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PROCEEDINGS

The 1st International Congress on Soil Science

XIII National Congress in Soil Science

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THE USE OF HIGH RESOLUTION SATELLITE IMAGES FOR DEFINING CHANGES IN THE ECOSYSTEMS

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ABSTRACT

The adequate biodiversity protection at the species and genetic level is not possible without the adequate site protection. The climate change causes the increase in the air temperature (increased evapotranspiration), decrease in the quantity of precipitation, as well as the deterioration of the soil physical characteristics. The deterioration of the water-air soil characteristics will lead to the deterioration of the structure caused by the decrease of the nutrient content. The protective role of the vegetation will be reduced; the soil erodibility will increase, as well as the number of the wildfires, whereas the site conditions will deteriorate drastically. The global changes also affect the smaller regions, owning to which the monitoring of them is of a particular importance for the changes in the ecosystems. For this purpose we use the satellite photos of the high resolution, and by the use of GIS technology the method of the monitoring of the periodical changes in the ecosystems was developed. The collected data will enable the creation of the model which contains the dynamics of changes in the natural ecosystems. This paper analyzes cadastral municipality Djurašići. The classification based on EUNIS system of the site classification was applied. By the use of the satellite photos of the high resolution (pixel size 1m) for Djurašići area the spatial distribution of the sites was defined. By the periodical recording of the characteristic areas in Serbia the spatial distribution of the ecosystems, as well as the changes in their composition and structure, will be monitored.

Keywords: ecosystem, biodiversity, climate change, site, GIS

INTRODUCTION

Climate is a natural condition that most directly affects forest ecosystems. On forest ecosystems affected by climate as:
- macroclimate (planetary)
- regional climate (regional impacts of climate) and
- microclimate (climate of small spatial units, and even point (eco climate - climate of flowers or plants, air tree crowns).

Effects of climate are:
- indirectly, through climate factors (latitude and longitude, the layout of land and sea, altitude, etc.)
- directly, through the elements of climate (radiation, air temperature and soil, air pressure, wind, humidity, cloudiness, precipitation, etc.)

In its development of forest vegetation, provided that the ecosystem cannot be seriously disturbed by a change in environmental factors, reaching its peak represented a stable community, in conformity with the regional climatic conditions. As a result climatogene or climate zonal communities occur, which are tailored to regional climate conditions and the most complete reflection of the natural conditions of a region. Community-specific mountain belts are climate regional. All of these communities caused by the general climatic conditions are now simply called the zonal vegetation, including the same concept climate zonal (in plain) and climate regional (in the high mountain belts).

Projections of climate change in the 21st century

Presented according to the latest estimates of regional climate change in Southern Europe Region which belongs to the Republic of Serbia, in addition to the trend of further increase in air temperature, in the coming period is expected to further decrease precipitation, followed by reducing the number of days with snow and snow cover, reducing runoff, soil moisture and availability water resources.

Climate change projections for Europe show a reduction of annual rainfall in South Eastern Europe by 1% per decade. This decrease of rainfall in South East Europe would be the most distinctive in the warm half of the year, and for a given scenario amounted to about 22% at the end of this century. Climate change in our cause of increased air temperature (evapotranspiration increased), reducing the amount of rainfall as well as the deterioration of physical properties of soil. Deterioration of water-air properties of soil will term deterioration of soil structure caused by the reduction of organic matter. Reduce the protective role of vegetation, soil erosion ability increase the number of forest fires, and will dramatically worsen living conditions for afforestation. A large part of the negative effects caused by climate change can be reduced by proper choice of ways to use the land, the replacement of cultures and species that are adapted to new conditions and other measures. Based on monitoring changes in temperature can be planned in future afforestation activities in terms of proper choice of species (species that are best submitted made changes), such as planting materials, choosing the appropriate method of soil preparation.

MATERIAL AND METHOD

Cadastral municipality Djurašići is located in the territory of Municipality of Prijepolje. It stretches from the bank of the river Lim or the very city of Prijepolje, and rises to 1,400 meters above sea level. It borders with the cadastral municipalities Izbičanj, Crkveni Toci and Gornje Babine (Fig. 1).

Climatic characteristics were determined based on data received from weather stations Priboj, Pljevlja and Bijelo Polje. Digital Model of Terrain (DMT) was done like one of the characteristics of the studied area, and it was used as the basis for making aspect - slope map (Fig. 2-5). The zones with different geologic substrate were cartographically identified. Determination on the satellite images was performed in combination with the scanned map of geologic substrate. The zones with different types of soil were cartographically identified. It was used the Classification of the soils of Yugoslavia (Škorić, A. *et al.*, 1985).

For determination of the erosion intensity it was used the Classification made by Gavrilovic (1972). The erosion map was made based on the available documentation, the data collected in the field, the application of adopted methodology and data provided by satellite images. Present erosion processes are classified into five categories: from the weakest form of erosion (Category V) to the greatest form of erosion or excessive erosion (Category I).

Habitat classification was performed using the EUNIS habitat classification as well as by determination of habitat on satellite images and testing of selected homogeneous units in the field. Based on all the data, the attributing of homogeneous units was performed using geoprocessing method.

RESULTS

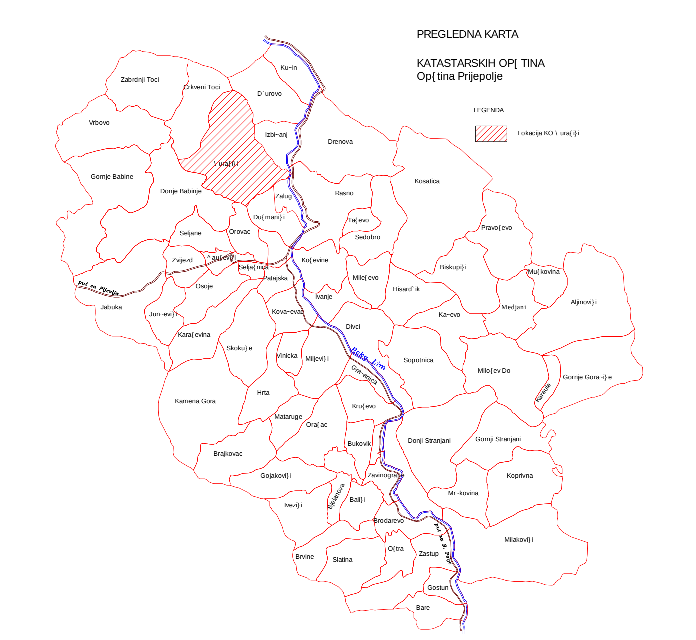

Fig. 1. Overview of the cadastral municipalities of Prijepolje

Because of the mountain nature and the flow of air masses from the south, in the studied area there are three climatic regions. These regions are mostly conditioned by relief, direction of extension and the aspect of terrain. Lowland region includes the valley of the Lim River and its tributaries, from 400 to 700 meters above sea level. In the river valley is moderate - continental climate, whose influence in this area is weakened, so the climate in river valleys is milder. On transient region there are plateaus at an altitude between 700-1300 meters. Here prevails moderate-continental climate with characteristics of mountain climate. Mountainous region is at more than 1300 meters above sea level, ie. these are the highest parts of the region where prevails mountain climate.

Djurašići cadastral municipality belongs to the basin of the river Ljupča that has the typical shape of an elongated fan. Based on the obtained values of the basin shape coefficient it can be seen that there are favorable conditions for the occurrence of high flood waters and their rapid concentration in the lower course.

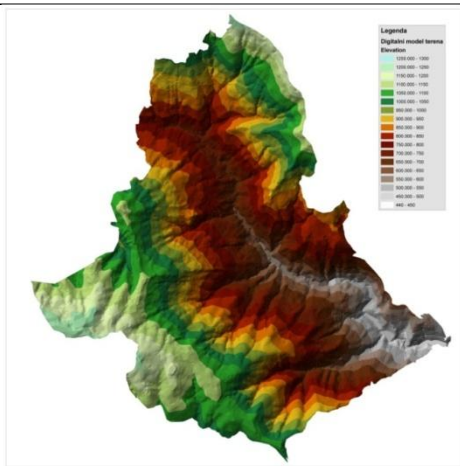

Fig. 2. Digital Model of Terrain

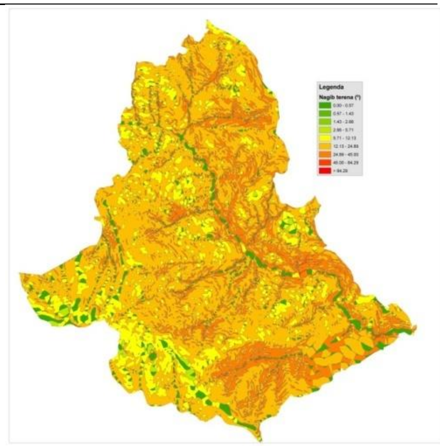

Fig. 3. Slope map

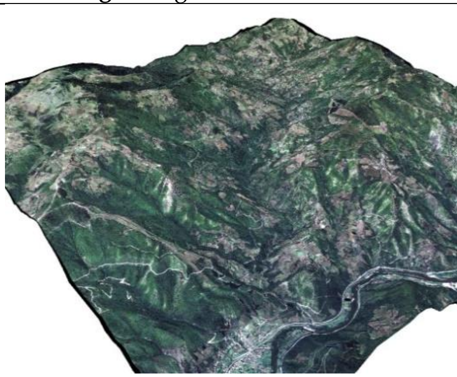

Fig. 4. Satellite image of DMT

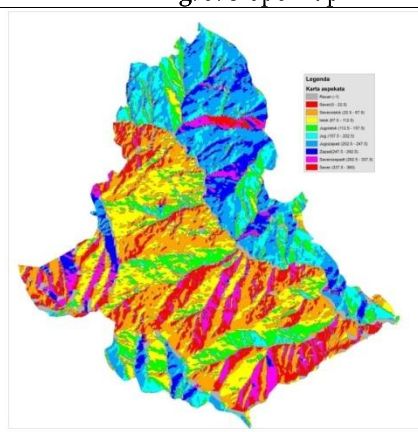

Fig. 5. Aspect map

Terrain configuration is stressed; the slopes are very steep and intersected by numerous ravines of very large longitudinal sides. Steep slope angles are typical for the flow of river Ljupča. River-bed width varies and in some places it is very narrow even below 10-15

m. Ljupča tributaries are deeply cut into the parent rock, cross-section of their basin often has the shape as the letter "V". Potential of Ljupča flow in the period of torrential rain P_{sl} is 608, which indicates the possibility of a very large flow in the period of torrential rain. In this area are presented non-classical sedimentary rocks, igneous rocks, metamorphic rocks and unconsolidated deposits (Fig. 6). Their share in the total area is shown in Tab. 1.

Table 1. Geologic substrate of cadastral municipality Djurašići

Geological substrate	Number of homogeneous units	Area (ha)	% share
alluvium	11	4,80	0,19
diabase	39	35,07	1,36
phyllite	772	2385,38	92,79
limestone	53	137,15	5,34
serpentinite	9	8,20	0,32
Total	884	2570,60	100,00

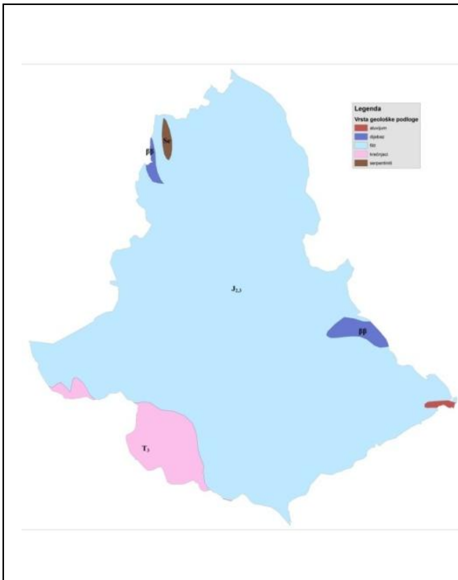

Fig. 6. Geologic map of cadastral municipality Djurašići

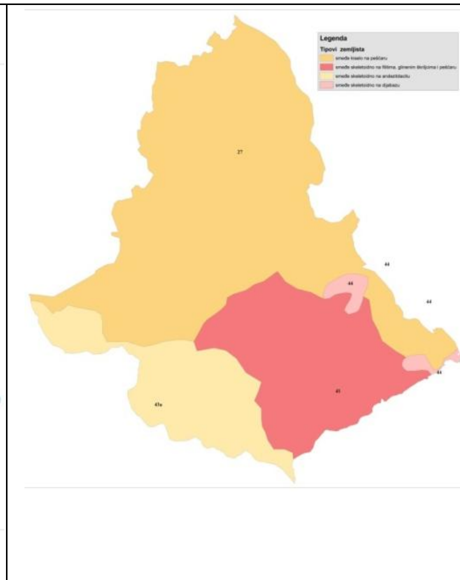

Fig. 7. Pedologic map of cadastral municipality Djurašići

The area Djurašići is characterized by hilly and mountainous relief which caused the formation of mainly shallow to moderately deep soil with different percentage of skeleton. The main types of soil registered in Djurašići area are shown in Table 2 and Figure 7.

Table 2. Represented soil types

Soil types	Number of homogeneous units	Area (ha)
acid brown on sandstone	566	1525,56
brown skeletal on andesite-dacite	106	406,87
brown skeletal on diabase	49	42,74
brown skeletal on phyllite, clay schist and sandstone	187	595,43
Total	908	2570,60

Erosion processes

Given that the hilly and mountainous land covers most of the area and that the existing geologic substrate favors the development of erosion, soil erosion processes have more or less overtook the whole area (Table 3).

Based on the data from the map, the mean value of the coefficient of erosion for the entire cadastral municipality Djurašići has been determined. Mean coefficient of erosion (Z) is 0.29, so the area is classified in IV category of destructiveness - low erosion (Figure 8).

Potential erosion endangerment. Factors that influence erosion are climate, soil type, slope, vegetation and land-use. The infiltration capacity of substrate influences the amount of surface water runoff. Surface runoff and erosion are increased with increasing of the slope degree, as well as with increasing of the slope length. The slope exposition may also influence the degree of erosion, indirectly, through the composition of the vegetation. The intensity of erosion largely depends precisely on the conservation and nature of vegetation. Forest ecosystems are characterized by high infiltration capacity and the presence of forest cover that has a high water holding capacity which affects the process of mitigating of water erosion. On the denuded areas there is increased surface runoff followed by soil depletion and erosion endangerment (Table 3, Figure 9).

Habitat classification

The concept of protection of biodiversity habitat becomes a central unit of protection. Habitat is defined as a "community of plants and animals (and other members of biocoenosis), which together with abiotic factors (soil, climate, water quantity and

quality, etc.) represents a unique functional unit" (Davies CE & Moss, D. 2002: EUNIS Habitat classification).
– European Habitats Classification System, European Environment Agency & European Topic Centre on Nature Protection and Biodiversity).

Table 3. Erosion intensity and potential erosion endangerment in cadastral municipality Djurašići

A. Erosion intensity	Num.of homogeneous units	Area of homogeneous units	%	B. Potential erosion endangerment	Homogeneous units	Area of Homog. units	%
Excessive	12	30,25	1,26	Area of very strong endangerment	13	30,82	1,28
Strong	134	229,55	9,53	Area of strong endangerment	134	246,07	10,21
Medium	125	701,62	29,12	Area of medium endangerment	128	736,03	30,54
Weak	69	166,57	6,91	Area of weak endangerment	71	120,75	5,01
Very weak	375	1281,66	53,19	Area of very weak endangerment	368	1275,91	52,95
Accumulation	-	-	-	Without endangerment	1	0,08	0,00

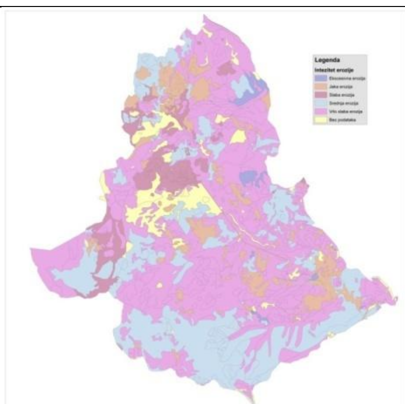

Fig. 8. Erosion map of cadastral municipality Djurašići

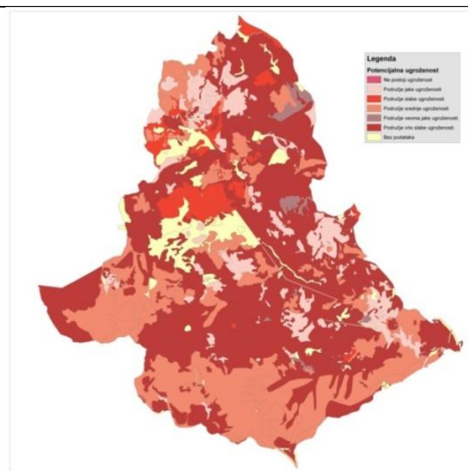

Fig. 9. Potential erosion endangerment, area of cadastral municipality Djurašići

The main documents that define the initial elements in the protection of habitat for:

- Convention on Biological Diversity - CBD - UNCED, Rio de Janeiro, 1992
- Berne Convention - Council of Europe, Bern, 1972 and
- Habitat Directive - the EU Habitats Directive 92/43/EEC.

Serbia habitat classification system is based on the EUNIS classification system (Lakušić, D. 2005). Most, but not all EUNIS habitats are actually biotopes or areas with equal environmental conditions enough to support a distinctive combination of organisms that inhabit them. All EUNIS habitats (except the smallest) include at least 100 m^2 surface, while the upper limit is determined.

At the low scale can be described and called "microhabitats" (which generally take up less than 1 m^2, and is significant for some small invertebrates and lower plants). Examples of this are dead trees from old forests, which are ideal habitats for many species decomposers. For larger scale habitat can be grouped in the so-called. "Habitat complexes" often occur in a typical mosaic, or a combination of individual habitat types, which may be in mutual dependence.

With the development of the classification itself, made the basis of parameters that includes the reference systems for climate, soil, water quality, vegetation, and typical physiographical elements, or the dominant plant and animal species

The aim of establishing this system is just creating a reference database on species, habitats and areas that forms the basis of the Directive on Birds and Habitats Directives of the NATURA 2000 network and its network of similar EMERALD Berne Convention, and is also used in the development of indicators (EEA Core Set and others) and create reports on the state of environment. Habitat types of cadastral municipality Djurašići (Table 4, Figure 10-13).

Table 4. Types of habitat in cadastral municipality Djurašići, digital processing of IKONOS satellite images

Types of habitat	No. of homogeneous units	Area of homogeneous units
C2.2 – Permanent, fast and turbulent watercourses whose levels do not change	1	3,37
E1.2B2 – Serpentine steppe on shallow rocky soil	3	11,01
E2.1 – Permanent mesophillic pastures and meadows for grazing after mowing	60	492,86
E2.13 – Abandoned pastures	6	10,21
E2.33 – Balkan high mountain meadows	131	165,50
E5.21 – Xero-thermophilic forest lanes	1	0,10
E5.22- Mesophilic forest lanes	4	2,57
F3.16 – Bushy habitats of common juniper (Juniperus communis)	12	43,44
G1.1211 – Mountain mono dominant gray alder galleries (Alnus incana)	1	0,79
G1.211 – Ash - Alder (Fraxinus) – (Alnus) forests along streams and springs	1	3,40
G1.6914 – Moesian mountain beech forests with Sessile oak (Quercus petraea)	16	141,42
G1.6926 – Moesian mono dominant acidophilous beech forests	7	18,25
G1.6931 - Moesian mountain beech forests with hornbeam (Ostrya carpinifolia)	1	1,79
G1.6941 – Moesian mono dominant mountain beech forests	7	10,60
G1.6C – Illyrian beech (Fagus) forests	5	16,18
G1.7511 - Moesian mono dominant Sessile oak (Quercus petraea) forests on limestome	5	9,09
G1.7512 - Moesian mono dominant Sessile oak (Quercus petraea) forests on serpentinite	1	3,94
G1.757 – Illyrian Sessile oak (Quercus petraea) forests	90	204,20
G1.7611 – Typical forest of Hungarian and Turkey oak	2	1,91
G1.761E – Forest of Hungarian and Turkey oak with beech (Fagus)	4	17,67
G1.871 – Moesian acidophilous Sessile oak (Quercus petraea) forests	203	751,62
G1.872 - Moesian acidophilous Turkey oak (Quercus cerris) forests	7	4,53
G1.91B – Balkan birch (Betula) forests on terrain that is not marshy	1	0,62
G1.923 – Moesian mountain beech forests with bilberry (Vaccinium myrthyllus)	5	1,11
G1.95 – Forest of European Aspen (Populus tremula) and birch (Betula) with elderberry	1	0,31
G1.D4 - Orchards	7	8,86
G1.D5 – Other orchards with high trees	2	0,80
G3.1E51 – Dinaric calciphile Common Spruce (Picea abies) forests	4	1,85
G3.1E52 - Dinaric acidophilous Common Spruce (Picea abies) forests	10	38,40
G3.F111 – Artificially established Spruce stand with naturally regenerated Sessile oak	1	0,60
G3.F14 - Artificially established Austrian pine stand	3	6,38
G3.F141 – Artificially established Austrian pine stand with naturally regenerated Sessile oak	2	0,37
G3.F16 - Artificially established Austrian and Scots pine stand	1	6,10
G3.F17 - Artificially established Spruce and Austrian pine stand	7	32,44
G4.611 – Mixed forests of beech and fir on silicate	1	0,92
G4.612 – Mixed forests of beech and fir on carbonate soils	4	59,44
G4.613 - Mixed forests of beech and fir on serpentinite	4	23,82
G4.62 - Mixed forests of beech, fir and spruce	7	16,41
G4.63 - Mixed forests of beech and spruce	41	189,13
G5.61 – Deciduous scrub forests	2	11,06
G5.71 – Coppice forests	9	26,03
G5.81 – Recently deforested areas	6	35,78
H3.2 – Basic and ultra-basic inland cliffs	4	1,53
H5.6 – Trampled areas	1	0,15
H5.61 – Bare ground	10	6,64
I1.13 – Small intensive monoculture (<ha)	3	6,61
J4.2 – Road network	1	0,10

In the area of cadastral municipality Djurašići noted the following habitats:

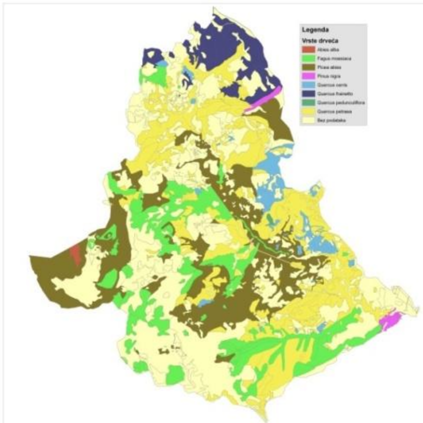

Fig. 10. Types of trees

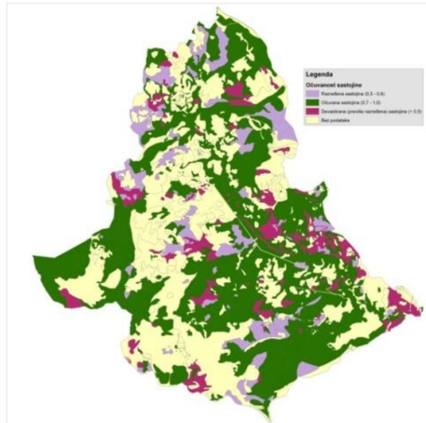

Fig. 11. Preservation of stand

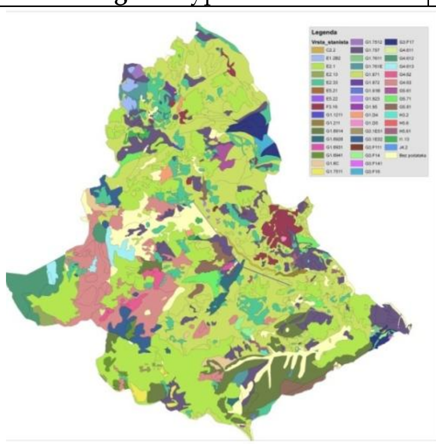

Fig. 12. Map of research habitat areas

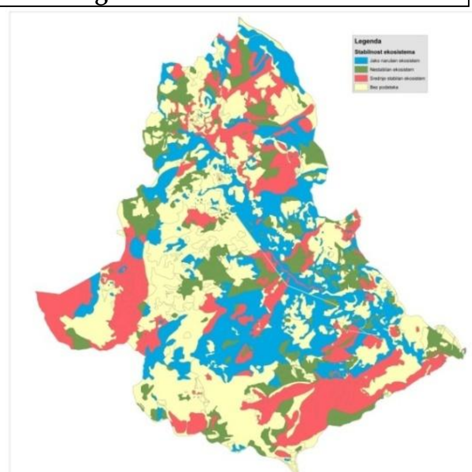

Fig. 13. Map of ecosystem stability made on the basis of satellite images

TYPES OF CHANGES HABITATS

The changes represent a translation of habitat area one category to another class of habitats. Conditions for the identification of categories of habitats using satellite imagery have changed the reflection spectrum. These changes recognize the changes in properties of elements are interpreted. On a methodological point of view it means that the Figures of two or more periods (time series) used to identify changes in land cover. They use two basic methods for the detection of changes in satellite images:

• Visual and computer-aided visual interpretation
• The method of digital identification changes

In order to monitor changes in habitat most used visual interpretation of satellite images. All necessary changes are performed at the initial (primary) layer of the data that changes only locally in the areas where they identified changes in the habitats. All unchanged polygons (homogeneous) keep the border areas from the previous period. Do not create the new database but the data supplement. This will minimize the occurrence of errors in the database during the change, which is common when comparing independently established database.

Significantly and reduced cost (drawing) polygons. On the use of high resolution satellite imagery database to form a homogeneous whole of the minimum area of 1 m^2. Changes in the habitats of the map if they reflect the actual evolution of changes in habitats (e.g. growth of settlements, clear cutting forests, etc.) rather than its seasonal changes.

Typical types of changes are:

• Changes in habitat on the entire surface of the polygon: Balkan high mountain meadows (E2.33) and abandoned pastures (E2.13);
• Exchange of land between two polygons: for example, small intensive monocultures (I1.13) with orchards (G1.D4);
• The appearance of the new polygons: for example Forest of European Aspen (Populus tremula) and birch (Betula) with elderberry (G1.95) within deciduous scrub forests (G5.61)
• The disappearance of the polygons: for example Bushy habitats of common juniper (Juniperus communis) (F3.16) with artificially established Austrian pine stand (G3.F14).

CONCLUSION

Global changes are reflected in the areas of smaller regions, so that their monitoring of great importance to changes in ecosystems. For this purpose we use high resolution satellite images, and using GIS technology developed is a method of monitoring the periodic changes in ecosystems. The collected data allow development of models that contain dynamic changes in natural ecosystems.

Periodic recording of the characteristic areas in Serbia will be followed by a spatial representation of ecosystems, as well as changes in their composition and structure.

ACKNOWLEDGEMENT

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