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GEOECOLOGICAL EVALUATION OF NOVI SAD AND ENVIRONMENT FOR THE PURPOSES OF HEALTH TOURISM AND RECREATION

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ABSTRACT

Novi Sad and its surroundings are rich with the most diverse natural values that are good for the development of health tourism and recreation activities on their territory. Being in nature, next to water surfaces, forests and all green favorably affects on psycho – physical condition and improves life quality in urban environments. Aim of this work is geoecological evaluation of Novi Sad and its surroundings with the use of quantitative model of diversity, ie Hans Kiemstedt model for the purpose of health tourism and recreation. With this work authors want to contribute to further affirmation of geoecological evaluation in the area of planning and managing of urban areas. Methodology is based on Kiemstedt model, and criteria that are used are: forest and water edges, relief energy, way of land use and climate factor, or conditions of natural environment. Use of this model gives less of more favorable surfaces for the development of mentioned activities. The advantage of this model is the use of modern GIS technologies, obtaining tested and objective data that have a wide use.

Key words*: geoecological evaluation, Kiemstedt, health tourism and recreation, Novi Sad and surroundings, GIS*

INTRODUCTION

Novi Sad is an administrative center of Autonomous Province of Vojvodina and South Backa county (figure 1). Area of the city includes surface of 702.7 km^2, which according to data from 2011 is inhabited with 341 625 inhabitants (together with city municipality Petrovaradin). It is the second largest city in Republic of Serbia, after Belgrade, with the highest level of urbanization and great international importance. Favorable geographical position, good traffic connection, abundance of natural and anthropogenic values made it possible for Novi Sad to become economic center of this part of Serbia, center of education (University city), culture, history, communication and tourism. Surrounding of Novi Sad consists of: spacious fertile Pannonia basin under arable land on north, Danube (river of international importance, European corridor VII), mountain and national park Fruska gora on south (Crveni cot, 539 m) that is the most important forest area of Vojvodina and famous vineyard region, then SNR Koviljsko – petrovaradinski rit and NR Begecka pit as representatives of natural swamp complexes.

Base of development of health tourism make Jodna (iodine) spa within is set hospital complex with rehabilitation center (more touristic affirmed in past), famous for its sources of mineral water, and also spa Beocin whose tourist potentials are not sufficiently recognized. Area of the city belongs to

moderate-continental climate, dominant winds are North i Kosava, average annual temperature is 10,9 °C with the coldest month being January and the hottest July [1,2].

Geoecological evaluation of urban areas and their surroundings is important for future planning, landscaping, protection and managing that implies further development and promotion of tourist and recreation activities. In order to see real potentials and possibilities for tourism and recreation development, is necessary to apply different methods of geoecological evaluation, preferably Hans Kiemstedt model, which can be supplemented with bioclimatic model Menex [3,4,5,6,7].

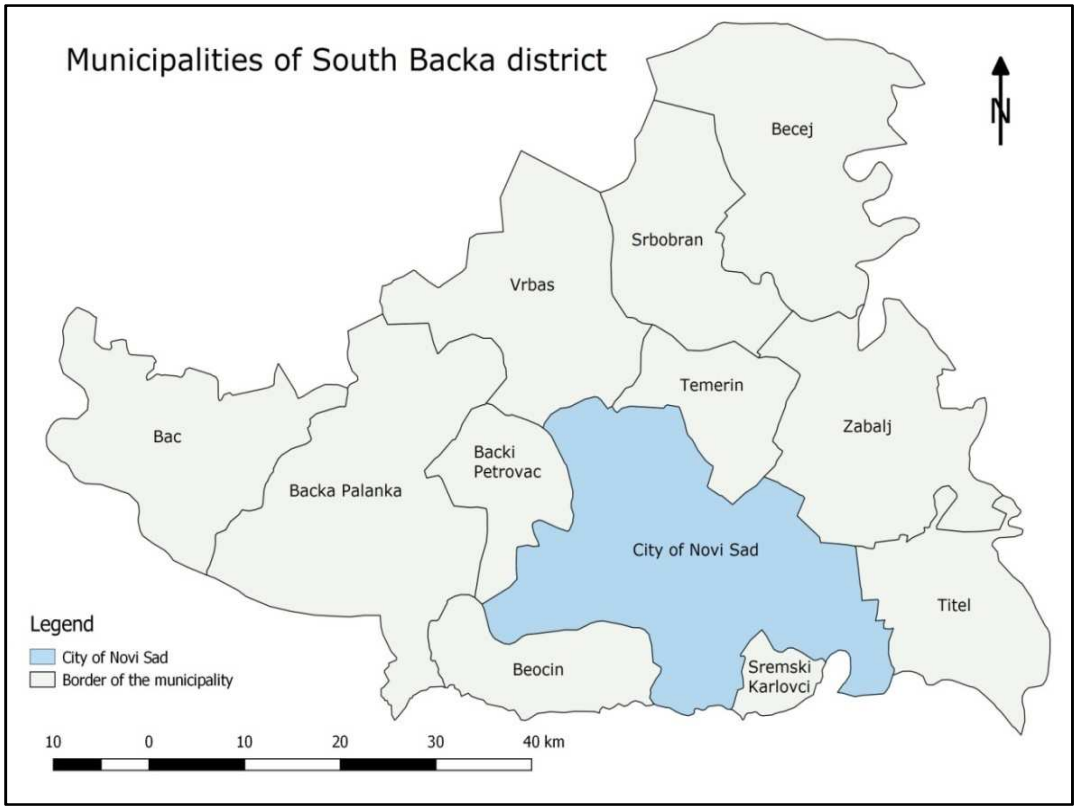

Figure 1. The position of Novi Sad city within the South Backa county

METHODOLOGY OF THE RESEARCH

Subject of this work is a geoecological evaluation of Novi Sad and its surroundings in order to find out which are the most favorable areas for the development of health tourism and recreation. Geoecological evaluation was done with quantitative method of "diversity" (V-Wert Method) Hans Kiemstedt. During time model developed, improved and today is successfully used in areas of planning and spatial managing. It is especially useful for evaluation of hilly – mountainous areas [8,9]. Convenience of area for tourism and recreation is determined with the formula [10,11,12] :

$$V = \frac{W + (G \times 3) + R + N}{1000} \times K$$

where: W –forest edges, G –water edges, R – relief energy, N – way of use and K – climate factor.

For the purpose of research and displaying of results that are presented in this work was used GIS software based on ESRI technology ArcGIS 10.4. Conducted analysis enabled overview of assessment of the considered area according to all criteria of Hans Kiemstedt model of geoecological evaluation of areas. With overlapping of layers was obtained a synthetic map of conveniences of Novi Sad for recreation, which was the main aim of the work.

At the beginning of research was formed a net of GRID cells dimensions of 1x1 km over whole considered territory, so for every area could be determined convenience in relation to every criteria of values that were presented with the mentioned formula.

FORESTS AND WATER EDGES

Forest edges W (waldrandzahl) are the carriers of contrast and changes in space that effect on senses of observer and represent typical elements of cultural area. Water edges G (gewässerrandzahl) increase tourist value of the area, make it more diverse, attractive and from recreational aspect are favorable for development of larger number of recreational and touristic activities, especially in domain of health tourism, because staying in nature have a good effect on psycho – physical condition of human. Roles of forests and waters are very similar, provided that water additionally richens the area and in accordance to that lengths of all water coasts are valued with factor 3 [3,8].

For data about length of water edges and forest edges was used digital base of data about state and changes of land cover and purpose of use of all Europe CORINE Land Cover 2012 [13]. Data base contains 44 categories of way of land use, and based on available data on area of Novi Sad and surroundings were allocated two types of present forests: deciduous and mixed forests. For determination of length of forest edges were considered also transient forest – bushy ecosystems. After that was expressed length of forest edges in meters for every separate raster cell. At the end, with analysis and processing of data was obtained the length of coast in meters in every GRID cell, that is by km^2, for whole surface of researched area.

RELIEF ENERGY

Relief energy R (reliefzahl) represents height difference between the highest and the lowest elevation in corresponding raster (GRID cell) that is expressed in meters. To determine this criteria of evaluation, was necessary to use data of digital elevation model DEM [14,15], and data obtained with analysis are shown on relief map of Novi Sad (map 1). To every raster cell was given value that represents the difference between the highest and the lowest point of altitude. In accordance to that were given values shown in table 1.

Table 1: Scale of relief values

Altitude difference (m)	Values of the relief
10 – 20	220
20 – 30	300
30 – 60	400
60 – 100	590
100 – 250	860
250 – 500	1200

WAY OF USE

Way of use N (nutzungszahl) was determined so it could be established the possibilities for the use of different space elements for recreation purpose. To obtain values of this factor was calculated percentage share of different types of land use in corresponding raster square, that are then multiplied with corresponding weight factor, table 2 [11,14]. Summation of obtained partial values of every type of use, gives final value for every raster. To determine the way of use were considered data from CORINE Land Cover 2012 base [13], map 2.

Table 2: Weight factors for each purpose of area

Type of use		Weight factors
Cultivated fields and gardens		6
Meadows and pastures		15
Orchards and vineyards		8
Forests		19
Heath		21
Ponds		12
Swamps		10
Infertile land		21
Waters	Rivers	50
	Lakes	50
	Streams	20
	Canals (main)	10

CLIMATE FACTOR

Climate factor K (klimafaktor) is calculated based on average annual temperature, average annual participation and altitude of type of area. Hans Kiemstedt in its model suggested values in range for the following bioclimates (for researched area of Germany) [11]:

- Urban climate: 0,65 – 0,80
- Climate of basin: 0,70 – 0,90
- Climate of North - Germany lowland: 0,90 – 1,10
- Coastal climate (Baltic and North Sea): 1,30 – 1,60
- Climate of sub mountainous zone: 1,10 – 1,20
- Climate of mountainous zone: 1,20 – 1,40
- Climate of high mountains: 1,30 – 1,50
- Climate of central Alps: 1,30 – 1,80

For the purpose of determining of climate factor were used data of temperature, participation and dominant winds based on which were allocated bioclimates. Lack of geoecological evaluation with the use of Hans Kiemstedt model is seen in the fact that mentioned types of climate were related only to area of Germany, so in this situation urban area of Novi Sad has the values of urban climate, higher parts that belong to Fruska gora have values that correspond to climate of sub mountainous and mountainous zone while remaining area corresponds to North Germany plane climate.

CATEGORIES OF DIVERSITY AND MAKING OF SYNTHETIC MAPS FOR HEALTH TOURISM AND RECREATION BENEFITS

After collecting of necessary data about criteria that are considered during geoecological evaluation with the use of Hans Kiemstedt model and their analysis, was approached to making of thematic maps that are given in this work as annexes. Overlapping of this maps and conducting of certain geospatial analysis and quarries with the use of mentioned formula, gave an overview of conveniences of studied area for the purpose of tourism and recreation by Hans Kiemstedt [8,16] (table 3).

It is important to mention that in work method of evaluation is conducted on slightly wider area in relation to administrative boundaries of Novi Sad, so instead of 702.7 km^2 was evaluated the area of 790 km^2, which included also closer surrounding of the city. Reason for that is that it was considered every raster unit (GRID cell) within even the smallest part of the territory of Novi Sad city. After conducted evaluation, were obtained final results based on which were presented levels of conveniences of different parts of the city and its surroundings for recreation. Levels of conveniences were classified into four categories:

- Unfavorable surfaces: 583 km^2 or 73.80 %,
- Conditionally favorable surfaces: 98 km^2 or 12.41%,
- Favorable surfaces: 60 km^2 or 7.59 %,
- Very favorable surfaces: 49 km^2 or 6.20%.

On synthesis map 3, can clearly be seen unfavorable surfaces that take the biggest part of the subjected area, with over 73 % of total territory. They are set dominantly on north, north east and north west part. Follow conditionally favorable surfaces with 12.41% that are mostly present in central part of the city, its immediate surrounding and less in south and south east parts. Even less are present favorable surfaces with 7.59 % that usually follow the flow of river Danube, parts of central city park as well as areas of national park Fruska gora and SNR Koviljsko – petrovaradinski rit. The least are present very favorable surfaces with characteristics that are most suitable for tourist and recreation activities development and take 6.2 % of total territory. Very favorable zones intended for health tourism and recreation are located on the Danube coast, on slopes of Fruska gora and special nature reserve Koviljsko – petrovaradinski rit, as natural resources of the highest importance in this part of Vojvodina. Since those are zones that have rich biodiversity, area diversity and preserved natural environments with reason belong to group of very favorable surfaces, with the highest potential for development of different types of tourism and recreation.

Table 3. Categories of diversity by Hans Kiemstedt

Categories	Classes	Span
I	Unfavorable	V < 3,72
II	Conditionally favorable	3,72 < V < 7,44
III	Favorable	7,44 < V < 11,16
IV	Very favorable	V > 11,16

CONCLUSION

Urban area of Novi Sad represent complex combination of changings of natural and cultural areas that correspond to development of tourist and recreational activities. Health tourism and recreation become more and more significant factor of attraction which generates larger number of visitors in this city annually. Since on the city territory exist several protected natural areas, accent is put on sustainable approach of tourism. Sustainable development of tourism is possible only if exist adequate planning with considering of area specifics. Geoecological evaluation as approach offers a series of conveniences and with it can be provided over needed data that are used for different research, especially in domain of area planning.

Subject of this work was geoecological evaluation of Novi Sad and its surroundings with the use of Hans Kiemstedt model for the purpose of health tourism and recreation. Evaluation was conducted based on considered criteria: forest and water edges, relief energy, way of use and climate factor, with the use of modern GIS technology (software ArcGIS 10.4). With conducted complex geospatial analysis, that present the biggest advantage of GIS use in geoecological evaluation of area, overviewed were surfaces less or more suitable for development of touristic and recreational activities. The most favorable surfaces are on the river coast of Danube, then on area of national park Fruska gora, SNR Koviljsko – petrovaradinski rit that is the most famous representative of swamp ecosystems in South Backa county and also are present within central city area. These parts represent the most important natural touristic values of Novi Sad and its surroundings and are important part of touristic offer in Vojvodina.

Mountain Fruska gora is one of the most visited areas of Novi Sad inhabitants and tourists from other parts of the region and country. It is becoming more and more attractive on international level, so more often there can be seen foreigners, nature lovers and history lovers. Modern and fast way of life in big and urban centers imposes the need for short term vacation in nature. Being in nature and by the

water, greenery, peace, possibility of recreational passive or active playing of sports favorably affects on humans and their psycho – physical condition and improves the quality of life.

Results of this work besides contribution to affirmation of used methods of geoecological evaluation of urban and natural areas, can contribute to future development of tourist and recreational activities on city territory, their diversity, further promotion of so far insufficiently developed health healing tourism, and also give significant data that can be used in other areas of human impact. Hans Kiemstedt model can be successfully used for evaluation of areas with expressed values in Republic of Serbia. Lack of this model, considering climate factor that corresponds to area of Germany, can be solved with the use of bioclimatic model Menex whit which were obtained more objective overview about real bioclimatic state on subjected territory, and is based on the use od daily weather data. Combining of these two models contributes significantly to improvement of geoecological evaluation of area, which represents area for future research.

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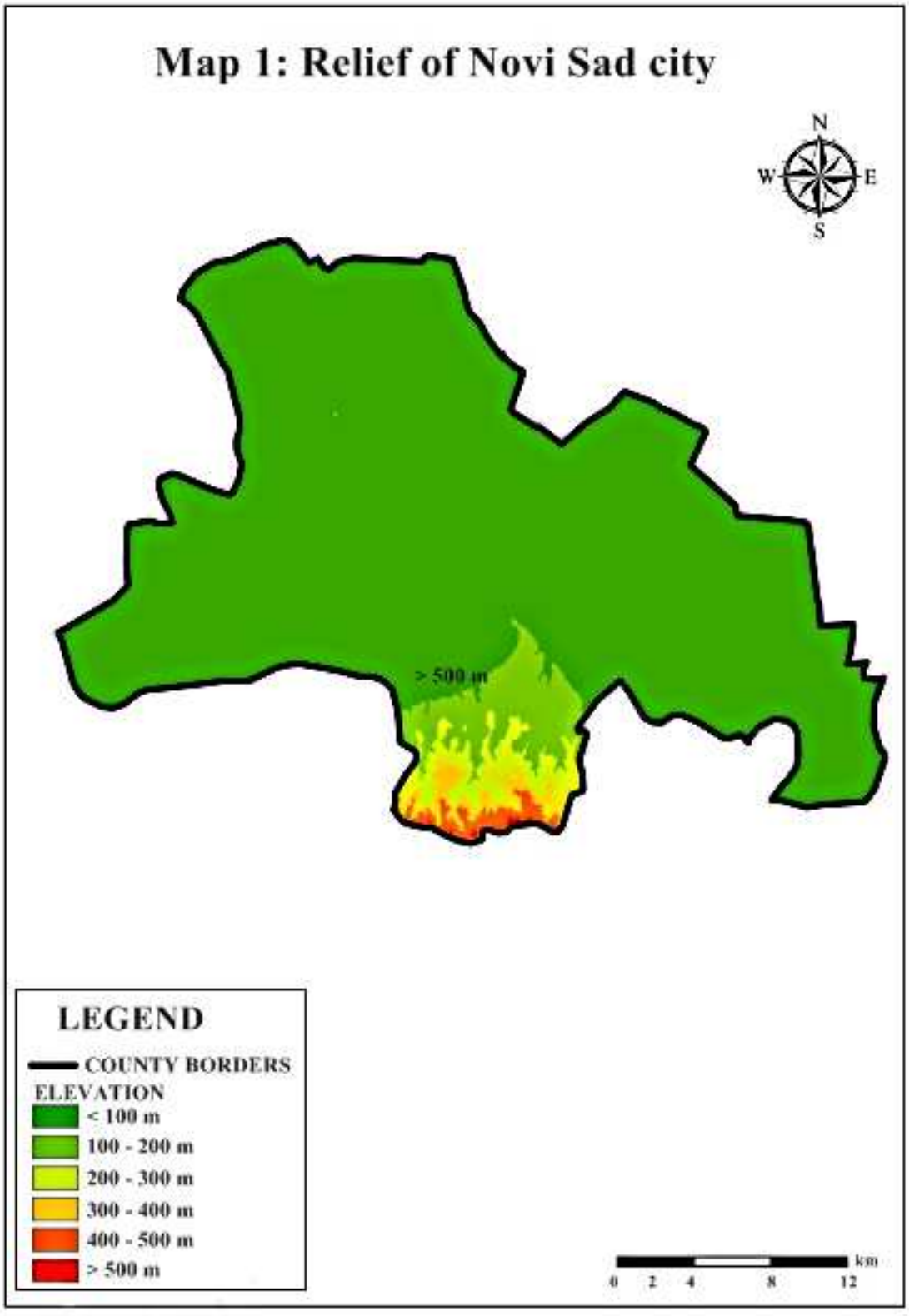
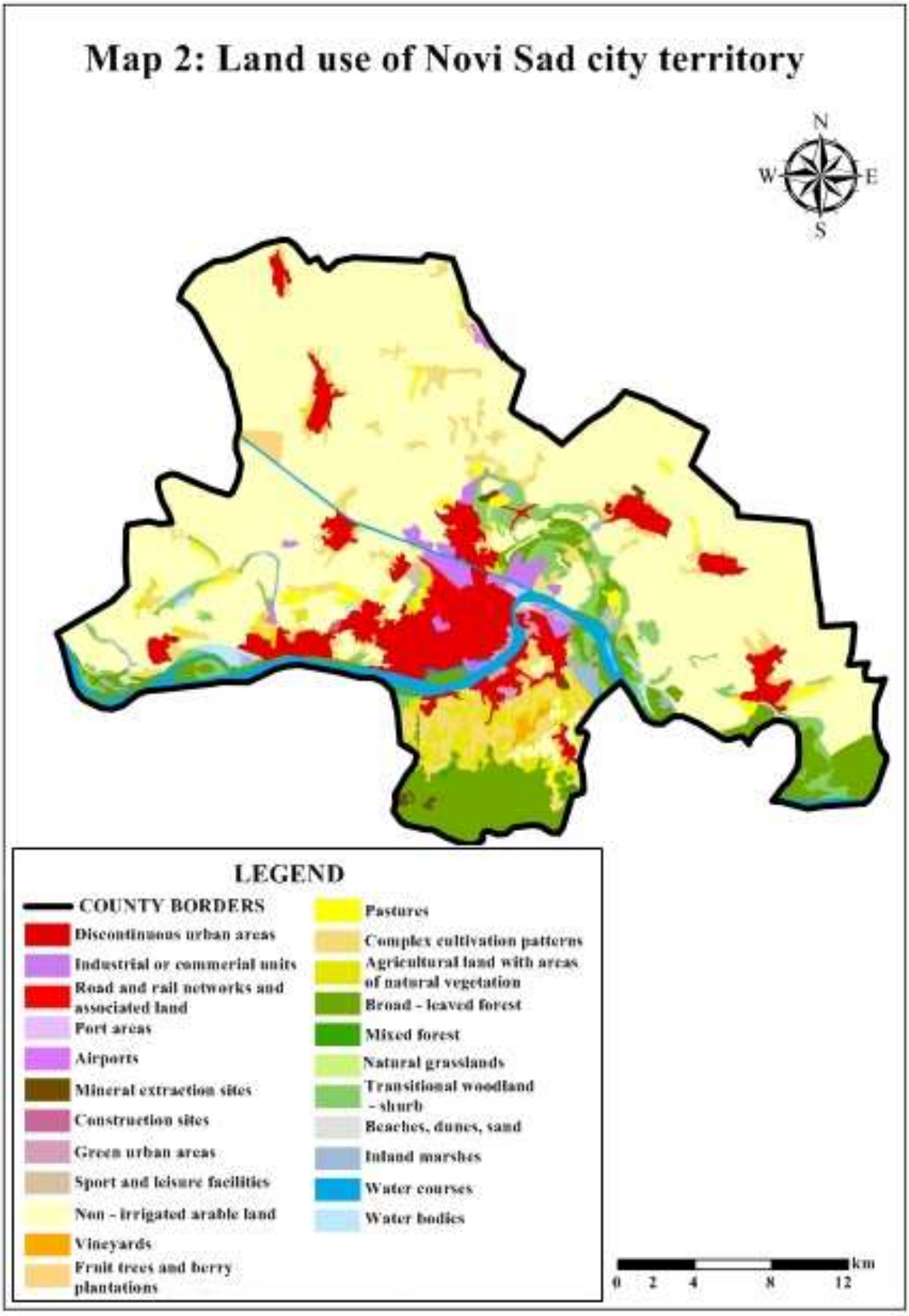
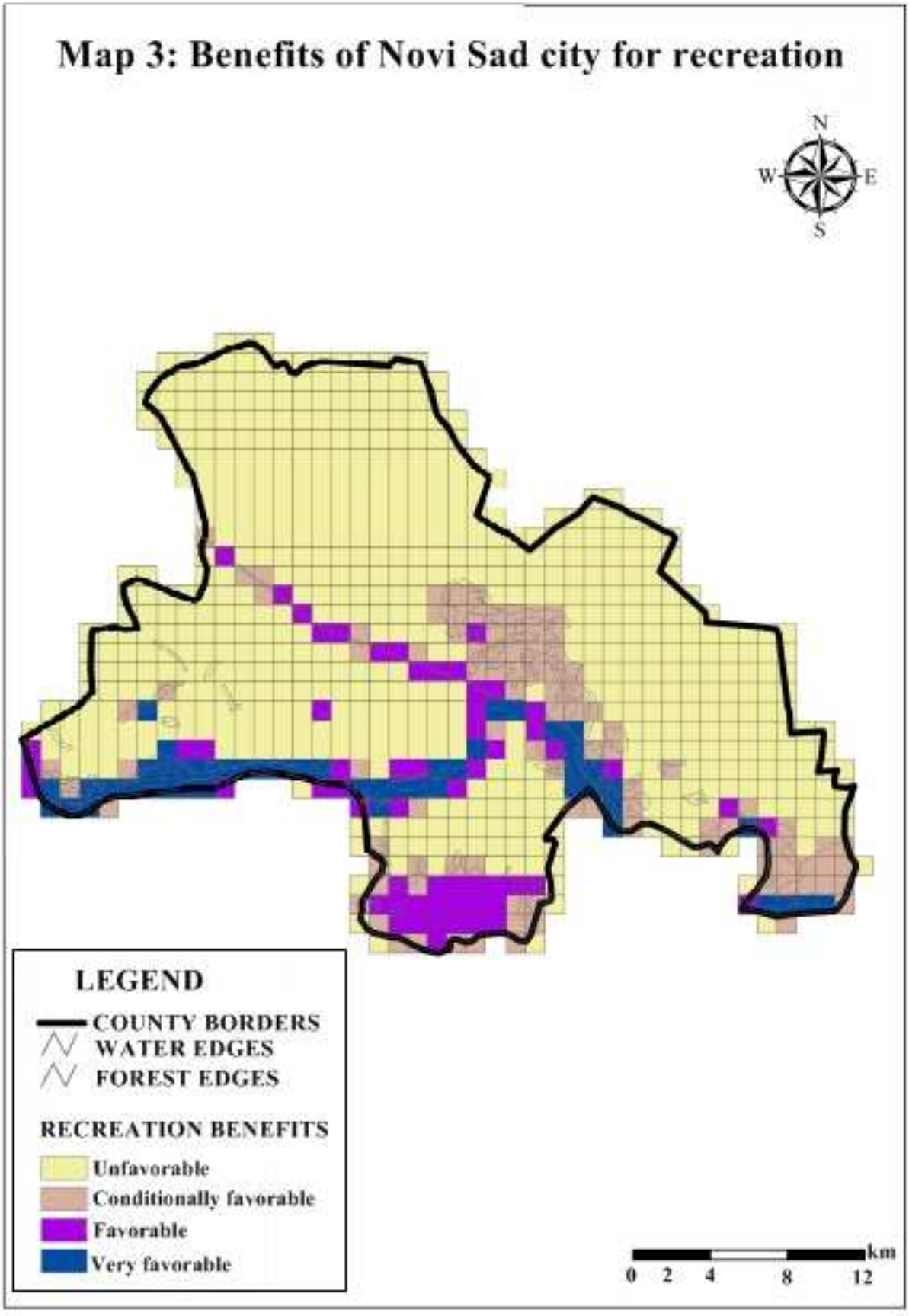
Annexes:
Map 1. Relief of the city of Novi Sad
Map 2. Land use in the city of Novi Sad
Map 3. Benefits of the city of Novi Sad for recreation




Map 2: Land use of Novi Sad city territory
N
W
E
S
LEGEND
COUNTY BORDERS
Discontinuous urban areas
Industrial or commerial units
Road and rail networks and associated land
Port areas
Airports
Mineral extraction sites
Construction sites
Green urban areas
Sport and leisure facilities
Non - irrigated arable land
Vineyards
Fruit trees and berry plantations
Pastures
Complex cultivation patterns
Agricultural land with areas of natural vegetation
Broad - leaved forest
Mixed forest
Natural grasslands
Transitional woodland - shurb
Beaches, dunes, sand
Inland marshes
Water courses
Water bodies
km
0 2 4 8 12


Map 3: Benefits of Novi Sad city for recreation
N
W
E
S
LEGEND
COUNTY BORDERS
WATER EDGES
FOREST EDGES
RECREATION BENEFITS
Unfavorable
Conditionally favorable
Favorable
Very favorable
0 2 4 8 12
km