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Anti-influenza drug derivatives with potential biological activity

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Abstract: Influenza is one of the devastating viral infectious diseases. During the 20th century it has caused three pandemics, which had led to millions of human deaths. In present times the continuing occurrence of seasonal epidemic outbreaks is a widespread concern regarding the eventual risk of influenza pandemics.

Currently in combating influenza viral infection, two classes of antiviral drugs are approved -M2 blockers and neuraminidase inhibitors. However, the effectiveness of those drugs might be inadequate when selection of resistant viral mutants has taken place. Limitations of monotherapy highlight the urgency for new and efficient strategies for viral treatment. Furthermore, the design of hybrid molecules comprising of two distinct drug moieties is a promising modern approach to reach various therapeutic goals. In this regard, herein we report our results on the synthesis and biological activity of the newly synthesized derivatives of anti-influenza drugs.

Keywords: anti-influenza drug derivatives, influenza virus, biological activity

1. INTRODUCTION

Influenza virus infection has generated some of the worst pandemics in human history. The most devastating one- The *Spanish flu* has swept across the world in three waves and is responsible for over 20 million deaths - more than doubling the total casualty of the previous mortality leader, the Black Death. Nowadays influenza virus (especially type A) remains a major threat contributing to severe global social and economic impact. It affects the population irrespective of age, and poses a global concern due to its unpredictable, pandemic potential and pathogenesis.

The current trends in fighting influenza comprise two main strategies: vaccination and antiviral treatment. Although vaccines are a better option for influenza control, their success rate is not as high as desired [1]. Additionally, their composition must be updated regularly to reflect the changes in circulating viruses. Therefore, antiviral drugs could represent the first line of protection against pandemic influenza strains. Despite the intensive efforts for designing new influenza virus inhibitors, two major groups – M2 ion channel blockers (amantadine and rimantadine) and neuraminidase inhibitors (oseltamivir, zanamivir, peramivir) are clinically used for prophylaxis and treatment [2].

Due to the potential for rapid development of drug resistance, monotherapy with a single anti-influenza drug might be with limited efficacy [3]. In accordance to an innovative approach, combination chemotherapy consisting of two or more drugs targeting different viral

proteins or the host immune response, may provide additive or synergistic antiviral activities [4]. Combination chemotherapy reduces the risk of rapid development of drug resistance. A bifunctional conjugate compound is expected to yield a greater effect than the sum of the single components [5]. A novel literature survey reveals a dual-targeted bifunctional anti-influenza drug obtained by conjugation of zanamivir with an anti-inflammatory agent, caffeic acid, for simultaneous inhibition of influenza virus neuraminidase and suppression of pro-inflammatory cytokines [6]. Because of the high affinity of zanamivir to the viral neuraminidase, zanamivir conjugates are brought to the influenza infected tissues, allowing the anti-inflammatory moiety of the conjugates to suppress the induction of proinflammatory cytokines in a highly effective manner [6].

In quest of a similar effect, herein we report the modification of anti-influenza drugs (rimantadine and oseltamivir) with *N*-(2,3-dibromo-3-phenylpropanoyl) amino acid amide.

2. METHODS AND APROACHES

Preparative thin-layer chromatography *separations were* carried out *on* Merck silica gel plates (60-F254). Attenuated total reflectance infrared spectroscopy (ATR-IR) measurements were performed using Thermo Scientific Nicolet iS10 FT-IR device with ID5 ATR accessory (diamond crystal) ¹H-NMR spectra of the synthesized amides were recorded on a Bruker Avance III 400 spectrometer, operating at 400.15 MHz. The NMR spectra were acquired using standard Bruker pulse sequences, at ambient temperature (300 K) in CDCl₃ solution. Chemical shifts were referenced to internal tetramethylsilane (TMS).

Electrospray Ionisation (ESI) mass spectra were recorded on an Esquire 3000.

3. RESULTS AND DISCUSSION

Based on the development of new potential multi-target-directed antimicrobial agents for overcoming drug resistance [7,8], in the present work we modified anti-influenza drugs (rimantadine, oseltamivir) with dibrominated cinnamoyl amino acid amides.

Since the *N*-cinnamoyl amide of isoleucine methyl ester (1) has once been obtained by EDC/ HOBt as described in our previous work [9], the reaction divides into the following two branches (Scheme 1):

The first stage (A) involves a simple bromination of compound **1** by traditional method in CHCl₃. In α , β -dibrominated *N*-cinnamoyl amide **2**, the proton-proton coupling (with ${}^{3}J \sim 11$ Hz) at 4.7 and 5.5ppm dues to the electronegative bromine atoms adjacent to the vicinal protons. Thereafter, adduct **2** is subjected to alkaline carboxylic ester hydrolysis and afforded compound **3**. The nucleophilic attack of amino group of oseltamivir to the activated (by EDC/HOBt method) carboxylic group of compound **3** yielding the desired amide **6**, which was purified by preparative thin layer chromatography (CH₂Cl₂:CH₃OH).

By the second route (B) the starting compound **1** was found to readily undergo conversion to the free acid (**4**). Subsequent EDC/ HOBt coupling of adduct **4** with rimantadine occurred smoothly and the product (**5**) was crystallized from acetonitrile in good yields (45 %). According to the ¹H NMR, the large proton-proton coupling between olefinic protons (15.6 Hz) indicated *E*- π -diastereoisomeric form of amide **5**. In the final step of route B addition of Br₂ to cinnamoyl moiety of compound **5** gave the expected amide **7**. The latter was isolated in 42% yield by crystallization from abs. C₂H₅OH.

The positive-ion ESI-MS spectra of the newly compounds **6** and **7** indicate that the molecular ion peak was observed as a based peak at m/z 750.5 (compound **6**) corresponding to $[M+H]^+$, whereas compound **7** was observed at m/z 655.5 (**7**) corresponding to $[M+Na]^+$. Due to bromine isotopic compositions (⁷⁹Br:⁸¹Br=50.69:49.31) mass spectrum reveals characteristic isotopic clusters (1:2:1). The structures of both compounds (**6**, **7**) were further supported by IR spectra and they revealed strong absorptions at ~3270 (N-H), 2902 (C-H), 1690 (C=O), 1620, 1540, 1495 (aromatic C=C) cm⁻¹.

Correspondingly, an ester group of compound **6**, exhibited additional strong bands at 1728 cm⁻¹ (C=O) and C—O single bonds, near 1247 and 1054 cm⁻¹.



Scheme 1.

The in vitro evaluation of newly synthesized derivatives of anti-influenza drugs is in progress. Tests will be carried out in the multicycle CPE inhibition experimental set-up in monolayer MDCK cells.

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Proficiency testing (PT) - statistical approaches and criteria for evaluation of results

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Abstract: Proficiency testing (PT) is a method of checking testing laboratory performance by means of an interlaboratory comparison. It is an important way of meeting the requirements of ISO/IEC 17025 and other applicable standards in the area of quality assurance of the analytical results. An important part of interlaboratory comparisons is the determination of the assigned value of the measurand(s) and the PT standard deviation. There are standardization documents giving guidance, but any particular PT scheme requires examination in order to select the most appropriate method - depending on the nature of the sample, measurands, number of participants, measurement traceability etc. The choice of the appropriate approach is key important for each PT scheme since the criteria should be announced before starting of the comparison. The case study includes analysis and selection of the approach of determining the assigned value, standard deviation of PT scheme and criteria for performance evaluation concerning testing of parameters of artificial drinking water as nitrates, nitrites, fluorides, phosphates, chlorides, sulphates and ammonium ion. The optimization of parameters is guarantee for a competent assessment and achievement of the PT scheme's purpose. Conducted study will be used in organizing future similar comparisons - as matrix and measurands.

Keywords: Proficiency testing, Proficiency testing scheme, Assigned value, Certified reference material, Uncertainty of measurement

1. INTRODUCTION

Participation in proficiency testing (PT) is a mandatory condition for demonstrating the competence of laboratories in accordance with the requirements of EN ISO/IEC 17025 [1]. PT schemes are organised either to check the ability of laboratories to deliver accurate testing results to their customers or to find out whether a certain analytical method performs well and is fit for its intended purposes. PT scheme should be organized competently and this includes choice of appropriate method for determination of assigned value and PT standard deviation, as well as relevant criteria for evaluation.

Typical methods of assessment of PT results and approaches for assigning of measurand values are described in standards ISO/EN 17043 [2] and ISO 13528 [3].

The adaptation for any specific PT scheme is depending on many factors such as the nature and type of the sample, the parameters for determination, the potential applicable methods of analysis and the profile of the participating laboratories, for example whether laboratories are sufficiently experienced to make uncertainty calculation etc. Another significant factor related with the selection of a suitable approach for assigning of measurand values is the number of laboratories participating in the scheme for suitability. [4, 5]

The method for assigning value of measurand values and standard deviation of PT according to ISO / EN 17043 [2] shall be announced to the participants before starting the PT scheme. For this reason, the best approach should be explored before applying in order to

ensure that the objectives of the PT scheme will be achieved - competent and responsible assessment of the performance of the participants.

The subject of the present study is the determination of the most appropriate PT scheme for drinking water analysis. The sample is artificially prepared tap water with controlled content of the following measurands: nitrate, nitrite, fluoride, phosphate, chloride, sulphate and ammonia ion. The selected measurands and their concentration levels are corresponding to the national legislations – Ordinance № 9/2001 for quality of the drinking water.

The aim is to investigate and propose the most adequate method for the assignment of measurands concentrations values and to produce a proper certified reference material applicable for verification and validation of the applicable methods, as well as for internal quality control purposes in the analytical laboratories

The present work is focused on one of the measurands – chloride anion.

2. METHODS AND APROACHES

For assignment of the measurand value, two basic approaches were applied:

- Certifying the reference material (PT sample) by calibration
- Consensus value, obtained from PT scheme participant's results calculated as the robust average value and robust standard deviation [3].
 Accordingly, the standard deviation is calculated:

- Based on the results of all participating laboratories;

- Based on the results of all participating laboratories as robust standard deviation [3].

The criteria applied for performance evaluation of participating laboratories, in accordance with the international standard were following:

• z – criterion:

$$z = \frac{x_{lab} - x_{ref}}{s}$$

where: s is the standard deviation derived from all results of the participating laboratories; x_{lab} - result of the particular laboratory/participant; x_{ref} - assigned value for the measurand in the particular PT – scheme.

• "ζ -zeta" criterion (only for the laboratories presenting results with declared uncertainty):

$$\zeta = \frac{x_{lab} - X_{ref}}{\sqrt{u_{lab}^2 + u_{ref}^2}}$$

where: x_{lab} - result of the particular laboratory/participant; x_{ref} – assigned value for the measurand in the particular PT – scheme; u_{lab} – the combined standard uncertainty of the participant's result; u_{ref} – standard uncertainty of the assigned value (x_{ref}).

The decision making rules were following:

If $|z,\zeta| \le 2,0$ - the results are satisfactory.

If $2.0 < |z, \zeta| \le 3.0$ - the results are questionable.

If $|z, \zeta| > 3,0$ - the results are unsatisfactory.

The study is performed by help of ASPL at CPAchem Ltd, Stara Zagora accredited from American Accreditation Body - ANSI-ASQ National Accreditation Board by international standards ISO/IEC 17043 [2], ISO/IEC 17025 [1] μ ISO Guide 34 [6]. The same laboratory performed preparation and characterization of the certified reference material used in the PT scheme, as well as the homogeneity and stability studies according to ISO/IEC 17043 [2].

The assigned (consensus) measurand value, based on all presented results, was obtained using robust (median) statistics [7].

3. RESULTS AND DISCUSSION

For the purpose to the establishment of the best model for assigning the values of the measurands was produced artificial water. Sample preparation was made on an in-house method, using a high-purity starting materials, acid from sub-boiling and 18 M Ω deionized water. The data obtained from stability and homogeneous studies confirm the homogeneity and stability of the sample.

Seven measurands were certified in the artificial tap water CRM (Table 1) [9] and and the PT sampels are presented to the PT participants.

Measurand	Certified Value and Uncertainty , k=2
Nitrates (NO3 ⁻), mg/l	51,19 ± 0,22
Nitrites (NO ₂ -), mg/l	0,698 ± 0,004
Fluorides (F ⁻), mg/l	1,395 ±0,009
Phosphates (PO4 ³⁻), mg/l	0,803 ±0,003
Chlorides (Cl ⁻), mg/l	122,2 ±0,5
Sulphates (SO4 ²⁻), mg/l	135,93±1,01
Ammonium ion (NH4 ⁺), mg/l	0,692 ±0,034

Tab. 1: Measurands, Certified Values and their uncertainties

Eight accredited laboratories (according to EN ISO/IEC 17025) and control bodies (according to EN ISO/IEC 17020), working in a similar fields, participated in the present PT trial. The results obtained for the measurand Cl⁻ are summarized in the Tab. 2. Nine results are included since one of the participating laboratories has applied two alternative methods presenting the results separately.

Tab. 2: Statistical summary for the measurand Cl-

	Value
Number of valid results	9
Number of excluded results	0
Mean value	122,8 mg/l
Robust mean	122,6 mg/l
Combined standard uncertainty of the robust mean	0,62 mg/l

Certified reference value	122,1 mg/l
Combined standard uncertainty of the certified value	0,25 mg/l
Standard deviation	3,24 mg/l
Robust standard deviation	1,72 mg/l
Range of the results	from 118 mg/l to 130 mg/l

The participants used routine methods for the analysis by their choice. The most of them are used a standardized volumetric method BDS 3414:1980. Two participants are used spectrophotometric method. All methods used by participants are listed in Table 3.

The metrological traceability of consensus value is on base of information provided by PT participants. Participants provide information (some more detailed, others not) on how they provide metrological traceability of measurand. In practice the participants are using reasonable and commonly accepted approaches for provision of metrological traceability of measurement results related and consistent with the specificity of the measurement methods such as reference material, calibrated measuring instruments, test sets and etc.

The assessment of individual performance is presented in Tab. 3. The criteria: "z - score" and " ζ -zeta" score are calculated both against certified reference value and against consensus value.

Nº	Measurement method	Result Standard mg/l combined uncertainty		Compared with the certified reference value		Compared with the consensus value	
			тığл	Z	ζ	Z	ζ
	Volumetric						-2,2
1		121	0,36	-0,34	-2,51	-0,92	
	Volumetric						-
2		123	-	0,28	-	0,24	
	Volumetric						1,20
3		124	1	0,59	1,84	0,82	
	Volumetric						-2,31
4		121	0,3	-0,34	-2,82	-0,92	
	Volumetric						1,01
5		123,3	0,33	0,375	2,9	0,412	
	UV-VIS						6,30
6		130	1	2,47	7,66	4,30	
	Volumetric						-0,76
7		118	6	-1,28	-0,68	-2,66	
	Volumetric						0,35
8		123	1	0,28	0,87	0,24	
	UV-VIS						-0,50
9		122	1	-0,031	-0,097	-0,34	

Tab. 3: Methods used, results, uncertainties, z- and ζ -zeta- scores for all laboratories participating in the PT scheme

Figure 1 show the graphical presentation of the results obtained for Cl⁻ content in the artificial tap water CRM obtained by all participants. The laboratories are represented by numbers according to confidentiality rules of ISO/IEC 17043 [2].



Fig.1: Results and their uncertainties

Fig. 2 shows the distribution of values obtained from participants in ascending order, taking into account the methods used. The data and graphic presentation of various methods doesn't give any grounds to assume that results can be grouped depending on used methods – no major tendencies can be noticed, connected with the used analytical methods.



Fig. 2: Distribution of the results and analytical methods used by participants in PT scheme.

The results are summarized in the Fig.3.

z - score: 8 satisfactory results and 1 questionable result

" ζ -zeta" score: 4 satisfactory results , 3 questionable results and 1 unsatisfactory result



Fig.3: Histogram z – score and " ζ -zeta" score

Using two approaches for assigning value to measurand is done in order to assess:

- the impact of the method used for characterization of certified reference material;

- the availability of trends in the methods used by participants;

- the impact of the standard uncertainties of the certified value and the average robust

value.

It should also be noted the fact that:

- the number of participating laboratories (8, i.e. below 10) is not large enough and

- reported values are relatively in wider range.

By this reason using the robust statistic for consensus value is not sufficiently reliable [5]. For processing of the results - calculating the robust average value and its standard uncertainty, robust standard deviation of PT scheme and criteria z and zeta has created a spreadsheet (Excel Sheet), which is confirmed/verified by manual calculations.

4. CONCLUSIONS

The considered approaches about assigning measurand value and standard deviation of PT scheme have advantages and disadvantages.

The using an external certified reference value obtained from an accredited laboratory, is a guarantee that metrological traceability of the measured values is ensured, i.e. the metrological traceability chain is clearly established. This is a significant advantage as well established metrological traceability to SI units is the basis for comparability of results.

The associated uncertainty of the certified reference value is calculated according to validated methods and all contributions to the uncertainty are evaluated. The associated standard uncertainty of the certified value is relatively low compared with the standard uncertainties reported by the participants. In general, low uncertainty (if it is realistic estimated) is an indication of high metrological quality of the result and this is also an advantage of the approach.

In the second approach - when the assigned value in consensus value, the metrological traceability is not clearly established, it is only based on information of participants.

The uncertainty assosiated to the consensus value is determined by robust statistic and is obtained from the results and uncertainties reported by participants. The robust statistic is well known as statistical method for combining results with different uncertainties, but this method assume that the stated uncertainties of the results are correct. The standardized volumetric method that is used by the majority of participants did not include an evaluation of the uncertainty of measurement and obviously the participants evaluated uncertainties by their own procedures. The analysis of evaluation of uncertainty, performed by participants is in most cases 'realistic' ($u_{as/ref} \le u_{lab} \le \sigma$)). Some participants give uncertainties which are "probably overrated" ($u_{lab} > \sigma$) [8]. In fact, the very purpose of proficiency testing is to establish whether the participants can measure within their claimed uncertainty.

The Robust statistic is well founded and generally works well, but as it is shown in this case it may come to the wrong conclusion for small data sets (below 10) that include broader range of values with significantly different uncertainties.[4] This can be seen as a disadvantage of the second approach.

Consequently in such PT schemes the certified reference value is the preferred approach for assigning value of the measured value as stated in the literature [5].

Base on different statistic way for PT sample - artificial drinking water for the reviewed measurand values - is more appropriate to use certified reference value determined by a competent laboratory. Metrological traceability, which is clearly established is a basis for the establishment of equivalence and comparability of the results of the participating laboratories. When the value is assigned as consensus, the reason for the choice should be justified.

In the present case, produced certified reference material [9] is adequate with the requirements of Ordinance № 9 and will be used by laboratories for verification or validation of analytical methods and internal quality control. [10]

The results obtained on the basis of the experiment will be used in the organization of future PT schemes for drinking water, which are held regularly for support the implementation of National and European legislation and requirements of accreditation bodies. Thus ensuring implementation of preliminary defined criteria and guarantees the achievement of the purposes of comparison, to provide an objective of assessing and demonstrating the reliability of data produced by participants.

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Influence of the physicochemical parameters on the electrical outputs of Sediment Microbial Fuel Cells

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Abstract: In this work, the impact of the sediment and water composition on the performance of sediment microbial fuel cells has been analyzed. The working parameters of identical fuel cells were compared over time in order to prove their reliability as a power source. The contribution of each factor was evaluated by regression analysis on the data obtained. **Keywords:** Sediment microbial fuel cell, physicochemical parameters, electrical outputs, regression analysis

1. INTRODUCTION

Sediment Microbial Fuel Cell (SMFC) technology draws increasing attention among scientists of various fields. SMFCs are a variety of Microbial Fuel Cells, which operational principles are based on the specific property of the so-called "exoelectrogenic" bacteria to couple their metabolic processes with extracellular electron acceptors [1,2]. In their natural environment, such bacteria (e.g. Shewanella oneidensis and Geobacter sulfurreducens [2]) utilise in most cases insoluble Fe(III) and Mn(IV) oxides as final electron acceptors. In SMFCs, the anode, embedded in a layer of sediment or soil, substitutes the insoluble electron acceptors. The cathode is placed in the overlying water column above the sediment. Catabolizing the available organic matter in the sediment, the existing exoelectrogenic bacteria transfer the generated electrons to the anode. The electrons flow from the cathode to the anode via and external electrical circuit driven by the potential difference between the two electrodes. Simultaneously, the protons migrate through the sediment layer to the cathode, where they combine with the electrons and oxygen molecules from air to produce water. This simple design allows the construction of cheap fuel cells, which can be used as power sources on the field.

The first practical application of SMFCs as power sources was reported in 2008 [3]. Meteorological buoys, powered by SMFCs, were deployed in the Potomac River near Washington, USA, transferring real-time data using radio signal.

Despite the intensive studies in the field, the achieved power outputs of SMFCs are still very low [4], thus limiting their wide application.

The aim of the present study was to examine the influence of physicochemical parameters of the water and sediments used on the electrical outputs of SMFCs. For this purpose, identical SMFCs using river and marine sediments from different aquatoria were constructed and explored. The data obtained during the first 11 weeks of their operation is reported and discussed.

2. EXPERIMENTAL SETUP

Water and sediment samples were collected from several rivers in Bulgaria as well as from Black Sea and Aegean Sea. The GPS coordinates of the sampling sites are shown in Table 1.

Sampling site	Coordinates	Sampling site	Coordinates
Black sea	42°21′15.66		42°19'10.859"
	027°80′82.34	Topolnitsa river	023°05'51.082"
Aegean sea	40°05′381.1		41°98'02.32"
	023°34′20.99	Chetirka river	023°06'97.78"
Rilska river	42°03'48.772"	Struma river	41°99'03.54"
	023°03'21.833"	Strumanver	23°06′75.01′′
Arkata rivor	42°26′13.025"	26'13.025" Pictritop rivor	
	023°07'15.230"		022°45'08.116"

Tab.	1:	Sites	of	sample	collection
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The pH, redox potential and electrical conductivity of the water samples were measured on site using Hanna Instruments HI98204 Watertest. After the homogenization of collected sediments, samples were prepared for chemical analysis. Each sample was dried in a vacuum drier at 105 °C to constant mass. In order to measure the semi-total metal content, approximately 1g of sediment was dissolved in 15 ml Aqua regia (3:1, v/v, 34% HCl to 68% HNO₃). After dilution, the samples were analyzed using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) (Icap 7400 DUO, Thermo Fisher Scientific).

The collected water and sediment samples were used to construct pairs of identical single-chamber fuel cells of volume \approx 1.2 l. Graphite discs (9 cm in diameter, 1.5 cm thick) were used both as cathodes and anodes. The anodes were embedded in a 13 cm sediment layer and the cathodes were placed near the surface of the overlying 5 cm water column.

After assembling, the SMFCs were loaded with 510 Ω resistors, which in a previous study was found to be an optimal electrical load for this configuration [5]. In order to trace the performance of the SMFCs over time, consecutive cycles of 90 hours work under load, followed by 74 hours open circuit recovery were conducted. After each cycle polarization curves were taken along with measurement of the short circuit current and the cathode potentials (vs. Ag/AgCI electrode).

The data collected during the first 11 weeks of SMFC operation were treated by regression analysis is search of correlation between the analyzed physicochemical parameters and the recorded power outputs.

3. RESULTS AND DISCUSSION

Based on the studies of the metabolism of electrogenic bacteria the contents of 9 metal ions in the sediment samples were checked for correlation with the electrical outputs.

Results of the chemical analysis are shown in Table 2. The concentration of the different metals significantly varies between the samples. The quantities of iron and manganese vastly exceed all other metals. Molybdenum was found to be the scarcest element from the studied and its content in all samples is below the detection limit of the method used.

Sample	Fe [µg/g]	Mn [µg/g]	Cd [µg/g]	Cr [µg/g]	Mo [µg/g]
Black sea	5751 ± 79	195 ± 3.84	2.05 ± 0.04	3.82 ± 0.04	< 0.5*
Aegean sea	940.85 ± 20.00	67.93 ± 13.50	< 0.025*	5.07 ± 0.05	< 0.5*
Rilska river	10330 ± 142.00	114.40 ± 2.50	0.26 ± 0.005	10.93 ± 0.11	< 0.5*
Arkata river	29520.89 ± 405.00	919.00 ± 18.08	0.98 ± 0.02	26.09 ± 0.27	< 0.5*
Topolnitsa river	24536.40 ± 336.50	902.29 ± 17.75	0.59 ± 0.01	21.49 ± 0.22	< 0.5*
Chetirka river	27100.02 ± 372.00	548.67 ± 10.79	0.68 ± 0.01	30.33 ± 0.31	< 0.5*
Struma river	30045.15 ± 412.50	599.98 ± 11.80	0.88 ± 0.02	30.29 ± 0.31	< 0.5*
Bistritsa river	277.75 ± 6.00	359.56 ± 7.00	0.51 ± 0.01	1.12 ± 0.01	< 0.5*

Tab. 2: Metal concentration in the sediment samples

Sample	Co [µg/g]	Cu [µg/g]	Ni [µg/g]	Zn [µg/g]
Black sea	2.37 ± 0.02	16.45 ± 21.64	2.44 ± 0.05	16.67 ± 0.15
Aegean sea	0.46 ± 0.02	5.12 ± 0.10	2.92 ± 0.10	35.97 ± 0.75
Rilska river	3.65 ± 0.04	23.60 ± 0.46	7.04 ± 0.04	42.00 ± 0.88
Arkata river	12.82 ± 0.12	71.71 ± 0.55	26.36 ± 0.15	128.23 ± 2.69
Topolnitsa river	12.29 ± 0.12	45.45 ± 0.89	14.57 ± 0.08	106.55 ± 2.24
Chetirka river	10.15 ± 0.10	50.15 ± 0.35	22.07 ± 0.12	86.72 ± 1.82
Struma river	11.02 ± 0.11	60.34 ± 0.45	22.37 ± 0.13	126.46 ± 2.65
Bistritsa river	7.23 ± 0.05	10.96 ± 0.21	8.70 ± 0.25	153.61 ± 3.22

 $\ensuremath{^*}$ Under the detection limit of the method used

Immediately after construction all SMFCs were loaded with 510 Ω resistors and left for 20 days to reach stable electrical outputs.

After the preliminary period, consecutive discharge and recovery cycles were conducted. The data was recorded using data acquisition system (Model 2700, Keithley

Instrument) in intervals of 300s. The generated currents of 10 river SMFCs during a discharge cycle and the following open circuit voltages of the recovery cycle are shown in Figure 1. The high currents at the start of the discharge cycle quickly decrease until the fuel cells reach a stable output which remains steady in time. After the disconnection of electrical loads, the open circuit voltages were rapidly increasing trending to a steady state.



Fig. 1: a) Discharge under 510 Ω load; b) open circuit recovery

In order to measure the temporal power outputs of the SMFCs and trace their variations, polarization curves were obtained after each recovery cycle, by varying the external resistance from 100 k Ω to 10 Ω , using resistance decade box (Figure 2).



Fig. 2: Polarization and power curves of SMFC Arkata 1 and Arkata 2

The short circuit currents of six pairs of fuel cells measured in the course of the periodical polarizations are shown in Figure 3.



Section: "Chemistry"



Fig. 3: Short circuit currents over time

Significant deviations between the parameters of SMFC pairs using different sediment samples were observed. The generated currents over time largely vary in magnitude and no common pattern was found in their progress. Whereas the individual cells of each pair show similar behavior, the currents they generate are comparable and they follow common tendencies. This fact indicates that since all fuel cells have identical construction, the differences in sediment composition and possibly in bacterial content have a decisive effect on the electrical outputs.

In order to estimate is there a relation between any of the investigated physicochemical parameters and the generated currents and powers, regression analysis was applied. The values of the coefficients of determination R^2 as general were found to be rather low and varying considerably between the different measurements. No distinctive trends in time were observed. The highest correlation observed between any of the investigated parameters and the power outputs from the single measurements are shown on figure 4 (a). In order to trace any dependencies, the data from all single measurements was plotted over time figure 4 (b).





(a)

Fig. 4: a) Conductivity over Isc and Pmax for a single measurement; b) correlation over time

The summarized coefficients of determination R² from the regression analysis of data collected during the 11 weeks of study are shown in Table 3.

Table 3. Average values of the coefficients of determination (R ²) from the linear regression analysis of	Эf
the investigated parameters	

Coefficient of determination (R ²)	Fe	Mn	Cd	Cr	Со	Cu	Ni	Zn
I _{sc}	0,098	0,259	0,250	0,070	0,287	0,142	0,137	0,268
P _{max}	0,105	0,204	0,226	0,067	0,220	0,120	0,119	0,201

(a)

Coefficient of determination (R ²)	рН	Reduction potential	Conductivity
+ _{sc}	0,381	0,064	0,580
P _{max}	0,335	0,132	0,448
	(b)	

Despite the correlation between the conductivity of the water samples and the power outputs is the largest, its values are still assumed as insignificant.

4. CONCLUSIONS

In the current study no distinctive correlation between any of the investigated parameters and the electrical outputs of the SMFCs was found. The lack of relationship shows that the variations of the physicochemical parameters within this range don't affect directly the currents and powers generated by the fuel cells of this configuration.

Among all parameters the electrical conductivity of the water samples most significantly correlates to the generated power outputs. It should be noted that as all biological systems the sediment microbial fuel cells often show fluctuations in their performance and in order to attain reliable conclusions a more extensive study is required. In order to determine the impact of the studied factors on the electrogenic properties of the bacteria a different system should be used in which as many as possible factors can be individually controlled. Analysis of the bacterial strains contained in the sediments is also required.

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Students' brigades - benefits, opportunities and disadvantages

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Abstract: The report is based on a research conducted among 500 students and their families in the period 2011-2016 year, which studies the phenomenon of "international student labor migrations", also known as "student brigades." Large number of quantitative indicators is being studied by which different aspects of the phenomenon can be analyzed - benefit, cost, duration, workload and others. The survey also studies and some qualitative aspects of the phenomenon, associated primarily with the subjective impulses influencing the behavior of young people and influencing their decision-making.

Keywords: students, migrations, mobility, cross-border, employment

1. INTRODUCTION

1.1. Actuality of the topic

The international students' labour migrations, also known as "students' brigades" are a socio-economic phenomenon, which is **remarkably widespread**.

Since 2000 more than 337 500 Bulgarian citizens are falling directly under its influence, as personally participating, or as members of families/households of participants. Indirectly students' brigades affect the life of more than half of the population of the country. This is an amazing scale of influence for any socio-economic phenomenon; therefore it must be examined and researched thoroughly.

Last, but not least, **the phenomenon is popular in many other Central and Eastern European countries.** There are many similar features between its characteristics in all these countries, including Bulgaria, since the young participants choose the same destinations and accepting countries, work and live under the same conditions there during their holidays. All the research about the students' brigades that took place in Blagoevgrad will be of use for the rest of the areas, where the phenomenon is observed.

1.2. Object of study

Object of study for the research is the phenomenon of the international students' labour migrations, also known as "students' brigades"

1.3. Main purpose and task of the study

This research aims to reveal 3 main features of "students' brigades":

- Their benefits
- The opportunities they create for young people
- Their disadvantages

2. METHODS AND APROACHES

2.1. Author's definition

For being able to research the phenomenon, we must first introduce and accept an acceptable definition, since there isn't a unified one until now. According to the author's definition of the phenomenon, "students' brigades" represent:

"The process whereby participating students in bachelor's or master's programs voluntarily change their place of residence for a certain period of time (usually between 3 and 6 months), going outside their own country, to participate in economic activities, with or without the assistance of an intermediary, as it does not change their status of students. "

2.2. Methods and approaches

For the purpose of the study the following methods were utilized: representative sample surveys among approximately 500 students for a period of 5 years, between 2011 and 2016; method of comparison; analysis of statistical data from official sources; complex analysis.

In this survey was used the regional approach – defining the area of study and the selection of participants; the individual approach – working individually with many related respondents.

2.3. Most preferred destinations

At the first stage of study information was collected about the most preferred destinations of the participants. The accepting countries, chosen by students for summer brigades were summarized as following:

USA – 76% of the participants; United Kingdom – 15%, Germany – 4%, others (Canada, Denmark, Greece, Cyprus etc.) – 5%

2.4. Benefits of participation

In order to reveal the beneficial part of participation in a student brigade we first collected data about the predominant economic activities, which Bulgarian students are employed in.



Source: Karadzhov, V., 2013



These seasonal jobs are characterized by low qualification requirements, seasonal appearance (mostly in tourist and agricultural sectors), and they are also very profitable according to Bulgarian standards. These jobs also require sustainability to work hard, outdoors, often under the strong sunshine, wind and other unfavorable natural conditions. This is the reason for demanding young people (students) to employ.

We compared the average **monthly and hourly wages in Bulgaria**, for the **similar activities**, for a **period of 4 months** – that is the average period of residence on a brigade, with the **financial funds spared averagely during a brigade** in order to find out **if the students brigades are more profitable** than a seasonal work in the home country or not.

EMPLOYEES UNDER LABOR CONTRACT, AVERAGE PAID HOURS AND AVERAGE NET AND GROSS <u>MONTHLY SALARY</u> IN OCTOBER 2 AND ECONOMIC ACTIVITIES – TOTAL: FULL AND PART-TIME WORK						BER 2010 BY SEX			
ECONOMIC		PAID	HOURS		GROSS	5 MONTHLY SA	LARY		
ACTIVITIES – ACCORDING TO THE NATIONAL CLASSIFICATION OF ECONOMIC	EMPLOY	общо	в т.ч. платени часове за извън- реден труд	общо	в т.ч. ДТВ за извън- реден труд	в т.ч. ДТВ за работа на смени	коефици- ент на вариация	медиана	NET MONTHLY SALARY
ACTIVITIES , 2008	NUMBER	NUMBER	NUMBER	LEVA (BGN)	LEVA (BGN)	LEVA (BGN)	%	LEVA (BGN)	LEVA (BGN)
TOTAL	2 272 509	158	0.77	603	4.39	2.26	0.20	432	479
MINING AND EXTRACTION	24268	165	1.46	956	15.81	22.45	1.16	820	758
PROCESSING INDUSTRY	524606	163	1.43	530	7.57	2.46	0.31	400	419
	158 352	155	0.40	558	2.53	0.31	0.74	478	441
TRADE; CAR AND MOTORCYCLES REPAIR	422 584	154	0.17	486	0.94	0.63	0.54	369	384
TRANSPORT, LOGISTICS AND POSTAL SERVICES	142 02 1	159	0.74	651	4.57	6.24	0.85	482	519
HOTELS AND RESTAURANTS	114 313	143	0.13	347	0.58	0.59	0.73	335	273
ADMINISTRATIVE AND SUPPORTING ACTIVITIES	114289	148	1.18	380	3.32	2.08	1.01	290	301
CULTURE, SPORTS, ENTERTAINMENT	31 434	161	1.41	529	3.71	1.25	1.59	431	420
OTHER ACTIVITIES	35 2 4 9	147	0.05	428	0.22	(0.04)	1.52	325	337

Source: Karadzhov, V., 2013

EMPLOYEES UNDER LABOR CONTRACT OVERTIME IN OCTOBER	, AVERAGE GROSS ANI 2010 BY SEX AND PRO	ERAGE GROSS AND NET HOUR SALARY AND AVERAGE GROSS <u>HOURLY SALARY</u> FOR 0 BY SEX AND PROFESSIONS – TOTAL: FULL AND PART-TIME WORK					
PROFESSIONS – ACCORDING TO THE NATIONAL CLASSIFICATION OF JOBS AND CAREERS, 2011	EMPLOYEES	GROSS HOUR SALARY IN LEVA (BGN)	COEFFICIENT OF VARIATION IN %	NET HOUR SALARY IN LEVA (BGN)			
TOTAL	2 272 509	3.81	0.19	3.03			
MANAGERS	132 754	8.34	0.78	6.76			
SPECIALISTS	378 721	5.55	0.39	4.42			
TECHNICIANS AND APPLIED SPECIALISTS	224 001	4.82	0.51	3.83			
SUPPORTING ADMINISTRATIVE PERSONAL	211 006	3.34	0.42	2.64			
PERSONAL EMPLOYED WITH POPULATION SERVICES, TRADE AND SECURITY	485 048	2.33	0.22	1.83			
QUALIFIED WIRKERS IN AGRICULTURE, FORESTRY, HUNTING AND FISHERIES	3 523	2.26	2.45	1.78			
QUALIFIED WORKERS AND SIMILAR CRAFTS	281 256	3.36	0.33	2.65			
MACHINE OPERATORS AND CONSTRUCTORS	278 633	3.18	0.32	2.51			
PROFESSIONS WITHOUT SPECIALIZED QUALIFICATION	277 566	2.27	0.28	1.79			

Fig. 2: Average wage a month in BGN in Bulgaria

Source: Karadzhov, V., 2013

Fig. 3: Average wage an hour in BGN in Bulgaria

After we calculated the **total wage** for the period, **excluding** the funds, necessary for the **student's maintenance**, here are the results about the possible savings:

For a period of **4 months in Bulgaria**:

The **biggest possible savings are 2133.16 BGN (1233.04 USD)** at greatest possible scarcity, if students are living at the poverty line.

The possible **savings at normal maintenance are 897.00 BGN (518.50 USD)**, if students are living at the average maintenance, according to the National Statistical Institute of Bulgaria (1 USD = 1.73021 BGN according to the National bank exchange rate for 10.06.2016).

For a period of 4 months abroad:



Source: Karadzhov, V., 2013

Fig. 4: Money saved by Bulgarian students during a summer work program abroad

According to data collected in previous authors' surveys is obvious, that students working abroad manage to collect between 3 000 and 5 000 USD for a period of 4 months, Fig. 4. This is way higher as a total wage than what can be collected at the local basis (518.50 USD).

This data corresponds and approves the results from another stage of the survey. According this stage most of **the students who work abroad are predominantly satisfied with their incomes**. The results are shown on Fig. 5.



Source: Karadzhov, V., 2013

Fig. 5: Income satisfaction of Bulgarian students working abroad

The **conclusion** is: **Students' brigades are very profitable!** This is a very sustainable benefit, and among the strongest reasons for the attraction of students brigades together with the adventurous side of the process. Students' brigades will continue to expand the number of participants, until they manage to sustain their high profitability.

2.5. Disadvantages of participation

During the survey some disadvantages were also observed. They included predominantly:

- The stress, suffered by the participants, caused by the hard and prolonged work;

- The **exhaustion** from the long working days, less resting and the long period of 3-4 or more consecutive months of hard work (Fig. 6 and 7);

- The **psychological discomfort**, caused by the lack of friends and family as a main supporters in life, their miss and the nostalgia for home;

- Some **health problems** appear within the participants. These are mainly: increase or decrease of weight, acne, skin problems, menstrual problems, allergies etc. Their symptoms mostly are quickly overwhelmed after returning home and having a good rest.



Source: Karadzhov, V., 2013

Fig.6: Duration of a working day for Bulgarian students working abroad



Source: Karadzhov, V., 2013

Fig.7: Total duration of a student brigade for Bulgarian students working abroad

The **conclusion** is: **Students' brigades are exhausting!** Despite that, students are more than happy to have more working hours in order to save more money during the student brigade.

2.6. Opportunities of participation

The international students' labour migrations, also known as "students' brigades", create variable opportunities for the participants. Among the most important are:

- Students can collect some financial capital for future business

- Students can discover **new ideas for business and new economic niches**, which they can use after returning home.

- Students brigades create opportunities for **language learning** and improvement the foreign language skills

- Students' brigades play a significant role in **widening the participants' general** culture

3. CONCLUSIONS

As revealed so far, the main conclusions about the students' brigades can be summarized in the following statements:

- Students' brigades are **very profitable**.
- Students' brigades are **exhausting**.
- Students' brigades create opportunities for the young people.

Most of the participants are very satisfied with their summer brigade experience and are enthusiastically advising other students to participate.

Students' brigades allow maximum utilization of the students' free time during their vacation. Students' brigades create chances for full realization of youth's labour potential that are absent in their home countries. They are very profitable. The negative effects are acceptable. There are no adequate alternatives as seasonal activities at the present moment here.

The general influence that students' brigades cause upon the participants and their countries is predominantly POSITIVE.

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Municipalities Rila and Kocherinovo - zone shared gravity

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Abstract: Administrative - territorial division is a form of territorial organization of the state, based on which create regional and local authorities and self-government. Territorial communities are split apart in time administrative business units, which consist of hierarchically subordinate, complementary systems and components, connected by functional links and dependencies. They gravitate toward outspoken center. Centers and the territorial scope of administrative units are dynamic categories. Make the structuring of these units after consideration of complex factors - the natural geographical, economic, political, administrative, demographic, cultural and others. In administrative - territorial structure is essential territorial scope of each unit the maximum extent possible be aligned with the actual boundaries within which run economic and social processes.

Keywords: zone shared gravity, administrative - territorial division, and administrative centers

1. INTRODUCTION

Administrative-territorial division is a form of territorial organization of the state, based on which create regional and local authorities and self-government. Territorial communities are split apart in time administrative - economic units, which consist of hierarchically subordinate, complementary systems and components, connected by functional links and dependencies. They gravitate toward outspoken center. Centers and the territorial scope of administrative units are dynamic categories. The structuring of these units is made after consideration of complex factors – natural geographic, economic, political, administrative, demographic, cultural, etc., not least must be specify the role of continuity in their development.

The state regulates its territorial organization by planning laws. It defines the institutional structure of ATS. Administrative and Territorial affects system the state and local authorities and between them and the population. In administrative -territorial structure is essential territorial scope of each unit, the maximum extent possible be aligned with the actual boundaries within which run economic and social processes. The correspondence between the territorial and socio-economic structure of the country supports the management of these processes and stimulate their development.[3] From this arises the main task of territorial Administration, namely the creation of favorable conditions for realization of social politically, socio-economic and law-enforcement functions of the state based on the principles of democracy, self-government and self-determination.

The object of the study are Rila and Kocherinovo municipalities located in the southern part of the Kyustendil region and bordering Blagoevgrad.

The main objective of this study is to identify the key factors that determine the gravity of the municipalities to Blagoevgrad.

The task is to analyze the main factors influencing the development of the surveyed municipalities - Rila and Kocherinovo and the impact of Blagoevgrad

Methods and approaches: To achieve the goal using different tools for analysis - comparative and statistical methods.

2. RESULTS AND DISCUSSION

The municipalities Rila and Kocherinovo are located in the southern part of the Kyustendil region, on the border with Blagoevgrad. Both municipalities are located along the river Rilska and natural-geographic perspective are settled geographical area. Rilska and its valley is open to the west and the river flows into the Struma River, which passes through Blagoevgrad. The development of human history is closely linked to the environment or is it nature, which amends the labor of the people. [1] Municipalities represent a zone of shared gravity between two regional centers is one Kyustendil region, whose administrative borders fall and the other is Blagoevgrad, which are closest relationships of different nature. Blagoevgrad is a town of second level - major cities of national importance and the town. Kyustendil is the third level of regional importance near the two communities remains only Dupnitsa, but he also has a lower rank and municipalities themselves are set like many small towns and villages of the fifth level.

Geographic features and geo-strategic position of each territory are one of the most important factors for its current development as a prerequisite and potential for its future better development. Each territorial community has unique local conditions that can help or hinder its development. These facts form the basis for planning and implementation of local development strategies. To build a strong local economy, each community can launch a collaborative process through which to understand and to base future actions on development. Local authorities have an important role in creating favorable conditions for successful business development and job creation in the municipality. In this sense, local development is a partnership between local authorities, business and the interests and opportunities of society.

Kocherinovo municipality is located in the southern part of Kyustendil region and is located 52 km from the town of Kyustendil, 25 km from Dupnitsa Municipality, only 10 km from the regional center Blagoevgrad. Basic geostrategic factor for the development of Kocherinovo municipality is passing through road Sofia - Kulata and near the town. Kocherinovo highway "Struma". This transport-geographical position is one reason for waiting in improving the economic and social position. Geographical location, topography and climate of the municipality Kocherinovo determine the existence of favorable conditions and prerequisites for priority development of certain economic sectors such as modern agriculture, including forestry and wood processing development are becoming more popular and demand rural, eco, cycling tourism, hotel management, processing of agricultural, products and etc.

Undeniable truth is that transport and related infrastructure are a major factor for regional development. Each urbanized environment in antiquity occurred or around existing transport artery, or are causing such. The transport system of any location regardless of where it is located represents its backbone and provides mobility and active links of the population, economy, business, culture, trade and tourism. The more this system is adequate to the problems of a modern urban environment, and the problems are placed and decided to look to the future, the greater the guarantee of successful sustainable development in each territory.

Rila municipality is located in the southern part of Kyustendil region. Bordered by eight municipalities of the east - with Samokov and Belica, to the west – with Kocherinovo and Boboshevo, the north - with Dupnitsa and Samokov, in the south - with Blagoevgrad and Razlog. The territory of Rila municipality covers an area of 360 acres 933.687. The total area of urban areas is 2 177.296 ha, or only 1%. Predominant forest fund, which occupies 197 acres 948.730 or 54.84% of the municipal territory.

Physiogeographic features of the municipality imposed a number of restrictions to its conventional development, but can compensate with modern policies and practices for environmentally friendly lifestyles and business management. There are prerequisites for the development of organic farming to intensive agriculture in response to the ever-growing world, European and national interest in organic products. Municipality of Rila occupies part of the middle and southwestern Rila Mountains and its foothills.

The area is mainly high - 52%, with only 5.5% of it is under 600 meters altitude. The municipality includes the town, Rila municipal center, the villages Smochevo, Pastra, Padala and populated area "Rila Monastery", which falls within the land boundaries of the Natural Park "Rila Monastery". Mountainous territory determines the development of a limited settlement network.

In transport and communication regarding the municipal center - town Rila has quick and easy access to key economic centers in the country, as follows:

- 100 km from the city Sofia
- 65 km the regional center of town Kyustendil
- 20 km from the town of Blagoevgrad town Blagoevgrad
- 10 km of European highway E79
- 30 km from the town of Dupnitsa

Availability of clean and peaceful living environment in combination with appropriate forms of employment, for example in the food, textile industry can become a successful formula for attracting territory of external human resources. Of course, one should not underestimate the role and function of infrastructure planning and implementation of policies settlement. The biggest advantage of the municipality towards becoming a preferred place to live. Due to its proximity to the city. Blagoevgrad and the fact that on its territory there is no industrial production, polluting the environment and prevention of such a clear vision and policy of the local government for future environmentally sound development of the municipality [5].

In a move with the world, which in a few years are registered nationally, trends in settlement outside urban areas are prominent in recent years a number of intentions of foreign investors to build residential buildings, incl. such for public service, tourist facilities, parking and more the territory of Rila municipality. This is an indicator of investment activity whose institutional support at the local level should be aimed at providing the basic conditions for its implementation - areas infrastructure, relieved local regulatory regime [6].

Territorial processes studied municipalities are related primarily to labor trips, but also with travel related to training, health care service, which are available at a higher level in the larger and developed center, namely Blagoevgrad. As physical media spatial processes are infrastructures Isochrones transport accessibility particularly those achieved with mass passenger transport to the towns - are the synthesized form of the area of spatial processes.

Blagoevgrad is defined as an "urban gravitational field", covering territory to which gravitate studied municipalities i. e. the limits within which daily closes lifetime: "labor,

occupation, education, health care, sports, culture, and commerce". [8] These limits are determined taking into account the following criteria: 10-12 km / 20-25 min. Isochrone transport; labor and domestic trips a day; demographic stable settlements with over 2 000 people and available intensive business relationships with a high degree of economic dependence. Residents of Rila and Kocherinovo municipalities receive services - education, health, culture, sports and trade in the near placements city – Blagoevgrad in that city there is significant part of their jobs. Communication and transport links of these settlements with the city Blagoevgrad are provided with regular bus and railway transport.

Demographic dynamics is among those social factors that give a sense of spatial and regional planning and influence the overall development not only of the country but also of individual territories. The population is a major demographic parameter that is used, as an indicator of the extent of the population in a given area. It's too dynamic indicator, which is influenced by a number of conditions and factors of economic, social and psychological character. The population of Rila and Kocherinovo municipalities is affected by the ongoing demographic processes in the country, which have an adverse nature. Municipalities are significantly by the affected negative demographic situation. For the period 2008-2015, amid very unfavorable demographic development of the country as a whole and the majority of Bulgarian regions and municipalities, the demographic crisis manifested quite strongly in the municipalities of Rila and Kocherinovo. Following these processes the population in total municipalities decreased by 1138 people.

Data from demographic statistics show that the main role in reducing the population of the municipalities Rila and Kocherinovo has low fertility, high mortality, aging and mechanical movement. In recent years, mechanical growth is a positive example for municipality Kocherinovo 47 persons (2014), so the number of settled is higher than the number of displaced people, but this is not enough to provide quality human resources for the business. Besides the quantitative parameters of the population for demographic vitality of Rila and Kocherinovo, municipalities have influence and qualitative characteristics. Conceptually, the qualitative characteristics of human resources of the municipalities have a certain weight:

• The age and educational structure of the population.

The age structure of the population is a major demographic sign for the quality of human resources of each municipality. It gives an idea of reproductive abilities to his employment and educational potential, etc. The population in both municipalities have good educational qualifications - for example, Rila municipality 12 percent of the population with higher education. Municipal and regional center - the city Blagoevgrad is very well developed multi-purpose center with a covered service and economic functions of regional importance. These links have an impact on the demographic development of municipalities - as part of the population leaving municipalities and settled in the near placements regional center due to better and wider opportunities for their professional and personal fulfillment.

Among the group of three neighboring municipalities - Rila, Kocherinovo and Blagoevgrad-though not their administrative center, there are historical, permanently exhibiting links running along the line of:

• The mechanical movement of the population, the focus of its attraction is the town Blagoevgrad, outlining the tendency to form a center of attraction of adjacent municipalities Rila and Kocherinovo.

• Approved bilaterally oriented directions of labor and other trips as the settlements of municipalities Rila and Kocherinovo to town Blagoevgrad and in the opposite direction to

areas exceptionally clean natural environment and opportunities for practicing various types of tourism, sports offering municipalities.

• Maintain a certain contingent of temporary resident population in the municipality of Blagoevgrad, including Blagoevgrad University students and students in specialized and vocational schools in the city. Blagoevgrad that are surveyed municipalities that make up the other administrative staff, under existing administrative territorial division of the country.

• Cultural life, health and other daily trips to Blagoevgrad from neighboring municipalities Rila and Kocherinovo.

Municipalities represent a zone of shared gravity between two regional centers is one Kyustendil region, in which administrative borders fall and the other is Blagoevgrad which are closest relationships of different nature.

Due to the limited opportunities for professional development in the municipalities of Rila and Kocherinovo, much of the working-age population emigrated mainly outside the city to larger and nearby settlements like Blagoevgrad and Sofia. There is a strong daily migration - a journey of the population outside of the municipality to the neighboring township - Blagoevgrad. This mechanical movement is caused by better employment opportunities and higher incomes in these localities. It does not reflect a lasting impact on the population of the municipality, as the closeness of the regional center has a beneficial effect on preservation of some of constantly living on the territory of the municipality population; it provides income without the need for a change of residence.

Opportunities for business development, especially in the services sector / hotels, restaurants, cultural, ecological and rural tourism / arising from geostrategic position of municipalities Rila and Kocherinovo and their roads are underused by private businesses and the population of region. This should be one of the development priorities of the municipality, in order to maximize utilization of their resources and their geographic features

Municipalities have objects of education, health and other services, but questions remain about the quality of public services, physical and financial access to them and the satisfaction of users of these services. This is crucial to provide the necessary types of quality public services in the municipalities. The development of communities play an important role connectivity and accessibility within them and outside them. Assessment and condition of road network is one of the keys to access the territories and avoid isolating distal regions.

A great advantage of the surveyed municipalities Rila and Kocherinovo is that in conditions of globalization and urbanization in keeping with the unique nature, cultural values preserved customs and traditions, especially villages that appropriately displayed will show Bulgarian identity as a leading target groups in tourism-oriented to untouched by urban environment. Tourism and agriculture are the main sectors that will contribute to the development of these areas. The diversity of economic activities that can be conducted in the study area would be a sign of revival.

The economy of municipalities Rila and Kocherinovo is characterized by agroindustrial structure that in recent years the development of agricultural activities is a faster rate to these sectors of the industry. Determining factors for the economy of municipalities Rila and Kocherinovo include:

• The available natural resources, which offer excellent opportunities for the development of agriculture and tourism.
• Proximity to the district town of Blagoevgrad and the international road E-79, which in turn provides opportunities for market production and opportunities for tourism development.

• Availability of natural landmarks.

• Availability of human resources for agriculture experienced and established work habits that are transmitted between generations.

Cooperation between the three neighboring municipalities would diversify the environment for the implementation and development of various activities such as hiking, creating a more diverse tourism products, agro economy, and development of organic production. To optimize local development would be better to build partnerships between municipalities of Blagoevgrad, Rila and Kocherinovo the principle of clustering to develop the territory, retain existing population, and why not attract the young population of the city.

Clusters are defined as geographically connected network of similar interrelated or complementary competitors' operators with active channels for dialogue, which share a specialized infrastructure, labor market and services, and are presented to the general development opportunities.

Cluster approach in tourism is based on partnership and cooperation of various direct and indirect participants in the creation of tourist products and ensuring the overall experience of tourists in a tourist destination. Clusters in tourism emerge and evolve to unite mostly representatives of small and medium tourism businesses that compete globally and to provide joint marketing activities, exchange of experience and knowledge more dynamic and effective development and implementation of innovations, inclusion in national and international networks. The main objective is to increase competitiveness of the sector locally [2]. As a result of various economic and social processes occurring within Europe and therefore occurring in our country over the last 7-8 years there is tendency of creating crosssectoral clusters, i. e. clustering organizations of funds and activities of participants several businesses, non-profit and non-governmental sectors, with none of them take the lead. In much of this kind of alliances includes representatives from tourism, culture and leisure, local industry and agriculture, as well as a public institution of local government.

Thematic tourist cluster will attract manufacturers of foods, beverages, equipment and goods for sports and entertainment, and specialized (eco spa and spa tourism) attract manufacturers of equipment and technologies that have application not only in the tourism sector. Today approximately 40% of registered clusters, besides tourism include organizations from areas such as media, technology - IT, organic farming or environmental, recreational, cultural or creative industries, manufacture of goods of light and food industries. The Interl Cross sectoral cluster approach is important not only to achieve higher competitiveness of industry, but also to the economic growth of the territories. It acts as an engine of sustainable development in the region, which is defined by:

• The contribution of the approach to integrated territorial development, i. e. for the simultaneous development of the region in four dimensions - economic, social, environmental and institutional;

• Ensuring by the approach of the synergistic effect, i. e. four-measured result, current and future importance for the whole region, from the interaction of several sectors - business, nonprofit and public.

Through integrated territorial development will be stimulated and achieved economic growth in the issue areas. Together with adjustable impact on the environment and consistent with the available natural capacity, as well as a balanced satisfaction of the interests of many social groups - business, local residents, public authorities, social and

educational institutions and others. The Interl cross - sectoral cluster approach is a driving factor of these processes, but also by providing input through the operation of public-private partnership that brings together institutions of local government, local business and NGOs from the social sphere. The synergistic effect of the application of sector-cluster approach is a complex result in the following dimensions:

- Economic growth in the area and the region, but based on diversified economy and creating specific value
- Social improving the quality of life for local people, visitors, tourists and future generations
- Environmental conservation of local natural resources
- Ecosystems, and the ecological functions and processes that exceed in importance the region and destination
- Institutional development of civil society.

Inter-sectoral cluster groups are mostly business representatives from the fields of organic production, tourism, food and light industry in a given geographical area. Organic production has great potential for sustainable economic and social growth in rural areas [4]. These cluster groups responsible for building and maintaining the image and integrated image of the distinctive rural areas and municipalities surveyed fall, and in this category - rural area through which to support their development.

The Inter-sectoral cluster approach has the greatest importance for the economically underdeveloped areas or those who need to diversify the economy because it is based on partnership and cooperation between tourism and traditional and / or most important domestic economic sectors. In these areas tourism development can help local businesses and non-profit activities, some farewell, or problems related markets, investments and. But without destroying their original character, value and importance. This happens most often through mutually stimulating sales and revenue sectors - participants in the cluster, such as tourism and producer of local food and wine; tourism, cultural and entertainment industry and textiles and clothing.

The Inter-sectoral cluster approach is suitable in the municipalities, because in these municipalities there operate small family businesses producing dairy products (first certified farm for breeding buffalo and dairy production in Bulgaria – town Rila production of wine (" Medi Valley" - winery in village Smochevo), fruits, vegetables, and production of ecologically pure honey. The aim is to develop agriculture and tourism in concurrence using mainly local resources and conditions in the municipalities of Rila and Kocherinovo, available demographic social, economic and natural capital to be integrated exploited without breaks.

3. CONCLUSIONS

The economic crisis canses a reassessment of lifestyle, values, capabilities, knowledge and skills of courage and quest in search of a place where young people of working age to stay, to stay and develop. The ideal place where people want to live, work and make a family is different for each individual. This ideal is form of traditions, culture, fashion, the degree of economic development of the country, by educated attainment of social status, age, by marital status. Most of these factors will have a positive impact if municipalities and in most places, there is capacity to manage socio-economic processes.

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Opportunities to modernize the activities of waste management on the basis of cluster approach -Blagoevgrad region

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Abstract: The idea of creating cluster structures is not new-in 1890 Al-fred Marshall has determined the cluster as a "concentration of specialized industries in certain locations." Currently prof. Michael Porter of Harvard University gives a broad definition - "A cluster is a group of geographically nearby companies and organizations with a particular activity, linked by commonalities and complementarities." Environmentally sound management of waste is a set of rights, obligations, decisions and activities that should ensure sustainable management through specialized forms of treatment and kontrol.Na this stage, Bulgaria apply waste disposal by landfill. To be effective and safe landfills must meet a number of reauirements in the process of their design, construction. operation and zakrivane. Ministerstvo of Environment and Water has adopted an approach to build 55 new stores on a regional basis. The report has been viewed regional policy manage-ment of nonhazardous waste and Blagoevgrad Region retrospective of klasteriterizatsiyata in Bulgaria in order to attempt to create a cluster "waste" that has not been formulated in our country. Keywords: cluster, waste, regional waste landfill

1. INTRODUCTION

One of the prerequisites for improving competitiveness is implementing a new development model based on the interaction between different structures based on common economic interests by creating clusters. They bring together companies, researchers, NGOs and other organizations, bodies of state and local authorities with common interests to form a sustainable competitive advantage, strengthen market positions, further economic development and increase competitiveness.

The idea of creating cluster structures is not new-in 1890 Alfred Marshall has determined the cluster as a "concentration of specialized industries in certain locations," and later prof. Michael Porter of Harvard University expands and specifies ponyatieto- "A cluster is a group geographically nearby companies and organizations with a particular activity, linked by commonalities and complementarities." [1]

The initiative for the construction and development of clusters is an important new direction in economic policy of the Bulgarian government and socio-economic partners based efforts for macroeconomic stabilization and growth and increase competitiveness. Association of Business Clusters [2] based on the current condition of our country expands and clarifies the term "cluster" - combination of legal and / or sole traders registered under the Commercial Law, Law on obligations and contracts or Law for Non-Profit purpose, which may also include universities, research organizations and / or municipal and state authorities, NGOs and individuals from a particular sector or region having common economic interests and / or covering successive levels in the chain of production and distribution of goods and services in order to increase administrative capacity, research potential, competitiveness and business development of the members of the grouping and the grouping as a whole.

2. FORMULATION OF THE PROBLEM AND TARGETS

Both globally and in the countries of the European Union increased the deficit of raw materials and energy resources. This necessitated a reassessment of policy and waste management in our country, based on sustainability and regionalism. Following the European model, the Ministry of Environment and Water has taken the construction of landfills for the disposal of waste from several neighboring communities and meeting the increased regulatory requirements. In the infrastructure of regional landfills foresees the construction of sorting installations and plashtadka site composting of bio-waste in order to:

□ doseparirane of separately collected packaging waste

□ separation of recyclable waste in the general waste stream

 $\hfill\square$ removal of accidentally caught up in the general waste stream of hazardous waste from households

□ minimize the quantities of waste subject to disposal at regional landfills

□ reduce the amount of greenhouse gases produced by the decomposition of the biodegradable fraction of waste

After examining the established clusters in Bulgaria are formed 190 clusters [3] from different fields of activity and found that the country will set up a cluster waste, which would facilitate their management on a regional basis. By 2020, it foresees the territory of Bulgaria to take effect 55 regional landfills to be recovered and disposed waste from several neighboring municipalities. For the territory of Blagoevgrad Region provides waste management by municipalities of Blagoevgrad, Simitli, Kocherinovo, Boboshevo and Rila. Creating a model for cluster "Resource recovery of waste and mitigate climate change" would lead to cost savings for municipalities due to the geographical concentration of certain companies and organizations. Reducing the costs of participants at Model Cluster "Resource recovery of waste and mitigate climate change" is expected to be a result of:Повишаване качеството на управление на отпадъците от петте общини;

• Offer new products and services;

• A highly skilled workforce;

• Waste recovery and recycling of waste that will be stimulated through the formation of clusters;

• Geographically concentrated multiplier effect;

- · Increased demand and supply of products and services;
- Internal network cooperation with training and scientific production organizations;
- Improved infrastructure and communications.

The main objectives to be achieved by creating a cluster are:

• Establishment and development of a network of collaborative relationships among cluster partners and network of stakeholders in the management of municipal waste and its treatment;

 $_{\odot}$ Facilitate access to the achievements of science, technology and exchange of experience;

• Creation of new and improvement of existing services and products to increase the competitiveness of the partners, including the strengthening of "value chain";

 Supporting entrepreneurship and innovation in the cluster work and creating conditions for effective commercialization of research results;

• Mitigation of climate change by limiting greenhouse gas emissions [4].



Fig. 1: Sample composition of cluster

Main reasons for clustering:

- 1. Sharing knowledge, skills and experience;
- 2. Economic benefits;
- 3. Mutual trust;
- 4. Free access to the combined resources (financial, material and human);
- 5. Exiting the common market

The biggest drawback to the development of clusters in Bulgaria is insufficient involvement of universities, research institutes and centers, schools and other educational institutions in the issue clusters, which is related to technological development, innovation transfer and training of highly qualified personnel.

To create a cluster model "Waste" is necessary to analyze the current state of their management at the municipal level. For Blagoevgrad Region has done research on quantities of waste composition and condition of current landfills municipalities of Blagoevgrad, Simitli, Kocherinovo, Boboshevo Rila and who will participate in the regional system. Regional Association for Waste Management - Blagoevgrad is an independent, voluntary, nonprofit organization uniting on a regional basis following municipalities:



Fig. 2: The municipalities entering the regional association

The main objectives of the "Regional Association for Waste Management - Blagoevgrad" are:

Joint construction, management and operation of the municipal association of regional landfill for the disposal of non-hazardous waste on property owned by the Municipality of Blagoevgrad falling within the existing landfill of the Municipality of Blagoevgrad;

• Creating a system of waste management consisting of regional landfill and / or other facilities for waste treatment in accordance with legal requirements;

• Effective treatment of waste in compliance with the requirements of the waste management regulations and the National Plan for Waste Management;

• Application of the municipalities of the regional association to finance projects in waste management of EU funds, the state budget, enterprise management activities on environmental protection to the Ministry or other national public sources of funding;

• Improving the quality of services for the collection, transport and disposal of household waste and assimilated waste;

· Efficient use of resources arising in the process of waste management;

• Optimizing the processes of waste management to reduce the cost of service for collection, transportation and disposal of household waste and assimilated waste;

· Achieving transparency and accountability processes waste management;

• Encourage and promote the activity of individual citizens to participate in processes for waste management;

• Promoting dialogue and interaction between the state, local authorities, business organizations in solving problems related to waste management. [5]

Each municipality member of the regional association will participate percent in the cost of building a regional landfill and its commissioning, the cost of construction of facilities for waste treatment, making money (property) contributions. In providing project financing for various stages of construction of the regional landfill and / or other facilities for waste treatment, the municipality participates in the percentage size of the contribution of the regional association for project implementation.



Fig. 3: The percentage participation of each municipality member of the Regional Association

3. CONCLUSIONS

Business clusters can be used as a locomotive for regional smart specialization in Bulgaria because they involve real elements existing in the areas of innovation infrastructure. Moreover, the development and creation of new clusters are a prerequisite for developing links between education, training and business. Clusters can contribute to setting standards of competence in the regional waste management. In this area there are a number of challenges in terms of improving separate collection and recycling management processes of recycling and recovery of a number of waste streams, as well as awareness and motivation of the population. On one hand, attention should be paid to the substitution of conventional exhaustible resources with new technological solutions or the use of recycled raw materials, and on the other - to be stimulated reuse that can be applied mainly in regional waste management model for cluster "Resource recovery of waste and mitigate climate change." So Blagoevgrad region realize its contribution to sustainable and effective waste management in the country as a whole in accordance with the requirements of European legislation, which in turn will contribute to the realization of major Community priorities for cohesion policy: sustainable development and improving the attractiveness of regions by improving accessibility, ensuring adequate quality and level of services and preserving their environmental potential.

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Creative Industry – Nature and Importance. EU Policy for the Creative Economy

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Abstract: Since the late 90s of the last century, jobs in the manufacturing industries in the countries of EU and in Bulgaria have decreased by half. That is an illustration of the transformation of the economy from the traditional system of mass production to an economy based on knowledge and innovation, which increasingly relies on latest generation services and products that satisfy the increasingly fragmented tastes of the consumers. At the same time, the social and economic importance of the cultural and creative industry is constantly growing. The current study examines the nature and importance of the creative industry and analyzes existing policies and regulations in some member states of the European Union, as well as examples of good practice aimed at promoting the creative industry.

Keywords: innovation, creative Europe, creative growth, sustainable regional and urban development, creative clusters, business incubators

1. INTRODUCTION

Since the late 90s of the last century, jobs in the manufacturing industries in the countries of EU and in Bulgaria have decreased by half. That is an illustration of the transformation of the economy from the traditional system of mass production to an economy based on knowledge and innovation, which increasingly relies on latest generation services and products that satisfy the increasingly fragmented tastes of the consumers. At the same time, the social and economic importance of the cultural and creative industry is constantly growing. Art and the various creative sub-sectors provide significant growth and employment (about 5 million jobs in the EU) and contribute to the sustainable economic development in all Member States.

As a result, the development of cultural and creative industries goes beyond making policies and stands at the top of the strategic agenda of many governments at European, national and regional levels.

Topicality of the subject: the creative industry is a new sector of the economy. The processes associated with it are dynamic. It has been topical in the last few years and will stay topical in the future.

Object of study: status of the creative economy and development opportunities in Bulgaria and further development in Europe. Main objective of the study: analysis of the nature of the creative industry.

Tasks: analysis of the importance of the creative economy in Europe; review of existing legislation at EU level; analysis of the examples of good practices on the issues of the creative industry in Italy, France, and United Kingdom.

2. MATERIALS AND METHODS

For the current study have been used current normative documents at EU level which are part of the legislation of the above stated Member States.

The used methods are as follows:

- theoretical analysis of used literature related to the studied issue and introduction of basic concepts;
- review and analysis of the legal documents and specific actions for promotion of the creative industries;
- documentary study of existing analyzes and reports concerning the problem of the creative industry.

3. ANALYSIS, RESULTS, SUMMARIES

3.1. Creative industry – history of the theoretical concepts, nature

"Creative Economy" or industry is a new type of economy based on creative industries, led by creative people. The term was coined by John Hawkins (Hawkins, J., 2001) in his eponymous book of 2001. Initially, his idea was considered utopian. Ten years later, however, the creative economy is flourishing. With the introduction of new technologies many of the boring and pointless duties have been automated. With regard to the above, the innovative and entrepreneurial spirit, imagination and unconventional thinking are the most valued qualities in the creative economy. Much of creativity comes from emotions caused by different ideas in more emotionally developed people. Therefore, it is easier for them to identify the potential of the ideas. Many creative ideas often come as a result of group brainstorming.

The main catalyst for the emergence and development of creative and culturallycreative industries are the post-industrial societies in Europe and America.

Creative businesses are a key driver of renewal and innovation: structures from all industries use the creative capacity to develop products and services in the center of which stands the user. The economy is becoming more common, connected in a digital network and at the same time aimed at satisfying the desires of the end user.

Given the diversity in Europe, it is not surprising that efforts and methods supporting the cultural and creative industries vary in different regions and countries. Therefore, exchange of experience on how to support creativity in the best way is of huge benefit to public administrations and development structures.

The meaning of the cultural and creative industries for Europe

There is much evidence that cultural and creative industries are vital for Europe's economic recovery and the creation of globally competitive jobs.

According to a working paper of the European Commission from 2010, creative industries represent 3.3% of total EU GDP and 3% of the employment in Europe, which places them among the most dynamic sectors in the EU. Although employment growth has been uneven, the total employment in creative industries increased by an average of 3.5% annually in the period 2000-2007, compared with 1.0 percent a year for the EU economy as a whole.

It is also necessary to acknowledge that the development of cultural and creative industries "has important external effects on other industries." For example, it contributes to:

• development of ICT infrastructure (broadband networks) and distribution of consumer electronics (the success of Apple);

• the attractiveness of some tourist destinations (Bilbao, Budapest, Berlin, etc.);

• regeneration of regions and cities (a good example is the renewal of the Greater Manchester area in northwestern England in the last 20 years).

In this context, the study of competitiveness stresses that "creative industries are not only innovators themselves, but they are also important drivers of innovation developed in non-creative industries." Apart from these examples, organizations from different fields increasingly rely on services and conditions introduced by the companies in the creative sector in order to upgrade their products and services and reach their users and partners in new ways. A research done by the UK based National Foundation for Science, Technology and the Arts (Nesta) shows that "companies that spend more than twice the average amount for creative resources are 25 percent more likely to innovate."

Therefore, companies from the creative sector can in many ways be seen as role models for a new kind of innovation, which depends on both cultural understanding, consumer insight, experimentation and collaboration, and the accumulation of technological expertise. Their importance to further economic recovery and growth across Europe therefore needs to be assessed and promoted. (www.creative-growth.eu)

3.2. Subsectors in the creative industry

According to several authors who have written in the past fifteen years, there are different definitions and classifications of which the main "creative industries" building the creative industry are. Many of them overlap and complement each other. The main "creative industries" are: Filmmaking, Radio, Television, Music, Arts, Crafts, Computer Games, Publishing, Digital Media, Fashion, Performing Arts, Advertising, Photography, Design, Tourism, Cultural Heritage, Art Markets, Architecture, Engineering and Technology (www.creative-growth.eu).

3.3. EU policy for creative economy

Key documents in Europe related to the creative economy:

"Europe 2020 - a strategy for smart, sustainable and inclusive growth", the very title of the strategy speaks about its goals and priorities. "Europe 2020 for smart, sustainable and inclusive growth, which should "provide high levels of employment, productivity and social cohesion". "Europe 2020" aims to correct major failures of its predecessor and also to establish a comprehensive roadmap for the economic recovery of the EU.

In its conclusions, the Commission proposed a limited number of goals - five measurable objectives for the EU which should be translated into national targets for achieving the highest political commitment from the Member States. These measurable "objectives of the EU" include the achievement of certain levels by 2020. The Council determined that the strategy will be a framework for "enhanced coordinated action" and "support for the implementation of structural reforms." It was emphasized that "the focus now must be on implementation and we shall supervise and observe this process."

The objectives must be reached no later than 2020. The Member States shall establish national targets in these areas, taking into account the starting positions and national circumstances and in accordance with their national procedures for decision-making. The fact that each Member State shall determine its own desired level towards the common objectives of "Europe 2020" is an important element of the strategy, which ensures that

national targets have been subjected to internal political debate and adopted as their own by the different states.

"Europe 2020" puts "the talent and creativity" of European citizens among the strengths of Europe. The Green Paper of the EC "Unlocking the Potential of Cultural and Creative Industries" indicates the potential contribution of the creative industries in leading initiatives of the strategy "Europe 2020" - "Innovation Union", "Program in the Digital Agenda", "Agenda for New Skills and Jobs", "Industrial Policy for the Globalization Era". (http://ime.bg/var/Overview_Europe2020_NPR.pdf)

Program "Creative Europe" (2014-2020) brings together existing programs of the European Union - "Culture" and "Media" by expanding its scope. The program was created based on the experience of a number of analyzes, reports and pilot projects conducted within the union. The general objectives of the program are:

a) preservation, development and promotion of European cultural and linguistic diversity and promoting European cultural heritage;

b) strengthening the competitiveness of European sectors of culture and creativity, the audiovisual sector in particular, in order for smart, sustainable and inclusive growth to be promoted.

The concrete objectives of the program are:

a) supporting the opportunities to lead the work of European sectors of culture and creativity to transnational and international level;

b) promotion of the transnational proliferation of cultural and creative works and transnational mobility of cultural workers and artists, in particular artists, as well as attracting new and wider audiences and improving the access to cultural and creative works in the Union and beyond it with a special focus on children, young people, people with disabilities and underrepresented groups;

c) strengthening of the financial capacity of SMEs and micro, small and medium-sized organizations in the sectors of culture and creativity in a sustainable way, while striving to ensure a balanced geographical coverage and sector representation;

d) promoting policy development, innovation, creativity, and audience attraction, as well as new business and management models through support for transnational cooperation in the field of politics.

Decision № 1622/2006/EC of the European Parliament and the Council - Action "European Capital of Culture" and Decision № 1194/2011/EC of the European Parliament and the Council – Action "European Heritage Label" contribute to the Union's actions in favor of the sectors of culture and creativity.

In the UNESCO Convention of 2005, which entered into force on 18 March 2007 and to which the Union is a party, underlines that cultural activities, goods and services have both an economic and a cultural nature, because they convey identities, values and meanings, and therefore should not be treated as having only commercial value. That convention was aimed at strengthening the international cooperation, including international agreements for co-production and co-distribution, as well as to solidarity in favor of the cultural expressions in all countries and all people. Therefore, a program for supporting the sectors of culture and creativity should encourage cultural diversity at international level in accordance with the Convention.

The promotion of tangible and intangible cultural heritage inter alia in the context of the UNESCO Convention of 2003 for the Safeguarding of the Intangible Cultural Heritage

and the UNESCO Convention of 1972 for the Protection of the World Cultural and Natural Heritage should also contribute to raising the value of the seats and creating a sense of belonging to the cultural and historical value of such places.

Independent financial instrument - Cultural and Creative Sector Guarantee Facility ("Guarantee Facility") should enable these sectors to achieve growth as a whole and should also provide sufficient funds for new activities and opportunities – by means of leverage in particular. Selected financial firms should act in favor of the cultural and creative projects in order to ensure a balanced portfolio of loans in terms of geographical coverage and sector representation. Moreover, public and private organizations play an important role in this context in order to achieve a broad approach within the guarantee facility.

EU Regulation № 1295/2013 of the European Parliament and of the Council establishing the "Creative Europe" (2014-2020), a founding document of the "Creative Europe" program.

Important for the development of the creative economy are also all programs, regulations and laws at a national level in the individual Member States related to copyright protection and the possibility of patenting various innovations and inventions, the fruit of creative thought and individual or group work.

To an European strategy for creative growth

As inspiration from some progressive regions of the EU and the Member States which examine and support cultural and creative industries development at an early stage, significant progress in the development and partial implementation of a strategy for unlocking the potential of creative industries Europe was achieved in the recent years. Although it is beyond the scope of this study, in order to outline in detail all that is done at EU level, a concise overview of some of the highlights and some thoughts on the challenges that lie ahead is needed:

• The European agenda for culture in the globalizing world is the first ever European strategy that has an overview of the importance of culture in the European project. In terms of the economic potential of cultural and creative industries it suggests that the EU uses the potential of culture as a catalyst for creativity and innovation;

• The potential of cultural and creative industries, which contributes to economic and social renewal in Europe, was confirmed by several resolutions and conclusions of the the Council;

• Moreover, the European Parliament plays an important role in creating the EU's approach to a better development of the creative industries. From a regional perspective, the EP particularly underlined the importance of promoting "regional-designed or locally adapted projects, as these are the most effective and sustainable projects for regional and urban development";

• In order to facilitate the "open method of coordination" - the interaction between European policy development and policy development in the Member States - several groups of stakeholders were set up;

• Finally, several scientists authorized by the Commission, who dealt with the development of the creative sector in several aspects, were informed about the EC strategy for creative industries.

These developments have led to the publication of the Green Paper of the European Commission for unlocking the potential of cultural and creative industries in 2010. The Green

Paper contains detailed description of many of the mentioned issues. It was released and set out for discussion and attracted more than 350 individual reviews from industry, research, governments, and many intermediary institutions. Many of the respondents work at local and regional levels. While the majority of responses welcomed the comprehensive and very broad treatment of key issues, some asked for a more focused analysis of certain critical points (cultural diversity, copyrights, business models / investments in creativity, mechanisms for public support - these are only some of them).

While most of the above-mentioned events have occurred at a strategic level, to some extent they should already have been translated into concrete funding opportunities for cultural and creative industries:

• Directorate General "Industrial Enterprises" - initiated by the European Creative Industries Alliance, as a result of which it was launched in 2011, will create a political platform by a group of high level experts, as well as several pilot projects, all of which aimed at building spill-over effects between cultural and creative industries and enterprises in other industries.

• Directorate General for Scientific Research published an invitation for proposals concerning research relating to links between creativity, culture, creative industries and innovation in its field of "Science and Society".

• Currently, the European Commission is considering the creation of a new support program named "Creative Europe", which will integrate the cultural program and the MEDIA program in a single large initiative.

• Just like "Creative Growth", several transnational cooperation projects focus on the development of the regional sector and are supported by INTERREG, URBACT, FP7 and other programs of EC. (www.creative-growth.eu)

4. CONCLUSIONS

At the beginning, the idea of a creative industry emerged as something crazy or illusory. Just ten years later, however, the results have proven that notion completely wrong. The trends in Europe in the postindustrial period of the 1990s show the gradual displacement of traditional sectors and industries and their transformation into a new economy based on knowledge, creative thinking, and innovation. The European Commission and the European Parliament have created regulations and normative documents which complement the basic operational programs Creative Europe (2014-2020) and OP "Regions in Growth" (2014-2020).

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Importance of the Quaternary Morphotectonics of the Rhodopean Mountain Massif Regarding of the Regional Endogenous Risk Processes

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Abstract: The aim of this study is the morphotectonic analysis of regional conditions for the Late Quaternary endogenous risk processes in the Rhodope Mountain, which is an attempt to build a general model of endogenous morphogenesis.

To achieve the goal of the study are formulated following scientific tasks:

- clarifying the nature of the regional morphotectonic situation in the Rhodopean Mountain Massif from Quaternary until today;

- analysis of the conditions for the occurrence and nature of manifestation of regional endogenous processes with risk character in the Rhodopean Mountain Massif;

- creating a generalized model of regional seismic hazard in the Rhodopes;

Keywords: endogenous, seismic hazard, Rhodopes, morphotectonics

1. INTRODUCTION

The Rhodopean Mountain Massif is the largest mountain system in the eastern part of the Balkan Peninsula. It is prolonged in WNW – ESE direction at one longitude from 225 km by maximal width-130 km in South Bulgaria and North-East Greece. The total area of the Rhodope Mountain is about 18 000 km², as the Bulgarian part is 14,738 km² (81.88% of its entire area).

The Rhodope Mountain is a large inwardly complex composed mountain system. This feature distinguishes it from the other first-rare positive morphounits of the Rila-Rhodopean Mountain Massif (the Rila, Pirin, Slavyanka, Ograzhden Mountains, etc.).

The Rhodopean Mountain system includes a big number of different oriented mountain ridges. The altitude characteristic of the Rhodopean complex positive morphounit is a good reason to divide it in general on the Western and Eastern Rhodopes [Гълъбов, 1966]. The boundary between them is marked by the Kalyayka, Borovitsa and Varbitsa Rivers.

The complex morphotectonics development of the Rhodopes gave the prerequisites for the emergence of endogenous risk processes, such as earthquakes. Comparing regional morphostructural setting with seismic events shows the following: if we compare the whole area of the Rhodope Mountain with the location noted in its medium and strong earthquakes we see that the location of these seismic effects is normally tied to the periphery of the mountain. The central parts (except in the area of Velingrad-Batak and Pamporovo-Smolyan) did not field on such seismic events. Another such center of seismic expression is Varbitsa fault, which appears as physical-geographical and seismic-tectonic boundary between the Western and Eastern Rhodopes. The previous interpretation of this fact according to geosynclinal theory is associated with the presence of "long-lived" (in the order of tens, hundreds and millions of years) "depth" faults with strictly defined invariably available in the eastern part of the Balkan Peninsula. From the point of the overlapped in this study Plate tectonics idea for the Neogene and Quaternary morphotectonics, the seismic processes in this region can not to be attached to stationary for hundreds of millions of years seismically active fault zones, because the removal of lithospheric plates in the Rhodopes and along the Earth's surface is constantly and rapidly. From this perspective the earthquake hazard in the Rhodope Mountain should be sought in modern endogenous crustal processes in connection with the ongoing collision between the relevant part of Neo Europe and the northern edge of Gondwana.

In this regard the main goal of this study is the morphotectonics analysis of regional conditions for the Late Quaternary endogenous risky processes in the Rhodope Mountain, which is an attempt to build a general model of endogenous morphogenesis based on prevailing today Plate tectonics model.

To achieve the goal of the study are formulated following tasks:

- clarifying the nature of the regional morphotectonics situation in the Rhodopean Mountain Massif from Quaternary to the present;

- analysis of the conditions for the occurrence and nature of regional endogenous risky processes in the Rhodopean Mountain Massif;

- creating a generalized model of regional earthquake hazard in the Rhodopes;

2. QUATERNARY MORPHOTECTONICS EVOLUTION OF THE RHODOPEAN MOUNTAIN MASSIF

The Post Alpine geotectonic evolution of the eastern part of the Balkan Peninsula was began with the Late Oligocene - Early Pleistocene relatively long (28 - 0.78 Ma) apparent geodynamic "lull". At this time the relief setting on region was determined by the lowland plateau landforms, with savanna-like characteristics. The widespread at that time braided rivers were contributed to the building of several super positioned large denudationaccumulative planes - orthoplains. Powerful argument in support of this are the many founded here remains of Pleistocene fauna (lions, hippopotamuses, mastodons, etc.), which is known to inhabit flat surfaces. The building of the orthoplains took place at the Post Early Pleistocene period (before 780 000 – 800 000 years), which precede probably the beginning of the transcontinental collision between the landmasses of Gondwana and Neo Europe in the East Mediterranean region [Fig. 1]. This process was provoked by the relative rapidly and high intensive uplifting of the most south parts of Neo Europe and causes the building of the high mountain massifs, such as Alpes, Dinarides, Pind, Helenides, Rila, Pirin, etc. Their morphogenesis is connected with the Middle Pleistocene – Holocene temporal progressive destruction of the parts of the Post Early Pleistocene orthoplain and the building of positive (dome-like, concentric) morphostructures. The dimensions and the mosaic regional position of those morphounits were limited by the deep crust faulting.



Fig.1: Stages from the closing of the Tethys Ocean and transcontinental collision between Gondwana and Neo Europe. 1- Gondwana continental massif, 2- Tethys Ocean, 3- Paleo Europe continental massif, 4 oceanic crust, 5- Phanerozoic subduction of the Tethys Ocean down the Paleo Europe continental massif, 6- fragments from the Gondwana's continental crust in the Tethys Ocean, 7- Mediterranean Sea building (after the Tethys Ocean closing), 8- transcontinental collision between the Gondwana and the Neo Europe continental massifs. (by Tzankov, Iliev, 2015)

The Contemporary morphotectonics setting in the Rhodopean Mountain Massif is result from the morphotectonics processes in connection, as already noted above, with the transcontinental collision between the continental lands of Gondwana and Neo Europe. Those deformations are beginning after the end of Early Pleistocene (before around 800 000 years) (Tzankov, Iliev, 2015). In that time the existing Post Early Pleistocene orthoplain was intensive destructed from the beginning of the orogenic uplifting of the area. They are rested some little fragments (bottoms of the contemporary kettles and morphostructural passages) only.

The modern Rhodopean Mountain morphotectonics pattern was formed by the compounded influence of the three constituted in the area Quaternary morphostructural generations. Its morphogenetic role is different. The fragments (traces) from the Late Pleistocene-Early Holocene circular concentric morphostructures have relatively very little sizes. They have local importance for the relief building (some little ridges, hills or valleys).

The numerous Late Pleistocene-Early Holocene dome-like morphostructures are the most widespread morphounits in the Rhodopean morphostructural area. They are given the morphostructural aspect of the local and regional contemporary relief. Its origin is connected with the maximal uplifting centers, the listric faulting and the local fault net in every superficial Earth's crust block, whose total action in turn is a prerequisite for the emergence of endogenous risky processes in the area.

3. MECHANISMS OF OCCURRENCE OF ENDOGENOUS RISKY PROCESSES

The Earth's hard shell- the lithosphere is a product of many complex interacting processes. They are caused almost entirely by the action of endogenous Earth's forces that raised some sections of the Earth's crust and contribute to the formation of small or large landforms. In distinction from exogenous processes, who owe their origin to the radiant solar energy, endogenous processes seeking its energy source deep in the Earth's bowels. According to the theory of lithospheric plates major endogenous energy generator is a redistribution of substance and energy between the Earth's crust and the asthenosphere (in upper mantle), which in turn ensures continuity of geotectonic crustal changes.

Earth can be viewed as a complex nonlinear dynamic self-regulating system made up of various subsystems (geospheres) - lithosphere, atmosphere, hydrosphere, biosphere, etc., within occur very complex physical, physic-chemical and biochemical processes. A common feature of all non-linear dynamic systems is the lack of balance which in turn is a catalyst for this system to acquire new properties, new levels of self-organization and generally new qualities. (Haken, 1977) All components in the system interact with each other through the exchange of matter and energy, maintaining the overall balance. A change in the original terms of interaction and even slight changes in the parameters of the operation could lead to a special state, known in the literature as "chaos" or "dynamic chaos".

The main reason for the emergence of dynamic chaos appears envisions an element of instability in any system, direct response to a dis-balancing external or internal influence. [Fig.2]



Fig.2: In any dynamic system due to realization of certain external destabilizing effect occurs state of chaos, and following termination of exposure occurs again necessarily order.

The state of disequilibrium is a prerequisite for the emergence of a new organization, a new kind of order, entirely new systems, which in turn is a vivid sign of development and system evolution. (Haken, 1977)

According to the theory of critical state of geosystems steady self impaired by phases of accelerated or sudden phenomena and processes with risky character. These phases of sudden spontaneous events are different by genesis, mechanism of realization and spatial-temporal amplitude.

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To the group of risky processes with endogenous genesis should be attributed slow oscillatory movements prompting a widespread and continuous changes in the spatial distribution of continental and water surface over thousands, hundreds of thousands and even millions of years, as well as tectonic movements with sudden or risky nature (earthquakes, volcanism). Given the peculiarities of the Rhodope region of interest to study represents only the earthquakes.

4. EARTHQUAKE HAZARD IN THE RHODOPE MOUNTAIN

Over time even the smallest Earth's crust movements may cause sudden release of stored energy toward the Earth's surface. That would exceed the inner strength of lithological foundation and could ultimately lead to the realization of dangerous seismic phenomenon - an earthquake. Earthquakes are one of the most complex geological phenomena that for all of human history caused incalculable misfortunes of mankind. Most destructive earthquakes are sudden release of accumulated potential energy in the form of elastic seismic waves [Fig.3]. Such earthquakes are known in the literature as tectonics.



Fig.3: Earthquakes originate where rocks are strained beyond their elastic limits and rupture. (by Hamblin and Christiansen, 2003)

In terms of seismicity the Rhodope Mountain is part of the Rhodope zone of the Rila-Rhodope seismic area. The Rhodope seismic zone is located between Struma seismic zone to the west and Srednogorie seismic zone to the north within Bulgaria and Xanthi seismic zone to the south in Greek territory. It includes the Rhodopean Mountain Massif as well as the easternmost edge of the Rila Mountain.

The Rhodope seismic area has a complex seismic-tectonic character, conditioned by the presence of numerous active faults that serve as boundaries of mobile crust blocks.

The earthquakes in the region are to VII-VIII degree by MSK-64 intensity scale. It is known Chepelare seismic fireplace with earthquakes of VII degree (1939, 1941). Very actively is the Velingrad earthquake fireplace, where in 1977 realized a strong earthquake measuring 5.3 on the Richter scale and intensity VII-VIII degree by MSK-64 Intensity Scale.

The Rhodope Mountain characterized by a heterogeneous crust with strongly decreasing thickness from the west (45-50 km for the West Rhodopes) to the east (30-35 km for the eastern periphery of the zone) (Dachev, 1988).

Seismic hazard in the Rhodope Mt. is moderate and is characterized by seismically active fault systems along the western edge of the mountain (Kovachevitsa, Chepino, Middle Mesta), with located deeper in the mountain Dospat and Devin active faults, with the most seismically active in the region Varbitsa fault, which marked morphological contact between the western and eastern parts of the massif and localized to the east Ardino and Momchilgrad fault structures. Further small seismic faults represent the boundaries between uplifted local dome structures within the Rhodope Mountain.

The fault surfaces in the eastern part of the research area marked meridional situated boundary between western and eastern parts of the mountain massif. As a whole the Rhodopes are characterized by normal-strike-slipe fault regime or reverse-strike-slipe fault regime, with dominant role of the normal fault regime, with the exception of the region of the town of Kardzhali, where both types of fault mechanism have uniform appearance (Protopopova, Botev, Georgiev, Dimitrov, 2015) [Fig.4].



Fig.4: Main fault structure types associated with the seismicity in the Rhodope Mountain

The seismic picture in the Rhodope Mountain is characterized by a relatively high incidence of earthquakes, but mostly low magnitude (M \leq 3). For example, for the period 1980-2014, the share of micro earthquakes amounted to 97.29%. As for the last 35 years there has been an increase in seismic activity in the Rhodopes [Tsekov, Botev, Borisov 2015]. About 90% of the epicenters of earthquakes in the Rhodope Mountain are located in Bulgaria, while the remaining 10% on the territory of Greece [Fig.5].



Fig.5 Epicenters of earthquakes in the Rhodope Mountain for the past 50 years [Iris Earthquake Browser- <u>http://ds.iris.edu/ds/</u>]

The maximum observed earthquake in the 20th century is the event of 1905 with magnitude M=5.4. There is no information for larger events before 1900 in the Bulgarian territory of this zone, but the strong historical earthquakes of 1829 (magnitudes 7.2 and 6.9) in the Greek territory can be assigned to this zone (Christoskov et al., 1979). These quakes occurred at the southern margin of the Rhodope Mountain and are associated with the activity of the Middle Mesta fault.

5. CONCLUSIONS

The analysis is based on modern morphotectonics detailed picture of the Rhodope Mountain in the light of Plate tectonics with the known literature data on seismic hazard in the region. The results of the study of endogenous risky processes in the Rhodopean Mountain Massif lead to the following conclusions:

✓ The majority of earthquakes in the Rhodopes are concentrated on the periphery of the mountain massif. Exceptions are areas of Velingrad-Batak and Pamporovo-Smolyan and also the Varbitsa River fault lineament, which serves as a seismic-tectonic boundary between the central and eastern parts of the Rhodope Mountain.

 \checkmark The most risky in seismic terms are the southwestern edge of the mountain (near Serres-Drama region in Greece), northwestern edge of the mountain near the town of Velingrad and the region between the towns of Kardzhali, Ardino and Momchilgrad.

✓ Micro earthquakes account for 97% of all cases of seismic events within the mountain massif. Stronger seismic effects are rare, as the most powerful earthquake ever had a magnitude of 7.2 on the Richter scale.

 $\checkmark\,$ All earthquakes in the Rhodopes are shallow, from which it follows that geodynamic risky processes are fully attached to the Earth's crust.

 \checkmark As a whole the Rhodopes are characterized by normal-strike-slipe fault regime or reverse-strike-slipe fault regime, with dominant role of the normal fault regime, which is a testimonial that in the Rhodope region there has a regime of Earth's crust extension.

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Research on the intensity of the implemented policy of sustainable regional development in Bulgaria

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Abstract: This study is focused on establishing a regional model for analyzing the intensity, the result and the monitoring of the conducted policy of sustainable regional development in Bulgaria after its accession to the European Union. By distinguishing the terms for "sustainable development" and "path to sustainable development" interrelationships in regional model are identified, analyzed, classified, grouped and indexed as well as their correlation interdependencies to the previous programming period 2007-2013. An intermodal forecast of the sustainability of regional development in the current programming period 2014 - 2020 is carried out.

Keywords: sustainable regional development; way to sustainable regional development; politics; model; biome;

1. INTRODUCTION

Etymologically the word "region" is derived from the Latin "regre", meaning lead, manage, exercise power. "Regio" covers many meanings region, locality, national territory. Under region mean part of the homogeneous ground surface according to one or more characteristics, from which it is distinguished from the rest of the territory. The great diversity of functional connections testifies before everything for the complexity of regional development. That's why studying the interaction between individual subsystems and components in it requires the use of cybernetic approach and system analysis. Constructively, the region and regional development determine the presence of specific properties set it apart from other systematic formations: dynamism, sustainability, inertia and diversity. Main feature of regional development is its dynamism. It finds expression in continuous modification of parameters and indicators, characterize it as a whole, and its sub-systems and structural elements.^[2]

Actuality of theme

The strategic guidelines, principles and objectives of EU policy are balanced and sustainable development of countries and regions; providing conditions for accelerated economic growth and high employment; reducing interregional and intraregional differences in the degree of economic, social and territorial development that is sustainable regional development. They are enshrined as fundamental objectives and principles in the Law on Regional Development of Bulgaria.

Object of research

National territory of the Republic of Bulgaria – NUTS0.^[4]

Regional system or regional synthesis of economic, social and environmental indicators, covers the national territory of the Republic of Bulgaria and should be seen within the meaning of Art. 1 of the Law on Regional Development of the Republic of Bulgaria in 2015.^[6]

The main goal

Construction of regional model; which analyzes the intensity and the result of policy, of sustainable regional development in Bulgaria after the country's accession to the European Union.

Basic tasks:

- 1. Distinguish the concepts of sustainable development and path to sustainable development.
- 2. Establish, indexing, clustering, analyzing and systematization of the interrelationships in the regional model and their correlation interdependencies for the previous programming period 2007-2013.
- 3. Forecasting Regional Development at the end of the current programming period 2014-2020, through variance approach.

2. USED APPROACHES AND METHODS

The creation of a system of indicators for sustainable development of Bulgaria is the result from joint project of Eurostat and NSI in cooperation with the "Energy Strategy" of the Ministry of Economy and Energy. The system includes 10 themes and 64 indicators, selected and based on the selection of 14 criterions, which are related to public importance, data quality, validity and others. These indicators affect economic, social, environmental and institutional issues connected with sustainable development. The structure of the list of indicators is a two-tier and defines 13 key criterions that meet the key challenges of sustainable development both at national and European level^[3] The article examines 13 key indicators, two of them (3.1. Share of persons at risk of poverty - before all and including social transfers and 7.1. Modernization of transport infrastructure) are expressed separately with each of its component indices (due to their heterogeneous composition it's impossible to present, as a general index in this study) therefore the number of indicators in the survey is 16.

Correlation index is calculated between each pair of variables, forming the regional model of sustainable development (horizontal relationships). Identified degrees of connectivity between pair's phenomena through their arrangement in a matrix. It's calculated Coefficient of determination and Coefficient of uncertainty:

 R^2 – Coefficient of determination;

 K^2 – Coefficient of uncertainty.

Selected contingent indices: Intensity of the policy of sustainable regional development (IPSRD) and Result of the policy of sustainable regional development (RPSRD) express vertical relationships in the regional model. Valued quantitative result of the conducted policy of sustainable development in Bulgaria, determined by the presence (or absence) of a beneficial effect on the index of an indicator a measure of the degree of sustainable development in the country, the end of a programming period (article contains statistics for 2007-2013 and forecast statistics for 2014-2020).

IPSRD the percentage ratio of the amplitude of the manifestation of this indicator and its value at the end of the programming period:

IPSRD = (MAX - MIN) / IEPP * 100

IPSRD - Intensity of the policy of sustainable regional development;

MAX - Maximum manifestation of this indicator;

MIN - Minimum manifestation of this indicator;

IEPP - Value of this indicator at the end of the programming period.

RPSRD represents the percentage difference between row of median numbers and value of the index at the end of the programming period, to the value of the index at the end of the programming period:

RPSRD = (Me - IEPP) / IEPP * 100

RPSRD - Result of the policy of sustainable regional development;

IEPP - Value of this indicator at the end of the programming period.

Forecasting of regional development at the end of the current programming period of 2014-2020 was made in Excel environment. There were an estimated future values of key indicators for sustainable development of Bulgaria; using existing data from the previous programming period 2007-2013, by Exponential Smoothing (ETS) algorithm.^[5] Were constructed three options (realistic, optimistic and pessimistic) of outlook index, of the indicators examined for sustainable development in Bulgaria. The aim is to see the development ("Evolution") of regional system by analyzing and indexing her specific properties and indicators; determining the effect of the policy of sustainable regional development in Bulgaria, on biome.

3. RESULTS AND DISCUSSION

The elements of the regional system interact with each other (horizontal relationships), as well as with other elements of the biome - "Scenery-Society" (vertical relationships) within the territorial range. The main task of the study is to distinguish between the concepts of "sustainable development" and "path to sustainable development".^[1] According to the etymological interpretation of the word "road" - can be viewed from two aspects: trajectory that body travels to reach a particular purpose or distance from one place to another. Sustainable development is a possible optimal state of biomes, characterized by a synergistic effect between structuring elements it. Indivisible and completely stable

synthesis, containing in itself the natural balance of the environment and management functions of the individual, precludes ("deformations" ((development of an aspect of the regional system at the expense of another). That path is a function of sustainable development.

Path is a function of sustainable development. (comparable magnitude, argument value). That in establishing deformities (development of an aspect of the regional system at the expense of another) amend the trajectory of the "evolution" of the region, from the optimum possible state of biomes (At that point); therefore, the path to this synergistic state becomes longer, difficult foreseeable, timing and probability indefinite.

Another main task of this study: ascertainment, indexing, clustering, analyzing and systematization of the interrelationships in the regional model and their correlation relationships for the previous programming period 2007-2013.

Horizontal relationships representing diffusion coefficients in conditional regional model (R² and K²) are calculated based on empirical statistical information on the previous programming period 2007-2013. It is not possible calculation of R2 and K2, by Estimated statistics. Therefore the calculated R2 and K2, are used for the current programming period 2014-2020. In order to satisfactory justification the reasons set out below interpretations on the displayed resource-based and conducted policy within the territorial issue complex; parallel we will see the last of the major tasks - forecasting of regional development at the end of the current programming period of 2014-2020 through variant approach.

Nº	Indicator	2007- 2013	2014- 2020	2014- 2020	2014- 2020
		(A)	(RF - A)	(OF - A)	(PF - A)
1.1.	Growth rate of GDP per capita (%)	102,6	99,8	109	90
2.1.	Municipal waste per capita (kilogram/human/year)	519,0	369,7	465	250
2.6.	Primary energy consumption (thousand t. n.e.)	17918,4	16315,2	17899	14409
3.1.1.	Share of persons at risk of poverty (and before all social transfers included) - Poverty level before social transfers (%)	40,9	47,3	53	42
3.1.2.	Share of persons at risk of poverty (and before all social transfers included) - Poverty level before social transfers including pensions (%)	26,6	26,9	28	25
3.1.3.	Share of persons at risk of poverty (and before all social transfers included) - Level of poverty after social transfers (%)	21,5	21,4	22	20
3.5.	Coefficient of long-term unemployment (%)	5,0	9,0	12	6,1
3.6.	Early left the education and training (%)	13,6	11,0	12	9,3
4.1.	Total fertility rate (Average number of children)	1,5	1,5	2	1,5
4.2.	Coefficient of demographic replacement - total (%)	76,8	62,0	80	44,4
5.1.	Life expectancy at birth by sex (Years)	70,5	71,9	72	71,8

Tab. 1: Actual values of key indicators for sustainable development in Bulgaria.

6.1.	Total greenhouse gas emissions (Millions of tonnes of CO2 equivalent)	50,7	44,4	52	35,5
6.4.	Total final energy consumption from VES (%)	13,6	23,0	25	22,6
7.1.1.	Modernization of transport infrastructure by Type - Share of motorways of the total length of the National Road Network (%)	175,7	179,1	181	177,3
7.1.2.	Modernization of transport infrastructure by Type - Share of electrified railways of the total length of railways (%)	2,4	3,6	4	3,1
8.1.	Population connected to urban wastewater treatment plants for waste water with at least secondary treatment (%)	47,2	64,8	71	62,4

(A - Average; RF - Realistic forecast; OF - Optimistic forecast; PF - Pessimistic forecast.)

In accordance with the main goal set. Construction of regional model analyzing the intensity and outcome of the policy of sustainable regional development in Bulgaria after the country joined the European Union. The above (empirical and predicted) statistical information (Table 1); follows express the socio-economic profile of the regional system (Bulgaria) to the previous 2007-2013 and the current 2014-2020 programming periods. Following the cyclicality of the "evolution" (vertical relationships) System and internal (constant) horizontal relationships is presented (indexed) amplitude probability development of real measures on sustainable development in the country (2007-2020). The plausibility of the data model (Their performance in their respective measure) facilitates understanding of the structure (his horizontal relationships) and supports the process of analysis. Visualization of horizontal and vertical relationships between the selected conventional indexes, measures of the policy of sustainable development in Bulgaria, expressed through the "distortions" in the regional pattern (Figure 1; 2; 3; 4) compiled, analyzed and systematized the effect of the policy of sustainable development in Bulgaria in order to understand the regional system and establish means for sustainable management.

It is presented conditional version of the system - "Plunderer - Prey" expressed in three types of indicators (grouping vertical relationships in the regional model): Steady (a variation of characteristic indices below 10%); Cyclic stable (from 10 to 20%) and Unstable (over 20%). Coefficients R2 and K2 are static; facilitate management of regional system (Expressed likelihood to cause an impact on the regional system). Sustainable development indicators falling in the first case are characterized by progressively fading oscillations inducing effect of equilibrium in the regional system (priority management process). Indicators which measure the sustainable development in Bulgaria fall in the second case and is characterized by a wider oscillation that lead to deviations from a given point, so their effect is less pronounced in time and probability defined (from those in any equilibrium state), that is their priority "use" under current conditions and the requirements of good governance is inappropriate. In the third case regular oscillations (in the conventional model "Plunderer -Prey") of relevant indicators up cyclically fluctuating trajectory of the index from the point of equilibrium (The effect of the indicators come in this case is negative therefore, should not the policy of sustainable development to be held by them). Compared to their horizontal relationships, the indicators are divided into two types: Determined \geq 50% and Undefined < 50%. They have constant values for each of the chronological stages of the "evolution" of the region: Determining total of seven indicators (a degree of definiteness of their impact on regional model: 6.4 .; 5.1 .; 4.2 .; 8.1 .; 3.5 .; 7.1.1 .; 2.1. - Table 1.) Undefined 9 indicators (a degree of definiteness of their impact on regional model: 7.1.2 .; 3.6 .; 2.6 .; 3.1.1 .; 6.1 .; 1.1 .; 4.1 .; 3.1.3 3.1.2 .; . - Table 1).





The results of the study of horizontal and vertical relationships in the regional model of sustainable development of Bulgaria for the previous programming period 2007-2013 are as follows: Steady - 7 indicators; Cyclically stable – 3 and Unstable - 6. Horizontal relationships in the model are constant. It is therefore possible to determine the most cost-effective management solution based on the scope of this study (Key indicators for sustainable development in Bulgaria) - In the retrospective aspect it has a control character to monitor over the effectiveness of the policy of sustainable regional development in Bulgaria for the current programming period. Observe the following order of performance to their vertical (evolutionary) relationships in regional model (in priority): 5.1 .; 7.1.2 .; 3.1.3 .; 3.1.2 .; 3.1.1 .; 2.6 .; 4.1 .; 2.1 .; 1.1 .; 3.6 .; 6.1 .; 8.1 .; 4.2 .; 7.1.1 .; 6.4 .; 3.5. - Table 1.



Fig. 2: Horizontal and vertical interrelationships in the regional model of sustainable development of Bulgaria to the 2014-2020 (Realistic forecast).

The results of the study of horizontal and vertical relationships in the regional model of sustainable development of Bulgaria to this programming period 2014-2020 (RF) are the following: Steady - 10 indicators; Cyclically stable - 2 and Unstable - 4. Horizontal relationships in the model are constant. The most profitable management decisions based on the scope of this study and vertical relationships in the model is the realization of intermodal

realistic forecast to the end of the current programming period 2014-2020 and is characterized by the following order of priority indicators in: 3.1.3 ; 4.2 ; 1.1 ; 5.1 ; 4.1 ; 2.6 ; 6.1 ; 7.1.2 ; 3.1.2 ; 3.1.2 ; 3.1.1 ; 3.6 ; 2.1 ; 8.1 ; 7.1.1 ; 6.4 ; 3.5 - Table 1.



Fig. 3: Horizontal and vertical interrelationships in the regional model of sustainable development of Bulgaria to the 2014-2020 (Pessimistic forecast).

The results of the study of horizontal and vertical relationships in the regional model of sustainable development of Bulgaria for this programming period 2014-2020 (PF) are the following: Steady - 9 indicators; Cyclically stable - 2 and Unstable - 5. Horizontal relationships in the model are constant. The most profitable management decisions based on the scope of this study and vertical relationships in the model is the implementation of intermodal pessimistic forecast at the end of this programming period 2014-2020 is characterized by the following order of priority indicators in: 3.1.3 .; 4.1 .; 3.1.1 .; 5.1 .; 1.1 .; 2.6 .; 7.1.2 .; 3.1.2 .; 6.1 .; 3.6 .; 7.1.1 .; 3.5 .; 8.1 .; 6.4 .; 4.2 .; 2.1. - Table 1.



Fig. 4: Horizontal and vertical interrelationships in the regional model of sustainable development of Bulgaria to the 2014-2020 (Optimistic forecast).

The results of the study of horizontal and vertical interrelationships in the regional model of sustainable development of Bulgaria for the programming period 2014-2020 (OP) are as follows: Steady - 10 indicators; Cyclically stable - 1 Unstable - 5. The horizontal relationships in the model are constant. The most profitable management decisions based on the scope of this study and vertical relationships in the model is the implementation of intermodal optimistic forecast to the end of the current programming period 2014-2020 and is

characterized by the following order of priority indicators in: 3.1.3 .; 1.1 .; 5.1 .; 2.1 .; 6.1 .; 2.6 .; 7.1.2 .; 4.1 .; 3.6 .; 3.1.2 .; 3.1.1 .; 8.1 .; 6.4 .; 7.1.1 .; 4.2 .; 3.5. - Table 1.

4. CONCLUSION

Sustainable development is the possible optimal state of biomes, characterized by a synergistic effect between elements structuring it. Indivisible and completely stable synthesis, containing in itself the natural balance of the environment and management functions of the individual, precludes "deformities". Through the establishment of the trends and the patterns of development ("Evolution") of the region and its internal relationships, it had been traced the degree of effectiveness of ongoing and expected policy of sustainable regional development in Bulgaria, for each indicator in the programming period. The constructed regional model analyzes the intensity and outcome of the policy of sustainable regional development in Bulgaria and is tracking the effect after accession to the European Union. Built in accordance with the theoretical postulates of general scientific methods of analysis and monitoring; incorporating the specific characteristics of the region and regional development (distinguish it from other system formations). Etymological interpretation of the term "Region" ("regre" - lead, manage, exercise power), its meaning in this article - National territory and its results, show that the analysis of the regional system is conditional factor in establishing stability in the biome, and "Good governance" is a resource factor.

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Age of glacial relief as an indicator of the intensity of tectonic movements in southwestern Bulgarian mountains

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Abstract: Contemporary traces of Würm glaciation in Northeastern Pirin and Northeastern and Central Rila proved to be an important benchmark for intensity and character on orogenesis in eastern part on the Balkan Peninsula.

The young age of relict glacial forms in our highest mountains /not older than LGM age, 24-18 ka BP/, and the almost complete absence of traces of ancient glacial landscape, supports the suggestion for the relatively young intensive uplift of Rhodope massif (very strong during the second half of the Pleistocene).

Keywords: Glaciokarst, Würm glaciation, Continental collision

1. INTRODUCTION

Relief of Earth's surface is a result of the ever-lasting interaction (confrontation) between endogenous and exogenous processes. Each of these groups of processes have changed their rates numerous times in history. Traces of former glaciation in mountains, and its expression in present-day relief, can be used as a proxy to prove and assess neotectonic activity.

Glacial landforms, sculpted during Ice ages, overprint the formerly existing erosion and denudation topography, defined by tectonics. Glacial erosion (exaration) can be sometimes so strong that older forms may become virtually indistinguishable. Spatial configuration of particular glacial lanfdorms depends on tectonics, but their expression in landscape is determined most of all by climate. If we assume that former Ice Ages had well expressed global or at least regional character, we could expect they had similar impacts on different mountain ranges within a given geographical region. If glacial traces in a particular area indicate that the Ice Age was not similarly expressed, the observed differences on a relatively small distance can be due to inequalities in the former position of mountains compared to the present day (in context of altitude for example). Such is the hypothesis that our present work is trying to raise.

For each glacial stage of the past, the expression of landforms depends on the *ELA depression* for the respective stage. ELA depression is known as the difference between the average altitude of the highest peaks of a mountain, and the altitude position of the glacial Eqiulibrium line for the particular glacial stage (Ice age). Equilibrium line is the line that separates accumulation zone from the ablation zome of a mountain glacier [24], [25]. Exactly on this line the average annual income of solid precipitation (snow) is equal to annual snow melt. As in mountains equilibrium line corresponds to particular altitude for each glacier, or valley system, it is also known as Equilibrium line altitude (ELA).

The aim of the present study is to argument the relatively fast uplift of Bulgarian highest mountains Rila and Pirin during the late Quaternary, with the expression of ELA depression during the ice ages of the late Quaternary (from until 400 Ka to present).

2. THE MAXIMUM GLACIATION IN BULGARIAN HIGHEST MOUNTAINS

In Bulgaria, relict glacial landforms in their classical appearance, similar to those in the Alps, can be found only in the highest mountains Rila and Pirin [9].



Fig. 1. A model of Wuermian glaciation in Southern Europe. Red circle indicates Rila and Pirin mountains [15]

Glacial landform complexes were subject to numerous studies. The first to describe glacial traces in Bulgaria was Jovan Cvijic [13], whose pioneer work in glacial geomorphology was done in Rila Mountain. He was the first to propose that during the Late Pleistocene (Wuermian) glaciation the ELA should have been at about 2200 m. Cvijic [13,16] tried to search for evidence of older glaciations (morainic deposits in the valley of Iskar river above Samokov), but his views were rejected by most of the scientists who studied glacial landforms in Rila after [5,11,14]. End moraines of the maximum glaciation in Rila were described by [4-7]. Later Kuhlemann et al. [24] made an inventory of terminal moraines throughout Rila Mountain, and sampled some of them for abosolute dating (¹⁰Be method). Obtained ages between 24 and 16 ka BP are in support of the hypothesis for the young age of the maximum glaciation. Glacial landforms in Pirin were discussed in the works [10,26,27] and many others. Some considered traces of only one Ice age (the Wuermian) with three retreat stages, while most [2-6,13,16] think traces exist also from an older (Rissian) glaciation. Amost all of these authors however agree that the forms that now indicate the maximum extent of former glaciers are from the last (Wuermian) ice age.

3. ELA DEPRESSION DURING MAXIMUM GLACIATION IN RILA AND PIRIN

Figure 2 shows Pleistocene glacial cirques in the high part of Rila and Pirin mountains. Along with the configuration of valleys and valley shape, they indicate the position of former equilibrium line at altitudes between 2150 and 2250 m a. s. l. [23,25].



Fig. 2: Cirques and cirque thresholds in Rila and Pirin mountains.

As we know at present the level of the highest peaks in both mountains is at 2600-2700 m a. s. l. (reaching above 2800 m a. s. l. only in few locations), which means that the approximate value of ELA depression for the maximum (Wuermian) glaciation (24-18 ka BP) was 400-600 m. Such a depression allowed glaciers to flow up to 22 km away (Beli Iskar glacier) and form prominent exaration landforms: sharp peaks (fig. 3), deep cirques, U-shaped valleys, et cetera.



Fig. 3. Sinanica peak (2517 m) in Pirin, example of glacial carling, and the glacial lake Sinanishko. Source: [29]

If we have in mind the present level of the equilibrium line, which is about 3150-3200 m a. s. l. [17,18], we can consider that presently it lies 900-1000 m higher than 20 thousand years ago. If precipitation has not changed that is eqial to about 6.5°C drop of annual temperature during the Last ice age according to present (see also [19]). Even today, however, several tiny glaciers and glacierets still survive in the mountains of Southern Europe. Among them, the most southerly located are the two glacierets in the Pirin Mountain of Bulgaria. This comes to demonstrate the fact that in appropriate topographic conditions glaciers can persist even 700-750 m below the equilibrium line altitude, defined by climate.



Fig.4: Location of the southernmost glaciers in Europe (Grunewald and Scheithauer 2010). The last glacier in Sierra Nevada (Spain) disappeared in the first decade of 20th century

4. DISCUSSION: COMPARISSON OF ELA DEPRESSION IN RILA/PIRIN AND THE ALPS

Dating of the end moraines on Maximum glaciation in Rila Mountain [25], proved the assumptions of the young (Wuermian) age of maximum glaciation in Bulgarian mountains, which had previously been proposed by most of the other scientists. At the same time in the Apls, like in those continental parts of Europe and North America, which were subjected to glaciation many times during the Quaternary, the maximum extent of glaciers was registered during the older Rissian/Saalian/Eemian glaciation (352 - 133 ka BP, [1,21,22]). Older absolute maximum of glaciers was reported also for mountains in the Western Balkans [20]. The absence of clear traces of an older glaciation in the mountains of Bulgaria (with exception in some single input forms in cirques and valleys on high part on Rila Mountain) and especially ones situated beyond Wuermian terminal moraines, speaks in favor of the fact that the Rissian glaciation, which was maximal for northern hemisphere, was more modest in our mountains than the last (Wuermian) glaciation. In the context of all discussed above, we can propose the following explanation, for now only a hypothesis: In this earlier period high mountains in SW Bulgaria were much lower than they are now, and hardly reached the altitude of the equilibrium line of glaciers. So then the ELA depression in Rila and Pirin was smaller, the glaciers that formed during that period were also smaller, and the traces they left were almost completely wiped out by the younger and much larger glaciers of the Wuermian stage. On the contrary, in the Alps the opposite picture is observed: traces of Wuermian glaciers are smaller and are incised within the older (Rissian) forms, without reaching beyond.



Fig.5. Relative positions of ELA (Equilibrium line altitude) and ELA depression in the Alps and in Rila/Pirin during Rissian and Wuermian ice ages

Schematically the comparison can be expressed like on fig. 5. As glacial phases are of a global character, the ELA during the Rissian stage was lower than during the Wuermian in all Europe, but, possibly due to the intensive uplift of Rila and Pirin in late Quaternary, the zone above the ELA during the Wuermian occupied greater area of our high mountains than it did during the Rissian.

Such a hypothesis is concordant with some studies of vertical movements of Earth's crust in Bulgaria, which suppose quite high uplift rates for some locations in the south-west part of the country. Kanev [8] considered that at present the rising is about 2 mm/y, in particular in Rila. Rila and Pirin are surrounded by active faults, and development on relief is mainly controlled by positive crustal movements. Later the same author [9] pointed out that in modern times the uplift of Rila has been proceeding with a higher rate – around 4 mm/year, and this determines the high seismic activity of the region.

The proposed intensive uplift of the high mountains of South-west Bulgaria should come as a consequence of the deep transcontinental collision between Europe and the downward moving frontal part of Gondwana (African plate) [12,28].



Fig.6: Morphotectonic position of the Bulgarian microplate ([28]).

It seems that this process, which began with the completion of subduction of Tethys Ocean at the end of Mesozoic and the onset of the Cenozoic, is especially pronounced in the eastern part of the Balkan Peninsula. Nowadays only small fragments remain from the
primary prtoplain that should have existed before the Quaternary. As such should be considered the bottoms of the tectonic depressions that represent present-day kettles, and some piedmont surfaces on mountain slopes [28].

5. CONCLUSION

Field evidence found by now support the hypothesis that during the end of the Wuermian ice age (the episode of the Last Glacial Maximum, 24-16 ka BP) glaciers in the highest mountains of South-west Bulgaria: Rila and Pirin, reached their maximum extent for the Pleistocene. The largest spread of glaciers in the Alps, Central and Northern Europe, is found to have been during the much older Rissian Ice age (320-130 ka BP), and there the Wuermian glaciers had smaller extent. The weaker expression of Rissian glaciation in Bulgarian mountains compared to the Wuermian (as until now no traces have been found to prove the opposite) suggests the fact that these mountains might have had much lower altitude at that time, and subsequently they were sparcely glaciated even the absolute value of ELA was lower compared to the Wuermian. The intensive uplift of the mountains in the late Quaternary made them reach much higher than the snow line (glacier equilibrium line) during the last, Wuermian ice age, and the glaciation then was strongest, even the absolute altitude of the equilibrium line was higher than during the Rissian stage.

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Anthropogenic changes in the Bulgarian part of Vlahina Mountains in recent years

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Abstract: The Bulgarian part of Vlahina Mountains is characterized as sparsely populated underdeveloped border region in socio-economic terms, but meanwhile it has significant untapped natural-resource potential. In this article are discussed the anthropogenic changes in the mountains from 1989 until 2012. The CORINE land cover and land use data are analyzed using Q-GIS software. The results show significant growth in territorial scope of first level CORINE classes artificial surfaces and agricultural areas and decline in forest and seminatural areas.

Keywords: Vlahina Mountains, ecosystem services, anthropogenic influence, land use and land cover, CORINE Land Cover data.

1. INTRODUCTION

Rational use of natural resources with economic benefits for local communities without irreversible deterioration of the environment depends largely on awareness of the importance of ecosystem services and their evaluation. After the "Millennium Ecosystem Assessment" in 2005 is marked a rapid growth of interest in ecosystem services science and policy management [2]. The most of human activities directly affect the environment and lead to land cover and land use changes. The detection of trends in anthropogenic impacts in the Bulgarian part of Vlahina is based on the relationship between the type and intensity of land use and extent of changes in the environment. These changes influence the capacity of the ecosystems and hence goods and services that they provide to people. The process of using ecosystem services from the society must be limited to the extent that it does not violate the sustainable use of natural resources and the normal functioning of human-nature system [4]. To describe the performance and reveal the dynamics and trends of anthropogenic intervention is necessary to make a qualitative and quantitative assessment of ecosystem services. For this purpose land cover changes should be analyzed at first. This can be made on the base of CORINE Land Cover (CLC) and their interpretation in GIS [5]. CLC is an open database which allowing both targeting and comprehensive assessment of ecosystem services [2].

Contemporary changes in land cover worldwide are caused mostly by human activities. These changes can lead to serious environmental problems that affect not only the environment but can endanger the sustainable development of the investigated area. They are usually result of poor management and implementation of inefficient practices in agriculture, urban and forest areas managing. Changes in land cover constitute one of the most important consequences of the growing human influence. In different countries and regions of the world they show divergent trends in different periods. After 1989 in Bulgaria occurred serious political and socio-economic reforms. Some of them are associated with the restructuring of all former cooperative farms that have been transformed into thousands of

new private farms without applying the system to provide the necessary technical and economic support for the appropriate use and management of natural resources. Also these changes are not accompanied by adequate and effective tools to control land use. One of the most frequently cited examples are associated with deforestation and conversion into grassland or cropland. Another example of change in land use is the construction of road infrastructure and expansion of urban areas [2]. There is a growing necessity to study the effects on land cover and land use caused by socio-economic changes. For the last 60 years are developed dozens of classification systems of land use and land cover on national and international levels [6].

2. DATA

To assess the anthropogenic influence and the changes in land use and land cover in the Bulgarian part of Vlahina in recent years are used vector and raster data from CORINE Land Cover 1990 - Bulgaria and CLC 2012 - Bulgaria provided by the Executive Environment Agency [9]. Due to the limited volume of the report and the initial stage of the study only the first and final year data are compared. No sub-periods are divided. The focus of the study is put on the processes of deforestation or afforestation, changes in the degree of urbanization, increase or decrease of farmland and other changes in the territorial scope of the relevant classes of CORINE.

3. TERRITORIAL SCOPE OF THE RESEARCH

Bulgarian part of Vlahina, the subject of this survey, is part of the Osogovo-Belasitsa Mountains range which is in the frame of the Rila-Rhodope morphostructural field [3]. In the north-west Vlahina Mountains touches the Osogovo Mountains which connects via Black Rock saddle (930 m). The border between the both mountains is marked by the valleys of Rechitsa and Eleshnitsa River. Struma River is the northern and eastern border, which separates Vlahina of Razmetanitsa Ridge, part of Konyavska Mountains to the north and Rila Mountains to the east. In the south the border with Maleshevska Mountains, passes along Sushitska River. The two mountains are connected by Sedloto col in the region Momina Fountain. Western scope of the study area is limited by the state border with the FYROM. Vlahina is characterized by a complex structure. The area of the Bulgarian part of Vlahina is 650 km², with an average altitude of 810 m. The mountains length is 54 km and width about 17 km [1]. Delchev Pass divides the mountain in two parts - northern and southern. The southern part is occupied by a slim array of Mount Kadiytsa (Ogreyak) (1924 m), the ridge that is short and clearly arranged with height 1800 m. In north side the height is sharply reduced, the ridge continuously winds, but overall the direction is north-north-west and the height is 1300-1400 m and gradually decreasing in Vlahinski and Frolosh Ridge [3]. Administratively the studied area covered five municipalities - Simitli, Blagoevgrad, Kocherinovo, Boboshevo and Nevestino. Natural and socio-economic potential of Vlahina is poorly examined and such is the situation with the researches on ecosystem services, anthropogenic influence and the changes in land cover.

4. METHODS

The remote methods can be used for analysis and evaluation of ecosystem services through the changes in land cover and land use [7]. These methods provide data about changes in land cover with high geometric and thematic accuracy.

CORINE Land Cover (CLC) - Bulgaria is a project that aims to ensure full compliance of the geographical information on the types of land cover in the country and any changes, which are observed using the unified EU methodology and nomenclature. This project is the first completed database of land cover that overlays the entire territory of the country. It is also the first major digital database at national level that is compatible with CLC – databases, displayed in other European countries [9]. CLC is a management tool for statistics, planning and environmental protection. Information about land use and land cover types and their changes is renewed periodically according the environmental policies both in Bulgaria and in Europe.

For the purpose of this study the main CLC nomenclature consisting of three hierarchically organized levels was undertaken [8], [9]. Although developed CORINE classification in fourth and even fifth level is planned to be used in further investigations. The choice of a three-level hierarchy is dictated because of low resolution of the data from 1990 and the need for comparability. The first level includes five basic categories of land cover: 1) artificial surfaces, 2) agricultural areas, 3) forests and seminatural areas, 4) wetlands and 5) water bodies. The second level consists of 15 classes, considered as subclasses of first level in the scale from 1:500 000 up to 1:1 000 000. The most detailed third level consists of 44 specific classes in scale 1:100 000. The minimum mapping unit in the CORINE database is 25 ha. Additional national datasets are available for 100 m and 250 m network and 1 km grid for the years 1990, 2000, 2006 and 2012 [9].

5. RESULTS

Data from CORINE 1990 and 2012 give us a visual idea through the attached thematic maps (Fig. 1 and Fig. 2) about the spatial distribution and changes in land cover and land use in the research area. For both periods are represented four of the five classes of land cover top-level and third level includes 14 classes in 2012 and 13 in 1990 (Fig. 1, Fig. 2 and Tab. 1). Due to technical reasons there is no class of water bodies in the 1990's classes. The main reason for this is the small proportion of water bodies of the total area. This contributes to the presence of uncertainty when comparing the two periods but it is minimal.

The research area covers a territory of 99 454 ha. In first level the class of artificial surfaces increased from 1298 ha in 1990 to 1561 ha in 2012 or a growth of 20,3% (Tab. 1). The increase here is a fact despite the declining population that is tough to explain. The agricultural areas is the second class of first level also showed significant overall growth of over 25%, from 31 877 ha to 40 061 ha. Nevertheless there is a drastic decrease (about 40%) of non-irrigated arable land (211) and vineyards (221) relating to the classes of agricultural areas from the third level. The reason for this is obviously rooted in socio-economic and demographic crisis associated with the transition in Bulgaria since the beginning of the 90s of last century and the decline of agriculture as one of the main types of economic activity in the area.



Fig. 1: Map of land cover in the Bulgarian part of Vlahina by 1990 CORINE data

Overall the increase in the proportion of agricultural land is the result of the growth of pastures (231) by 150% and the highest growth was observed in land principally occupied by agriculture, with significant areas of natural vegetation (243) that from 18 202 ha in 1990 reached to 28 732 ha in 2012 (Tab. 1). Perhaps this is due to two main reasons. First of abandonment of non-irrigated arable land (211) and passage of large areas in other subclasses - pastures (231) or agricultural land with significant areas of natural vegetation (243), resulting in the emergence of new phytocenosis caused by the decline in agricultural activity in the region in recent more than two decades.



Fig. 2: Map of land cover in the Bulgarian part of Vlahina by 2012 CORINE data

The growth in the territorial scope of land principally occupied by agriculture, with significant areas of natural vegetation (243) exceeds double the reduction in hectares of nonirrigated arable land (211). Parts of the destroyed forests most likely are assigned as farmland with significant areas of natural vegetation. The second reason for the overall increase in the areas of farmland probably is associated with excessive legal and illegal logging. This assumption is confirmed by the overall reduction in the scope of the territories of Class 3 (forests and seminatural areas) from 66 279 ha to 57 546 ha (Tab. 1). An interesting fact is that almost of all subclasses of third level decreased from 3% to 25%. This applies to the transitional woodland shrub (324), broad-leaved forest (311) and mixed forest (313), while only in coniferous forest (312) was observed growth of 8,75%.

Classes	Code	Classes	Area	Area	Change	Change
(1-Level)		(3-Level)	(ha)	(ha)	(ha)	(%)
			1990	2012		
1.Artificial	112	Discontinuous	927	1 138	211	22,8%
surfaces		urban fabric				
	121	Industrial or	371	423	52	14%
		commercial				
		units				
	Total		1 298	1 561	263	20,3%
2.Agricultural	211	Non-irrigated	9 250	5 446	-3 804	-41,12%
areas		arable land				
	221	Vineyards	476	282	-194	-40,76%
	231	Pastures	770	1 930	1 160	150,64%
	242	Complex	3 179	3 671	492	15,48%
		cultivation				
		patterns				
	243	Land principally	18 202	28 732	10 530	57,85%
		occupied by				
		agriculture, with				
		significant areas				
		of natural				
		vegetation				
				10.001	0.404	
	l otal		31 877	40 061	8 184	25,67%
3.Forest and	311	Broad-leaved	22 227	18 714	-3 513	-15,8%
seminatural		forest				
areas	312	Coniferous	7 113	7 736	623	8,75%
	040	forest	44444	40 5 40	0.500	
	313	Mixed forest	14 111	10 548	-3 563	-25,25%
	321	Natural grasslands	11 292	9 493	-1 799	-15,93%
	324	Transitional	11 365	10 957	-408	-3,59%
		woodland-shrub				
	333	Sparsely	171	98	-73	-42,7%
		vegetated areas				
	Total		66 279	57 546	-8 733	-13,18%
4.Water	512	Water bodies		286		
bodies	Total			286		
	Whole		99 454	99 454		

Table 1: Changes in land cover in the Bulgarian part of Vlahina for the period from 1990 to 2012

6. CONCLUSION

After 1989 in the investigated area is observed a change in the basic livelihood of the population and clearly outline decreasing of agricultural activities and enhancing of the logging. There is an important logical inconsistency – both population and agriculture economic activity shrinks, but at the same time the territorial scope of agricultural areas

increases. The growth of agricultural land with 8184 ha roughly corresponds to the decrease in the class of forests that is 8733 ha (Tab. 1). It is difficult to say with certainty whether it was the result of real change or is likely due to the referral of the areas concerned to other classes of land cover without actually exists the type of land use, i.e. possible misinterpretation in the deciphering of the satellite imagery.

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Comperative study of three cases of modern landslide activity in south-west Bulgaria

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Abstract: Detail description of the landslide morphology of three modern landslides in South West Bulgaria has been given. An attempt for classification of the types of landslide deformations, with relation to lithology and existing fault systems is made. Pictures with type of deformation related with the different destruction areas, as well as the main landslide's elements, are presented. During the field researches to collect verbal information, about the starting point and the age of the destructive process, meetings with local inhabitants were made.

Keywords: Landslides, modern tectonics movements, hazards and risks

1. INTRODUCTION

Landslides are important element, of hillslopes evolution and natural factor, for development of modern relief. They represent a serious danger for buildings, roads and other engineering facilities [6]. The object of this research is detail description of landslide morphology of three active landslides in South-West Bulgaria and it's relation with the underlying litolology as well as it connection with existing set of tectonic ruptures to be presented in order a comparative study of the three modern cases of landslide activity to be done. The first landslide is situated near the village of Pelatikovo, Nevestino municipality (1), from North-East to South- East, it has a length around 700-800m and average width, not bigger than 50-100 m. The second one, is situated in lower foot hills of South-West Rila mountain, near Bakar tepe top, 20 km East to South East of Blagoevgrad city and has irregular shape, with maximum length of 400m and average width of 60-70 m (1). The last case of modern landslide activity is the well known composite landslide situated next to Oranovo neighborhood, which is part of Simitli city(1). It is enormous in size and big scale destruction is observed, along a steep hill slope with area of tens of thousand square meters. Length of the landslide is more than 1450 m and has an average width of 600-700m. The destructive processes in first two landslides started in the winter of 2015 during which abnormal amount of rainfall was observed around South-West Bulgaria and reach it's peak in the winter of 2016. The third one is older, with first observations of landslide activity recorded back in the 1950s, of the last century, but recently renewal big scale destruction, maybe connected with the exploitation of Oranovo coal mine is observed.



Fig. 1: Landslides from left to right-Pelatikovo, Bakar tepe and Oranovo

2. GEOLOGYCAL AND TECTONIC SETTING

Pelatikovo landslide is developed in late Oligocene sediment complex, which is build of constant alternation of impermeable layers of Limestone, Mudstone and Sandstone that are covered with permeable thick, massive layer of unconsolidated sandstone. This sediment complex is subject of tectonic stress along interacting faults with NW-SE and NE-SW direction. Of great importance for genesis and evolution of landslide destruction, is one listric fault with NW-SE direction along which the hanging wall is vertically dislocated and rotated. As a result the impermeable beds of the hanging wall are tilt westwards in 40 degree angle. Developing a sliding surface that interacts with the fault surface also tilt in angle of 40-50 degree but in opposite East direction. In this way under the soft and unstable sandstone, a V shape sliding surface of impermeable layers is formed (fig. 2).



Fig. 2: Geology setting of Pelatikovo landslide, Red arrows – strata inclination, blue arrows tectonic movements, Black line fault plain.

Bakar tepe landslide is develop along the boundary, between Maleshevska Gneiss-Migmatite metamorphic rocks formation, which includes Paleoproterozoic Biotite, Biotite-Mica Gneisses and Migmatites and Chetirka amphibolite formation [5], both underlying the recent superficial thick cover of eluvium, colluvium, and diluvium. A normal fault line with NW-SE direction (fig.4), is developed along the boundary line between the fore mention rock formations. This is the reason thick layer of weathered material subject of late landslide destruction to be accumulated at the spot.

Oranovo landslide, is developed in late Neogene terrigenous sediment complex build of consistent alternation of beds of clays sends and conglomerates with different thickness underlying beds of coal deposits subject of active exploitation since 1970 and covered on the top with 5-10 m thick layer of reddish Early Quaternary conglomerates [5]. All underlying sediment strata are tilt Eastwards opposite to the slide direction and slope inclination in angle of 15-20 degrees. An Interacting system of, modern steep faults first one, with N-NW to S-SE and second with E-NE to W-SW direction is presented in the area. Along the first fault lines the fault plain bears marks of shear stress with right lateral movements. The genesis of the small coulee that marks the south boundary of the landslide and plays an important role for slope destabilization process is controlled by the fore mention faults.

3. LANDSLIDE MORPHOLOGY

Pelatikovo landslide (fig.3) is situated next to village of Pelatikovo, Nevestino municipality it has a length of around 750-800 m and width of 50-100 m. as the landslide foot is reaching the very center of Pelatikovo village. The long axe is NW-SE oriented and the short is SW to NE oriented. It is develop along a small coulee which is left tributary of river Grashtica and enclosed an area subject of destruction of 72 ha. The landslide has complex morphology and divers genesis.



Fig. 3: Palatikovo landslide from left to right-landslide toe, foot and track.

Key role for the appearance of destructive forces is playing first; one listric fault (fig. 2) with NW-SE direction along which the hanging wall is not only vertical dislocated but also a back clock rotation is observed and second the alternation of impermeable Oligocene beds of limestone, mudstone and sandstone covered with soft and permeable also Oligocene aged sands. Because of the rotational movements, 40 degree inclination of the strata in the hanging wall towards the fault surface is presented. The fault surface on the other side is also tilt in angle of 40 degree and as a result a V- shape sliding surface along the landside canal is developed (Fig.2). According the types of Morphosculpture elements and the applying destructive forces the landslide can be classify as a typical earth to mud flow and three zones in the landslide morphology, can be distinguished. The source area, which occupy 38% of the landslide area, main track 23% of the area subject of destruction and depositional area with 39%. The surface water has a significant role acting as catalyst of the destructive forces. First, by infiltration along fault plane and along the tilt strata of impermeable Oligocene clays, accelerates the gravity movement and second, as weathering agent helps the decay to clay of underlying sheared rocks, in the landslide body. According numerous eyewitness records, the destructive forces have been active from the winter of 2015. The speed of the landslide, is not equally presented through the time and is highly proportional to the rainfall quantities and soil moisture, therefore active periods and periods with slower speed of mass movements between, are observed in landslide morphology. During filed observations speed of 30 m per hour is detected in the upper part of the depositional area (Fig.3).



Fig.4: Bakar tepe landside

Bakar tepe landslide (fig.4) is a small slump situated 20 km East to South East of Blagoevgrad city in lower foot hills of South-West Rila mountain, near Bakar tepe top. It is smaller than Pelatikovo landslide and posses different morphological features. It has a circus like shape, with long axe, N to S with length of 150 m and the short axe is W to E oriented and 20-30 long and the landslide occupy an area of 5 ha. It is developed in thick and massive deposits of recent superficial cover of eluvium, colluvium, and diluvium, which cover the local differences, in underlying rocks represented by the bordering area of Maleshevska and Chetirska rock formations [5]. The rock formations, in landslide body, are subject of massive tectonic stress, by the two systems of interacted normal faults, presented in the area, the first one is North-East to South- East oriented and second one is North-South. The second one is also the actual border between the underlying rock formations and is crucial for destruction forces in the area because is playing role, first as infiltrating surface along which surface water deeps underground and second as a sliding surface. According the types of Morphosculpture elements and the applying destructive forces the landslide can be classify as a rotational one and three zones in the landslide morphology, are defined. The first one is the Landslide head closed between landslide crown and the landslide track. Vertical moved down, rotational block's, with reverse slopes and temporary small lakes are observed in this area. The second zone is the slide track, where predominantly horizontal displacement of mass occur and the last zone is the depositional area represented by the landslide foot and toe. The first appearance of land destruction, is recorded in the winter of 2015 and reached a peak the same as Pelatikovo landslide during the winter of 2016. Between those two winters more than 50 m of horizontal and up to 5-7 m vertical mass displacement is observed. Because the landslide is developed in, and affecting the superficial cover of weathered materials and the lower boundary is restricted by the metamorphic rocks, it is shallow with average deep of 10 to 15 m.



Fig.5: Listric prism in Oranovo landslide

The biggest and the oldest of three landslides is the one situated next to Oranovo neighborhood of Simitly city (fig.5). It is enormous in size and a big scale destruction is

observed along Natin rid hill. The landslide is developed between the Natin rid divide to the north- and Bukov dol to the south. These boundaries enclosed an area of 680 ha. It has irregular, circus like shape with long axe- 1450m., developed in NE-SW direction and the short one-720m., developed in NW-SE direction. The average slope inclination is between 25-30°[3] as the inclination is bigger in the lower parts of the slope. The landslide posses complex and composite morphology and presumably is more correct to be refer as landslide area rather, than a single hydro generated landslide. It is developed in late Neogene terrigenous sediment complex, which on one side is destabilized by a set of tectonic, interacting in 90 degree faults with NE-SW and N, NW-S, SE direction and on the other side by the continuous exploitation of the coal deposits situated directly beneath the landslide. The sediment beds are tilt to the East, opposite to the direction of destruction processes, therefore it does not have a single water generated origin, with clear slip surface divided two layers with different permeability [6], rather than a gravity movement and disintegration of the hill. Because of that huge listric prism blocks (fig.5), subject of vertical and horizontal movements, as well as back clock rotation and separate by mini grabens are well presented in the slump morphology. The last prism is so big, that a separate rotational, with transitional features to earth flow landslide is developed along its SW slope. The landslide foot and toe of which reach Bukov dol coulee and as a result, a bent across Bukov dol coulee is build. Also, vertical moved down, rotational block's, with reverse slopes and temporary small lakes are observed in this secondary landslide. The first records for destruction activity are from 1950 s, with subsequent active periods in 1992, 1994, 1994 and last active phase started in 2009 and the landslide remain active since [3]. Further more, it is not only active, but the area affected by the landslide destruction is constantly on the rise and migrating East towards the hill slope. Since 2010 a few new landslide scarps are developed, with the big one situated close to the highest point of Natin rid. Probably, the continues and growling landslide activity is a result of the ongoing exploitation of coal deposits underneath Natin Rid Hill.

4. CONCLUSIONS

The landslides, that are object of this enquiry are active and represents an object of scientific interest. It's, elements are newly formed and chronology of the destructive processes, interacting, with inherent geology setting can be defined. The primary reason for the landslide destruction is the complex tectonic setting including crossed normal and listric faults and underlying bedrock strata as well as the mining activity in the last one. Based on the types of Morphosculpture elements and the applying destructive forces the presented landslides can be classified as follow:

- Pelatikovo landslide: Earth flow type
- Bakar tepe landslide: Rotational type
- Oranovo landslide: Composite type

	Palatikovo	Bakar tepe	Oranovo	
Area/ ha	75	5	680	
Deep/m	20	10-15	100-150	
Relative speed	Fast	Slow	Slow	
Geological hazards	High	Small	Very high	
Туре	Earth flow	Rotational	Composite	
	Source are Main track Depositional are	Corregands Correg	e.g. composite, non-circular part rotational/part translational slide grading to earthflow at toe	

Additional research by permanent GPS points are required to determine more precise the landslide's speed. Still open is the question, if the initial destructive events represented a new, active phase of tectonic development in the area.

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Creation of maps compatible with Google maps

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Abstract: Web mapping is a new direction for the compilation and publication of maps and spatial information on the Internet. This report aims to show that the maps and the Internet play a leading role in modern geographical research. The different types of maps on the web, their advantages and disadvantages are described. The mapping service Google Maps, which is free and provides 2D and 3D maps through the internet browser, is considered. The possibility for introducing of own spatial information and its visualization on the map is explored. As a result a thematic map is composed and shared on the Internet.

Keywords: Maps, Internet, Google Maps.

1. INTRODUCTION

The most popular method of posting static bitmap maps on the Internet is already history. Interaction with them is difficult, and the raster geo-referenced image greatly increases the file size. With the help of modern technology the publication of interactive applications created on the basis of vector images was made possible. Their biggest advantage is the option to create your own map to be shared with Internet users, without requiring any special programming knowledge.

One of the easiest ways to create your own maps is through the site Google Maps. Such a map is a route map that contains general geographic information about all the places you want to be included. There are additional options to change the style of the fonts, add text descriptions, pictures, or video.

More interesting, but a bit more complicated is the sharing of thematic maps in an environment of Google Maps and Google Earth, containing attribute data tables for mapping geographical phenomenon or object.

All CAD and GIS software products have the option to output KML files. This is also licensed ArcGIS software at the Department of Geography, Ecology and Environmental Protection (GEEP) at South West University. The aim of this report is to explore the possibilities of sharing KML file that combines several map layers and their import in an environment of Google Maps and Google Earth. At the same time, mapping and analyzing one of the most current problems of modern society is carried out, namely natural disasters.

2. INTERNET CARTOGRAPHY

2.1. Maps on the Internet

In essence Internet maps are all maps that are available through the Internet and the process of creation, dissemination and use of maps and spatial information over the Internet are defined as Internet mapping [1]. The term Web mapping is also used.

There are 3 types of maps on the Web pages.

• Static raster maps are the most common and represent a digital version of the traditional maps saved as a GIF or JPG files.

• Interactive static maps have the option to "click" and move the mouse over the territory, and this allows the appearance of additional information. For example, by increasing the visual scale, appear additional cartographic objects and their names.

• Interactive (multimedia) maps [3] are cartographic models in the digital environment, which contain additional multimedia information for cartographic objects. They are also bearing the name "interactive" because of the possibility of working in interactive mode between the user and the computer during which the active user assigns program commands and receives response.

2.2. Web mapping server and web browser

Servers for interactive web mapping store created maps with different content and purpose. The Web server is a program that runs on the computer (server) where there are websites. It processes requests sent by users via a Web browser or other application. Modern cartographic servers should have all the possibilities for spatial visualization and simple analyzes that have any GIS software.

A Web browser is a software application for visualization and transfer of information on the Internet. When you enter the site name, the web browser detects the server that is hosting the web page to load its contents.

3. GOOGLE MAPS

3.1. General information

Google Maps is a map service of Google Inc., launched in February 2005 by providing 2D and 3D maps through the internet browser. There are satellite images, detailed street maps, panoramic maps (Street View), traffic conditions in real time (Google traffic) and route planning to travel on foot, by car, bike or public transport.

In June 2005 Google launched a new service Google Maps API (Application programming interface) for creating interactive web software applications [5]. The service is free and its main advantage is the ability to share and visualize your own spatial information in your own websites.

Basic programming language to use the Google Maps API is Ajax (Asynchronous JavaScript and XML), which requires knowledge in programming.

The technology for creating and publishing maps on the Internet has both advantages and disadvantages [2].

Advantages:

- Fast, easy and inexpensive way to share maps and digital information;

- Users' choice of cartographic symbol, color and labelling;
- Easy access of users to the shared maps;
- All the changes made during the creation of the map are automatically saved;
- Ability to embed the map in a specific website;
- Ability to download a KML file;
- Ability to print a map.

Disadvantages:

- There is no possibility to use different mapping methods for displaying information. Primarily the choropleth map is used for data visualization;

- There is no possibility to submit more than one attribute for mapping of the phenomenon and application simultaneously on multiple cartographic method;

- Low security, quality and accuracy of information, especially if it comes from an unauthorized source;

These disadvantages limit the ability of Google Maps to compile more complicated maps. For users with programming knowledge some of the shortcomings can be eliminated. This can be done through Google Maps API for writing a software application for creating custom map.

3.2. Keyhole Markup Language (KML) file

Keyhole Markup Language (KML) is eXtensible Markup Language (XML) file format for sharing and visualization of geographic information represented by points, lines, polygons, images and models. It is used in a number of Internet-based 3D browsers such as (Google Earth, ArcGISExplorer, NASA World Wind), 2D (Google Maps, Bing Maps, WikiMapia), and in recent years in various mobile devices.

Originally KML was created for use only in Google Earth and was named Keyhole Earth Viewer, interpreted by web browsers in the same way as Hyper Text Markup Language (HTML) and XML files. KML files similar to HTML have a structure based on tags with names and attributes.

KMZ file is an archived version of a KML file and if it has related documents such as images, 3D models, etc., it contains them too. Google Earth and Google Maps can directly read KML and KMZ files.

KML provides tools for visualization of spatial information on the Internet. However, they are still not good enough in terms of editing and applying different visual characteristics of objects.

3.3. Creating and sharing the KML file

KML enters increasingly into web cartography and finds wide application. There are different ways to create KML files. Usually, GIS and CAD products have such functions and offer a quick and easy way to output KML files. Another way to create KML files is through the use of online converters.

KML files can be shared by e-mail, via VPN (Virtual Private Network), web server or from the local hard disk of the user.

When using Google Maps it is required to upload the files to the public server [6]. Google maps allow us to upload KML files directly from our personal computers, but there is a limit to their maximum size. When this size is exceeded it is necessary to share the KML in Google Drive. When using the geo browser as Google Earth or ArcGIS Explorer, there is no such limitation.

In Google maps the sharing of the the KML file gets along with the sharing of the map. The KML file contains all shp files created in ArcMap. Google maps allow us to determine which users can have access to the map or the right to download the shared KML file. After sharing the URL address of the KML files, they can be seen on the public Web server.

Another way to create a custom map is by using the Google Maps API to write a software application.

4. PUBLICATION OF THEMATIC MAP IN AN ENVIRONMENT OF GOOGLE MAPS

A thematic map is composed in an environment of ArcGIS. The territory of the cartographic study is the world, and the subject of mapping is the countries affected by the floods in 2015. For the drawing of the thematic maps were performed the following cartographic processes:

- entering of general geographic content (layer borders). The data are in geographic coordinate system (source ESRI);

- Introduction of thematic data for floods (source http://www.emdat.be/database);

- Output of a KML file in an environment of ArcGIS Desktop that contains all the necessary data to create a map in Google Maps. ArcGIS Desktop provides us with a quick and easy way to create KML files.

After entering the KML file on Google Maps data are automatically transformed into Normal Mercator projection.

In the environment of Google maps can be made a simple analysis, for example by pointing to a particular country data from the attribute table is being visualized. Also the search by a certain criterion with the subsequent positioning of the found object is possible.

According to the information published in [4] a total of 78 countries were affected. Killed were 3433 people with the the largest number being in India and China. Affected by the floods were 34,529,763 people.

On the map is represented the number of people by country who died as a result of the floods in 2015, categorized into the following groups: from 0 to 8; from 9 to 21; from 23 to 34; from 40 to 133; from 138 to 839;

5. CONCLUSION

Although it does not have all the properties of specialized software for mapping, Google Maps allows us to share spatial information quickly and easily and to create maps that are available for different users, no matter whether using computer, tablet or smartphone. Like all information technologies, Google Maps API is developing and will enable better handling of large datasets. In the future most likely Google Maps will become more and more popular among Internet maps users.

In this report we used tools that Google Maps provides us for sharing the constructed thematic map. In a subsequent stage of the study to improve the cartographic visualization of data will be used the tools of the API for writing software application.

The map of the floods in 2015 in the world can be found on:

https://drive.google.com/open?id=1QsVxlQ_m_ZR4-d6AjdJ5w0xMI8s&usp=sharing

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Results of the implementation of educational tasks in the 10th grade chemistry class

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Abstract: Nowadays the requirements for studens' performance aimed to improve the students' scientific literacy. Educational tasks are especially suitable for teaching at 10th grade Chemistry class. For this aim are created working lists with tasks which required work with text, grafic, tables and images.

For reporting of the efficacy of the implementation of these working lists have been performed outcoming tests, as the data is compared with the results of these students who have been working with the traditional way. The results showed that the students who resolved the educational tasks have better indications for selflearning. The skills for treatment and presentation of the data in different way also lead to increase the level of education, which showed that the implementation of the educational tasks in the Chemistry education helps for students' scientific literacy developing.

Keywords: education in Chemistry, educational tasks, selflearning, scientific literacy.

1. INTRODUCTION

A current problem in teaching Natural Sciences has been a search for ways of promoting students' scientific literacy. It happens because the results from the international research in Bulgaria, TIMSS and PISA, shows that the majority of Bulgarian students "experience great difficulties when interpreting and using scientific data; a great part of them do not do any tasks requiring an interpretation of a text, graphics or diagram; they have difficulties applying their knowledge in a certain situation" [1]. Bulgarian research confirms these results [2, 3, 4, 5, 6, 7, 8, 9].

In the survey for the students' scientific literacy conducted in the Secondary school of Mathematics and Natural sciences "Acad. S.P.Korolyov"- Blagoevgrad, there have been expressed opinions for diversification of the teaching methods as well as for increasing the number of assignments connected with independent learning in class. For this purpose, teaching tools have been prepared, including a set of educational and cognitive tasks for formation of skills for independent learning and scientific literacy [10]. The educational tasks which have been prepared contain elements of an educational text and an assignment [11]. A resemblance between the task and the assignment has been detected. It means that the tendency when working with an educational text is to recognize the elements in the task structure whereas when working with a task is to modify it in such a way so that to resemble a scientific text. Educational tasks of this type develop students' logical thinking and intellect [12].

This paper aims at showing the efficiency of the prepared set of educational tasks for formation of scientific literacy and skills for independent learning.

In this regard worksheets have been prepared on the section of Chemical processes from the educational content of the school subject Chemistry in the 10th grade. Additionally, a

pedagogical experiment has been conducted with the students from two classes and the achieved results have been detected through a post-test. The analysis has been made by comparing the results of students who have worked in a traditional way.

2. PRESENTATION OF THE PROBLEM

The worksheets can be considered as a means of self-education where the teacher's role in this educational process is to be "an organizer and a consultant encouraging the student's self-learning activity" [13]. The teacher has to convince the adolescents that "their chances to succeed depend on their efforts" [14]. It is "an inner but alterable attribution which gives students an opportunity to expect success if they do their best" [14]. At the end of the school class the teacher helps students to discuss the results and to compare the variants. In this way, students get an immediate assessment of their results, which motivates them to put more effort into the assignments [13].

When students use worksheets with educational tasks their passive role in the educational process turns into an active one. Adolescents acquire knowledge on their own and develop skills for self-education and self-development. New competences are achieved by students through educational tasks, their scientific literacy is promoted and their abilities to deal with different life situations are developed.

The results obtained from the worksheets with educational tasks show that high school students can transform data from scheme, write down and work out mathematical equations and write chemical equations according to their description in a text. Some students find it difficult to define an unknown idea through a mathematical formula as well as to determine a unit of measure [15].

When adolescents use worksheets, it can be viewed that they are concentrated until the end of the class. They gain knowledge on their own and say: "We broaden our knowledge. We go home having learned our lessons".

3. RESULTS AND DISCUSSION

This paper presents a comparative analysis of data gathered from a post-test (Appendix 1) so as to assess the results of the students who have worked in the traditional way in class and the results of the students who used worksheets with educational tasks.

The post-test includes multiple-choice questions, open-ended questions, questions in which the answer is given in the question itself and two educational tasks. The two classes have been selected according to their similar average results from Chemistry education.

The analysis of the achieved results from the post-test shows that students from both classes have almost the same average results (Fig. 1). Nevertheless, students who have used worksheets have higher results.



Fig. 1: Results from the post-test of both classes (average % of correct answers)

The results of the answers of separate questions in the post-test are presented in Fig. 2. As it can be seen from Fig. 2, almost 100% of the students from both classes have answered the multiple-choice questions correctly.





Questions 8, 11, 14 and 16 are open-ended questions and required explanation of the chosen answer. It can be seen that the majority of students who have suggested explanation of their choice are the students who used worksheets in their education (Fig. 3).



Fig. 3: Percentage of correct answers to open-ended questions (average % of correct answers).

In questions 7 and 8, the correct answer is given in the question itself. Question 7 has been answered correctly by approximately 45% of the students who have been taught in the traditional way, whereas over 90% of the students who used worksheets in their education have given a correct answer. The percentage of the students who have given a correct answer to question 8 from both classes is almost the same, but only 20% of the students who have been taught in the traditional way have explained their choice.

Questions 12 and 14 are educational tasks. Question 12 requires working with graphics. Students must use them to work out a mathematical problem and then to define a concept. Question 14 has several sub-questions. Students must use a given image so that they can find a solution to the problem. The greater number of students who have answered correctly are those who have used worksheets in their education.

Students who have been taught in the traditional way find it difficult to work with a text, graphics or an image. The percentage of students who have given correct answers of questions connected with this type of skills is lower.

It can be concluded that the educational tasks prepared for this research help to develop students' scientific literacy, their skills for self-education as well as to increase their motivation to learn. Solving such problems, which demonstrate consistency in reasoning so as to achieve the final goal, is a challenge for students and evokes their interest to natural sciences.

4. CONCLUSION

The preparation of the teaching tools, the organization of this research and the achieved results make it possible to conclude the following:

> The results from the post-test show that students who have been taught by means of worksheets achieve skills for independent learning and develop their scientific literacy.

> The chosen teaching tools should be used with students of the same age group, but who attend comprehensive and professional high schools.

> The research presented in this paper can be used as a model for extending the application of educational tasks in different classes and sections in the school subjects, not only in Chemistry but in all natural sciences too.

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APPENDIX 1

1. Finish the definition: The thermochemistry is a branch of chemistry, which

2. Hess's law says that the heat of chemistry reaction, which undergoes in closed system:

a) Depends from the reaction path;

b) Depends from reaction path, but not from the initial and final conditions;

c) Depends only from the initial and final condition of the system, but not from the reaction path.

d) Does not depend neither of the initial and final condition, nor from the reaction path.

3. Given are the reactions:

 $2AI_{(\text{TB})} + 3/2O_{2(r)} \rightarrow AI_2O_{3(\text{TB})} + Q_1$

 $2Cr_{(TB)} + 3/2O_{2(\Gamma)} \rightarrow Cr_2O_{3(TB)} + Q_2.$

How will you calculate the heat effect of the reaction.

 $2AI_{\scriptscriptstyle (\mathsf{TB})} + Cr_2O_{3\scriptscriptstyle (\mathsf{TB})} \rightarrow AI_2O_{3\scriptscriptstyle (\mathsf{TB})} + 2Cr_{\scriptscriptstyle (\mathsf{TB})} + Q_x$

a) $Q_x = Q_1 + Q_2$; b) $Q_x = Q_1 - Q_2$; c) $Q_x = 2Q_1 + Q_2$; d) $Q_x = Q_1 + 2Q_2$?

4. Given is the chemical reaction: $3CO_{(r)} + Fe_2O_{3(TB)} = 2Fe_{(TB)} + 3CO_{2(r)} + Q$. Mark by a letter how the heat of reaction can be calculated.

5. If a process is endothermic, that means:

a) the process is very slow; c) heat is absorbed during the formation of chemical bonds

b) the process absorbs heat; d) the products have higher energy that the starting products.

6. The calorific value of substance is calculated for unit of mass of heat:

a) of formation; b) of combustion; c) of melting; d) dissipated into the surroundings.

7. The heat effect of reaction is also a heat of formation, when simple compounds react and 1 mol of product is formed. In which of the given thermochemical equations the heat of formation is marked:

a) $N_{2(r)} + O_{2(r)} \rightarrow 2NO_{(r)} - 180, 8 \text{ kJ; c}$ $1/2N_{2(r)} + 1/2O_{2(r)} \rightarrow NO_{(r)} - 90, 4 \text{ kJ/ mol;}$

b)
$$2CO_{(r)} + O_{2(r)} \rightarrow 2CO_{2(r)} + 566 \text{ kJ; d}) CH_{4(r)} + 2O_{2(r)} \rightarrow CO_{2(r)} + 2H_2O_{(r)} + 890 \text{ kJ/ mol.}$$

8. The heat effect is also a heat of combustion, when 1 mol of compound is burned in oxygen environment and a higher oxide is formed. Which of the heat effects of the reactions are heats of combustion of the products:

a) $S_{(TB)} + O_{2(r)} = SO_{2(r)} + Q_1$; b) $CH_{4(r)} + 2O_{2(r)} = CO_{2(r)} + 2H_2O_{(r)} + Q_2$; c) $4P_{(TB)} + 3O_{2(r)} = 2P_2O_{3(T)} + Q_3$.

Motivate your answer.

9. The nitroglycerin is three nitro derivative of the glycerol and can be expressed by the formula: $C_3H_5(ONO_2)_3$. At normal temperature the nitroglycerin is unstable liquid, which decomposes with an explosion into carbon dioxide, water, nitrogen and oxygen:

 $4C_{3}H_{5}(ONO_{2})_{3} \rightarrow 12 \text{ CO}_{2} + 10 \text{ H}_{2}\text{O} + 6 \text{ N}_{2} + \text{O}_{2} + 800 \text{ kJ}$

Help Ivan to calculate the heat of reaction of decomposition of 1 mol nitroglecerin. What type is the reaction – exothermic or endothermic.

10. The branch of chemistry which study the rate and mechanism of chemical reactions is called:

a) Thermochemistry; b) electrochemistry; c) chemical kinetics; d) chemical equilibrium.

11. The kinetic equation of the process $2H_{2(r)} + O_{2(r)} \rightarrow 2H_2O_{(r)}$ is:

a) $V = k.c^{2}(H_{2}O)$; b) $V = k.c^{2}(H_{2}).c(O_{2})$; c) $V = k.c(H_{2})$; d) V = k.

Motivate your answer.

12. On the graph is shown the rate of change of the concentrations of the reagents and the products of the reaction with respect to time.



a) Write down the average rate (velocity) in both cases, having in mind that rate (velocity) is positive quantity, because time goes only in one direction.

b) Define the unit of the rate.

c) Determine which graph is related to the products and which to the reagents.

13. How the rate of the reaction is changing: $N_{2(r)} + 3H_{2(r)} \rightarrow 2NH_{3(r)} + Q$ if:

a) the concentration of N₂ increase 3 times.

b) the concentration of H_2 decrease 3 times.

c)the pressure of the entire system increase 3 times.

14. Three identical plates of zinc, copper and calcium are put in excess of hydrochloric acid:

A) By using the chemical activity of the metals, determine in which vial, which metal is put. a) b) c)



B) Propose a metal which is going to dissolve with higher rate than the zinc, calcium and copper.

Motivate your answer.

15. Catalysts are compound which are changing:

a) the direction of the chemical processes;

b) the position of the chemical equilibrium;

c) the rate of the chemical reactions, without participating in the reaction;

c) the rate of the chemical reactions, without changing their structure at the end of the reaction.

16. Students perform the following experiment: in four vials they put 5 cm³ hydrochloric acids with concentration 4 mol/1 and add 0, 5 g iron with different form. In which vial there will be the most intensive release of gas:

a) granular iron; b) iron plate; c) iron dust; d)iron cube.

Motivate your answer.

17. Connect with an arrow the most suitable catalyst for the process:

$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$	Ni
$H_2C=CH_2 + H_2O \rightarrow CH_3CH_2OH$	H_2SO_4

Enzymes

18. Reversible are the process which proceeds:

a) only in reverse direction; b) only in the forward direction;

c) in the presence of catalyst; d) in both ways depending from the conditions.

19. The forward reaction of the equilibrium process $2NO_2 \leftarrow 2NO + Q$ will proceed, if:

a) the concentration of the oxygen increases; c) the pressure increases;

b) the concentration of the NO₂ increases; d) the temperature increases.

20. When the concentration of one of the compounds in the equilibrium system change:

a) no changes occur in the system;

b) new equilibrium concentrations are established;

c) the equilibrium concentrations do not change;

d) new equilibrium with a new equilibrium constant is established.

21. When the concentration of one of the products in the system increases:

a) no changes occur in the system;

b) the concentration of the products decrease;

c) the concentration of the reagents decrease;

d) the concentration of the reagents also increase.

22. Write down the equation for the equilibrium constant κ_c for the process:

 $2NO_{(r)} + O_{2(r)} \stackrel{\longrightarrow}{\leftarrow} 2NO_{2(r)} + Q.$

23. In which of the equilibrium system the decrease of the pressure leads to increase of the quantity of the products:

a) $C_{(TB)} + CO_{2(r)} \stackrel{\longrightarrow}{\leftarrow} 2CO_{(r)}; b) 2SO_{2(r)} + O_{2(r)} \stackrel{\longrightarrow}{\leftarrow} 2SO_{3(r)};$

c) $NH_{3(r)} + HCl_{(r)} \stackrel{\longrightarrow}{\leftarrow} NH_4Cl_{(TB)}; d) Ca(OH)_{2(TB)} + CO_{2(r)} \stackrel{\longrightarrow}{\leftarrow} CaCO_{3(TB)} + H_2O_{(T)}?$

Practical applications of information and computer technology in the teaching process of mathematics

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Abstract: The use of information and computer technology (ICT) in Bulgarian schools is known for a fact. To this moment the question of "For or Against" their application has been answered, and they have been deemed a necessary tool in education. The questions of "When" and "How" they can be best applied await their answer next. Current study aims to find out, on the one hand, the frequency of use of ICT in teaching mathematics and the form it's been used under, and on the other hand to provide blueprints for their exact application. Aggregated data from student surveys shows that mathematics is one of the school subjects least prone to innovative methods of teaching. Reasons for that have been carefully singled out and analysed. MATEK - an equation solving software, has been precisely described. Multiple examples of when and how it can be utilized in the mathematics teaching process have been demonstrated. Pros and cons of its application have been assessed. Bottom-line is that ICT has its place in the teaching process in mathematics, and can therefore be used as a tool for carrying out of all fundamental educational activities. **Keywords:** MATEK, mathematics, equations

1. INTRODUCTION

The use of information and computer technologies (ICT) in the Bulgarian school is a fact. The strategy for effective application of ICT in the education and science of the Republic of Bulgaria (2014-2020) [1] raises the problem of finding the way to effective use of ICT in the process of study. An answer should be found to the questions "When?" and "How?" they will be applied in the educational process. The problem of the ICT introduction in the process of study and their effective use basically refers to the classes in Mathematics since it is one of the most conservative disciplines. Therefore this article is aimed at establishing the following things: how often and in what way are ICT used in the classes of Mathematics; to look for the reasons for the low application of technologies in education; to give an answer to the questions "When?" and "How?" can ICT be applied in the learning process by giving concrete examples of their application.

2. USE OF ICT IN THE PROCESS OF STUDY – ANALYSIS OF DATA FROM A SURVEY AMONG STUDENTS

For the aims of the research a survey of 569 students (10 and 11 graders) from 5 schools of three Bulgarian towns is carried out. In these schools Mathematics is not a profile subject and is studied in 3 classes per week for the 10th grade and 2 classes per week for the 11th grade.

On Figure 1 we can see the results from the answer to the question related to the frequency of IT use in classes of different subjects.



Fig. 1: Frequency of computer technologies use in the different classes

The data from the diagram show that in the schools that have been surveyed ICT are not used regularly in the process of study. About 50% of the students say that they have never used ICT in their classes in neither of the subjects learnt at school. It should be mentioned that new technologies are used only in the foreign language classes, and they are very little used in classes of Mathematics, Physics, Astronomy and Philosophy. It is clear that only timid attempts are made by some teachers to install innovative approaches in the teaching process.

Another question whose answer is looked for in the survey is: how are the classes of information and computer technologies organized. Fig. 2 shows the data from the students' answers.



Fig. 2: Types of use of the computer technologies in education

The data show that educational computer games, specialized software and simulations are not used in the process of teaching. We understand that technologies are rather used for watching films and presentations. All these makes us think that in most cases the teachers alter the teaching means of expression but not the core of the approach – it remains one and

the same. They are not successful to effectively install information and computer technologies in their methodical work and cannot create an interactive educational environment.

3. REASONS FOR THE INEFFECTIVE APPLICATION OF ICT IN CLASSES OF MATHEMATICS AND MEASURES TO INCREASE THEIR EFFECTIVE USE

ICT are not used in classes of Mathematics because of several reasons:

- It is difficult for the teachers to find the place and role of ICT in the teaching process;

- The contents and tasks in the present students' books are difficult to adapt to an interactive educational environment;

- The teachers are not trained to use innovative teaching methods;

- Not all teachers are convinced that ICT effectively support the teaching process in Mathematics;

- There are no electronic teaching materials and resources in Mathematics especially for high school teaching;

- There are still schools that have no computers and multimedia in the rooms and there is no Internet access.

The reasons so described outline the necessary measures that have to be taken not only for the ICT use in the classes of Mathematics but also for their effective application:

- According to Tonova [2]: "For an adequate use of technologies for the purposes of Mathematical education it is necessary to develop a new teaching methodology through tasks of new contents and structure."

- Teachers should enhance their professional competency through visiting qualification courses.

- The educational programmes at universities should be adapted to the contemporary tendencies. It is necessary that students from "Pedagogy of Mathematical Teaching" and "Pedagogy of teaching Mathematics and …" subjects be trained on how to use innovative methods.

- According to Chehlarova [3]: "Teachers should be ensured with updated information on available software for teaching Mathematics, on the advantages and disadvantages, on the difficulties in their use."

- It is necessary that, on the one hand, electronic resources for teaching Mathematics be created and, on the other hand, they should be popularized.

- It is necessary that teachers share their good practices so that they can be followed by other teachers.

- It is necessary that all rooms in every school be equipped with computers and multimedia and Internet access should be ensured.

The measures mentioned are necessary conditions to increase the frequency and effectiveness of ICT use in the process of teaching Mathematics. We will look at an example for actions that can be taken for the realization of some of them, namely: we will describe a concrete educational software for teaching Mathematics - Matek; we will give some ideas on how and when it can be used in the process of teaching Mathematics; we will point the advantages and disadvantages of its application.

4. MATEK

Matek – snap, solve, learn mathematics or snap, solve, learn Mathematics – this is the motto of a software for solving linear equations, quadratic equations and some equations of a higher power and irrational equations. The software makes it possible for the solutions of the equations to be presented analytically and graphically. On the one side it generates in detail the steps of the solution and on the other side it provides information necessary for the

solution or gives links to certain educational sites where teaching materials or video lessons can be received.

4.1. Matek Interface

The Matek Interface is pleasant, practical and easy to use (Fig. 3).



Fig. 3: Matek

The design of the icons suggests the functions they implement. When you point at an object on the screen a message is displayed (in English) with its description.

4.2. Introduction of equations

The introduction of equations can be implemented in several ways:

• Through the mouse. The system recognizes hand-written and printed symbols that can be written: by pressing the right button of the mouse and movement at the same time (Fig. 4) or by the keyboard of the programme (Fig. 5). The symbols that the system maintains are:

- all figures (0, 1, 2, ..., 9);
- small Latin letters: x, y, a, b, c;
- the signs: +, -, *, /, =, (,), ., $\sqrt{}$



• the programme is constructed for computers and mobile devices with a touch screen, therefore it is possible to write with a pen as well as with your fingers directly on the screen of the device (Fig. 6);

• through a web camcorder (Fig. 7). This is the possibility that impresses a lot and makes the work easier. The equation is taken photo of (by pressing the icon with the camera logo a camcorder is activated through which the equation is focused and taken photo of), the programme recognizes the symbols and generates the solution of the task step by step.



Fig. 6: Writing with a pen



Fig. 7: Taking photo of an equation

After the equation is entered, by either methods, the icon for symbol recognition is pressed. If a symbol is entered unknown for the system, the software signals an error, explains the type of error and offers ways for its elimination.

4.3. Solving equations

The analytical solving of equations starts with pressing the icon that resembles a luminous lamp (Fig. 8).



Fig. 8 Choice of a function to solve the equation

The software has several functions for solving equations from which the user should choose:

Forwarding to an outer mathematical software: Cymath or Wolfram. This option provides access to programmes that can solve problems which Matek cannot deal with;

- Display of all steps (Fig. 9). The programme provides an entire solution by showing all stages. After each step there is an explanation of the implemented actions and possibility to receive additional information: examples, rules and formulae, generated by the system or links to electronic materials, video lessons and education platforms like Khan Academy;

- Step by step solution. Each stage of the solution is displayed by pressing the Next step button, and there are explanations and access to additional information;

- The graphical solution of equations starts with pressing the icon denoting a graphic (Fig. 6). After that the programme draws the graphic (Fig.9).



Fig. 9: Graphical solution of an equation

5. METHODICAL NOTES

"It can be the worst nightmare of every teacher in Mathematics." – this is a quotation from an article in an English electronic newspaper [4], referring to the mobile application PhotoMath. PhotoMath is an application for solving equations, analogous to Matek. There is a wide variety of software for solving Mathematical tasks based on the principle: I take a picture and the programme solves the problem or I enter the task and the computer solves it. The words from the article can refer to all software products that solve students' tasks. The ICT can in some cases be really a nightmare for the teachers. These are the cases in which the students do not use the advantages of the new technologies in the right direction but in a wrong and degrading one - cheating, plagiarism, etc. All these could lead to students' poor knowledge and skills; to hindering the process of forming skills and habits for an active cognitive activity; to frustrating the development of the abilities to think – critical attitude, flexibility, thinking breadth and quickness; to violation of moral principles. The fears of the teachers are related to the problems so outlined and these are just fears, but we cannot and should not stop the development of technologies, nor can we stop the use of computers and Internet by the students. A fast and adequate solution should be found. It is very often the case that the solution to a given problem is hidden in the problem itself. It is the same in this case: the solution is to find the right way to use the ICT in an effective way. Thus, for example, Matek and the other alternative programmes can be used in a beneficial way during the teaching process. The solving of tasks step by step by the Matek software can be a very useful means of teaching in schools as well as at home. It should be noted that when applied in class a computer has to be ensured as well as multimedia and Internet (necessary for work with electronic resources outer for the programme. The teacher has leader functions - he / she is to define the place and role of ICT in the teaching process.

6. EXAMPLES OF MATEK APPLICATION IN THE TEACHING PROCESS IN MATHEMATICS:

• In class it can be applied for checking homework. The classes in Mathematics in high schools are quite few, and the new material is a lot, therefore teachers neglect homework checking in order to save time. This problem can partly be solved by ICT application. Let us take an example with the 8th grade – this is the grade when quadratic equations are introduced. It is very convenient and economical if at the beginning of the class the students' homework is checked by Matek: the teacher takes a picture of the task from the students'

book or the book of Mathematical problems and the solution is displayed on the presentation screen step by step. Thus, on the one hand, some time is saved (it is not necessary to waste time to write the solution) and on the other hand you can focus on the things that students find difficult.

• The programme can also be used in the classes for practice. Very often the following situation is observed in the classes for practicing new knowledge and skills: a student or a teacher solves a task on the blackboard, one part of the students copy the solution and a very small part of students work on their own. Conducted in this way, the class is not useful for most students, it is necessary to find an approach for their involvement. The following situation is also possible: all students work on their own in their notebooks or are divided into groups (each group should have successful and not so successful students) to work together on the solution of a given task. At that time the teacher has the opportunity to help those who have difficulties or work faster. Thus conditions are ensured for an active creative process. In the process of work the teacher shows on a presentation screen the different stages of the tasks solution with the help of Matek. This allows students to follow the right solution of the tasks, to find the errors they have made (if there are errors) and to get detailed information related to the solution. It turns out that very often students do not ask questions for things they do not understand because they feel shy and ashamed. The teachers on the one hand leave out the explanation of certain parts because they consider them to be clear and on the other hand the graphical and written information which the teacher can offer with the help of the marker (crayon), is extremely economical. When solving equations these problems can be eliminated by Matek – the information is given in small portions and is accompanied by explanations, formulae and rules (Fig.9). With the possibility that ICT provide in Mathematical practice classes, that has been described in this way, the following can be achieved: realization of individual approach with students, activation of the cognitive activity and formation of skills for self-education and work with computer programmes for teaching.

• Matek can solve the equations graphically. This function can successfully be used in classes. In the process of solving equations through the graphical method the students find out that it is very inaccurate. In most cases the teachers explain that the graphical method is a powerful method for solving algebraic problems because in many cases it gives an approximate solution of equations and inequalities whose analytical solution is difficult or impossible. It is made clear that the solutions are approximate values which depend on the concept and the value itself. It is mentioned that this problem is solved with the help of a computer but do not demonstrate its strength. It could be of great interest for the students if the solution of the problems is presented through a relevant software like Matek. For this purpose the following is relevant to be done: an equation has to be solved graphically (the equation is chosen in such a way that its roots are not whole numbers), and the students are encouraged to be as exact as possible when drawing so as to get true answers. After that the results are compared and it can be stated that their values have close quantities. Thus, quite naturally arises the necessity to find a way to define the correct answer. This is the moment when the teacher can explain the reasons for the different results and to present the solution through Matek or another software. With its help the analytical as well as graphical solution of equations of a different type can be discussed very quickly and easily. Moreover, in this way the two methods can be compared. The method so described contributes on the one hand to motivate skills for using drawing tools and on the other hand to form a stable interest for Mathematics.

• The Matek software can be used in lessons when new material is taught as a means to update old knowledge and skills that are going to be used in its presentation. For example in the 9th grade this can happen when Viet's formulae are introduced. It is possible to use the following method: the teacher divides the class in three groups and each group is given the task to find the sum and the product of the roots of the quadratic equation. The equation has to be different for each group and also such equations should be included that have a positive and a negative discriminant, which equals nought. By this not only updating is

achieved of old knowledge but also preparation for new knowledge– when D≥0 the sum and product can be found of the roots of the quadratic equation, and when D < 0 the latter cannot be found. It is good if Matek is used for checking the solution of the given task by the use of the programme, on the one hand, some time is saved for finding the roots of the three equations which is not the purpose of the lesson, and on the other hand a focus is put on the conditions for existence of a solution of a quadratic equation. After that the students are challenged: to give an example of a quadratic equation, and the teacher has to find the sum and the product of the roots in his / her mind, and it is made clear that he / she is allowed to find only the discriminant by making calculations. Again Matek is used: through the option display of the solution step by step the possibility is ensured to find the discriminant quickly and exactly. The students are quite enthusiastic about this task and give examples of guadratic equations with factors fractional and irrational numbers with the aim to make the task as hard as possible for the teacher. After an answer is given to the task the solution is again checked with the help of the computer. There is an incredible euphoria among the students when the teacher has successfully dealt with the problem and they start asking themselves how he / she has solved the problem successfully and what techniques he / she has applied. This is the moment when the teacher can announce that he / she uses Viet's theorem and after that the teacher can state and prove it. With the approach, so described, for ICT use as a means to introduce new knowledge an update of old knowledge and skills as well as high motivation is achieved.

• The task to work out a quadratic equation with given roots is based on Viet's theorem. A bigger part of the students can cope with such type of task comparatively well but there are also such students who make mistakes in the transformations and arithmetical actions and so they cannot work out the equation correctly. In this case it is a good idea to check whether the quadratic equation they have worked out has the given roots. This can be found very quickly and precisely through Matek.

• Matek can be used not only in classes of Mathematics but also in classes of physics. In classes of physics problems are solved that are reduced to solving equations. Emphasis is put on what principles and laws should be applied in order to work out an equation or on the grounds to work out a mathematical model and not on its solving. The software can be useful every time the tasks are reduced to solving an equation and the activities for its solving is not purpose of the lesson.

• The software is a perfect means for self-preparation.

With the so described examples the basic principles in pedagogy can be followed, according to which: "It is not enough for teachers to know the contents included in the educational programmes well. They should also have a repertoire of pedagogical situations in which the students could use the concept they construct. Moreover, these situations should be created in such a way as to provoke students' spontaneous interest [5]".

7. ADVANTAGES AND DISADVANTAGES OF THE USE OF MATEK IN THE TEACHING PROCESS

The interface is easy and accessible, therefore, it can be used by users of all ages. The introduction of symbols and equations was implemented in several ways: mouse, pen, fingers and web camcorder. It can be applied in school as well as at home. The programme is a very useful means for studying because it can show the solution explained step by step or forwards to other electronic sources for more information. Matek is a software which boosts the relations among the different subjects and among the different disciplines. It is an innovative STEM application for solving equations. STEM is an acronym formed by the first letters of the English words science (science), technology (technologies), engineering (engineering) µ mathematics (mathematics) and is a concept for integrated teaching. It
provokes interest and forms skills for self-education through computer teaching programmes. With its use time can be saved.

The disadvantages include: The working language is only English. The introduction of equations by a web camcorder is the possibility which impresses a lot and makes the work easier but it is not always so effective. Sometimes depending on the text it is difficult to focus the equation. The system maintains very few symbols. Matek can be used for cheating.

8. CONCLUSION

The conclusion that can be drawn is that ICT have their place in the teaching process in Mathematics and can be used as a means for implementation of basic activities in class, namely: when preparing the inner conditions for new knowledge and skills; introduction of new concepts; supporting and extending old knowledge and skills; checking of knowledge and skills. Their effective use depends on the pedagogical mastership of teachers and on the desire and skill to improve lesson organization.

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