NICOLAE POPOVICI
(1938-2009)
Profesor universitar doctor inginer hidrotehnist

Remarcabil cadru didactic şi cercetător ştiinţific, prof.univ.dr.ing. Nicolae Crăciun Popovici şi-a închinat întreaga viaţă pregătirii multor generaţii de studenţi în domeniul Hidrotehnicii.

S-a născut la 4 decembrie 1938, în localitatea Orăştie, judeţul Hunedoara. A urmat şcoala primară în localitatea natală şi liceul la Alba Iulia. În iunie 1964 a absolvit cu notă maximă Facultatea de Hidrotehnică din cadrul Institutului Politehnic din Iaşi, secţia Îmbunătăţiri Funciare. Imediat a fost numit şef de laborator la Facultatea de Hidrotehnică. Din anul 1965 a parcurs toate treptele ierarhiei didactice universitare, prin concurs: asistent (1965), şef de lucrări (1969), conferenţiar (1990), profesor universitar (1991). În 1980 a obţinut, la Institutul Politehnic „Gh. Asachi" din Iaşi, titlul de doctor inginer în specialitatea Îmbunătăţiri Funciare, cu teza *Cercetări asupra amenajărilor antierozionale în zona Sturza-Vrancea,* având conducător ştiinţific pe prof.dr.doc. Chiril Popescu. Din anul 1990 a fost conducător ştiinţific pentru doctorat în specialitatea Îmbunătăţiri Funciare (domeniul Inginerie civilă).

Între anii 1999-2005 a fost profesor asociat al Facultăţii de Hidroamelioraţii şi Cadastru din Chişinău, Republica Moldova.

În îndelungata sa activitate didactică, de aproape 45 de ani, a predat cursuri de: *Combaterea eroziunii solului şi a proceselor asociate*, *Regularizări de râuri şi gospodărirea apelor*, *Stabilizarea versanţilor,* *Protecţia şi conservarea solului*, *Amenajarea complexă a bazinelor hidrografice,* *Sisteme Informaţionale Geografice*, *Apărare împotriva inundaţiilor şi G.I.S.*, la specializările Îmbunătăţiri Funciare, Ingineria Mediului şi Cadastru. Prelegerile sale se distingeau prin claritate şi ţinută ştiinţifică. Paralel cu activitatea de predare a cursurilor a condus lucrări practice, proiecte de an, a îndrumat proiecte de diplomă şi masterat ale studenţilor şi inginerilor de la Facultatea de Hidrotehnică, a antrenat şi iniţiat studenţii în activitatea de cercetare ştiinţifică. Pentru a veni în sprijinul procesului de învăţământ a editat la Universitatea Tehnică „Gh. Asachi" din Iaşi cinci cursuri universitare (unic autor) şi patru îndrumătoare de lucrări şi proiectare pentru studenţi.

Activitatea ştiinţifică a prof.dr.ing. Nicolae Crăciun Popovici s-a concretizat în publicarea a peste 180 de lucrări ştiinţifice, atât în ţară, cât şi în străinătate, publicate în reviste de specialitate, în volume a unor conferinţe sau simpozioane naţionale şi internaţionale.

Domeniile şi direcţiile de cercetare ştiinţifică au fost: eficienţa tehnică în timp a unor amenajări complexe antierozionale şi a regularizării cursurilor de apă cu îmbunătăţirea concepţiei de proiectare în acest domeniu; stabilizarea şi valorificarea terenurilor agricole afectate de alunecări; dinamica proceselor de colmatare a acumulărilor colinare; conceperea de noi tipuri de lucrări hidrotehnice pentru amenajarea versanţilor; implementarea Sistemelor Informaţionale Geografice în monitoringul proceselor de degradare a terenurilor prin eroziuni, alunecări şi inundaţii. A fost coautor la editarea a şapte cărţi de specialitate, dintre care menţionăm: *Beton structural pentru acumulări* (Ed. Gh. Asachi, Iaşi, 2000), *Sisteme geoinformaţionale* (Ed. Gh. Asachi, Iaşi, 2000), *Stabilizarea şi valorificarea terenurilor agricole alunecătoare* (Ed. Gh. Asachi, Iaşi, 2003).

A deţinut patru brevete de invenţie şi un certificat de inovator privind noi tipuri de elemente şi structuri constructive pentru lucrările hidrotehnice folosite în amenajarea torenţilor.

Între anii 1990-1992 a fost şef de catedră. Ca o recunoaştere a bogatei sale activităţi ştiinţifice a fost ales membru în Consiliul Tehnico-Economic al fostului Departament de Îmbunătăţiri Funciare din Ministerul Agriculturii (1991-1994); membru în colectivul de specialişti din Ministerul Agriculturii şi Alimentaţiei pentru elaborarea proiectului *Lege a terenurilor degradate* (1997), membru în Comisia Judeţului Iaşi de Apărare împotriva dezastrelor, secţia Efecte seismice şi alunecări de teren, din anul 1998; membru în comisia de organizare a Simpozionului ştiinţific internaţional de Sisteme Informaţionale Geografice, ediţia a X-a, anul 2002, la Academia de Ştiinţe a Republicii Moldova, Chişinău; organizator al Simpozionului ştiinţific internaţional de Sisteme Informaţionale Geografice, ediţia a XI-a, la Facultatea de Hidrotehnică din Iaşi, noiembrie 2003 şi 2008; consultant tehnic în probleme de CES şi stabilizarea versanţilor la ISPIF, activitate apreciată printr-o Diplomă de Onoare pentru „Colaborare meritorie în domeniul studiilor, proiectării şi cercetării-dezvoltării" ISPIF, Bucureşti, 2002.

Ca o recunoaştere pe plan internaţional, biografia sa a fost inserată în *Who's who in European Research and Development*, Londra, Anglia, 1994; în *Dicţionarul Specialiştilor* – un *Who's who* în ştiinţa şi tehnica românească, vol.1, Ed. Tehnică 1996, în *Who's who în România*, Ed. Pegasus Press, Bucureşti, 2002.

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conf. dr. ing. Gabriela Biali

SPATIAL MODELLING OF SOLAR RADIATION COMPONENTS USING GEOGRAPHIC INFORMATION SYSTEMS

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Резюме: *Рассматриваются пространственные распределения годовой прямой, диффузной и суммарной солнечной радиации и длительность солнечного сияния на территории Республики Молдова, рассчитанные по разным моделям с использованием ГИС технологий. Приводится сравнительный анализ точности этих моделей.*

Key words: *solar radiation, solar radiation models, values accuracy.*

Rezumat*: Sunt examinate distribuţiile spaţiale ale radiaţiei solare anuale directe, difuze şi totale şi durata strălucirii solare pe teritoriul Republicii Moldova, calculate după diferite modele, utilizând tehnologiile SIG. Este efectuată analiza comparativă a exactităţii acestor modele.*

Cuvinte cheie: *radiaţia solară, modelele radiaţiei solare, exactitatea valorilor.*

Taking into account that Republic of Moldova is poor in local energetic resources and they are represented mostly by non-traditional ones (3% from total country's energetics), thermal power resources spatial distribution's estimation is necessary for their efficient usage.

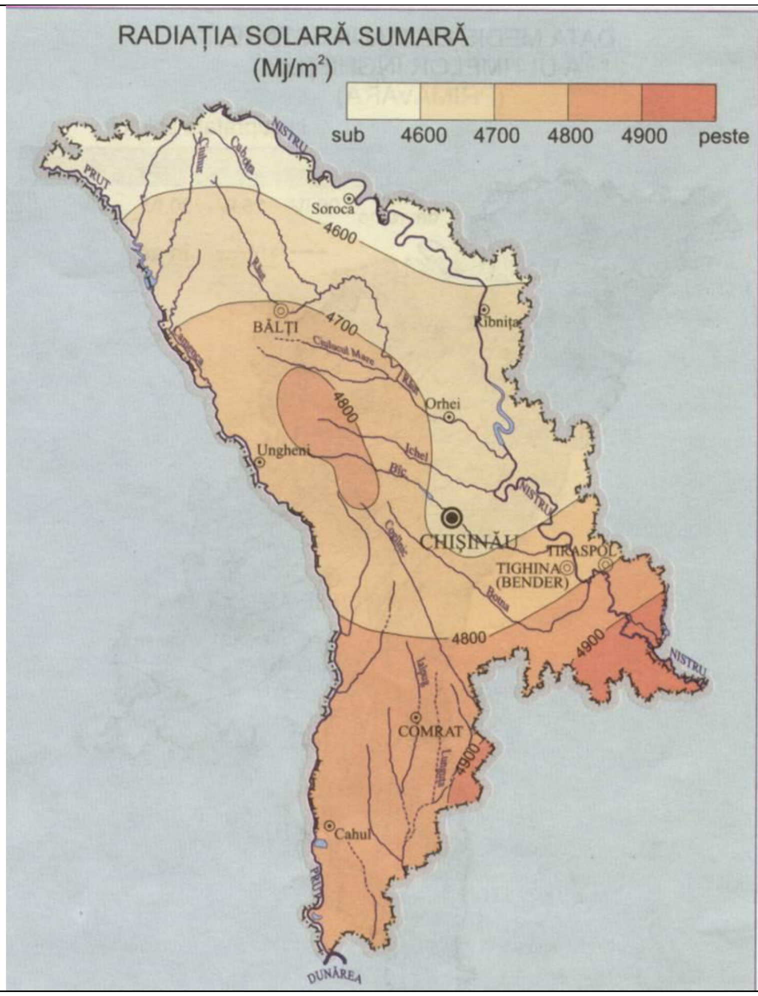

Figure. 1. ***Total solar radiation [1].***

Solar radiation, received by terrestrial surface (insolation), largely determines the thermal regime of land. This value is strongly influenced by slope's angle and orientation, atmosphere's transparency and Sun's position as a function from latitude and local time. Total solar radiation ***Q*** is a sum between direct radiation sum ***S'*** and diffused one ***D:***

$$Q = S' + D$$

The maps of solar energy quantity received by soil's surface are of extreme importance for green mass estimation and for optimum placing of agricultural crops according to their requirements. At the same time these maps can be used also for placing installations that transform solar radiation in electrical and thermal energy.

Traditional method of solar radiation representation by isolines reflects in a very general mode actual spatial distribution and only identifies some areas (figure1).

Complete actinometrical observations are executed only at Chisinau weather station and just total solar radiation is registered at several otherweather stations in the country. Therefore it is necessary to use other methods and models of spatial interpolation, other than those of direct spatial interpolation of observational data.

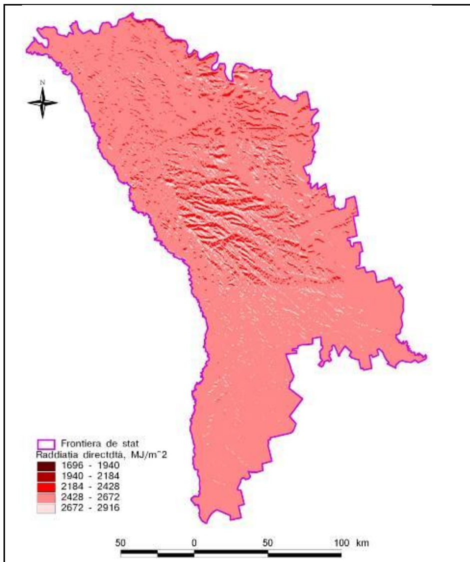

Figure 2. ***Direct solar radiation modelling using coefficients***

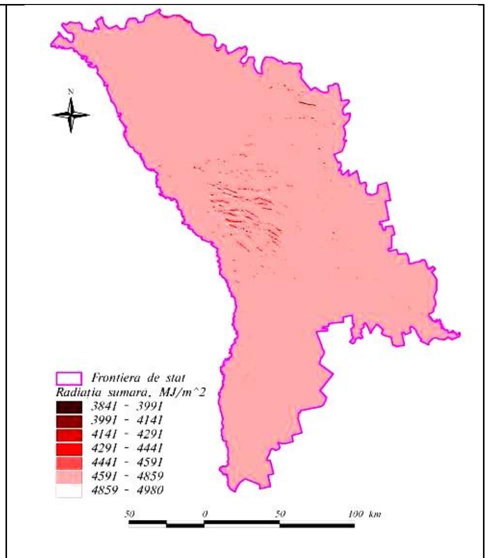

Figure 3. ***Total solar radiation modelling using coefficient*s**

A more adequate method of solar radiation components estimation was developed by E. N. Romanova [2], and was used 5 years ago [3]. The method consists in using coefficients for different months and slopes with different gradients, aspects and latitudes. These coefficients are calculated for warm period (April-September) for 42-66 degrees latitude with 4 degrees increment and represent relation between radiation on the slopes and those on horizontal surface. Coefficients for 5, 10 and 20 degrees slopes and North, East, South, West aspect are available for direct solar radiation. For total solar radiation only coefficients for slopes of 10 and 20 degrees and North and South aspect are available, while coefficients for 5 degrees slopes and East and West exposition are considered equal to one. This rough estimation of relief's particularities has as a consequence distinct smoothing of radiation values in spatial aspect [figures 2 and 3].

The most appropriate calculation method is using Solar Analyst software, elaborated by Helios Environmental Modeling Institute [4] and included subsequently in geographic informatics systems software of ArcView 3x and ArcGIS 9x. Digital Elevation Model, mean latitude, desired resolution, the number of days from start and finish from year's beginning, day and hour quantification intervals, Z-factor of altitude's multiplication, slope's angle and orientation, the number of directions needed for calculation, the number of azimuth divisions, the number of vertical divisions, relation between diffused radiation and total, atmospheric transparency and names of final files for direct, diffused and total radiation and number of hours of direct solar radiation are used as input data. Input model does not require actinometrical data except for values that characterize relation between diffused radiation, total one and atmosphere's transparency. If the first value can be deduced from data observed on Chisinau weather station, then the second one is not known. Solar Analyst gives possibility to calculate solar radiation components not only for certain area, but also for a certain point. In order to find out atmosphere's transparency value we need to proceed in the following way. The calculations were made for point location Chisinau weather station at various values of transparency of atmosphere and was selected the value of transparency that corresponds to radiation values, registered at station. Subsequently the values of direct, diffuse, total solar radiation and total number of hours with sunshine were calculated and developed their spatial distribution maps. The final results are presented in figures 4-7.

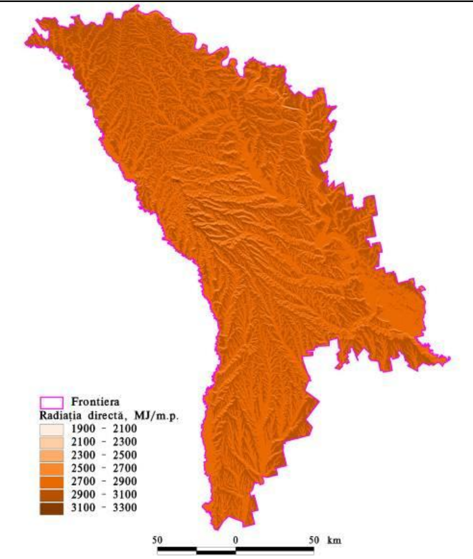

Figure 4. Direct solar radiation modeling using Solar Analyst software

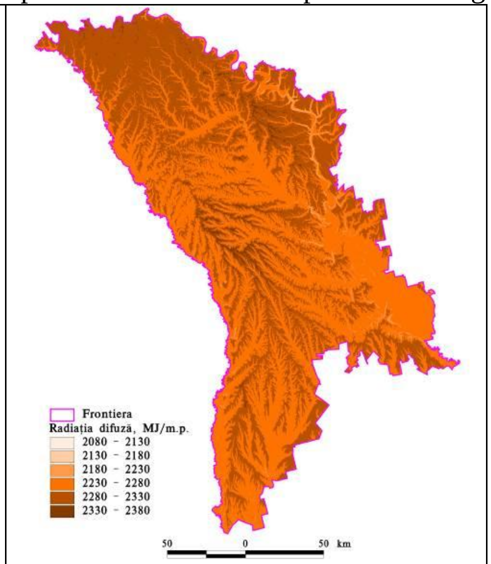

Figure 5. Diffused solar radiation modeling using Solar Analyst software

Characteristics of used models are presented in the following table.

Characteristics	**Romanova E.N. model**	**Solar Analyst Model**
Slope resolution, degrees	10, 20 (total radiation) 5, 10, 20 (direct radiation)	1
Exposition resolution, degrees	180 (total radiation) 90 (direct radiation)	1
Resolution of latitude, degrees	2 (total radiation) 4 (direct radiation)	< 0,000001
Total radiation's spatial variation interval, MJ/m^2	3800 - 4900	4000-5800
Direct radiation's spatial variation interval, MJ/m2	1700 - 2900	1900 - 3300
Horizon effect	No	Yes
Calculation possibility for every time interval	No	Yes

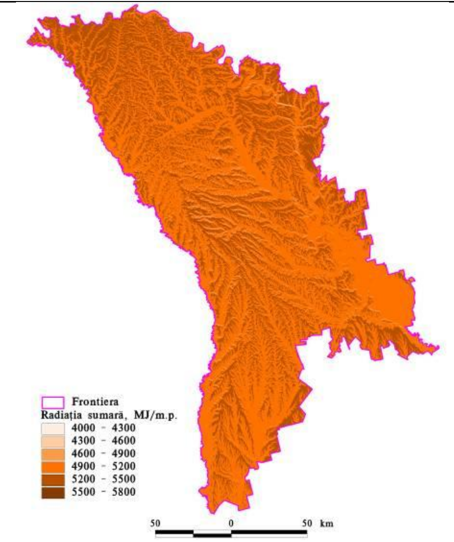

Figura 6. **Total solar radiation modeling using Solar Analyst software**

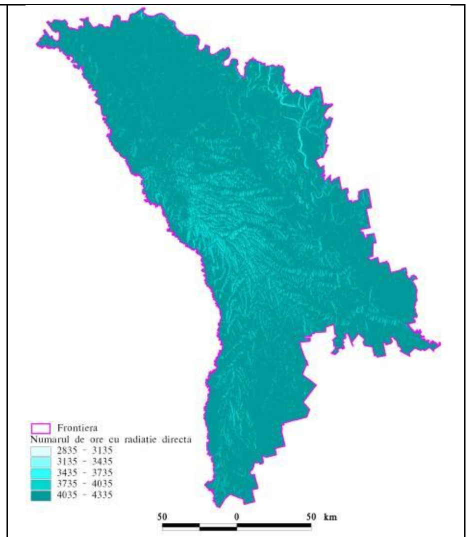

Figura 7. **Number of hours with direct solar radiation**

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ASSESSMENT OF AGRICULTURAL SUITABILITY POTENTIAL LAND IN BĂLŢATA BASIN

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Resumé *L`évaluation du potentiel de l'aptitude des terres est une étape importante dans la définition des limites écologiques de la planification territoriale. Nous parlons de la recherche dans la façon dont certains types d'utilisation des terres influencées sur la productivité. Cette étude évalue l'aptitude des terres dans le bassin Bălţata sur la base d'une expertise des indicateurs de favorabilité: la pente et de la terre à l'aide, la texture du sol, teneur en matière organique des substances, l'épaisseur de la couche d'humus. Une carte d'aptitude des terres à des fins agricoles a été élaborée sur la base de la modélisation. Les résultats de la recherche montrent que la plupart de la surface du bassin est propice à l'agriculture, mais certains ajustements aux conditions locales morphologiques sont nécessaires. Près des trois quarts de la région a une bonne aptitude des terres et équitable, alors que 14,7% de la région est modérée et la moyenne. 10% de la surface du bassin ne sont pas propices à l'agriculture. Il s'agit notamment de zones dégradées, les zones habitées, et des bassins hydrographiques.*

Cuvinte-cheie: utilizarea terenurilor, pretabilitatea agricolă, bazinul r. Bălţata.

1. Introduction

Evaluation of the land suitability potential, especially under conditions of limited land resources is an important step in assessing environmental status and planning. The purpose of the evaluation of the soil pretability is the prediction of the soil natural potential with the aim to maintain a certain way of use for a long time period without worsening the soil quality. In conditions of temperate continental climate with dry and hot summers, soil and water resources conservation practices are carried out on the level of basin, as the basins represent integrated units. Each basin land unit, delimitated according to its properties, has its own potential and limits of use. The land units can be evaluated according to their qualitative characteristics (FAO, 1990). The analysis of the contribution of different parameters was assessed according to different land favorability parameters. Agricultural land suitability index is a parameter which values are grouped into six categories of suitability: very good, good, moderate, medium and low. This classification was made by superimposing different layers with the respective share using the Geographic Information System (GIS).

2. Study area

As a subject was selected the Băltata basin, located at east of Chisinau, at Northern latitude 46°58'41" and 47°06'46" and Eastern longitude 28°51'42" and 29°13'17", with a total area of 166,94 km^2. Agricultural activity in this area is focused on cereal crop production and viticulture. The dominant soils are cernoziom, carbonate soils and low humid typical with average thickness (25-50 cm) on sandy and clay rocks. In the medium and lower waterstream of the river meadow the substrate is represented by limestone and on the slopes by pebble. Interfluve gravels consisting of sand, comprise the old terraces of river Dniester. The average altitude within the basin is 123 m and varies from 17,6 m to 220,8 m. The average monthly temperatures range from -3°C in January to 21°C in July. Average annual precipitation ranges from 500 mm in the eastern basin to 550 mm in the west. Basin is characterized by a high share of degraded land. Thus, 30,9% of land is eroded and the area occupied by landslides shares 6,3%. During a long period, detailed measurements were made at 24 hydrological and meteorological stations. The data resulted in subsequent studies that can serve as sources of information in assessing the correlation level of different geographical landscape components. Taking into consideration the mentioned above this river was selected as the pilot region for the assessment of agricultural land suitability.

3. Datasets

In conducting this study there were used 2004Landsat satellite images, Google 2008Earth images, topographic maps 1: 50 000; soil map 1: 200 000; Geological map 1: 200 000 and the data collected in the field. The data process was done using ArcGIS 9.3 and ERDAS IMAGINE 8.7 software. The basin boundaries were drawn based on topographic maps. In the field, there were collected data on the geological composition (wells and geological sections), soils (profiles), land use (identification of the type of vegetation, type of crop, the degree of land degradation, etc.). The information on land use were obtained through satellite imagery processing and using the Land Cadastre on village level for 2008.

4. The factors taken into account while the assessment of suitability and the research methodology

The steps undertaken for the development of land suitability maps represent a result of the decisions regarding land that need to be improved and the way how to improve them. Therefore, the assessment of land suitability takes into account the physical particularities, socio-economic limits and possibilities of the territory. In general, they are limited to the natural potential of land for agriculture.

The joint effect of physical parameters determines the suitability degree and also facilitates the hierarchization of lands into different classes of development. In addition, the land suitability assessment process depends very much on the predominant conditions such as degree of anthropogenic influence on land. It is in this context, that the suitability analyses, carried out in this research, should be approached as the identification of priorities for the development of agriculture. This is why there are carried out interdisciplinary researches (field trips, facts, old maps and satellite images) in order to determine the suitability of land use and to identify the regions to be used for agricultural purposes. The following parameters are relevant for the soil suitability analyses: (I) land use / categories of land, (II) soil type, (III) content of organic matter in soil, (IV) humus layer and (V) slope (S. Bandyopadhyay, and others, 2009). The assessment of physical parameters is completed by the information on usage restrictions for agricultural purposes. The notion of limit is derived from the land quality. For example, if the slope has considerable values, there are restrictions about the soil erosion severity and, on contrary, higher organic matter content shows a "better health" of soil. All the mentioned physical parameters were used to identify areas suitable for agriculture. The multifactor analysis of the suitability indicator was performed by unifying these parameters in a GIS environment.

On the basis of the data obtained by processing satellite images and topographic maps (scale 1: 50,000) and soil map (scale 1: 200,000) there were developed a set of thematic maps: land use map (I) soil map (II), the map soil organic matter content (III) depth map (thickness) of soil (IV) and slopes map (V).

For the development of the digital database and for the data analysis, the ArcGIS software was used. Thematic maps have been transferred into digital format, in vector format and then drawn. All the polygons from the thematic maps were given specific values of favorability. Initially each polygon of the final thematic layer was viewed qualitatively in one of the following categories: (I) good, (II) fair, (III) moderate, (IV) average and (V) poor. These values were assigned based on the importance of land for agriculture. Subsequently these values were introduced in each thematic layer, resulting from its features. A database was made for each layer and all of them were integrated and analyzed by weighted aggregation method, using function ArcToolbox / Analisys Tools / Overlay / Union (ESRI 1988, 1989). Using this method all these values were summed, the final polygons are representing the sum of the different layers, accrding to their suitability. The formula used for the assessment of the suitability potential for agricultural purposes was calculated by using ArcToolbox / Data Management Tools / Fields / Fields/ Calculated:

$$\mathbf{IPAT = 0{,}2\ (UT)_{\mathit{i=1\text{-}6}} + 0{,}2\ (TS)_{\mathit{i=1\text{-}5}} + 0{,}1\ (P)_{\mathit{k=1\text{-}6}} + 0{,}25\ (CO)_{\mathit{l=1\text{-}4}} + 0{,}25\ (A)_{\mathit{m=1\text{-}4}}}$$

Where, the IPAT is - agricultural land suitability index, UT - land use (grades 1-6), ST - soil type, considered as specific texture, degree of erosion, etc.. (classes 1-5), P - slope (grades 1-6), CO - soil organic carbon (grades 1-4) and A is the depth factor (thickness) of soil (grades 1-4). Indices *i*, *j*, *k*, *l* and *m* denote subclasses, based on the degree of importance in the formation of land suitability.

The next step is the integration of spatial layers, which is done with the formula of ArcGIS module, based on logical analysis and assigned values. The initial information on the parameters that influence the land suitability is in a descriptive form and shows the qualitative indicators that influence significant the agriculture. In order to come to efficient conclusions by carrying out calculations and other math operations with a subsequent analysis in GIS, the descriptive information was converted in suitability indices of the agricultural land or rating. The influence of variables on land suitability was classified in the following order: organic carbon content, soil depth, soil texture, land use and slope. Given the importance of these indicators regarding the land suitability for different classes, the polygons were given certain values, as sensitivity among the other classes in the same thematic layer. Integration of various land suitability influencing factors was carried out on this stage. Higher values indicate that the factor has a major impact on agriculture. Different classes of each thematic map were grouped in one of the categories and the corresponding values were indicated according to the relative favorability or unfavorability of the land suitable for agriculture. Finally the demarcation of land suitable for agricultural production according to the potential was carried out.

4.1. Land use

For the development of the thematic map "Land use" there was used Landsat satellite imagery, Google Earth images of 2001 and 2008. The satellite images were classified using maximum probability methods. There were defined several classes, which, subsequently using ERDAS software, were grouped into six categories of land: urban land, farmland, orchards, vineyards, pastures, forests and water bodies.

According to the use of land, arable land areas have been classified in the category of good suitability. Normally, they could receive the maximum value (very good suitability), but much of these lands are situated on the slopes, which contribute to activation of erosion processes. The pastures and fallow lands, which currently are not used, are allocated with the category average suitability land. The perennial plantations have a low suitability because mostly they are located on the slopes. Even if forests fall into the category of land suitable for agriculture, due to environmental and legal reasons, were placed in the category of those with low suitability, as they can't be used in agricultural purposes. Water and human settlements get null value that excludes them from the final map.

4.2. Soil Map

While development of the soil map there was used soil map with scale 1:200 000, corrected during the field trips. On the basis of the soil map of the study region, the soil depth profiles for each defined area were developed. During field trips the interpretation units of soil maps and classes were correlated and interpreted data from the map 1:200 000 were transferred to the final soil map. Overall five soil types (series) have been identified and mapped.

Based on genetic characteristics of the soil (texture, susceptibility to erosion and physical-chemical reaction), morphological features of land (slope, drainage) and ecological factors (those agro-climatic) which restrict the land use, the classification of soil suitability was developed. The soils of 3rd type are thick, clayey, sandy loam and clay loam, slightly eroded or not eroded. They are represented by levigated chernozem and typical weak humified chernozem, with the richest organic carbon content (1,51 to 2,63%). They meet the interfluve areas. These areas were classified as with high favorability. Type 1 soils have a sandy loam and clay loam structure and have the same properties as the type 3, but they differ in thickness (lower) of the humus layer (50 cm or less) and a lower organic carbon content (0,51 to 1,50%). They were grouped into the category of those with good suitability. Type 5 soils includes alluvial soils and vertic chernozems, with thick humus layer (50-100 cm), non eroded surface, clay and sandy loam with poor and medium drainage.

Type 2 soils are clayey and clay loam with small thickness (25 cm), medium eroded and with a moderate organic matter content (1,58-2,04%). They were also classified as land with medium suitability. Type 4 soil have a sand-clay structure, small thickness, with moderate inclined slopes affected by erosion and relatively low organic carbon content. In this category the chernozems affected by landslides and all the residential areas are included. They have a low agricultural suitability.

4.3. Slope

For the delimitation of the slopes the land numerical model developed on the basis of land contours, extracted from the topographic map scale 1:50000 was used.

From morphometrical point of view, the study area is a hilly plain, with transition landscapes to plateau areas with sharp slopes. Slope value varies from 0 to 31°, with an average value of 31°. According to the slope value, the study area has been divided into six classes. Classes 1 (0-1°) and 2 (1-3°) are rated as very good and good respectively, due to nearly plain relief and optimal penetration rate. Land these classes are more common in the east and north of the basin and are currently used as farmland. Classes 3 (3-5°) and 4 (5-10°) are classified as moderate and middle, due to rugged landscape with maximum partial infiltration, they are good for agriculture. Class 5 (10-15°) with relatively high amount of flow is attributed to the category poor. Class 6 (>15°) include unsuitable or very weak land, due to the presence of sleep slopes and big surface of flow. The land is rough on the right side of the river. These soils have low soil fertility and currently are occupied by forest plantations and vineyards.

It should be added that often within the basin the morphological particularities of land location are not followed. According to some authors (V. Surd, 2005) the arable land must be located predominantly on slopes with gradients up to 5 degrees, vineyard land - on the slope of 10-30°, land tree - 15-40°, hay - 0-5°, pastures - 5-40°, buildings and roads - 0-40° (depending on the lithology), forest lands have no such limits.

4.4. Organic matter

Role of soil organic matter is very important. They are the best source of principal soil nutrients. Quantity of humus in the soil was determined based on soil map. The obtained value was multiplied to a conversion factor to obtain the percentage of humus in the soil. Soil humus content changes according to the soil type and the management of land resources (degree of erosion, land use etc.). Humus contain content in soil shows its state and suitability for agriculture. The average quantity of organic carbon in soil within the basin is 1,4% and the maximum – 2,63%.

4.5. Soil thickness.

Soil thickness is an important physical parameter. It determines the grow of the plant root system, the available water and air volume that may contain the soil. Shallow soils and rocky substrate restricted root system growth. The soil thickness changes depending on the clay minerals type. Measurement of the soil effective thickness has been made both basing of the soil map and on profiles. To determine the thickness of the soil the profiles of each type of soil were studied basing on the cartographic materials, relevant bibliography and the field trips.

Soil thickness changes depending on soil type. It also depends on the specific landscape and morphology of native rock. More inclined slopes, as, for example, those near the settlements Sagaidac, Valley Village and Cimişeni, have a thin humus horizon. The texture (especially the granular-metric size), mineralogical composition and degree of rock substrate weathering are also important factors influencing soil thickness. For agriculture the soils of medium thickness that combine the high content of organic humus with optimal conditions of aeration have the best suitability (excellent and good). Soils with high and low thickness, respectively, receive low and average values.

5. Results and discussion

After the classification, all the thematic layers were overlaid in ArcGIS using weighted aggregation method (weighted aggregation method). By grouping layers and polygons the areas of suitability for agriculture were delineated: very good, good, moderate, medium and low.

Areas with high suitability for agriculture represent 51,8% of the basin (Figure 1). In these areas there are favorable soil conditions (typical and carbonate chernozem) and slope has low values - below 5°. These areas are represented by arable land, which is normally recommended in such situations.

Sectors with good suitability are represented by meadows and some slopes areas on with the angle up to 10°. They occupy 23,5% of the basin and are used as grasslands (meadow areas), forests and arable land. The last type of use is contraindicated and it is recommended that these slopes be turned into arable land meadows, orchards and / or plantation forestry.

The land with moderate suitability value for agriculture includes slopes with the angle 5-10°, sometimes 10 to 15° with the carbonate and typical chernozem. These areas represent 7,4% of the total area. They have an insular distribution, being recorded in more compact areas in north of the village Cimişeni and west of the Cruzeşti village. These lands, according to the exposition, are recommended to be used as pastures or perennial plantings.

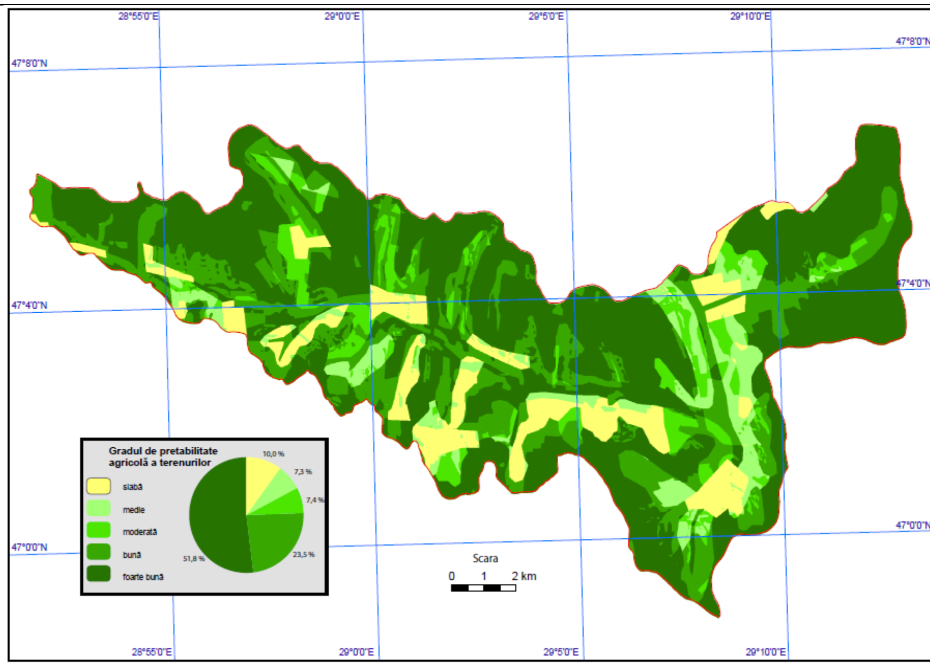

Figure 1. Agricultural suitability of land

The areas with average suitability values (7,3%) are found on the slopes of the lower watercourse between the localities Bălăbăneşti and Cimişeni where slope value reaches 15°. These fields have different uses, but forest plantations predominate, some sectors are covered with bushes and orchards, which are recommended in such conditions.

Land with low levels of agricultural suitability includes areas occupied by towns, ponds and wooded areas affected by landslides. These fields are represented by a meadow plane relief (in case of localities) or slopes with angle 15-31°.

6. Conclusions

Modeling based on GIS map was developed for agricultural land suitability. The study shows that most of the river basin planning is suitable for agriculture, but some sectors require adaptation to local conditions of morphological relief. About ¾ of the region is characterized by high and good agricultural suitability. Moderate and average suitability is characteristic for 14,7% of the basin. Non suitable land for agriculture accounts cca. 10% of the basin and includes buildings, water bodies and areas affected by landslides.

Research shows that 7,4% of the land is not used as requires the basin geomorphology and soil. For a sustainable use of land and for obtaining optimal agricultural productivity it is necessary to develop action plans based on potential values of land suitability and water availability. Land conservation measures must be accepted as an indispensable part of sustainable development plan. Action plans and their implementation should include crop rotations with leguminous crops. These measures are required in areas with high, good and moderate suitability, but in terms of the presence of available water resources for irrigation. Land with an average potential can be used as a pastures or for the rotation system. Forest-pastoral and forest systems can be used on the low agricultural suitability land.

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THE APPLYING OF THE GOOGLE EARTH SIGHT MATERIAL WITH PURPOSE OF SPACE ARRANGEMENT OF THE TERITORY OF AN ADMINISTRATIVE UNITY

Mihai Turculeț[*], Sergiu Popescul[*], Angela Popescul[**]

Abstract: *in this work there are presented some results of the accuracy checking of relief representation on the posted materials on sight Google EARTH.*

The work is motivated by the collecting and examination of the cartography material being necessary for the locality GIS elaboration with didactic goals by the students.

Key words: *Geographical Information System, modeling, Google EARTH.*

Rezumat: *În lucrare sunt prezentate unele rezultate ale verificării preciziei de reprezentare a reliefului pe materialele postate pe situl Google EARTH.*

Lucrarea este argumentată prin necesitatea de colectare şi examinare a materialelor cartografice necesare elaborării GIS - ului localităţii în scopuri didactice de către studenţi.

Cuvinte cheie: *Sistem Informaţional Geografic, model, Google EARTH.*

The digital models integration of the lot in the geographical informatical systems (GIS) were suggested by B. Makaroic (1977); that were also a more detailed investigated subject by R. Adlor (1978). During 70 th years some activities have already divided into data bases for the digital models of the lot (A.A.Noma, 1974, I.R.Jancaitis, 1976, A.A.Elassal, 1978, A.A.Noma/N.Spencer, 1978) but it has existed a non correlation on the structure base for GIS.

An other trial was oriented at that time on the digital administration of cartographical data at the general model. Very soon the solving came from the GIS exterior by a interdisciplinary approach and then the most problems of GIS could be solved by the 2,5D structures that were anticipating the assimilation of the lot data.

For decades territorial (urban) planning was done by drawing plans and building elaborate models from wood and pasteboard. The modern 3D – computer simulation derived from informations of the digital map are revolutionning process.

3D visualizations give a better impression of the surrounding than 2D - maps and help pinpointing areas where something needs to be done.

The GIS diffusion in Moldavian Municipalities is increasing. In the most cases urban planning is the leading application but GIS is far from being an actual support in planning process. GIS is going include 3D tools that can well improve planning application.

The paper investigates haw territorial planning can use the existant materials that is important for the study process. The key idea is to use a lot the advantages of the 3D visualization.

3D manipulates planning offers many advantages to students such as:

- students get more involved in planning processes once they really see what is going to be drawing.
- planners like it because they can explain their ideas much more fully. They can speed up the planning process and are still able to test more variants.

At present the Geographical Information Systems are generally used for spatial information analysis but they can be also used for the projection works in the area of engineering arrangements, urbanism and the territory systematization, etc.

Many GIS - applications are based on cadastral information. Unfortunatelly to the cadastre elaboration in Moldova Republic the information about the relief is not included in data bases. Data-collection and its maintenance is a part of GIS-applications which is already solved in a lot of organizations.

The use of SIG with the purpose of the territory management became more and more spread last years.

Practically every territorial administrative unity must hold an integral base of geographic data about the territory that belongs to it being applied for the planning and motoring works but accounting the SIG potential to be adopted operatively the decisions. At present on evaluating the resources for the capitalization of the new technologies like the informational systems the main attention in the most of cases is attracted to the mode of data collection and their administration, but the quality aspect was shadowy remaining. By the quality of data is meant both their structure and make-up and their precision. This indicator will directly influence the final product. This aspect must be clarified still at the initial stage of the sources choosing from which the data will be corrected. The success of SIG applying will be influenced by the professional preparation of the specialists that obtain the first skills during the study years.

With the goal of the professional preparation of the future specialists the authors suggested themselves to do an investigation concerning the accuracy of the relief representation with help of the digital model. At present, applying the existent materials timely the students elaborate annul projects and graphical works at the studied subjects.

In the nearest future we intend to use this tindem to use our results for integrating diverse sources. The studies are at the initial stage being a domain that we wish to be possessed by the studious young people.

As reference point for studies effecting in this area were served:

- the fragment of digital model of the village Poganeşti from Moldova Republic elaborated on the basis of the elevations of 2006, took over the Google EARTH sight;
- the elaborated topographical plan on the scale 1:5 000 with the equidistance of the curves at the 2 m level;
- the recommended technical instructions.

The history of the evolution of the Poganeşti commune is very varied. It is placed in the centre of the Republic of Moldova at the latitude of 46°41'34"N and longitude 28° 13'59"E, the average well balanced altitude. The total surface of the locality constitutes 2042ha. A great part of this territory is covered by private gardens. The locality relief is very diversified where prevails a rugged territory submited to erosion phenomena. Up to this data areas have been surveyed mainly by employing photogrammetric thus achieving accuracy hardly ± 0,5 m.

The topographic quality depends of the precision of representation on the plan of the relief - scope, named and the precision of the altimetrical topographic base being characterized by the total error of quota determination of a point under the level curves outlined on the plan.

In the (fig. 1) is presented the image of Poganeşti locality with help of the EARTH Google sight.

Fig. 1 – The geographical emplacement of the Poganesti locality, district of Hinceşti.

According with the instructions in force the average error of rising of the relief in comparison with the geodesical network points must not surpass the size equal to:

- 1/4 from the equidistance of the level curves for the flat zones with slopes up to 2º;
- 1/3 from the equidistance of the level curves for the breaking down zones with slopes comprised between 2º and 6º for

the topographic plans with the scales 1:5 000 and 1:2 000, and for the plans with the scales 1:1 000 and 1:500 with slopes over 10º.

- 1/3 in case of the curves equidistance of level equal with 0,5 m – for the elaborated plans with the scales of 1:5 000 and 1:2 000.

On the lots with constructions the tolerance may be raised by 1,5 times.

For the crumbed zones with slopes greater than 6º - for the plan sat the scales of 1:5 000 and 1:200 and larger of 10º, for the plans at the scales of 1:1 000 and 1:500, the number of the level curves must correspond to the level difference, determined between the breaking up points of the slope but the average square error of characteristic points quotas of the relief has not to surpass 1/3 of the level curves equidistance.

The accuracy is not sufficient for increasing requirements of special applications on hydrology, forestry, agriculture not for designing urban settlements.

The average square error of the plan determination of the m_H point quota being between two neighbor level curves depends on:

- the square average error of plan position of the level curve m_h challenged by the levelment accuracy;
- the square average error of plan position of the m_c level curve challenged by the accuracy of the interpolation of the level curves (on drawing on the plan of the level curves by interpolating between the quoted points).

The general applied relation in this case is:

(1) $$m_H = \pm\sqrt{m_h^2 + m_c^2},$$

or in Kopp opinion:

(2) $$m_H = \pm\left(a + b \times tg\gamma\right),$$

where: a – is the coefficient that characterizes the position error in the plan of the level curve due to the precision of the levelment;

b – the coefficient that characterizes the position error in the plan of the level curve due to the precision of the level curves interpolation;

y – the average angle of the lot inclination.

The graphic precision of the plans and maps depends on the scale. An error of 0,2 mm on a plan with the scale of 1:1 000 will mean a error in the lot of 0,20 m, while a plan with a scale of 1:10 000 will mean ten times larger, that is 2,00 m.

Fig. 2 – The locality lots submitted to the researches.

For determinating the quality of the posted material on the sight EARTH Google the authors applied different methods of positioning and determination of the points altitude from the topographic surface.

As it is seen in the (fig. 1) and

(fig. 2) the locality relief is comparatively broken. For these reasons it was decided that the study tube effectuated both on the broken lots and on the flat ones. During the investigations they were deposited 300 points. In the result of the measurements effectuation both on the sight material and on the topographic plan it was established that the error constitues on an average 2,25 m.

Taking into account the obtained result one can say that the set material on EARTH Google may be utilized in didactic goals, but in the future may appear the necessity of the raising at the higher level of the material quality.

Detailed investigation into the accuracy of this model depends on the lot slope resulted in standard deviations between ±0,5 m (flat lot) and ±0,5 m (lot with 70% slope).

The histogram shows that the residuals between control points and interpolated ground elevations are in good approximation gauss – distributed. The maximal residual reaches 3,5 m. This is equivalent to 2,5 times of the standard derivation of these residual series.

The accuracy has to depend on the main purpose connected with an efficient economic maintenance.

The quality of these 3D views is low, they are far from being realistic simulations. They are acceptable only if they are quickly and easily produced, if they are addressed to planners.

The three dimensional description of the terrestrial surface of settlements and methods to maintain, update and distribute these data are major tasks of the modern geographical data management.

Currently we a have not access to source data from aerial photogrammetric and terrestrial surveying.

The traditional maps are abstractizations of the real world, a sum of important elements sketched on the list of paper by symbols representing physical objects. People utilizing maps must interpret these symbols. The topographic maps show the lot form with help of the level curves. The teal form of the lot may be seen only with the mind eyes. The technics of graphic representation of the digital model of the lot make visible the relations between the map elements, increasing the skill of extracting and analyzing the informations.

Intended under a matrix form the digital model of the lot stocks the information of the elevation for a certain surface. The determinant for the information quality is the size of the grille (in vectorial mode) or the value of the pixel (in raster manner) at which it was achieved (the fineness with which was done the area division along the axis of X coordonation, respectively Y, corresponding to chosen geographical projection.

At the demand of a digital model it is being started from the digital map of the lot comprising the level curves and quoted points with the information of associated elevation, the rivers and the crest lines represented as 3D lines, the slope breaks as well as the rest elements that have an importance in the mathematic modeling of the lot.

Besides of the accounts made for the estimation of the space orientation of diverse zones of the studied surface one may generate the matrix of the digital model taking into account the chosen space intervals.

The digital model is a complex product that in the conditions of using a cartographic material of good quality has characteristics that for a specialist are equivalent with the utilization of the satellitary images and the stocked information in a digital model is more easily to be used.

Among the domains where the digital model of the lot may have an immediate applying one can enumerate: the analysis of the telecommunications systems (with the achieving of the lot profiles, the analysis of propagation, etc.), the projection in the domain of conduct networks (for example the water bringing) the command and control of the diverse systems, as well as in the all other areas where is necessary the knowledge of the altitude information in various points of a surface.

In the result of the effectuated investigations they were made the following conclusions:

1. The utilization of the geographical information set on the Earth Google sight is one of the future activity – the access, analysis and stock with help of the Internet;

2. The unknowledge of the materials may cause the loss of the resources and do the system inefficient irrealisable or that the taken decisions will become dangerous;

3. The determination of the accuracy must be put in discussion at the initial stage as it affects the cost, time and choice of collecting sources of the primary information included in the data bases.

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USING GIS FOR DETECTING SPATIAL CHANGES IN THE HEALTH SYSTEM ADMINISTRATION DOMAIN

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Abstract. *În ultimul timp s-a pus accentul pe posibilitatea de a putea analiza, folosind sisteme precum GIS -ul, activitatea unor instituţii de importanţă majoră care, prin rezultatul activităţii, au o influenţă asupra populaţiei din anumite regiuni. Instituţii, precum cea sanitară, au sau pot găsi în acest instrument de analiză o privire de ansamblu asupra schimbărilor care se produc la nivel administrativ şi pot detecta schimbările ce pot surveni de-a lungul timpului într-o regiune, judeţ etc. Un rol important în acest sens îl joacă autocorelarea spaţială, care presupune că două elemente învecinate se corelează mult mai bine decât două elemente îndepărtate, şi asupra gradului de corelaţie intervine efectul decalajului sau poziţionării în spaţiu sau în timp.*
Key words: *Administrative changes, GIS, Health, Space, Spatial autocorrelation.*

INTRODUCTION

This study is based on few projects wich already studied the spatial autocorrelation in specific domains, even sanitary. One of the projects was the analisying of epidemiology desease in Thailand, where the GIS system provide the posibility to integrate data in space and time. Another project was the one from China. Here the GIS system highlighted the region development in the Greater Beijing.

The purpose of the current study is to identify the spatial changes happened after the 90's in the Bihor county using an GIS system based on spatial autocorrelation indices analyse. In this case the system refears to the numbers of the doctors and to other employees from the sanitary system, like the social asistance personal.

The Minister of Health and Family have the control over the public sanitary units activity at a county or local level and also the control over the law application methodology used in the sanitary domain (Ordonanţa nr. 70 din 29 august 2002).

In the application of the ordonance no. 70 from 29 august 2002 the Minister of Health and Family, like an principal in the sanitary domain have more attributions. One of them is to ensure that the repartition and redistribution of doctors in the public sanitary units is equilibrated and it's made based on informations regarding the excced of doctors and the unoccupied working places received from the local autorities. The administration manage also the others sanitary domain employees, like the social asisstence.

MATERIALS AND METHODS

The spatial pattern of geographic objects are often the results of physical or cultural processes taking place on the surface of the earth. Spatial pattern is a static concept since these patterns only show how geographic objects distribute at one given time. However, spatial processes is a dynamic concept because these processes show how the distribution of geographic objects changed over time. For any given geographic phenomenon, we often need to study both its spatial patterns and the spatial processes associated with these patterns. Understanding the spatial patterns allows us to understand how the gegraphic phenomenon distributes and how it can be compared with others. Spatial statistics are the most useful tools for describing and analyzing how various geographic objects (or events) occur or change across the study area.

We can use spatial statistics to describe the spatial patterns formed by a set of geographic objects so what we can compare them with patterns found in other study areas. For the spatial processes associated with these patterns, we can use spatial statistics to describe their forms, to detect changes, and to analyze how some spatial patterns change over time.

To realise the purpose of this project we chose to study the Bihor county, divided by villages. For this, it has been obtained a database with data and specific parameters for the sanitary domain for the years 1992, 1998 and 2004. The shapefile used for analysation is polygon based, where each polygon represente a village. For attributes we take in consideration the number of doctors from the villages, and the number of employees used in social asistance.

The method was spatial autocorrelation based. Spatial autocorrelation means that the attribute values being studied are self-correlated and the correlation is attributable to the geographic ordering of the object.

To make a spatial autocorrelation measurement in an graphic object dataset, first we have to discuss the methods that are used to capture spatial relationship among the areal units (between the villages). This methods can be finded in a GIS software. In the next few rows we gone describe the algorithms that are used to calculate the matrix used in finding the spatial relationship.

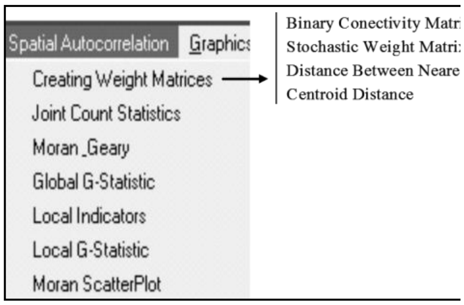


Fig. 1. Spatial Autoccorelation script - list of functions

The GIS software used is ArcView 3.2 and the script „Spatial Autocorrelation". This tools allows statistics and matrix calculations. (Fig. 1.).

Binary connectivity matrix making is based on giving binary attributes to the polygons, 0 or 1. So, the algorithm will give value 1 if the polygons are next to each oder and 0 if they are not adjacent. This matrix also shows how the polygons are connected between them, that's why we can call her the *connectivity matrix*.

The matrix can be obtain using the next formula:

$$c_i = \sum_j c_{ij} \quad (1)$$

- where i - row,
j - column,
c_i – can be only 1 or 0.

To find out how much a neighbor has influence on the value of the study area it is necessary to realise the *stochastic matrix*. The matrix takes in consideration the number of neighbors that each village have and give numeric values in a proportional way with the neighbor weight. If for example one village have six neighbors thant the value gived in the matrix for each of the six neighbors will be 1:6 , means 0.17.

Besides using adjacency as a measure to describe the spatial among a set of geographic features and to define a neighborhood among them, another common measure is *centroids distance*. One of the first rules of geography is saying that all the objects have a connection, but the closer have the better connection. This algorithm it's using the distance between the center of the polygons that are defining the villages.

For the GIS software this is an easy job, but the methods that are applying are different because some of them are applying the centroid outside the polygon area. Because the distance is used for the weight, the matrix of spatial matix is noted with „D", and it has values like d_{ij}, wich is representing the distance between centroids.

In modeling spatial processes, the distance weight is often used in an inverse manner, as the strenghts of most spatial relationships diminish when distances increases. Therefore, when the distance matrix is used, the weight is an inverse of the distance between polygon i and polygon j.

$$w_{ij} = c_{ij} / c_i \, (2)$$

- where w_{ij} is the weight.

With the advances in GIS software algorithms, features other than the distance between centroids can be easily determined. It is also relatively easy to determine the distance between any of two geographic features based on the distance of their nearest parts. A value of 0, means that polygons are adjacent.

In the next phase, based on the calculated matrix, we will make the study of the spatial autocorrelation using global and locals indices. In Fig. 2 there is an schematic representation of the algorithms.

Spatial autocorrelation global indices

The use of *joint count statistics* provides a simple and quick way of quantitatively measuring the degree of clustering or dispersion among a set of spatially adjacent polygons. This method is applicable to nominal data only. In this case the spatial autocorrelation can be positive or negative. This situation is quite restrictive, as most real-worlds cases deal with variables at interval or ratio measurement scales. In these cases, Morans'I and Geary Ratio C can be used.

Morans'I and *Geary's Ratio* have some common characteristic, but their statistical properties are different. Still, both statistics are based on a comparasion of the values of neighboring areal units. If neighboring areal units over the entire study area have similar values, then the statistics should indicate a strong positive spatial autocorrelation. If neighboring areal units have very dissimilar values, then the statistics should show a strong negative spatial autocorrelation. The two statistics, however, use different approaches to compare neighboring values.

$$I = \frac{n\sum\sum w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{W\sum(x_i - \bar{x})^2} \quad (3)$$

- where: I – is Moran's I and values between -1 and +1 (I = -1, negative autocorrelation; I = +1, positive autocorrelation).

w_{ij} - weight distance

x_i - scale

W - sum of the values from weigth matrix.

$$c = \frac{(n-1)\sum\sum w_{ij}(x_i - x_j)^2}{2W\sum(x_i - \bar{x})^2} \quad (4)$$

- where:

c – Geary ratio, scale is between 0 and 2 (c = 0, perfect positive spatial autocorrelation; c = 2, perfect negatice spatial autocorrelation).

n – studied village numbers.

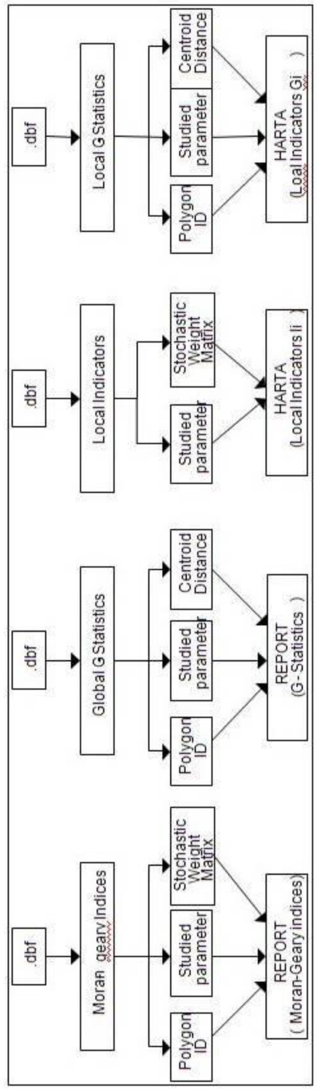


Fig. 2. Spatial autocorrelation indices calculations – schematic represantion

The difference between them is that Moran's I is comparing neighbors values with the average and Geary Ratio is comparing neighbors values directly, each one with other.

Moran's I and Geary's Ratio have well-established statistical properties to describe spatial autocorrelation globally. They are, however, not effective in identifiyng different types of clustering spatial patterns. These patterns are sometimes described as hot spots and cold spots.

The general *G – statistics* has the advantage over Moran's I and Geary's Ratio of detecting the presence of hot spots or cold spots over the entire study area. These hot spots or cold spots can be thought of as a spatial concentrations.

The value of G -statistic can be calculated using the next formula:

$$G(d) = \frac{\sum\sum w_{ij}(d)x_i x_j}{\sum\sum x_i x_j} \quad (5)$$

- where $i \neq j$,

d – is the distance within wich areal units will be regarded as neighbors.

The value of G – statistics can be interpreted like the follow: a moderate level of G(d) reflects spatial association of high and moderate values, and a low level of G(d) indicates spatial association of low and below – averages values.

Spatial autocorrelation locals indices

All the spatial autocorrelation statistics discussed so far share a common characteristic: they are global statistics because they are summary values for the entire study region. It is resonable to suspect that the magnitude of spatial autocorrelation does not have to be uniform over the region (spatial homogeneity), but rather varies according to the location. In other words, it is likely that the magnitude of spatial autocorrelation is high in some subregions but low in other subregions within the study area. It may even be possible to find positive autocorrelation in one part of the region and negative autocorrelation in another part. This phenomenon is called spatial heterogeneity.

In order to capture the spatial heterogenity of spatial autocorrelation, we have to rel on another set of measures. All these measures are based unpo their global counterparts discussed above but are modified to detect spatial autocorrelation at local scale. This indicators are local Moran and local G – statistic.

The *local Moran* statistic for areal unit i is defined as:

$$I_i = z_i \sum_i w_{ij} z_j \quad (6)$$

- where z_i and z_j are the deviations from the mean.

The advantage of this indicator is the fact that he can provide values for each areal unit (village), and the results can be mapped. The local Moran reflects how neighboring values are associated with each other.

The *local G – statistic* is derived for each areal unit (village) to indicate how the value of the areal unit on concern is associated with the values of surrounding areal units defined by a distance threshold, d. Formally, the local G – statistic is defined as:

$$G_i(d) = \frac{\sum_j w_{ij}(d) x_j}{\sum_j x_j} \quad (7)$$

- where $i \neq j$.

RESULTS AND DISCUSSIONS

The results obtained are represented like maps, in order to discuss and interpretating data (Fig. 3, Fig. 4). The functions from above have been applied for parameters like numbers of doctors in each village and other employees from the sanitary domain like social asistance personal for the 1992 – 2004 scale (Fig. 2).

CONCLUSIONS

This study uses recent developments in GIS to analyse changes of the sanitary system from administrativ point of view and highlights the importance of the spatial effects over the studied area, the Bihor county. We demonstrate also that the GIS and the analyse of spatial data can descover the finest spatial caracteristics of Bihor county, regarding the evolution of sanitary system in this area.

The local analyse also reveals that the teritory of Bihor county is divided in parts regarding the number of doctors and social asistance employees. From the maps we can observe that in 1992 the spatial autocorrelation was positive with a clustered grouping aspect of the values. However we can observe that the sanitary system is suffering a few modification, the spatial autocorrelation has become a little randomized, and the changes are made in an negative direction (Fig. 5).

Spatial autocorrelation can be a valuable tool to study how spatial patterns change over time. Results of this type of analysis lead to further understanding of how spatial patterns change from the past to present, or to estimations of how spatial patterns will change from the present to the furture (H. Nakhapakorn et al., 2006).

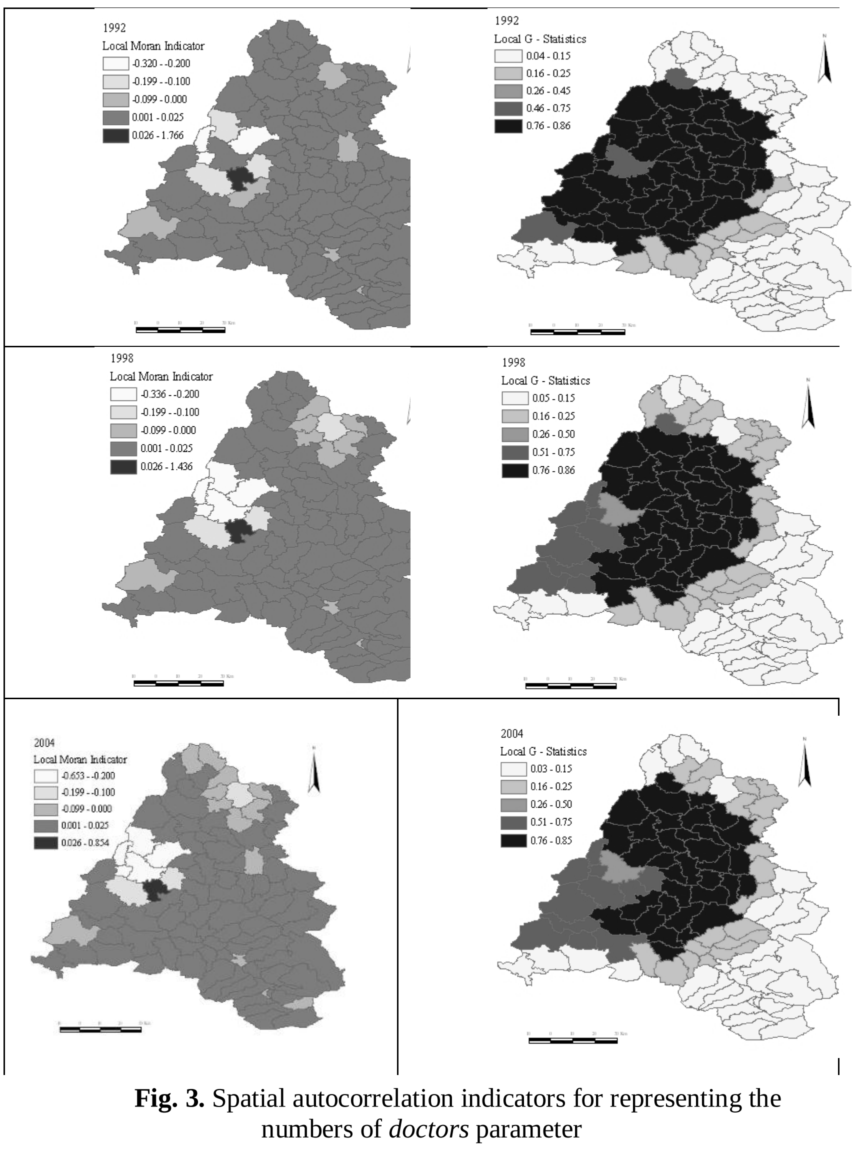


Fig. 3. Spatial autocorrelation indicators for representing the numbers of *doctors* parameter

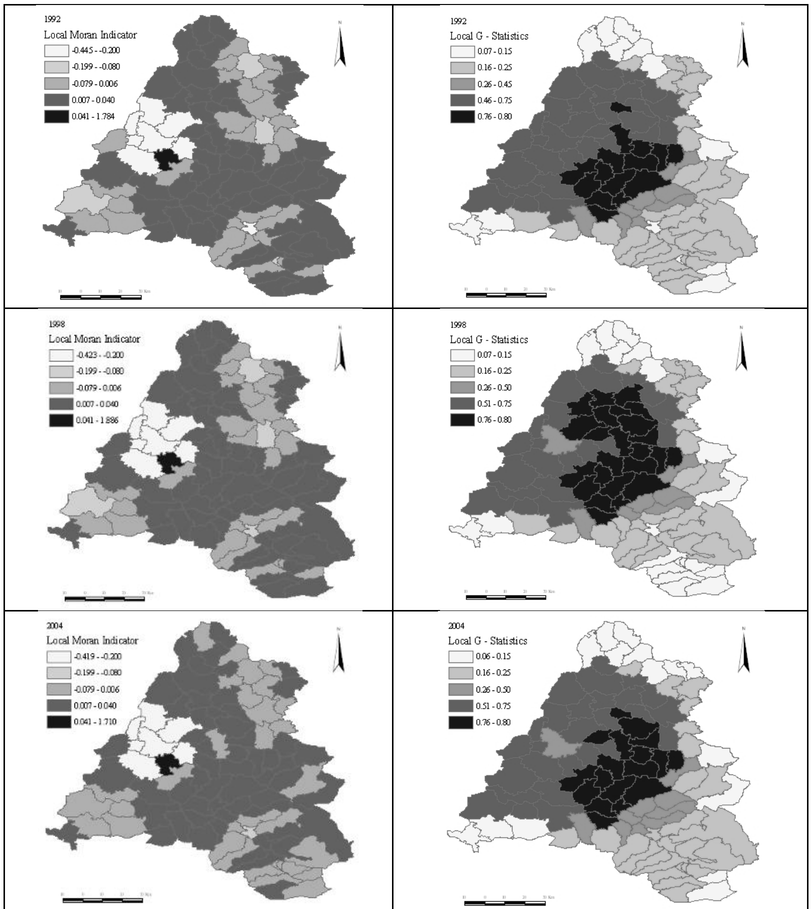
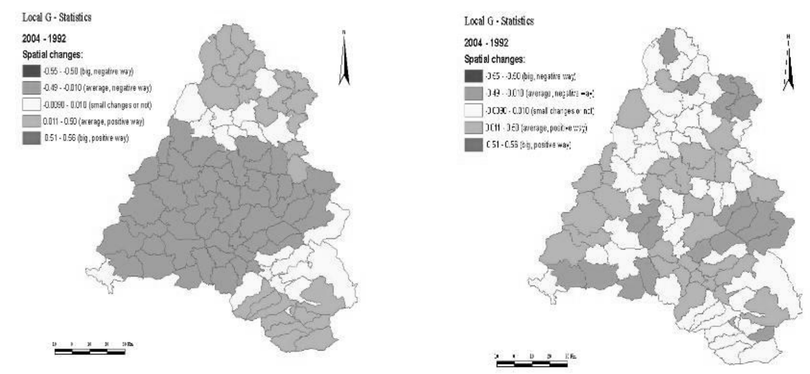


Fig. 4. Spatial autocorrelation indicators for representing the numbers of *social asistance employees* parameter



a)Gi for numbers of doctors *b) Gi for number of social asistence employees*

Fig. 5. Difference between 2004 -1992 looking at Gi indices for the studied parameters

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APPLIED GIS FOR DESIGNING THE DATABASE AND MAPPING SPECIFIC TO FORESTRY

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"Babeş-Bolyai" University, Faculty of Geography, Romania

Abstract. *Gestionarea pădurilor, în lumea zilelor de azi, care se schimbă de la zi la zi, a devenit o provocare mult mai complexă şi dificilă. Hărţile, luarea în calcul a diferiţilor factori, precum şi deciziile care se impun pentru valorificarea produselor forestiere, se iau sub o notă de conflict des întâlnită, care totodată are şi o doză de incertitudine. Specific amenajării pădurilor, în ultimul timp s-a dezvoltat o nouă tehnologie de informatizare a cartografiei, integrată într-un sistem informatic geografic (GIS) prin care elemente ale spaţiului geografic sunt completate cu informaţii tematice specifice amenajării pădurilor. În acest sistem se realizează modelul digital al terenului, ca expresie a stocării şi prelucrării informaţiei cartografice exprimată prin caracteristicile topografice de planimetrie si nivelment ale suprafeţei terestre.*

Key words: *Cartography, Forest management, Forest planning, GIS, Maps.*

INTRODUCTION

This study wish to highlight how digital mapping features can improve the forest management, providing an improved overview of forest, but in the same time to allow for various scenarios that reflect the action of certain factors on the forest in a given area. With modern means of calculation and storage of information through the GIS we can provide a spatial database that associates geographic elements derived both from graphics (maps, topographical plans) obtained by ground or air methods (photogrammetry, remote sensing) and from other sources that can be integrated into forest geographic information system (Al. Imbroane, D. More, 1999).

Topographic plans and base map, the specific elements for the forest planning, once implemented in digital form is passed to the creation and use of GIS database by connecting logic elements with the digital cartography for the characterization of the forest stands conditions and forest vegetation, resulting the possibility of digital cadastral fund and forest planning, including automatic completion of thematic maps (M. Predescu, 2007, D.J. Wilford, 2007).

The area of the study is the surface of an forest unit located in the area of Apuseni mountains (**Fig. 1.**), specifically in the wooded mountain of Gilău in the Someşul Rece catchment area, a tributary of the Someşul Mic river.

MATERIALS AND METHODS

For the data source used to realise the geodatabase we took in consideration the forest paper map of the "I Ijar" forest unit, which is managed by Gilau forest district, the topographic maps for the level of the area and the writed forest inventory for this surface. For the next phase we procced to georeferencing maps, in the Stereo70, projected system, wich is the projection used nationwide.

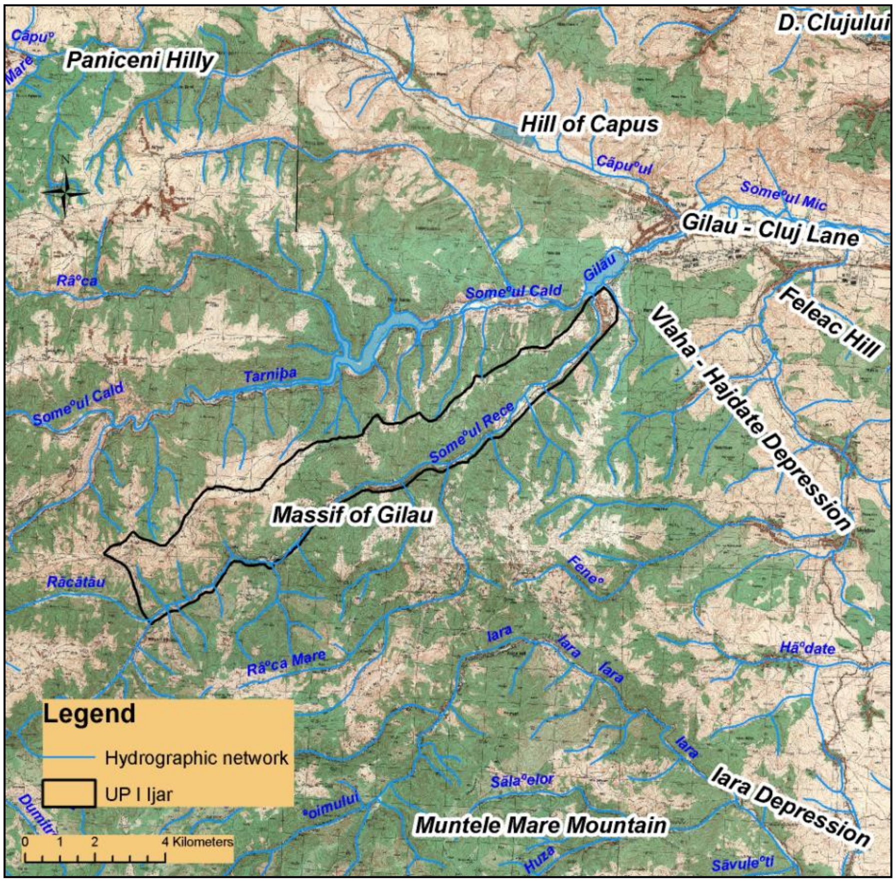

Fig.1. Studied surface location

With this step done we start digitizing data. This step was made using the geodatabase advantages. The geodatabase main advantage is that we can integrate data from source maps in separate feature dataset. Geographic features like roads, rivers, area limits, forest stands and localities has been separated in feature classes. Feature classes has been defined like in the **Table 1**.

Using a tool from the GIS software (the ArcGIS Desktop software package), by digitizing contours on topographical plans, digital terrain model was obtained which allowed the calcualtion of slopes, exposures and allowed the classification in terms of altitude for the studied surface.

Table 1

Database desing for collecting data from map sources

Feature class	Type	Attributes
Roads	line	type, name, shape lenght
Hydrographic network	line	type, name
Topography limits	line	code
Localities	polygon	name
Forest stands	polygon	forest type etc.

Attribute data, taken from the forest inventory plans have been processed in an Excel document that was added by the Join function to the digitized map. Soo the polygons coresponding to forest stands will contain information such as name of the stand, soil type, forest type, type of forest resorts, category of service, age of forest stands, subunit production type, area (ha), type of ownership, the proportion of different species, stand density, etc.

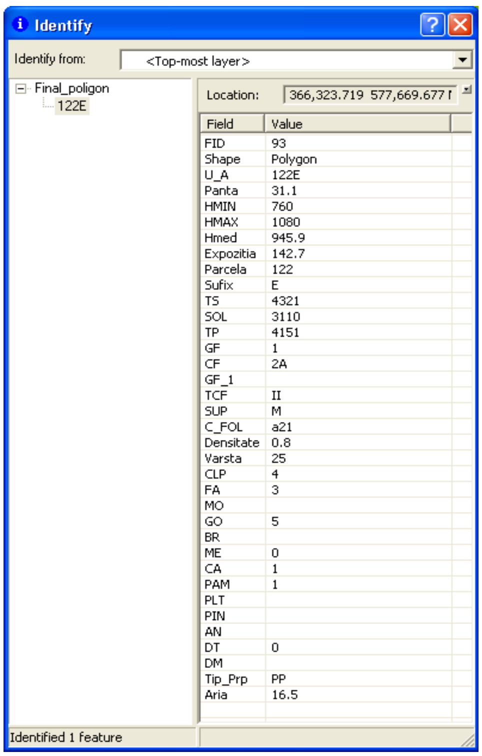

Fig. 2. **"122E" forest stand attributes**

Values thus obtained were integrated in the designed database, so that each polygon received values that help's in characterization of each forest stand. After these operations the GIS system will display information about forest stands as those in **Fig. 2**. The attributes obtained, like *Hmed* (average altitude of the forest stand), exposure, soil type can make the purpose of an graphic representation, in this case a map. This fields values and representation are important in classifing and gruoping the forest stands.

RESULTS AND DISCUSSIONS

The making of an forest geodatabase, covered by this study, presents great advantages as it allows for querying on a single criterion (attribute value) and on several criteria, or allow a classification on a single criterion or multi. It involves the condition of obtaining a result that can be perceived and analyzed by forest engineers.

A classification involving several criteria should be the one that is grouping the forest stands by their productivity. This involves two factors: the type of stand conditions and the type of forest in the each stand. This is explained by the fact that the type stand conditions gives creditworthiness of the stand and the type of forest is giving us the type of vegetation in each stand. The result of such classification is shown in **Fig. 3**.

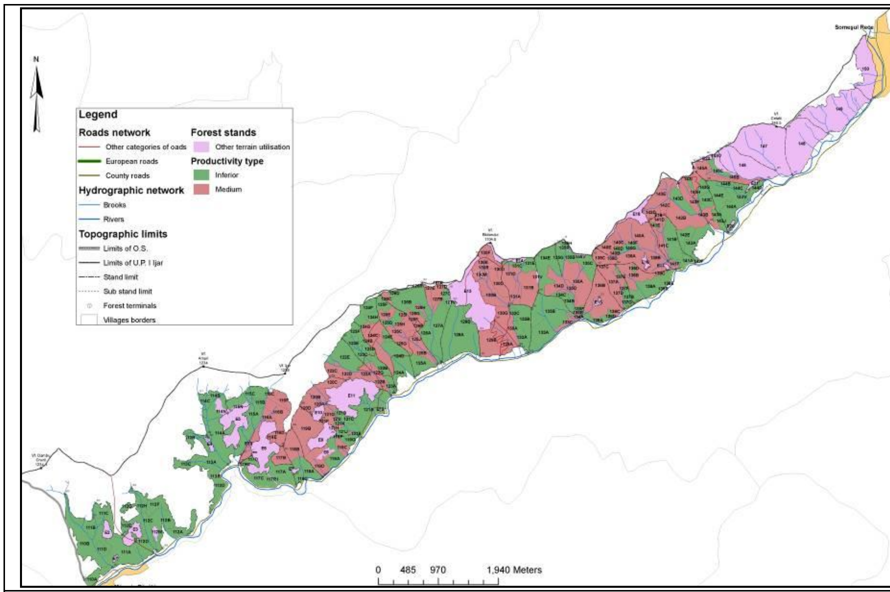

Fig. 3. Result of forest stands clasification regarding their productivity

The map querying, one of the most popular methods of GIS analysis, but also used by forest engineers on the database so created, can be really useful. It allows obtaining specific thematic maps such as one for forest operations regarding wood harvesting (**Fig. 4**).

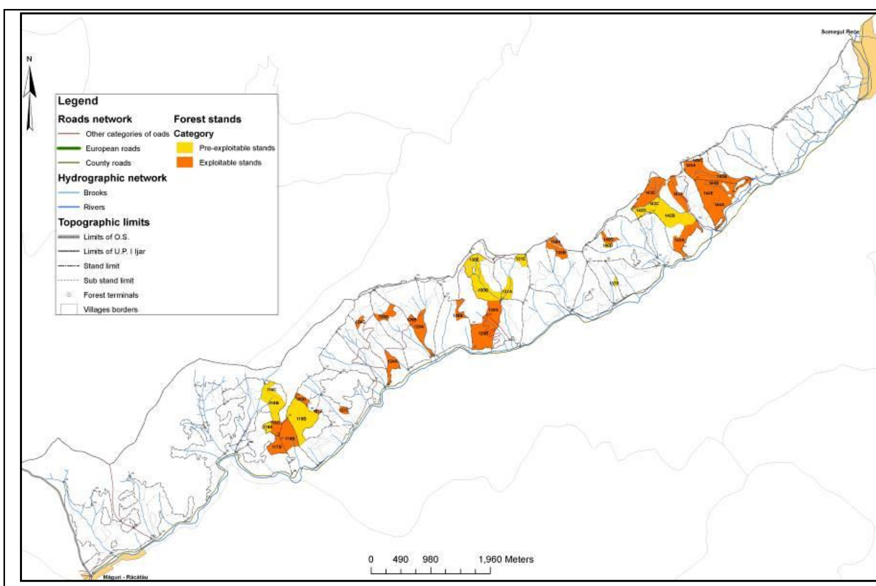

Fig. 4. Results of map interogation regarding wood harvesting

CONCLUSIONS

One of the most important conclusion is that making such database it could be possible to integrate more types of data like tabular and graphic. Also achieving specific spatial database for forest planning for the unit production, like U.P. "I Ijar", and of course the results obtained, are designed to increase speed in making decisions, to allow an overview of forest and to allow analysis and study in different situations. Thematic maps obtained as a result allow full view over the forest, in terms of its functionality. This is more beneficial than tabular data, because now we can better understand how forests interact.

Acknowledgements

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APPLICATION OF RELIEF'S FRAGMENTATION DEPTH ESTIMATION METHOD FOR CODRY PLATEAU AREA, REPUBLIC OF MOLDOVA

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Резюме. *Рассмотрены сравнительные характеристики различных методов для оценки глубины фрагментации рельефа. Смоделированы карты относительной высоты с использованием Цифровой Модели Рельефа.*

Key words: *Digital Elevation Model, relief's fragmentation depth, values histogram.*

Rezumat: *Au fost precautate caracteristicile comparative ale diferitor metode de apreciere a adâncimii fragmentării a reliefului. Au fost modelate hărţile altitudinii relative, utilizând Modelul Numeric al Reliefului.*

Cuvinte-cheie: *modelul numeric al reliefului, adâncimea fragmentarii reliefului, histograma valorilor.*

Introduction

In the last decades there were developed GIS technologies that allow quick and effective modeling of many derivations from Digital Elevation Model. Relief's fragmentation depth is one of such derivations playing an important role in climatic indexes modeling, and mainly for average seasonal temperatures modeling.

Materials and methods

Fragmentation depth or relative altitude is a substantially suitable form for expensing relief's quantitative characteristics. Relief's fragmentation depth's average value is calculated as average height between profile's two neighbor inflexion points oriented perpendicularly to the main relief lines [1].

Thus, if we take the number of inflexion points throughout the duration of one profile as M, then fragmentation's average depth characteristic for this profile's zone will be calculated according to the following formula:

$H_m = (h_1 + h_2 + \ldots + h_{m+1}) / m + 1$, (1)

where h_1, h_2…are the differences in heights between neighbor inflexion points. [2]

A more simplified variant and one which is more adopted to algorythmization, will be the one using moving window of a given size and form and fragmentation's depth calculation for every iteration through the given altitude matrix. The classical method uses moving window with the size of one kilometer and is used on topographical maps, minimum and maximum altitude points are identified with low accuracy degree. [3].

Investigation results

ArcGIS 9.2 software provides a more flexible method for this sort of calculations. The sizes and form of the moving window are selected by the user, and minimum and maximum altitudes calculation is executed with high accuracy.

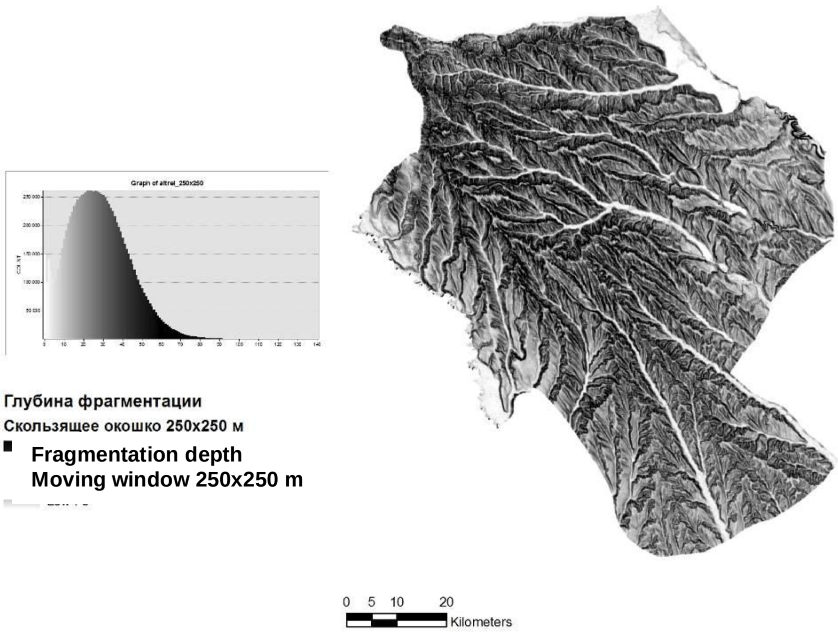

Figure 1. **Fragmentation depth (m) of Codry Plateau's relief modeled using moving window with dimensions of 250x250 m**

Spatial Analyst Tools Package that includes Map Algebra tool allows calculating desired fragmentation depth by the following formula:

Grid: RELREF = (focalmax (DEM, rectangle, <width>, <height>) –

focalmin (DEM, rectangle, <width>, <height>), (2)

where DEM – Digital Elevation Model, rectangle – the form of the moving window, <width>, <height> - its size. [3, 4, 5]

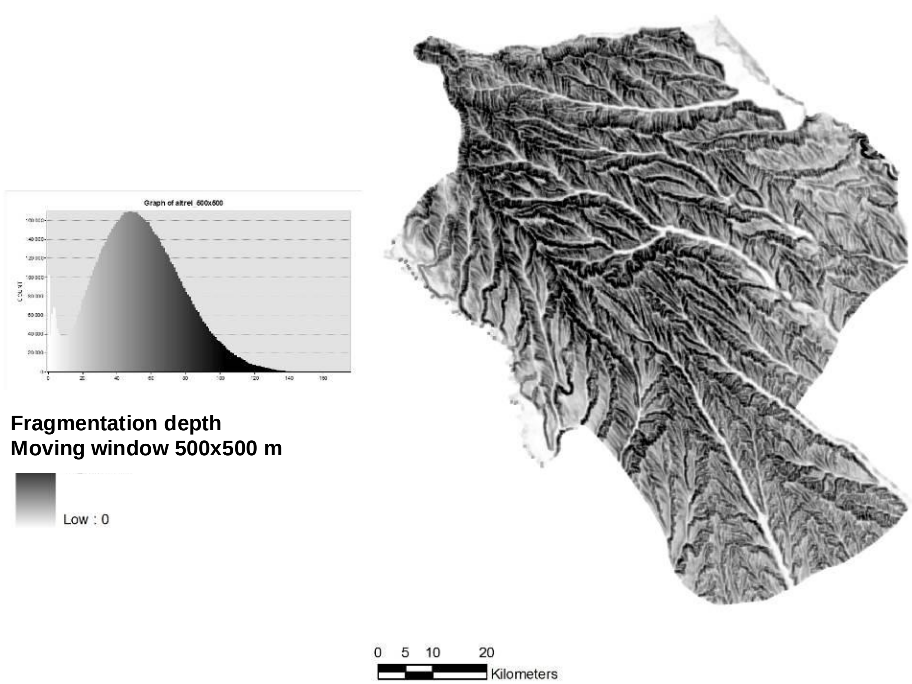

Figure 2. **Fragmentation depth (m) of Codry Plateau's relief modelled using moving window with dimensions of 500x500 m**

Relief's fragmentation depth maps calculated on the basis of Digital Elevation Model (cell size is 30 m) is shown hereafter using moving window with dimensions of 250x250, 500x500 and 1000x1000 m for Codry Plateau Region (fig. 1, 2, 3).

Fragmentation depth's values histogram shows a more uniform distribution of values when using a moving square of side 1000 m and consequently a more adequate result in comparison with histograms obtained for relative altitudes using moving squares of 250x250 m and 500x500 m dimensions correspondingly. Spatial distribution of relief's fragmentation depth also depends from both Digital Elevation Model's cell size and used moving window dimension.

At the same time the limits of obtained fragmentation depth models also change in dependence of moving window dimension.

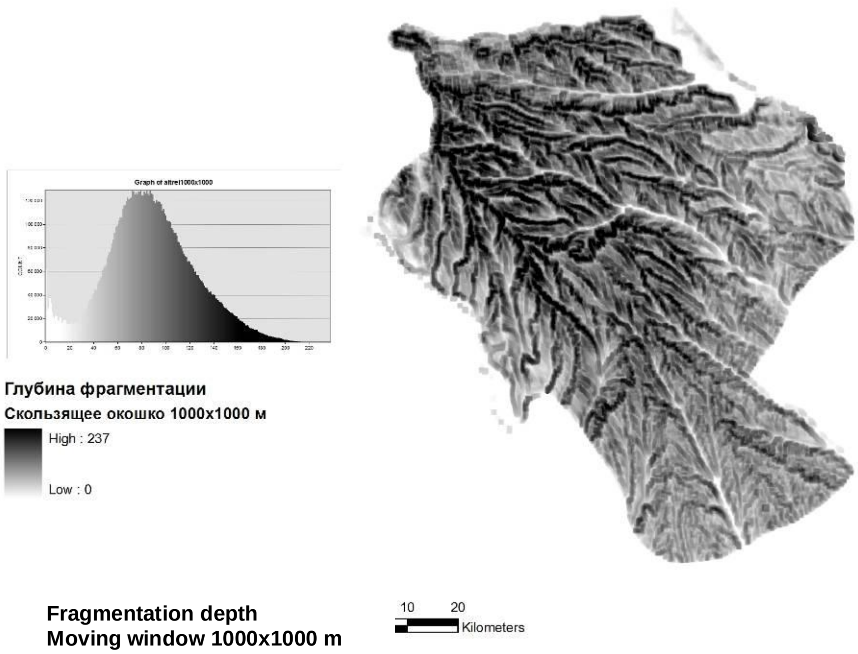

Figure 3. Fragmentation depth (m) of Codry Plateau's relief modeled using moving window with dimensions of 1000x1000 m.

The values vary from minimum interval of 0 - 140 m (moving window of side 250 m), till maximum interval of 0 - 237 m, obtained by using moving window of 1000x1000 m dimensions. Consequently, the most adequate size for moving window for Digital Elevation Model with cell size equal to 30 meters is a square of side 1000 m. The spatial distribution obtained with it is confirmed by the investigations that were carried out earlier using classical methods [6].

Conclusion

Therefore we can conclude that in order to obtain the most adequate reflection of fragmentation depth or relative altitude map it would be relevant to use Digital Elevation Model of a corresponding cell size and maximum possible square size. The obtained fragmentation depth digital model map can be used both for relief's particularities analysis and for statistical analysis and further modeling of thermic and humidification climatic indexes.

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THE APPLICATION OF GIS FOR THE EVALUATION OF THE IMOVABLE PROPERTY

Sergiu Popescul

Abstract: *The application of GIS for immovable property evaluation in Moldova Republic is enough important for the country economy, in the context of radical modification occurred last years in the economy of the country. It is related to the knowledge of realest value of the immovable property especially within built-up area of the localities.*

In the given work it was tried to present succinct information in order to select a spacious information and numerical alfa about immovable objects and at same time to carry out the necessity of the implementation of the GIS in the given domain.

Key words: *GIS, numerical alfa, description.*

Rezumat: *Aplicarea GIS – ului în evaluarea bunurilor imobile în Republica Moldova este destul de importantă pentru economia ţării, în contextul schimbărilor radicale ce au loc în ultimii ani în economia ţării. Este legată de cunoaşterea valorii cât mai reale a bunurilor imobiliare, în special în intravilanul localităţilor.*

În lucrarea dată sa încercat să se prezinte o informaţie succintă în vederea selectării informaţiei spaţiale şi alfa numerice despre obiectele imobiliare şi totodată să reflecte necesitatea implementării GIS - ului în domeniul dat.

Cuvinte cheie: *SIG, alfa numerice, descriere.*

Except usual utilization of GIS such as: cartography, relief study, cadastre of imovables, management of editorial networks, the monitoring of some natural processes (the lots degradation), GIS may also play an important role in the process of imovables evaluation made by authorized persons. GIS must have the same weight in the evaluation of the imovables as in the cadastral works, the representation on the maps of the information and the description in the registers of a specific information.

The GIS application in the evaluation of the immovable property is rather important for the country economy in the context of the radical modifications that had taken place for the last years in the economy of the country. It is connected with the knowledge of the realest value of the movable properties especially within the built-up area of the localities with the following goals: the establishment of the sale prices and purchase, of the taxable quotation as well as for imovables respective utilization in the social activities with maximum efficiency. Concerning the evaluation of unconstructible or constructible lots, the value will depend on the capacity of satisfying of the society requirements. For determination of the lots value the following factors have an active contribution: longevity, unicity, emplacement, offer, etc. The nearest value to the reale one of the lot is the value of circulation of these ones that is established in the market conditions. In the case of the lots within the built-up area of the localities, the criteria of evaluation are different of the criteria of the lots evaluation out of the built-up area. The value of the real estate will be actualized with a coefficient of adjustment, depending on the inflation indexes in the period in which the evaluation is performed. Due to its unitary character the land can not be evaluated separately of the constructions on it, estimating the market value having as a result the highest value of the evaluated goods.

In this context there are necessary data and information being very diversely taxed mainly by the legislation in force and that may be quantified by a knots system. These information are:

a) the informations concerning the localities:

- the category of locality (district, city/town, village);
- the emplacement of the lot;
- the economical functions and social characteristics of the locality (agricultural, industrial, etc.);
- the juridical situation of the property.

b) data concerning previous realized sales and their afferent prices;

c) *the informations referring to the constructive elements of the construction:* the occupied surface, the destination, the levels number, the number of subsoils, the resistance structure, the building materials, the nature of the walls, the roof, the type of property, the mode of administration, the number of rooms and annexes.

d) the informations referring to the position of the imovables according with:

- the transport nets;
- the specific endowment to the urban environment (railway stations, bus terminals, parkings, etc.);
- edilitary nets.

e) *the informations referring to the existence and distance according to the economical and social institutions (trade centers, markets, workshops, banks, post office, establishments of education, etc.);*

f) *the geometrical characteristics of the lot;*

g) *the restrictions of the lot utilization under certain government reglementations of the general urbanistical plan;*

h) *the ecological informations concerning the environment;*

i) *the criminality state of the district, etc.*

While at the basis of the lots evaluation out of built-up area it was taking into account the soils fertility class and their efficacious productivity that have mainly in mind the natural properties of the soil, the climate conditions, the relief, the hydrology as well as the arrangement of land improvements that were effectuated on then.

In this case the reference value depending on the inflation indexes and individualizing coefficients (the adjustment) of the plots, that takes into account of: the lot form, sizes, orientation, slope, the category of utilization, the degree of degradation, etc.

Taking into account the presented cases above we consider that only with GIS it may realize the sorting and stocking of the data, traditionally presented-basis data including the technical and economical characteristics of the real estate as well as geographical one-emplacement, neighborhoods, the traffic level, etc., and also by various multimedia methods. By overlapping and processing of the information on the thematic stratums, it may obtain interesting crossing and necessary informations both for establishing of certain scores, that would facilitate the establishment as possible as correct of the value of the real estate-to which the reference is done being able to effectuate utilizations and analysis that would serve among other things to the zoning of the locality in different classes of urban behavior or to constitute sources of decisional information for the interested factors. In the case of GIS application one of the component of the special information being totally different from the others even if we would have taken into account only the sources and modalities after which it is verified, administrated and then exploited. The spatial informations and numerical alfa attributed in the process of evaluation are reflected in (Table 1).

The investigations of the properties and their evaluation are also facilitated by the capacities of the special analysis by maintaining together the informations about the real estate.

The investigations of the properties and their evaluation are also facilitated by the capacities of the special analysis by maintaining together the informations about the real estate.

Table 1

The systematization of the spatial information and numerical alfa about immovable object.

Conditions of evaluation and interested criteria	Sources of informations or sources of data
1. Access to the net of roads or connections (communications)	1. The road map of the residential zone
2. The traffic intensity	2. The map of the street net, informations of traffic and tests

3. Access to the edilitary nets	3. The map of the edilitary nets
4. Social costs: duties, taxations, etc.	4. Registers of duties and taxations of authorities
5. Convenient emplacement (picturesque situation, the distance related to the economic, social and administrative establishments, the meteo conditions, etc.)	5.Topographical, touristic, meteo maps, photogrammetric products at the scale 1:5 000, 1:10 000 (photogram), etc.

The investigations of the properties and their evaluation are also facilitated by the capacities of the special analysis by maintaining together the informations about the real estate.

Except the special analysis a GIS offers also the management possibility, the bases in the respective process of reasonable data allowing to the evaluators to do access efficiently and in a real time all the informations concerning the tables and diagrams. In the result of those ones exposed above it must mention the following principal elements:

1) the achievement of the statistics concerning the lots prices evolution for a certain time period.
2) the forecast of the prices evolution of the real estates.
3) the obtaining of the much more veridically of the sale-(purchasing prices), etc.
4) the GIS will be an ideal solution for the raising of the evaluators activity level.

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SPATIAL ANALYSIS IN SOIL RATING BY MEANS OF GIS TECHNIQUES

Biali Gabriela[1]

***Résumé:** *Le projet envisage implémenter la techniques GIS (Systèmes Informationnels Géographiques) à l'étude de la qualité des terrains agricoles. Vu que les facteurs qui déterminent la qualité des terrains agricoles ont une distribution spatiale, l'on considère que l'action complexe d'évaluation (surtout sur de grandes surfaces) ne peut se réaliser que dans le cadre d'un système informationnel. Par rapport à d'autres procédés d'évaluation du potentiel productif des terrains agricoles, l'utilisation des techniques GIS (Systèmes Informationnels Géographiques) fait possible le stockage et le traitement facile, informatisé de certaines données complexes géoréférencées et descriptives, provenues de différentes sources et qui offrent aux facteurs décisionnels du management agricole / territorial, des informations dans un bref délai et à un prix bas.*

Keywords: layers, quality of soil, geographical information system.

***Rezumat:** Proiectul îşi propune implementarea tehnicii GIS în studiul calităţii terenurilor agricole. Ţinând seama de faptul că factorii ce determină calitatea terenurilor agricole au o distribuţie spaţială, considerăm că acţiunea complexă de bonitare (îndeosebi pe suprafeţe mari) nu se poate realiza decât în cadrul unui sistem informaţional. În comparaţie cu alte procedee de evaluare a potenţialului productiv al terenurilor agricole, folosirea tehnicilor GIS face posibilă stocarea şi prelucrarea facilă, computerizată a unor date complexe georeferenţiate şi descriptive, provenite din surse diverse, oferind factorilor decizionali în managementul agricol / teritorial, informaţii într-un timp scurt şi la un cost mult mai scăzut.*

Cuvinte cheie: sraturi informationale, bonitarea terenului, sistem informational geographic.

1. Introduction

The use of Geographic Information Systems - GIS, in determining the quality of soils and the appraisal of agricultural land is a very modern technique both in our country and worldwide. As there is a wide variety of environmental conditions, in order to assess lands' productivity, we selected only the most significant aspects, namely, the conditions connected to landscape, climatic resources, hydrology and the features of soil. Within these groups of factors we also set only certain indicators, the most important, significant and most easily measurable, which are usually found in existing mapping papers: rating indicators. Value scales or divisions, partitions were developed for each indicator. The degrees of the value scales or divisions were thus designed to allow the differentiation of their influence by figures – coefficients. The use of GIS techniques is required and is justified especially due to the spatial display of information as well as the speed of obtaining information.

In 1977 a National System of Monitoring Agricultural Land Quality was founded in Romania as part of the Environment Quality National System, according to the recommendations of U.N.E.P. and the Order of the Agriculture Ministry.

The objective of this system is to observe the development of local soil features and their capacity of crop production and develops prognoses for the evolution of soil quality, in order to prevent the development of unwanted soil processes in due time.

Agricultural land rating represents a complex action of study and quantitative appraisal of the main conditions for plant growth and production, of establishing the degree of favorability for these conditions in the case of each use and crop (because a particular land may not be favorable for certain uses and cultures, but may be favorable for others).

Since lands' production capacity is altered under the influence of natural factors, but mainly due to man's intervention, the appraisal must be permanently kept up to date (to correspond to each stage of agricultural and economic development, on the whole). In the event of land improvement works which determine, in each case, a significant upgrade of environmental factors, this should be taken into account when assessing the land's production capacity by introducing the so-called potentiating elements.

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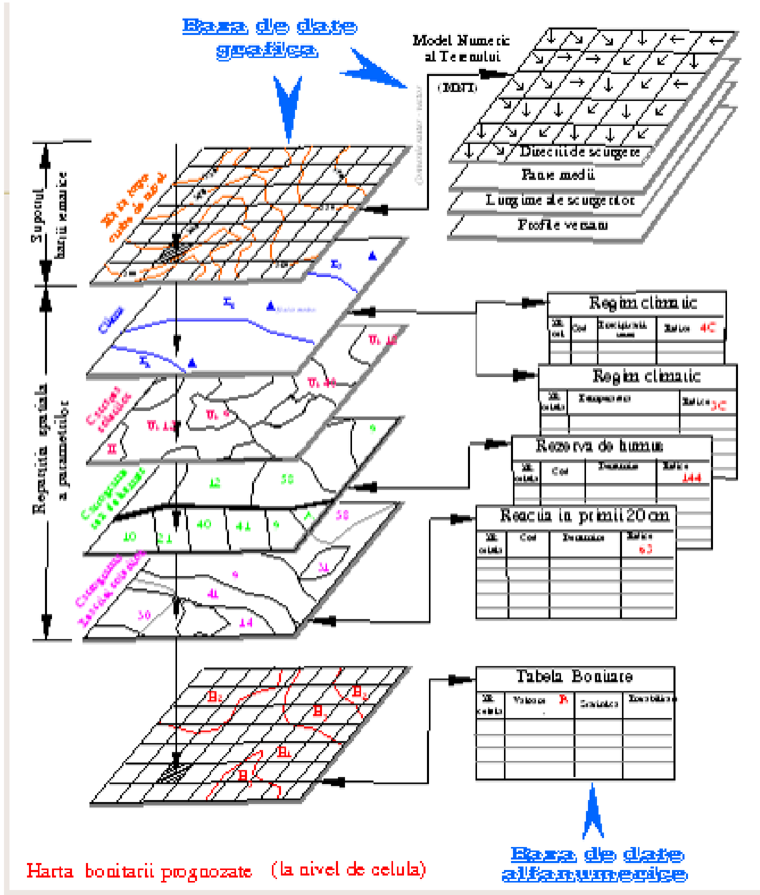

2. Study location

The studies for this paper are located in „Valea Livăzui" river basin, a tributary of Şomuzul Mic in Suceava county. The area studied is exclusively part of Fălticeni Plateau which represents the southern part of Sucevei Plateau. The studies were conducted in the Şomuzul Mic river basin, representing a hydrographic complex with an area of almost 300 ha located between Suceava de Nord and Şomuzul Mare de Sud rivers.

3. Research method approached

For implementing GIS techniques in the application from this contract we employed GEO – GRAPH Geographic Information System, a GIS-type software.

Figure 1 – *Overlay* technique for information layers within the GIS project

We used the overlay technique for information layers, by means of the pixel method. The size of a pixel was of 50 x 50 m; the graphic database was created on a relational-type SGDB (FoxPro under Windows). The scheme of this method is shown in figure no.1

The main stages of the study conducted (with examples in the following figures) are the following:

- identification of the studied river basin, complete study data;

- creation of GIS project architecture
- plan conversion from analogical into digital format – vectorization;
- creation of information layers for each rating indicator (graphic database);
- topology development;
- creation / development of calculation/simulation programs for Geo-Graph;
- development of attribute-type database (alphanumerical) (figure 3);
- software development for GIS-type query

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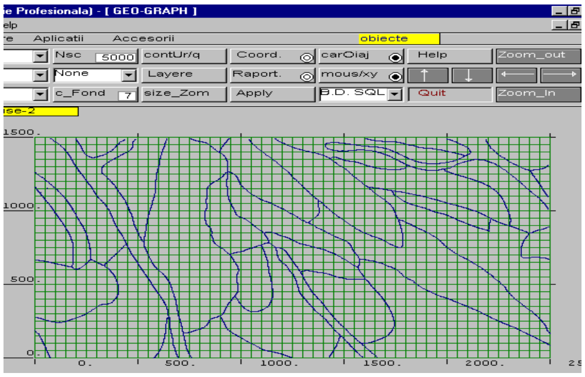


Fig. 2 – Detail for the overlay of the grid over the land unit plan for developing the topology

As the site plan of soil units is the most significant media for creating the database (and implicitly of the study) of rating indicators, the following layers which will be generated and shown in this study report are based on the mentioned site plan.

The SGDB proposed in the GIS project represents a system for the management of relational databases. Simply put, a relational system comprises several databases (usually called *„tables”*) simultaneously opened,

CoefS	DBF	65,422
Cote	dbf	1,877,480
Directii	dbf	1,877,480
Eroziune	dbf	1,877,480
Folosint	dbf	2,743,996
Pante	dbf	1,877,480
Sisteme	dbf	2,743,996
Soluri	dbf	2,743,996

Figure 3 – Tables from the alphanumerical database

connected through common field. The number of databases and of common connection fields defines the complexity of the S.G.D.B.

One of the main functions of a GIS is the query of the alphanumerical database, this function representing the difference between CAD and GIS systems. For making a query, the Database Management System which is used during the query as well as the query type need to be set up.

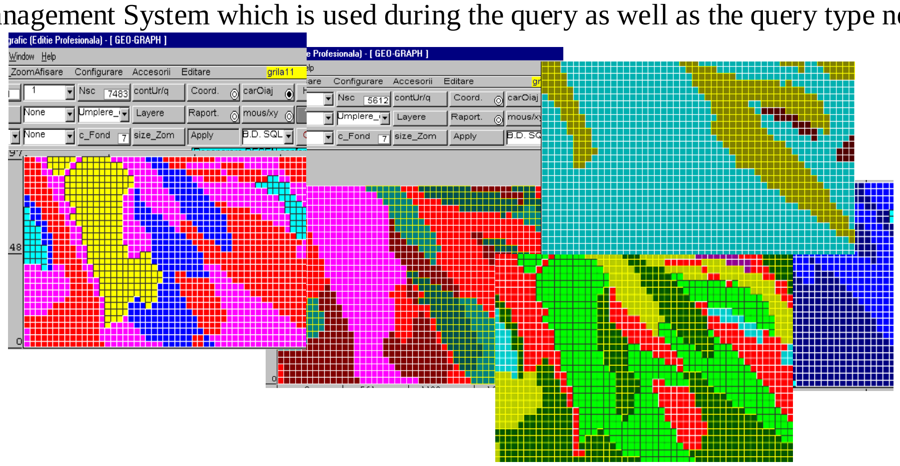


Figure 4 – Information layers for 5 rating indicators in the studied territory

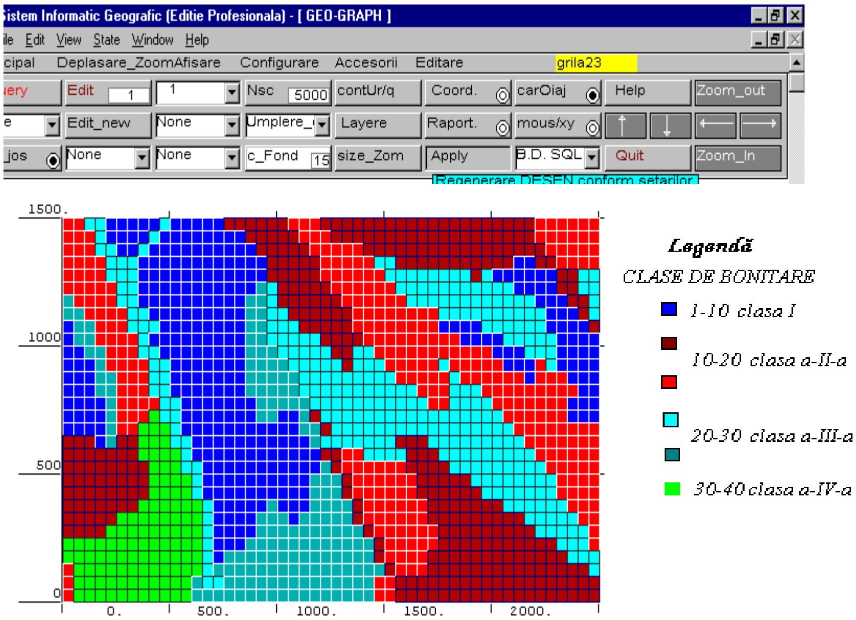


Figure 5 – *„Grid 23”* information layer - Rating classes resulted

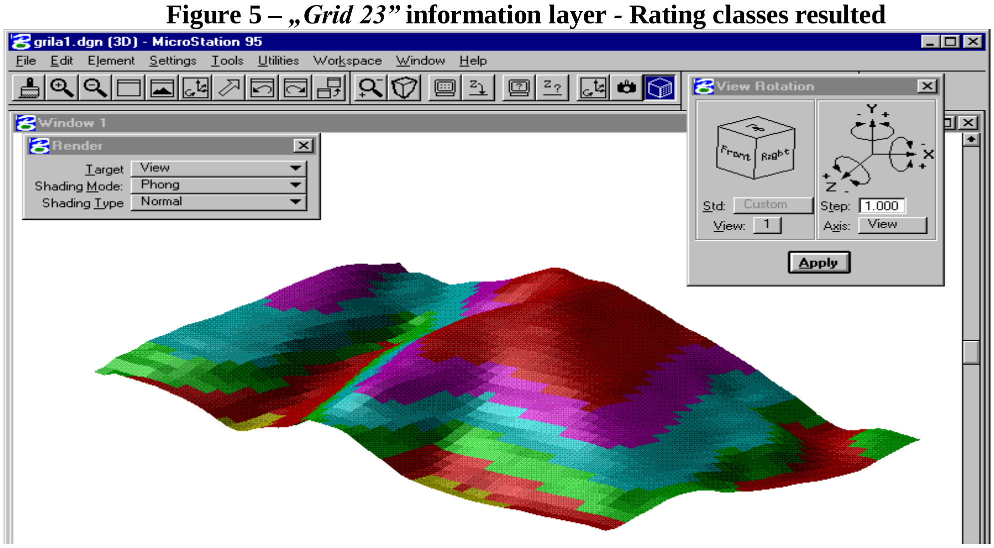


Figure 6 – Digital model of the field in 3D representation 3D on a test area

4. Results obtained regarding rating indicators for the studied river basin

For the GIS project, the following types of query are possible: through *„Fox keys”* or through *„ SQL language”*, and by editing an SQL command, the *criteria query* is possible.

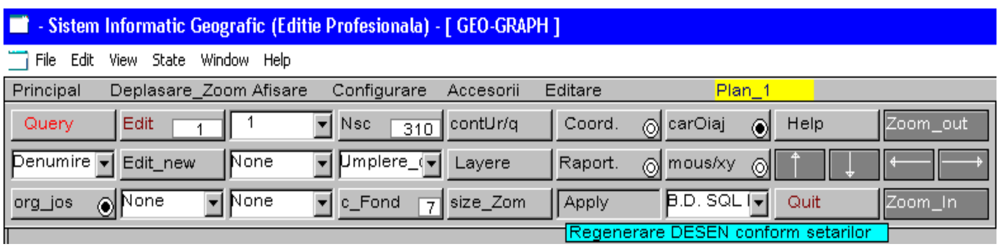
For the 3D display of the land’s digital model it is necessary to use a software that has the capacity of *„rendering”* three-dimensional vector images. In the next figure we show the 3D graphic representation of the studied perimeter in the river basin, selecting the use of Microstation 95 (Bentley) software.

5. Conclusions

1. The need and usefulness of creating a system for the supervision of soil and soil features' hydrotechnical improvement systems for irrigation and drainage, in which the hydric and salt regime of the soil is highly altered due to the agricultural developments; the aim of this monitoring has been and still is to timely identify the negative trends of soil features' evolution under the influence of land improvement works and to take the appropriate measures to prevent or stop these tendencies, in due time.

2. The increased accuracy of studies conducted on the agricultural land quality may be achieved by constant database development and update and by making use of complex mathematical models for the prognosis of its evolution.

3. In the context of employing a GIS, a wide variety of data from various sources can be introduced in the system, sometimes extended through automatic statistical processing and thus a multitude of information is obtained, including syntheses for certain periods of time, graphics, and thematic maps for erosion risks or the need of intervention with agricultural- pedological improvement measures.



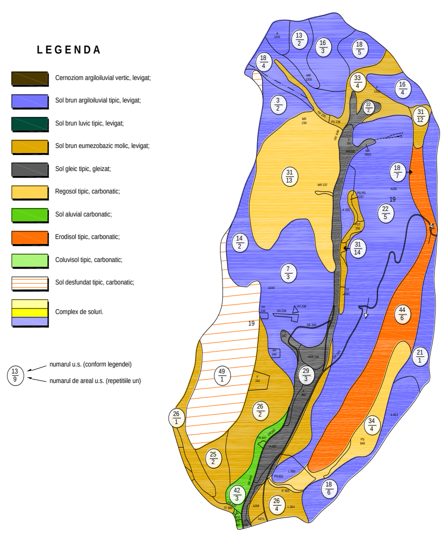


Figure 7 – Map of soils in digital format under Geo-Graph software in the studied river basin

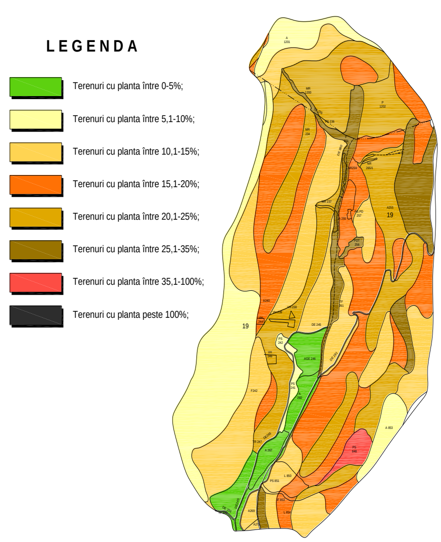


Figure 8 – Map of slopes in digital format under Geo-Graph software, in the studied river basin

4. *GEO – GRAPH* is a useful tool for the management and processing of graphical and non-graphical information. In the study reports, for each stage it was shown that the GEO – GRAPH system is an open system due to the structure of ASCII format input data. The user can generate his/her own programs which will create input data acknowledged by the GIS system, such as: data from sites represented by coordinate and outline files or data from *.dxf* files resulted from vectorization.

5. For the works of cadastre rating, it is required to transpose the limits of soil units taken from the pedological map on the lot cadastre plan. The rating marks (weighted averages) for each cadastre lot are recorded in the land registers.

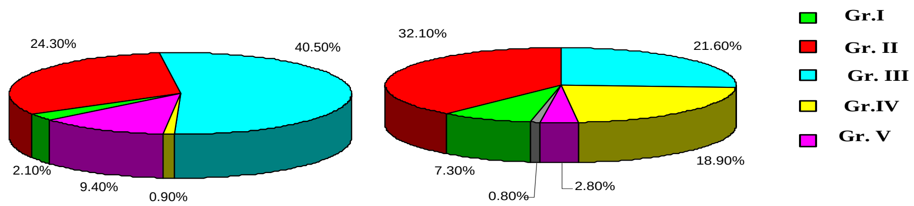


Figura 9 – Rating group repartition diagrammes in the studied river basin
evolution appeared simultaneously with the intensification of

6. The modeling/ simulation models support the specific land development solutions; the integration into a GIS, needs more data than usual, in order to obtain information / results as maps.

7. By analogy with other processes of production potential evaluation for agricultural lands affected by permanent degradation processes, GIS techniques provide real-time low-cost information to the land management decision makers.

8. In the context of natural and social-economic conditions from Romania, the use of Geographic Information Systems for the study and prognosis of land erosion and other associated processes represents a very modern requirement, taking into account the economic grounds and the speed of obtaining the information required for taking the appropriate decisions of improving the situation, in real time.

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THE INFLUENCE OF THE TRANSPORT NETWORK ON THE ACCESSIBILITY DEGREE OF AMBULANCES. CASE STUDY: CHISINAU.

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Rezumat: *Reformele implementate în Sistemul de Asistenţă Medicală (SAM) în ţara noastră impun noi abordări şi ridică noii cerinţe faţă de modul în care se realizează şi se asigură asistenţa medicală a populaţiei. O componentă importantă a SAM este Serviciul de asistenţă medicală urgentă.*

Localizarea staţiilor SAMU determină costurile (distanţă şi timp) de acces a serviciilor medicale spre populaţie. Buna funcţionare a SAMU presupune un nivel mare de accesibilitate şi mobilitate, care condiţionează menirea principală a serviciului. Nivelul înalt al accesibilităţii poate fi obţinut prin localizarea corectă a staţilor de intervenţie în cadrul zonei deservite cât şi prin eficientizarea rutelor de la staţii spre populaţie, dar şi de la populaţie spre centrele medicale, ultimele fiind în multe cazuri şi punctul final al rutelor.

Key words: *road network, accessibility, access zones, isochrones.*

Introduction

The implemented reforms in the System of Medical Assistance (SMA) in our country impose new approaches and submit new demands towards the way it is achieved and assured the medical assistance of the population. An important part of the SMA is the Service of Medical Emergency Assistance (SMEA). In the city of Chisinau SMEA represents a territorial structure formed on the hierarchical system of a principal station and 4 secondary stations endowed with 61 specialized motor vehicles (MSRM, 2005).

The localization of SMEA stations establishes the price (distance and time) of the accessibility of the medical services for population. The good functioning of SMEA supposes a high level of accessibility and mobility that determine the main aim of the service. The high level of accessibility can be obtained by correct localization in the zone and both by making more efficient the routes from stations towards population, and from population towards the medical centres, the last ones being in many cases the final point of the routes.

The form of the territory of the city of Chisinau represents a polygonal structure elongated from south-east to north-vest with a surface over 120 km^2. This polygonal structure is covered by 5 SMEA stations. The uniform territorial covering of the residential zones in the city districts with operative medical services and the improving of SMEA’s access represent the goal of this study.

The population’s acces to services is very important and is connected to working of a well organized and effectively managed healthcare system. The existing studies (Penchansky,1981; Guagliardo,2004; Brans,1981) distinguish five levels of population's acces[1]: availability, accessibility, accommodation, affordability and acceptability. In this study we report only on the accessibility represented by the location, time of access and distance.

Methods and Materials

On the first stage it was formed the linear network of the system of motor vehicles in Chisinau. The network was obtained by digitizing 1:10 000 the topographical maps and the visual rectifying according to Ikonos satellite images of Chisinau. The satellite pictures were of a great utility especially in renewing and actualizing the information about roads. Also due to satellite pictures there were established the portions with the highest motor traffic.

A special role in the investigation is played by the route measurements of the road portions in the network. There were done ten measurements for each road category. It is to mention that this stage was one of the most difficult, implying work on the territory, GPS measurements and high fuel consumption. The measurements pointed out several sections with the highest traffic pressure on the road network. These sections have a very important role on the functioning of the whole road network. Their influence is decisive in increasing the access speed in network and in its diminishing.

To generalize the measurements on road sections we started from the idea of speed homogenizing on the whole segment. The average speed of the section was determined as the average speed of the active motion (A) and the pending motion (B). The first one is conditioned by the speed settled by the Traffic Rules and the type of road wear and the second by the existence of traffic-lights, intersections, and traffic jams (fig.1).

The following stage represented the indexation of the vectors (roads) with random data and network contents, such as: main roads, secondary roads and neighborhood roads, one way or two-way traffic roads etc. For each network segment, which in fact represents a road section, there were calculated lengths (meters), average speed (km/h) and time of travel (minutes) (Butler, 2008).

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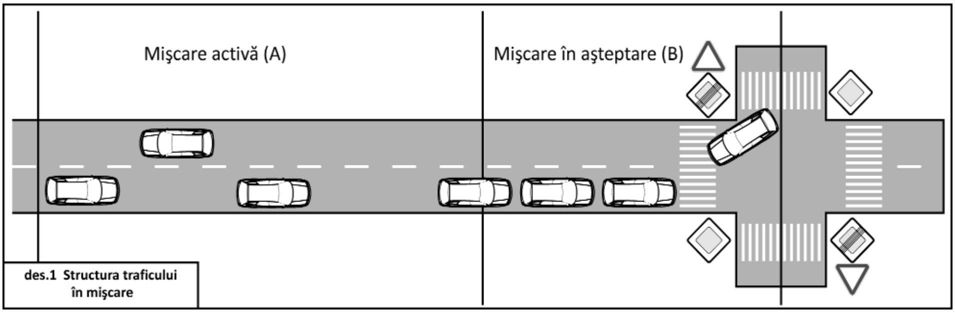
[1] În articolul "The Concept of Access. Difinition and Relationship to Consumer Satisfaction" Penchansky R. şi Thomas J.W. evidenţiază cinci nivele de acces - ***Availability****, the relationship of the volume and type of existing services (and resources) to the clients' volume and types of needs.* ***Accessibility****, the relationship between the location of supply and the location of clients, taking account of client transportation resources and travel time, distance and cost.* ***Accommodation****, the relationship between the manner in which the supply resources are organized to accept clients (including appointment systems, hours of operation, walk-in facilities, telephone services) and the clients' ability to accommodate to these factors and the clients' perception of their appropriateness.* ***Affordability****, the relationship of prices of services and providers insurance or deposit requirements to the clients' income, ability to pay, and existing health insurance.* ***Acceptability****, the relationship of clients' attitudes about personal and practice characteristics of providers to the actual characteristics of existing providers, as well as to provider attitudes about acceptable personal characteristics of client'. "*

In the study as tools there were used specialized software from GIS-T (geographical information systems in transport) group: TransCad 4.5 and ArcGIS 9.1 (module Network Analyst). They allowed the reduction of calculation time and the simplification of case sittuations' modeling.



des.1 Structura traficului în mişcare

Results and Comments
Geographical location of the SMEA stations.

Analyzing the location of SMEA stations throughout the districts of the city we can mention that their location is more or less uniform. All the stations are situated in residential zones of the city. The SMEA stations of Riscani, Centru and Botanica are situated inside the residential zones, excepting those of Buiucani şi Ciocana which are located at the edge of residential zones.

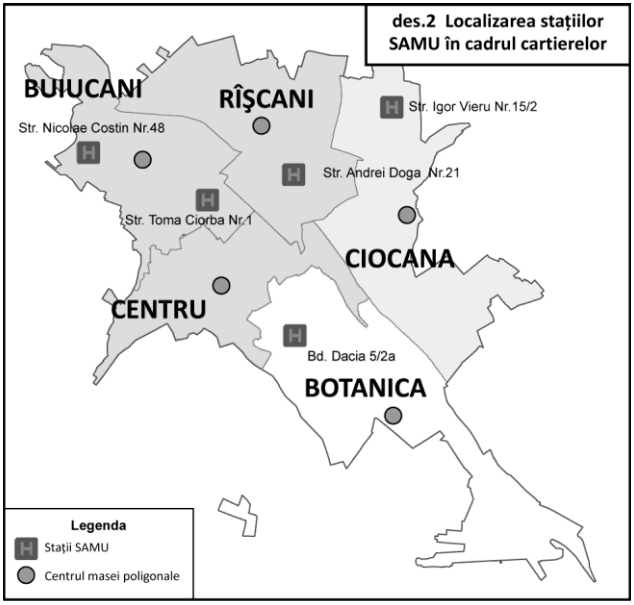
It is difficult to highlight the favourability of stations' location. It can seem that their central location in the district is the best solution, but if taking into account the form of the motor transport network and the traffic pressure on the network, it makes possible the short time entrances of the ambulances from the boundaries of residential zones towards inside without staying in traffic jams. A totally different situation is recorded in the case of SMEA stations of Centru, Buiucani and Rascani. Their location inside the residential zones requires direct entrances in the transport network even in the segments where it is the highest traffic. This conditions the diminishing of the route speed in the incipient phase.

To identify the position of the stations concerning the centres of the districts it was calculated the centre of polygonal mass for each district (Jenness, 2006) (fig.2). The calculations show the location of SMEA stations compared to the centres of the districts. In the case of the Buiucani station it is situated 1,6 km towards north-west, the Riscani station is 1,8 km towards south-east, the Ciocana station is 3,2 km towards north, the Botanica station is 3,9 km towards north-west. In the case of the Centre station it is situated 2,7 km northward, being located even in another district (Buiucani).

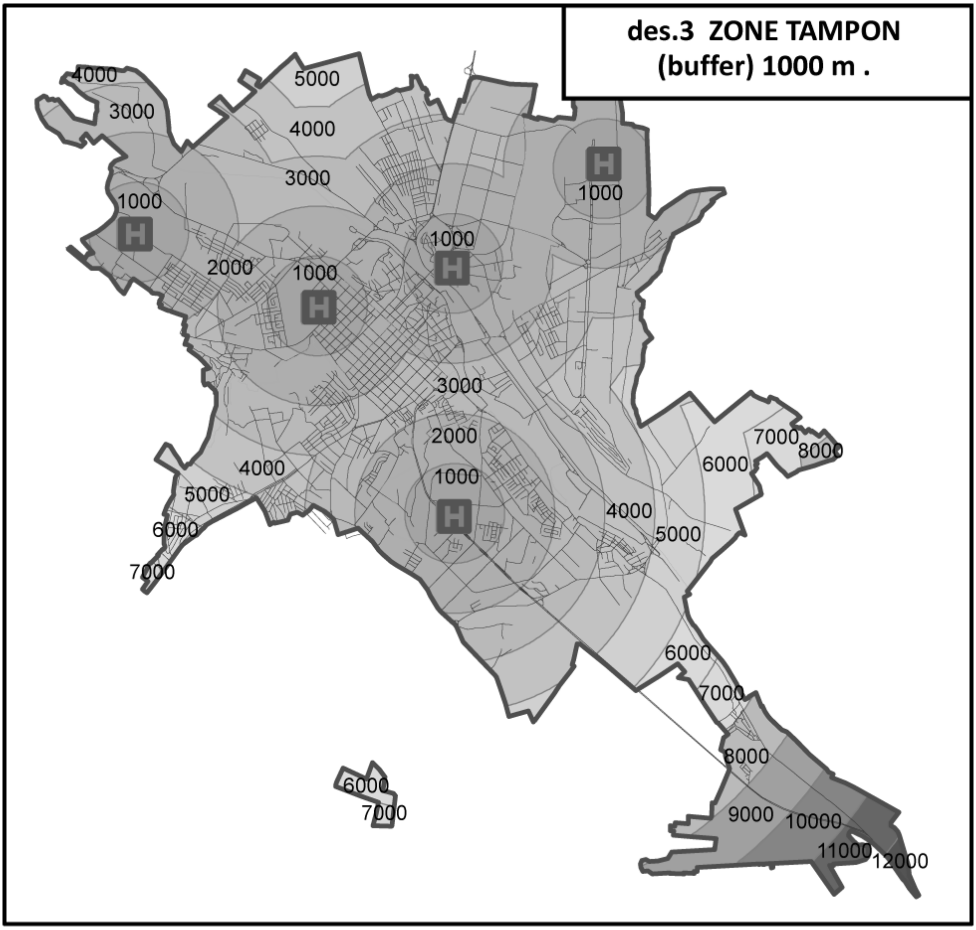
Buffer zones.

An important role in the efficient functioning of the SMEA plays the area of the territory which the service can cover. There were formed several buffer zones marked over 1000 metres. When the zones were formed it was paid attention to the fact that all the stations work as a system. The formed zones represent the territorial overcast of the city by all the stations altogether (fig.3).

The furthest zone is that of 9000 -12000 metres that comprises the south-east part of the city (the region of the airport). Most of the city's rezidential zones are around 1000 - 4000 metres from the SMEA stations.



It must be mentioned that the buffer zones don't exactly reflect the coverage index, because it doesn't take into account the form and the content of the road network. The formation of buffer zones reflects more a generalizing index of territorial coverage. Eventually the ambulances don't circulate on straight lines, but on roads that can take different configurations and have different cross time.



Time and Distance.

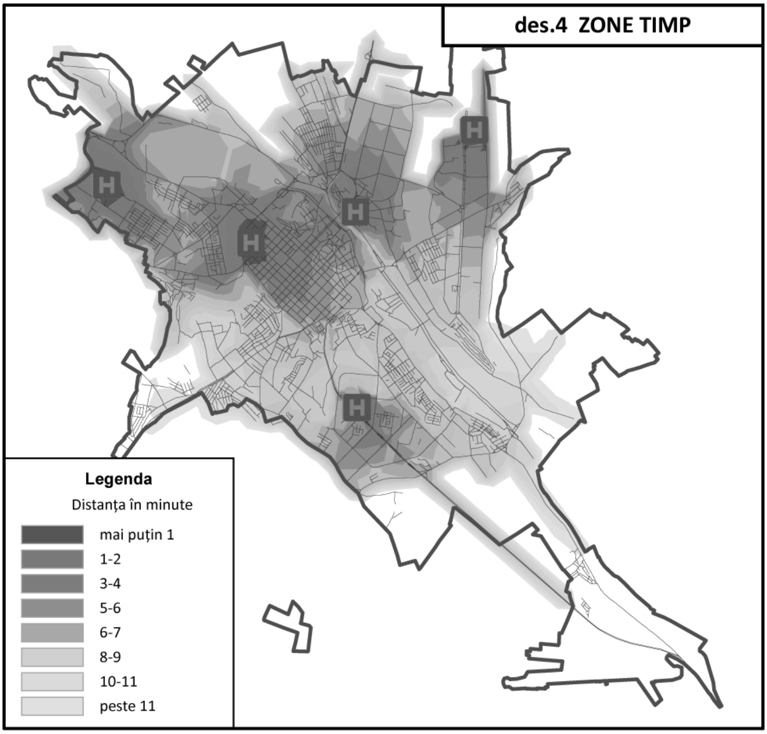
Time and distance in network are two measure indicators that demonstrate the efficiency of network. They are the values that can measure the accessibility of SMEA services to the population and vice versa. The calculations refer primarily to the measurements in the road network in Chisinau city. In order to determine the time and distance zones 135 ambulance calls were modeled. The points for calls were placed arbitrarily all over the city, but taking into account the distance from the main road lines, the location of SMEA stations, the location within the residential zones of the districts.

Time. The time indices are in direct correlation to the location and extention of the five city districts and the location of SMEA stations.

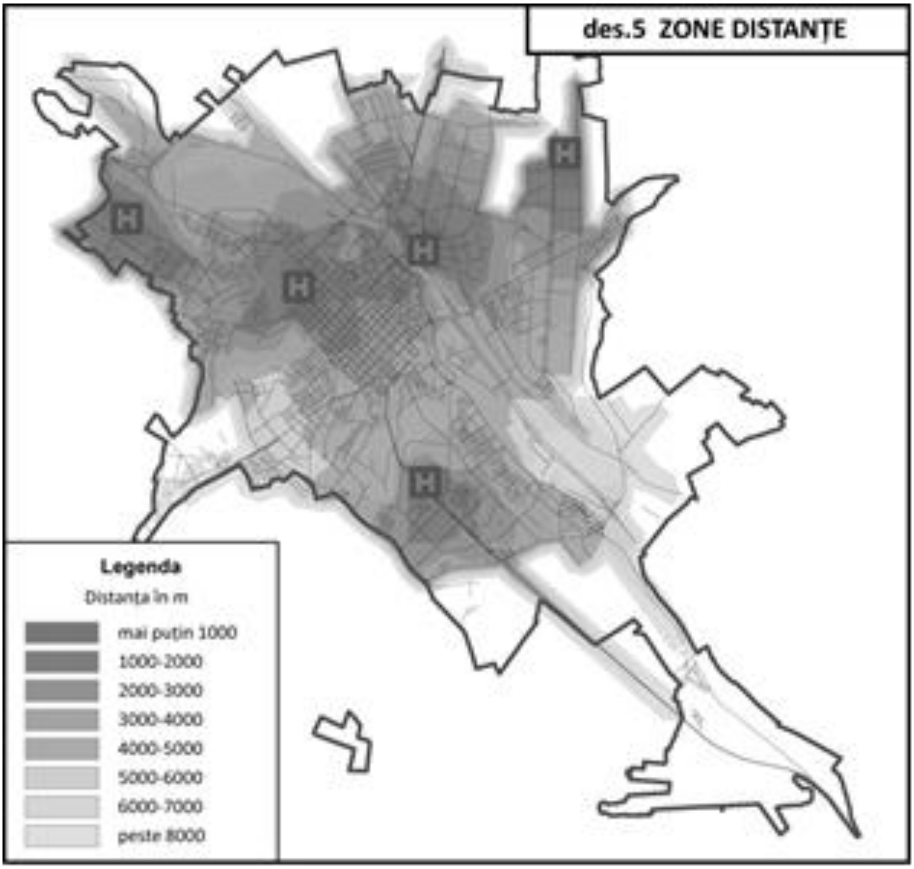
Table 1 Zones of covering of Chisinau city districts with SMEA service, by time

Nr. rd	ZONES	BUIUCANI		CIOCANA		BOTANICA		CENTRU		RÂŞCANI	
	minutes	km²	%	km²	%	km²	%	km²	%	km²	%
1	0 - 1	0,78	9,50	0,22	4,95	0,07	0,77	0,00	0,00	0,10	1,15
2	1 - 2	1,37	16,75	0,49	10,71	0,14	1,59	0,00	0,04	0,71	7,88
3	2 - 3	2,02	24,71	0,72	15,77	0,46	5,44	0,58	6,37	2,35	26,11
4	3 - 4	2,52	30,90	0,58	12,85	1,54	18,10	0,92	10,21	2,84	31,54
5	4 - 5	1,16	14,23	0,64	14,06	1,76	20,67	0,89	9,85	1,91	21,24
6	5 - 6	0,19	2,28	0,70	15,34	0,87	10,30	1,22	13,54	0,60	6,67
7	6 - 7	0,10	1,17	0,29	6,44	1,96	23,08	1,63	18,05	0,19	2,16
8	7 - 8	0,01	0,13	0,21	4,55	1,00	11,72	1,59	17,60	0,04	0,43
9	8 - 9	0,01	0,10	0,33	7,26	0,11	1,24	0,80	8,88	0,03	0,36
10	9 - 10	0,01	0,07	0,13	2,95	0,05	0,64	0,34	3,79	0,02	0,28
11	10 - 11	0,00	0,05	0,12	2,57	0,05	0,64	0,08	0,92	0,02	0,24
12	11 - 12	0,00	0,03	0,04	0,81	0,07	0,88	0,12	1,32	0,02	0,18
13	12 - 13	0,00	0,00	0,02	0,44	0,14	1,59	0,41	4,51	0,01	0,16
14	13 - 14	0,00	0,00	0,01	0,29	0,13	1,57	0,29	3,23	0,01	0,15
15	14 - 15	0,00	0,02	0,01	0,20	0,03	0,32	0,04	0,41	0,01	0,15
16	15 - 25	0,00	0,06	0,04	0,82	0,12	1,44	0,12	1,28	0,12	1,32
			100,00		100,00		100,00		100,00		100,00

The obtained indices are the result of a complex modeling that takes into account the system's operation for the simultaneous serving of all the districts by all the SMEA stations. In our modeling, the serving is not directly connected to the affiliation to a well defined district. Through aggregation were distinguished the polygons of the districts that represent the residential zones of the city. Afterwards, overlaped through „overlay" - „intersect" with attributes' transfer with time zones. There were stabilized 16 zones within the districts with different time of acces of the ambulances (fig.4, tab.1).



The district of Buiucani, according to the obtained data, has the best covering. Over 99% or 8,13 km^2 of the residential zones area is comprised by the zones 1 – 7. The most remote limits of the district can be reached in 7 minutes. Over 97% (4,42 km^2) of Ciocana district are covered by 11 zones, i.e. 11 minutes. The big number of time zones is explained by the big extention of Ciocana district and by the insular shape of the residential zone. Approximately 90% (6,84 km^2) of the residential zone of Botanica district is comprised by 6 time zones. In case of Botanica district the closest zones of 1-2 minutes cover only 2,3%. This fact is explained through the location of SMEA station regarding the district, through configuration of transport network and through the traffic direction in the immediate vicinity to the SMEA station of Botanica. 98 % (8,92 km^2) of residential zone of Centru district is covered by most of time zones, except only zones 1, 2, 11, and 15. The lack of 1-2 minutes zones is explained by the fact that in this district there are no SMEA stations. The residential zone of Rascani district making 98% (8,83 km^2) is covered by eight time zones: 1-7 and 16.



Distance. Distance indices offer another view over the covering of city's residential zones with SMEA services.

Table 2 Zones of covering of Chisinau city districts with SMEA service, by distance

.ord	ZONE	BUIUCANI		CIOCANA		BOTANICA		CENTRU		RÂŞCANI	
	km	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
1	**0 - 1**	1,38	16,87	0,41	8,99	0,21	2,45	0,00	0,01	0,67	7,43
2	**1 - 2**	2,56	31,38	0,90	19,83	1,49	17,50	0,34	3,73	2,95	32,77
3	**2 - 3**	3,32	40,62	1,01	22,38	2,26	26,57	1,31	14,55	3,57	39,67
4	**3 - 4**	0,87	10,66	1,16	25,65	1,92	22,65	1,86	20,56	1,33	14,78
5	**4 - 5**	0,01	0,17	0,28	6,12	1,87	21,99	2,77	30,69	0,21	2,36
6	**5 - 6**	0,01	0,15	0,31	6,93	0,12	1,43	1,54	17,01	0,05	0,58
7	**6 - 7**	0,01	0,07	0,30	6,60	0,03	0,31	0,27	2,95	0,04	0,47
8	**7 - 8**	0,00	0,00	0,10	2,16	0,06	0,72	0,06	0,66	0,03	0,35
9	**8 - 9**	0,00	0,03	0,02	0,53	0,27	3,15	0,62	6,85	0,03	0,30
10	**9 - 10**	0,00	0,01	0,02	0,40	0,20	2,35	0,23	2,55	0,04	0,48
11	**10 - 11**	0,00	0,01	0,01	0,11	0,03	0,32	0,02	0,24	0,02	0,24
12	**11 - 12**	0,00	0,02	0,00	0,11	0,02	0,27	0,01	0,10	0,02	0,27
13	**12 - 13**	0,00	0,02	0,01	0,21	0,03	0,30	0,01	0,12	0,03	0,32

The distance values aren't connected to the traffic and to its intensity as time indices are. They depend only on the remoteness of call points from the SMEA station and on the presence of a road with a geometry closer to a straight line.

There were established 13 zones that cover all districts of the city. All zones as well as the time zones start from the SMEA stations to the districts' outskirts.

The zones were traced over 1 km (fig.5, tab.2).

Over 98% (8,33 km^2) of Botanica district are covered by 8 zones. 98,8% (8,94 km^2) of Centru district are included in 8 zones (2 – 7 and 9 – 10), among which, the zones 3 – 6 cover 82,8%. Five zones (1 – 5) cover over 97% (8,73 km^2) of the area of residential zone of Rascani district.

Conclusions

1..SMEA stations' location is more or less successful.

2..The stations can cover with services the largest part of the city, taking into account the possible growth zones of the city.

3..The accessibility of ambulances is hampered by several factors:

4. Inadequate movement of traffic members;

5 Violation of traffic rules by the traffic members;

6 Damaged road coverage, which reduces the call time and speed;

7 The incorrect algorithm of route covering etc.

8Neutralization of the statement that in Chisinau city the ambulances can not reach all the calls together for less than 10 minutes.

9The extention of the districts and the peripheric location of SMEA station complicate the access and speed of the call (in case of Ciocana, Buiucani and Botanica, with reference to microdistrict „Airport”).

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AGRO-ENVIRONMENTAL ASSESSMENT OF THE PRODUCTIVITY OF AGRICULTURAL CROPS IN THE SOUTH OFf THE REPUBLIC OF MOLDOVA WITH THE HELP OF GIS

T.Constantinov, I. Mangul, L. Fedotova, I. Roşca

Рассмотрена агроэкологическая оценка продуктивности сельскохозяйственных культур на юге Республики Молдова при помощи ГИС – технологий. Произведен анализ научных исследований о пространственно-временной изменчивости агроклиматических показателей и урожая сельскохозяйственных культур, выявлены основные закономерности их распределения в рельефе.

***Key words**: agro-climatic parameters, precipitation, amount of active temperatures, absolute minimum temperature, the yield of crops.*

***Rezumat** În articol este reflectată evaluarea agro-ecologică a productivităţii culturilor agricole în partea de sud a Republicii Moldova, utilizând tehnologiile – SIG. Este efectuată o analiză privind variabilitatea spatio-temporală a indicilor agroclimatici şi randamentul culturilor agricole, fiind identificate principalele regularităţi ale distribuirii lor în acest spaţiu.*

***Cuvinte cheie**: parametrii agro-climatici, precipitaţii, suma temperaturilor active, temperatura minimă absolută, recolta culturilor agricole.*

In the modern conditions science-based land assessment allows making the right choice of cultivars and crop management technologies, avoiding ill-considered losses and risk of damage to the plants due to adverse weather conditions - frosts, early autumn and late spring frosts, droughts, etc.

Therefore, the aim of our research is the analysis and evaluation of agroecological conditions in terms of a separate village's land use in order to optimize the agricultural crops placement. Among the indicators used to assess the agroecological resources, pedological and morphometric characteristics as well as the air and soil heat and water balance components are most commonly used [2,4,5,8]. In this case agroclimatic characteristics are expressed through various factors and indexes.

Materials and methods of the research.

The source material for this study was information about the productivity of major crops grown on the Congaz village territory. Meteorological data (heat and humidity characteristics) was provided by the State Hydrometeorological Service of

Republic of Moldova. Pedological and morphometric characteristics of the territory were provided by the Institute of Ecology and Geography, Academy of Sciences of Moldova.

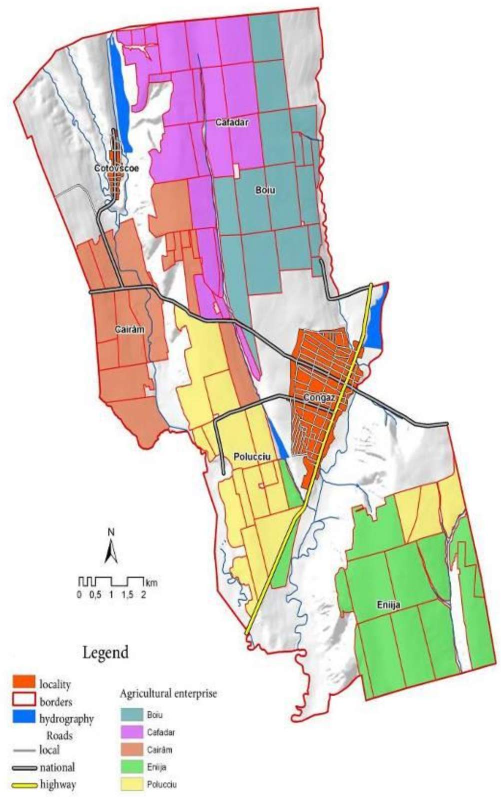

Figure 1 Location of agricultural enterprises on the land of the village Congaz

Five agricultural enterprises are currently situated on the fields of Congaz village land-utilization: Border Boiu, Cairam, Polucciu, Kafadar and Eniija, which were organized on the basis of former collective farm "Russia" (***Figure 1***).

The soil cover in the studied area mainly consists of typical weakly humeferous chernozems and calcareous chernozems.

Typical weakly humeferous chernozems are warmer and less provided with moisture compared with leached chernozem. These soils predominate in the southern plains of republic, where they occupy 32-39% of the area. They have 82 points by productivity and are the most fertile soils to the South of Codry. These soils are suitable mainly for field crops and grapes.

Calcareous chernozems - a distinctive soil subtype containing carbonates from the surface, the least humeferous and most lightly-colored - is notable for the most moisture deficit. Especially prevalent in the southern plains, where they reach 36% from the whole. By productivity they have 71 point, for viniculture- the highest score (100 points).

Here is a brief overview of soil cover in the research area: Typical weakly humeferous chernozems and calcareous (mainly moderately humeferous clayey-loamy ones) chernozems are common on the territory of ***Eniija enterprise***. In percentage: 30% - weakly eroded calcareous chernozems, 20-30% - moderately eroded calcareous chernozems and strongly eroded loamy and clayey-loamy, under the vineyards. Typical weakly humeferous chernozems constitute 40% of all soils and are under annual crops.

Pulucciu Enterprise - here prevail (40%) alluvial mollic soil, moderately loamy or clayey-loamy, weakly eroded in some places. Nearly 40% of the territory are occupied by weakly eroded typical weakly humeferous chernozems , and only 20% of the territory – with weakly and moderately eroded calcareous chernozems.

Kairam Enterprise - this area is dominated (50%) by calcareous chernozems, clayey-loamy and sandy-loamy varieties, weakly eroded. 30% of the territory is occupied by the typical weakly humeferous chernozems, strongly humeferous clayey-loamy chernozems, weakly humeferous clayey-loamy and sandy-loamy chernozems. About 25% of the territory is occupied by strongly eroded and deformed soils, rugged by ravines and destroyed by landslides.

Kafadar Enterprise is characterized from pedological point of view by calcareous clayey-loamy chernozems (60%), 25% of the territory is occupied by weakly eroded typical weakly humeferous chernozems and 15% of enterprise area is occupied by deformed and eroded soils.

On the ***Border Boiu enterprise*** territory the largest area (65%) is occupied by flat areas of weakly eroded typical weakly humeferous chernozems. Calcareous chernozems here occupy about 30% of the area, humic gley soils also can be met on nearly 5% of the territory.

Currently, the data obtained by the network of weather stations and posts is commonly used to estimate the agroclimatic resources of the territories [1,6]. This usually does not take into account the fact that the weather stations and posts are placed in different locations. For example, the Moldova's weather stations and agrometeorological posts' altitude varies from 26 m on Vulcanesti post till 232 m at Cornesti weather station. In addition to that, many of them are located on various forms of relief.

Given that the studied area is located on complex relief, and, consequently, agricultural fields are located in different agroecological conditions, we tried to identify microclimatic features of the territory and sites of natural, most favorable microclimate for agricultural crops cultivation. For this purpose, microclimatic data from Agroclimatology Laboratory, Institute of Geography, Academy of Sciences of Moldova was used, field studies of which were made on Baurci village fields - adjacent to Congaz village's land-use territory.

Agroecological estimation of crops growing conditions in the areas that are not covered by instrumental observations is performed using computational methods, involving long-term agroclimatic data of Comrat weather station. It should be noted that microclimatic patterns of distribution of several meteorological parameters - radiational, heat, humidity and other characteristics for complex relief areas have been investigated by present due to field studies and computational methods, as well as informational technology features. Patterns are often presented in the form of microclimatic maps. [2,4,5,9]. In order to elaborate microclimatic maps, traditional methods of inter- and extrapolation of meteorological values are commonly used to establish the statistical relationship between relief characteristics and meteorological values. [2,8,9]. In this case, the real picture is not always reflected objectively.

GIS technologies were used for elaboration of agrometeorological indexes distribution maps in this paper. Characteristics of the air thermal regime was expressed as an average of the absolute minima and the sum of active temperatures above 10°. The amount of precipitation per year was adopted as moisture. As a basic characteristic of plants heat supply, the sum of air temperatures depends on the values of latitude and altitude above sea level, which determine the degree of its variability.

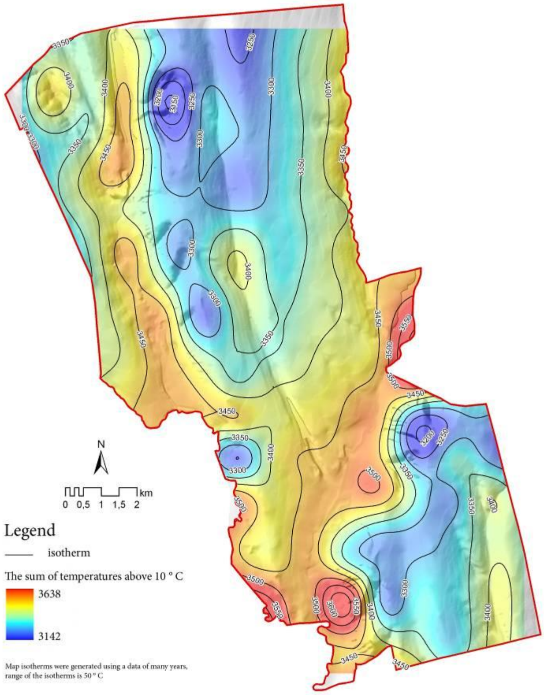

Figure 2 Microclimate variability of the amounts of active temperatures above 10 ° on the land of the village Congaz

Figure 2 shows the microclimate map of the distribution of sums of active temperatures on the Congaz village land .

The map analysis showed that the variability range in the amounts of air temperatures above 10° C at the study area is 500°, i.e. depending on the location of the plot in the relief, the amount of temperature changes from 3150 to 3600°. The smallest amount of heat enters the Eniija and Kafadar farms territory (3150 ° -3350 °), the warmer areas are located on the territory Kairam and Polucciu (3400° - 3500°). These sums of temperatures, on average, at 50-250° compared with those contained in the handbook [1] for the III-th agroclimatic region, comprising the Congaz village territory. These differences obviously can be attributed to global and regional climate warming, which is observed in recent decades and are not included in the directory, since it was published in 1982, as well as a detailed account of the topographic features.

It is known [7,9] that the minimum winter air temperatures are one of the limiting factors of overwintering perennials. According to the studies [9] not-ukryvnaya culture of grapes for the relatively hardy varieties is advisable in areas situated to the south of the contours of the average absolute minimum temperature -20° C, for half-hardy -19° C, for tender -18 ° C. Consequently, in the territory of farms the possibility of not covered grape cultivation technology is provided only in the areas where the minimum temperature does not fall below 18 ° -20 °. However, the ruggedness of terrain significantly affects the distribution of minimum air temperatures, especially in the cold and transitional periods, when this factor becomes the second most important after the latitude. With this in mind we found simulation of the field average of the absolute minima of air temperature interesting (***Figure 3***) on the Congaz village land and in this case the differences were significant in the distribution of minimum temperatures. The range of variability of the average of the absolute minimum here may vary from - 17,8 ° to 24,5 °. Less frosty areas are located in the farms Eniija and Kafadar, where the average of the absolute minima does not fall below the -22°. More severe conditions for overwintering of winter crops and perennial plants are formed on the territory of farms Polucciu and Cairam where the average of the absolute minimum is -23-24°. Lands with a minimum air temperature 18-20° occupy small areas and are located primarily in the inconvenient. Uniform deposition.

For the III-th agroclimatic region, which includes the land of the Congaz village, average of annual precipitation is 486 mm [1]. Consequently, the lack of water here is about 100-300 mm, depending on the conditions of the year.

But as it turned out, the underlying surface characteristics also affect the allocation of the precipitation amounts. ***Figure 4*** shows the distribution of average annual precipitation in the study area. According to the map the amount of precipitation varies from 490 to 530 mm in the study area. The highest precipitation amounts fall in the territory of farms Kafadar and Eniija (470-500mm), on the rest of the territories their sum varies between 450-480mm. This precipitation amount has been significantly less than optimal, and gives evidence in the terms of moisture supply to the lack of moisture resources. Consequently, this territory is at risk, requiring additional measures to ensure sustainable harvests.

This to some extent, may be facilitated by considering the agro-ecological conditions, which are one of the additional intensifying factors that determine the structure of the fields and the placement of crops based on the plants requirements to the environmental conditions and their provision. Thus, the emphasis should be placed on the greening of agriculture, in terms of crops location and the organization of field agro-based crop rotation.

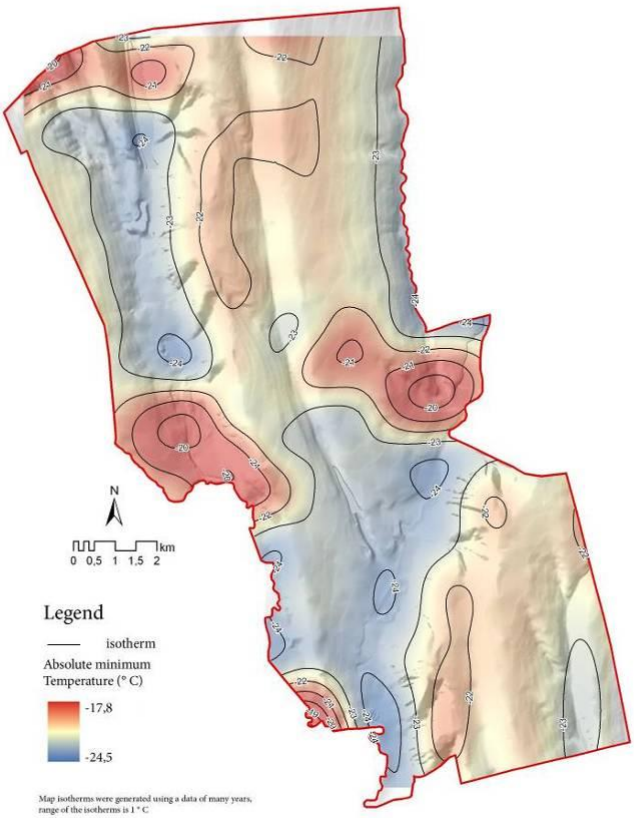

Figure 3 Microclimate variability of the average of the absolute minima of air temperature on the land of village Congaz

1. To this end, on one hand the requirements of different varieties to basic natural factors such as the orientation of slope, elevation above sea level, the slope magnitude, soil types and subtypes, their texture and degree of flushing are studied, but on the other hand, an inventory of

natural conditions within the habitats that determine the specific environmental conditions for cultivation of crops is made. An indicator of availability of crops climatic resources is their level of productivity, as well as its variability from year to year.

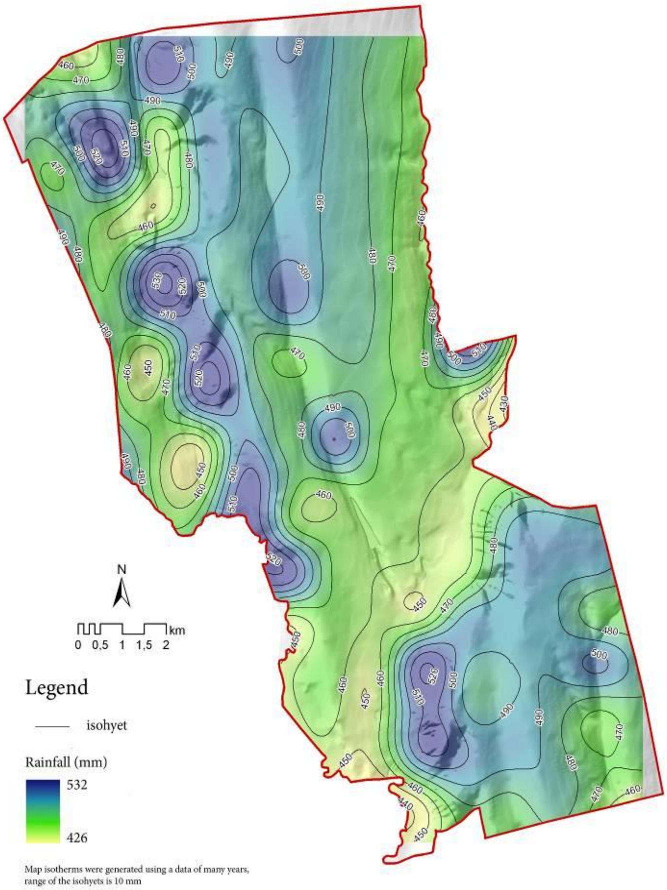

Figure 4 Microclimate variability of rainfall on the land of the village Congaz

2.***Winter wheat.*** In the south of Moldova winter wheat is the major grain crops, in this connection significant experience on the technology of its production has been gained here[1, 7,8]. However, in the years of adverse weather conditions, the yield of winter crops is markedly reduced, often significantly. Thus the maximum yield of winter wheat during the observation period (2000 and 2005) on the land of the Congaz village was 50,5 q/ha, while the minimum yield for this period amounted to 2,4 q/ha, hence the difference in yield was 48,1 q/ha.

3. Thus, the winter of 2002 - 2003 and the hot and dry summer of 2003 has turned out highly unfavorable for the winter crops. This year, the winter wheat yield was very low (5-6 q/ha) on the land of the Congaz village. The sleet in winter and the drought in summer had a severe negative impact on the harvest of winter crops. The average yield for farms this year was 5 q/ha (***Table 1***), and its value ranged from 2,4 q/ha in the Border Boiu farm to 9,5 q/ha in the Eniija cooperative.

The average yield of crops change on the Congaz village land during years 2000 - 2005

Table 1

Years of research	Winter wheat			Corn			Sunflower			Grape		
	AV farm	Δ yield	AV South	AV farm	Δ yield	AV South	AV farm	Δ yield	AV South	AV farm	Δ yield	AV South
2000	23,2	2,7	24,4	14,6	12,9	8,7	11,4	5,4	10,8	51,4	36,0	41,9
2001	41,7	14,5	37,0	20,5	9,4	15,8	11,6	7,7	13,1	30,2	25,2	26,9
2002	27,8	9,1	21,1	14,4	10,0	10,5	12,4	4,0	11,0	51,8	24,1	38
2003	5,0	7,1	5,7	19,5	10,4	17,1	8,8	9,3	9,7	48,7	27,8	37,7
2004	33,5	9,6	33,7	34,2	13,8	29,4	12,2	5,3	10,8	76,1	36,4	45,7
2005	31,6	11,2	24,7	31,1	10,5	26,0	15,1	9,0	11,7	53,1	39,8	32,8
Average	27,2	9,0	24,4	22,3	11,6	17.9	11,9	8,5	11,2	51,8	31,5	37,1

*** *Note:*** *AV farm-average yield on the farms (centner/ha);* Δ yield - *the difference in yield between farms (centner/ha); AV South - the average yield in the south of Moldova (centner/ha).*

However, under such extreme conditions on the territory of the cooperative Eniija, the harvest of winter crops was relatively good for this year and amounted to 9,5 q/ha. This can be explained by a little better temperature-humidity indices during the growing season and wintering conditions in this territory compared to other farms. Figures 2,3,4, represent microclimatic characteristics of these farms. In addition, the soil of these areas influenced the growth, development and yield formation. The difference in yield of winter wheat harvested in cooperatives in this year amounted to 7.1 q/ha, with an average harvest in the south of the country's 5.7 q/ha.

In 2001 the harvest of winter crops was generally high and varied from 36.0 q/ha in the farm Kafadar to 50,5 q/ha in Polucciu. Such a relatively high yield of winter crops is due to the amount of precipitation and their uniform distribution in time, as well as the relatively low level of temperatures. This year, the differences in yield of winter wheat in the study area amounted to 14.5 q/ha. The average yield in the south of the country this year amounted to 37 q/ha.

Table 2 presents information about the harvest of winter wheat, maize, sunflower and grapes for each farm separately, for the same period (2000 -2005). It should be noted that, in characterizing the spatio-temporal variability of the yield on the average of its value, the fact that the average number of a row evens out its value and does not reflect the full range of its variability must be taken into account. Thus, according to *Table 2*, the average yield of winter on farms totaled 27.2 q/ha, and the differences in the average yield of winter wheat between farms amounted to 3.8 q/ha.

The average crop change for the territory, the period of studies (years 2000 - 2005, the Congaz village). **Table 2**

Crops	Border Boiu	Kairym	Polukchu	Kafadar	Eniyzha	Average yields on the farm	The difference in yield between farms	Average yield in the south of the republic
Winter wheat	26,6	28,4	27,4	25,1	28,9	27,2	3,8	24,4
Corn	20,6	19,7	21, 6	23,3	26,7	22,3	7,0	17.9
Sunflower	9,7	13,7	12,3	11,9	10,7	11,6	4,0	11,2
Grape	43,0	67,3	55,5	54,9	38,6	51,8	28,7	37,1

Corn. It is known that corn is a very susceptible to external conditions culture [10]. The year 2000 can serve a good example of this, when due to adverse weather conditions very low yields were obtained, which ranged from 8 to 21 q/ha, thus, differences in yield in the territory amounted to 13 q/ha. In the favorable 2004 the harvest of maize was 30-44 q/ha. Differences in corn yields between farms amounted to 10-14 q/ha.

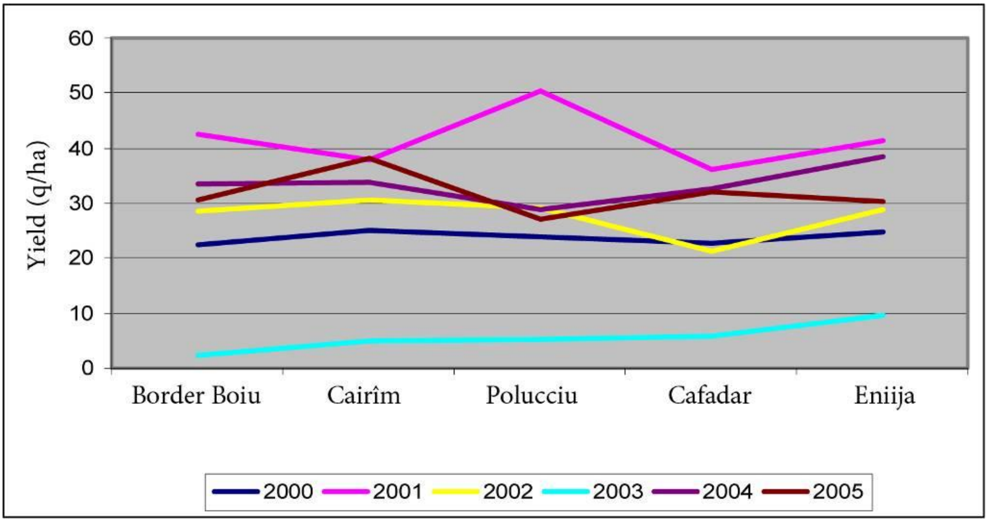

Figure 5 Spatial - temporal distribution of harvest of winter wheat on the land of the village. Congaz (2000 and 2005).

As ***Table 1*** shows, the average yield of corn during the study period varied from 14 q/ha to 34 q/ha. Differences in the average yield of maize in some years ranged from 9 to 14 q/ha. The maximum yield of maize was 43 q/ha, minimum 8.1 q/ha. The average yield in the south during this period was lower and varied between 9 to 29 q/ha. According to ***Table 2***, the average yield of maize in the studies varied from 19.7 q/ha (Kairam) to 26.7 q/ha (Eniija), which can be explained by natural conditions of these (Fig. 2, 3).

Sunflower. Although sunflower is considered drought-tolerant crops, it is very responsive to the moisture conditions [6]. Since 2003, which was characterized as arid, especially the first half of it, the average yield of sunflower in the Congaz farms this year was not high and amounted to 8.8 q/ha.

As ***Table 1*** shows the average yield of sunflower in the period 2000 to 2005 ranged from 8.8 to 15.1 q/ha. Differences in yield in individual years ranged from 4.0 to 9.5 q/ha, with an average of 8,5 q/ha. The maximum yield of sunflower was 18 q/ha, minimum 4.0 q/ha. The average yield in the south during this period was somewhat lower and varied between 10-13 q/ha.

The data presented in ***Table 2*** indicates that the best conditions for a crop of sunflower formed in the territory of Kairam with moderately warm conditions and relatively low precipitation and little washed calcareous soils.

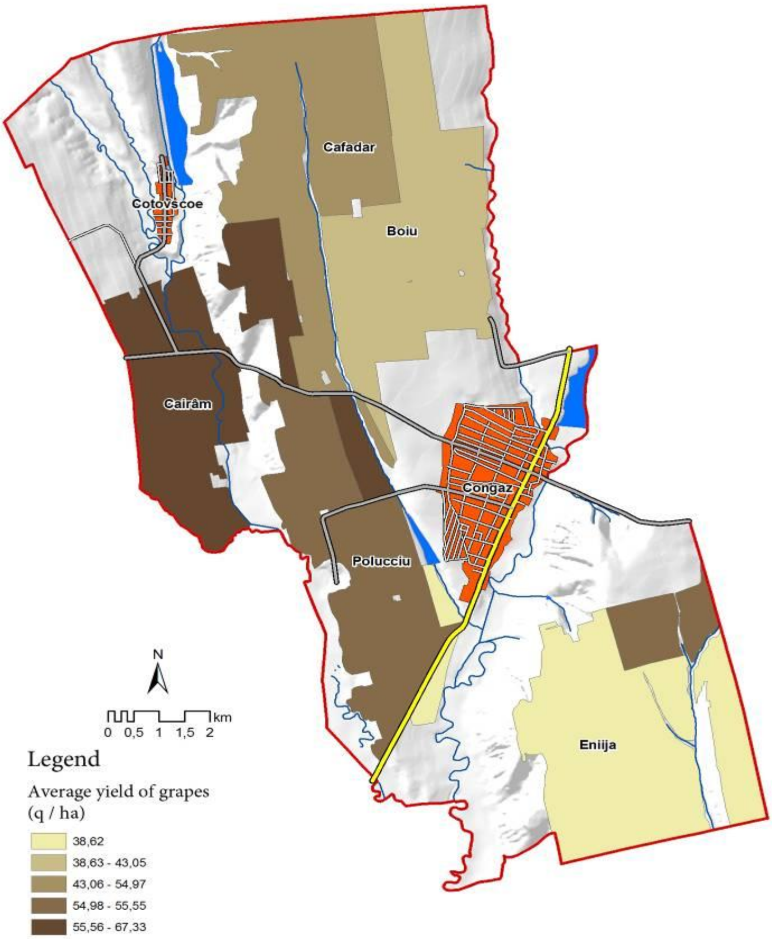

Figure 6 Variability of grapes harvest on the land of the village Congaz during 2000 -2005

Grapes. It is known that the quantity and quality of grapes depends largely on the environmental conditions of the area. In wine, as in a mirror appear particular qualities of the grapes cultivar and the place of its growth [3,9]. As ***Table 1*** shows, the average yield of grapes in the farms of Congaz during the studies period ranged from 30 q/ha to 76 q/ha. Differences in the grape harvest in some years reached 24 -

40 q/ha. The maximum yield of grapes was 96,4 q/ha, the minimum 14.8 q/ha. The average yield in the south during this period was significantly lower, it varied between 27-46 q/ha.

According to *Table 2*, the highest yields of grapes were collected at the farm Kairam with more moderate temperature regime and relatively low precipitation and little washed calcareous soils. On average of 6 years harvest here constituted 67 q/ha, this is 12 q/ha more than in the Polucciu and Kafadar farms and 29 q/ha higher than the crop harvested in Eniija.

Visually the winter wheat harvest distribution for each year of research and on individual farms is presented in *Figure 5*.

Conclusions.

1. Low yields of crops and their vast space-time variability is due largely to different levels of availability of natural conditions. The average crop grown in the fields of the Congaz village during the 2000-2005 years was higher than the average harvest in the south: in the winter crop at 3 q/ha, in maize at 2 q/ha, in sunflower at 0.7 q/ha, in grape at 15 q/ha
2. Differences in yield of crops grown in the land of the Congaz village, depending on the year, has varied considerably: in winter crops from 3 to 15 q / ha, in maize from 9 to 14 q / ha in sunflower from 4 to 9 q / ha and a grape-25-40q/ha.
3. The microclimate data of the individual farms territories allows one to correctly place the crops and crop rotations, as well as to differentiate the agricultural work that contributes to higher and stable yields and sustainable use of and. Establishment of a cartographic database for the different levels of economic organization will optimize the use of agro-ecological potential and reduce costs associated with the production of agricultural crops.

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THE ACCESSIBILITY IN NETWORK. CASE STUDY: ATU GĂGĂUZIA

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Rezumat: *Mişcarea populaţiei este unul din factorii determinativi ai vieţii societăţii. Reducerea consumului de timp şi distanţe inutile au fost şi sunt una din tendinţele principale în dezvoltarea societăţii. Accesibilitatea populaţiei este determinată în mare parte de căile de acces către servicii sau către alte obiective ce asigură buna vieţuire a oamenilor (accesibilitatea către serviciile medicale, pompieri, la justiţie, poliţie, pieţe de desfacere, instituţii de învăţământ etc.).*

Se analizează reţeaua de transport rutier din Unitatea Teritorial Autonomă Găgăuzia, care include măsurătorile de distanţe; formarea rutelor intre localităţile unităţii administrative şi centrul administrativ, ca prestator a majorităţii serviciilor, formarea zonelor de accesibilitate (prin isochrone); determinarea densităţii reţelei rutiere pe comune etc.

Key words: *road network, accessibility, access zones, network density, isochrones.*

Introduction

This study comes to complete the investigation started for the assessment and the measurement of transport networks in administrative districts of the Republic of Moldova. It is tried to identify the GIS processes for measuring the capacity and structure of networks of the same kind as the content and theme. The networks of any type can be caracterized by size, location, structure, connectivity, pressure on its structural elements etc.

In the south of the country there are located two territorial-administrative units - Cahul and Autonomous Territorial Unit of Gagauzia (ATUG). The road network of Cahul Unit was the subject of a research in wich several network indicators were analyzed as time and distances in the network, the level of accessibility from and to the administrative center etc. (Mamot, 2008).

The Autonomous Territorial Unit of Gagauzia (ATUG) is located in the south-east of Moldova, holding an area of over 1 832 sq km. This unit includes 33 localities with a population of 155 646 inhabitants. ATUG includes three administrative districts – Comrat, Ciadar-Lunga and Vulcanesti.

The form and content of the transport network is determined by the geographical position of the administrative unit. Gagauzia represebts a structure of five territorial components, disconnected from each other. This division is largely due to the ethnic structure of the component localities. In most localities, only a few exceptions, the majority population is represented by the Gagauz.

The main road arteries mostly repeat the directions on wich the ATUG territories stretch. The most important roads are: **Road M-3** that connects the southern country (*Giurgiulesti* customs) with Chisinau, but less used on the *Cimislia-Chisinau* section for technical reasons. This road partly passes the ATUG's territory. It plays the role of transport collector from the dispersed territories of Gagauzia; **Road R-36** – links Cazaclia locality with Cioc-Maidan commune through eastern extremity; **Road R-37** – collects the transport flow on the south-east – north-west directionfrom Comrat and Ciadar-Lunga districts; **Road R-35** unites Cioc-Maidan commune with Comrat town.

The extension and structure of ATUG determine different levels of accessibility by the population of the services like justice, firefighters, medical emergency service etc., usually offered in district centres. The study considered the fact that most facilities are located in administrative centre of ATUG – Comrat town.

The accessibility taken as a basis for analysis and intervention influences directly the sustainable local development. The accessibility determines the costs that population consumes to reach objects and realize activities in geographic space (Burns, 1979; Miller, 1999; Rodrigue et all, 2009). The accessibility is one of the ensurance premises of population's necessity in facilities. Starting from the idea that the transport's role is to insure the connection between the localities and the good markets' functioning, there exists a high potential for using the models of accessibility with reference to economic sectors and domains (electroenergetics, education, justice, health, sales markets, agriculture, labour market etc.).

Methods and Materials As a research support the transport network of ATUG was digitized by 1:50 000 topographic maps. For a spatial analysis it was constructed a geometrical network of roads of all categories in district boundaries.

Table1 Length and time indicators in the automobile road network of ATU Gagauzia												
	All road categories		Categories 1-2		Category 3		Category 5		Category 6		Category 10	
COMMUNES	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)
Ceadar-Lunga	254	2,64	44	0,45	125	1,31	10	0,11	56	0,59	18	0,19
Avdarma	153	2,32	6	0,09	109	1,65	2	0,03	23	0,35	13	0,20
Baurci	213	2,78	9	0,11	151	1,98	6	0,08	33	0,43	14	0,18
Besalma	131	2,15	12	0,20	88	1,44	5	0,08	22	0,36	4	0,07
Besghioz	109	2,06	11	0,21	74	1,41	3	0,06	13	0,25	7	0,14
Bugeac	34	1,86	5	0,26	21	1,17	2	0,11	4	0,22	2	0,10
Cazaclia	241	2,25	13	0,12	170	1,58	8	0,07	29	0,27	22	0,21
Chiriet-Lunga	139	2,37	15	0,25	102	1,74	2	0,03	18	0,31	2	0,04
Chirsova	210	2,04	10	0,10	163	1,59	4	0,04	29	0,29	3	0,03
Cioc-Maidan	155	2,03	12	0,16	98	1,29	7	0,09	30	0,39	8	0,10
Congazcicul de Sus	115	2,73	13	0,31	82	1,94	3	0,07	9	0,22	8	0,19
Copceac	232	2,22	16	0,16	167	1,60	6	0,06	36	0,34	7	0,06
Cotovscoe	29	1,86	2	0,13	23	1,47	1	0,09	3	0,16	**0**	**0,00**
Dezghingea	226	2,27	8	0,08	169	1,70	9	0,09	35	0,35	5	0,05
Ferapontievca	71	2,15	8	0,23	51	1,54	3	0,10	9	0,28	**0**	**0,00**
Gaidar	121	2,42	13	0,26	77	1,53	4	0,07	15	0,30	12	0,25
Joltai	76	2,11	7	0,18	51	1,43	2	0,05	11	0,31	5	0,14
Tomai	146	1,84	17	0,21	93	1,16	4	0,05	17	0,21	16	0,20
Vulcanesti	394	2,59	51	0,34	230	1,51	13	0,08	62	0,41	**37**	0,24
Cismichioi	229	2,43	23	0,24	142	1,51	10	0,11	40	0,42	14	0,15
Etulia	113	**1,83**	14	0,23	76	1,22	5	0,07	12	0,19	7	0,11
Etulia	**0**	2,53	**0**	**2,53**	**0**	**0,00**	**0**	**0,00**	**0**	**0,00**	**0**	**0,00**
Chioselia Rusa	27	2,79	5	0,54	12	1,26	2	**0,25**	4	0,39	3	0,35
Svetlii	59	2,66	6	0,26	43	1,92	1	0,05	10	0,44	**0**	**0,00**
Congaz	271	2,09	28	0,22	175	1,35	7	0,05	42	0,32	19	0,15
mun.Comrat	**421**	2,50	**57**	0,34	**275**	1,63	**14**	0,08	**73**	0,44	1	0,01
Carbalia	42	3,06	**0**	**0,01**	30	**2,17**	1	0,09	6	0,44	5	**0,35**
Carbalia	2	**8,03**	**0**	2,34	**0**	**0,00**	**0**	**0,00**	1	**5,69**	**0**	**0,00**
TOTAL	**4 213**	70,60	**404**	10,55	**2 800**	40,13	**135**	2,08	**640**	14,34	**233**	3,50
AVERAGE		**2,52**		**0,38**		**1,43**		**0,07**		**0,51**		**0,13**

The network is a vector set af data, represented by nodes interconnected by lines.As nodes can serve localities, facilities, road intersections etc.

For a proper functioning of the network in the GIS system there was worked on the formation of a corect topology. The topology supposed to „teach” the network to function as an integral whole. Minor segment errors generate significant errors throughout the whole network, in our case the the road network.

For graphical data a base of attributes was created, which included noy only names and categories of the roads, but also the following information: administrative belonging, road categories by quality, distance, time, nodes, crossing directions, bridges, closed roads, asphalted and unasphalted roads etc (Butler, 2008). As a result it was constructed a network with 4 856 nodes and 11 898 arcs.

Table 2 Length and time indicators regarding ATUG population accessibility to the administrative centre (Comrat)

	STRAIGHT LINES DISTANCE		ROUTES					AVERAGE SPEED	DIFFERENCE COMPARED TO STRAIGHT LINES		ROUTE SINUOSITY COEFFICIENT
Locality	**Meters**	**Km**	**Nr. route**	**Minutes**	**Hours**	**Meters**	**Km**	**Km\h**	**Meters**	**Km**	
Alexeevca	31069	31,069	24	41	0,68	32148	32,148	47	1 079	1,079	0,97
Avdarma	14634	14,634	23	19	0,31	17298	17,298	55	2 664	2,664	0,85
Baurci	22340	22,340	1	57	0,95	26341	26,341	**28**	4 001	4,001	0,85
Besalma	14552	14,552	13	22	0,36	16073	16,073	44	1 521	1,521	0,91
Besghioz	25532	25,532	4	53	0,88	35380	35,380	40	9 848	9,848	0,72
Bugeac	7571	7,571	11	12	0,20	8215	8,215	41	644	0,644	0,92
Carbalia	49809	49,809	8	102	1,70	57704	57,704	34	7 895	7,895	0,86
Cazaclia	31666	31,666	3	78	1,31	36424	36,424	28	4 757	4,757	0,87
Ceadir-Lunga	30334	30,334	31	43	0,71	35772	35,772	50	5 439	5,439	0,85
Chioselia Rusa	25833	25,833	19	42	0,71	30029	30,029	42	4 196	4,196	0,86
Chiriet-Lunga	23802	23,802	21	29	0,49	27015	27,015	55	3 213	3,213	0,88
Chirsova	**6452**	**6,452**	14	**9**	**0,15**	**6498**	**6,498**	42	**46**	**0,046**	**0,99**
Cioc-Maidan	14295	14,295	22	15	0,25	15398	15,398	**61**	1 103	1,103	0,93
Cismichioi	86023	86,023	17	125	2,09	94199	94,199	45	8 176	8,176	0,91

Congaz	21060	21,060	16	27	0,45	21236	21,236	48	176	0,176	0,99
Congazcicul de Jos	6819	6,819	20	13	0,21	7290	7,290	34	471	0,471	0,94
Congazcicul de Sus	8078	8,078	25	15	0,26	9526	9,526	37	1 448	1,448	0,85
Copceac	49415	49,415	7	104	1,73	56568	56,568	33	7 153	7,153	0,87
Cotovscoe	18670	18,670	12	42	0,70	32050	32,050	46	13 380	13,380	**0,58**
Dermengi	49798	49,798	29	119	1,98	63666	63,666	32	**13 868**	**13,868**	0,78
Dezghingea	14608	14,608	10	23	0,38	15895	15,895	42	1 287	1,287	0,92
Dudulesti	11473	11,473	27	19	0,31	13199	13,199	43	1 725	1,725	0,87
Etulia	86036	86,036	18	121	2,01	92541	92,541	46	6 504	6,504	0,93
Etulia Noua	**88322**	**88,322**	26	**126**	**2,10**	**95181**	**95,181**	45	6 859	6,859	0,93
Ferapontievca	11294	11,294	15	14	0,23	12566	12,566	54	1 272	1,272	0,90
Gaidar	22734	22,734	2	43	0,72	28526	28,526	40	5 792	5,792	0,80
Joltai	21045	21,045	6	38	0,63	27670	27,670	44	6 625	6,625	0,76
Svetlii	31968	31,968	9	41	0,68	32647	32,647	48	678	0,678	0,98
Tomai	14646	14,646	5	23	0,39	17959	17,959	46	3 313	3,313	0,82
Vulcanesti	70701	70,701	30	94	1,57	79685	79,685	51	8 984	8,984	0,89
SUM	**910581,0**	**910,6**	**30,0**	**1508,4**	**25,1**	**1044700,3**	**1044,7**	**1302,4**	**134119,3**	**134,1**	**26,2**
AVERAGE	**30352,7**	**30,4**		**50,3**	**0,8**	**34823,3**	**34,8**	**43,4**	**4470,6**	**4,5**	**0,9**

The highlighting of roads categories started with the idea of accessibility, level of use, content and structure of the road. Six road categories were distinguished (Table 1, fig.1). Most important for both economy and population are the following categories:

1.Improved asphalted roads,
2. Asphalted roads,
3.Paths and country roads,
4.Central roads in localities,
5.Secondary roads in localities,
6.Local unasphalted roads.

The third category provides the accessibility of the population only inside the communes' territories. GIS softwares (TransCad 4.5 and ArcGIS 9.1, extension Network Analyst) were used as tools for the analysis of space and accessibility level.

Results and Comments

The density of road network.

In the first step it was determined the assurance degree with roads of all categories by calculating the transport network density for an administrative unit's communes. The highest density of roads of all categories is registered in *Carbalia* commune (8,03 km/km^2), *Carbalia* village (3,06 km/km^2) and *Comrat* municipium (2,79 km/km^2). In twenty-two localities the values of road density are recorded between 2 and 3 km/km2. In the remaining localities the values fall within 1-2 km/km2 (fig.1, Table1). The road density indices by a category in part repeat the indices with the reference to the density for all road categories.

Table 3. Distribution of population by zones of 10 km

Buffer Zones	Frequency	Population (hab.)	Population(%)
0-10	5	33984	21,8
10-20	8	19705	12,7
20-30	7	34456	22,1
30-40	4	30991	19,9
40-50	3	10119	6,5
60-70	1	267	0,2
70-80	1	16900	10,9
80-90	4	9224	5,9
TOTAL		155646	100,0

Zones and distances.

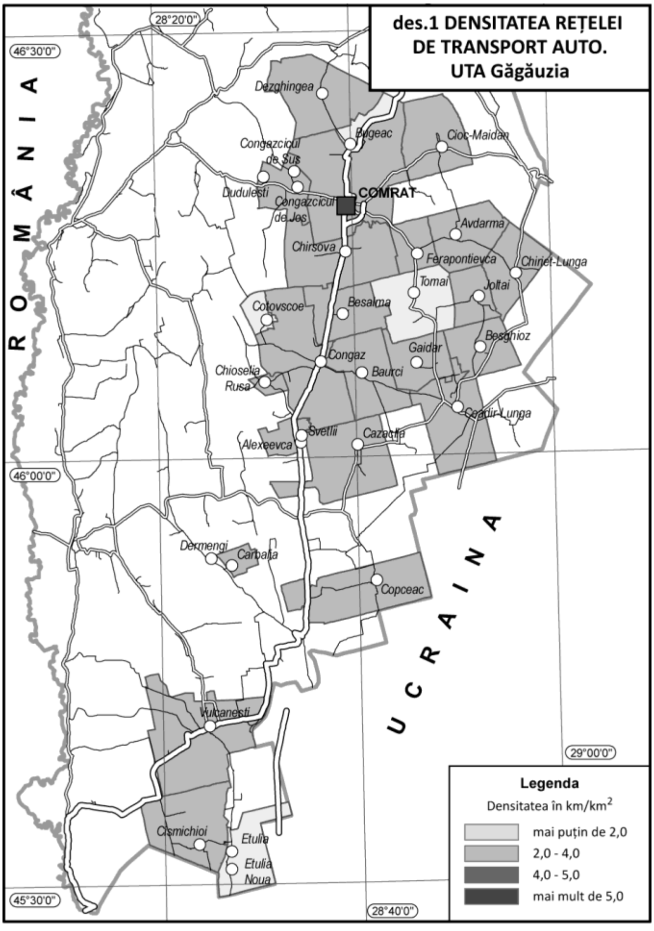
The distance is one of the categories that provides the accessibility level of population.the distance determines the remoteness of entities (localities) from facilities (Comrat town) and vice versa. There were defined buffer zones of 10 km with the purpose to group the localities by distance to the administrative centre of ATUG (fig.2, Table 3). The territory of autonomous unit was „covered" by nine meridional buffer zones.

The most numerous, as inhabitants, are zones I, III and IV, concentrating over 63% of ATUG population in 16 localities. In zone I live 21,8% of population of autonomous unit. This zone concentrate the population of 5 localities, including Comrat town. Zone VII doesn’t contain any localities.

On the greatest distance on straight lines of *Comrat* town are situated the localities *Etulia Nouă* (88,32 km), *Etulia* (86,0 km), *Cişmichioi* (86,0 km). The nearest localities to Comrat town are *Chirsova* (6,4 km), *Congazcicul de Jos* (6,8 km), *Bugeac* (7,5 km).

Accessibility and routes.

The term of „accessibility” is often confused with „mobility”, i.e. the ability to go from one place to another. The word "accessibility" is derived from the words access and ability to access. Access is approached as the possibility to become closer to something (Hansen, 1959). Access is moving across the network in order to arrive at the destination.



High level of mobility not always means a high level of accessibility. A high level of accessibility can be achieved in case of a low mobility (Miller, 1999). The level of accessibility can be influenced by several factors: arrivals in urban zones, wich are slower than crossing; road quality; transport network quality and afficiency; the presence of natural barriers etc.

Starting with the above mentioned there were set up 32 access routes to *Comrat* town (fig.3, Table 2). The drawn routes are largely served by the autonomous unit's personal transport network. Exceptions are only several localities which use roads from afferent transport networks (Cahul and Taraclia district): *Etulia, Cismichioi, Carbalia, Chioselia, Vulcănesti town, and Copceac*.

The performed measurements have distinguished several groups of localities, that fall in different time access zones. The large majority of localities (24) are sittuated at a distance of one hour from Comrat town, the remaining are at 1-2 hours distance (Table 4, fig.4).

Tab 4. Distribution of population by zones of 30 minutes (isochrones)

Zones (minutes)	Frequency	Population (hab.)	Population (%)
0-30	14	71996	46,3
30-60	10	48838	31,4
60-90	4	10388	6,7
90-120	5	24424	15,7
TOTAL		**155646**	**100,0**

Length of route. Accessibility is also determined by the legth of routes, that indicate the distance from the start till the destination. Routes being the covered ways to the destinations within the network. The smallest route length indicators are recorded for localities *Chirsova* (6 498 m), *Congazciucul de Jos* (7 290 m) and *Bugeac* (9 061 m), which are located in the immediate vicinity of Comrat town. High length indicators are recorded in coomunes *Etulia Nouă* (95 180 m), *Cismichioi* (94 199 m), *Etulia* (92 540 m).

An interesting situation is registered in case of several localities that record different time and length indicators, being sittuated at larger distances, register shorter time access, than other localities, that are sittuated closer to the destination. This difference is due to different speed, recorded on different road categories.

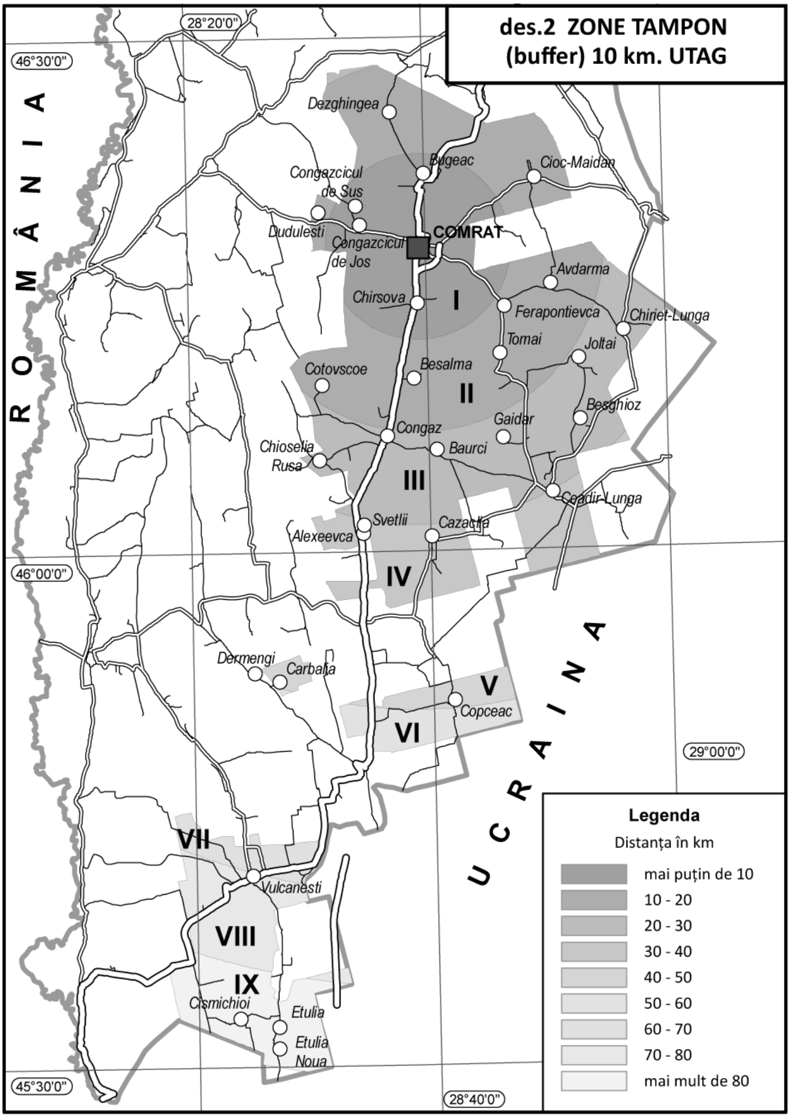
The speed inflences the time spent by people till the destination where facilities are offered. In our case the speed is directly connected to the road category. In the network the average speed of crossing the road segments is 43,4 km/h (Table 2).

Table 5. Distance Matrix – ATU Gagauzia

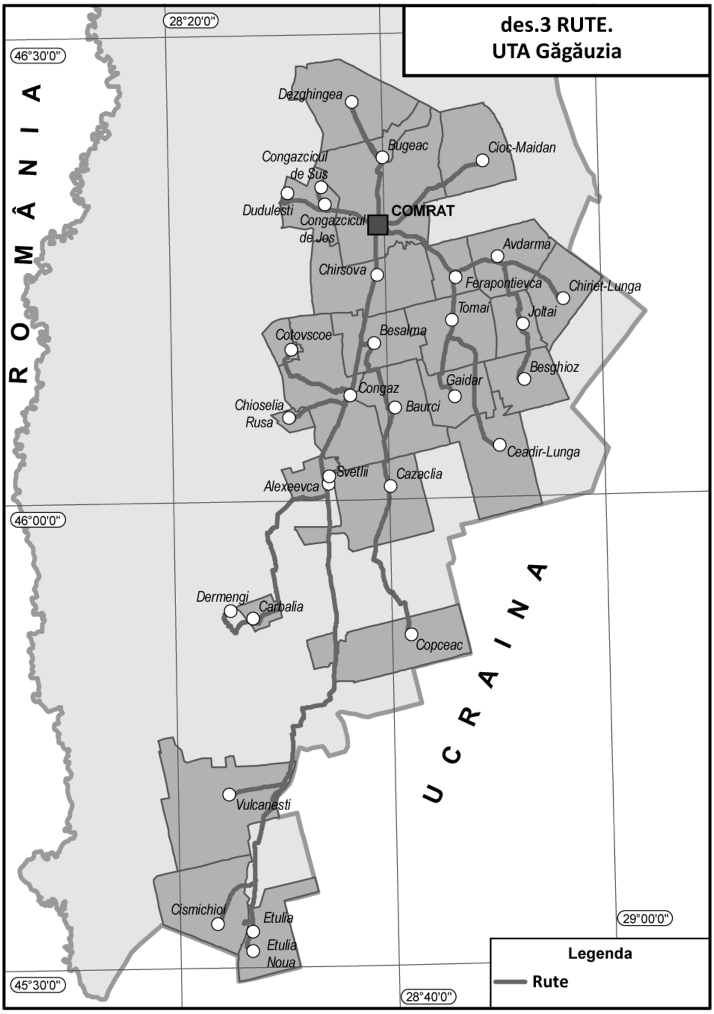
	Alexeevca	Avdarma	Baurci	Besalma	Besghioz	Bugeac	Carbalia	Cazaclia	Ceadir-Lunga	Chioselia Rusa	Chiriet-Lunga	Chirsova	Cioc-Maidan	Cismichioi	Comrat	Congaz	Congazcicul de Jos	Congazcicul de Sus	Copceac	Cotovscoe	Dermengi	Dezghingea	Dudulesti	Etulia	Etulia Noua	Ferapontievca	Gaidar	Joltai	s.c.f. Etulia	Svetlii	Tomai	Vulcanesti
Alexeevca	0	42	17	19	39	40	26	16	30	10	51	26	47	63	32	11	39	41	27	21	32	48	40	61	64	35	27	41	61	1	31	48
Avdarma	42	0	33	23	19	25	68	42	28	40	10	20	13	104	17	31	25	27	60	42	73	33	30	102	105	7	23	11	102	42	12	89
Baurci	17	33	0	10	23	35	42	10	14	15	34	20	41	77	26	6	33	36	30	17	48	42	35	75	78	26	10	26	75	17	21	62
Besalma	19	23	10	0	30	24	45	20	24	17	33	10	31	81	16	8	23	25	40	19	51	32	29	79	82	16	19	22	79	20	11	67
Besghioz	39	19	23	30	0	43	59	26	10	37	12	38	32	89	35	29	43	45	41	39	65	51	49	88	90	23	18	8	87	40	19	75
Bugeac	40	25	35	24	43	0	66	45	44	38	35	15	23	102	8	29	15	17	65	40	72	8	20	101	103	21	37	36	100	41	26	88
Carbalia	26	68	42	45	59	66	0	34	50	32	71	51	73	44	58	36	65	67	27	43	6	74	65	44	47	61	52	67	44	25	56	27
Cazaclia	16	42	10	20	26	45	34	0	16	23	37	30	51	66	36	16	43	46	20	27	40	52	45	65	67	35	20	33	65	15	30	52
Ceadir-Lunga	30	28	14	24	10	44	50	16	0	28	21	34	42	79	36	19	43	45	31	30	56	52	49	78	80	23	9	18	77	31	18	65
Chioselia Rusa	10	40	15	17	37	38	32	23	28	0	49	24	45	72	30	9	37	39	37	12	38	46	36	71	73	33	24	39	70	11	28	57
Chiriet-Lunga	51	10	34	33	12	35	71	37	21	49	0	30	23	101	27	40	34	37	53	51	77	43	40	99	102	16	29	18	99	51	22	86
Chirsova	26	20	20	10	38	15	51	30	34	24	30	0	21	88	6	15	14	16	50	26	57	22	19	86	89	15	28	31	86	26	21	73
Cioc-Maidan	47	13	41	31	32	23	73	51	42	45	23	21	0	109	15	36	23	25	71	47	79	31	28	107	110	20	36	24	107	48	25	95
Cismichioi	63	104	77	81	89	102	44	66	79	72	101	88	109	0	94	73	101	104	52	83	45	110	102	7	9	97	86	97	4	62	93	17
Comrat	32	17	26	16	35	8	58	36	36	30	27	6	15	94	0	21	7	10	57	32	64	16	13	93	95	13	29	28	92	33	18	80
Congaz	11	31	6	8	29	29	36	16	19	9	40	15	36	73	21	0	28	31	36	11	42	37	30	71	74	24	16	31	71	11	20	58
Congazcicul de Jos	39	25	33	23	43	15	65	43	43	37	34	14	23	101	7	28	0	3	64	36	71	17	7	100	102	20	36	35	99	40	25	87
Congazcicul de Sus	41	27	36	25	45	17	67	46	45	39	37	16	25	104	10	31	3	0	66	37	73	14	6	102	104	22	38	37	102	42	27	89
Copceac	27	60	30	40	41	65	27	20	31	37	53	50	71	52	57	36	64	66	0	46	33	72	65	50	53	55	40	49	50	26	49	37
Cotovscoe	21	42	17	19	39	40	43	27	30	12	51	26	47	83	32	11	36	37	46	0	49	48	34	82	84	35	27	41	81	22	30	67
Dermengi	32	73	48	51	65	72	6	40	56	38	77	57	79	45	64	42	71	73	33	49	0	80	69	45	48	67	58	73	45	31	62	27
Dezghingea	48	33	42	32	51	8	74	52	52	46	43	22	31	110	16	37	17	14	72	48	80	0	17	108	111	28	44	43	108	49	34	96
Dudulesti	40	30	35	29	49	20	65	45	49	36	40	19	28	102	13	30	7	6	65	34	69	17	0	100	103	26	42	41	100	41	31	87
Etulia	61	102	75	79	88	101	44	65	78	71	99	86	107	7	93	71	100	102	50	82	45	108	100	0	3	96	84	95	3	60	91	18
Etulia Noua	64	105	78	82	90	103	47	67	80	73	102	89	110	9	95	74	102	104	53	84	48	111	103	3	0	98	87	98	6	63	94	21
Ferapontievca	35	7	26	16	23	21	61	35	23	33	16	15	20	97	13	24	20	22	55	35	67	28	26	96	98	0	16	16	95	36	5	83
Gaidar	27	23	10	19	18	37	52	20	9	24	29	28	36	86	29	16	36	38	40	27	58	44	42	84	87	16	0	16	84	27	11	71

Joltai	41	11	26	22	8	36	67	33	18	39	18	31	24	97	28	31	35	37	49	41	73	43	41	95	98	16	16	0	95	42	11
s.c.f. Etulia	61	102	75	79	87	100	44	65	77	70	99	86	107	4	92	71	99	102	50	81	45	108	100	3	6	95	84	95	0	60	91
Svetlii	1	42	17	20	40	41	25	15	31	11	51	26	48	62	33	11	40	42	26	22	31	49	41	60	63	36	27	42	60	0	31
Tomai	31	12	21	11	19	26	56	30	18	28	22	21	25	93	18	20	25	27	49	30	62	34	31	91	94	5	11	11	91	31	0
Vulcanesti	48	89	62	67	75	88	27	52	65	57	86	73	95	17	80	58	87	89	37	67	27	96	87	18	21	83	71	82	18	47	78
Vulcanesti c.f.m.	44	85	58	62	71	84	27	48	61	54	82	69	90	20	76	54	83	85	33	65	31	91	83	19	21	79	67	78	18	43	74

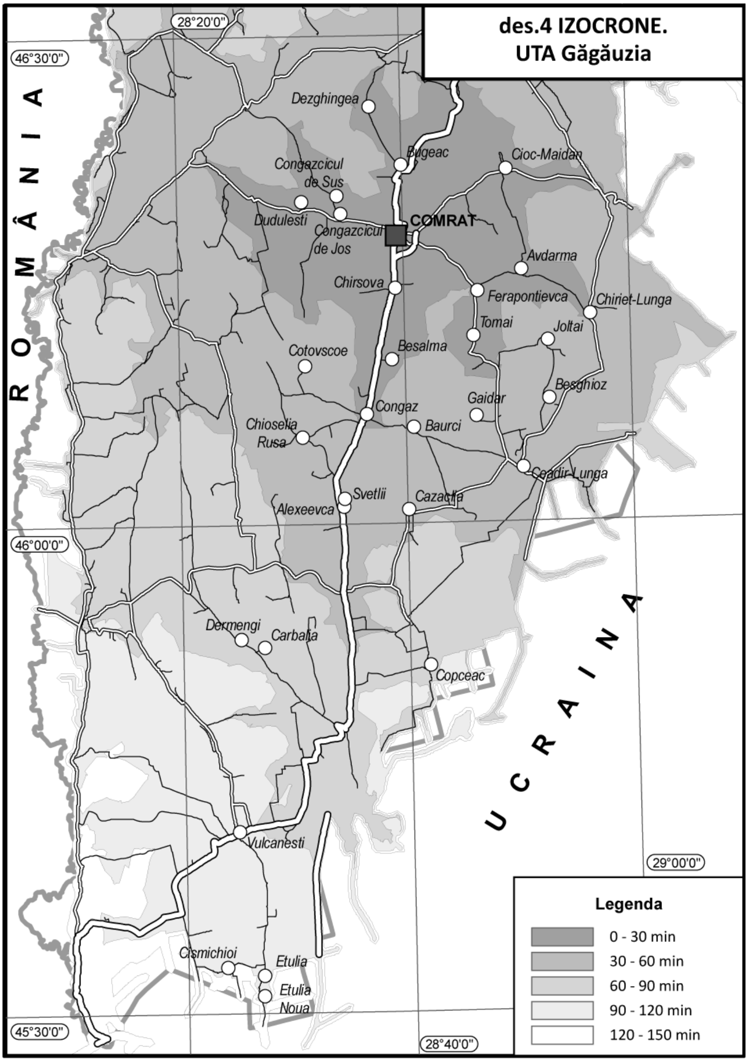
The average speed of crossing different road categories was determined through GPS measurements of road portions. This indicator is average one. Obviously it is a general indicator, however it can be easily modified for its application in calculations for entire road network.



The highest speed (65 km/h) is recorded on *„Improved asphalted roads" and „Asphalted roads", i.e. categories 1 and 2*. It's important to note that on these roads even higher speeds can be achieved, but it was taken average speed



The lowest speed in network was recorded on the road category named „*Paths and country roads”* – 15 km/h. It was also recorded the average speed of



crossing the localities. The roads in localities were divided into two categories – *„Central roads in localities”* and *„Secondary roads in localities”*, 30 and 18-15 km/h respectively. This road category greatly influences the accessibility, because the fewer arrivals there are in localities, the shorter is the time spent till the destination.

As the example it can be taken the case with *Gaidar* and *Chiret-Lunga* localities, that are situated at the same distance from Comrat town, but access time and average speed are different. It is because of the number of localities existing on the way of the route *Chiret-Lunga – Comrat* (8 localities), that reduce the speed from 65 to 30 km/h. In addition the route *Chiret-Lunga – Comrat* is formed road of lower speed categories, while the route *Gaidar – Comrat* represents segments of road with higher average speed (60 km/h).

The study also points out the routes that register the highest crossing speed. For example, route of 14,2 km *Cioc-Maidan – Comrat* is covered with an average speed 60 km/h, *Avdarma – Comrat* (14,6 km) speed 55 km/h, *Cismichioi - Comrat* (23,8 km) with a speed of 55 km/h. Concerning the localities Cioc-Maidan and Avdarma, the high speed is explained by the connection of these localities with Comrat though the roads of categories 1 and 2 with high speeds. The lowest indicators are recorded on the routes *Baurci – Comrat* (27 km/h), *Cazaclia – Comrat* (27 km/h) etc. On the short routes is recorded low average speed and inversely on long distances average speed is high

Routes' sinuosity. An indicator frequently used in road network analysis is road sinuosity, which was taken from hydrology for calculating river's sinuosity. It was tried to adapt this indicator with reference to routes' sinuosity. Such tests are already done by calculating the Detour index (Rodrigue et all, 2009). This index shows the assertion „geographical proximity is not always a high accessibility".

In its calculation was used the ratio of indicators of straight lines distance and route length (Table 2). The highest indicators are recordeed in case of following localities: *Chirsova* (0,99), *Congaz* (0,99), *Sveltlii* (0,97), *Alexeevca* (0,96), and *Congazcicul de Jos* (0,93). The lowest indicator is recorded in *Cotovscoe* (0,58) where the route is 2 times longer than straight line distance from *Comrat* town. It is followed by *Berghioz* (0,72), *Joltai* (0,76), and *Dermengi* (0,63).

The sinuosity coefficient is influenced by several factors, as follows: natural barriers (relief, hydrography, vegetation etc), localities and, in our case, lack of direct roads of necessary category (1, 2, 4, 5 and 6). Unlike Cahul district where the sinuosity indices are lower, in ATUG the values are higher, that says about a relatively insignificant impact of natural barriers on the road network.

The Degree of Circuity in network. It is an indicator that measures the traffic level for every locality from transport network. Obviously it is one of the range of indicators (cyclomatic index, alpha, beta, gamma, eta, pi, iota, total transport score etc.) that caracterise a network (Kansky, 1989; Rodrigue et all, 2009). There was selected an indicator that caracterises the *Degree of Circuity in network*, because in the above listed indicators is considered the number of nodes and arcs in network, equaling all network elements as value and importance, also the valence, and its costs.

Table 6 Degree of Circuity for road network of ATUG					
Locality	**Km per locality**	**Km per locality in network**	**Locality**	**Km per locality**	**Km per locality in network**
Alexeevca	205,15	6,22	*Congazcicul de Sus*	278,80	8,45
Avdarma	286,15	8,67	*Copceac*	280,85	8,51
Baurci	221,23	6,70	*Cotovscoe*	362,12	10,97
Besalma	183,84	5,57	*Dermengi*	474,38	14,38
Besghioz	334,12	10,12	*Dezghingea*	232,07	7,03
Bugeac	210,56	6,38	*Dudulesti*	274,76	8,33
Carbalia	338,22	10,25	*Etulia*	296,28	8,98
Cazaclia	243,62	7,38	*Etulia Noua*	309,86	9,39
Ceadir-Lunga	226,16	6,85	*Ferapontievca*	245,03	7,43
Chioselia Rusa	229,73	6,96	*Gaidar*	294,94	8,94
Chiriet-Lunga	323,43	9,80	*Joltai*	321,94	9,76
Chirsova	192,81	5,84	*Etulia s.c.f.*	315,43	9,56
Cioc-Maidan	258,44	7,83	*Svetlii*	195,44	5,92
Cismichioi	335,23	10,16	*Tomai*	256,38	7,77
Comrat	146,92	4,45	*Vulcanesti*	332,24	10,07
Congaz	150,14	4,55	*Vulcanesti c.f.m.*	274,35	8,31
Congazcicul de Jos	265,18	8,04			
AVERAGE IN NETWORK - 8,16 km					

In our case, the localities of ATUG can serve as network nodes, but segments are the roads of major importance for the traffic (main, republican, and local roads) that link these localities. As for the first step a distance matrix was constructed for localities of ATUG. (Table 5, 6).

Degree of Circuity in a network is calculated using the following formula:

$$GC = \frac{\sum_{i=1}^{n}(E-D)^2}{v},$$

Where $\sum_{i=1}^{n}$ *is number of routes, E – route length, D – euclidian distance (straight lines), v - number of nodes (ATUG localities).*

This index shows the pressure on every node (locality) within a network. It is assumed that nodes are of the same level of value. The lowest indicators are recorded in the following localities: Comrat, Congaz, Besalma and Chirsova. High indicators are registered in Dermenji, Cotovscoe and Carbalia

Conclusions

1.The road network in ATUG doesn't assure the access of population to the administrative centre. There are used afferent networks, especially the roads of Cahul and Taraclia districts.

2. In case of ATUG, time accessibility difers from length accessibility.

3. The higher is the weight of roads of greater categories, the higher is the level of accessibility and the average crossing speed.

4. The localities set on the route's way increase the time of access.

5. The existence of the three administrative centers, of a lower rank, within ATUG (Comrat, Ciadar-Lunga and Vulcanesti), somehow disperses the road density indicators and approach the services to the population.

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APPLYING GIS-TECHNOLOGIES METHODS TO WIND ENERGETIC RESOURCES MAPPING

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Резюме: *В данной статье приводятся результаты исследования ветрового режима на территории Республики Молдова. С целью оценки ветроэнергетического потенциала при помощи современных ГИС-технологий осуществлено картирование основных характеристик и энергии ветра.*

Key words: *renewable energy sources, wind energy, wind's operation speed.*

Rezumat: *Acest articol prezintă rezultatele studiului regimului vântului pe teritoriul Republicii Moldova. În scopul evaluării potenţialului energiei eoliene cu ajutorul tehnologielor moderne SIG au fost cartografiete caracteristicile de bază şi a energiei eoliene.*

Cuvinte cheie: *surse de energie renovabilă, energia vântului, viteza de operare a vântului*

Introduction

During hundreds of year's man tried to benefit from wind power by building wind stations that execute various functions: windmills, water and oil pumps, power plants. Wind energetics started its active developing after the world-shaking oil crisis in 1973, because, first of all, wind is inexhaustible energy source and its cost is equal to zero, and second, energy that is obtained by its usage is much cheaper and safer for health when comparing it with the energy obtained from carbon combustibles. At the present stage using wind as renewable energy source (RES) is developing mostly in some European regions, USA, India. Several countries' experience (Israel, Germany and Denmark) indicates high RES efficiency, especially in rural regions and for small scattered objects' power supply [1, 2, 3].

In the beginning of the XIX century there were 6208 windmills on Moldova's territory, and by the end of the century it occupied fifth place in the world for wind energy resources usage [4]. In present Republic of Moldova's climatic conditions, technical and economical possibilities allow using sun, wind and hydraulic energy, biomass and organic waste. The strategy based on governmental newly adopted legislation [5, 6, 7] has defined state politics in organization and carrying a set of works aiming to use different types of renewable energy sources and to increase their share in fuel and energy balance of our republic with the aim of end-users' power-supply improvement and countries' increase in energy security. According to this strategy in perspective for 2015-2030 period there will supposedly be created and installed wind-power units with gross output of 8 MW, and also wind-works (gross power up to 30 кW) for water supply, feed preparation, power supply of the end-users that are not connected to the common electrical network.

Materials and investigation methods

An investigation result for complex of characteristics of wind regime's and estimate indicators defined by the statistical models and probability distribution functions are given in this article. Taking into account the investigations previously made in this direction [8-11], comparative analysis for spatial and temporal wind climate indexes distribution was executed. Hydrometeorological State Service's primary data for 14 weather stations placed in various republics' landscape zones for 1964-2001 periods was used as data source. Wind energy potential was estimated on the basis of modern GIS-technologies and wind's main characteristics and energy, operation speed's durations and wind engine's stoppage was mapped. Maps, obtained with the help of application program «SURFER», allow identifying the most perspective regions for wind energy purposes and give quantitative estimation for mean wind resources for each of them, and also to get a general idea of wind's impact in major fuel and energy balance of the country.

Investigation results

In present times RES are not yet competitive with traditional types of fuel and energy resources because of low technologies familiarization. However, RES usage problem exists and is global. International market of installations for renewable energy obtaining and transformation is forming and United Energetic space' creation works are executed.

The following indexes of wind regime were analyzed in order to estimate wind-driven electric plant's placement perspectives: average multiyear wind speeds, their annual and diurnal variation, operation 3 m/s and 8 m/s speed's frequency.

Investigation of multiyear wind speed values spatial variability on Moldova's territory shows their variation from 1.8 to 3.9 m/s (Fig. 1). Wind speed' maximum values were registered in winter in the South in Cahul

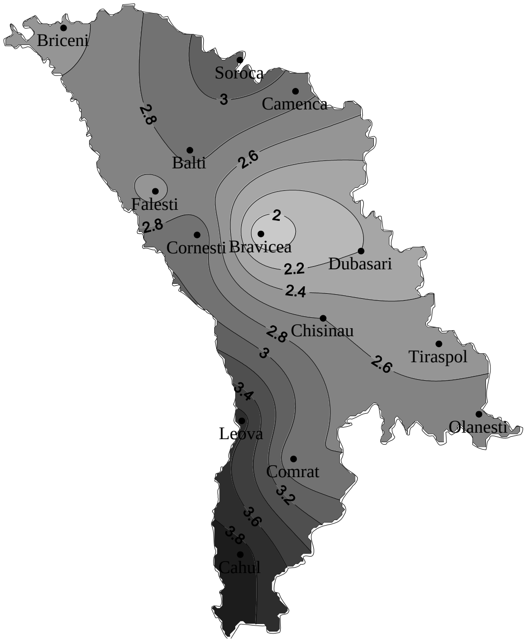

Figure 1. ***Average annual wind speed (m/s) for 1964-2001 period***.

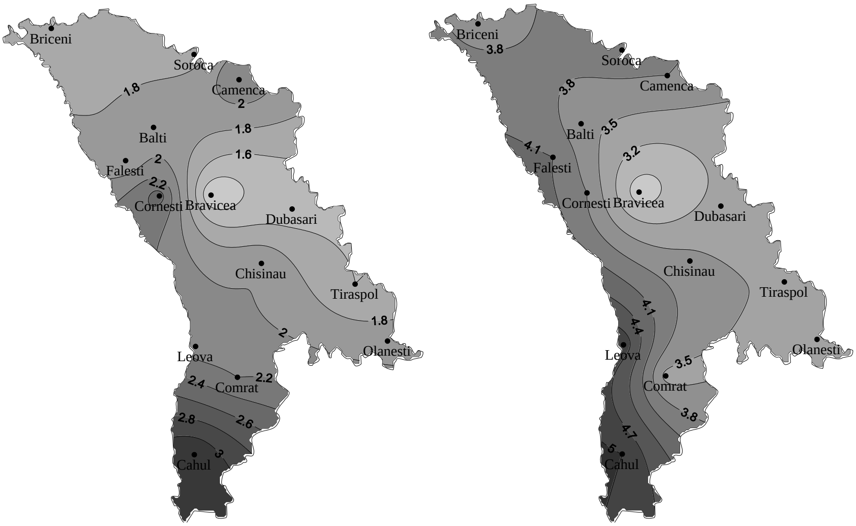

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Figure 2. ***Mean minimum (a) and maximum (b) wind speed (m/s) for 1964-2001 period.***

(January–6.7 m/s, February and March-6.2 m/s). Minimum values (0.4 m/s) were registered in August in Soroca weather station (Fig. 2 a, b).

Diurnal wind speeds show that it reaches maximum values in the day-time, as a general rule, after midday. Minimum speeds are observed before the sunset. Wind speed's increase in the day-time is an advantage factor for wind-engine for electrical energy production.

Because wind energy usage means the realization of natural geophysical process's energy, therefore wind regime data needs to be presented by objective numeric characteristics.

The process of wind energy finding can be presented as: CF $\rightarrow$ EU$\rightarrow$PU, where CF are climatic factors forming wind energy regime, EU – energy unit and its technical parameters, PU – power of the unit [12].

Climatological studies in the first place must take into account spatial and temporal particularities of wind flow of the region in question. Deeper formulization of wind energy's structural and regime characteristics applied to certain natural and geographical conditions are needed in order to calculate wind energy parameters with high priority speed factor. In this relation mean statistical indexes of standard deviation (σ) and variation coefficient (C_v) for representative weather stations placed in various landscape conditions in Republic of Moldova were calculated in Statgraphics Plus software. The distribution of σ (fig. 3 a) allows estimating general variability of average wind speed, and C_v (fig. 3 b) – allows tracking its relative variability.

It is obvious that for Republic of Moldova's territory standard deviation's geographical distribution (σ) is similar to mean speed's distribution and varies from 0.3 m/s till 0.8 m/s during year.

Parameter's maximum values are characteristic for the Region of Budgeac steppe dissected plains; minimum variability is identified in the areas of forest-steppe hills and plateaus. Annual values of C_v coefficient for the most weather stations is within 0,12-0,23 limits, and only in South-Western part of republic, where intensive persistent winds are observed, it decreases till 0,10. The obtained cartographical models allow selecting regions with low and significant wind potential on Republic of Moldova's territory

Wind's structure varies with its height above the ground surface, air flow stability increases in high air's layers. The difference in wind speed requires certain constructive approach at wind-powered generating plants (WPGP) Newest scientific and experimental developments for transformation of wind's kinetic power into electrical one are included in modern WPGP constructions. It consists from windmill device (of rotor or propeller kind), electric power supply, automatic devices coordinating work of wind engine and generator, and facilities for their installation and attendance. Wind engine’s power depends from windwheel’s size, wind speed and mast’s height

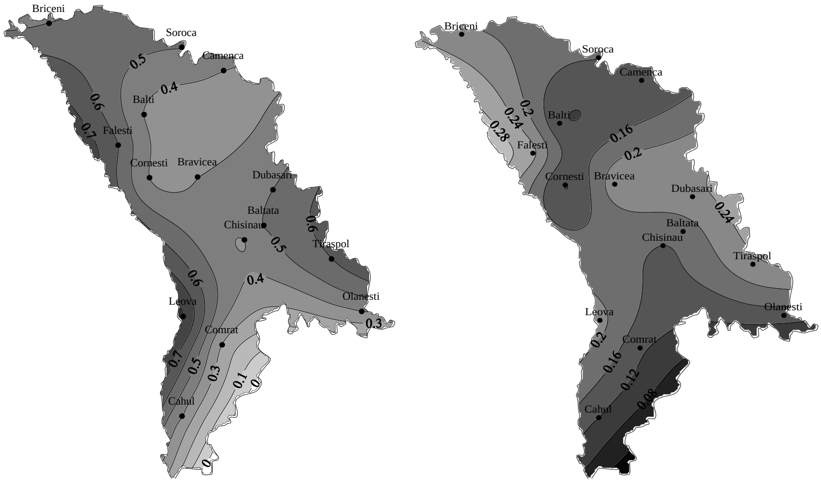

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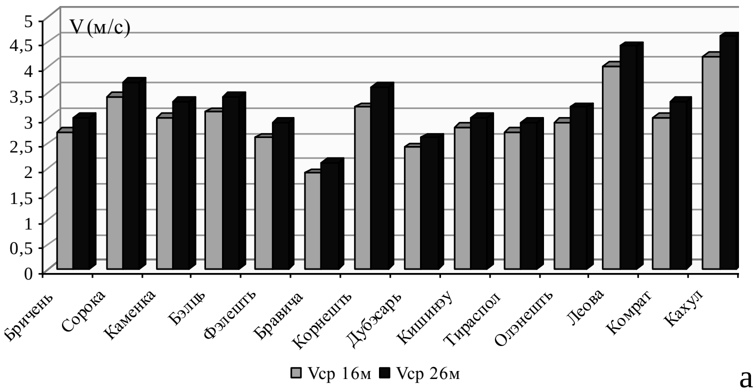
Figure 3. ***Statistically average parameters distribution on Republic of Moldova’s territory: a) σ - standard deviation, b) C_v - variation coefficient***

Average annual wind speeds’ study registered on Republic of Moldova’s weather stations demonstrated that their variations are connected with general change of wind speed on republic’s territory, and also with wind vane’s heights difference and its safety level. In order to exclude its influence we have carried out comparative analysis of mean multiyear values and wind speed on 16 m and 26 m height, which corresponds to wind wheel tower heights at typical wind engine, and also was investigated energy distribution at the given heights (fig. 4).



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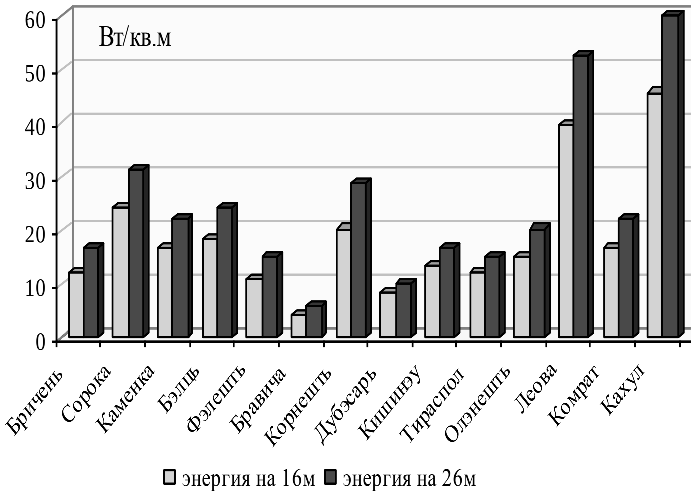

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Figure 4. ***Distribution: a) of speed and b) of wind energy on the wind-turbine's 16 m and 26 m heights***

From the obtained calculated data it is obvious that wind speed at 26 m height in comparison with 16 m increases by 0,2-0,4 m/s, and wind energy increases from 1,5 till 14,3 W/m^2. We can draw a conclusion that by increasing wind turbine height we would obtain optimal energy for its functioning.

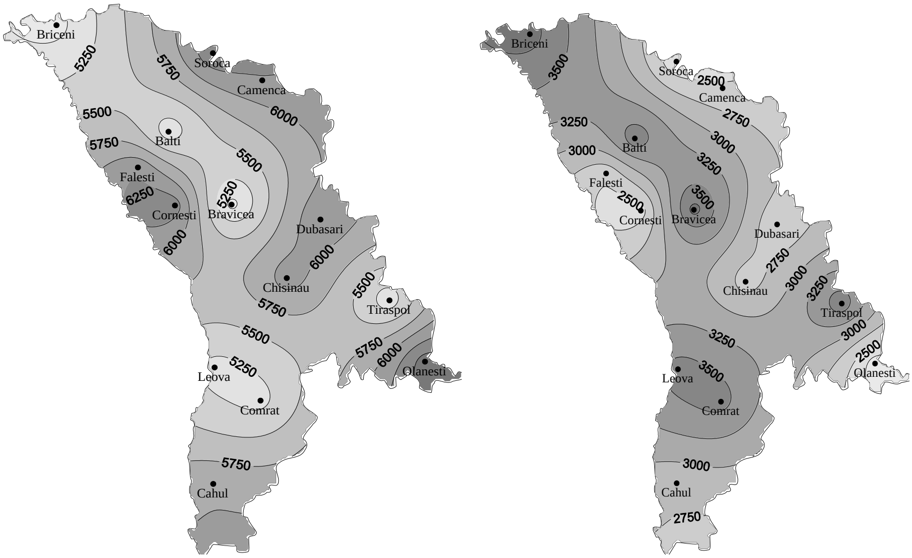

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Figure 5. ***Duration (hours): a) wind turbine work; b) wind turbine idle at wind speed ≥3m/s***

When studying wind from the point of view of effective propelling power along with diurnal, annual and multiyear wind speed, we need data on its operation speed frequency – 3 m/s (the speed at which plant begins its work) and 8 m/s (the speed at which major economic effect is attained). Numerical values of these parameters were calculated as a result of investigations, and also wind turbine's idle duration was calculated. The obtained data is presented as maps on Figures 5 and 6.

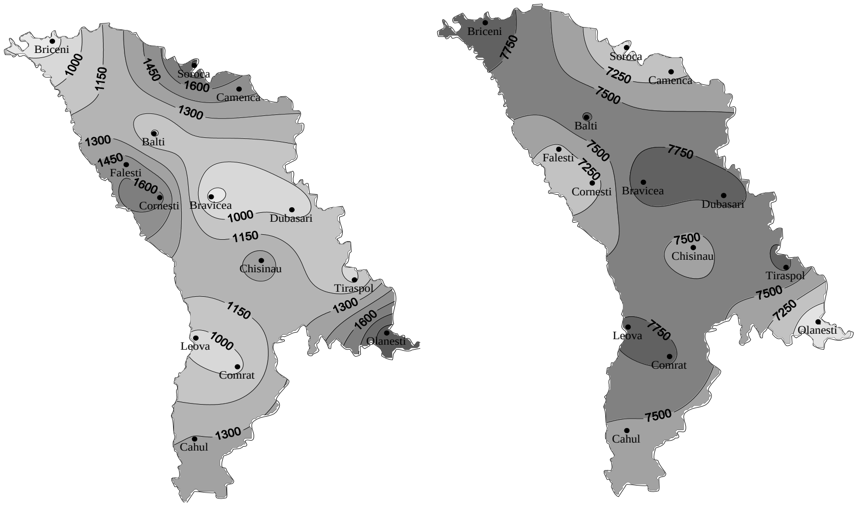

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Figure 6. ***Duration (hours): a) wind turbine work b) wind turbine idle at wind speed ≥8 м/с.***

As we can see from cartographical models, wind turbine’s engine can work economically effective at wind speed equal to 3 m/s from 5000 hours a year (Bravicea, Briceni) till 6600 hours (Cornesti, Cahul). At the wind speed exceeding 8 m/s, which is observed rarely on Republic of Moldova’s territory, wind turbine’s working hours vary from 900 till 1800 hours. It’s obvious that the higher the wind turbine’s design speed is, the less hours it is working, but with the bigger average power.

Conclusion

The obtained wind characteristics and wind energy potential calculations yield of computer cartography and presented models can be used in the investigation of a wide range of issues connected with creation and usage of installations and systems for renewable energy obtaining in Republic of Moldova.

World practice shows us that wind power stations number’s growth rate is increasing by 30% each year. WPGP’s effective use is most attractive as natural energetic balance on the planet is not disturbed and simultaneously we use non-waste, ecologically pure technology of energy creating for streets illumination, heating of buildings, houses, farms, field camps, grain elevators, pastures, beeyards etc.; electrization, battery charging and electric energy storage, and also electric power supply in district electrical supply.

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EVALUATION OF RELATIONSHIP BETWEEN LANDSLIDES AND GEOLOGIC CHARACTERISTICS IN CENTRAL PART OF THE REPUBLIC OF MOLDOVA

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Abstarct *The article is dedicated to studying landslide distribution patterns and to assessing landslide development using fine-resolution remote sensing data and GIS technologies. There were obtained digital models of geological structure of the study area and key sectors. There were shown up dependency of the landslide development on geological conditions of the territory.*

Keywords: *landslides, geological conditions, GIS, Codri Hills, Republic of Moldova*

1. Introduction

Landslides in the Republic of Moldova are very common. They generally occur more frequently in the plateau and hilly regions of the country. For example, in the Central Region of the Republic of Moldova, known as Codri Hills or Bîc Hills, landslides annually cause damage to property, destroy houses, roads, industrial objects, agricultural lands, and so forth. In the Republic of Moldova, in the period of 1970 and 2005, annual growth of landslide area reached up to 1000 ha; in this time period Bîc heights had the highest frequency of landslides: 40-50 landslides/100 km^2.

Present work is elaborated within the project "Landslide susceptibility assessment in Central Part of Republic of Moldova", supported by NATO within Science for Peace and Security Programme (Award No: SfP-983287) (launched on March 25, 2009), which is being realized at the Institute of Ecology and Geography MAS within Landscape Science and Dynamic Geomorphology labs, in collaboration with Geological Engineering Department of Hacettepe University, Ankara, Turkey. The project's general objectives are the following:

- Elaboration of the methodology of landscape studying, using remote sensing and geoinformation technology methods;
- Landslide inventory and description;
- Landslide causes assessment;
- Elaboration of landslide susceptibility map of the Bîc heights, using various methodologies, and assessment of their performance;

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- Providing information for the Project's end-user (Civil Protection and Emergency Situations Service) with the purpose of taking decisions and proposing recommendations on diminishing landslide impact on economy, environment and human lives [5].

In present work we will analyze the way how geological characteristics influence appearance and evolution of landslides with the aid of simple GIS principles.

2. Object of study and methods

Central part of the Republic of Moldova, mainly including Codri Hills or Bîc's Codri Hills, was selected as the study area (fig. 1). It is the country's biggest heights unit, where maximal altitude reaches 429 m (Bălăneşti Hill). This geomorphologic unit has the highest relief energy, which exceeds 250-300 m, having in such a way an aspect of low mountains. Intense fragmentation, against predominance of the slopes with angles of about 7°-8° and constituted of the clayey-sandy rocks with acquifer complexes, contribute to development of the extremely large landslides, which cover considerable areas. Frequently, landslides affect settlements, industrial objects, agricultural lands, roads and railways, etc.

Landslide distribution assessment can be performed in different ways. There are known many classification schemas with regard to landslide causes. For example, U.S. Department of the Interior U.S. Geological Survey (Fact Sheet 2004-3072, July 2004) groups them into three categories:

1. Geological;
2. Morphological;
3. Human causes.

On Moldova's territory, first assessments of landslide distribution depending on geological factors were made in the early XXth century by O.K. Lange (1916) and F.S. Poruchik (1917). In 1960-1970 there appear a set of published works [28, 29, 26, 35] in which there were analyzed ways how geological structure and hydrogeological particularities influence on landslide emergence and evolution.

The specificity of geological structure was analyzed on the basis of medium-scale geological map, bibliographical sources and field research. For assessing the role of disjunctive tectonics in the appearance and dynamics of various landslide categories, there were analyzed geological map, landslide distribution map and tectonic map.

The objective of this study consists in the assessment of distribution pattern of the landslides depending on geological characteristics of the Codri Hills.

Geological causes include:

A. Weak or sensitive materials

B. Weathered materials

C. Sheared, jointed, or fissured materials

D. Adversely oriented discontinuity (bedding, schistosity, fault, unconformity, contact, and so forth),

E. Physical characteristics such as permeability, stiffness of the materials

F. Earthquakes.

In this work we show some preliminary GIS-related results of our work. Using of geoinformation technologies has allowed us developing spatial model of geological structure of the study area (Figure 1). We used 1:200 000 geological map of the Republic of Moldova, elaborated by "Moldavgeologia" in 1988 (Ob'yasnitel'naya zapiska, 1988) as reference material. Tectonic map by A. Drumea et al. (1978) was used for creation of spatial model of tectonic structure of the study area.

3. Results

If overlaid landslide locations and the lithologic units in GIS environment, it reveal that the landslides in central part of the Republic of Moldova develope in Neogene and Pleistocene rocks. In general, the territory between Dniester and Prut rivers (Figure 1) has in its geologic structure, mainly, platform features, except for a small area in the south, where northern slope of Dobrogea folded construction can be identified [21]. Ryphean, Paleozoic, Mesozoic and Cenozoic rocks contribute to geological composition of national territory; they have different completeness and are represented unevenly within the country's territory.

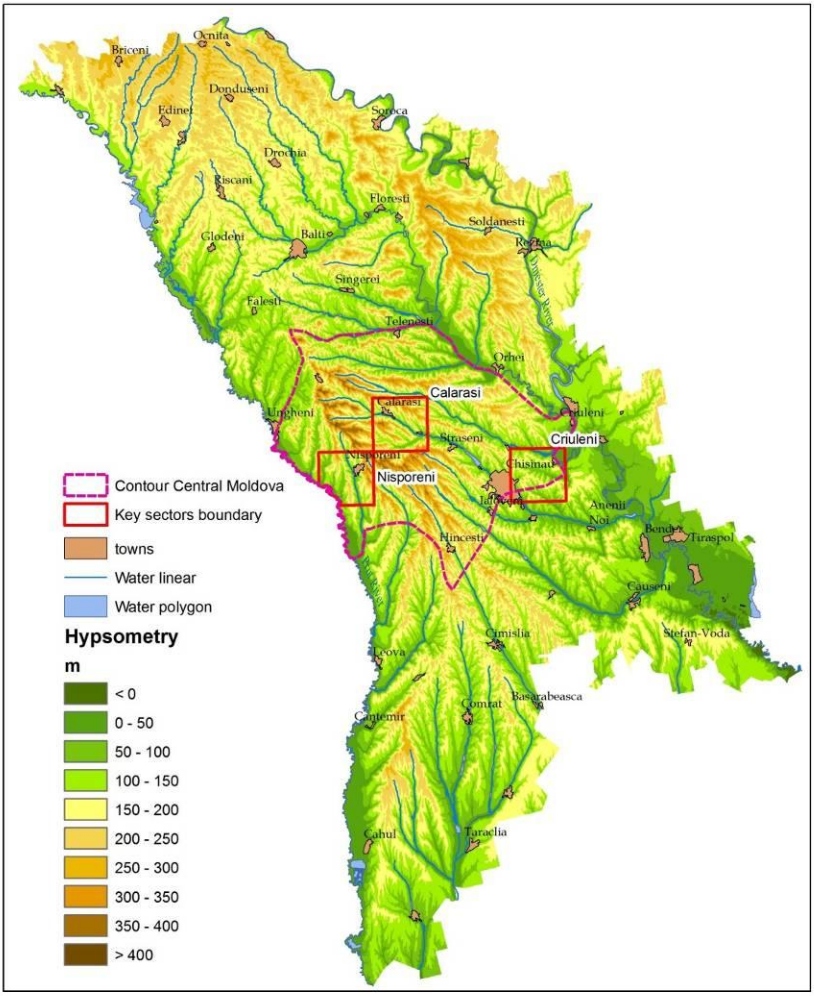


Figure 1. Region of the study and key areas location

In the north-eastern part of the country, such crystalline rock outcrops as gneisses, gabbros, and various granitoids exist. To the south-west, the foundation is covered by progressively increasing strata of sedimentary rocks of various compositions and ages. Their thickness reaches 4000 m in the south, on northern slope of Pre-Dobrogean depression [21]. Bedding depth of foundation rocks within study area is about 1300 m.

Ryphean-Paleozoic and Mesozoic deposits outcrop just in the northern part of the country and do not contribute to landslide occurrence.

Neogene deposits have the most significant role in landslide development; they are outcropped by erosion network. Neogene rocks are represented by various facieses, ranging from marine to continental. They are divided in two series: Miocene and Pliocene. These rocks are transgressively bedded on the Cretaceous, Jurassic and Paleogene deposits, burying to south-west. The thickness of these deposits constitutes 400 m in the northern part of the study area and about 600 m in the south.

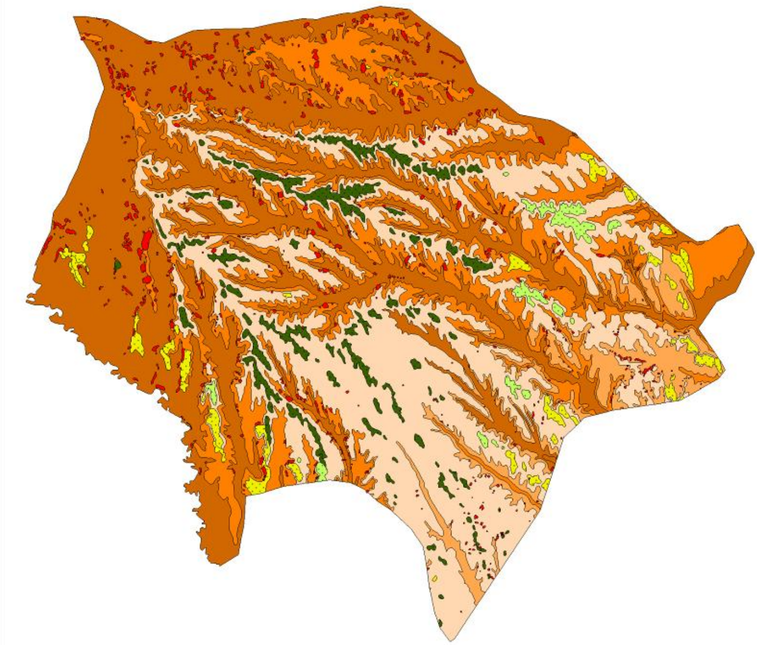
Miocene deposits are represented by various limestones, clays, marls, sands, sandstones, aleurites, and are divided into middle and upper subseries.

Middle Miocene subseries are represented by the deposits of ***Badenian regional stage***. According to the numerous investigations performed through drilling, grey clayey limestones, volcanogenic sandy clays, quartz sandstones, limestones and gypsum with subordinated intercalations of clays bed on Upper Cretaceous sandstones. In the study area, these deposits do not outcrop and do not contribute to landslide occurrence.

Upper Miocene subseries are represented by marine Sarmatian and Meotian rocks, as well as by their continental analogues.

Sarmatian deposits represent polyfacial strata. Their thickness increases from north-east to south-west, where it reaches 380 m. These deposits are divided into three substages: *Volhinian* (N_1s_1)*, Bessarabian* (N_1s_2) *and Khersonian* (N_1s_3).

Volhinian deposits consist of various limestones and, partly, marls, clays, sands and sandstones; their thickness varies from 20 to 50 m and increases under the reefs up to 110 m [27, 24]. They outcrop along the Dniester and Prut valleys, as well as in all its tributaries from extreme north southwards until the latitude of Orhei town. To the south, these deposits are bedded under the erosion base level. Clays are represented by light-grey, dark-grey, rarely by brown thinly laminated differences of aleurite-pelite and pelite structure. Stratification is conditioned by the intercalation of clayey and sandy materials.



Index	Erathem	System	Series	Subseries	Stage	Substage
N2ak	Cenozoic	Neogene	Pliocene	Upper	Akchagylian	
N2k+ak	Cenozoic	Neogene	Pliocene	Middle-Upper	Kimmerian-Akchagylian	
N2k	Cenozoic	Neogene	Pliocene	Middle	Kimmerian	
N1h-m	Cenozoic	Neogene	Miocene	Upper		
N1h	Cenozoic	Neogene	Miocene	Upper	Sarmatian	Khersonian
N1bs2	Cenozoic	Neogene	Miocene	Middle	Sarmatian	Bessarabian
N1bs1	Cenozoic	Neogene	Miocene	Middle	Sarmatian	Bessarabian
Landslides						

Figure 2. Geological structure of the study area
(Note: Akchagylian=Romanian, Kimmerian=Dacian)

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Bessarabian deposits are spread out on the entire country's territory. They are represented by clays, aleurites, sands, limestones. Their thickness increases from east to west, achieving maximal values of 360-370 m. Clays are represented by yellowish-grey, steel-blue, dark-grey differences with thinly and latently laminated texture and pelite, aleurite-pelite structure

Bioherm rock masses along the line Camenca-Orhei-Chişinău-Ialoveni were formed by a barrier reef in Early Bessarabian; they divide study area in two structural-facial zones: eastern and western [33]. To the east of the barrier reef belt (Orhei-Chişinău-Ialoveni), the role of the limestones in the geological section increases. Bessarabian rocks compose valley slopes in central part of the country. To the south from the line Cărpineni-Hînceşti-Bender, they plunge below the erosion base level.

Depending on the character of Bessarabian deposits, there are two rock masses, which correspond to two marine transgressions in Early and Late Bessarabian [33].

Khersonian deposits are spread in central part of the country and are attributed to different facieses: shallow marine, delta-front and continental [34]. Marine facieses are composed of clays, aleurites and sands with subordinated layers of limestones; delta-front facieses are predominantly constituted of sands, frequently with oblique stratification; lacustrine and lagoonal facieses are dominated by cloddy clays with rare intercalations of sands and aleurites and thin intercalations of brown coal. The clays are yellow and greenish-brown. Upper Sarmatian deposits constitute valley slopes on the territory limited to the north by the latitude line passing northwards from Chişinău municipality. They form certain slope parts of the Bîc valley around Vatra town, slopes of the Hulbocica stream, upper slope parts and interfluves in the lower course of Bîc, Ichel and Dniester rivers.

Khersonian rocks form quite abundant aquifers, discovered in Prut River valley southwards from Ungheni town, in Dniester River valley between Soroca and Dubăsari towns and from Bender city to the mouth, as well as in river valleys of Dniester tributaries Bîc and Botna.

Meotian deposits have been reliably determined in the south-western part of the country. They are represented by grey and greenish-grey clays and aleurites with greenish-grey and rust-brown spots, clays with intercalations of aleurites and sands. Meotian deposits are bedded almost everywhere below the modern erosion base level, and, therefore, they neither participate in slope composition, nor in exogenous slope processes.

In central and, partly, southern part of the Republic of Moldova, alluvial deposits of Balta suite are widely spread; they form a rhythmic rock mass of sands with oblique stratification and lenses of sandstones and cloddy clays [22]. Rhythm's thickness varies from 5 m to 25 m; genetically, each rhythm represents a complete alluvial cycle. There are up to eight such rhythms. The rocks of Balta suite, dated to *Upper Bessarabian substage – Meotian stage*, are up to 150 m thick, sometimes up to 190 m, and play significant role in slope composition; therefore, they constitute the environment for development of the majority of exogenous geologic processes.

Upper Sarmatian-Meotian aquifer is confined to the deposits of this stage; its main reserves are located in the Prut River valley southwards of the Ungheni town.

Pliocene series are represented by various facieses of the Upper Pliocene subseries: lacustrine-fluvial and subaerial formations. Lacustrine-fluvial formations are spread out more largely and are represented by Pliocene terraces of the Danube, Prut and Dniester rivers. Their thickness is about 60 m.

In the study area, Pliocene cross-section is represented by alluvial formations of the upper terraces of the Prut, Dniester and Răut rivers. Total thickness of Pliocene deposits reaches up to 200 m.

These series' rocks form the Middle-Upper Pliocene aquifer, whose main reserves are contained in the Prut valley southwards of Ungheni town.

Quaternary deposits are spread out, practically, on the entire country's territory. They are bedded on uneven surface of older deposits. These rocks are represented by alluvium (pebblestones, gravel, sands, clays) of *Eopleistocene* terraces and *Holocene* deposits in floodplains and cover deposits (loams, loess-type loams, sandy loams, in some areas with fossils, slack, detritus, landslide accumulations). Cover formations interlap interfluves, slopes and river terraces alluvium in the form of mantle. Their area and thickness have an increasing north-south trend. However, in the regions with positive neotectonic movements, thickness of these formations is low. In the areas with negative vertical movements their thickness reaches up to 30 m.

Distribution of various lithologies in the study area is given in Figure 3.

In order to assess region's landslide susceptibility, three key sectors were selected: Nisporeni, Călăraşi and Criuleni with total surface of 1019 sq. km, situated in different, but characteristic to the entire study area, geological and geomorphologic conditions [5].

Geologic structure of the Nisporeni sector

Prut River's floodplain, lower and middle part of the slopes, floodplains and slopes of the first, second and third Prut's tributaries, floodplain and lower slope parts of Nîrnova River are composed of *lower Bessarabian rocks*, in which three rock bundles are evidenced. The lower bundle is mainly clayey, the middle one is represented by intercalations of clays, sands and aleurites, the upper one is sandy. Deposits' thickness largely varies between 30 and 190 m. It is worthy of mentioning that third bundle's deposits remain just within Codri Hills, and their thickness can achieve 40-45 m [25, 27]. The upper boundary of these deposits is located at the altitudes of 150-175 m.

Middle and upper slope parts of the Nîrnova River, certain slope parts of the Prut's tributaries are represented by *upper Bessarabian rocks* composed of sands, aleurites and clays with thin intercalations of oolitic and shell limestones. Their thickness sometimes reaches up to 80 m.

Upper slope parts and interfluves between Nîrnova and Lăpuşniţa rivers, upper parts of the interfluves between Nîrnova River and small Prut River's tributaries are represented by rhythmically composed sandy-clayey rocks of *nonsegmented Khersonian-Meotian strata*. Each rhythm starts with medium-grained quartz sand, which is progressively replaced by fine-grained one. The sand is crossbedded and contains sometimes limestone lenses. Upwards the cross-section it passes into fine-grained clayey sand and aleurite. The rhythm's top is formed of cloddy clay.

The highest interfluves between Nîrnova and Lăpuşniţa rivers in the north eastern part of the sector are represented by alluvial deposits of *lower Middle Cimmerian strata*. They are represented by Mileşti horizon (XVIth Pra-Prut terrace above the floodplain) – intercalations of sands, clays and aleurites. Thickness of the intercalations varies between 2 and 15 m [13]. This horizon is represented by two facieses: in-stream and floodplain. Sands are fine- and medium-grained with lenses of various-grained ones, incorporating rare grains of Carpathian jasper; the sands are loose, rarely semiconsolidated. Clays are compact, aleuritic, with many sliding surfaces. Clayey aleuritic sands are also present. Aleurites are clayey, compacted; sometimes they represent intercalations of up to 3-4 m thick. Average altitude of the deposits' base constitutes 360-375 m.

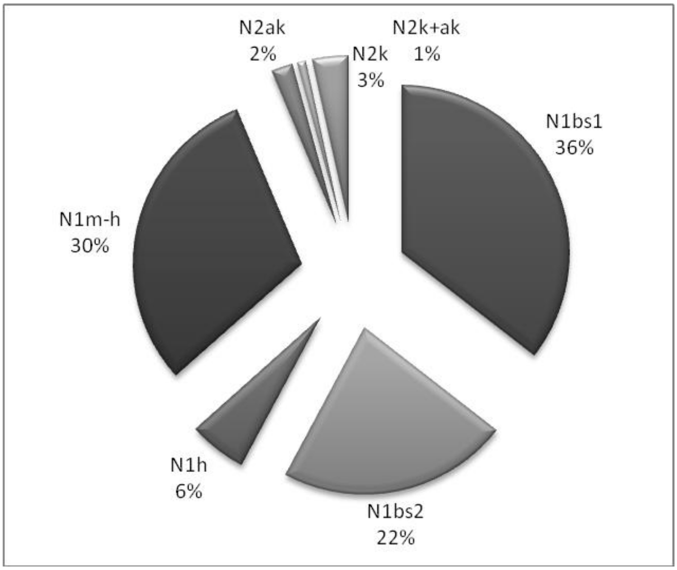

Figure 3. Distribution of different lithologies within the study region

Lower parts of the interfluve between Nîrnova and Lăpuşniţa rivers, the highest part of the interfluves between Nîrnova River and Prut River tributary are composed of the deposits of *upper Middle Cimmerian strata*. They are represented by Floriţoaia Nouă horizon (XV^th Pra-Prut terrace above the floodplain) and are composed of sandy-gravel-pebble deposits, which include 0.1-0.5 cm pebbles of Carpathian jasper, Vendian sandstone and aleurolites, Cenomanian flints, metamorphic and intrusive rocks [25, 15]. Altitudes of the base vary between 270-280 m.

On the interfluves between Nîrnova River and the third Prut River tributary there are located alluvial deposits of the *nonsegmented Upper Cimmerian-Lower Akchagylian deposits* (XIIIth (Musait) Pra-Prut's terrace), which are represented by intercalations of sands and clays 2-13 m thick [15]. Total thickness of these deposits exceeds 60 m. Sands have various fineness with grains of jasper and aleurite intercalations. Sometimes sands are water-bearing. Clays are plastic, thinly laminated, in fissures. Altitudes of the base constitute 220-235 m.

Interfluves of Prut and Nîrnova tributaries represent alluvial terraces attributed to *Akchagylian regiostage*, divided in three regiosubstages.

Lower Akchagylian is composed of alluvial and subaerial deposits of *Cîșlița-Prut horizon* (XII^th Pra-Prut's terrace above the floodplain) [2, 13, 12]. Seven bundles of intercalations of sands, pebble stones and clays are determined in these deposits. Thickness of sand layers, predominantly fine-grained, varies between 1.5 and 10 m, thickness of sandy, cloddy clays is 0.5-3.0 m; total thickness of the deposits constitutes 36 m [32]. Altitudes of the base vary between 200 and 220 m.

Interfluves of the Prut River tributaries are composed of *Buciumeni horizon* deposits with alluvial and subaerial formations attributed to XI^th Pra-Prut's terrace above the floodplain [25, 13, 20]. These strata are predominantly composed of sandy-gravel deposits, fine-grained sands, floodplain aleurites, sandy clays. Sand strata's thickness varies between 1 and 4 m, clays are 1 m thick. Total thickness of this horizon is about 10 m.

Deposits of the X^th Pra-Prut's terrace above the floodplain (*Manta horizon*) are attributed to *Upper Akchagylian regiosubstage* and compose southern parts of the Prut River tributaries. They are separated from the lower terrace by a shoulder 15-20 m high. Terrace deposits are presented by medium- and fine-grained sand with gravel and pebbles of Carpathians jasper, Vendian sandstones and aleurolites [27]. They are bedded on the Upper Sarmatian rocks, whose altitude constitutes 125-130 m.

Geologic structure of Criuleni sector

Dniester and Ichel rivers floodplains are composed of *lower Bessarabian deposits*, represented by pelitomorphic, oolitic and foraminiferal limestones. Their thickness does not exceed 10 m. Limestone and silica clay rocks, are intercalated by limestones, marls and clays. Thickness of these deposits reaches up to 15 m. [16, 11]

Bottom parts of valleys, floodplains and lower parts of slopes of Dniester River tributaries are composed mainly of limestones with intercalations of sand and clay of *upper Bessarabian deposits*, 40 m thick.

Middle and upper slope parts of Bîc and Ichel interfluves are represented by *Khersonian deposits*: mainly sandy-clayey rocks with intercalations and lenses of shell limestones. Thickness of these deposits sometimes achieves 100 m.

Interfluves are composed of sandy-clayey *nonsegmented Khersonian-Meotian deposits*. Each rhythm starts with medium-grained quartz sands, which are progressively replaced upwards by fine-grained ones. Sands are cross-bedded and contain sometimes limestone lenses. Upwards within cross-section they pass into fine-grained clayey sands and aleurites. There are up to 8 such rhythms.

Interfluves of the sectors, neighboring Dniester River, represent alluvial terraces. They are attributed to *Middle Akchagylian regiosubstage* and form *Bălţata horizon* with alluvial and subaerial deposits of XIth terrace above floodplain [27]. Mainly, they are sandy-gravel deposits with separate boulders of Vendian sandstones of 5-10 cm in size, bluish-gray fine-grained sands, pale-yellow floodplain aleurites. Total thickness is about 20 m.

Deposits of Xth Dniester's terrace above floodplain (*Fîrlădeni horizon*) are attributed to Upper Akchagylian regionsubstage [18, 10]. They are separated from the below terrace by the clearly visible shoulder 15-20 m high. They are bedded on Upper Sarmatian rocks. They represent terrace deposits of fine- and medium-grained sand with gravel and pebble of Carpathians jasper, Vendian sandstones and aleurolites.

Geologic structure of Călăraşi sector

Floodplain, lower part of Bîc valley slopes and Bîc's tributaries are composed of *Lower Bessarabian deposits*, in which three bundles show up. The lower bundle is mainly clayey, the middle one represent intercalations of clay, sand and aleurites, the upper one is sandy. Thickness of these deposits varies within large limits from 30 to 190 m [1, 11, 6]. Their roof is located at the altitudes of 150-175 m.

Middle part of Bîc valley slopes and Bîc's tributaries are represented by *Upper Bessarabian deposits*, constituted of sands, aleurites and clays with thin intercalations of oolitic and shell limestones. Their thickness reaches up to 80 m.

Upper part of slopes and lower interfluve sectors are composed of rhythmical *non-segmented sandy-clayey Khersonian-Meotian deposits*. Sands are cross-bedded and contain sometimes lenses of sandstones. Upward within cross-section they pass into fine-grained clayey sands and aleurites. The rhythm ends by cloddy clays. Maximal thickness of the strata reaches 190 m.

The highest sectors are composed of *lower Middle Cimmerian alluvial deposits* [17, 11]. They are represented by *Stolniceni horizon* (XVIth Pra-Dniester's terrace above floodplain). Anisomerous sands with gravel lenses and small pebble conglomerates 3-10 m thick represent in-stream facies [14]. Floodplain clays are compact and aleuritic. Total thickness of these deposits is 30-50 m [16]. Relative height of the base constitutes 280-310 m.

Bîc-Ichel interfluves are composed of *upper Middle Cimmerian deposits*. They are represented by *Călăraşi horizon* (XVth Pra-Dniester's terrace above floodplain) and consist of in-stream sandy-gravel-pebble deposits, which includes pebbles of Carpathians jasper and black siliceous rocks, like menelite slates 4-7 m thick [13]. Floodplain facies is represented by semicompacted aleurites 2-2.5 m thick and cloddy clays 1-1.5 m thick. In the majority of cases sands outcrop and are covered just by soil. Altitudes of the surface constitutes 295-305 m.

On the sector of Răcătău-Bucovăţ interfluve, of Bîc tributaries, there were revealed *Hruşova horizon* deposits of the *Middle Akchagylian regiosubstage* with alluvial and subaerial rocks attributed to XI*th* Pra-Dniester's terrace above the floodplain. Mainly, they are represented by sandy-gravel strata, small- and fine-grained sands, floodplain aleurites, sandy clays. Sand strata thickness is 12 m, clays are up to 1 m thick. Altitude of the base varies between 160 and 170 m.

Particularities in landslide distribution within key sectors

Within Nisporeni key sector there have been identified 100 landslides of various types. The great majority (85%) of the landslides here, as well as in Călăraşi key sector, are formed on the slopes composed of Bessarabian rocks: 48% of landslides are located in lower Bessarabian strata, while 37% - in the upper ones. Landslides in lower strata are more numerous and have slightly bigger area (landslide's average area constitutes 19 ha), which increases their share in total landslides' area. Landslides are also mentioned in the deposits of non-segmented Khersonian-Meotian strata as well as in Akchagylian ones (Table 1).

Table 1. Association of landslides by geological complexes (Nisporeni key sector)

Geological complex	Geological index	Number of landslides	Total area, ha	Average area, ha
Lower Bessarabian strata	N_1bs_1	49	944	19
Upper Bessarabian strata	N_1bs_2	37	413	11
Nonsegmented Khersonian-Meotian strata	N_1h-m	13	121	9
Akchagylian strata	N_2ak	2	2	1

Wihin Criuleni key sector there were revealed 34 landslides of various types. Their majority (73%) is located on the slopes composed of Khersonian deposits. The number of landslides is 5 times less within upper Bessarabian strata. However, landslides in Bessarabian strata are almost 2 times bigger (average area is of 27 ha) than those in Khersonian ones (13 ha). Besides these deposits, landslides have also been identified in nonsegmented Khersonian-Meotian strata as well as in Akchagylian deposits (Table 2).

Table 2. Association of landslides by geological complexes (Criuleni key sector)

Geological complex	Geological index	Number of landslides	Total area, ha	Average area, ha
Upper Bessarabian strata	N_1bs_2	5	135	27
Khersonian deposits	N_1h	25	324	13
Nonsegmented Khersonian-Meotian strata	N_1h-m	3	15	5
Akchagylian strata	N_2ak	1	1	1

Within Călăraşi key sector there were identified 106 landslides of various types. Their majority (74%) is located on the slope sectors, composed of Bessarabian rocks: 22% of the total number of landslides is linked to lower Bessarabian strata, while 52% is located within upper ones. Comparing their size, upper strata's landslides are slightly bigger (average area is of 23 ha), which is reflected in their increased share in total landslide area. The number of landslides within non-segmented Khersonian-Meotian strata is also significant (23%). Besides these deposits, landslides in Călăraşi key sector have been identified within Cimmerian deposits (Table 3).

Table 3. Association of landslides by geological complexes (Călăraşi key sector)

Geological complex	Geological index	Number of landslides	Total area, ha	Average area, ha
Lower Bessarabian strata	N_1bs_1	23	351	15
Upper Bessarabian strata	N_1bs_2	55	1258	23
Nonsegmented Khersonian-Meotian strata	N_1h-m	25	447	18
Cimmerian strata	N_2k	3	8	3

From the viewpoint of the mechanism of movement, complex landslides of translational-earthflow type are dominating. They are usually big, reaching up to 30-40 ha in surface. Translational landslides are less frequent, as well as small earthflow ones. General data, totalizing the information within all the key sectors, are represented in Table 4.

In what follows we add some statements to the relationship between landslide and disjunctive tectonics.

Geological researches of the late XXth century have allowed detailing structural specificity of the upper part of Moldavian Platform's sedimentary mantle. Investigations show up existence of the two main systems of tectonic deformations (Figure 4): dominant system, oriented NW-SE, represented by tectonic faults parallel to East Carpathians and the system oriented NE-SW, perpendicular to Carpathians.

Table 4. Association of landslides by geological complexes within 3 key sector

Geological complex	Geological index	Number of	Total area,	Average
Lower	N_1bs_1	72	1295	18
Upper	N_1bs_2	97	1806	19
Khersonian	N_1h	25	323	13
Nonsegmented	N_1h-m	41	582	14
Akchagylian	N_2ak	3	3	1
Cimmerian	N_2k	3	8	3

Significant influence of disjunctive structure (tectonic faults and fissures) on landslide development and dynamics in the Republic of Moldova has been mentioned by many authors [3, 4, 30]. Remote sensing outcomes have allowed obtaining reliable data on the share of landslides within the areas of tectonic faults Călăraşi and Bucovăţ etc. The influence of the faults and high degree of tectonic fissuring on landslide development and dynamics is explained through clayey rock resistance to movements on the slopes; this process is being favored by considerable increase of the humidity of the landslide body.

Existence of the fissures in clayey rocks contributes to both diminishing their hardness and facilitating penetration of water into the rock mass. As a result, hydrostatic and hydrodynamic pressures of water on the rock increase; clays swell, especially montmorillonite ones, presented in Codri Hills. In the fault area, besides superficial landslides, massive landslides are present; they can be attributed to the category of rotational landslides. Thus, landslides in the Mălăeşti village area, on the left bank of Dniester River within Criuleni key sector, landslides in the area of Pocşeşti and Vorniceni villages within Călăraşi key sector are the examples of rotational landslides. Their appearance is explained by highly fissured rocks [4].

An important role in landslide development is played by seismic processes [29, 4]. The last author shows on the map (pag.124) appearance of about 40 new landslides (19 of them are located in the Central Moldova) as a result of the earthquake of 7.3 degree Richter occurred on March 4, 1977 with epicenter located in Vrancea Mountains (Romania), 200-250 km south-west from the study area.

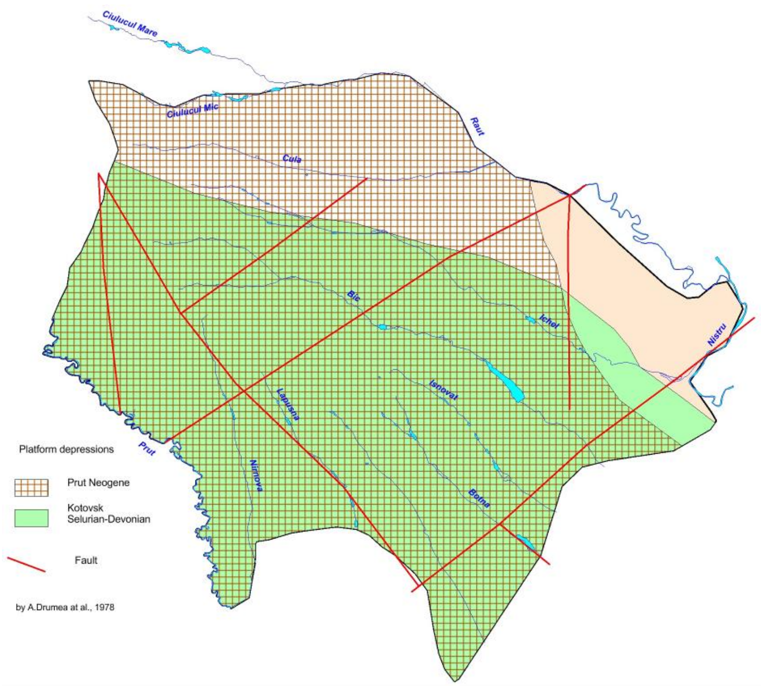

Figure 4. Tectonic map of the study area

4. Conclusions

Summarizing the results presented above, the following conclusions can be made:

1. Landslide appearance and dynamics is mainly determined by geologic factor (clayey-sandy facieses, existence of ground waters and linear disjunctive structures, highly fissured rocks etc.). However, influence of the morphological and human causes cannot be neglected neither.

2. Among the rocks, which form geological structure of the territory of study area, Miocene and Pliocene clayey-sandy deposits dominate. They are characterized by the intercalation of sands and clays of various thicknesses. Up to the geological section sand's share increases.

3. In spite of the fact that Bessarabian deposits constitute 56% of all three key sectors, 77% of landslide areas are located in them.

4. The biggest area, as well as the most numerous landslides, has been identified within the upper strata of Bessarabian deposits. The contribution of lower Bessarabian strata is less significant due to lower share of sands in geological section. Landslide average size in these two geological complexes varies insignificantly.

5. More than one third of Codri Hills is covered by Khersonian deposits and nonsegmented Khersonian-Meotian strata. In their geological section sand's share is higher than in older deposits; just 28% of all the landslides are located here. Landslide size is smaller than the one in Bessarabian rocks by 35%.

6. Just singular manifestations of landsliding can be identified in alluvial deposits because of the local causes.

7. Landslide distribution characteristics are comparable for Călăraşi and Nisporeni key sectors: in both sectors landslides are mainly located within Bessarabian substage. At the same time, in Criuleni key sector landslides are identified within Khersonian and non-segmented Khersonian-Meotian strata.

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ANALYSIS OF POSSIBLE SPREADING OF THE AREA UNDER CULTIVATION OF LATE MATURITY MAIZE HYBRIDS ON THE TERRITORY OF THE REPUBLIC OF MOLDOVA BY USE OF GIS TECHNOLOGIES

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Показано, что будущее увеличение продолжительности вегетационного периода и соответственно сумм активных и/или эффективных температур позволит перейти уже к 2010-2039 гг. к выращиванию практически на всей территории Республики Молдова среднепозднеспелых гибридов кукурузы ($\sum T_{ак}$ >10^0C - 2950^0C), обладающих более высокой потенциальной урожайностью, чем их скороспелые аналоги. К 2040-2069 гг. в результате возможных изменений в термическом режиме значительно увеличится и ареал возделывания позднеспелых гибридов кукурузы ($\sum T_{ак}$ >10^0C - 3200^0C), относительно базового периода 1961-1990гг. Что позволит повысить адаптационный потенциал и урожайность кукурузы как культуры в целом. Так как в среднем в системах выращивания зерновых такие меры адаптации как изменения сортового состава и времени посадки позволяют избежать 10-15% снижения урожайности, что соответствует местному повышению температуры на 1-2^0C.

Key words: *maize (Zea mays L.), late maturity hybrids, sum of biologically active and/or effective temperatures, area under cultivation*

Rezumat *S-a relatat, că prelungirea perioadei de vegetaţie şi în consecinţă, creşterea sumei temperaturilor active şi/sau efective, ar urma să contribuie către anii 2010-2039, la sporirea arealului de cultivare a hibrizilor de porumb semitardivi ($\sum T_{ac}$ >10^0C - 2950^0C), cu un potenţial de productivitate mai mare decât omologii lor timpurii, practic pe întreg teritoriul Republicii Moldova. Către anii 2040-2069, ca urmare a unor eventuale modificări în regimul termic, va creşte în mod semnificativ suprafaţa de cultivare a hibrizilor de porumb tardivi ($\sum T_{ac}$ >10^0C – 3200^0C), în comparaţie cu perioada de bază (1961-1990). Ceea ce va spori capacitatea de adaptare şi productivitatea a porumbului ca cultură agricolă. Urmează a se ţine cont şi de faptul, că măsuri de adaptare în cadrul sistemele de producţie a cerealelor, precum modificarea compoziţiei de soiuri şi termenilor de*

însămânţare, permit a evita scăderea productivităţii cu circa 10-15%, ceea ce ar corespunde unei creşteri a temperaturii la nivel local cu circa 1-2^0 C.
Cuvinte cheie: *porumb (Zea mays L.), hibrizi semitardivi şi tardivi, suma temperaturilor active și/sau efective, arealul de cultivare*

INTRODUCTION

The yield of cultivated crops is directly dependent on the length of the period during which they can carry the photosynthetic process and accumulate biomass. This dependence is typical for maize. In particular, the length of the growing season and the sum of biologically active and/or effective temperature defines a group of maturity of maize hybrids, which can be grown in specific climatic conditions, as well as their potential yields. Late maturity maize hybrids are usually more productive in comparison with the early-ripening hybrids growing in similar conditions. The most productive maize hybrids are mid and mid-late ripening ones for the climatic conditions of the Republic of Moldova [1].

With the lengthening periods of active vegetation and, correspondingly with increasing the sum of biologically active and/or effective temperatures is possible to cultivate hybrids of later maturing, thus enhancing their adaptive capacity and yield of maize as a crop in general. As generally, within the grain production systems, such adaptation measures like change of sort composition and time of planting allow to avoid a 10-15% reduction of yield, which corresponds to the local air temperature rise of 1-2^{0}C [2].

Therefore, the aim of presented work was to analyze the possible expansion of the area under cultivation the most productive mid-late and late maturity maize hybrids on the territory of the Republic of Moldova as a result of future changes in the length of the growing season and as a consequence increase the sum of biologically active and/or effective temperatures for three time periods according to CSIRO-Mk2, HadCM2, ECHAM4 models relative to the reference period 1961-1990.

MATERIALS AND METHODS

It is known that maize requires a longer growing season and in comparison with other crops is more sensitive to weather conditions. According to some studies, as the lower threshold of maize vegetation start there is accepted the temperature of 10^{0}C [3-7], while according to the others, the 13^{0}C [8-10]. We have chosen as agro-climatic indices the degree of adaptability of the thermal regime for maize cultivation: the date of transition of average daily air temperature over 10^{0}C in spring and autumn; the length of the growing season with air temperatures above 10^{0}C; the sum of the biologically active and/or effective air temperatures above

10^0C. For these agro-climatic indices were calculated the projections of future changes according to global circulation models of the atmosphere and ocean (GCM): CSIRO-Mk2, HadCM2 and ECHAM4, for three time periods (2010-2039, 2040-2069 and 2070-2099) relative to the reference period of 1961-1990. IS92a scenario served as the basis for the determination of the greenhouse gas emissions development patterns. GCM scenarios are available in the archives of Hadley Center for Climate Prediction and Research (http://ipcc-ddc.cru.uea.ac.uk/is92/gcm_data.html) (DDC GCM Data Archive). A spatial assessment of the possible spreading of the area under cultivation of mid-late and late maturity maize hybrids on the territory of the Republic of Moldova as a result of the future changes in the thermal regime has been undertaken by use of the computer program EcoClass [11, 12]. The respective program is based on GIS technology and allows generating maps of spatial and temporal distribution of agro-climatic indices for the reference climate scenario and other different climate change scenarios. The main input data of the program are: the average daily air temperature and the average daily precipitations for the 1961-1990; climate change scenarios, which include models of global atmospheric and ocean circulation (GCM): CSIRO-Mk2, HadCM2 and ECHAM4.

RESULTS AND DISCUTION

With the temperature conditions of growth and development of maize are closely related the issues of agro-climatic zoning of this crop. For the normal passage of ontogeny (from germination to full maturity of grain) maize plants shall receive a certain amount of heat. This amount represents the sum the average daily air temperatures during the vegetative season, except for days with daily average air temperature below 10^0C. To be noted that the maize hybrids which are distinguished along the length of the vegetative season require different sum of cumulated air temperatures.

In a range of studies [13, 9, 10, 3, 4, 6, 7, 14 and others] there were revealed the sum of biologically active and/or effective temperatures needed for maize plants to achieve the certain phenological phases of development, inclusive the physiological maturity of the grain at hybrids of ifferent group of maturity.

As an example, could serve the classification of Shashko [cit. to 6] developed on the base of scientific literature analysis and personal researches (Table 1).

Table 1: Heat Demand of Different Maize Hybrids and Varieties by Phenological Phases of Vegetation, according to D.I. Shashko

Group of maturity	Phenological phases of vegetation	Sum of temperatures (^{0}C)	
		Biological	Bioclimatic
The earliest (Beloiarskoe psheno et al.)	sowing – silking	1100	1350
	sowing – milk ripe	1700	1950
	sowing – maturity	2100	2350
Early (Bezenchukskaia 41 et al.)	sowing – silking	1200	1450
	sowing – milk ripe	1800	2050
	sowing – maturity	2200	2450
Semi-early (Harcovskaia 23 et al.)	sowing – silking	1300	1550
	sowing – milk ripe	2000	2250
	sowing – maturity	2500	2650
Mid (VIR 25 et al.)	sowing – silking	1400	1650
	sowing – milk ripe	2100	2350
	sowing – maturity	2500	2750
Mid-late maturity (Krasnodarskii et al.)	sowing – silking	1500	1750
	sowing – milk ripe	2200	3450
	sowing – maturity	2700	2950
Late maturity (VIR 166 et al.)	sowing – silking	1600	1850
	sowing – milk ripe	2300	2550
	sowing – maturity	2900	3150

Using the data presented in Table 1 and the sum of biologically active air temperatures $\Sigma T_{ac} > 10^0$C, it is possible in the first approximation to identify potential areas of cultivation under maize hybrids and varieties with different maturity degree.

For accuracy of calculations it had better use the bio-climatic temperatures. The *sum of bioclimatic temperatures represents the sum of biological air temperatures, increased by a certain amount to guarantee the full yield ripening (or the occurrence of the desired phase of vegetation).* Thus for instance, the late maturity maize hybrid LG 25.33 (LZM 549/06) for grain can be cultivated just southward of $\Sigma T_{ac} > 10^0$C - 3200^{0}C; mid maturity maize hybrid PORUMBENI 375 AMRf, respectively southward of $\Sigma T_{ac} > 10^0$C - 2800^{0}C and the early maturity hybrids and varieties - southward of $\Sigma T_{ac} > 10^0$C - 2400^{0}C. Northward of this line growing of grain maize cannot be guaranteed, there can be cultivated only the maize for silage or for green feed.

For comparative assessment of heat requirements of different maize hybrids it is sometimes used the biological indicator 'number of leaves on the main stem' [13]. It was revealed, that the respective character of precocity of the maize hybrids and varieties it is closely related with the indices of ‘sum of active $\Sigma T_{ac}> 10^0C$ and/or effective $\Sigma T_{ef}>10^0C$ air temperatures.

Average daily air temperatures can be transformed into effective air temperatures by subtracting the biological minimum (i.e., temperature 10^0C) from each average daily index, then by summarizing the obtained temperatures during the whole growing season.

Although in the southern regions during the daytime the air temperature often exceeds 30^0C, when the growth and development of plants are significantly suppressed. Such temperatures are called ‘ballast temperatures’ and they must also be considered. It was obtained the equation which permits to switch from $\Sigma T_{ef}> 10^0C$ (x) to the sum of effective temperatures without ballast (y). This relationship is represented by the equation: $y = 0.74x + 140$. By using the respective equation it is possible easily to calculate the effective temperatures without ballast for each maize development phase in any area of its cultivation [15].

By using the sum of biologically active and/or effective temperatures can be also predicted the possibility of additional cultivation of crops on the same plot of land. The study [16] revealed that the sum of effective temperatures $\Sigma T_{ef}> 10^0C$ in the Central and Southern areas of the country, since the period of harvesting the winter crops (early July) until the stop of vegetation period at maize (the first decade of October), has constituted $800-860^0C$. During this period, the early-maturing maize hybrids can achieve the dough phase of grain ($820-840^0C$), while the semi-early and mid maturing maize hybrids can achieve the milk- dough phase of grain ($850-880^0C$).

Table 2: Development of the Growth Pattern in the Average Daily Air Temperature above 10^0C and the Length of the Period with Temperatures above 10^0C for the Three Time Periods According to the CSIRO-Mk2, HadCM2 and ECHAM4 Models in Comparison with the Reference Climate Period (1961-1990)

Region	CSIROMk2			HadCM2			ECHAM4		
	The date when the average daily air temperatures exceeds 10^0C		Deviation (+/-) as compared to 1961-1990	The date when the average daily air temperatures exceeds 10^0C		Deviation (+/-) as compared to 1961-1990	The date when the average daily air temperatures exceeds 10^0C		Deviation (+/-) as compared to 1961-1990
	Spring	Autumn		Spring	Autumn		Spring	Autumn	
2010-2039									
North	06.04	15.10	+20	21.04	19.10	+9	20.04	15.10	+6
Center	30.03	19.10	+24	08.04	23.10	+20	04.04	20.10	+21
South	29.03	22.10	+26	06.04	26.10	+22	29.03	22.10	+26
2040-2069									
North	04.04	21.10	+28	21.04	25.10	+15	04.04	19.10	+26
Center	29.03	26.10	+33	04.04	31.10	+32	27.03	26.10	+35
South	27.03	31.10	+37	01.04	01.11	+33	26.03	07.11	+45
2070-2099									
North	01.01	22.10	+32	07.04	25.10	+29	25.03	26.10	+43
Center	29.03	07.11	+45	04.04	13.11	+45	21.03	12.11	+58
South	28.03	12.11	+48	30.03	13.11	+47	18.03	13.11	+59

Note. The observed mean annual date of the transition air temperature over 10^0C and the length of the period with average daily air temperatures above 10^0C during the base period 1961-1990: North in the spring - 22.04, in the autumn 10.10 (173 days); Center: in the spring - 20.04, in the autumn -16.10 (179 days); South: in the spring - 21.04, in the autumn - 19.10 (182 days), respectively.

New conditions of heat supply for maize (see Table 2) is estimated as changes in the length of the period with the average daily air temperatures above 10^0C, as well as the degree-days sum of this temperature (see Table 3). In the future climate, due to earlier springs and longer autumns, it is expected that there will be a significant increase in the length of the vegetation period (Table 2).

Long-term average observed length of the vegetation period with the average daily air temperatures above 10^0C changed across the territory: from 173 days in the North to 182 days in the South of the country for the reference climate 1961-1990. By the end of 2099 year the length of the vegetation period will be significantly increased, varying within the range of 29-43 days in the North and 47-59 days in the Centre and South of the Republic of Moldova. An increase in the length of the vegetation period is accompanied by a corresponding increase in degree-days.

Table 3: Projections of Changes in the Amounts of Active and /or Air Temperatures above 10^0C for the Three Time Periods According to the CSIRO-Mk2, HadCM2 and ECHAM4 Models in Comparison with the Reference Climate Period 1961-1990

Region	CSIRO-Mk2				HadCM2				ECHAM4			
	$\sum T_{AC} > 10^0C$	(+/-) to 1961-1990	$\sum T_{EF} > 10^0C$	(+/-) to 1961-1990	$\sum T_{AC} > 10^0C$	(+/-) to 1961-1990	$\sum T_{EF} > 10^0C$	(+/-) to 1961-1990	$\sum T_{AC} > 10^0C$	(+/-) to 1961-1990	$\sum T_{EF} > 10^0C$	(+/-) to 1961-1990
2010-2039												
North	3224	+479	1294	+269	3174	+429	1354	+329	3126	+381	1336	+311
Center	3719	+554	1679	+304	3758	+593	1728	+353	3712	+547	1713	+338
South	3788	+566	1708	+306	3798	+376	1758	+356	3824	+602	1744	+342
2040-2069												
North	3504	+759	1494	+469	3507	+762	1627	+602	3513	+768	1523	+498
Center	4025	+860	1904	+529	4134	+969	2024	+649	4066	+901	1926	+551
South	4121	+899	1931	+529	4207	+985	2057	+655	4234	+1012	1964	+562
2070-2099												
North	3763	+1018	1714	+689	3837	+1092	1817	+792	4117	+1372	1967	+942
Center	4379	+1214	2139	+764	4523	+1358	2233	+858	4715	+1550	2406	+1031
South	4472	+1250	2172	+770	4564	+1342	2274	+872	4861	+1639	2451	+1049

Note. The observed mean annual sum of active and effective temperatures for the reference period 1961-1990: $\sum T_{AC} > 10^0C$: North (2745^0C), Center (3165^0C), South (3222^0C); $\sum T_{EF} > 10^0C$ - North (1025^0C), Center (1375^0C), South (1402^0C).

The obtained results show that a pronounced pattern of the significant sum of air temperatures growth will persist during the next 100 years for the days with the temperatures above 10^0C. Already by 2039 year the sum of biologically active temperatures $\Sigma T_{ac} > 10^0C$ will grow by 429 and 479^0C and make 3174 and 3224^0C in the North of the Republic of Moldova under HadCM2 and CSIRO-Mk2 models, the respective values would constitute 381^0C and 3126^0C respectively under the ECHAM4 model.

By 2099 year the sum of biologically active temperatures $\Sigma T_{ac} > 10^0C$ will be within the range of 3763-4175^0C in the North of the Republic of Moldova and as high as 4379-4715^0C and 4472-4861^0C respectively in the Central and Southern zone (Table 3).

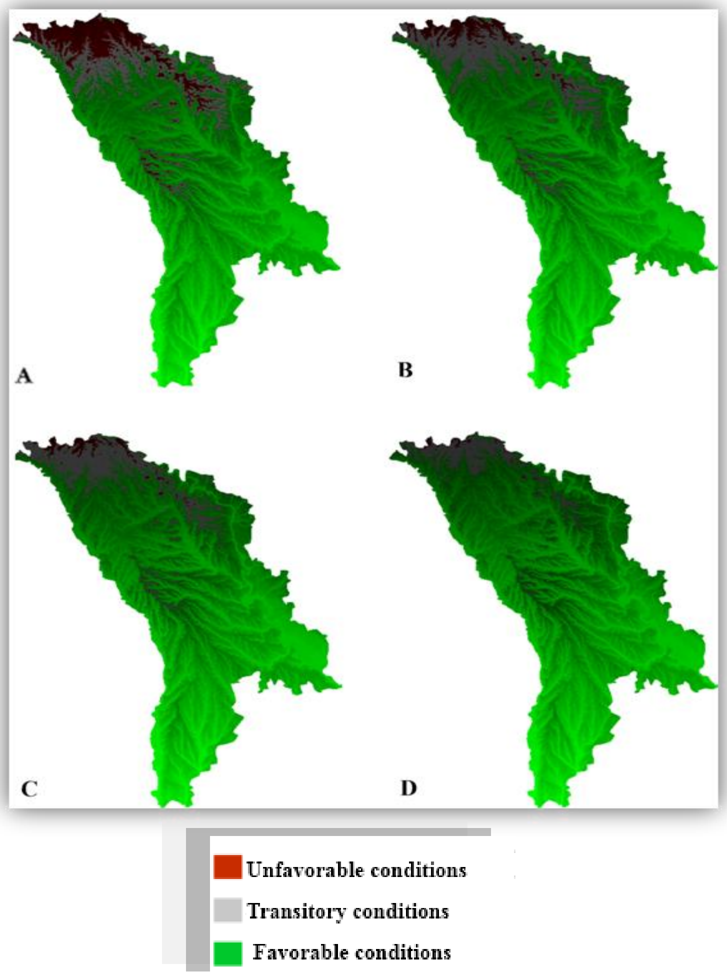

Figure 1: Distribution of the potential spreading area under the mid-late maturity maize hybrids as KISHINIOVSKYI 401 L, LG 34.09 (LZM 451/05), MOLDAVSKYI 411 MRf, MOLDAVSKYI PORUMBENI 459 MRf 425 MRf, MOLDAVSKYI 450 MRf, PORUMBENI 458 CRf on the Republic of Moldova's territory. $\sum T_{AC} > 10^0C$ **- 2950^{0}C**

A. Reference Period, 1961-1990, B. CSIRO-Mk2, 2010-2039, C. CSIRO-Mk2, 2040-2069 , D. CSIRO-Mk2, 2070-2099

Note: Names of hybrids and maturity groups are given according to the National Register of Plant Varieties, 2009 [17].

Such changes in the thermal regime on the Republic of Moldova's territory, in particular the increase of the length of vegetation period with active temperatures above 10^{0}C and, correspondingly the increase of the sum of biologically active temperatures ΣT_{ac}> 10^0C and/or effective temperatures ΣT_{ef}> 10^0C would lead to a possible spreading to the North of the area under cultivation of mid-late and late maturity maize hybrids.

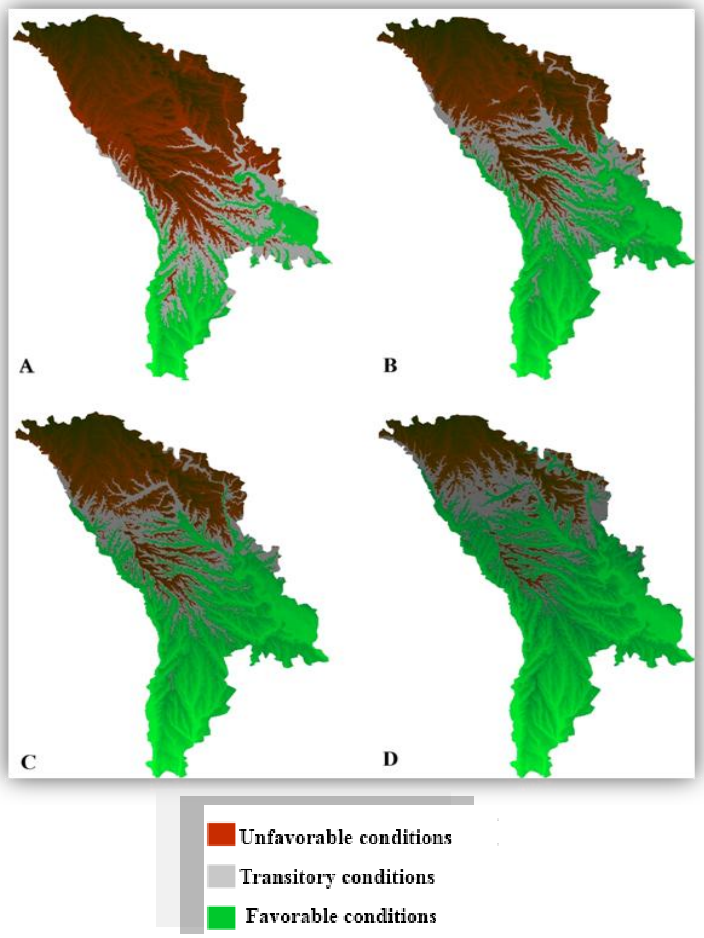

Figure 2: Distribution of the potential spreading area under late maturity maize hybrids as CANTABRIS (ESM 44X), ES DIADEME (RM 23), ES SENSOR (ESM 54X), LG 25.33 (LZM 549/06), FRUCTIS (RM 25), KWS 3381 (KXA 3381), KWS AMBER (KXA 6378) on the Republic of Moldova's territory. $\sum T_{AC}$ >10^0C - 3200^0C

A. Reference Period, 1961-1990, B. CSIRO-Mk2, 2010-2039, C. CSIRO-Mk2, 2040-2069

D. CSIRO-Mk2, 2070-2099

Note: Names of hybrids and maturity groups are given according to the National Register of Plant Varieties, 2009 [17].

The assessment of the potential spreading of the area under cultivation with mid-late and late maturity maize hybrids as impact of future climate change has been undertaken through the use of the computer program EcoClass. Figures 1 and 2 show the possible spreading of the area under cultivation with mid-late and late maturity maize hybrids according to the CSIRO-Mk2 model for the three time periods 2010-2039, 2040-2069 and 2070-2099, as compared to the climatic values registered during the reference period of 1961-1990. To determine the suitability of the thermal regime for cultivating mid-late and late maturity maize hybrids on the territory of the Republic of Moldova it was used the index 'cumulated biologically active temperatures' $\sum T_{ак} > 10^0C$, which amounted 2950^0C and 3200^0C, respectively.

During the 1961-1990 time series (Figure 2A) the favorable conditions for cultivating the late maturity maize hybrids has existed only in some Southern areas of the Republic of Moldova and in certain very limited areas in the Center and the Western part of the country. Within the 2070-2099 years the favorable conditions for cultivating the respective hybrids will exit almost on the whole territory of the Republic of Moldova (Figure 2D). The EcoClass program is able to generate maps – similar to those exposed below (Figures 1 and 2), revealing the optimum conditions which would determine the potential spreading area under any other varieties or hybrids cultivated or expected to be cultivated in the Republic of Moldova or for any wild flora species, any pest or pathogen causing plant damage or disease for any point in time during the period of 2010-2100.

CONCLUSION

It was revealed that a further increase of the length of vegetation period and respectively, of the sum of active and/or effective temperatures, would allow by the years of 2010-2039 the cultivation of mid-late maturity maize hybrids ($\sum T_{ac} > 10^0$C - 2950^0C) with a greater productivity potential than their earlier counterparts, by almost the entire territory of the Republic of Moldova.

By the years of 2040-2069, as a result of expected changes in the thermal regime, there will increase significantly the area under cultivation with late maturity maize hybrids ($\sum T_{ac} > 10^0$C - 3200 ^{0}C), comparative with the reference period (1961-1990). This will increase the adaptation potential and the productivity of maize as a crop. In general, in the respective agricultural systems, such adaptations measures as changes in the sort composition and planting periods, allow to avoid the yield decline in productivity by circa 10-15%, which corresponds to a local temperature rise by 1-2^0C.

This research was supported by the UNEP-GEF Project “Republic of Moldova: Enabling Activities for the Preparation of the Second National Communication under the United Nations Framework Climate Change Convention (UNFCCC)”.

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DEVELOPMENT OF DIGITAL ELEVATION MODEL FOR MODELLING AND SPATIAL ANALYSIS OF FLOODS IN THE PRUT HYDROGRAPHIC BASIN

Lucia Căpăţînă[1]

Abstracto. *La modelación y el análisis espacial de las inundaciones en el medio GIS solicitan una amplia y detallada información sobre las características morfológicas y morfometricas del alivio territorial estudiado. En este trabajo están presentadas las etapas de la creación del modelo digital de alivio de la cuenca hidrográfica Prut. En base de este modelo hemos generado una serie de indicios morfometricos y analizado la distribución espacial de estos indicios en aria de la cuenca.*

Key words*: GIS, Digital Elevation Model, Shuttle Radar Topography Mission, hydrographic basin.*

Abstract. *Modelarea şi analiza spaţială a inundaţiilor în mediul GIS solicită o informaţie amplă şi detaliată despre particularităţile morfologice şi morfometrice ale reliefului teritoriului studiat. În lucrare sunt prezentate etapele creării modelului digital al reliefului bazinului hidrografic Prut. În baza modelului au fost generaţi o serie de indici morfometrici şi analizată distribuţia spaţială a acestora în cadrul bazinului.*

Cuvinte cheie: *Sisteme Informaţionale Geografice, Modelul Numeric al Terenului, SRTM, bazin hidrografic.*

Introduction.

The Prut River originates in the Carpathian Mountains (Ukraine), Goverla peak, on the north-eastern slope of the ridge Cerna-Hora (2068 m). By form and geomorphological appearance, in the Prut basin three sectors are clearly identified: the upper flow, medium flow, and the lower flow. In the upper Prut river flow, the direction is from NW to SE and in the medium and lower direction is from N to S.

The Prut hydrographic basin expands over the territory of three countries: Ukraine, Republic of Moldova, and Romania. The total surface is of 27450 km^2: R. Moldova - 8250 km^2 (cca. 30 % from the total basin surface), Romania – 10900 km^2 (40 %), Ukraine – 8300 km^2 (30 %).

The main flow has a total length of 967 km. Respectively, in the Republic of Moldova the Prut river has a length of 695 km, and represents completely the natural border with Romania (or 72% from the total length), on the Ukrainian territory – 251 km (26%, the upper sector of the river), to which 21 km are added, which represent the natural border between Ukraine and Romania (2%).

For modeling and spatial analysis of floods in the Prut hydrographic basin, a first step would be to develop the numerical model for this area.

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DEM combines a complex of information technology, earth sciences and mathematics, known as terrain analysis or quantitative geomorphology.

Digital Elevation Model implies the approximation of a portion of the topographic surface using electronic means of calculation and an appropriate mathematical model based on the coordinates (Xi, Yi, Zi) points "known" on it so that the interpolation to obtain share Zj any point in the same area, defined by its coordinates planimetry (xj, yj), with a precision fit for the purposes envisaged and the available means (Craciunescu V. http://earth.unibuc.ro/analiza-mnat).

The implementation of DEM on a global or regional level, takes place through a series of projects, such as ETOPO5, ETOPO2, GTOPO30, GLOBVE, DTED0, SRTM. Satellites also can be used as bases for creating DEM, thus for this reason having made known our satellite images Aster.

In the present paper, DEM for the area of study were created based on the SRTM90 images.

Data sources. The SRTM90 data for creating DEM were downloaded from Global Land Cover Facility (http://www.landcover.org/index.shtml), currently available for free online. The original data have the resolution of approx. 30 m, but which are available only for the USA.

It is important to mention that SRTM was realized through usage of the “interferometry radar”. Thus, a radar signal is transmitted, reflected by the Earth's surface, and captured in 2 points simultaneously. As a result, 2 radar images are captured. The differences between these two images allow the calculation of the altitude. The SRTM mission has used 2 antenas, one main and a secret antenna, fixed on a 60 m extension arm. The differences between images allow the calculation of the altitude of a dot. The SRTM mission has used 2 antennas – 1 main,

Methods and Analysis. With the goal of creating DEM, the SRTM images that fully cover the Prut hydrographic basin were downloaded from Global Land Cover Facility.

Thus, 5 images were downloaded. To join these pictures, we used the ERDAS 9.1 program, and mosaication is necessary to reach this goal.

The newly created mosaic (fig. 1) is the work base in the future. The only inconvenience is that some black dots or “no data” dots are observed. It could be that these appeared during the process of obtaining the data itself.

To remove the “no data” points, the ENVI 4.5 software was used, where the 'Replace Bad Values' function allows this to be done. Finally we obtained a DEM without “no data” values. But, due to the fact that the area of study does not fully occupy the obtained area, it is necessary to mark only the surface of the area of interest, or of the Prut hydrographic basin.

The strictly geographic delimitation is obvious, by following the water. Using the GIS technology, this is possible to realize with the ArcGIS 9.3 software. For this, the following steps were taken (Jigmond M., 2007): “waving” the surface, determining the direction of the water flow, possible accumulations, transformation of the layer from vector format in raster format, and finally setting the closing point. The point chosen is positioned at the confluence of the Prut river with the Danube river, which represents the closing point of the basin.

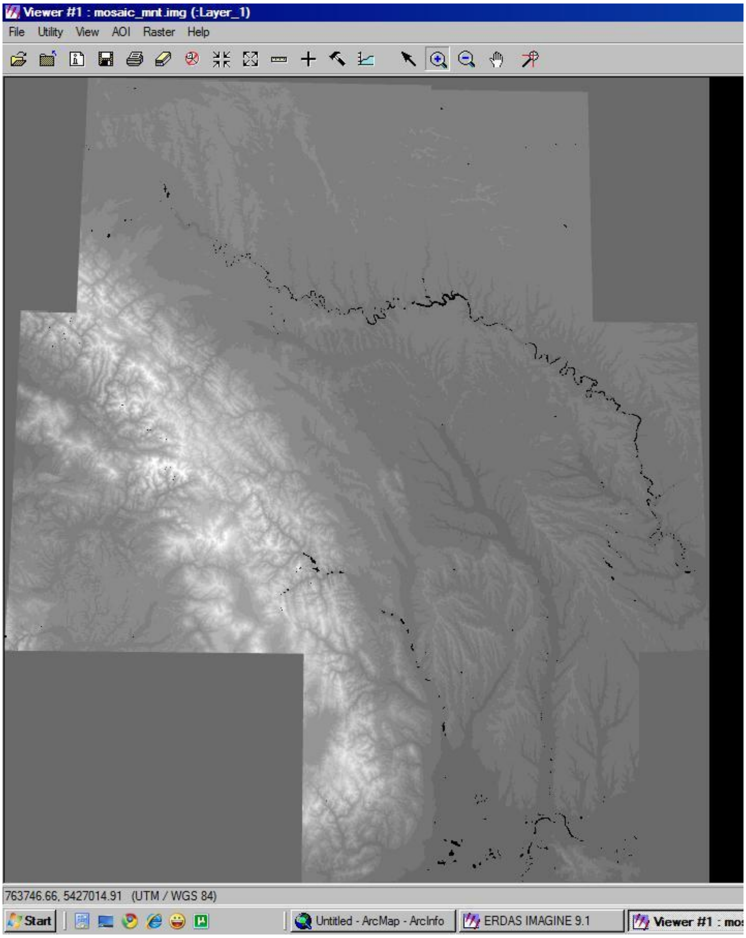

Fig.1 The mosaic.

In fact, DEM is a very useful base in the spatial analysis of hydrological processes. This enables the automatic extraction and classification of the river system, automatic delineation of hydrographic basins and calculation of associated indices (ex: the sediment transport capacity, potential water infiltration, etc.). But in the process of flood modeling and spatial analysis is important first to analyze the morphometric indices which may explain some subsequent hydrological processes. Morphometric indices developed are: hypsometric, slope, slopes exposure.

By creating a buffer zone of 3 000 m, we obtained the limits of the Prut hydrographic basin, created based on the DEM.

Results and Discussion.

DEM obtained under SRTM90 was used successfully as the basis for representation morphometric indices, such as hypsometric, slope, slopes exposure.

Hypsometric map (fig. 2) of the area studied was classified in altitude steps of 50 m to 50 m, which allows us to see clearly that the subject of the study has the following features: the upper course of the Prut River prevailing altitudes above 1000 m, which gradually descends, along the river valley reaching up to 100 m

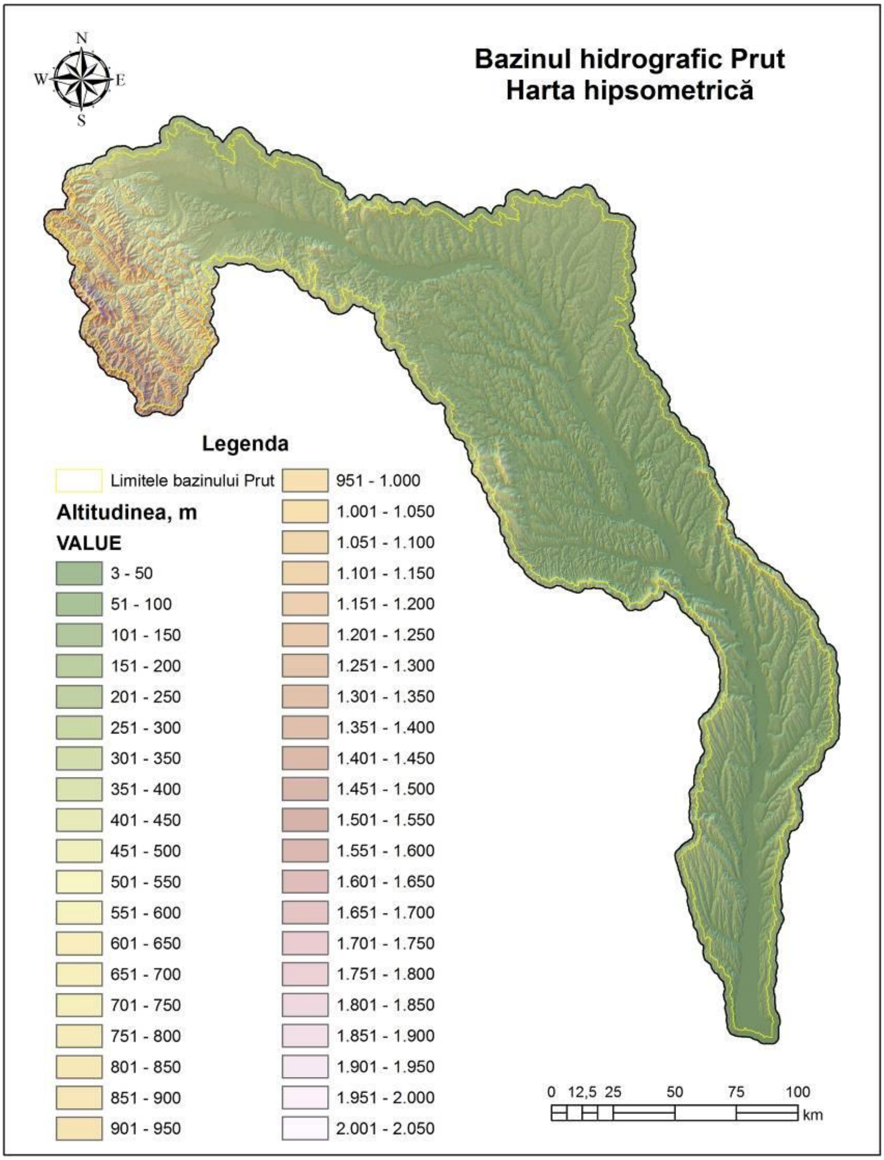

Fig. 2. Hypsometric map

Slope is one of the most important morphometric parameters of an area, which through the allocation and the way of combination on the terrain, highlights the major steps of relief. Also of particular interest for hydrological processes in determining the direction and intensity of water leakage, accumulation or deposit of eroded material

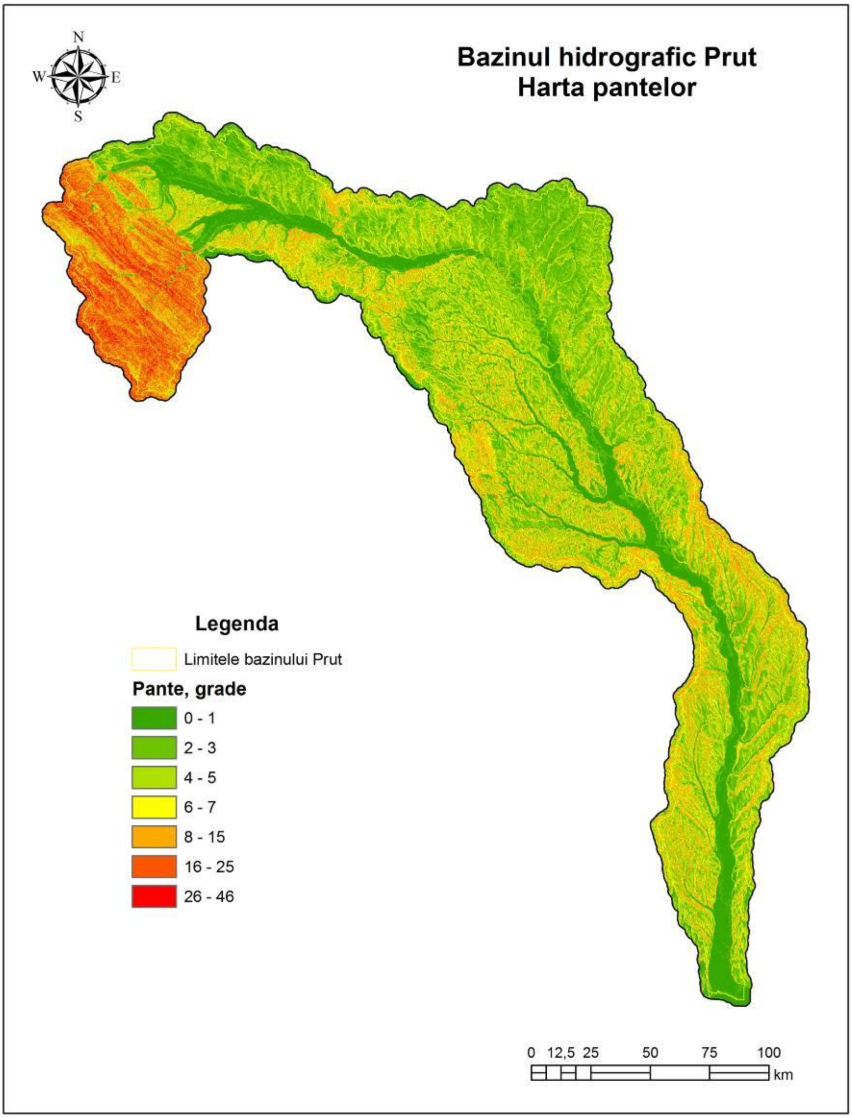

Fig. 3. Slope gradient map

To calculate the slope by classical methods (based on topographic maps and plans), it takes time and often the final results have a low accuracy. DEM use as a basis for calculating slope leads to superior results in a relatively short time.

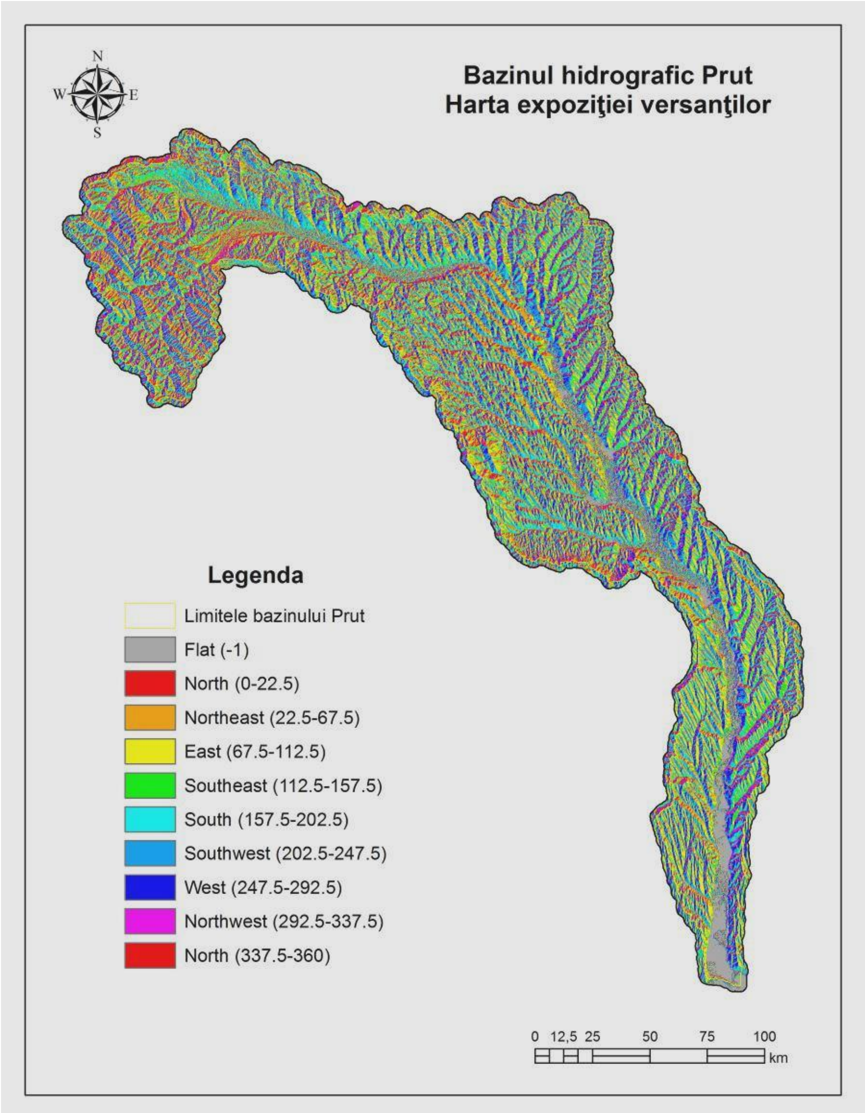

Fig. 4. Aspect-slope map

Geometrically speaking, the slope is the angle described by the tangential horizontal plane and the surface at the same point. The slope measured in degrees (0^0-90^0) or percentages. In the process of calculating the slope on the digital map is taken into account altitude values of the cells neighboring that point.

Analyzing the slopes map (fig. 3), we can see that in the Prut river basin the maximum value of the slope is of 46^0, in the upper basin due to the presence of a mountain landscape. However, slopes with values up to 3^0 occupy large areas, mainly along the valleys of the main course and its tributaries.

In general, however, it is observed that the left side of the Prut River is slower than the right, which is clearly expressed in the middle. While on the right side the prevailing values range between 8^0 and 15^0, on the left side values up to 3^0. Toward south, basin surface narrows and the slope reach maximum values of 15^0, but decreases gradually towards the river meadow. The main factor that determines the specific area is the hilly topography (Middle Cogilnic Plateau forest steppe, the middle hills of the steppe Tigheci).

Exhibit slopes, as morphometric index, was achieved in the DEM (fig. 4), which allows easy and accurate calculation of the index.

Conclusion

In this paper the initial goal of creating the DEM on the basis of SRTM90 was achieved and was also used as a basis for obtaining indices. For modeling and spatial analysis of flood risk, development of DEM is a first step in this direction.

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MAPPING METHODS OF POLITICAL AND ELECTORAL REALITIES AT THE WORLD LEVEL

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Résumé: *L'ouvrage se propose de mettre en évidence les modalités de cartographie des quelques éléments politiques and électorales (l'appartenance des quelques pays a diverses organisations mondiales, continentales, régionales, la typologie des pays avec/sans littoral, la distribution chrono-spatiale des démocraties électorales, du niveau de la démocratie dans le monde, du niveau des droits civiles and des libertés politiques, du niveau de la liberté de la presse, de la présence au vote, des différents orientations politiques et autres). Ils sont relevées, aussi, des difficultés liées par la création et la complétion de la base statistique (plus fréquent, a cause de l'absence ou de l'inaccessibilité aux informations, de la variabilité des limites administratives, ou/et du statut des divers entités politiques), de l'utilisation, s'il est possible, du même niveau politique pour la cartographie (la grande variabilité tant du statut des divers entités politiques : colonies, protectorats, dépendances, états indépendantes ou/et quasi-indépendantes, quant leur limites) et du groupement des variables électorales dans les principales familles politiques (a cause des quelques noms qui ne sont pas liées avec l'orientation politique réelle des ces formations politiques, spécialement en Afrique, Asie ou dans l'Amérique Latine, de la présence des formations politiques des minorités ethniques et confessionnelles, du passage, pendant du temps, des quelques partis politiques d'un orientation a l'autre ou a cause de la présence des plusieurs formations avec des orientations diverses dans la même alliance, coalition, etc.).*

Key words: *representation, political and electoral realities, chrono-spatial distribution, hierarchical ascendant classification;*

Introduction

We aim to present several ways of mapping political and electoral realities (membership of countries from various world, continental of regional organizations, the typology of the state with sea coast or not, the chrono-spatial distribution of electoral democracies, of the level of democracy in the world, the level of political rights and political liberties, the level of press freedom, the voter turnout, the different political orientations and others).

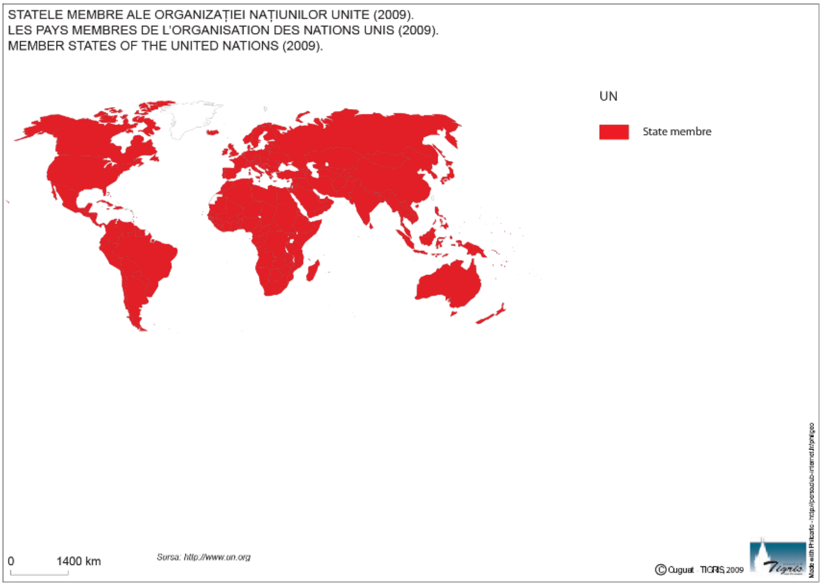
This intension was hit by several problems related to the variability of the borders and of the number of independent countries over time, or the difficulty of framing the political groups in some regions and countries in the political families.

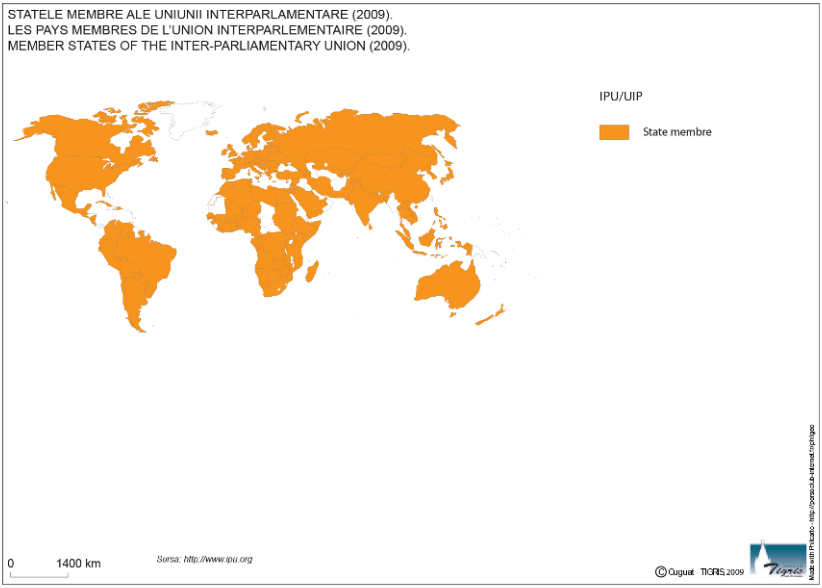
The working methodology included in the first stage, the documentation, made entirely from various electronic sources: Center for Systemic Peace, Freedom House, the organization Reporters sans Frontières, Central Intelligence Agency, the Inter-Parliamentary Union, the United Nations, Transparency International, the Fund for Peace, the United Nations Development Program, the *Foreign Policy* magazine, the Institute for Democracy and Electoral Assistance (International IDEA), the national electoral authorities, various regional organizations (European Union, African Union, Central American Integration System, etc.). Data were introduced and processed in Microsoft Excel file type.

The second phase was the mapping of these realities. To do this, it was necessary to draw in Adobe Illustrator, various world maps, taking as the starting, the end of the eighteenth century, exactly 1790, when the French Revolution was underway and appeared the young independent country called United States of America. The methods used for mapping was the colors beaches and the hierarchical ascendant classification (to make maps with this method was necessary to bring the data in percentage format). The program used for mapping is Philcarto.

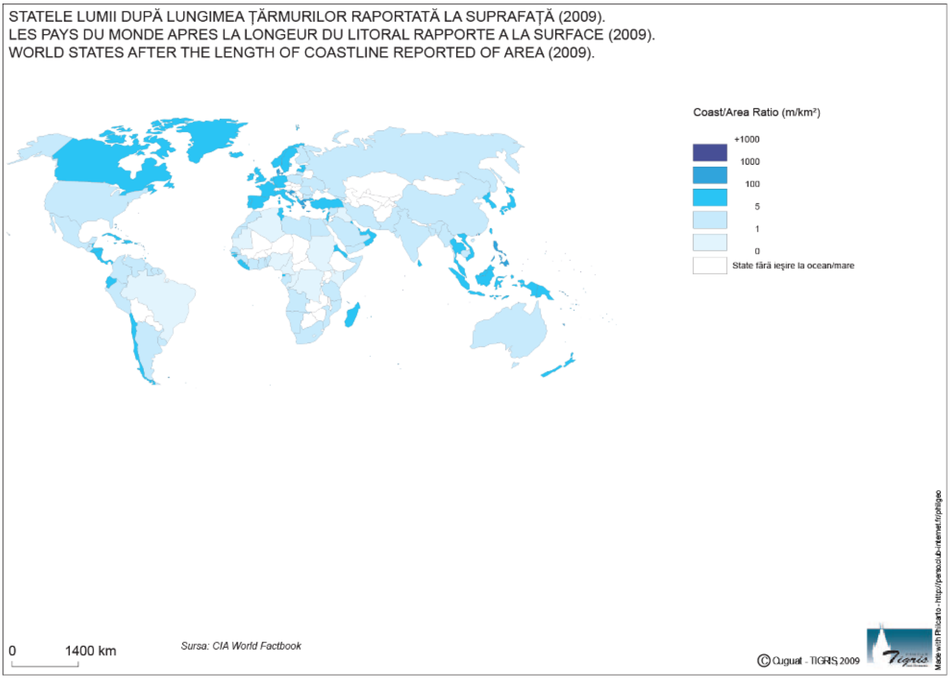
Mapping the political-electoral realities at the world level

The representation of various organizations on the world map (UN, IPU, WTO, various regional organizations) was made by the method of colors beaches, after we noted, in the database, with 1 the Member States of these organizations.

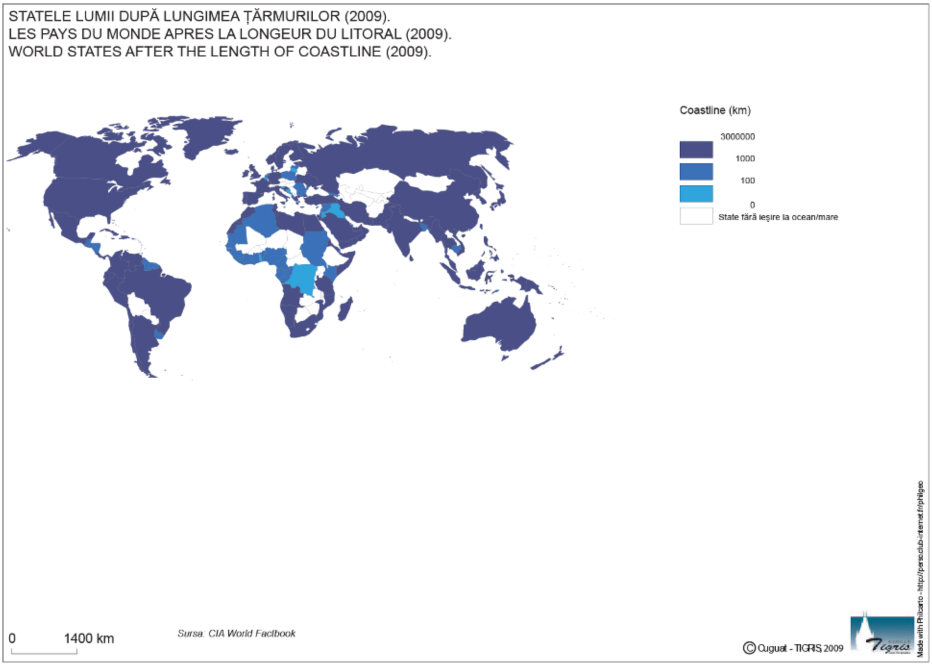




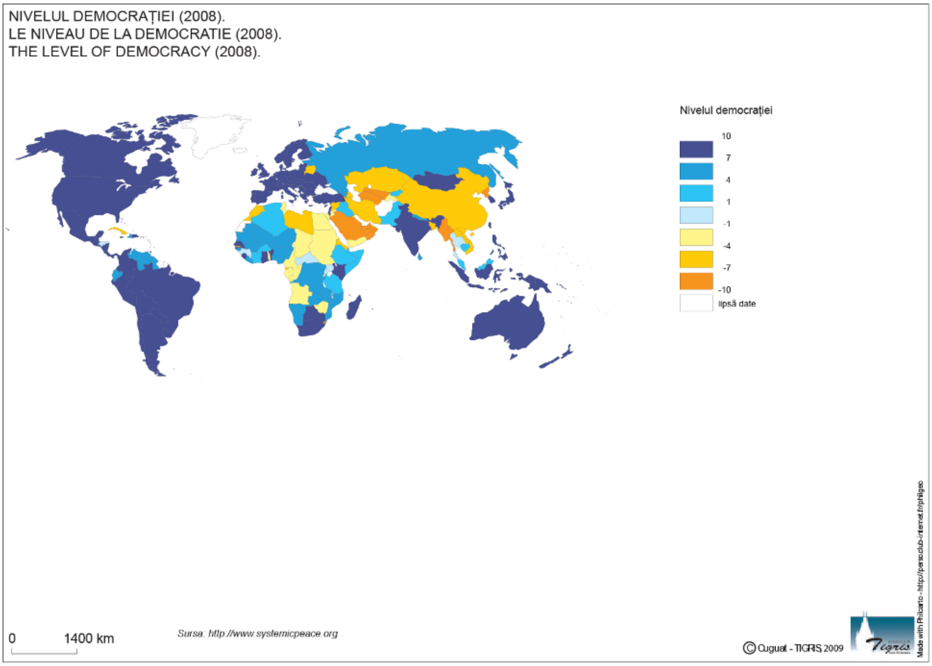
If in the case of United Nations and of the Inter-Parliamentary Union was somewhat simple, because in the table appeared the same number to each state, in the case of mapping the Member States of the World Trade Organization, we given different figures for the special status of some countries (outside the Member States, exist the observers too). After the mapping with Philcarto program, in Adobe Illustrator we replace the figures with the text, meaning the status of such political entities.



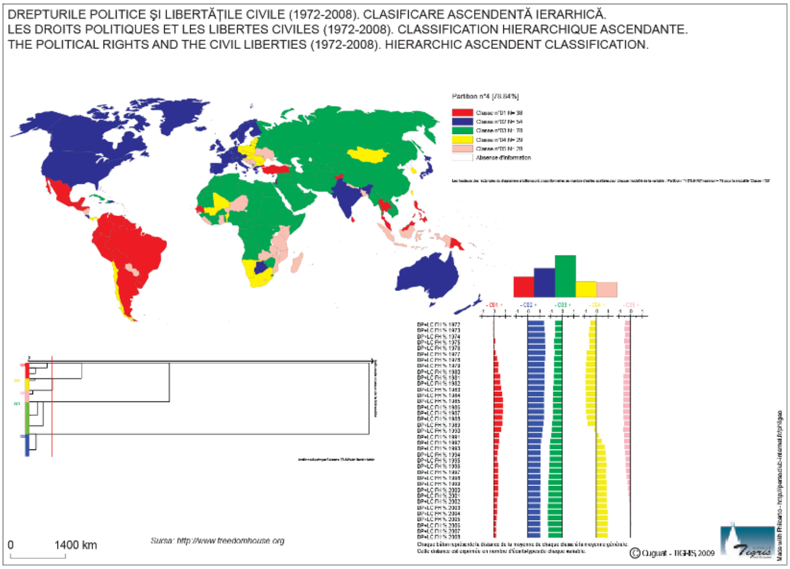
The representation of geographical features with geopolitical importance (the countries with sea line, the length of the coast) was achieved by the same method, and we used different shades of blue, depending on how extensive is the coast line, or how big is the ratio between the length of the coast and the country surface.

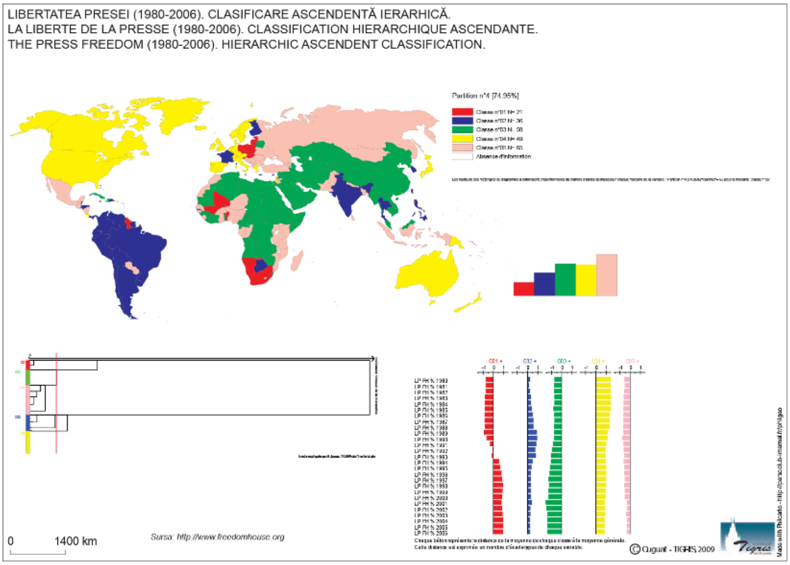


To represent the level of democracy (according to the Center for Systemic Peace, „George Mason" University, United States) we used the same method of colors beaches, varied according to the „notes" of American data (from very dark blue for the countries where the democracy is at its highest level, to the pale blue, used in the case of the „oscillating" countries between being democratic or not, to orange, used for dictatorial, authoritarian, absolutist regimes, etc.). The database, extended over more than two centuries, allows highlighting the chrono-spatial distribution of this indicator, for a period covering the whole modern and contemporary times.

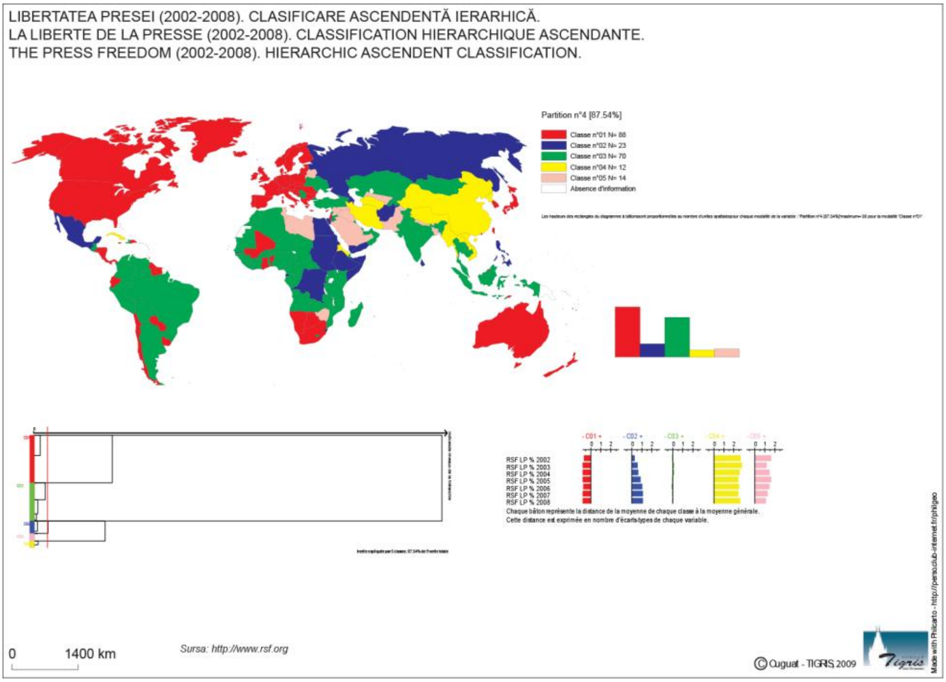


The representation of political rights and civil liberties (according Freedom House data) can be achieved by both methods, using colors beaches (with shades of green for the level considered „free” after the terminology of the cited organization, orange for the level „partly free” and red, for the case of „not free” countries) for the different notes accorded annually by these organization, but for chrono-spatial representation of these indicator we can used the hierarchical ascending classification. Knowing that this method requires the transformation of notes to 7 (maximum) to 1 (at „zero” political rights) as a percentage, we using prior to mapping, a mathematical trick, which we converted the notes in the percentages. Thus, note 7 are 100 % and the lowest percentage values are found were the notes going to 1. Since the notes for press freedom, accorded by the same organization, are in the same scale, we applied the same method. Please note that the shades for every class are chosen automatically by the program without any relation to the status of countries in this class.



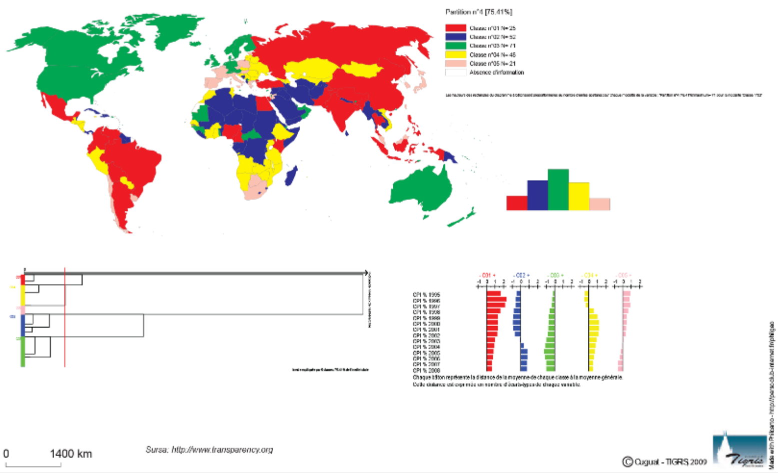


The press freedom (as the professional organization Reporters sans Frontières), be treated a little differently. Since that score, in this case is between 120 (for the countries without freedom of press) and about 10 (in the case with full freedom of journalists), we converted these scores as percentages (120 points have become 100 %), the map below expressing, by the deviation from the mean of each class, the freedom of the press (in the first class, where the deviation is negative, because the values – absolutes and in percentages – are very small) or the absence of this indicator (e.g. the fourth class).

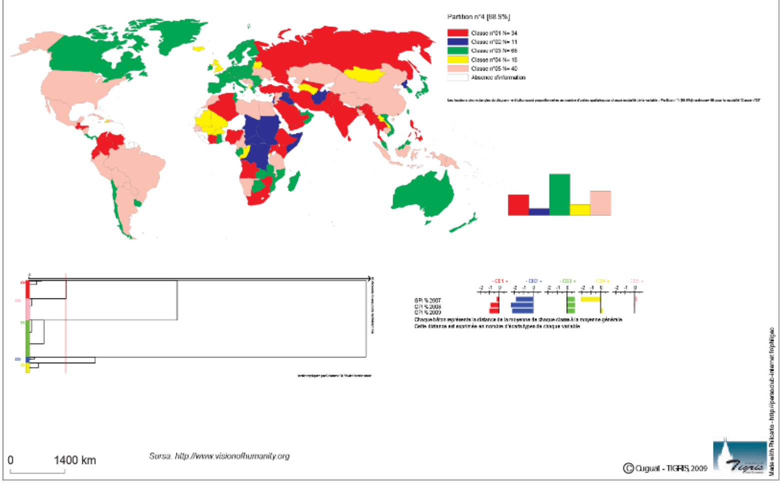


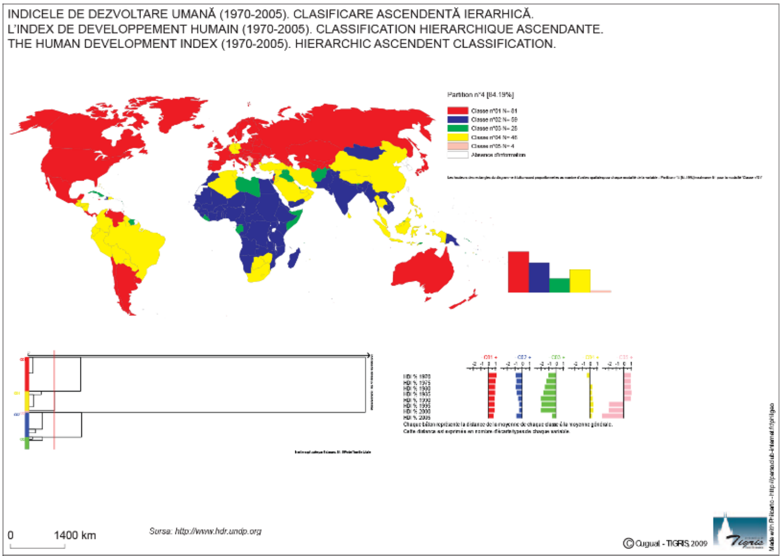
The same approach was employed to represent the Corruption Perception Index (according the data of Transparency International), the Global Peace Index (according the data of Vision of Humanity), the Human Development Index (after the data of the United Nation Development Program), or the Failed State Index (after the data published by the Fund for Peace and *Foreign Policy* magazine).

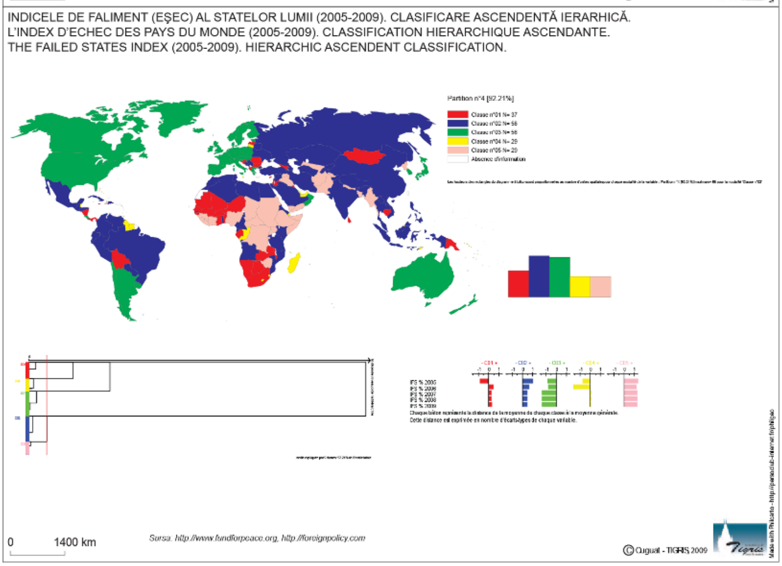
INDICELE DE PERCEPȚIE A CORUPȚIEI (1995-2008). CLASIFICARE ASCENDENTĂ IERARHICĂ.
L'INDEX DE PERCEPTION DE LA CORRUPTION (1995-2008). CLASSIFICATION HIERARCHIQUE ASCENDANTE.
THE CORRUPTION PERCEPTION INDEX (1995-2008). HIERARCHIC ASCENDENT CLASSIFICATION.



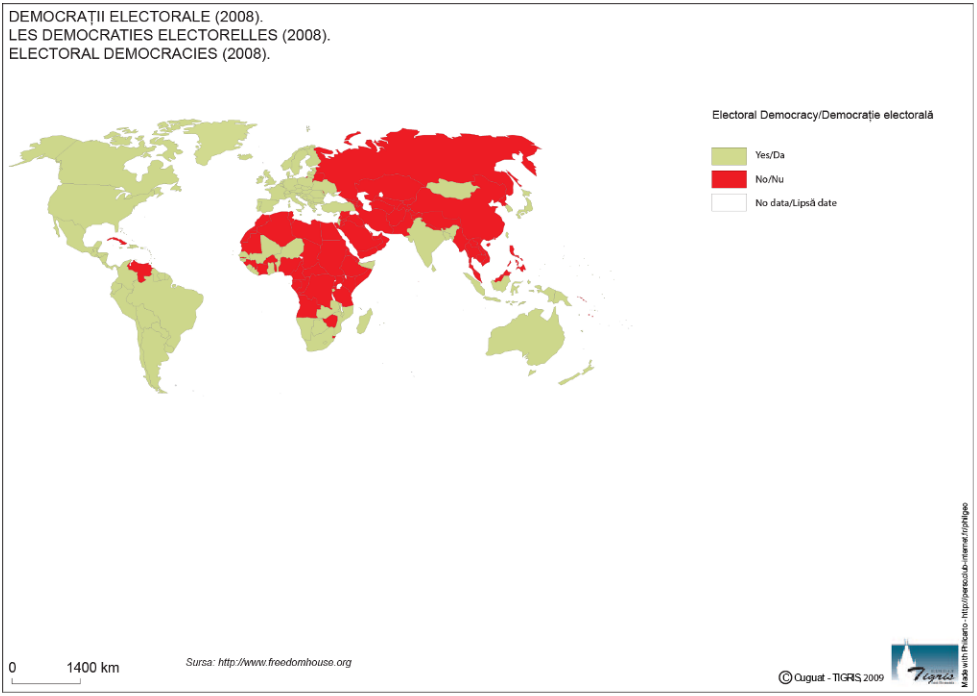
INDICELE PĂCII MONDIALE (2007-2009). CLASIFICARE ASCENDENTĂ IERARHICĂ.
L'INDEX DE LA PAIX MONDIALE (2007-2009). CLASSIFICATION HIERARCHIQUE ASCENDANTE.
THE GLOBAL PEACE INDEX (2007-2009). HIERARCHIC ASCENDENT CLASSIFICATION.



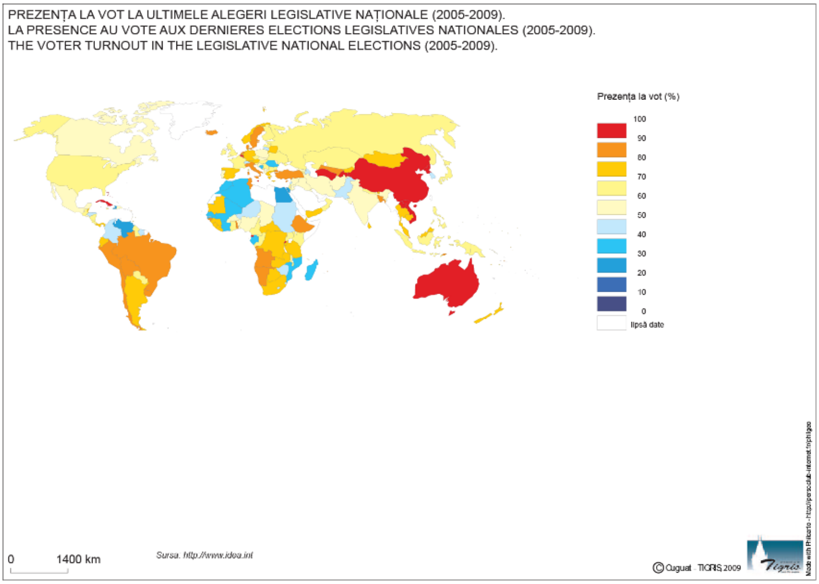


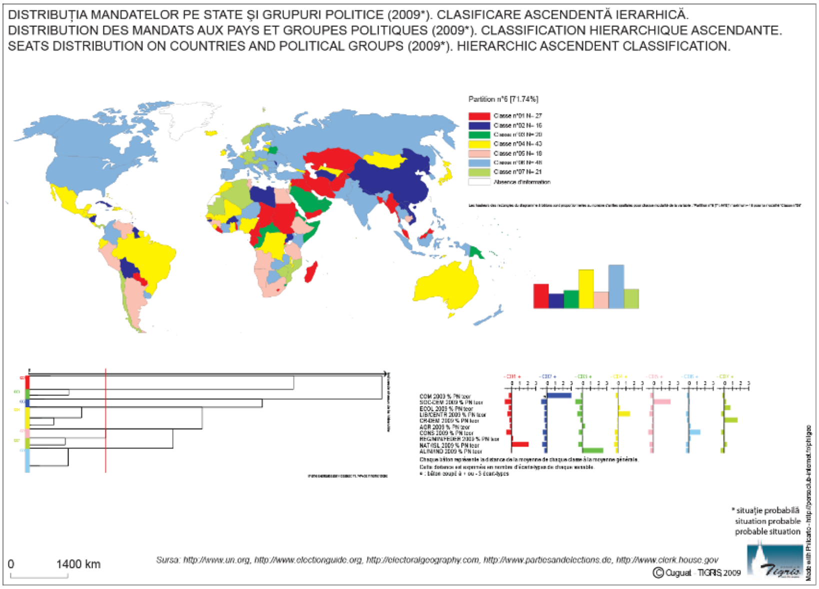


In the case of representation for the electoral democracies in the world (again, according the data of Freedom House), we created a table in which noted with 1 the countries that enter in these category and with 2, the others. Result the representations such as below.



The voter turnout in the parliamentary elections (after the data of the Institute for Democracy and Electoral Assistance, based in Stockholm), received of the method of colors beaches, using a color scale goes according to decreasing intensity of the phenomenon (i.e., with increasing the percentage of absenteeism at the polls) from „hot" colors (dark red) to „cold" colors (dark blue).





Finally, the distribution of seats on political families (after the data from the national electoral institutions and/or the sites with a regional dimension in Europe, America, Africa) has received, again, the use of hierarchical ascendant classification, which can be used not only to highlight the temporal dynamics of one or more indicators, but also the representation at the same time, of several variables. Thus, the positive deviation from the mean (right) shows, for each class, the presence, than the world average, of one or more variables (in our case, the percentage of seats belonging to a certain political family).

Conclusions

The presented methods allow a synthetic representation, easy to explain, for the different political and electoral realities worldwide. Thus, the representations in the colors beaches highlighted a single variable at one moment, allowing the observation of spatial differentiation (related to the status of countries in various world and/or regional organizations, or the affiliation in a particular category of countries in terms of view of political rights and civil liberties, of press freedom, etc.), their sequence, if they are integrated in „movies”, favoring the observation of changes in the spatial distribution of analyzed phenomena.

Instead, the hierarchical ascendant classification allows the representation of a single variable for a certain period of time (the press freedom, the political rights and civil liberties, the Corruption Perception Index, the Human Development Index, etc.), or of several variables, either at a single moment (as if the share of the seats by political families) or for a specific period of time. If the method of colors beaches allows the details observing at a moment and the changing of the images give the measure of changes in time and in space, the hierarchical ascendant classification highlights, in a single representation, in a synthesis, the peculiarities of each class, of each group of countries which enter into them.

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