, 2006). Tide gauges record relative sea levels. The sea level variability is due to influence a broad range of atmospheric and other forcing greatly complicates estimating accurate long-term trends. Some regions show a sea-level rise substantially more than the global average and others a sea level falls. This is due to global tectonic processes (PGR) or other processes tend to dominate the coastal vertical crustal movement. The last occur on a regional and local scale. They can contribute to relative sea level trends at a level comparable to the global trend.

The precise geocentric positioning of tide gauge benchmarks is performed by GNSS observations to obtain reliable estimates of vertical land movements and to decouple true sea level variations from land movements at the tide gauge stations. The development of high precision space geodetic techniques gives the unique possibility to determine height changes of stations with respect to a global geocentric reference system and to determine the “absolute” (eustatic) sea level rise (Wöppelmann et al., 2007)

Altimetric measurements have a vital importance for geosciences, since they provide very accurate and direct measurements of the instantaneous heights of the sea (Tziavos, 2008). One of the main goals of satellite altimetry is the study and observation of the processes and properties of the marine environment. Phenomena like mean sea level variations and changes, ocean circulation, mass variations and balance, ice transfer, wind speed, storm surges, wave height and water temperature would be feasible through utilized altimetry data. Owing to its global coverage, satellite altimetry also reveals high regional variability in the rates of sea level change, with some regions exhibiting rates of 5-10 times the global mean (IPCC, 2007).

Sea level measured relative to the geoid (the fundamental level surface), which will be determined to good accuracy by space geodetic missions such as GOCE in the next few years. This gravity mission provides the “sea surface topography” which allows estimation of ocean transports, and contributes ultimately to an understanding of climate change. One of the main achievements of space gravimetry mission GRACE is estimating a contribution of melting mountain glaciers to global sea level rise (Cazenave et al., 2009). Results obtained show that GRACE is indeed able to determine the contribution of terrestrial waters to sea level and associated ocean mass component. By combining satellite altimetry with gravity missions, it appears also possible to estimate the mean thermal expansion, totally independently of *in situ* ocean temperature measurements.

At present, due to short observational period of space satellite missions precise estimates for the sea level rise and long-term trend is difficult to determine. Several additional decades of altimetric and gravimetric measurements are required as well permanent GNSS observations to allow definitive conclusions on the low-frequency global sea level changes and to measure the acceleration of global sea level rise (IPCC, 2007; Joint EEA-JRC-WHO report, 2008).

3. BLACK SEA LEVEL STUDIES – OUTCOMES, LIMITATIONS AND FUTURE PERSPECTIVES

Geodetic and oceanographic studies dealing with different aspects of sea level change of the Black Sea are presented in (Pashova, 2004; 2008; Andrianova et al., 2007; Bondar, 2007; Palazov et al., 2007; Pashova and Yovev, 2008). Extended references on comparisons between and mutual analysis of tide gauge, satellite altimetric, GPS, and space gravimetric observations are given in (Casenave et al., 2002; Tziavos et al., 2004; Fenoglio-Mark et al., 2007; Rietbroek et al., 2007; Kotzev et al., 2009; Yildiz et al., 2008).

Estimates of the Black Sea rise obtained by tide gauge data are characterized by different trend values due to the common acting of the slow epeirogenic (vertical land movements of regional extent) crustal movements, local technogenic processes, the global sea level rise and the different water budget of the sea components (Table 1). Comparing the results for sea level rise from tide gauge and satellite altimetry data it is obvious that they are differ substantially. The higher value of sea level rise from satellite altimetry is due to short observational period, different data analysis approach, and unavoidable systematic errors. Error estimates of ~1.0 mm/yr for sea level rise seams too optimistic given the many correction errors and uncertainties of the satellite altimetry data. Further analysis is necessary before the merging of all available multi-mission altimetry data for long term Black Sea level variability studies.

Despite of most geographical regions of Europe, where the physical network for observing sea level at coastal sites is well developed, in the region of the Black Sea the network needs upgrading of the tide gauges to modern standards. Augmentation of the observing sites with equipment to monitor the stability of the tide gauge and vertical land movement applying geodetic methods is another urgent issue. The connection of working tide gauges along the entire coastline is hampered due to lack of junction between the national levelling networks of the Black Sea countries and simultaneously performed GNSS campaigns at the tide gauges. One of the reasons is the lack of a common regional policy for the GGOS implementation of the geodetic community.

Similarly, access to the large number of individual sea level databases in the Black Sea countries is still severely hampered due to national diver-

Tab. 1: Estimates of MSL rise and recent vertical clustal movements in the Black Sea coastal region.

Type of data	Observational period	Estimates and RMS mm/yr	Comments
TG data			
From 14 TGs	1973-1998	1.7 ± 0.5*	(Pashova, 2004)
From 8 TGs	1858-1998	0.9 (eustatic rise)	(Bondar, 2007)
Satellite altimetry			
(ERS1/2, TP)	1993-2001	-0.4	(Tziavos et al., 2004)
(ERS1/2, TP)	1992-1998	27.0±0.3	Casenave at al., 2002)
(TP+Jason1)	1993-2007	6.0 ± 0.9	(Yildiz et al., 2008)
Satellite gravimetry			
GRACE (mass change)	2002-2007	-1.0± 2.2	(Yildiz et al., 2008)

** Average value, which does not take into account the recent vertical crustal movements*

sity in operation, uneven technological developments, a multitude of databases, non-standardized products, and different levels of quality assurance (Vladimirov, 2008). A number of the available Black Sea data set is growing permanently, yet this process is still rather slow and insufficient.

There is a need to develop and sustain new scientific infrastructures for long term archiving and distribution of space and *in situ* data for the Black Sea region (Pashova, 2008; Pashova and Yovev, 2008). This infrastructure development - a key issue for multidisciplinary research work - should allow for integration of all *in situ* networks, space techniques and data services. To minimize and adapt to the societal and environmental impacts of extreme events and sea level change there is a need to initiate more international research projects. No single country or group of countries has the resources to achieve significant advance in complex study of the Black Sea on its own resources. Bringing researchers in the fields of geodesy and oceanography together with researchers studying other Earth systems is equally important.

Recently, the scientific community takes some steps to consolidate and to improve research collaboration to speed up Earth observation activities in the Black Sea region. Several national and international research projects have been initiated (Palazov et al, 2007; Pashova, 2008; Yildiz et al., 2008). But, there are a number of gaps in the current system of Earth observations, utilization, and information concerning the region, which have to be overcome.

4. CONCLUSIONS

More scientific data from multidisciplinary studies are needed for evaluating long term sea level change of the Black Sea for better risk assessment strategies. Further investigation will be necessary in order to identify and correct the remaining systematic error in all space satellite missions. Once the source of the differences in the different trends is understood and a longer time series becomes available, the components of the Black Sea observing system will also provide information about steric variations in the

deep sea that are currently not observed. A future improvement of physical closing of water budgets and more appropriate assimilation scheme, focus on absolute sea level analyzing, its role for evolution of baroclinic structure and circulation is needed (Fenoglio-Mark et al., 2007). Analysis of sea temperature and salinity data from profiling floats along with satellite measurements of sea surface height and the time variable gravity field will contribute to investigate the causes of the Black Sea level rise.

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RESEARCH ON FOREST FIRES ON A BROKEN GROUND*

Lyuben Elenkov, Veselina Stoyanova, Margarita Todorova
SWU “Neofit Rilsky”, Blagoevgrad,Bulgaria

***Abstract**: Forest fires put in the conditions of inversion and highly broken ground hide a lot of hazards. The preliminary preparation in order not to allow fires in such regions together with the preparation for fast and crucial striking against the fire at its very beginning are the basic means for its timely localization.*

***Keywords:** forest fire, inversion, localization.*

1. INTRODUCTION

Forest fires have always occurred and will occur in the future. The growth n the tourism and infrastructure, which has more and more spread over the wood massifs, is supposed and practically confirmed to increase the number of fires. The preliminary preparation in order not to allow fires and the organization created in the critical and hazardous periods during the year when the climate is getting warmer are insufficient. Resourcefulness and new ideas are needed for the protection of forests. The resources invested in construction of roads and grounds for special equipment including helicopters for hardly-accessible areas, construction of supporting stations for water-supply, will be many times returned as compared to the losses that this hard-to-predict hazardous event the forest fire, cause. Fire can occur in whatever moment in the day or night, during the risky months of the year and at a time of continuous dry spells.

2. FORMULATION OF THE TASK. PURPOSE OF THE RESEARCH

Many and various scientific researches are being made worldwide that not only has been focused on timely discovering of forest fires, but on the regulation of processes related to the dynamics the fire spreads with and the filling of fire also.

However, what has to be taken into consideration s the fact that the direct application of the results of world scientific researches would not give the desired results in our country. The reason lies in the lay peculiarities in Bulgaria, its forest vegetation, distribution of water resources, areas that are hardly accessible for equipment and living force, as well as the climate peculiarities, airflows, and the geographical position of Southwest Bulgaria.

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All these leads to the conclusion that a number of investigations, researches and reports that reflect this peculiarity have to be made.

The purpose of the present research is to follow the behavior of fires in experimental and specific conditions (a burrow), as well as the development of the convective flow and the influence of radiant heat exchange over flammable materials.

3. DESCRIPTION AND CARRYING OUT OF THE EXPERIMENT

We accept that flammable materials in a wood massif, according to the new theory of the author [1], grasses and woods, are a sufficiently equal distributed unbroken environment. The objective laws that govern the development and spread of fires are studied in terms of the numerous experiments and international researches made. The researches made in the books and the conclusions of some authors regarding the development of fires on a highly broken ground (burrow) do not satisfy us, but provoke us to carry out an experiment in laboratory conditions, which can be described as follows:

The flammable panel is bended to take the shape of a burrow, which forms two semi-planes α and β with imaginary crossline *c* and contracting a 45°-angle with the horizontal plane. The panel is fixed to a stand so that the straight line *c* (imaginary axis of the burrow) takes a 60°-angle towards the horizontal plane of the stand. At point A we have chosen (a calibrated opening - 5mm), the very beginning of the semi-plane β, in the immediate vicinity of straight line *c*, we set on fire the flammable panel. We expect the fire front to develop on plane β in the direction axis-symmetrical to axis *o*, contracting $\alpha = 30°$ with the straight line *c* (fig. 1a). The fire flame also forms ascending fire column perpendicular to the horizontal plane of the stand. The expectations during the experiment have been confirmed, which con be seen in the above-shown figure 1.

This means that the angle contracted between the straight line **c** and the direction of the fire also contract a 30°-angle (i.e. R (*o, c*) = 30°, fig, 1 a, b, c).

What strikes in fig. 1d is that the more intensely developed fire, the greater power of convective flows, i.e. the cresset is greater and the vertical development of the ascending flow becomes clearly visible, It is formed parallel to the normal of the stands horizontal plane, meaning it contracts a 45°-angle towards the plane β, where a local development of the fire starts.

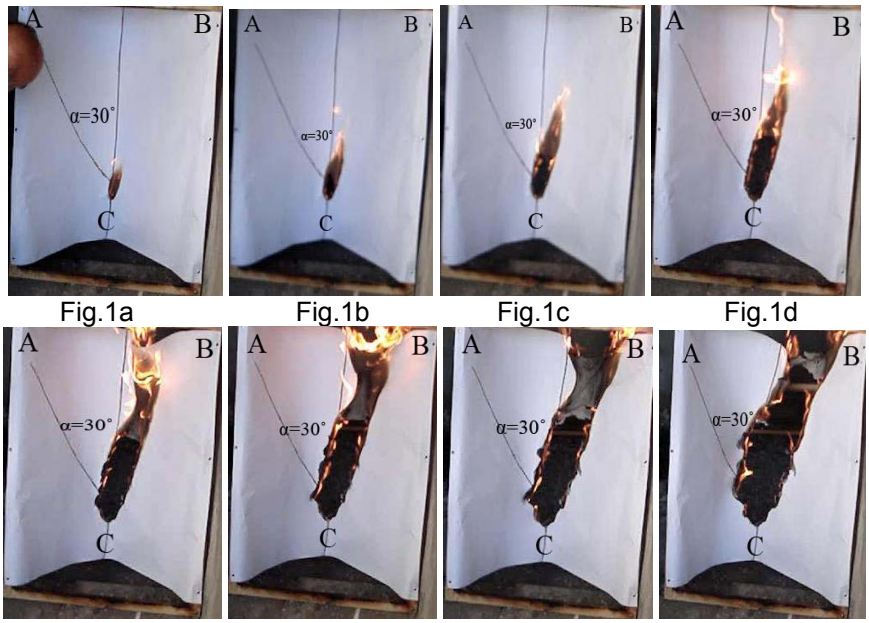

Fig.1a Fig.1b Fig.1c Fig.1d

Fig.1e Fig.1f Fig.1g Fig.1h

Fig. 1 Development of a forest fire in a burrow

The radiant heat exchange from the cresset of the flame emits heat in all directions, the most powerful, however, along the perpendicular of the flame (cresset).

The analysis of the experiment up to this point makes it clear that the burning from this point originates by the burning loading, which is under the effect of the radiant heat exchange, i. e. the closest distance between the cresset and the flammable materials, which is the 30°-angle, contracted between the cresset of the flame and the imaginary straight line that is parallel to the axis c.

The area, where the thermal influence of the radiant heat exchange is re-directed, is described by the help of the angle contracted between the straight line a and the ascending flow and is under the influence of the high temperature from the emission. It is seen in Figure 1g and Figure 1h that at a certain point a twisting and redirection of the fire and the semi-plane β takes place at the left flank, where flammable materials are closest to the cresset (panel). The right flank continues to form almost straight line, parallel to the axis a, while the left is turning to a path that forms the shortest distance to the flammable panel (the semi-plane β), starting from angle 45° and under the influence of the radiant heat exchange reaches to angle 30^{o} of the same plane in regard to the axis c.

The experiment results obtained are shown as a graphic in fig. 2. The information has been processed with the help of MatlabR2007b.

Figures 3a, 3b, 3c and 3d show the experimental data of the particular elements of the fire in the form of graphics as well the graphics of their ap-

proximations. Figure 3a is related to the study of the fire front. The approximation is fulfilled with the help of polynomial with real coefficients of third degree. Figure 3b shows the development of fire flank, the approximation is a polynomial of 20th degree; Figure 3c shows the fire rear and the approximation graphics - also a polynomial of 20th degree.

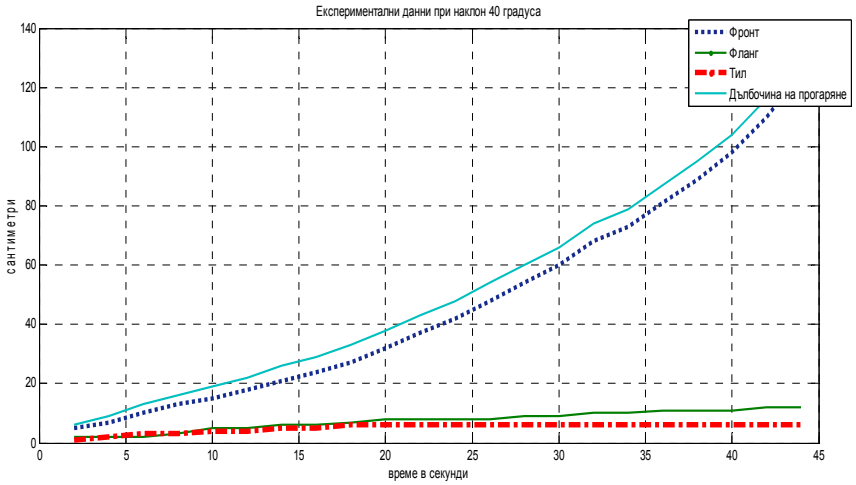

Fig. 2 Experiment results shown as graphics

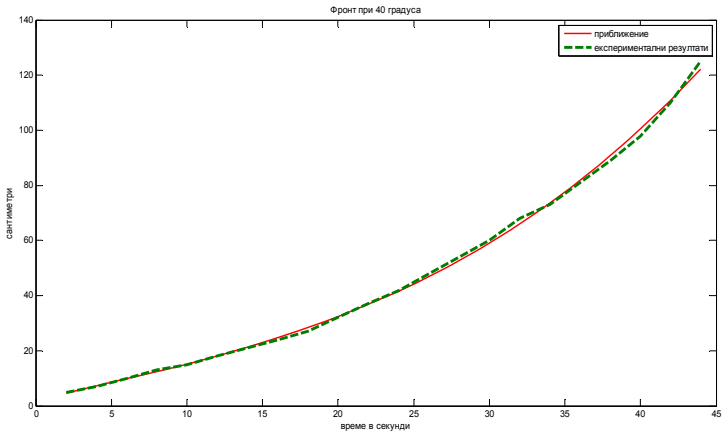

Fig. 3a Front — experiment results and approximation

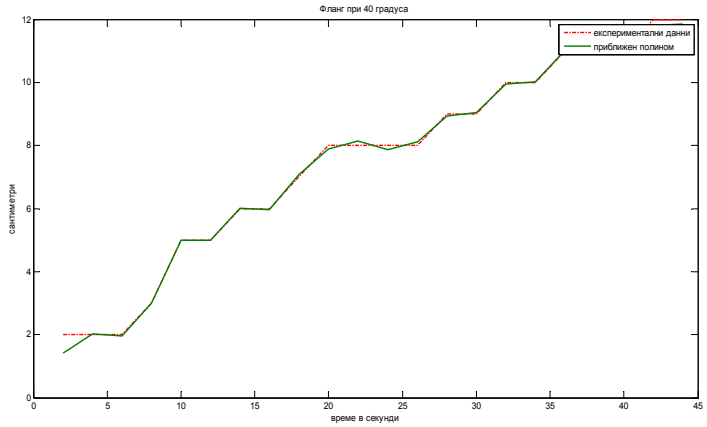

Fig. 3b Flank - experiment results and approximation

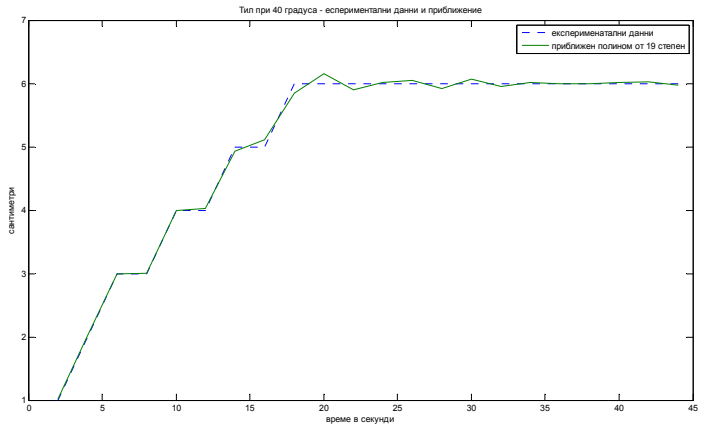

Figure 3c Rear — experiment results and approximation

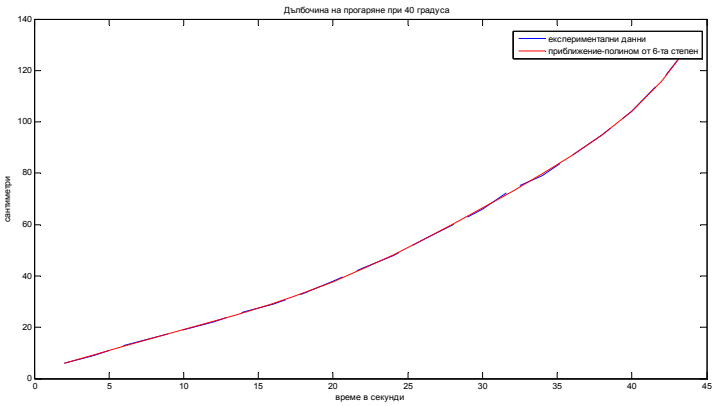

Figure 3d Burning depth — experiment results and approximation

4. CONCLUSIONS

- The fire together with its ascending flow rises perpendicularly up to the horizontal plane of the stand.
- Radiant heat exchange — the emission influences the burning Foading, most actively along the shortest path to the nearest flammable materials.
- It wind loading takes place, the deviation of the cresset is influenced by the direction and the speed of the ground v4nd and the burning depending on the closeness of the flammable materials.
- Experiments carried out in a laboratory give the opportunity for more precise study of the objective laws that govern the development and spread of the fire in particular conditions — a broken ground.

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SYSTEM OF ECOLOGICAL MONITORING IN NATIONAL PARKS “PIRIN” AND “RILA”

Antoaneta Milikina

Department of Geography, Ecology and Environment Protection, Faculty of Mathematics and Natural Science, South- West University “Neofit Rilski”, 66 Ivan Mihailov Str., 2700 Blagoevgrad, Bulgaria, e- mail: tonika_77@abv.bg

Abstract: *In accordance with the requirements of Bulgarian and international legislation in the management plans for national parks is to build a monitoring system.*

The information collected in carrying out environmental monitoring, will help the responsible parties in taking the correct, managerial decisions regarding the management of natural components and reduction of human impact in the parks.

Keywords: *environmental monitoring, national park, management plan, indicator, subject*

According to the Law on Environmental Protection (EPA) (Promulgated SG. Copy 91 of 25.09.2002), the National System for Environmental Monitoring includes national networks for monitoring of forests and protected areas, for biological monitoring and monitoring a series of abiotic components.

Directorates of the National Parks ensure that the national policy for environmental protection at regional level with the Regional Inspectorates of Environment and Water (RIEW) and the Basin Directorate. They perform supervisory functions in the state of environmental components and factors that affect them. [1]

Under Article 4, al.6 of the Rules for the structure and activities of the Directorates of National Parks (Promulgated SG. copy 68 of 16.08.2000) directorates monitor:

a) the state of natural ecosystems and communities, and the status of populations of protected and rare plant and animal species;
b) the state of other components of the environment - air, water, soil;
c) tourist load; [2]

According to the EPA “Environmental Monitoring” is the collection, evaluation and summary of environmental information through a continuous or periodic monitoring of certain qualitative and quantitative indicators characterizing the state of environmental components and their change as a result of the impact of natural and anthropogenic factors. [1]

System for ecological monitoring in national parks pursue the following objectives:

1. To help long-term monitoring and regular collection of information neces-

sary to assess the condition of the components of the environment and their modification as a result of the impact of natural and anthropogenic factors; 2. To ensure collection of necessary and sufficient information for adaptive management of the parks in order to ensure rapid mobilization of resources and measures to respond to changing conditions;

3. Ecological monitoring in national parks has focused on the conservation of protected sites, habitats and species, in their natural state; 4. Ultimately, the system aims to ensure ekomonitoring part of the information necessary to evaluate the effectiveness of the Management Plan and justification to maintain or change (in general terms) areas regimes and standards in the next ten-year period;

To achieve both objectives formulated, is gathering information needed to run in three main areas:

Basic data. Collection of basic biotic and abiotic data to monitor the parks elements / indicators. Such data could include threats and trends registered to conduct various environmental processes. The results of summary and analysis of accumulated information base may motivate further recruitment of specific data and / or research.

Conservation monitoring. It is important to know the role of the park to protect biodiversity and its contribution to the national ecological network-specific information on specific populations and species in the park, important in terms of biodiversity, high conservation significance of local, national, regional and global level.

Boundaries of permissible use. Successful management of the visitor flow and human impact is a priority objective for national parks. Monitoring the effects of great importance for the definition and implementation of the zones, regimes and norms, information at the end of 10 years of the Plan to enable management to assess whether proper designated areas, regimes and norms and how effectively fulfill their missions and functions.

Management plans are essential tools to guide development of a system for environmental monitoring in the parks and its structure. The scope and purpose of environmental monitoring shall be determined by reference to the three specific aspects of the management plan:

1. Relevance

The first environmental assessment under the Management Plan defines those components that are unique or important to protect the biodiversity of local, national, regional (Balkan), European and world level. The monitoring results serve as evidence of achievement of the objectives of park management for the protection of natural resources therein. These objectives are broadly: the conservation of biodiversity in the parks or conservation of species and habitat.

2. Areas, regimes and norms

Zoning is the first management tool, serving to ensure the conservation of species, communities and habitats in the parks. Each zone represents a distinct geographic area, aimed at reducing or, conversely, to focus on spe-

cific management activities. Environmental monitoring system should be consistent with specific features, characteristics and requirements of the zones in the park.

3. Threats

Ecological monitoring in national parks should be oriented in the first place to monitor the degree of manifestation of each of the identified threats to the parks, especially those with human nature. The monitoring system must determine how to monitor, timely data collection, reporting and assessment of threats in time and space.

Threats can be divided into two groups:

A) Threats on which the park management can not directly affect global warm spell, air pollution (long-distance transmission), contamination with heavy metals, water and discharge of water.

B) Threats which are capable of control and congestion-reducing (excessive concentration of people in the same place in the park).

Main ruling document in the selection of sites and locations for monitoring are plans for the management of national parks. In the selection of specific sites and development of the matrix for each park, the following criteria:

1. Species/ habitats that are environmental risk;
2. Species/ habitats that have high conservation significance;
3. Control areas, areas not subject to anthropogenic influences;
4. Tourist sites in the pilot areas (places to rest, look at places bivatsi);
5. Areas with high tourist load;
6. Species / habitats that are sufficiently representative indicators of changes observed in several components of the environment;
7. Objects for which there is information and systematic studies in the past;
8. Objects to be monitored and at present;
9. Representative sites for monitoring areas, areas for comprehensive monitoring, which are representative of the entire territory of the Park. [3]

In each of the national parks depending on the specific conditions are selected sites for monitoring. The majority of sites are common for three national parks, the main differences are in the selected species of animals and plants, some of which occur only in individual parks.

Types of monitoring carried out in the territory of NP ‘’Pirin’’ and NP ‘’Rila’’

Subject to monitoring	indicators	‘’Pirin’’	‘’Rila’’
1. Soil	analysis for pH, total N, P, K, Ca, Mg, content of heavy metals and radiation	no	yes
2. Standing-water ponds	Hidrohimiya-water temperature, dissolved oxygen, pH, conductance, dissolved substances, suspended solids and turbidity, inorganic forms of nitrogen,	yes	yes

	phosphate, COD and BOD5; Hidrobiologiya- chlorophyll A and phytoplankton;		
3. Water-flowing rivers	- water temperature, dissolved oxygen, pH, conductance, dissolved substances, suspended solids and turbidity, inorganic forms of nitrogen, phosphate, COD and BOD5; - Trophic index RETI and biotic index;	yes	yes
4. Forest	1. Health of darvostoya: - Composition, completeness, age, sklopenost, average height; 2. Sanitary condition of forest: - Defoliate and discoloration; 3. Vazobnovitelen potential of forest: - Germination and podrast;	yes	yes
5. Animals species: -Rupicapra rupicapra balcanica -Cervus elaphus -Capreolus capreolus -Sus scrofa -Ursus arctos -Canis lupus -L.europeas -V. vulpes -M.martes -Lacerta vivipara -Salmo trutta morfa fario - Spermophilus citellus -Tetrao urogallus - Bonasa bonasia - Falco peregrinus - Aquila chrysaetos - Circaetus gallicus - Falco cherrug - Aegolius funereus - Bubo bubo - Alectoris graeca - Picoides leucotos	number, age and gender characteristics	 Yes No Yes Yes Yes Yes Yes Yes Ye yes Yes Yes No yes yes yes yes yes yes yes yes yes yes	 Yes Yes Yes Yes Yes Yes No No No no No No yes yes yes yes yes no no no no no no
6. Plants species:	mestorastene, density, fenologichna phase, the vegetative phase, health threats		

- Leontopodum alpinum Cass.		Yes	No
- Oxytropis urumovii Jav.		Yes	No
- Gentiana lutea L.		Yes	No
- G. punctata L.		yes	No
- Verbascum davidovii Murb.		yes	No
- Heracleum angusticetum		yes	No
- Erigeron vichrensis Pawl.		yes	No
- Alchemilla bandericensis		yes	No
- Papaver degenii		yes	No
- Thymus perinicus		no	Yes
- Vaccinium myrtillus L.		no	Yes
-Gentiana frigida		no	Yes
-Empetrum nigrum		no	Yes
-Diphazium alpinum		no	Yes
-Pulsatilla vernalis		no	Yes
-Drias octopetata		no	Yes
-Pedicularis oederi		no	Yes
-Anemone narcissiflora		no	Yes
-Clematis alpine		no	Yes
-Artemisia eriantha		no	Yes
-Botrychum lunaria			
-Arctostaphylus uva-ursi			
7. Tourist load	number of tourist nights and number of visitors	Yes	Yes
8. Impact of tourist flow	Final grade is the average of the rates permitted the use of permanent (12) and current (17) indicators.	yes	no

Following the characteristics of the system for environmental monitoring in the two national parks can be made the following conclusions:

1. Indicators to monitor are the same for both parks.

2. Subjects to monitoring are divided into 8 groups- soil, standing water ponds, water flowing rivers, forests, animals species, plants species, tourist load and impact of tourist flow.

3. Monitoring system in NP “Pirin” include monitoring of- standing water ponds, water flowing rivers, forests, animals species, plants species, tourist load and impact of tourist flow.

4. In NP “Rila”- soil, standing water ponds, water flowing rivers, forests, animals species, plants species and tourist load.

5. In NP “Pirin” no monitoring of the soil.

6. In NP “Rila” does not monitor the impact of tourist flows on the environment.

7. In NP “Pirin” observed 20 species of animals, in Rila National Park - 11 species, with 9 species occur in both parks.

8. In NP “Pirin” observed 10 species of plants, in Rila National Park - 13 species.

REFERENCES

[1] Law on Environmental Protection, Promulgated SG. Copy 91, 25.09.2002.

[2] Rules for the structure and activities of the Directorates of National Parks, Promulgated SG. copy 68, 16.08.2000.

[3] Project Biodiversity Conservation and Economic Growth, 2002.

[4] Information for monitoring species that are in the territory of Pirin National Park.

[5] Information for monitoring species that are in the territory of Rila National Park.

INFLUENCE OF SECONDARY EDUCATION UPON THE REGIONAL DEVELOPMENT OF MUNICIPALITY OF BLAGOEVGRAD

Vladimir Nikolov Karadzhov

Department “Geography, ecology and protection of natural environment”
Faculty of natural and mathematic sciences,
South-Western University “N. Rilski”- Blagoevgrad

Abstract. *The purpose of this research is to reveal a new point of view to the following connection - youth education – socio-economic development of municipality Blagoevgrad. Discussing this topic usually underestimates the secondary education and gives priority to the university degrees studying. It is of big interest to analyze the dependences between the secondary education features and its transition to the university stage. Both educational levels have considerable traditions in Blagoevgrad, but their further realization/utilization in socio-economic sphere demands extensive research*

At a preliminary stage of research this work will analyze the influence of Language secondary school “Academician Lyudmil Stoyanov”, and at a later stage – the influence of all secondary schools in municipality of Blagoevgrad. Basically, the purposes of the research are the following:

RESEARCH PURPOSES:

Analyzes what are the benefits and losses for municipality Blagoevgrad in short- and long term plan from educating students from the whole South-Western region?
What does she receive in response to her investments?
Is the widening of material and labour basement of secondary education required? / Is it necessary to widen the material and labour basement of the secondary education? /
What influence cause the young people, who have been educated, upon the regional economic development through the structure of the spends, their contribution as a labour resource etc.

RESEARCH STRUCTURE: In the present appearance the research will pass trough 10 stages:

1 **Introduction – information about municipality of Blagoevgrad –** statistical data: geographical situation, area, number and structure of the population, number and type of settlements, economic situation of Blagoevgrad compared to the average economic indices of the other municipalities in Bulgaria.

2 **Number of secondary schools in Blagoevgrad and their names.**

3 **Statistical data about the secondary schools** – Their specialization by profiles, their size – as number of classes and number of students, number and structure of specialized classes.

4 **Type of property and ownership, and sustainance?** – Whose property and at whose sustainance are the secondary schools – municipal, at the Ministry of education and science, or private.

5 Settlement profile of educated students – To reveal the ratio between students from Blagoevgrad and students from outside (from the region and beyond). To create an analysis of the settlement structure of students in percentage – urban / rural

6 Average month and annual spends of the students in the town - How much they spend for rents, electricity and water supply, food, pocket money, transport (including taxies and urban transport), entertainment, school materials and other spends in Blagoevgrad. This part of the research will include inquiring students and their parents, and processing the data.

7 Average spends of municipality of Blagoevgrad (or Ministry of education and science) for the supplement of one student – according to the legislative norms.

8 Comparison of elements 6 and 7 i.e. the spends of educated students, at one side, and the municipal spends at the other – balance in short- and long term plan.

9 To reveal, trough inquiries and interviews, the intensions of the students for:

- proceeding their education in the universities in Blagoevgrad at: South Western University "N. Rilski", American University in Bulgaria or The college of tourism – Blagoevgrad.
- marriage, purchasing an apartment or a house (including trough bank loans or house credits), desire for permanent/sustainable work, permanent living in the town etc.

10 Analysis – is the profile of secondary education corresponding to the demands of business and administration.

For this purpose a comparison between the following elements will be created:

- number and specialties/profiles of the different classes in the municipality.
- Economic specialization of the region according to the National Categories of Economic Diversification (NCED) and share of the separate sub branches in the total economic product of the region.
- Is there a necessity of actualization and optimization of the educational profile of the region

When the results from the different stages of the research are ready, we will have data/information/, which can be used in different ways:

- for determined purposes of optimization and government of municipal resources at the present moment.
- as a methodology for further forecasting and research. The experience can be utilized in future by planning activities for economic growth and cultural development, intensifying “youth settling” in a certain municipality or region, using the structure of education – secondary and university.

I would like to represent to you part of the data, collected for this research so far. It is both general for the region and municipality of Blagoevgrad and particular – about the development of secondary education in it.

Region Blagoevgrad is situated in the South – Western part of Bulgaria at the border with Republic of Macedonia and Republic of Greece. Its population is 334 907 people in 2007. It is distributed in 280 settlements, 14 municipalities and 137 mayoralties.

Ethnic composition of the population – Region Blagoevgrad:

Bulgarian	**79.4 %**
Turkish	**9.4 %**
Roma	**4.2 %**
Other	**5.7 %**
Not determined	**1.3%**

Religious composition of the population – Region Blagoevgrad:

Christian	**79.1 %**
Muslim	**18.8 %**
Other	**0.1 %**
Not determined	**2.0 %**

Territorial balance – Region Blagoevgrad:

Total Area:	**6 449 474 (da)**	**100 %**
Agricultural areas:	**2 297 601 (da)**	**35.6 %**
Forests:	**3 635 936 (da)**	**56.4 %**
Urbanized areas:	**133 354 (da)**	**2.1 %**
Infrastructure:	**307 654 (da)**	**4.8 %**
Mining areas:	**22 361 (da)**	**0.3 %**
Water areas:	**52 568 (da)**	**0.8 %**

Municipality Blagoevgrad is situated in the South – Western part of Bulgaria and is part of Region. There are 26 settlements in the municipality, with total population number of 77 422 people in 2007.

Territorial balance – Municipality Blagoevgrad:

Total Area:	**620 118 (da)**
Agricultural areas:	**292 291 (da)**
Forests:	**263 196 (da)**
Urbanized areas:	**36 389 (da)**
Infrastructure:	**19 239 (da)**
Mining areas:	**2 388 (da)**
Water areas:	**6 615 (da)**

There are 14 secondary schools in the Municipality of Blagoevgrad. Students between 15 and 20 years old are studying in them distributed in classes - from 8-th preliminary to 13-th class. The total number of students is 5 542 in 225 classes (see Table 1)

Due to the negative natural and mechanical population growth in the last 19 years, there is a tendency to reduce the number of students and classes in schools. It is most obvious in the professional technical schools and schools of general education.

Such a tendency is not observed in the so called “elite schools”, in which basic educational profiles are foreign languages and information technologies.

An important fact is that the level of education of the other, non-profiling subjects, like Bulgarian language and Literature, Geography, Mathematics, History, Biology and Chemistry is also very high in these schools. These are the basic disciplines in the candidate student campaigns, when applying for specialities like: law, tourism, medicine, international relationships, the whole spectrum of natural and economic specialities and others.

This shows that students in secondary education are more and more adequate in selecting the most suitable educational profile and choose to study modern and popular specialties, with strong demand on the market of labour. At a later stage this will help them in applying university specialities, which ensure more prestigious and well-paid jobs.

We should not forget that not only the educational profile makes a school attractive, but also the quality and level of educational processes in it.

The present educational law determined new standards of funding and provided significant autonomy in school management. Most directors have a wide margin in the financial part. They manage the budget of the schools on the basis of their own style and vision - striving to spend wisely, to make savings, etc. Increasingly, successful director must be presented as a good manager, rather than as a pedagogue. Schools receive funding based on the number of students studying in them – i.e. system "money follows the student”.

This provides excellent opportunities for directors and teachers to motivate teams to better and beneficial work, to gain the trust of more students and thus to achieve a higher budget and salaries.

I hope that when this investigation is completed, it will contribute to a more - complete comprehension of the above processes in secondary school! This will benefit not only the Municipality of Blagoevgrad, but also the whole country.

Екологична оценка на горскостопанските дейности в горско стопанство Рилски манастир за периода 1947-1987 година.

Константин Тюфекчиев

Югозападен университет "Н. Рилски" – Благоевград

***РАЗШИРЕНО РЕЗЮМЕ**: Екологичният подход в стопанисването и експлоатацията на горските екосистеми е задължителен в съвременното прилагане на лесовъдската наука. По своята същност, още от своето създаване, тя е дълбоко екологична и интегративна. Основните принципи, залегнали в целите и задачите й, са насочени към повишаване количествените и качествените лесовъдски показатели на горските екосистеми за постигане на максимален икономически и екологичен ефект. Лесовъдската наука ползва всички съвременни постижение на биологичните и инженерните научни области, от една страна за повишаване интензивността и ефективността от горскостопанските дейности и от друга да сведе до поносим от горските екосистеми отрицателния ефект от отнемането на биомаса и използваните за това технологии.*

Прилагането на лесовъдската наука в България през различните периоди от развитието на страната страната сочи различна степен на съобразяване с екологичните принципи залегнали в нея. През много периоди лесовъдската практика е била в значителна степен откъсната от лесовъдските норми на натоварване на горите и това е довело до значителни промени с дългосрочен отрицателен ефект върху функционирането на екосистемите.

В настоящото проучване правим опит за екологична оценка на лесовъдската практика в горско стопанство Рилски манастир за период от 40 години (1947-1987 г.), който дава достатъчно информация за по-точен анализ на ефекта върху лесовъдските показатели на дървостоя.

През посочения период се констатира почти постоянно превишаване на добитата дървесина спрямо предвиденото за ползване, като за някои години то достига до 188% (1952 г. – предвидено-27701 м^3, отсечено-52067 м^3). Това е довело до влошаване на редица показатели за количеството и качеството на дървостоя в стопанството, като среден запас на 1 ха (от 183 м^3 през 1947 г. на 149 м^3 през 1968 г.), среден прираст на 1 ха (от 5,4 м^3 през 1947 г. на 1,9 м^3 през 1968 г.), средна възраст на горите (от 97 години през 1947 г. на 70 години през 1978 г.) и мн. др.

Един от най-точните показатели за качеството на една гора остава почти непроменен за сравнително дългия наблюдаван период

и значителната площ на новосъздадените горски култури: за 1950 г. – 0,5; за 1958 г. – 0,58 и 1969 г. – 0,59.

По отношение на останалите горскостопански дейности – залесяване, борба с ерозията, странични ползвания и др., общите констатации са за относително добри количествени (залесена площ, противоерозионни технически мероприятия и др.) за сметка на недостатъчно ниво на качествените показатели (несъобразяване на дървесния вид с типа месторастене, концентриране на пашата върху ограничена площ и др.).

***КЛЮЧОВИ ДУМИ**: горски екосистеми, ползване, сеч, запас, прираст, възраст, залесяване.*

МАТЕРИАЛ И МЕТОДИ

Целта на настоящото изследване е да се направи екологична оценка на основните стопански дейности осъществени на територията на горско стопанство “Рилски манастир” за 40 годишен период (1947-1987 г.).

Територията на горското стопанство включва водосборите на реките Манастирска, Илийна и Рилска, както и по-малък участък на запад от гр. Рила, заемайки части от 3 от дяловете на Рила планина – Северозападен, Югозападен и Централен. По-голямата част от нея е горски фонд, а останалите площи са високопланински пасища и други недървопроизводителни терени.

Обект на изследване бяха – промените в площа и структурта на горския фонд; дърводобивната дейност; залесяване и отглеждане на горските култури и насаждения и страничните ползвания в горския фонд, на територията на стопанството.

За дървостоя бяха изчислявани средните стойности по години и отчетни периоди на всички основни лесовъдски показатели на отделни горско-технически участъци и за цялата площ на горското стопанство. За залесяването бяха съпоставяни залесителния вид с типа месторастене на залесената площ, както и беше направен анализ на рецентното санитарно състояние на горските култури и насаждения. За страничните ползвания бяха проследени количествените и качествените показатели на горските продукти – паша сенодобив, събиране на горски плодове, билки, борина, смола и др., както и отстреляния дивеч, през целия изследван период.

РЕЗУЛТАТИ И ОБСЪЖДАНЕ

1. Административно деление и промени в площа на горския фонд.

Административното деление и промените в площа и структурата на горския фонд през разглеждания 40 годишен период на територията на горско стопанство Рилски манастир сочат непрестанно уедряване и функционално устройване, което е важна предпоставка за подобряване

качеството на управлението и повишаване ефективността на ползването му.

През 1948 г. площа на тогавашната Държавна гора Рилски манастир има обща площ 22 398,7 ха, от които 11 120,8 ха гори. До 1957 г. общата площ на стопанството нараства на 33 813, 3 ха, като през 1958 г. площа е намалена на 22 445,8 ха поради изключване на всички годни за земеделско ползване работни земи. За 1968 г. горския фонд е 21 797,8 ха, а през 1977 г. нараства с 600,9 ха на 22 398,7 ха. Голям дял в това увеличение се пада на неустроени дотогава гори и на залесените пустеещи земи.

По отношение на структурата на горския фонд се констатира намаляване на незалесените и недървопроизводителни горски площи, като само за периода 1967-1977 г. то е 6 %. Увеличаването на залесената площ е показано в Табл.1, което сочи тенденция на постоянно увеличаване.

Табл. 1. Залесена горска площ в горско стопанство Рилски манастир.

Година	1947 и 1950	1958	1967	1977
Площ (ха)	15 623,8	15 989,6	16 170,0	17 090,1

Постоянното увеличаване площа на горския фонд и компактността на дървостоя позволява по-добро планиране на всички мероприятия по отглеждането на дървостая, сечта и извоза на добитите материали, провеждането на залесителните мероприятия и отглеждането на създадените горски култури и насаждения. Това от своя страна повишава икономическата ефективност при експлоатацията чрез намаляване на разходите за изграждането на пътна инфраструктура и интензификация на технологичните процеси.

Административното поделяне започва през 1948 г. на основата на Първия стопански план, който оформя 2 самостоятелни горскостопански единици – “Рилски манастир” и “Рилска”. По-късно, през 1958 г. двете гори са устроени общо, като се извършва сложно повторно лесоустройство, а горското стопанство е наречено “Рилски манастир” с 2 технически участъка – “Манастирски” и “Рилски”. Със заповед от 1963 година Министерството на горите и горската промишленост разделя по стопански съображения горското стопанство на 4 технически участъка: “Манастирски”, “Илийна река”, “Пастра” и “Рила”, запазени до днес. Това усъвършенстване на административните структури позволява по-пълноценно използване на инженерния и административен персонал и интегративност на различните горскостопански дейности, извършвани на територията на съответния горскотехнически участък.

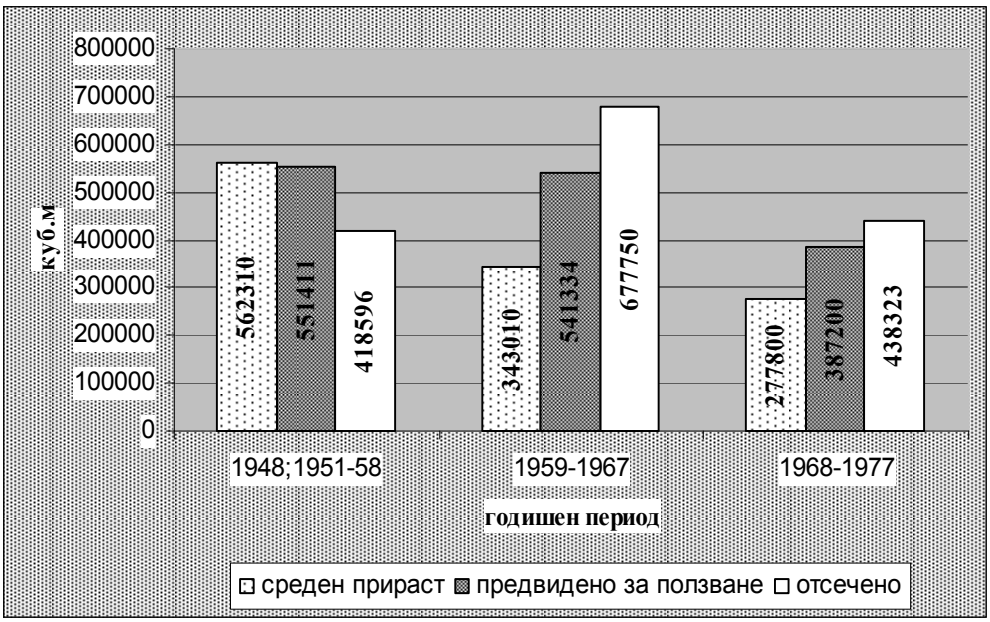
2. Дърводобивна дейност.

Главното ползване (дърводобив) от горите на територията на горско стопанство “Рилски манастир” за разглеждания период се характеризи-

ра с постоянно превишаване спрямо средния прираст и предвиденото за ползване (Фиг. 1).

Изключение на пръв поглед прави периода до 1958 г., но прегледа на съотношението между добитата дървесина от главни (353 391 м^3, при предвидено – 277 010 м^3) и отгледни сечи (25 099 м3, при предвидено – 177 210 м^3) само в Риломанастирската държавна гора демонстрира съсредоточаване на сечта основно върху елитните дървостои в близост до все още малкото горски пътища. Констатира се и неравномерност в ползването и по години, като само за 1952 г. отсеченото количество дървесна маса е 52 067 м^3 при предвидено годишно ползване 2 701 м^3, или 188%. Това предполага многократно претоварване на засегнатите горски екосистеми значително над податните им сили, а това доказано ще доведе поддържането им дълбока сукцесия.

Характерното за другата горскостопанска единица “Рилска” през този период е заниженото ползване – 46,4 % от предвиденото, което обаче е провокирано от продължаващото използване на клоносечното стопанство, водещо до девастиране на терените в някои участъци.



Фиг. 1. Добита дървесна маса от територията на горско стопанство Рилски манастир

Същите тенденции и грешки са продължили и до края на 70-те години. И за двата периода – 1959-1967 г. и 1968-1977 г., е характерно постоянно превишаване на ползването от тези гори над предвиденото, което е довело до рязко намаляване на продуктивостта им – постоянно намаляване на средния годишен прираст, а от там и на предвиденото

за сеч. Предвиденото годишно ползване по лесоустройствен проект от 1958 година – 60 141 м^3 пада на 24 860 м^3 през 1977 г., което е вече значително под средния прираст на цялата площ – 33 922 м^3. Неравномерността на ползването по години е характерно и за двата периода, като например количеството на дървесината, добита от цялото стопанство през 1961 г. е 109 260 м^3. Това прави с 81,7% над предвиденото по лесоустройствен проект и с 218,5% над средния дървесен прираст на стопанството.

За периода 1978-1987 г. е характерно ограничаване на ползването (22 450 м^3) в рамките на предвиденото за добив, което обаче е провокирано от продължаващата концентрация на сечите основно върху терени в близост до пътищата.

Турнусът на сеч е създаден за да повиши икономическата ефективност на горскостопанската дейност. При определена възраст всеки дървесен вид достига кулминацията на своята биопродуктивност. След нея производството на дървесна маса намалява, а се увеличава отпадът му (изсъхване, загниване и др.) и от този момент баланса става отрицателен. От икономическа гледна точка този етап от развитието на дървото не е изгоден и затова е приета възрастта на пиковата стойност на бипродуктивността за възраст на отсичане на дървото, която възраст се нарича – турнус на сеч. Погледнато от екологична гледна точка тази възраст е недостатъчна дървостоя да изпълнява екологичните си функции (биотична, климатообразуваща, защитна, въздухопречистваща, рекреационна и др.), тъй като те са в максимални стойности на значително по-висока възраст. Посочените стойности в Табл.2 на промяната в продължителността на турнуса на сеч само в 2 основни стопански класа показва постоянното им намаляване през разглеждания период. Намаляването с 28% в боровия стопански клас гарантира значително намаление на екологичните функции на дървостоя. На практика това се явява узаконяване на пресилената експлоатация на горите през този период.

Табл. 2. Промяна в продължителността на турнуса на сеч през изследвания период.

	Години		
Стопански клас	1948	1958	1968
Боров	140	120	100
Дъбов	160	160	140

За да докажем негативния ефект от тази пресилена експлоатация върху качеството на гората ще проследим промяната в качествените й показатели – дървесен запас, среден прираст, средна възраст, възрастова структура, пълнота и бонитет.

В Табл. 3 е посочен общия дървесен запас на горите в стопанството, който намалява с годините, въпреки че площа на горските насажде-

ния се увеличава, видно от Табл.1, и произведената от дървостоя биомаса през изследвания период. Това изтощаване на горските масиви се доказва и от намаляването на средния дървесен запас на 1 ха, който би трябвало да се увеличава след извършените масови залесявания през периода.

Табл. 3. Промяна в дървесния запас на горите на горско стопанство Рилски манастир през изследвания период.

Година	1947/1950	1958	1968
Общ дървесен запас – м^3	2 864 611	2 841 240	2 227 333
Дървесен запас на 1ха – м^3	183	178	149

Най-точен показател за интензивността на горското стопанство е изменението на средния прираст през един вегетационен сезон (най-често фиксиран като една година). Достатъчно е да проследим темповете на регреса му дори за този кратък период, показан в Табл. 4, за да се разбере, че засягането на екологичните функции на горските екосистеми на изследваната територия в действителност е в много по-голяма степен от колкото се вижда в Табл. 4. Свеждането му до стойност значително под средната за нашата географска ширина – 6,5-7,0 м^3/1ха, сочи намаляване на 3 пъти използваемостта на процеса на фотосинтеза от цялата площ на горите в стопанството.

Табл. 4. Промана в средния прираст горите на горско стопанство Рилски манастир през изследвания период.

Година	1947/1950	1958	1968
Среден прираст на цялата площ – м^3	56 231	34 301	27 780
Среден прираст на 1ха – м^3	5,4	2,4	1,9

Изключително важни фактори за пълноценното изпълнение на многостранните функции на горите са средната възраст и оптималната възрастова структура.

По отношение на средната възраст се установява постоянното й намаляване: 1947 г. – 97 години; 1958 г. – 76 години; 1968 г. – 74 години; 1978 г. – 70 години. Една от причините за това намаляване се пада и на голямото увеличаване на площа на културите и младите насаждения в резултат на масовите залесявания през тези години. Данните за вида на добитите материали, обаче сочат, че основната причина е ориентирането на сечта към най-възрастните и най-едрите дървета. Всичко това показва, че при планирането на обектите за сеч приоритет не са били дългосрочните цели за постигане на високопроизводителни и хомогенни гори с максимален екологичен ефект. Доказателство е наблюдаваната голяма диспропорция по отношение на възрастовата структура, изразяваща се в най-голям дял на насажденията от I и II клас на възраст – над 30 %, който се запазва и през 1958 и 1968 години.

Критериите за качеството на една гора са пълнотата и бонитетът – показатели за това, до колко даден дървостой използва максимално природните дадености (почвено плодородие, климат, светлина и др.) на различните месторастения, в които е разположен.

За разглеждания период се конктатира слабо увеличение на пълнотата - 1950 г. – 0,5; 1958 г. – 0,58 и 1968 г. – 0,59. Промяната е минимална въпреки сравнително дългия период и значителната площ на новосъздадените горски култури и насаждения. Причина за това може да се посочи постоянното превишаване на ползването от горите.

Средния бонитет на насажденията остава непроменен за целия 40-годишен период – IV. Това показва, че риломанастирските гори са с понижена продуктивност, което се дължи главно на факта, че на много места дървесните видове не съответстват на условията на месторастене и че работата по подмяната им с по-подходящи е била недостатъчна.

3. Залесяване и отглеждане на горските култури и насаждения.

Пълни данни за обема на извършените залесителни работи за периода от 1947 до 1967 г. Отбелязана е информация само за залесени общо 1208,5 ха с 6 иглолистни и 5 широколистни вида. По точна информация съществува за периода до края на седемдесетте години. Общата залесена площ от 1967 до 1977 г. е 2605 ха при план 2442,6 ха. По показатели тя се разпределя, както следва: залесяване на голи площи – 14,4%; попълване на изредени култури, на млади, средновъзрастни и дозряващи насаждения – 7,0%; реконструкция на нископродуктивни насаждения – 49,6%; лесокултурни мероприятия след извеждане на сечта – 29,0%. От екологична гледна точка положителен факт е голямият дял на залесяването на голи площи и реконструкцията на нископродуктивни насаждения. Това неминуемо ще доведе до дългосрочен ефект върху екологичните функции на Риломанастирските гори. Високият процент на залесителните мероприятия след извеждането на сечта доказва некачествено извеждане на изборните и постепенните сечи, доближаващо се до технологията за извеждане на голите сечи.

През последните години на разглеждания период се е увеличило както по обем, така и по видов състав разсадниковото производство. Средногодишно са се произвеждали по 2 500 000 фиданки. Освен основните дървесни видове (смърч, бял бор, черен бор, бяла мура, ела, топола и др.) са се произвеждали и са залесявани фиданки от зелена дуглазка (Pseudotsuga menziesii (Mirbel) Fronco), европейска (Larix decidua Miller) и японска лиственица (L. japonica M.), сребрист смърч (Picea pungens Engelm.), сребриста (Abies concolor Lindl.), гръцка (A. cephalonica London) и испанска ела (A. pinsapo Boiss.), секвоя (Sequoiadendron giganteum (Lindley) Buchholz), бреза, бук, салкъм (Robinia pseudoacacia L.), орех (Juglans regia L.), явори, ясени, ситков смърч (в

торфени саксийки), атласки кедър (Cedrus atlantica (Endl.) Carnier), веймутов бор (Pinus strobus L.) и др. Много от тези чуждоземни видове са подходящи за този район и създадените култури сега показват много добри резултати.

Извеждането на отгледни и санитарни сечи е най-мощния лост за повишаване качеството на дървостоя и синоним на ускорен еволюционен процес на горските екосистеми. Спазването на технологията при провеждането им посочена от лесовъдската наука гарантира по-здрава, по-качествена и по-продуктивна гора с повишени екологични функции. През изследвания период се наблюдава увеличаване на добитата дървесна маса от отгледни и санитарни сечи през периода 1958-1977 г. – 311 161 м^3 при предвидени по лесоустройствения проект 190 810 м^3. Въпреки превишението от 63%, насажденията, в които са извеждани, не са пресилвани. Малката разлика в процента на едрата строителна дървесина добита от главни (65,2 %) и отгледни (57,1%) сечи показва, че те са били извеждани главно в дозряващите и средновъзрастните насаждения, като маркирането е било насочено към по-едрите стъбла. По този начин е било нарушено основното лесовъдско изискване за извеждане на отгледните сечи – да се покровителстват желаните дървесни видове с добри стъблени форми и добра наследственост.

Интерес представлява отглеждането на насажденията през периода 1978-1987 г., когато се констатира изпълняване на предвиденото за ползване от отгледни сечи, които са основно средство за повишаване на качеството на дървостоите и техните многостранни функции в бъдеще. Общите количествени показатели, като обща отгледана площ и общо количество добита дървесна маса, не дават точна представа за ефекта върху екосисттемите. Прегледа на изпълнението по сортименти, обаче, сочи преизпълнението с 571% над предвидената по лесоустройствен проект общо едра строителна дървесина и 650% при едрата иглолистна дървесина. Това е доказателство, че отгледни сечи са били извеждани главно в средновъзрастните и дозряващите насаждения и имат характер на главни сечи. Маркирани за сеч са били най-едрите и елитните дървета. Още по-утежняващ факт е, че това превишение е получено от 190 ха площ, а не от предвидените 517 ха.

4. Странични ползвания от територията на горското стопанство.

Освен добива на дървесина комплексното използване на горските продукти включва и значителни по видов състав странични ползвания – паша, сенодобив, събиране на горски плодове, билки, смола, смърчови кори, борина и др. Общата констатация е, че тази дейност е подценявана извънредно много. Единствено не е намаляло значението на пашата. За това свидетелства фактът, че пусканите да пасат домашни животни винаги е по-голям от максималните възможности на територията на горското стопанство, което често се отразява

отрицателно върху природната среда и компрометира дейността на горските работници. Този конфликт между селскостопанската и горскостопанската дейности, който винаги е съществувал, през разглеждания период е продължил да се задълбочава. От 1958 до 1967 година домашни животни са били на паша върху площ от 2940 ха, при предвидена площ по лесоустройствен проект от 600 ха, което прави превишение от 5 пъти. През периода 1968 до 1977 година броят на пуснатите на паша овце е двойно повече от позволеното. Точна информация до 1958 година липсва, но посочваните отрицателни изменения на природната среда (утъпкване на почвата, намаляване на тревната покривка, промяна на тревния състав и т. н.) сочат също пресилено полване. Тази тенденция за намаляване на пашата се е запазила и към края на изследвания период тя е сведена в рамките на допустимите норми по лесоустройствен проект.

Констатираното намаляване на добива на сено, листников фураж, смола, смърчови кори и борина може да бъде определено от екологична гледна точка, като много положителна тенденция, поради факта, че всички тези дейности влияят отрицателно върху отделните компоненти на природната среда – поддържане на определен тип тревен състав, нараняване и ограничаване растежа на дърветата и др.

Ограниченото ползване през разглеждания период на горски плодове и билки също може да се определи като неправилно. Значението на тези естествени ресурси за човека, при масовото използване през този период на химически препарати в селскостопанското производство и ориентирането на медицината основно към антибиотично лечение, е безспорно. Данните сочат, че при събрани само за 1955 г. пет тона малини и 2 тона боровинки, изпълнението за целия десетгодишен период (1968-1977) е 21 тона.

Общата констатация за дейността по страничните ползвания от територията на горско стопанство Рилски манастир е негативна. За тези дейностти, които са развивани в голям обем (паша на домашни животни), се наблюдава неколкократно превишаване на ползването над податните сили на екосистемите, а другите, които са с изключително значение (добив на горски плодове и билки), са подценявани и изоставяни. Поради еволюцията на съвременната цивилизация една голяма част от страничните ползвания (добив на сено, листников фураж, смола, смърчови кори и борина), които имат негативен ефект върху екосистемите, започват да губят своето значение и това довежда до окончателното им спиране в края на изследвания период.

ИЗВОДИ

1. През изследвания период не е използван потенциала на административното деление и уедряването на площа, с което не е постигната максималната ефективност в стопанисването на горския фонд.

2. Главното ползване (дърводобив) от горите на територията на горско стопанство “Рилски манастир” за разглеждания период се характеризира с постоянно превишаване спрямо средния прираст и предвиденото за ползване достигащо до 218,5% над средния дървесен прираст.

3. Влошени са всички качествени показатели на дървостоя на територията на стопанството – намаляване на общия дървесен запас (от 183 м^3/ха на 149 м^3/ха), понижаване на средния прираст (от 5,4 м^3/ха на 1,9 м^3/ха), снижаване на средната възраст (от 97 г. на 70 г.), голяма диспропорция във възрастовата структура (I и II клас на възраст – над 30 %) и запазване стойностите на пълнотата (0,5-0,59) и бонитета(IV).

4. Извършените залесявания са в недостатъчен размер и насочени предимно върху терени, на които са извършени главни сечи.

5. Отгледните сечи, които са най-мощния лост за повишаване качеството на дървостоя и синоним на ускорен еволюционен процес на горските екосистеми, са извършвани основно в средновъзрастните и дозряващите насаждения с превишение над предвиденото, достигащо до 571% в едрата строителна дървесина. По този начин те не са си изпълнили основните екологични функции.

6. Комплексното използване на горските екосистеми, включващо и значителни по видов състав странични ползвания – паша, сенодобив, събиране на горски плодове, билки, смола, смърчови кори, борина и др., е компрометирано чрез превишаване в ползването (паша) или добив неколкократно под податните сили на територията на стопанството (добив на горски плодове и билки).

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Влияние на природните капсаициноиди върху неврофизиологичния и имунния статус на животни и възможности за повишаване на адаптивността и преживяемостта им при разселване.

Константин Тюфекчиев

Югозападен университет "Н. Рилски" – Благоевград

РАЗШИРЕНО РЕЗЮМЕ: *Днес намаляването на биологичното разнообразие води до ограничаване на хранителната база на ловните видове, а замърсяването на жизнената им среда - до усложняване на метаболитните процеси и най-често до намаляване на жизнения им потенциал. Това е в разрез с все повече налагащото им се адаптиране към територии, повлияни в по-малка или в по-голяма степен от човека, където те са със значително по-високи нива на стресово натоварване и ловна експлоатация. Крайният резултат от този конфликт за някои по-слабо пластични ловни видове е силното намаляване на естествените им популации. Изключителното им ловно значение, обаче, налага изкуствено размножаване и разселване.*

*Откъсването на животните от естествените им местообитания и отглеждането им първоначално в изкуствени условия води до ограничаване действието на закона за синергизма в йерархическата организация на биосистемите, което се изразява най-вече в ограничаването или изолирането на подсистемите, доставящи биологично активни вещества, стимулиращи биологичния потенциал, имунитета и адаптивните възможности на дивите птици (**Недялков**, 2003). Затова, като алтернатива, все повече се налага при отглеждането на ловни видове животни (ловен фазан, дива патица, кеклик и др.) към храната да бъдат добавяни някои екологически чисти средства като пробиотици и биологично активни вещества, екстрахирани от растенията, за да бъде запазени или повишени жизнения потенциал, имунния статус и адаптивните им възможности при разселване в естествена среда.*

В настоящата работа е направен преглед на влиянието на екстракт на капсаициноиди (за краткост CAP) от плодове на Capsicum annuum var. Annuum и техни аналози върху основни биохимични и имунологични показатели (Substance P, титър на комплемента, IgE, IL-1β и др.) на животински видове, имащи пряко отношение върху жизнения потенциал и адаптивните им възможности.

КЛЮЧОВИ ДУМИ: *capsaicin, Substance P, птича имунология, титър на комплемента, IgE, IL-1β, адаптация.*

Редица автори в своите изследвания сочат стимулиращото влияние на капсаициноидите върху укрепване здравния статус и повишаване на продуктивността на диви и домашни животни, носливостта, оплодеността, люпимостта и жизнеността на новоизлюпените пиленца при кокошки, фазани, патици и други, както повишаване на жизнеността и по-ранното им съзряване чрез изследвания върху развитието и функционирането на различните органи и жлези с вътрешна секреция.

Интерес за нас представляват неврофизиологичните ефекти и отражението върху имунния статус на третирането с CAP на диви и домашни животински видове, които са в основата жизнеността и адаптивността им.

Доказано е стимулиращото въздействия на природните капсаициноиди за отделянето на невропептиди от периферните пептидергични нервни влакна, които са важни медиатори при аферентно и еферентното провеждане на нервните импулси. Един такъв медиатор е substance P (NK1 или SP), чието излъчване се провокира от capsaicin-a в периферни нервни окончания със специфична чувствителност (NK1R) към него, поради което носят названието капсаицин-чувствителни (**Holzer**, 1988; 1991).

Още **Dun** and **Kiraly** (1983) посредством междуклетъчно записваща техника изследват ефекта на capsaicin-a (0.5-100 microM) върху невроните на изолирани долни мезентериални ганглии (i.m.g.) на морски свинчета и установяват дълготрайнна съпътстваща деполяризация на тези клетки, чрез интезивно невронно отделяне на ганглийна SP или на пептидна SP в Ca-зависима форма. През 1998 г. **Lai** et al. посочват данни, че човешките лимфоцити произвеждат ендогенна SP при нормални условия. **Yonehara** and **Yoshimura** (2001), които изследват ефекта от локалното приложение на капсаицинов крем върху неврогенно възпаление на седалищния нерв, установяват увеличено освобождаване на substance P, а **Ulrich** et al. (2001) за повишено освобождаване на имунореактивен генно-свързан калцитонинов пептид (ICGRP) от ганглиона на тригеминуса у плъх, в зависимост от концентрацията CAP-a.

Kim et al. (1998) след интравенозното инжектиране на vanillylamide (C18-VA), нелютив аналог на capsaicin-a докладват за значително повишаване секрецията на адреналин в плъхове, също така както и при capsaicin-a. В своето изследване, което демонстрира повишен плувен капацитет на мишки от capsaicin-a, дължащо се на предизвиканата от capsaicin-a адренална секреция на катехоламини, авторите изследват и ефектите на оралното прилагане на C18-VA върху плувния капацитет, използвайки пригоден басейн с течаща вода. Мъжки 6-седмични Std

ddY мишки са хранени на воля, а на една група е прилагано орално C18-VA чрез стомашно интубиране. Третираните мишки са плували по-дълго до изтошаване в сравнение с контролните мишки (62.9 ± 5.6 срещу 49.6 ± 7.0 min, $P < 0.05$), а концентрацията на substance P в церебралната течност на гръбначния мозък, която е замесена в предаването на болка и е първият директен критерий на лютивината, не е бил повлиян от доставката на C18-VA. Серумната концентрация на адреналин, обаче, 2 часа след прилагането е с по-високи нива на адреналина при третираните с C18-VA, както и при третираните с capsaicin мишки. Моментната концентрация на глюкозата в серума не е била повлияна. Тези резултати навеждат на мисълта, че C18-VA повишава плувния капацитет на мишките чрез освобождаването на адреналин, независимо от лютивостта. В помощ на тези заключения са и изводите на **Dessypris** (1991), че увеличеният обем на еритроцитите при третирани с capsaicin животни е свързан с по-високо ниво на хемоглобина, както и на **Magyda** et al. (2003), които докладват за по-висока кислородна консумация при третирани с капсаицин мишки и по висок кислород-свързващ капацитет.

Третирането с CAP в по-късен етап води до десенсибилизация, високите дози предизвикват изтощаване в отделянето на невропептиди и до разрушаване на самите нервни влакна (**Nagi**, 1982; **Jancso** et al., 1987; **Ritter** and **Dinh**, 1988 и др.). **Воробьева** и сътр. (1997), както и **Buck** and **Burks** (1986) докладват за нарушаване връзката на пептидергичните неврони с висшестоящите нервни центрове, което води до тяхната блокада. **Saria** et al. (1980) установяват, че capsaicin-а лесно прониква в мозъка. **Соловьева** и **Есаков** (1986) също считат, че при двукратно въвеждане на 30mg/kg субепителиално в езика на Rana Temporaria, capsaicin-а не увреждa самите клетки, а предизвиква дефицит на SP, в резултат на което се нарушава синтезата и фиксирането на серотонина**.**

Жукова и **Князев** (1995) установяват, че в резултат на дразнещото действие на CAP чувствителните неврони усилват инкрецията на невропептиди, които участват и в регулирането на кръвотока, пропускливостта на кръвоносните съдове и други процеси важни за метаболизма в тъканите, чието нарушение е причина за поява на дистрофични промени.

Според **Charcoudian** et al. (2001) локалното прилагане на CAP върху доброволци води до загуба на нервни влакна в епидермиса (ENFs) и дори до пълно изчезване след тридневно третиране, а реинервирането е наблюдавано 2-3 седмици след прекратяване на третирането с capsaicin. **Khalili** et al. (2001) също докладват за постепенно реинервиране на епидермиса.

По отношение на терапевтичния ефект на CAP-а върху дистрофични заболявания на гръбначния стълб и ставите, неврологични (плексит и радикулит) и посттравматични заболявания, като болестта на Кервен,

епикондилит и тендовагинит, редица изследователи докладват за положителното му влияние върху тях. **Гатев** и сътр. (1991) посочват изчезването на болка, скованост и отоци на ставите след 12-13 процедури, а **Surh** and **Lee** (1996) – успешно лечение на ревматичен артрит и диабетична невропатия. При изкуствено предизвикан на плъхове **Joe** and **Lokesh** (1997) постигат забавяне на началото и намаление на разпространението на болестта след третиране с CAP.

При изследвания на невровизиологичните ефекти на CAP-а върху патогенезата на гениталната инфекция причинена от virus herpes simplex (HSV-2) **Stanberry** (1990) докладват за ограничаване на пораженията й и различно действие при първоначален генитален херпес и латентната му форма. В опитите си с морски свинчета той не наблюдава развитие на характерните перинеални поражения при третираните с CAP животни, за разлика от контролните, които са развили типичните симптоми. Автора прави извода, че при предварително третираните с CAP морски свинчета, вирусът може да се изкачи от влагалището до гръбначния и главния мозък, но е възпрепятствано обратното му придвижване до кожата, за да предизвика характерните поражения за болестта.

Jancso at al. (1980) докладват за причинена от CAP-а избирателна дегенерация на хемосензорните неврони без да се засегнат хипоталамични структури при третирани новородени плъхове, докато при възрастни предварителното третиране води до увреждане на някои хипоталамични структури. **Hiura** at al. (2000) правят количествени изчисления за невроанатомичните повреди от неонаталното третиране с CAP върху загубата на клетки от ганглиона на дорзалното коренче и нервни влакна на дорзалното коренче, nervus saphenus, нерва на chorda timpani и нерви на пулпата, докато **Alm** and **Lundberg** (1988) използват CAP-а, заедно с 6-хидроксидопамина, като селективен химичен нож за симпатектомия при изучаване на пептидергичните и адренергичните нерви в бременна матка на морско свинче. **Dedov** at al. (2001) демонстрират предизвикано от CAP-а проникване на Ca (2+) в невроните на ганглиона на доразалното коренче и значително понижаване на потенциала на митохондриалната мембрана.

Редица автори (**Сердюк** и сътр., 1993; **Ando** et al., 20001; **Hohman** and **Herkenham**, 1998; **Miao** et al., 2001; **Ralevic** and **Kendall**, 2001 и др.) използват свойството на CAP-а селективно да уврежда C-фибрите в неврофизиологичните си проучвания и изследванията на мигрената и свързаните с главоболието разстройства (**Curter** and **Mitsicostas**, 1999; **Vass** et al., 2001; и др.).

В своя обзор **Scott** (2004) дава обобщен поглед върху съвременното състояние и тенденциите в изследователския процес свързан с птичата имунология: “В началото на модерната ера на птичата имунология в средата на петдесетте, следвайки откриването на ролята на бурсата на Фабриций (BF), устойчивото и постоянно изследване бе дирижирано от

учените. Откритията, които придвижиха напред нашето познание на хуморалния имунитет (HI), включващ специалната роля на B-клетките в продукцията на антитела, обяснението на разнообразието от антитела чрез генно пренареждане и преустройство, разпознаването на секретиращите разклонени клетки и разклонените клетки на далака, характеризирането на цитокинните фактори и картирането на гените MHC class II. Многочислени експерименти бяха дирижирани за да се оценят отговорите на HI на домашните птици чрез определяне на титъра на антителата и определяне на количеството на концентрациите на имуноглобулин във физиологичните течности. Изследванията на антитялото включваха генетиката на HI относно и на количеството и на устойчивостта на отговорите като повлияна от съставни гени и MHC haplotypes. В последното десетилетие появата на реагенти на моноклонални антитела за да се идентифицира повърхностните клетъчни маркери върху B-клетките и допълнителните клетки допусна разграничаване на HI функциите на клетките чрез имунохистохимията, flow cytometry и други техники. Сигнализиращите механизми на птичите B-клетки започнаха по-добре се разбират. Продължителната работа в птичия имунитет доведе до повече напредък в разпознаването, характеризирането и генната последователност на важните цитокини. Допълнителната работа е изискване да се идентифицира и генната последоватерност за много повече цитокини, които имат директен ефект върху B-клетките. Кратката история на публикуваните изследвания върху птичите B-клетки е представено с изследването на някои от важните изследователски открития съобщени в последните години.

Влиянието на CAP-а върху алергичната кожна реакция е изследвана от **Lundblad** et al. (1987) при хора, като са изследвани ефектите на предварителното локално третиране с capsaicin върху тройния отговор на кожната реакция, предизвикана чрез излагане на алерген или anti-IgE. Интензивното излагане на човешката кожа с capsaicin е причинило усещане за изгаряне и ясно очертана реакция на зачервяване, но не отговор на подуване, а неколкократното прилагане върху същите места е предизвикало изчезването на тези локални реакции към capsaicin-а. Зачервяващия компонент и субективното усещане на сърбеж на кожната алергична реакция към антиген от плъх в хората с повишена чувствителност или в неалергизираните хора с anti-IgE тогава са били подчертано намалени. Две седмици след предварителното третиране с CAP отговора на зачервяване към алерген не е бил достоверно променен спрямо реакцията на контролата, което внушава обратимия ефект на третирането с capsaicin.

Взаимодействието между нервната система, имунната система и бронхиалната реактивност е изследвана от **Nilsson** et al. (1991) в плъхове чрез използването на невротоксина capsaicin, третирани на 1-2 дневна възраст или в зряла възраст, преди или след повишаване на

чувствителността чрез подкожно инжектиране с яйчно-белтъчен албумин (OA). Нивата на невропептидите neurokinin A и calcitonin gene-related peptide са се понижили в белия дроб след третирането с капсаицин, което е определено с радиоимунологичен анализ, докато от друга страна нивата на neuropeptide Y са останали непроменени. В същото изследване авторите сочат, че нивата на IgA, IgE and IgG в бронхиалната промивна течност са били също повлияни, като все пак резултатите са били разнородни. Резултатите демонстрират, че намалението на нивата на невропептидите с capsaicin е повлиял и на двете – бронхиалната реактивност и на нивата на антителата в бронхиалната промивна течност, като прави уточнението, че не е забелязана взаимовръзка между тези два параметъра, което демонстрира сложността на системата.

Почти всички изследвания за влиянието на капсаициноидите върху имунния статус са извършвани в опити с мишки, плъхове и някои домашни птици. Характерна особеност при птичите видове е, че адаптивния имунитет забърква и двата имунни отговора – хуморалния и клетъчно медиирания (CMI) (**Erf**, 2004). Клетъчно медиираните отговори са плътно регулирани и извикани на помощ от клетките Т-помагачи, по-специално тип 1 Т-помагач клетки, които се характеризират с тяхната продукция на цитокини като interferon-γ (IFN-γ), тумор-некрозен фактор-α (TNF-α), и интерлевкини, управляващи CMI отговорите. Функционалните ефектори на CMI отговори са различни имунни клетки, включващи цитотоксични лимфоцити (cytotoxic T клетки и естествени клетки убийци) и макрофаги. Цитотоксичните клетки и макрофагите са специализирани в елиминирането на ендогенните и екзогенните антигени, поотделно. В последното десетилетие бе направен реален прогрес в дефинирането на ролята и регулацията на птичия CMI отговор. Други открития посочиха стратегии, които засилват този голям клон на адаптивния имунитет да оптимизира защитата още по-добре като защита срещу ракови и неракови заболявания причинени от вътреклетъчни патогени.

Kogut et al. (1998), отчитайки че хетерофилите са важни медиатори на вродената устойчивост на домашните птици, особено в млади птици, които нямат все още развит придобит имунен отговор, провеждат опит чрез контролирано вкарване на чревния салмонелен имунен лимфокин (ILK) в 18-дневни развиващи се птичи ембриони или в деня на излюпването на пилета и пуешки пиленца и докладват за увеличена устойчивост на органната агресия на Salmonella spp (SE). В този преглед те демонстрират, че защитата индуцирана чрез ILK е медиирана чрез мощно набиране и активация на хетерофили. Тези активирани хетерофили са мигрирали бързо към местата на бактериална агресия, където те фагоцитират и убиват SE. Тези резултати демонстрират важността на превантивната активация в домашните птици да индуцират миграцията на голяма численост от

активирани фагоцитни клетки към местата на инфекцията чрез патогенен организъм и да се повишава имунната потентност от възпалителния отговор, което причинява функционално узряване на хетерофили през първите 4 дни след излюпването. Това се потвърждава от **Santoni** et al. (2004), които докладват, че ефектът на капсаицина върху функцията на тимоцитите е зависим от опосредствената от капсаициновите рецептори регулация на SP.

В свое проучване **Yu** et al. (1998) изследват ефекта от дозиран CAP върху имунния статус и селективните имунни отговори. Мишки BALB/c са разделени в 5 групи и всяка група са диетично хранени с 0, 5, 20, 50 или 100 ppm CAP за 3 седмици. Параметрите са премерени с брой на лимфоцитите върху плочка, включващи mitogen-предизвикана пролиферация и общи нива на имуноглобулин в серума. В клетките на далака на мишки хранени с 20 ppm CAP индуцираните с mitogen T-клетки се е повишил, което е лимфоцитен пролиферативен отговор, както са се увеличили стойностите на IgG и IgM в сравнение към контролата. Ефектът на диетичния CAP върху активността на макрофагите е оценен чрез фагоцитозата и продукцията на тумор некрозен фактор-alpha (TNF-α), чийто нива са се повишили в същата група с третирани мишки. Тези резултати са в контраст с предишни изследвания, които показват подтискане на имунитета наблюдавано след инжектиране на CAP, и внушават, че диетичния CAP може диференцирано да повишава имунния статус също така добре и селективните имунни функции при мишки.

Joe and **Lokesh** (2000) от своя страна също докладват за възмажността капсаициноидите да повишат секреторната функция на макрофагите по един полезен начин. **Воробьева** и кол. (1997) установяват появата на млади хистоцити след внасяне на високи дози CAP в новородени и възрастни плъхове, което се свързва с тяхната детоксикационна функция, тъй като е известно, че хистоцитите участват в освобождаването на организма от токсични метаболити.

Klasing (1998) определя про-възпалителните цитокини, включително и IL-1β, като важни инициатори и регулатори на локалния имунен отговор. Те са също така освободени в достатъчни количества през време на някои инфекции за да координират органичната остра фаза на отговор, въздейства върху растежа, репродукцията и доброто съществуване на домашните птици. Разбирането на механизмите и използването на молекулите от макрофагите за регулиране на имунните и възпалителните отговори може да позволи развитието на продукти, диети или селскостопански техники, които да моделират имунитета за повишаване на продуктивността на птиците. Като изключително важен цитокин, IL-1β е отговорен за костимулацията на антиген-представящи клетки (APC), T- и B-клетъчната пролиферация, продукцията на имуноглобулини, активиране на фагоцитите и

хемопоезата (образуването и узряването на кръвните клетки от всички видове) и редица други имунологични реакции (**Стайс** и сътр.,1997).

В свои изследвания **Connora** et al. (2004) при опит с женски плъхове подложени на психофизиологичен стрес (стрес при плуване), демонстрират механичното разделение на способността на стреса да увеличава IL-10 и да подтиска продукцията на про-възпалителните цитокини – IL-1β и TNF-α. Резултатите в опита сочат намаляване под влиянието на стреса в стойностите на IL-1β и TNF-α, въпреки блокираното с nadolol увеличение на IL-10, който се счита за общ имуноподтискащ цитокинен фенотип.

Bret-Dibat et al. (1997) проучват физиологическите и поведенчески смущения при плъхове и мишки, наблюдавани по време на инфекция, възпроизведени чрез системно управление на про-възпалните цитокини (e.g., interleukin (IL)-1β, IL-6, tumor necrosis factor-α) или lipopolysaccharide (LPS), който е един по-могъщ причинител на тези цитокини и мощния сетивен невротоксин - capsaicin. Авторите проверяват свое предположение, че физиологичното имунно съобщение е преработено до централната нервна активация чрез действието на цитокини върху периферното прекратяване на аферентните неврони. Въпреки че третираните с КАР плъхове и мишки са променили вътрешната химиосензорна функция, роговичната и болковата чувствителност, нервно-медиираните ефекти за анорексия на холецистокинина и изтощени нива на SP в гръбначния мазък в участъка на гръдния кош, това е било напълно неефективно в блокиране поведението на намаление мотивацията за храна предизвикано чрез IL-1b (4 mg/rat IP в плъхове) и LPS (250 mg/rat IP в плъхове и 400 mg/rat IP в мишки). Това показва, че други аферентни, освен чувствителни на капсаицин C-фибри, са замесени в преноса на ефектите на цитокините през време на възпалителни и инфекциозни случаи.

В свое изследване **Chen** et al. (1996) проучват ролята на имунното подтискане, медиирано чрез substance P в гръбначния мозък (SDH), в патогенезиса на автоимунните заболявания. Установени са в морски свинчета и плъхове на Wistar животински модели на експерименталният алергичен неврит (EAN), експерименталният алергичен енцефаломиелит (EAE) и модифициран артрит (AA). Резултатите сочат, че намаляването на активността на SP в SDH чрез предварително третиране с capsaicin или чрез инжекционно вкарване в течността около гръбначния мозък на антагонист на SP могат да повишат клетъчните и хуморални отговори и да влошат автоимунните заболявания, докато интратехално вкараният антагонист на SP може да подтисне имунитета и да облекчи клиничните симптоми. Съдържанията на SP в SDH са се повишили значително в пика на имунните отговори. Според авторите тези резултати внушават, че SP в SDH може да участва в патогенезиса на автоимунните заболявания. Увеличението на съдържанието на SP в SDH може да възпрепятства имунната система чрез непознат път и

успокоение на клиничната суровост на автоимунното заболяване, където SP може да действа като невротрансмитер в имунната регулация на негативната обратна връзка. Да се повиши съдържанието на SP в SDH може да бъде благотворен за автоимунните заболявания.

Проучванията на влиянието на CAP-а върху промяната на телесната температура сочат нееднозначен ефект. **Серова** (1993) посочва по-висока температура при опитните плъхове, третирани неонатално, спрямо контролните животни, а **Yoshida** at al. (1988) и **Watanabe** et al. (1988) наблюдават повишение на температурата в кафявата мастна тъкан на плъхове, третирани с CAP. **Kawada** et al. (1991), които изследват съдържанието на термогенин в кафявата мастна тъкан, докладват за индукцията му след включването на CAP в хранителната диета, което е довело до ускоряване на термогенезиса по време на приема на храна. **Donnerer** и **Lembeck** (1990), обаче, докладват, че на 90-та min след излагане на студ, плъховете, третирани неонатално с CAP, са имали по-ниска ректална температура от контролните.

Kobayashi et al. (1998) правят опити с подкожно вкарване на CAP на анестезирани с urethan плъхове, внушавайки повишаване на загуба на топлина. Това е довело до незабавно повишаване на температурата на опашната кожа, консумацията на кислород и индекса на топлинната продукция. Тези открития дават основания на авторите да направят извода, че capsaicin-а активира едновременно независимите системи за загуба на топлина и продукцията на топлина.

ИЗВОДИ И ПРЕПОРЪКИ:

1. Прилагането на природни капсаициноиди и техните аналози върху животни доказано води до повишаване на тяхната физическа издръжливост, дихателен капацитет, прага на чувствителност и др., които са от изключително значение за преживяемостта им при разселване в естествени местообитания или интродукция на нови животински видове.

2. Използването на CAP-а предизвиква усилване на инкрецията на невропептиди, които участват и в регулирането на кръвотока, пропускливостта на кръвоносните съдове и други процеси важни за метаболизма в тъканите, което е от съществено значение за оцеляването на разселените животински видове при намирането и усвояването на храна в естествена среда.

3. Извършените до този момент имунологични изследвания върху влиянието на природните капсаициноиди сочат цялостно положително влияние при определени дози върху важни имунологични показатели (interleukin (IL)-1β, IL-6, tumor necrosis factor-α, IgG, IgM и много др.), което предполага повишен имунен статус за борба с непознатите за организма патогенни микроорганизми при разселването на ловни и интродукцията на нови животински видове.

4. Посочените в прегледа изследвания демонстрират неоднозначния ефект на природните капсаициноиди върху различните животински видове при различните дози и начини на прилагането им, което налага продължаване на проучванията с цел постигане максимален положителен ефект.

От всичко посочено до тук може да се направи извода, че природните капсаициноиди, които са един екологично чист продукт, представляват голям резерв за повишаване адаптивността и преживяемостта на животински видове използвани с цел разселване, аклиматизация и реаклиматизация, което ще доведе до обогатяване на биологичното разнообразие в природата. Необходимо е да се продължат изследванията в тази посока с цел постигане на по-пълно познаване на процесите на влияние на САР-а върху показатели характеризиращи адаптивността на организмите.

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