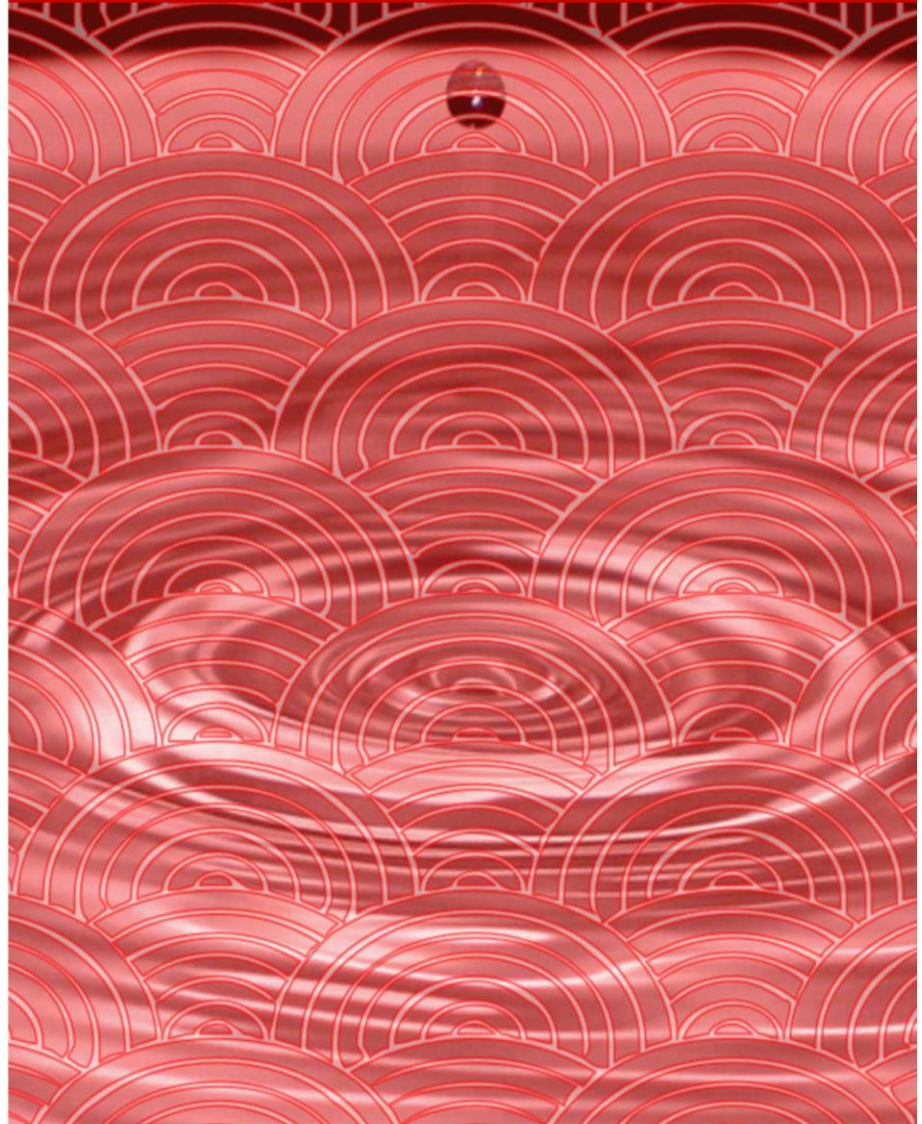




Volume 2, Issue 2, November 2017

GeoPatterns



University of Bucharest

Center for Risk Studies, Spatial Modelling,
Terrestrial and Coastal System Dynamics

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The evolution of the fluvial islets hydrodynamic shape. Applications for Danube's Islets between Giurgiu and Oltenita towns

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Abstract. This paper presents a brief analysis on the fluvial islets hydrodynamic shape. Proposed by the Wyrick (2005) and Wyrick & Klingeman (2011), the hydrodynamic shape criteria refers "to the subaerial planform shape of the river islets". According to them, these geomorphological landforms can have a streamlined shape, an angular aspect or irregular shape. Except for the last category, each of the other types has several subtypes. For this case study we selected the fluvial islets from the Danube River, the sector situated between Giurgiu and Oltenita towns. It can be observed that, nowadays (2017) there are five new islets unlike between 1889 and 1916 and most of the river islets have an irregular shape. Also, in the literature it is mentioned that there might be a connection between the shape and age of islets. So, in our study, we applied a Chi-Square Test to check this relation. The results show that there is a possible association between the shape and the age of the Danube's Islets.

Keywords: hydrodynamic shape criteria, diachronic analysis, chi-square test, fluvial islets, Danube River.

1. INTRODUCTION

A fluvial islet is a landform, surround by stream channels, exposed during bank-full flows and with some stability, imposed by the presence of the permanent vegetation (Osterkamp, 1998; Wyrick, 2005; Wyrick & Klingeman, 2011; Picco *et al.*, 2014; Picco *et al.*, 2015). Islets are very important from morphological, ecological, economical or geopolitical points of view. Being part of the river system, they are strongly influenced by the hydrological parameters and by the human activities (Sadek, 2012; Picco *et al.*, 2014; Marin & Armaş, 2016).

Fluvial islets have been extensively studied by the researches, under the issues of formation, evolution and classification (Machinov *et al.*, 1986; Osterkamp, 1998; Gurnell *et al.*, 2001; Wyrick, 2005; Gautier&Gravel, 2006; Zanoni *et al.*, 2008; Ricaurte *et al.*, 2012; Gao *et al.*, 2013; Nicholas *et al.*, 2013; Baubiniené *et al.*, 2014; Kiss & Andrasi,

2014; Picco *et al.*, 2014; Picco *et al.*, 2015; Raslan & Salama, 2015). A great work in this regard was made by Wyrick (2005), who, in his PhD Thesis, addresses such a topic. In particular, he chose to investigate the relation between the river islets and the fluvial processes, including the connection between their shape and the hydro-geomorphologic phenomena manifested in the river channel. He also proposed an island classification scheme as a tool for improved river classifications and restoration actions. The classification scheme is inspired from Rosgen's (1996) objectives channel classification. The author proposed three basic categories of characteristics, which needs to be determined for each fluvial islet (Figure 1): i) *Geometric* – those that can be measured from cartographic documents or aerial/satellite images, ii) *Biophysical* – characteristics which can be measured/observed "in situ" and iii) *Inferred* – those that can be deducted from the other characteristics of islands and/or from a known history.

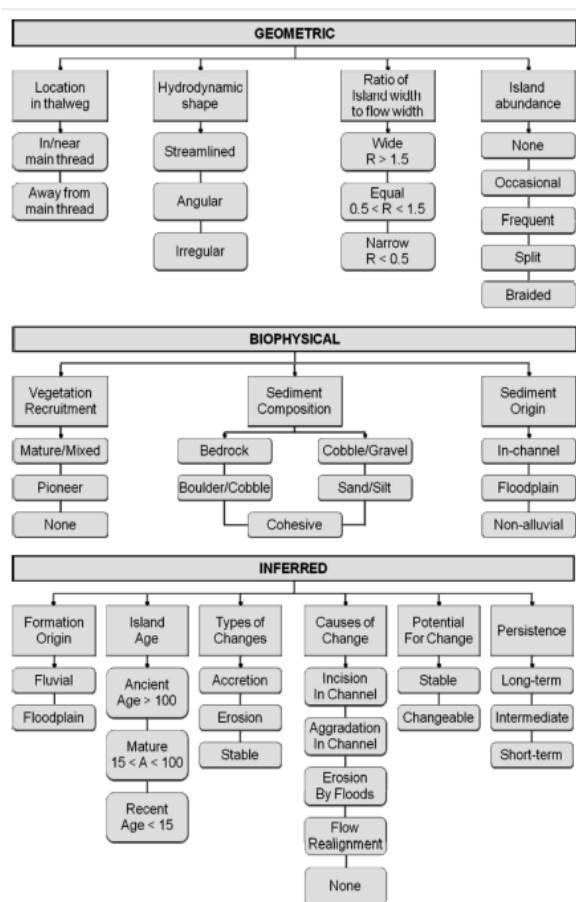


Figure 1 The distinguishing characteristics of islands proposed by J. Wyrick (Wyrick, Klingeman, 2011)

The hydrodynamic shape criteria refers "to the subaerial planform shape of the river islets" (Wyrick, 2005; Wyrick & Klingeman, 2011) and as can be seen in the Figure 1, according to J. Wyrick, these geomorphological landforms can be classified as: i) islets with streamlined shape, ii) islets with an angular aspect and iii) islets with an irregular shape.

In this paper, we aim to identify and to show the evolution of the shape of Danube's Islets using the methodology proposed by the Wyrick (2005) in his PhD Thesis. For this case study we have selected the sector between the towns Giurgiu/Ruse and Oltenita/Tutrakan, Romania-Bulgaria (Figure 2). The length of the Danube study area is about 73 km and includes the romanian and bulgarian islets between 493 and 470 kilometers points.

2. METHODOLOGY

To investigate the shape of islets along the selected Danube River reach, we used the

diachronic analysis. The fluvial landforms were observed: i) on ancient maps called *Planuri Directoare de Tragere*, which date from 1889-1916 and ii) on two sets of aerial and satellite images: orthophotoplans of Romania from 2010 (5 m spatial resolution) and Sentinel 2A image from 2017 (10 m spatial resolution). The shapes of fluvial islets were visually determined by consulting the cartographic materials and images mentioned above.

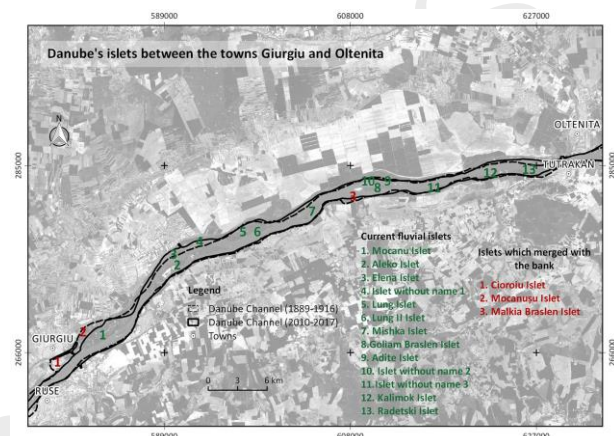


Figure 2 Location of the Danube's Islets between the towns Giurgiu and Oltenita

To classify these landforms by their shape, we used the hydrodynamic shape criteria from the classification proposed by Wyrick (2005) and Wyrick & Klingeman (2011) (Figure 3).

Shape Category	Shape name	Planform Shape
Streamlined	Lemniscate (upstream or downstream)	
	Elliptical	
	Lenticular	
Angular	Semi-circular or Hemispherical	
	Triangular	
	Rhombic	
Irregular		

Figure 3 Shape Category by J. Wyrick (2005) (Wyrick, Klingeman, 2011)

Because we found in the literature that there might be a connection between the shape and age of islets, we set the age of those landforms according to the appearance on maps and images. So, the islets that appear on all studied maps and aerial/satellite images are considered “old” and those which appear only on Sentinel 2A images are treated as “new”. It is important to mention that the age of the islets was determined based on another classification of Wyrick (2005): i) ancient islet, if it is older than 100 years and ii) new/recent islet, if it is younger than 10 years.

To evaluate the relation between the aspect and the age of fluvial islets, the Chi-Square test was applied, using SPSS software.

3. RESULTS AND DISCUSSIONS

The results obtained show that the Danube's islets between Giurgiu and Oltenita towns are classified into two major types: i) islets with a streamlined shape and ii) islets with an irregular shape. In the first category, predominant are the islets with lemniscate aspect, followed by the ones with elliptical and semi-circular shapes (Table 1).

In defining the shape of a fluvial islet, an important role is played by the age of the landform. The older the islet, the more it has been exposed to erosive-accumulative processes (Wyrick, 2005). In the Danube sector between Giurgiu and Oltenita towns five new islets were identified (Table 1): Elena Islet, Lung II Islet, Adite Islet and 2 islets without names. The Chi-Square test statistic applied in this study, indicate a possible association between the shape and the age of the Danube's Islets (Chi-Square = 27.6, df = 10, $p < 0.002$). So, the older islets, which have experienced more flows actions, tend to be irregularly shaped.

4. CONCLUSIONS

In the last 128 years (1889-2017), the fluvial islets of the Danube River have changed both in number and shape. If in the period 1889-1916, the number of islets with a streamlined shape (no = 6) was close to that of irregularly shaped islets (no = 5), at present (2010-2017) there are predominantly fluvial

landforms with irregular aspect. Also, the applied statistical test showed a possible association between the shape and the age of Danube's Islets in the conditions where an islet is older, the longer it is subject to the actions of the water and sediment flow.

Table 1 Classification of the Danube's Islets between Giurgiu-Oltenita towns based on their shape

NAME	SHAPE	
	1889-1916	2010-2017
Cioroiu	Streamlined - lemniscate	Irregular
Mocănaşu	Irregular	Irregular
Mocanu	Irregular	Irregular
Aleko	Irregular	Irregular
Elena	There is no islet	Streamlined - lemniscate
Islet without name 1	There is no islet	Streamlined - elliptical
Lung	Irregular	Irregular
Lung II	There is no islet	Irregular
Mishka	Streamlined - elliptical	Streamlined - lenticular
Malkia Brăşlen	Streamlined - lemniscate	Streamlined - lemniscate
Goliam Brăşlen	Irregular	Irregular
Adite	There is no islet	Streamlined - lenticular
Islet without name 2	There is no islet	Irregular
Islet without name 3	There is no islet	Irregular
Kalimok	Streamlined - lemniscate	Irregular
Radetski	Streamlined - lemniscate	Streamlined - semi-circular

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GIS in seismology: contributions to the evaluation of seismic hazard and risk

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Abstract. In this paper we highlight the capabilities and advantages of GIS, through an explicit analysis of its contribution within different studies of seismic hazard and risk assessment. These studies are related to Romania – one of Europe's countries with the highest seismic risk, mainly due to intermediate-depth earthquakes originating in the Vrancea Zone. We provide examples of how GIS contributes and enhances the evaluation of seismic hazard, the development of vulnerability spatial datasets, multicriteria analysis, real-time estimation of seismic risk, assessment of road network failure susceptibility and implications, mapping or others. The role of free data and contribution capabilities are discussed. In recent projects such as Bigsees and Ro-Risk, GIS was one of the elements that lead to innovation, and we aim to present the experience and results. Another important aspect is referred to: the importance of GIS to a research dissemination with great impact.

Keywords: GIS, seismic hazard, earthquake, maps, Romania

1. INTRODUCTION

GIS (Geographic Information System) is a fundamental tool that exploits the spatial dimension and its links with other dimensions, allowing to model and represent processes that are representative to the world we live in. GIS can find its place in almost all fields of study.

In seismic (and all types of) hazard and risk assessment, the need of considering location is embedded in the very definitions of the terms. But GIS can do much more than providing distance measurements and solutions for mapping. Among its numerous practical applications (Bonham-Carter, 2014) we mention that it can:

- allow a complex modelling of the data (both spatially and temporally);
- provide spatial and geostatistical analysis tools;
- provide filtering capabilities (text or location based)
- enable overlay analysis;
- have the function of an all-in-one platform, with database management, code development, automation and sharing capabilities;

- be the proper tool for disseminating the results (publicly or privately).

As reflected by more and more studies (such as Leonard *et al.* 2002, ESRI 2007, Rivas-Medina *et al.* 2013, Toma-Danila *et al.*, 2017a), the role of GIS became major in seismology – a geoscience in need of geographical instruments. The Generic Mapping Tool (GMT) or QGIS have been and are still being widely used by seismologists (they are open source), but other commercial software such as ArcGis (under which HAZUS-MH operates) are also of great reference.

In this paper, we will show and interpret different maps (which are a basic product of GIS) that were obtained not only by representing data specific to seismology (such as earthquake epicenters), but also by analyzing and modelling data. By doing so, we aim to highlight that GIS is not only for cartographic purposes, but also for data processing, spatial and geostatistical analysis and automation of tasks.

2. ENHANCING SEISMIC HAZARD ANALYSIS THROUGH THE USE OF GIS

2.1. Processing earthquake catalogues

Earthquakes do not respect national boundaries; that is why national earthquake catalogues might not be completely useful when assessing seismic hazard in near-border regions. But also, as our experiences showed, national catalogues are more precise for the area they focus on (when also trying to consider earthquake with small or moderate magnitudes). A compilation between multiple sources is the best solution for a more reliable seismic hazard assessment. GIS has the right tools to allow the identification of earthquakes with impact on a specific area and the compilation of multiple catalogues. We used these tools when creating the Bigsees Earthquake Catalog – by combining the ROMPLUS Catalog (NIEP, 2016) with the SHEEC Catalog (Grunthal *et al.* 2013) and more recent EMSC-CSEM data. Among the choices we made were the following:

- for Romania, we chose mostly earthquakes from the ROMPLUS Catalog (noticing that the other sources of data provide in some cases events located completely wrong or with unreliable magnitude and depth);
- for near-border regions, we compared the locations provided by different data sources and made an expert based selection (removing duplicates);
- for more distant areas (seismic sources in Serbia, Dulovo and Shabla, that were considered to have capability of influencing the seismic hazard within Romanian borders) we used the SHEEC Catalog.

Without GIS it would have been considerably difficult to identify duplicate or misplaced earthquakes, and to see how far to go beyond national borders, in the effort of assessing overall national seismic hazard. The aforementioned Bigsees Earthquake Catalog was also easily integrated in a webGIS app (Figure 1) which allows visualization, filtering and download capabilities, disseminating this product in a way of impact for the general public, stakeholders and the scientific

community. The past webGIS problems related to the speed of plotting multiple points in the same time on a map (more than 6600 events in the case of the Bigsees Earthquake Catalog) are now overpassed, since dynamic point clustering or pre-filtering techniques are available).

Earthquake catalogs are essential in seismic hazard analysis (whether probabilistic or deterministic). One of the initial steps in preprocessing catalogs is to decluster them, meaning the removal of foreshocks, aftershocks or swarms. There are several more or less empirical ways to do this (methods such as Gardner and Knopoff 1974 or Musson 1999), based on time and distance windows. GIS works with these dimensions, allowing automatic implementation of declustering algorithms and the development of new ones, which consider additional aspects such as fault plane solutions and spatially (and 3D) distributed patterns of the analyzed earthquakes.

In the effort of determining maximum magnitude, overlaying geological, tectonic, faults, focal mechanisms, crustal models and earthquake catalogues on a map can provide the basis for an insightful assumption. The same map setup can be used for determining the spatial extent of the seismogenic areas.

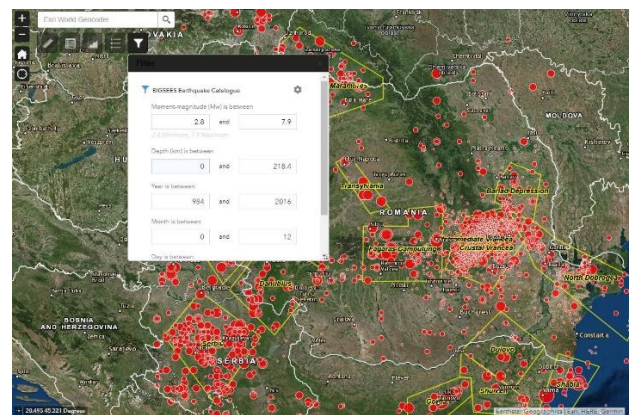


Figure 1 WebGIS app presenting the Bigsees Earthquake Catalog and the seismic sources defined through the use of GIS; (Source: bigsees.infp.ro/Results.html)

2.2. Ground motion distribution analysis

Seismic hazard analysis provides, ultimately, ground motion estimates for different plausible earthquake scenarios or return periods. These can have various distributions, depending significantly

on the choice of ground motion prediction equation (GMPE) and its properties and variables, and can be more or less compatible as trend with actual recordings. By bringing all data into GIS, a visual or geostatistical analysis can be performed, in order to check values, their distribution and effects of soil type consideration, their intra and inter-event variability, modifications from a GMPE to another or fit with real data.

The Vrancea intermediate-depth seismic source in Romania is known to produce large earthquakes (statistically, two or three earthquakes with moment-magnitude $M_w > 7$ occur per century), which can cause high intensities over a wide area, producing significant damage. It is also known that the extracarpathic area is more prone to high acceleration and intensity values than the intracarpathic (Transylvanian) Basin, due to specific earthquake mechanisms and geologic conditions (Marmureanu *et al.* 2016). Although GMPEs were developed specifically for this source, the uncertainty of the output is still significant; the number of real records from high magnitude earthquakes, which contributed to the GMPE determination, was small and values showed great variability. By using GIS we are able to analyze the results of GMPEs (also implement their equations), and make best fit selections, as shown in Figure 2.

In Toma-Danila and Cioflan (2017b) we used GIS capabilities to generate ShakeMaps (depicting peak ground accelerations right after an earthquake, based on real recordings and GMPEs) through a new approach: by choosing automatically the GMPE with the best fit for a certain azimuthal interval (45 degrees wide). The results are shown in Figure 2. GIS is also fundamental when trying to determine local soil effects or V_{s30} values – through methods such as topographic slope (Allen and Wald, 2007). Interpolation methods also are a part of GIS, and their selection is highly important, depending on the type of seismic data used; for acceleration values, probably the best is to use natural neighbor or inverse distance weight, in order not to alter the real-recorded values. Kriging is better to be used with macroseismic intensity values, which are much more subjective and need a better smoothing.

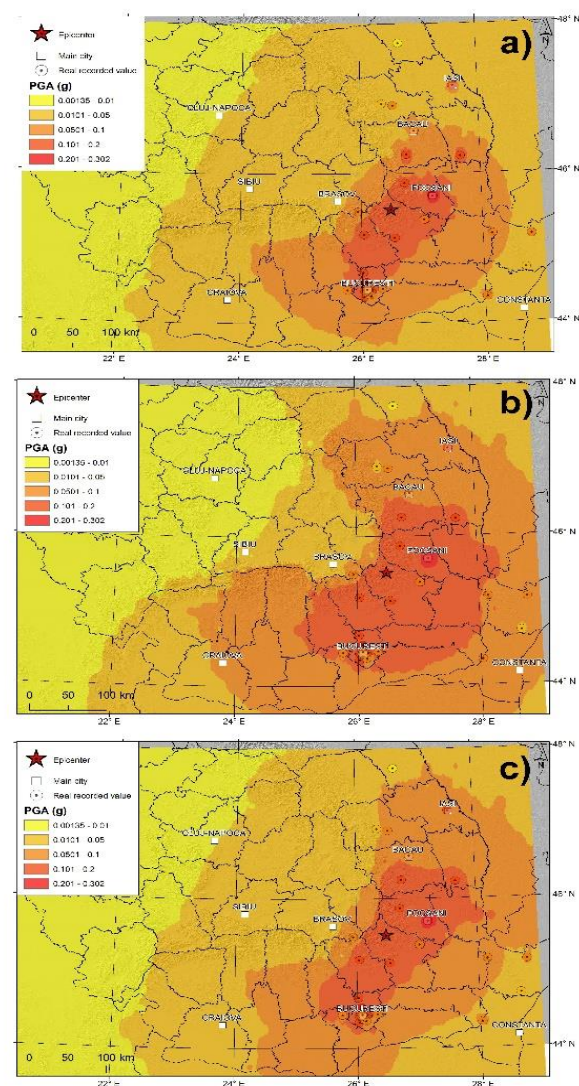


Figure 2 ShakeMap style representations of Peak Ground Acceleration (PGA) for a scenario of the 30 August 1986 earthquake ($M_w 7.1$), obtained automatically in GIS based on real-data from 30 stations and on two different GMPEs: Vacareanu GMPE (a) and Sokolov GMPE (b), combined based on azimuthal interval fit (c) using the methodology described in Toma-Danila and Cioflan (2017b)

3. USING GIS FOR SEISMIC RISK ANALYSIS

3.1. The contribution of GIS within risk evaluations at national level

SeisDaRo (The near real-time system for estimating the seismic damage in Romania) is an automated system installed at NIEP, which estimates minutes after an earthquake the possible damage, in terms of residential buildings affected (at city/commune level) and number of victims. At its core is the SELINA software (Molina *et al.* 2010), which is a Matlab routine that produces

tabular results, but not maps. We employed GIS both in preparing the input (geocoding of statistical census tracts with info regarding residential buildings and inhabitants, determination of soil type) and in processing the output, in a way that is useful for representation and dissemination. In Figure 3 we present some of the latest SeisDaRo cartographic products. These types of maps are

particularly useful and much appreciated by emergency management experts, although the uncertainties in the estimates need to be clearly stated, through the use of disclaimers. SeisDaRo also provides downloadable GIS data, which is further used in webGIS products that are easy to interrogate, filter and share.

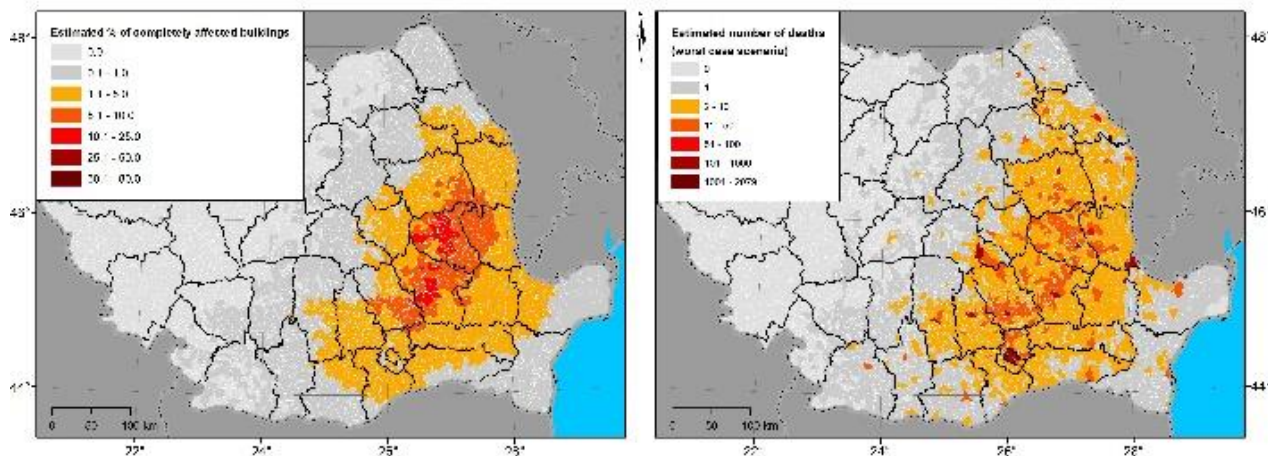


Figure 3 SeisDaRo maps depicting easy to understand seismic loss estimations, as percentage of completely affected buildings (left) and number of deaths in a worst-case scenario (right), for a Vrancea earthquake scenario with $M_w = 7.5$

Within the Ro-Risk Project, NIEP was in charge of assessing the potential loss on road networks, due to earthquakes in Romania. One of the basic inputs for this task is the road network definition, not only by shape, but also by properties such as road type, width, construction material, technical state, traffic values, etc. Unfortunately, in Romania most of this info is unavailable at administrative level (not to mention that an imposed GIS format for data is non-existent). As backup solution, we used OpenStreetMap (OSM) data, which was collected in a vector format from a well-known data repository (<http://download.geofabrik.de/>). It turned out that the data for important or even smaller county roads is highly accurate. By using the properties of this data together with other layers (landslide susceptibility, peak ground acceleration values or analysis of road damage index based on the work of Anbazhagan *et al.*, 2012) and a Multi Criteria Decision Analysis (MCDA), we obtained a preliminary risk map for road networks (Figure 4). The next step for this map is to integrate it in a GIS network analysis, reflecting also problems such as

the impact of loss of connectivity or traffic patterns in a post-earthquake situation.

3.2. Urban vulnerability and risk studies

Urban vulnerability and risk analysis is a great challenge; the intricate relations in this complex environment are difficult to explain and model. There are many aspects to be considered, and overlaying is fundamental.

Recently, we were able to acquire data from the 2011 national census for population and buildings, at census tract level, for Bucharest. We applied the SeisDaRo methodology to these data, also considering seismic microzonation maps (Cioflan *et al.*, 2004; Marmureanu *et al.*, 2010) reflecting differences in amplifications throughout the city (GIS was used to extract PGA in each census tract). Further on, by using overlay analysis with satellite imagery, removing areas like parks, water bodies, industrial areas, streets etc. from contiguous census tracts and isolating areas where only reinforced concrete flats are present, the urban seismic loss estimate map for Bucharest was enhanced (Figure 5).

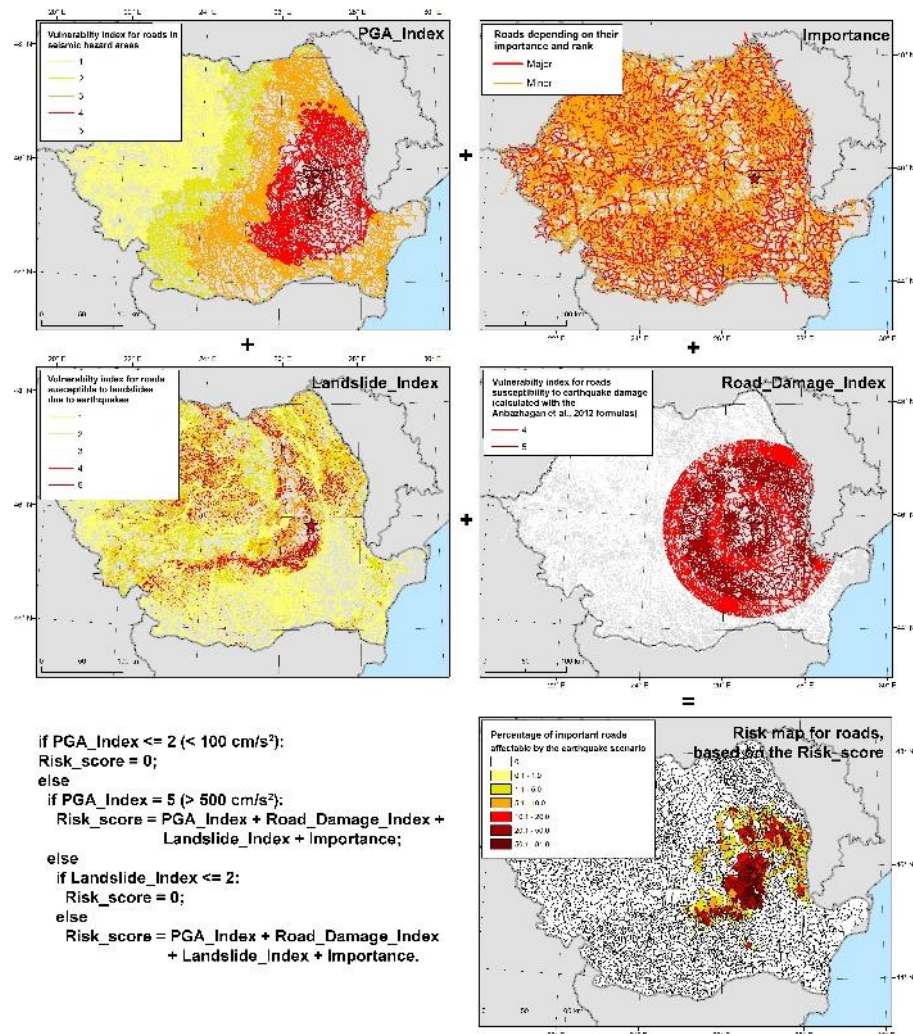


Figure 4 Maps depicting the datasets used within the Ro-Risk Project to determine the potential seismic damage of road networks; the formula shows the algorithm used to compute the risk score.

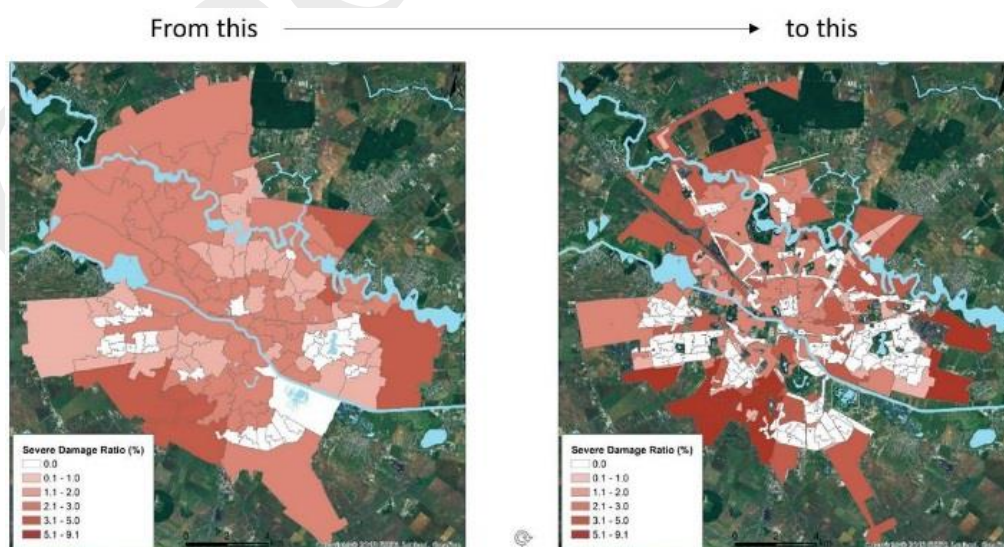


Figure 5 Maps presenting the Severe Damage Ratio in Bucharest due to an earthquake scenario similar to the 4 March 1977 event (Mw=7.4), in a SeisDaRo approach relying on statistical data (left) and after a GIS enhanced analysis (right) (source: Toma-Danila and Armas, 2017a)

Figure 6 reflects the results of another seismic urban risk analysis, addressed to determining which are the service areas and times of intervention for emergency hospitals (ambulances) and fire-fighters in Bucharest, considering a potentially damaged road network due to the collapse of high risk buildings and traffic congestion. ArcGIS and its network analysis module was the main framework used for computation, which could also be performed in real-time, contributing to a more efficient resources allocation in case of a disaster.

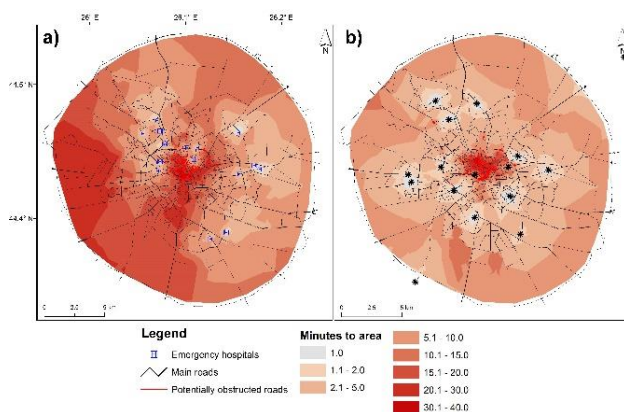


Figure 6 Maps with service areas (merged), for all emergency hospitals (a) and firefighter units (b) in Bucharest, considering a worst-case road network scenario (all potentially obstructed roads affected) and 8:00 AM Monday typical traffic (source: Toma-Danila, 2017c).

4. CONCLUSION

GIS is nowadays also a fundamental tool in seismology. It can be used in a wide array of applications, from processing and analyzing earthquake catalogs to seismic hazard and risk analyses or modeling tectonic processes. As shown in this paper, by combining different attenuation models with peak ground records, GIS is capable to generate ShakeMaps to be used as input for seismic damage and loss analyses, in real-time also.

In seismic risk (at national or urban level), GIS can lead to a refined evaluation of potential losses and a more insightful consideration of aspects within the spatial dimension. GIS has to be used not only for its cartographic value, but also for its capability to link layers together, process and model

them. The maps shown in this paper are the result of advanced use of GIS in seismology, and we believe that they also reflect best practices in mapping earthquake-related features. As initiatives such as HAZUS or OpenQuake show, the link between GIS and seismology is clear, and future common developments are certain.

ACKNOWLEDGEMENTS

We acknowledge the contribution of the BIGSEES Project (Grant Number 72/2012) and NUCLEU Program (Project No. PN-16-35-02-03), financed by the Romanian Ministry of National Education through UEFISCDI, and the contribution of Ro-Risk Project (The evaluation of disaster risks at national level; SIPOCA 30).

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Urban flood risk analysis

Case study: Bacău City

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Abstract. The subject of the present study is an analysis of urban flood risk for the city of Bacău in case of an extreme event situation, namely the failure of Izvorul Muntelui dam. Multi-criteria spatial methods have been applied in qualitative risk analysis to obtain a map of physical vulnerability by interpreting the data regarding the characteristics of each building within the areas prone to flooding. The social vulnerability was determined by using the same research method with a certain degree of uncertainty due to insufficient data available. The final result, the flood vulnerability map, obtained by interpolating the two variables – social vulnerability and physical vulnerability – can be used to support a more effective risk management.

Keywords: multi-criteria analysis, flood risk, vulnerability, hazard, dam

1. INTRODUCTION

Identifying the area prone to flooding, supervising and managing the water levels are the prime responsibilities of city authorities in order to maintain the population and their environment savings safe. One of the main steps in this process is measuring vulnerability to *identify vulnerable areas and adopting effective measures* (Takemoto, 2011).

The risk is defined in the literature as "the product of the probability of occurrence of a phenomenon and the harmful consequences it may have" (I. Stângă, 2007). In other words, we can say that the risk is the probability of exposing the environment and human society to the action of a hazard with a certain magnitude, which is predictable to some extent.

Hazard can be defined as a natural occurring or human-induced process or event, mostly unpredictable, releasing huge energies and causing great instability in a system, including threats to the environment, not just human settlements. The causes of hazards' occurrence and manifestation are

known, only the time and place of their appearance being random (Mac, 2003).

The magnitude of the hazards is given by its effects on the structure and functionality of a system, namely the resistance to change of the related system.

Hazard and risk are tightly connected. Hazard is a natural or anthropic process, characterized by its potential to produce damages, in other words, the general source of a future danger. Risk represents the human society or its valuable goods or the environment exposure to a hazard and is calculated as the product between probability and damage (Smith, Petley, 2009).

The evolution of a phenomenon has three stages: the hazard stage, where there is only the hazard, the occurrence of the risk where hazard can affect human society and finally disaster (Alexander, 1993).

Vulnerability is defined by the International Decade for Natural Disaster Reduction (IDNDR) as the degree of loss (from 0% to 100%) resulting from a potential damaging phenomenon.

When an extreme natural event is combined with human error, the results are certainly catastrophic, with many victims, a great deal of material damage and ecological unbalance. The following article describes the possible economic, ecologic and social effects caused by a flood for the city of Bacău in case of Izvorul Muntelui dam failure scenario.

2. METHOD

The vulnerability assessment includes the building's physical conditions and the settlement's social (demographic) indicators. The social vulnerability was determined by collecting and processing the data for each km² of the city by using ILWIS software (source: geo-spatial.org). In order to establish the physical vulnerability a structural specialist was consulted. The data was gathered through field campaigns for each building situated in the area prone to flooding.

Regarding the delimitation of the area prone to flooding, in this study we used the water mask determined by PhD. Eng. Gogoase Nistoran, by using numerical simulating models (Gogoase Nistoran *et al.*, 2016). In order to calculate the mask, in addition to the digital elevation model, the values of the flows and other natural parameters (the distance between the banks, the mean slope of the stream channel, the mean slope of the thalweg and lakes present on the stream course), construction data were also used.

In order to obtain all the parameters used in the computerized modelling of the region it was necessary to trace 179 transversal profiles, perpendicular to the banks and thalweg, downstream of Izvorul Muntelui, plus another 25 such profiles in the lake for a distance of 27, 31 km, from the dam to Poiana Teiului viaduct, upstream.

STRAT	ATRIBUT	DEFINITION
Population	TOT_P	Number of human inhabitants per km ²
	TOT_F	Number of female inhabitants per km ²
	TOT_M	Number of male inhabitants per km ²
	F_00_14	Number of female inhabitants, between 0-14 years, per km ²
	F_15_64	Number of female inhabitants, between 15-64 years, per km ²
	F_65	Number of female inhabitants, over 65 years, per km ²
	M_00_14	Number of male inhabitants, between 0-14 years, per km ²
	M_15_64	Number of male inhabitants, between 15-64 years, per km ²
	M_65	Number of male inhabitants, over 65 years, per km ²
	TOT_00_14	Total number of population between 0-14 years, per km ²
	TOT_65	Total number of population over 65 years, per km ²

Table 1: Indicators used for the assessment of social vulnerability for Bacău city

STRAT	ATRIBUT	DEFINITION
Buildings	H	Height of the building (meters)
	Year_constr	Year of the construction
	Material	Building material
	Nr_levels	Number of floors
	Type	Type of the construction
	Industry	Type of industry (if the case)
	Vulnerability	Vulnerability grade, scored between 0 and1, established after consulting a structural specialist
	Cost_m2	Cost of reconstruction, euro/m ² , for each type of building, established after consulting a civil engineer
	Area	The floor area of each building, calculated using the ArcMap program

Table 2: Indicators used for the assessment of social vulnerability for Bacău city

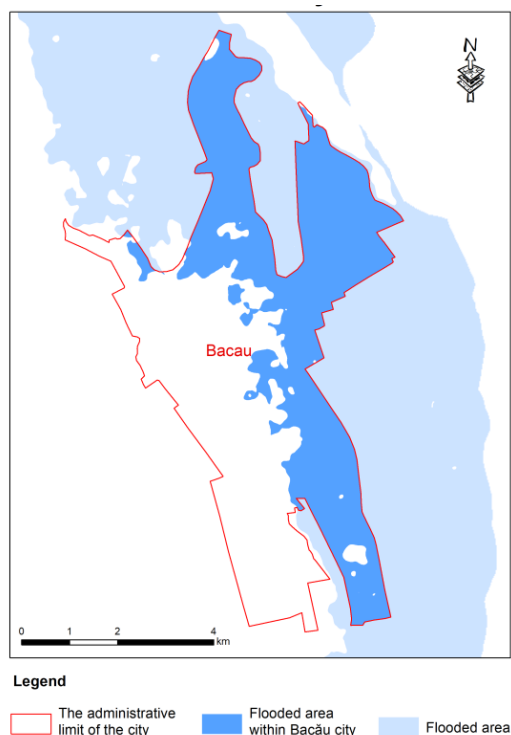


Figure 1: Flooded area within Bacău city

The risk is expressed according to the size of the hazard, the elements exposed to the risk (population, buildings, etc.) and their vulnerability (the level of damage that a particular phenomenon can cause). Mathematically, the risk is equal to the product of hazard (H), exposed to risk (E) and vulnerability (V) (Armaş, 2012).

$$R = H \cdot E \cdot V$$

The failure hypothesis for gravity dams, such as Izvorul Muntelui, involves the dismantling of 25-75% of the total number of plots within a time frame of 15-60 minutes. (*Risk Analysis and Coverage Plan in the Area of Competence of the Local Committee for Emergency Situations of Bacău Municipality, Annex no.1 to the Decision no.402 of 26.11.2008*).

For the present study we took into consideration the worst case scenario, 75% failure of Izvorul Muntelui dam, leading to serial fault of each of the downstream dams across Bistrița and Siret streams. Simulation results show that peak runoff rate at dam is 120.580 m³/sec, reaching the confluence with Danube, 260.7 km away, in 12 hours.

The wave would reach Bacău I in 2 hours and 6 minutes, in Bacău II in 2 hours and 22 minutes, and

in Bacău-Agrement in just 2 hours and 27 minutes. Regarding the height, the studies show that the wave can reach 60 meters high, reaching Bacău at a height about 8 meters.

LOCATION	WAVE HEIGHT (m)
<i>Izvorul Muntelui</i>	60
<i>Bacău I</i>	8.32
<i>Bacău II</i>	8.3
<i>Bacău-Agrement</i>	8.2

Table 3: The height of the wave released by the failure of Izvorul Muntelui dam

The SMCE model (Spatial Multi Criteria Evaluation) of Ilwis software has been used in order to assess both social and physical vulnerability. The process includes a number of sequential steps. The first step would be defining the main goal and structuring the benefit and cost factors into a criteria tree with branches or objectives. As the indicators may be in different formats (nominal, ordinal, and interval), the second step is the standardization of each factor, therefore the criteria is normalized between 0-1.

Normalization was performed using the Maximum method, with the formula:

$$\text{Benefit factor} = \text{value} / \text{maximum input value}$$

The maximum value will get the index 1, all the other values being determined accordingly. Exceptions are made by the total number of population per buildings for which the Goal method (linear function with a specified maximum and minimum) was chosen, with the minimum vulnerability starting from $x = 5$; residents with less than 5 people will not be considered vulnerable, thus being assigned the value 0.

$$\text{Benefit factor} = (\text{value} - \text{minimum goal value}) / (\text{maximum goal value} - \text{minimum goal value})$$

The third step is assigning weights for the factors in order to determine the performance of each pixel.

The weighting of indicators will be as follows: between “children” and the “elderly”, we will

assign a value of 0.4 to children and 0.6 to the elderly by using the Direct method.

The reason we made this choice is due to the fact that the elderly can suffer from certain conditions that can hinder the movement mobility, or they may even have to take care of the children.

For weighting between “density” and “age” groups, the Pairwise method was chosen, with the group “age” being moderately more important than the group “density”, thus obtaining the values of 0.75 for “age” and 0.25 for “density”.

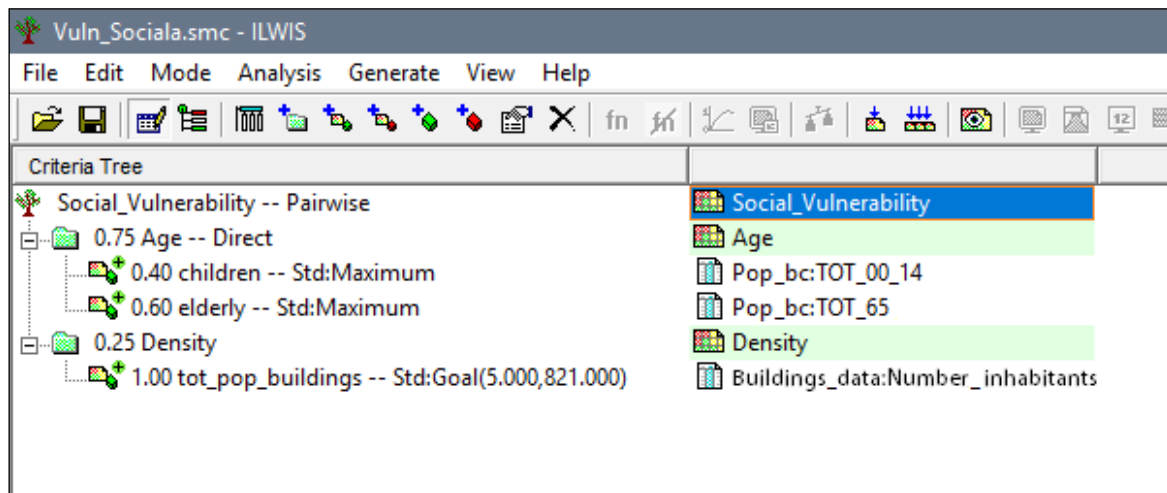


Figure 2: Multi-criteria Tree – Social Vulnerability

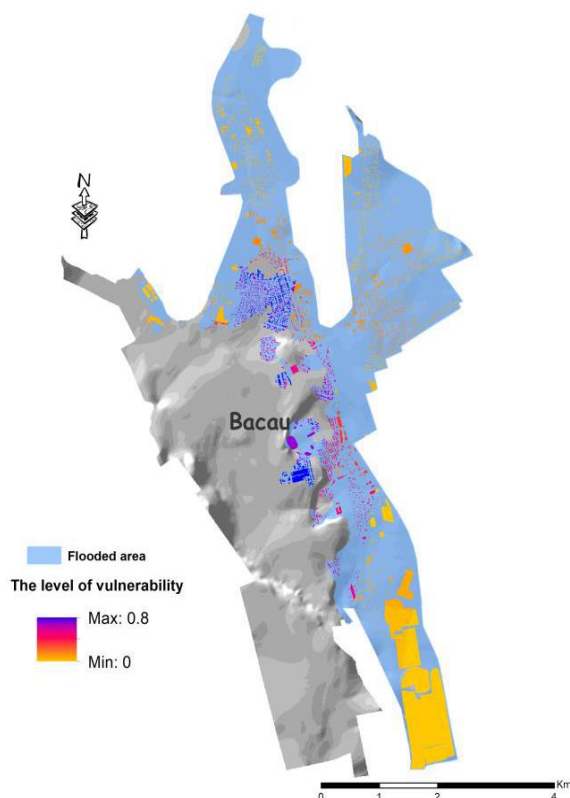


Figure 3: Map of Social Vulnerability to Floods

In addition to these direct effects on the population, the long-term psychological impact of

all the people who have taken part in the disaster must be taken into account. These psychological and social aspects are more difficult to be measured.

We determined the degree of physical vulnerability of the buildings and their reconstruction costs by consulting a group of civil engineers. This required the collection of data on the height, material, number of floors, year of construction for each building in the area with risk, detailed in Table 2.

Quantitative analysis of the data shows that 3,870 houses, 425 blocks and countless other buildings would be affected by the waters released by the failure of the dam. Vulnerability was calculated for a 1 m depth of water flow, depending on the material, year of construction and number of floors.

The following were taken into account: 1998 as a representative year for wooden constructions, because it was then when the treated, layered, more resistant wood started to be used, and the year 1977 due to the impact this year's earthquake has had on existing legislation regarding concrete structures.

The parameter was rated between 0 and 1, with 1 being assigned to the buildings with the highest vulnerability.

Vulnerability	Material	Year	Number of floors
1	Adobe	-	n
0.9	Adobe with wooden frame	-	n
0.8	Wood	Before and including 1998	>1
0.7	Wood	Before and including 1998	1
0.6	Wood	after 1998	n
0.5	Autoclaved aerated concrete (AAC)	-	n
0.4	Brick	-	n
0.3	Concrete	Before and including 1977	n
0.2	Sandwich panels	-	n
0.1	Brick	after 1977	n

Table 4: Physical Vulnerability

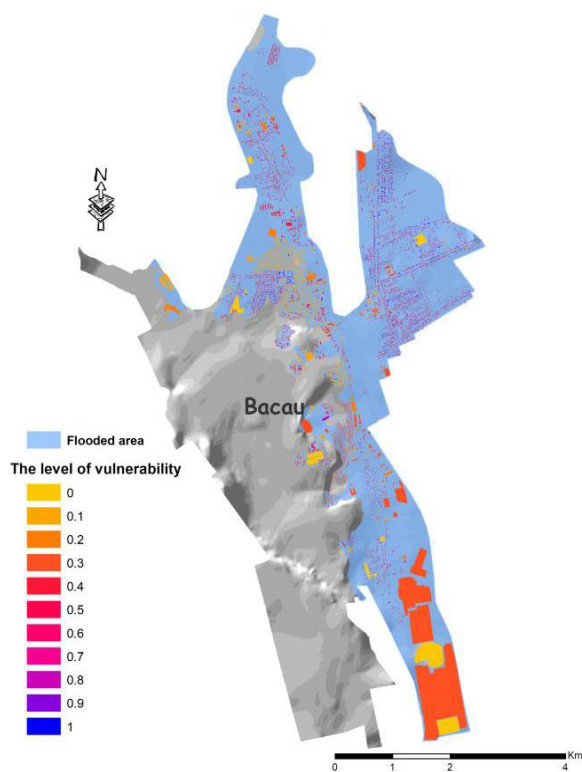


Figure 4: Map of Physical Vulnerability to Floods

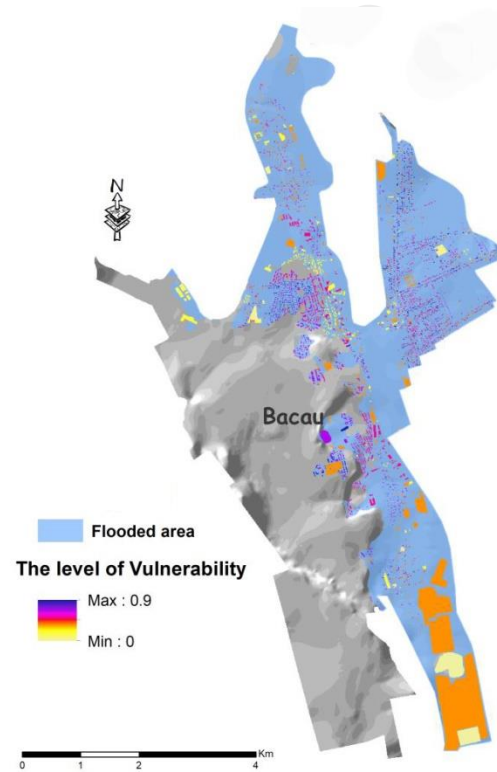


Figure 5: Urban flood risk. Bacău city.

3. RESULTS

The final map, specifically the flood vulnerability map, resulted from interpolating the two variables previously calculated: social vulnerability and physical vulnerability. The assigned weights were: 10 for buildings and 5 for population, values subsequently standardized using ILWIS software, thus obtaining 0.667 and 0.333. The reason for choosing these values is that even the destruction or damage of the buildings would be a factor that would increase the number of victims among the urban population.

The **economic effects** are expressed through both direct and indirect damage caused by hazards.

Direct damage refers to the destruction that actually occurs during the flood manifestation and consists of loss of human lives, the number of destroyed or damaged buildings and damaged industrial and commercial objectives.

The surface affected by the flood, established using the “Area” function from the layer’s attribute table, reaches 18 716 668 m², which represents 53.7% of the city’s total surface.

The reconstruction costs of different types of buildings and communication routes have been established by consulting a specialist.

In calculating the total value of potential damage to buildings in Bacău city, we have multiplied the vulnerability value with the ground surface and with the cost in Euro for each individual construction, thus obtaining a reconstruction cost bigger than 496 000 000 Euro.

The cost for the communication routes was established per linear kilometre, according to their type.

To rebuild these routes, so important for the society, the cost would reach 135 200 000 Euro, according to civil engineers.

In total, the buildings and the transport routes would deprive the state of over 630 million Euros. It is however, a very general loss estimation, without taking into account small variations per unit cost, which would have massive impact on large scale.

Indirect economic damages are referring to the effects of the flood that can lead to a temporary or permanent disruption in the activity of companies, the production processes, and even export reduction. The most costly from this point of view would be the industries, which are well developed in this city. Here we can mention: chemical industry, energy industry, food industry, wood processing industry, metal working industry, hydro constructions, a concrete plant, ballast stations, an electrical substation which would leave an extensive territory in dark in case of failure.

The expenses for the normalization of the situation and the resumption of the economic activities must also be taken into consideration. However, this is not always possible. If we are talking about old, historic buildings and memorial houses, the situation is getting worse, because even if they were to be reconstructed, their cultural value would decrease and tourism in the area would be severely affected.

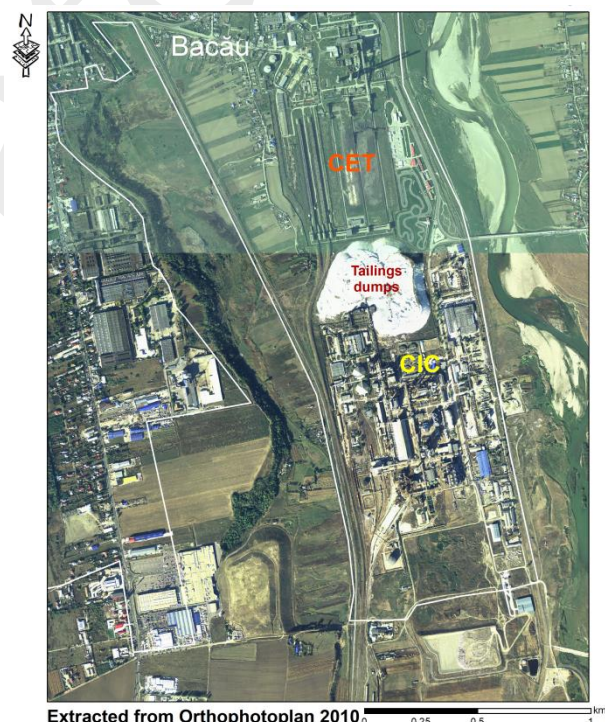
Negative environmental effects are highlighted by environmental degradation and damage to the quality of its factors. During floods, the surface water pollution is caused by all the waste carried into the riverbeds, by leaks from the oil pipelines damaged by the water etc. Simultaneously, there

would also be a pollution of groundwater and soil in flooded areas, if the water would carry harmful substances.

In case of Bacău city, the most dangerous materials transported by the flood water are the phosphogypsum tailings dumps from the chemical industry (CIC), covering an area of over 6 hectares and containing sulfuric acid, urea, ammonia, nitrates and nitrogen compounds, phosphates and other toxic substances, and having a radioactivity more than 6 times higher than the surrounding area.

As for the steel industry, the Bistrița river flood waters would disperse metallic carcinogenic powders, sulphur oxides, carbon oxides etc.

Energy industry, such as the district heating plant (CET), contributes to environmental pollution especially through sulphur and nitrogen oxides, which infiltrate the soil reaching the groundwater. As mentioned before, these substances are highly carcinogenic.



Extracted from Orthophotoplan 2010

Figure 5: The Industrial Area in southern Bacău City

The food industry (Agricola INT S.A.) could pollute waters with organic matter, nitrogen compounds etc., that can lead to epidemics.

To all these, we can also add the effects that consist of changes in the relief, especially regarding the land balance, shoreline erosion, erosion in the

riverbed, but also the changes in physicochemical qualities of the soil, changes in the local flora and fauna, both terrestrial and aquatic.

A disruption of previous ecosystems can occur, followed by a period of disorder, until the balance is restored.

Ecological effects are totally unquantifiable and require long periods of time to improve (if the improvement is even possible) (Grecu, 2009).

4. CONCLUSION

The analysis points out details regarding the impact of the flood on Bacău city, from an economical point of view, but also from an ecological and social perspective.

There are a series of measures in place, that can be taken in order to prevent such a dramatic event, namely: a meticulous supervision over the entire construction and the water levels by periodically inspecting the installations, conducting ongoing investigations into the forecast of flash floods, repairs whenever needed and, of course desilting of the lake in order to prevent the reduction of its volume.

The urban flood analysis in the event of damage of Izvorul Muntelui dam highlights the importance of risk studies in preparing for such situations through knowledge and optimal approach in practice of the particularities revealed above, taking into account the specifics of each variable.

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Multicriteria decision analysis applied in tourism

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Abstract. The decision analyses are useful tools used successfully in many fields – from Economics and Management to Urban Planning and Tourism. The aim of this analysis is to illustrate the usefulness and the potential of the decision analyses in tourism and even for business purposes. The paper presents a very brief introduction on the decision analyses with an emphasis on the multicriteria method applied in these. Further, applied on the study case, the phases of a decision analysis are being presented. The study case area is represented by a touristic area, which is not very well developed – Vrancea Depression – and it combines socio-economic aspects with touristic ones. At the end of the paper, some conclusions are drawn.

Keywords: multicriteria, decision analysis, spatial location, GIS, Vrancea Depression

1. INTRODUCTION

Decision analysis has emerged as a response to the needs of the managers and of the economists at the beginning of the 20th century. The decision analyses are being applied in all the domains where there are several stakeholders involved, the resources are limited, but the needs are almost unlimited. The fields in which these analyses are used are Economics, Management, Environment, Public Administration, and Urban Planning.

The majority of decision analyses, including the one presented in this paper, is based on the multicriteria method. This method has emerged due to the fact that the human brain could not keep up with the continuous increase of data, criteria and other factors that had to be taken into consideration during decision-making processes (Sharifi *et al.*, 2004). From simple, non-spatial decision problems (Cheung *et al.*, 2002, Işıklar and Büyüközkan, 2007), the decision analyses evolved towards more elaborate analysis, merging the multicriteria method with GIS capabilities. This merging created the premises for spatial decision analyses development (*e.g.* Chakhar and Martel, 2003, Eastman, 1999, Nas *et al.*, 2010). Today, their usage rage from

Urban Planning (*e.g.* Dai *et al.*, 2001, Gamboa and Munda, 2007, Sheppard and Meitner, 2005, Svoray and Bannet, 2005) to Economics (Pohekar and Ramachandran, 2004, Ho *et al.*, 2010), Ecology and Tourism (Dye and Shaw, 2007, Feick, 2000, Kapantow, 2004).

2. METHODOLOGY

Regarding the methodology, the spatial decision analysis based on multicriteria method starts by structuring the decision problem. This stage consists in setting the main objective and the secondary objectives and in establishing the factors needed to be taken into consideration in the analysis. Depending on the nature and the complexity of the decision-making problem, this stage can involve also establishing the stakeholders involved. Each stakeholder can have one criterion/factor or several criteria/factors regarding the decision problem. The criteria/factors in the analyses can be grouped by their subordination to one of the secondary objectives, obtaining a decision tree. In the next stage, all the criteria/factors are being standardized and then prioritized by their importance to the main objective. The final result is a suitability map (Fig. 1).

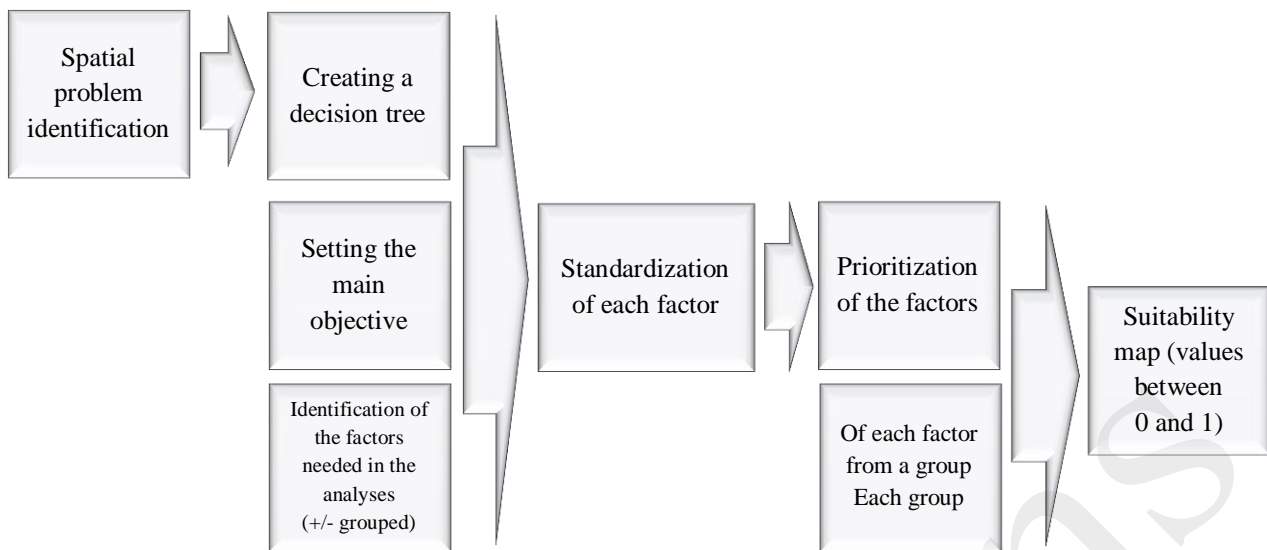


Figure 1 The flowchart for applying the multicriteria method in spatial decision-making problems (Gheorghe, 2014)

The software used in this analysis is ILWIS (*Integrated Land and Water Information System*), with its SMCE (*Spatial Multicriteria Evaluation*) module. This software was developed in 1984 by ITC, Netherlands. Its main purpose was to offer a tool for urban planning and for the management of water catchments studies. Starting with 2007, the software use is free of charge. The SMCE module is designed for applying the multicriteria method, including in spatial problems. The module can handle in the same time, spatial (maps) and non-spatial data (mainly numbers). The module integrates three types of analysis:

- **Problem analysis.** The result of this analysis is a suitability map (with values that range from 0 to 1).
- **Design of Alternatives.** This analysis is used in decision analyses for identifying the most suitable alternative(s)/feasible alternatives.
- **Decision Making.** This analysis is used in the final phase of the decision analyses, when the feasible alternatives resulted from the previous analysis are ranked. The result is either a map, if the decision problem is a spatial one, or some aggregated values, if the decision problem is a non-spatial one.

The main tool used in both multicriterial and decision analyses is the *decision tree* (Fig. 2). The starting point of the decision is the main objective, adding constraints and factors accordingly to the problem's nature. A constraint is a threshold, beyond or under which the criterion is no longer considered further in the analysis. The factors are

criteria with different values that influence directly the goal and the result of the analysis. The factors can be spatial and non-spatial, individual or grouped, depending on their nature.

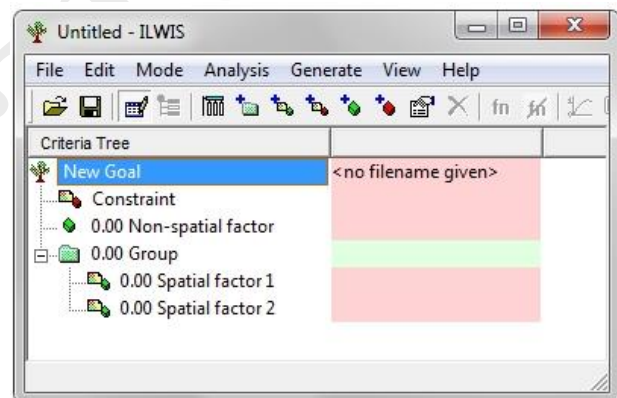


Figure 2 Decision tree structure from SMCE module of ILWIS software

After the problem structuring, using a decision tree. After the problem structuring, using a decision tree, all the factors have to be standardized. The software uses *value functions* that are established based on expert knowledge and human judgement. The value functions are in fact mathematical representations of the human judgement (Sharifi *et. al.*, 2004). The value obtained after the standardization range from 0 (the worst performance) to 1 (the best performance). Depending of the nature of the criteria, the value function can be a *cost* (the less, the better) or a *benefit* (the more, the better) and also can present linear functions, the majority of them, but also non-linear functions. The methods

used for standardization in this analysis are *maximum* and *interval*. The equations used for the standardization of the criteria are presented in Table 1.

Table 1 The equations used for the standardization of the criteria (ILWIS Help)

Type of factor (method)	Equation
<i>Benefit (maximum)</i>	Standardized value = value / maximum value of the input
<i>Cost (maximum)</i>	Standardized value = 1 – (value / maximum value of the input) + (value / minimum value of the input)
<i>Interval (better between a certain range of values)</i>	Standardized value = (value – minimum value of the input) / (value – maximum value of the input)

The next step in applying the multicriterial method is the prioritization, or the ranking of the criteria. The prioritization consists in proving weights to each criterion, depending of its importance in its group and/or for the analysis. This step is the most prone to error due to its high level of subjectiveness. In the SMCE module of ILWIS software, there are three methods implemented for the prioritization of the factors (Table 2).

Table 2 The methods used for the prioritization of the criteria

Method	Explanation
<i>Direct</i>	Based on direct assignment of weights for each criterion and/or group of criteria. The software normalizes the values by reporting the introduced weight to the sum of weights.
<i>Rank Ordering</i>	The user ranks the criteria and/or the groups of criteria from the most to the least important, accordingly to its own judgement.
<i>Pairwise comparison</i>	Based on the Saaty's analytic hierarchy process, it turns the qualitative preferences in quantitative values (from 1 – equally preferred, to 9 – absolute preference). For mitigating the probability for giving discrepant answers, the software offers the possibility of using a consistency factor (greater values of 0,1 means inconsistent answers).

The final step in the multicriterial analysis is the aggregation of all the criteria.

Regarding the decision analyses, there are numerous models provided by the literature, from simple ones (Dewey, 1914, Simon, 1960, Turban, 1995) to more complex ones (Mintzberg *et al.*, 1976), but they all have in common the fact that the phases of a decision analysis comprise of problem identification, designing alternatives and adopting a solution. The model used in the present paper is synthetized in the flowchart from Fig. 2.

In Tourism, the decision analyses are being used in planning certain touristic activities (Aminu *et al.*, 2014, Beedasy and Whyatt, 1999, Dye and Shaw, 2007), but also in touristic development (Abed *et al.*, 2011, Feick, 2000, Kapantow, 2004). All the factors have to be standardized. The software uses *value functions*, that are established based on expert knowledge and human judgement.

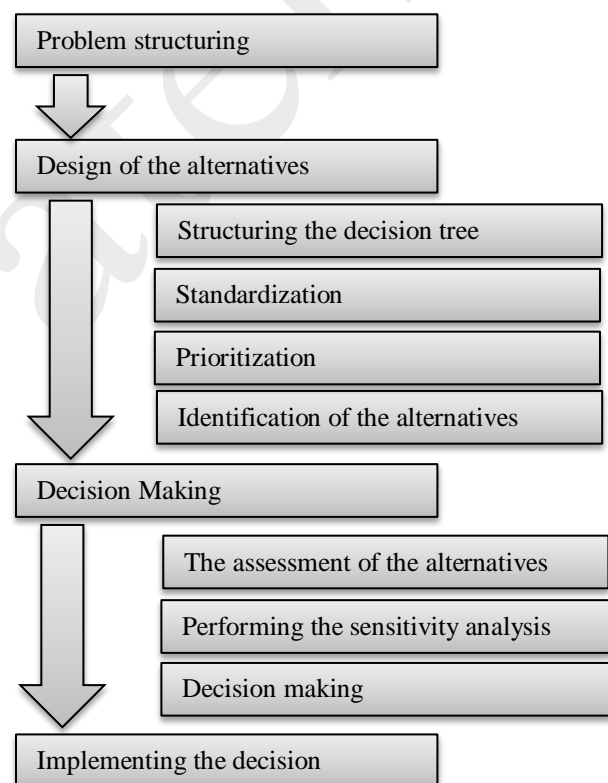


Figure 2 Stages of the applied decision analysis (Gheorghe and Armaș, 2015)

3. CASE STUDY

3.1. Study area

Vrancea Depression is situated in the eastern part of Romania, in the bending zone of the Subcarpathians,

between the Vrancea Mountains (W), Răchitașul, Răiuțul and Ghergheleu Hills (E), Șușița Valley (N) and Zăbala Valley (S). From the geomorphological point of view, Vrancea Depression comprises several hollows – Soveja, Nereju and Năruja (Grumăzescu and Ștefănescu, 1970; Posea and Badea, 1984). Regarding its administrative boundary, Vrancea Depression is overlaying several localities from Vrancea County: Soveja, Bârsești, Tulnici, Nistorești, Vrâncioaia, Valea Sării, Năruja, Paltin and Nereju (Fig. 3).

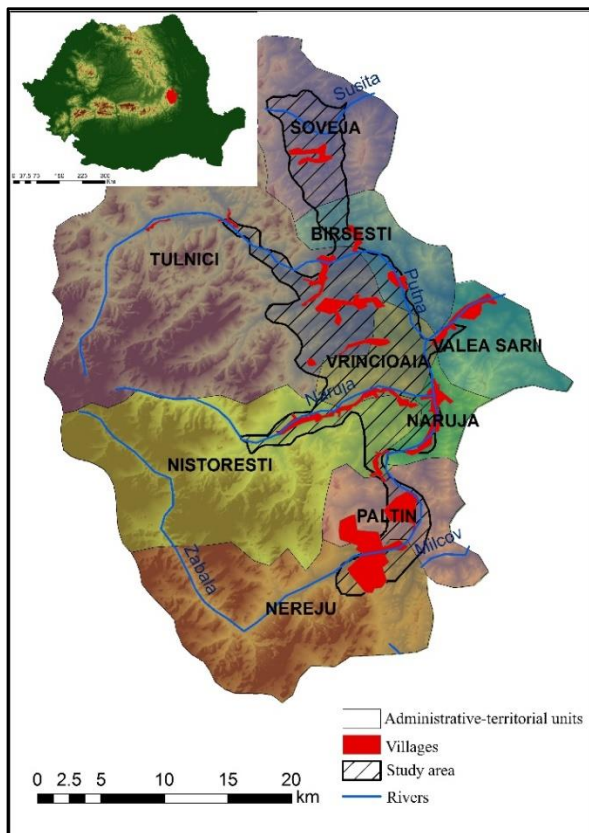


Figure 3 Vrancea Depression

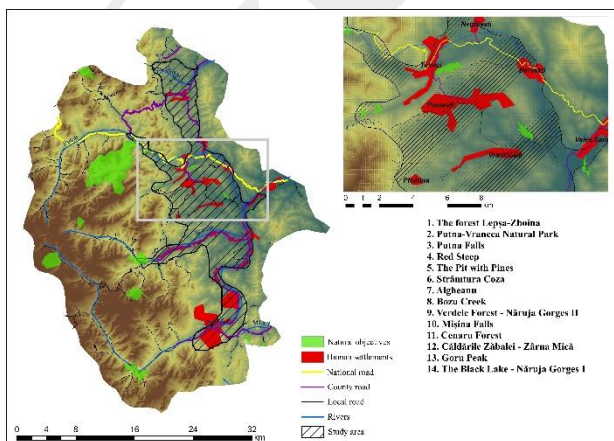


Figure 4 Natural touristic objectives

Although the study area does not have a significant number of natural touristic objectives (Fig. 4), which are situated higher up, in the mountains, it has a high touristic potential because of the anthropic touristic objectives (Fig. 5). Vrancea Depression is also overlapped over *Vrancea Country*, a well-known ethnological area for its traditional costumes, specific architecture, traditions and celebrations.

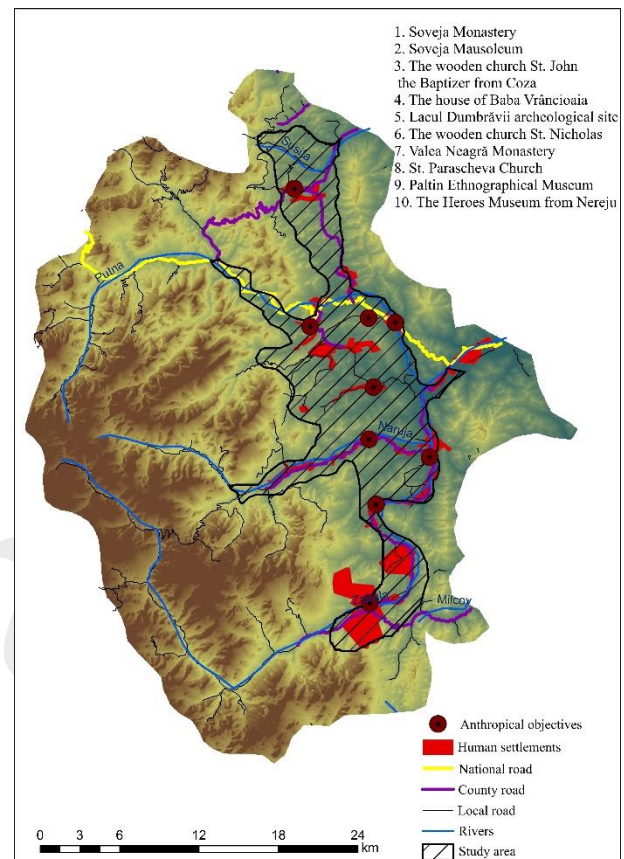


Figure 5 Anthropic touristic objectives

3.2. Problem Structuring

The decision problem identified is finding a suitable area in Vrancea Depression to build a new accommodation unit for tourists. The area lacks of touristic units, some hotels or bed and breakfast facilities are located in the north-eastern part of the studied area, but they service the localities of Soveja and Lepșa-Tulnici, situated at a higher altitude in the mountain area. In the studied area there are no touristic units, according to some touristic information and booking sites – www.infoturist.ro, www.carta.ro, www.booking.com. Also, they were not found during field trips.

3.3. Design of the alternatives

The first step towards designing the alternatives was to identify the needed criteria and to structure a decision tree. The criteria used in this stage is presented below, in Table 3.

Besides the distance to the main touristic objectives, that are essential to the success of a bed and breakfast or touristic facility, were also taken into consideration the accessibility (distance to the main roads) and the distance to a locality, that can provide different services (shopping, restaurants, transport etc.). The factors used as a criterion in the analysis were then standardized as shows in Table 4.

The selected method for prioritization was Rank Ordering – Rank Sum, in which the criteria were ranked from the most important one to the least important for the main goal of the analysis – finding

a suitable area for building a new accommodation unit. The most important factor was considered to be the distance to the main roads, for the accessibility of the new facility. The next factors considered to be less important were the distance to the natural touristic objectives and the distance to the Nature Reserve Areas. Both of them were considered equally important to the analysis. The distance to the anthropic touristic objectives was considered to be less important to the previous ones, because tourists generally prefer nature (falls, gorges, valleys, forests, etc.) over manmade items (churches and monasteries, sculptures, mausoleums, etc.). The least important criterion was considered the distance to the localities. After establishing this hierarchy, the weights for each criterion were as presented in the table below.

Table 3 Criteria used in the designing the alternatives

No.	Raster map	Description
1	dist_ob_nat	Distance to the natural touristic objectives (excluding the Nature Reserve Areas)
2	dist_ob_antropice	Distance to the anthropic touristic objectives
3	dist_ob_DN_DJ	Distance to the main roads (national and county roads)
4	dist_uat_puncte	Distance to the localities (centre of the settlements)
5	dist_rez_nat	Distance to the Nature Reserve Areas

Table 4 The standardization methods used in designing the alternatives

No.	Criterion/Factor	Standardization type and method	Rationality
1	Distance to the natural touristic objectives	Cost - Maximum	As the distance increases, the area is less likely to be suitable.
2	Distance to the anthropic touristic objectives	Cost - Maximum	As the distance increases, the area is less likely to be suitable.
3	Distance to the main roads	Cost - Maximum	As the distance increases, the area is less likely to be suitable.
4	Distance to the localities	Cost - Interval	For this criterion, it was considered that a distance between 1,5 and 7,5 km is the most suitable. A shorter distance could disturb the tourists that want to rest and to enjoy the nature and a longer distance could influence negatively the accessibility of the boarding house.
5	Distance to the Nature Reserve Areas	Cost - Maximum	As the distance increases, the area is less likely to be suitable.

Table 5 The weights obtained after the prioritization

No.	Criterion/Factor	Weight
1	Distance to the natural touristic objectives	0.233
2	Distance to the anthropic touristic objectives	0.133
3	Distance to the main roads	0.333
4	Distance to the localities	0.067
5	Distance to the Nature Reserve Areas	0.223

Through the aggregation of all the factor maps, considering the standardization and prioritization applied, it resulted the suitability map (Fig. 6). With green are represented the areas (pixels) most suitable for the main goal of the analysis (1) and with red are represented the areas (pixels) least suitable for building a new touristic facility. As shown in Fig. 6, the most suitable areas are located

in the north-central part, in Soveja locality and in the central part of the area, in the administrative boundary of Vrâncioaia. Smaller areas, with high values can also be observed on the valleys of Năruja and Zăbala, in the eastern part of the studied area. For the next phase in the analysis, the Decision Making, 5 alternatives were selected, based on the obtained suitability values (Fig. 6).

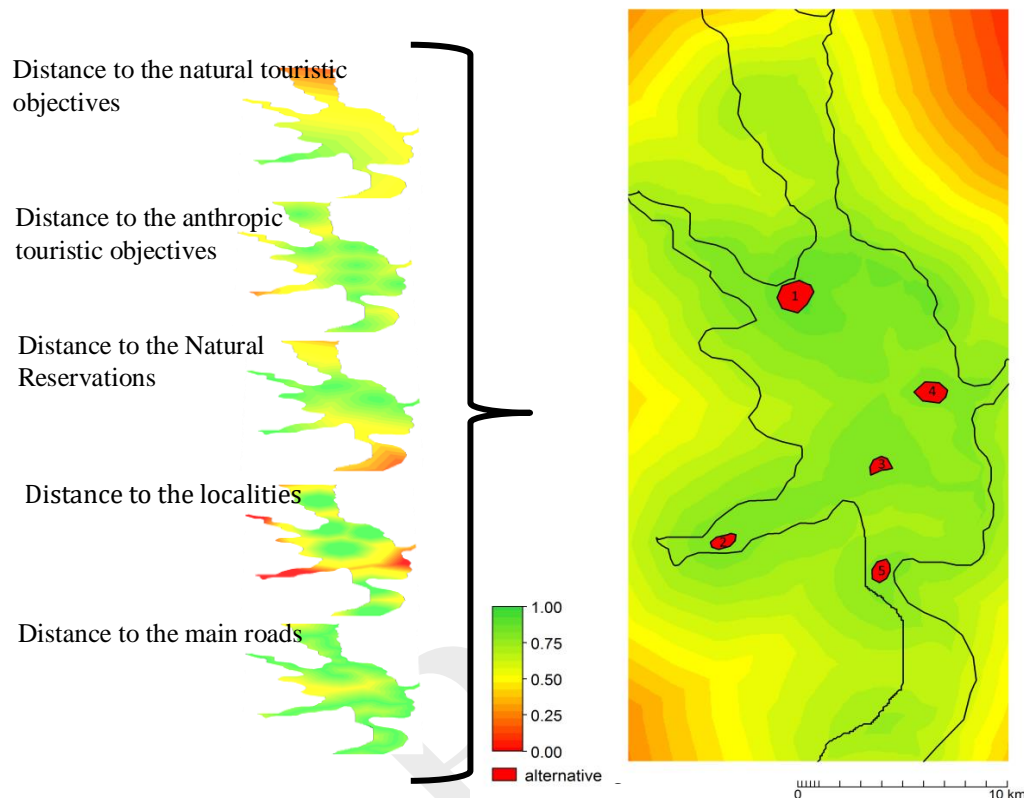


Figure 6 The suitability map and the selected alternatives for the decision-making phase

3.4. Decision Making

In this stage of the decision analysis, the feasible alternatives, selected in the previous step, were assessed. Thus, a new decision tree has been created, setting the analysis to *Decision Making*. In the new decision tree, five columns, corresponding to each one of the alternatives were introduced. Regarding the criteria needed for the assessment, it was established that for this analysis, and taking into consideration the lack of data on the studied area, the following four non-spatial criteria/factors will be used:

- (i) The number of the unemployed, reported to the total number of the population;
- (ii) The number of employees, reported to the total number of the population;

(iii) The average price of the land, in euros per square meter;

(iv) The average suitability.

The rationale behind the selection of these criteria was that a new touristic facility or hotel or bed and breakfast could also have a social and economic impact on the area. So, to minimize the cost with the human resources, the facility could be built in an area with a higher unemployment rate. And since the unemployment rate was not available, it was substituted by the number of employees, reported to the total number of the population. Also, because the number of active population was not available, it was substituted by the number of employees, reported to the total number of the population. The reference to the total population of

the localities from the studied area was considered necessary in order to normalize the data. The absolute values of both data, number of employees and unemployed, could have been irrelevant for comparing the situation in two or more localities.

The data were selected from the official statistics made available by the National Institute of Statistics (Table 6). The indicators were calculated for the entire administrative-territorial unit. Even though, the studied area does not include the whole territory

of the localities that overlaps, the main human settlements, from which the census data are collected, are located in the studied area. Also, the data were considered only for the localities in which the selected alternatives would be situated.

Even though there are five selected alternatives, they overlap on only three administrative-territorial units – alternatives 3 and 4 would be in Vrâncioaia and alternatives 2 and 5 would be located in Nistorești.

Table 6 The social indicators used in the analysis (INS)

No.	Locality	No. of unemployed	No. of employees	Total population	Unemployed/total population	Employees/total population
1	Tulnici	40	304	4158	0.01	0.073
2	Vrâncioaia	23	83	2857	0.008	0.029
3	Nistorești	29	57	2318	0.013	0.025

The price of the land was considered a necessary criterion from economic reasons, assuming that the land on which the facility will be build has to be bought. Because there is not an official site where the prices can be registered, a market research, over the internet, to see the requested prices for land for each of the localities from the studied area was carried out. The terrains situated outside the built-up areas were excluded because this fact could lead to a higher building cost or even to a rejection to build by the local authorities and the terrains that were not accessible from a main road were also excluded. The sites researched were: www.vanzari-terenuri.ro/

www.imobiliare.ro/; www.olx.ro/imobiliare/terenuri; www.multecase.ro; www.terenuri.net. The obtained average price per square meter was 4 euros in Tulnici, 2.5 euros in Vrâncioaia and 1.5 euros in Nistorești.

The last considered criterion, the mean suitability, was selected because it comprises all the assessments made in the previous step.

As in the design of the alternatives phase, all the criteria were standardized. The method selected for standardization was *maximum* for all the criteria. Depending on their signification for the decision-making problem, they were considered *benefits* or *costs* (Table 7).

Table 7 The standardization methods used in decision making phase

No.	Criterion/Factor	Standardization type and method	Rationality
1	The number of the unemployed, reported to the total number of the population	Benefit - Maximum	The higher the value, the more suitable the alternative is.
2	The number of employees, reported to the total number of the population	Cost - Maximum	The lower the value, the more suitable the alternative is.
3	The average price of the land	Cost - Maximum	The lower the price, the more suitable the alternative is.
4	The average suitability	Benefit - Maximum	The higher the average suitability, the more suitable the alternative is.

For prioritization, the method selected was also the Ranking Method – Rank Sum, as in the design of the alternative phase. Thus, the most important factors were considered the average price of the land and the average suitability, followed by the number of employees, reported to the total number

of the population and the number of the unemployed, reported to the total number of the population (the two, equally important). The weights obtained after the prioritization are noted in the table below.

Table 8 The weights obtained after the prioritization

No.	Criterion/Factor	Weight
1	The number of the unemployed, reported to the total number of the population	0.350
2	The number of employees, reported to the total number of the population	0.150
3	The average price of the land	0.150
4	The average suitability	0.350

After the aggregation of the factors, for each alternative a value was obtained and not a map, because in this part of the analysis all data used were non-spatial (numbers). The aggregated values obtained are: 0.6480 for alternative 1; 0.9102 for alternative 2; 0.8926 for alternative 3; 0.8727 for alternative 4 and 0.8983 for alternative 5. So, the ranking based on these values is: alternative 2, alternative 5, alternative 3, alternative 4 and alternative 1. Excepting the alternative 1, all the other aggregated values are very close, showing that is not a significant difference between them.

Also, alternatives 2-5 are very homogenous regarding all the criteria. They have similar values for the number of employees and unemployed reported to the total population and for the average suitability. Alternative 1 is situated in Tulnici, which is a more touristic locality, with several landmarks located higher up in the mountainous area, outside of the studied area. For this reason, the average price of the land is higher (4 euros/sqm) compared with the others (1.5 and 2.5 euros/sqm) and the number of employed people is also higher, making it the least suitable alternative under the objectives of this decision-making problem.

This fact can be related to the fact that the data used was not very appropriate nor sufficient.

3.5. Sensitivity analysis

The sensitivity analysis tests the robustness of a decision analysis (Sharifi, 2004). The major issues of a decision analysis are connected with comprising all the important criteria and data for the analysis, without missing any key-criterion and whether or not the standardization and prioritization were well rationalized and the method was accurately selected. Because the first issue is hard to verify, only with expert knowledge can be avoided,

a higher focus was concentrated on the second issue. The tool found for this problem is the sensitivity analysis, which can be performed using different methods and even different software.

A simple method that can be performed in the SMCE module of ILWIS software, is to change the standardization used in the analysis, the prioritization or even both of them. The change can be applied in the design of alternative phase or in the decision-making phase, or both. If the results change significantly after the sensitivity analysis, it means that the analysis is not robust, so it must be re-performed and re-thought. If the change does not differ significantly, it means that the analysis is robust, so the alternative with the highest aggregated value can be selected as a solution for the decision-making problem.

For the present analysis, because of their nature, the criteria were considered correctly standardized, so all the changes were applied to the prioritization (Table 9). Also, the sensitivity analysis was performed only in the decision-making phase for the same reason.

The results of the sensitivity analysis do not differ significantly from the initial analysis. For the first change in ranking, the results are identical with the original ones, only with lower values. For the second and the third change in ranking, in which the most important criteria were considered the social ones, the results showed a different ranking of the aggregated values for each alternative, alternative 3 having the highest value.

In practice, no economic agent would consider a social factor (e.g. the employment of some social categories) over the financial one (e.g. the cost of buying a certain terrain or the potential income obtained by locating the business in a suitable area). The only exceptions could be if the investment is made using sponsorships given with a certain social

condition or if the money invested are obtained from the public budget or maybe European funds and are subject to certain conditions (e.g. the employment of some social categories).

As a conclusion of the whole analysis, alternative 2 is the most suitable to be selected as a solution to building a new accommodation unit.

Table 9 Different rankings of the sensitivity analysis and the aggregated values for the selected alternatives

Criterion/Factor	Ranking	Weight			
<i>The average suitability</i>	1	0.150	corresponding aggregated values	Alternative 1	0.6793
<i>The average price of the land</i>	2	0.300		Alternative 2	0.9068
<i>The number of employees, reported to the total number of the population</i>	3	0.150		Alternative 3	0.9023
<i>The number of the unemployed, reported to the total number of the population</i>	3	0.400		Alternative 4	0.8795
				Alternative 5	0.8932
<i>The number of employees, reported to the total number of the population</i>	1	0.350	corresponding aggregated values	Alternative 1	0.6266
<i>The number of the unemployed, reported to the total number of the population</i>	1	0.100		Alternative 2	0.8326
<i>The average suitability</i>	2	0.350		Alternative 3	0.9636
<i>The average price of the land</i>	3	0.200		Alternative 4	0.9523
				Alternative 5	0.8258
<i>The number of employees, reported to the total number of the population</i>	1	0.350	corresponding aggregated values	Alternative 1	0.5641
<i>The number of the unemployed, reported to the total number of the population</i>	1	0.200		Alternative 2	0.8394
<i>The average price of the land</i>	2	0.350		Alternative 3	0.9443
<i>The average suitability</i>	3	0.100		Alternative 4	0.9386
				Alternative 5	0.8360

4. CONCLUSIONS

The decision analysis can be a useful tool for decision makers, from both the public and private sector. The analysis presented in this paper shows that also private investors can use these analyses in order to make the best decisions, under given conditions. But the most important feature is indication of the most suitable decision for a problem, but the fact that offers transparency in the decision-making process.

The decision analyses have their own limitations. A major limitation is that they are based on the human judgement and rationality, which are not always the most accurate. The problem structuring can also be a source of errors since it is the starting point of the analysis. In the problem

structuring phase, the decision maker has to state the main objective of the analysis and has to 'translate' in sub-objectives (criteria) all the needs of the stakeholders, if the case, or all the needs, and constraints regarding a decision problem. Secondly, the data availability is an important limitation. As it was seen in the present analysis, sometimes not all the needed data is available and the decision maker has to find related data in order to substitute the data that lacks. In the same context, a decision analysis does not have to be data-driven, starting the analysis from the availability of data and then setting the goal and the criteria.

To limit the errors a decision maker has to apply or rely on expert knowledge, to be open-minded to the opinions of the stakeholders and to make use of the sensibility analyses.

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Identifying limitations of Permanent Scatterers Interferometry for buildings monitoring

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Abstract. The Permanent Scatterer Interferometry (PSI) represents one of the most advanced monitoring techniques from space. In the current paper, the technique is applied for observing the movement behaviors of buildings found in the center of Romania's capital, Bucharest, in order to verify whether there is a possibility to differentiate among patterns. The main hypothesis of the research is that buildings respond to ground movement differently depending on their characteristics, such as age, construction material, and structure or height regime. Twenty-seven images acquired by the German TerraSAR-X (TSX) satellite, were processed in order to depict ground level deformations. The buildings were analyzed by classifying them in different categories, depending on their earthquake vulnerability, height and location. The results suggested that the movement patterns identified by the satellite depend mainly on the spatial distribution of the buildings.

Keywords: *Permanent Scatterer Interferometry, Urban monitoring, TerraSAR-X, InSAR*

INTRODUCTION

In the last 100 years, the urban population of the globe has grown from 5% to 50%. The fact that in the next 30 years the urban population is expected to double implies a fast spreading of the urban areas, with the cost of green spaces, low quality infrastructure and uncontrolled spreading of built-up areas. To avoid these phenomena, the urban areas are being monitored with different techniques. Traditional methods of capturing demographic data, censuses and maps based on samples, are impractical and unsatisfactory for urban management purposes. Remote sensing – as a surface observation technique of the Earth – can help solve these problems by generating spatial information updated periodically.

Compared with other techniques used by remote sensing experts and geographers, the remote sensing of urban areas, especially using satellites, is a relatively new subject. In the past, aerial sensors used to be the main source of remote sensing data,

but sensors on satellite platforms are now more popular, especially due to technical improvements that have allowed high-resolution images to be taken from high altitudes.

Even though optical sensors respond to many of the monitoring of the urban environment applications, the 3D component of cities, although substantial, cannot be captured in multi-spectral satellite imagery to a satisfactory level of detail. It is therefore necessary to use other types of sensors for observing the urban environment, such as the SAR (Synthetic Aperture Radar). Beside the thematic information that multispectral imagery can provide about urban environments, SAR images have the ability to improve the quality of classifications by exploiting the dielectric properties of microwave objects. This makes it possible to distinguish communication networks, individual buildings and green spaces by analysing the texture of objects on them or imagery representing data fusion between SAR images and multispectral images. Three-dimensional information about the built environment

can be obtained by SAR imaging interferometric techniques that make digital terrain or surface models. In addition, Differential SAR Interferometry (DInSAR) allows monitoring of deformations that could affect soil and urban constructions.

PROBLEM DEFINITION

Bucharest is one of the European capitals with a high number of old buildings (Armaş, 2006), especially in the center of the town. Being given its exposure to Vrancea earthquakes, the high population and the characteristics of the built-up area, Bucharest is very vulnerable to seismic hazard.

The heterogeneous built-up area of Bucharest consists in old buildings; built before 1940, made of concrete or masonry, without respecting any international construction codes. There is a large number of buildings that have been affected repeatedly by the earthquakes produced in 1940, 1977, 1986 and 1990. Local conditions can amplify seismic movements (Bozzano *et al.*, 2008).

The current study proposes the use of InSAR technology as an alternative method for faster identification of high-risk buildings by studying fine object movements. Accumulation of structural defects can lead to a change in the dynamic characteristics of structures (Doebeling *et al.*, 1996). In our study, we want to find out if satellite measurements are sufficient to distinguish between structural defects and those resulting from changes in non-structural components or environmental conditions.

Permanent Scatterer Interferometry (PSI) is the most advanced technique Differential Sar Interferometry (DInSAR), based on data acquired by SAR satellite sensors. Conventional techniques of DInSAR uses the information contained in the signal phase for at least two SAR complex images taken over for the same area at different times, from which pairs of interferograms are generated. Much of the results obtained with the DInSAR technique in the 1990s were achieved using the standard DInSAR configuration, which in some cases was the only one implemented due to the low

availability of SAR data (Rosen *et al.*, 2000, Crosetto *et al.*, 2005).

DInSAR results have been remarkably improved by advanced DInSAR methods, which use large sets of large SAR images that have captured the deformation phenomenon of an area over time. New techniques represent a great advance compared to conventional ones, given both the modelling capacity and the quality of the estimated deformations. Beginning around 1990, several methods have been proposed to work with large SAR databases, but a fundamental step was the proposed technique by Ferretti *et al.*, (2000), called the Permanent scatterer technique. The technique has now been adopted and adapted by other researchers in the field, being accepted as Permanent Scatterer Interferometry.

The deformations of the surface could not be reconstituted for an entire image without loss of information in some areas, mainly because of temporal decorrelation. To prevent lack of information, the method uses objects (pixels) whose signal is stable over time. A method of identifying pixels that remain coherent in time to radar signal is to analyse the dispersion index, which represents the ratio between standard amplitude deviation and average pixel value in all images, analysed in a stack. Also, a large ratio between a pixel value and the average pixel surrounding it indicates that the pixel could contain a permanent reflector (Adam *et al.*, 2008). The reflectivity density depends greatly on the type of ground cover and can vary significantly in a studied area. The highest density of persistent targets is found in inhabited areas, which makes the technique of persistent targets particularly useful in monitoring deformation or elevations in urban areas.

BUILDING ANALYSIS

In order to identify buildings that suffer degradations over time in Bucharest, an object-oriented analysis was applied in a restricted test area – the Old City Centre (Figure 1). The studied buildings are selected according to the existing terrain mapping. The results obtained from the PS analysis of 27 TSX images, obtained between 2011 and 2014,

were used in order to analyze building movements, being given the wavelength of the signal (3 cm) and the magnitude of the expected movements.

Six blocks have been delineated containing a large number of buildings considered very vulnerable in case of earthquakes, mainly because of their age, structure and localisation. The buildings in the study area have a similar height, 1-2 floors, and older than 50 years. In the behavioural analysis of buildings, it was assumed that structural or surface degradation could be observed by interpreting the behaviour of buildings emerging from the displacements of the points detected at their level. With the help of the TSX images, which have a 3-meter-high resolution, hundreds of building-related points were determined. The comparison of building movements was based on the determination of the minimum and maximum values of the displacements suffered by all the points of the studied building, the determination of the average standard deviation of the displacements, as well as the interpretation of the graphical representation of the variation of movement for each point.

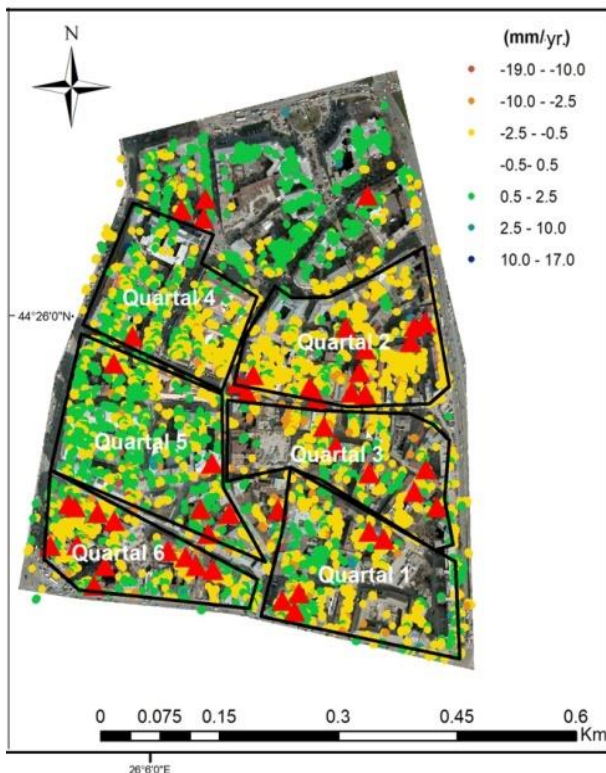


Figure 1. PS points resulted in the historical centre of Bucharest

First, an analysis was carried out on buildings differentiated by their appertenance to the earthquake risk class 1, as classified by the authorities (Table 1).

The investigation continued with buildings with a different height regime in order to identify the influence of the buildings' attributes on the movements detected by InSAR. For this purpose, we chose the 5th and 6th quarters, where we could identify 8 buildings with different height regime, not classified in any seismic risk classes, for which the following data were calculated (Table 2):

Table 1. Statistical analysis of buildings classified according to seismic risk

Quartal	Seismic Risk	Points	Displacement statistics			
			Avg. (mm)	Min. (mm)	Max. (mm)	Std. dev. (mm)
1	Yes	180	-2.53	-15.22	6.76	±1.80
	No	144	-1.32	-11.06	5.65	±2.02
2	Yes	143	-2.40	-11.26	7.54	±1.75
	No	150	-2.23	-10.23	4.56	±1.71
3	Yes	44	-2.58	-6.56	3.35	±1.45
	No	140	-2.44	-6.78	7.34	±1.65
4	Yes	151	-1.68	-8.42	7.23	±1.58
	No	160	-1.34	-6.35	7.34	±1.47

Table 2. Statistical analysis of buildings classified according to height from quarters 5 and 6

Quartal	Building type	Points	Displacement statistics			
			Avg. (mm)	Min. (mm)	Max. (mm)	Std. dev. (mm)
5 6	G+7	149	-0.98	-7.98	6.13	±1.38
	G + 4	48	-1.25	-7.72	4.34	±1.48
	G + 4	97	-0.50	-5.36	6.21	±1.37
	G+1	43	-0.82	-5.55	4.74	±1.42
	G+3	99	-0.25	-8.68	5.63	±1.40
	Church	36	-1.87	-8.07	10.32	±1.37
	G+1	76	-0.44	-8.50	4.49	±1.64
	G+1	100	0.40	-9.03	8.00	±1.46

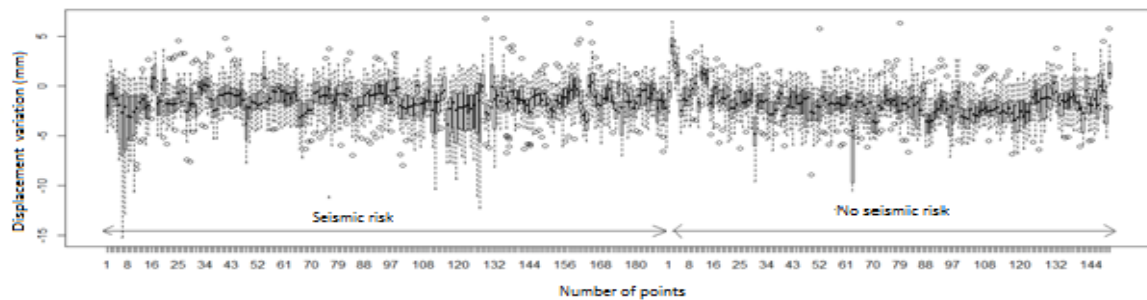
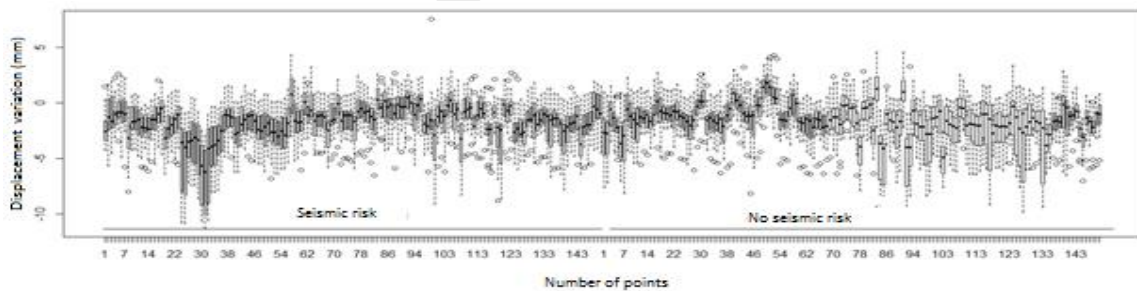
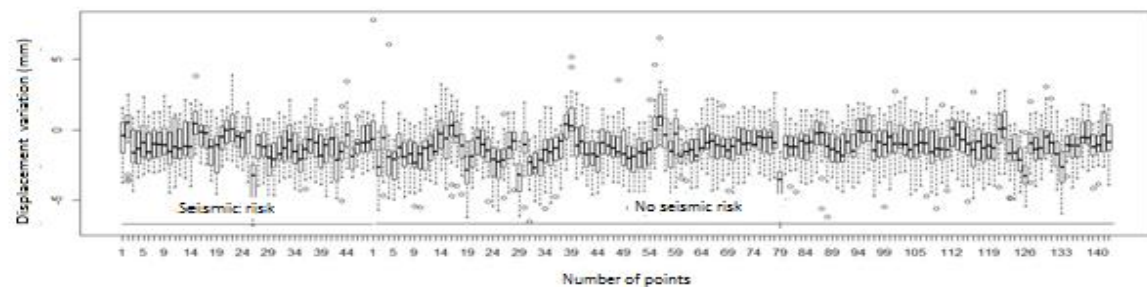
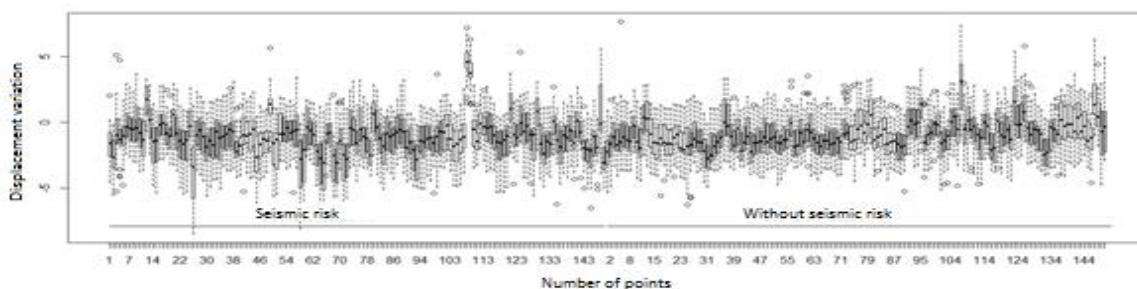
Table 3 summarizes the results obtained from the comparison of the statistical data calculated for buildings in P + 1 height, not included in seismic risk classes, in different regions, thus having a spatial distribution dispersed in all 6 considered quarters.

Table 3 Statistical analysis of buildings classified according to height from quartals 5 and 6

Quartal	Points	Displacement statistics			
		Avg. (mm)	Min. (mm)	Max (mm)	Avg. (mm)
1	144	-1.32	-11.06	5.65	± 2.02
2	150	-2.23	-10.23	4.56	± 1.71
3	140	-2.44	-6.78	7.34	± 1.65
4	160	-1.34	-6.35	7.34	± 1.47
5	76	-0.44	-18.50	4.49	± 1.64
6	100	0.40	-9.03	8.00	± 1.46

In figures 2, 3, 4 and 5, the variation of point displacement was represented for each quartal from

1 to 4, where buildings were classified according to the seismic risk.

**Figure 2.** Graphical representation of displacement variations of points in quartal 1, classified according to seismic risk**Figure 3.** Graphical representation of displacement variations of points in quartal 2, classified according to seismic risk**Figure 4.** Graphical representation of displacement variations of points in quartal 3, classified according to seismic risk**Figure 5.** Graphical representation of displacement variations of points in quartal 4, classified according to seismic risk

RESULTS AND DISCUSSION

After analysing the values obtained for the displacements and variations of the points displacements, it is observed that the average, minimum and maximum values do not suggest any remarkable differences between the buildings. Statistical data suggests that movement detected by InSAR means cannot be considered a predictor for identifying buildings classified in high seismic risk classes. Both the average displacement values and their variation of this are rather indicators of proximity of the investigated buildings, taking into account that the analysis was made on buildings with a similar height regime.

Building-type analysis has led to inconclusive results for differentiation of movements according to the height regime. Regarding both the centralized values as well as the graphical representation of the displacement variation of points on buildings over time, no classes could be identified in which they could be ranked according to the description of the point movements.

The last analysis of the points on buildings took into account the hypothesis that satellite recordings can primarily detect the building deformations due to ground surface movement. Considering the revisit interval of 11-day satellite imagery, which cannot often be reproduced due to the influence of meteorological conditions on images, we can assume that the characteristic vibrations of the buildings are not captured by the linear processing of satellite imagery. Also, façade elements that may be damaged on a medium or severe degradation building may cause excessive displacement, causing a loss of coherence in SAR images.

Both the statistical data and the graphical interpretation show that the differences between the magnitude and variance of the displacements determined by interferometric processing are predictors of the spatial distribution of the analysed objects and not the individual characteristics of the buildings.

The same interpretation of the movements can be found in Armaş *et al.*, 2017, in which the cracks appeared on the façade of four individual buildings, the Parliament Palace, the Lazarus College, the National Archives and the City Hall's headquarters,

were measured using a geological compass. The orientation of cracks appearing on the facade of buildings shows a correlation between nearby buildings and differences from buildings in a geomorphologically different area. As a result, the Palace of Parliament shows a predominantly East-West layout, which is also found in the building of the City Hall. At the headquarters of the National Archives and the Lazar College, the cracks are disposed of by the SVV-NEE. The headquarters of the City Hall, the National Archives and Lazar College headquarters also show cracks in the North-South direction, which are not observed on the Palace of Parliament building.

CONCLUSION

The main objective of the current paper was to identify the limitations of InSAR techniques in observing building deformations in urban areas. In this purpose, we processed 27 TSX images acquired between 2011 and 2014 over Bucharest. The old centre of Bucharest was considered the area of interest due to the characteristics of the buildings found here.

The analysis considered three scenarios in which different building characteristics that could influence movement patterns were considered: first was the risk class of the building, the second was the height regime, while the last considered only the spatial distribution of points, in different regions of the city centre. The main conclusion was that the main predictor of building behaviour that was identified by InSAR techniques is spatial distribution.

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Case studies of hydropower renewable energy and landscape quality from Romania

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Abstract. This paper is presenting case studies of large hydropower built on Romanian mountain rivers Danube, Argeş and Bistriţa during the communist regime and how they relate to criteria of landscape quality. The case studies were investigated as contribution to Working Group 2 and Working Group 3 of the COST action TU1401 „Renewable energy and landscape quality”, a European network spanning almost all countries of Europe. The context is given by the dialogue between the micro-hydropower and the large hydropower, the first being traditional constructions. We can learn from the watermills as we can from the windmills, is the critical reflection done at the end.

Keywords: *hydropower, renewable energy, public participation, Danube*

OVERVIEW

COST actions are thematic networks funded by the COST Association over a H2020 contract from the European Commission. Such an action is TU1401 “Renewable energy and landscape quality” (COST RELY). The action activities are grouped in four working groups which are:

- WG1 Systematic review of RE impacts on landscape quality;
- WG2 Strategic case studies on landscape sensitivity/potentials in terms of renewable energy;
- WG3 Socio-cultural aspects of sustainable RE production;
- WG4 Synthesis of findings and dissemination.

WG2 and WG3 prepared jointly a questionnaire which we used when analysing these case studies from Romania. In another paper (Bostenaru, 2017) we analysed solar power in Romania and Italy. In frame of the action Le Notre online lectures took place.

INTRODUCTION TO HYDROPOWER IN ROMANIA

Cheile Rudăriei (Fig. 1) is a watercrossing course in SW Romania, an area protected for its biodiversity including ancient watermills from the beginning of the 20th century, which are protected as historical monuments. The watermills served flour production from wheat. It is remarkable how constructions interact with the natural landscape in this case. The mountainous area where they are situated does not belong to the touristic highlights of Romania, and hence needs being made known, so that tourism increases and interest for monuments enhances their preservation prospects.

The conservation of the complex is an example of best practice in monument preservation. It is an example of preservation of early industrial projects.

Monument preservation in Romania is a problematic issue in the context of a speculative construction boom. The Ministry of Culture organized in 2008 an excursion here to make known the holiday sites of the Banat region.

These are water mills in a rural environment. Historic watermills in an urban environment can be found in the city of Esslingen in Germany (Fig. 1), for example. Their conservation is important.

Especially important is to see these small size water-energy-using-constructions which are well integrated in the landscape and do not destroy it as does microhydropower, currently very criticised in Romania, as shown in the presentations at the Bucharest Annual of architecture (Anuala de Arhitectură), 21 July 2014, WWF Danube Carpathian Programme. Microhydropower is against the natural habitat of species (Anderson *et al.*, 2015) and was as such even a subject at the architects Annual.



Figure 1 Cheile Rudăriei watermill (above). More photos in *photo.net* (2008): Photos: Maria Bostenaru, 2008. Bottom: Watermills in Esslingen am Neckar, Germany (below). Photo: M. Bostenaru, 2016.

PORTILE DE FIER HYDROPOWER

Project location is the entrance of Danube in Romania. The project was built 1964 / 1972.

Porțile de Fier hydropower (Fig. 2) is a major hydropower in Romania, one of the major European

ones and the largest on the Danube (Pașca, 2014). The water level has risen with 35 m due to the construction. An island, Ada Kaleh and some localities on the Romanian side, also including the old city of Orșova, which was relocated and Ogradena Nouă, Ogradena Veche, Ieșelnița – nowadays Eșelnița, Tufări, Jupalnic, Coramnic, Vârciorova (Osaci-Costache and Armas, 2016), were evacuated and are lost landscapes with the construction of the hydropower. The sturgeon fishes were affected, and on both the Romanian and Serbian sides natural protection parks were created. The Roman ruins in the area, including those of the bridge of Drobeta are major attractions, part of the national park. The lake runs until the confluence with Tisza, but the main part is in the Danube gorge, between Baziaș and Orșova towns. Orșova, the relocated city, presents one of the seminal works (AGERPES 2014) of modern church building (Fig. 3).

The power of Porțile de Fier I is 1080 MW and that of Porțile de Fier II 250 MW (Romanian part), otherwise counting for 2200 million cubic meter (Cârdă and Bara, 1998).

According to CORINE landcover nomenclature there are Forests and semi-natural areas/Forests/ Carpathian mountains (Table 1).

Table 1 Landscape functions

Landscape functions		Special meanings /assets
Tourism	<input checked="" type="checkbox"/>	National and international tourism
Residential	<input type="checkbox"/>	
Agricultural production	<input type="checkbox"/>	
Recreation	<input checked="" type="checkbox"/>	Local tourism
Industry	<input type="checkbox"/>	
Transportation	<input checked="" type="checkbox"/>	National roads
Nature protection	<input checked="" type="checkbox"/>	
Redundant area	<input type="checkbox"/>	
Other	<input type="checkbox"/>	

There is a recently finished doctorate in Germany by Arnošt Štanzel (2017) on hydropower in Romania with the title *Die Wasserwirtschaft in Rumänien und der Tschechoslowakei: Von Wasserträumen und Wasserräumen im*

Staatssozialismus. Ein umwelthistorischer Vergleich (The water economy in Romania and Czechoslovakia: from water dreams and water spaces in socialist states. A comparison of environmental history).

Funding was public funding (national). The general public was not involved. The public participation goal was not declared, as the regime was totalitarian. Given the evacuated localities, it is to assume that the inhabitants might have not agreed. Actor (stakeholder) national government was highly involved with the role 5 years plan – project coordinator, financial management, PR (Table 2).

Table 2 Stakeholder activities
intensity: low = 1, medium=2, high=3

phase	type of participation	intensity
Before the project started (e.g. contribution to the process development, research, analysis etc.)		1
Determination of need		1
Project preparation		1
Spatial planning		1
Permitting		1
Construction	Information	1
Operation	Information	1
Closing	information	1
After the course of the project (e.g. subsequently contribution to the process improvement, model development etc.)		2



Figure 2 The main part of the lake is from Baziaș to Orșova; this image presents a view from Baziaș. Photo M. Bostenaru 2008, during the same excursion of the Ministry of Culture.

As stated, there was no participation, although the 1960s were a time when public participation had begun in Western Europe.



Figure 3 Church in Orșova on the Danube, architect Hans Fockelmann (1972/77). Photo: M. Bostenaru, 2008.

IZVORUL MUNTELUI/BICAZ HYDROPOWER

The project is located on Bistrița River, near Bicăz, Romania. Timeline is autumn 1950 / 1 July 1960.

Izvorul Muntelui (Fig. 4) is the first large hydropower in Romania (Nistoran *et al.*, 2016). It is on the Bistrița river, crossing the Carpathians through a picturesque defile. Forced labour was used to construct it. Some localities including the

cemeteries were moved (22 totally or partially). The lake is a popular tourist destination. Its size is 32,6 km² or 1,250 million m³ (Cărdă and Bara, 1998). According to CORINE landcover: Carpathian Mountains forests.

Funding and public participation are the same as for Portile de Fier. It was too early for participation at that time, similar to Western Europe. Such megaprojects are well implemented when governed from above, as since the fall of the regime similar major projects were not finished anymore.



Figure 4 Izvorul Bicașului hydropower, photo Diana Gheorghe

VIDRARU HYDROPOWER

Project location is on the upper Argeș River, in the Carpathian Mountains, Romania. Timeline was 1961 / 15 March 1966.

Vidraru hydropower (Fig. 5) is a major hydropower in Romania, comparable only to Bicaș hydropower. In 1966 it was the 5th in Europe and the 9th worldwide in size. The construction of the hydropower not only permits to use renewable energy of water in the Romanian mountains, but also to prevent flooding. The villages just below the

hydropower in Corbeni, heavily flooded in 1940 and had to be rebuilt by a former Rome scholar, Richard Bordenache (Popescu, 2008 and the sources in the National Archives in Argeș).

Making the dyke flooded some buildings and cemeteries in the region.

The dyke is safe at an earthquake of 9 on the Richter scale, Romania being an earthquake prone region (Giardini *et al.*, 1999). Dykes collapsing in earthquakes are a major risk, as it was seen in Italy in Vajont in the Alps (Kilburn and Petley, 2003).

The hydropower is located in an important touristic region, with the Poenari castle between the Corbeni village and itself, and on the entry to the Transfăgărășan road crossing the Carpathians, chosen (Citizenside, 2012) as one of the most beautiful roads worldwide. On this road there is the Bâlea Lake, where ice houses are constructed every winter. As such, the hydropower also attracts tourists for boat rides on the lake and fishing.

As the Vidraru hydropower was constructed during Socialist times, the population was not involved at all, it was a state project. Public participation began in Romania with the fall of the regime. Size 17,034 GW. 10.3 km x 2.2 km. Funding was national. CORINE landscape as in the case of other hydropowers, but see also table 3.

We reviewed some contemporary policy (Păcesilă, 2013, Nedelea and Comănescu, 2011).

There was some previous local experience from the reconstruction of the village after floods, when the future inhabitants were involved in building, according to discussions with some elderly on site. The inhabitants were concerned that future floods might destroy their habitat.



a.



b.



c.



d.

Figure 5 a. Vidraru waterpower. Photo M. Mihaila; b. the road along the Arges River with Poenari castle. Photo M. Bostenaru 2012; c. Landscape of Arges River in Corbeni village. Photo M. Bostenaru 2012; d. village house reconstructed by Richard Bordenache 1940. Photo M. Bostenaru 2012.

Large scale hydropower as we presented on the Le Notre page for Vidraru is a good practice, and in countries like Canada brings significant energy contribution, however it can be carried out only as state projects.

Table 3 Landscape functions

Landscape functions		Special meanings /assets
Tourism	<input checked="" type="checkbox"/>	National and international tourism
Residential	<input type="checkbox"/>	
Agricultural production	<input type="checkbox"/>	
Recreation	<input checked="" type="checkbox"/>	Local tourism
Industry	<input type="checkbox"/>	
Transportation	<input checked="" type="checkbox"/>	Transfăgărășan road
Nature protection	<input checked="" type="checkbox"/>	
Redundant area	<input type="checkbox"/>	
Other	<input type="checkbox"/>	

In the 1940s, in war time, a huge flood happened in the village of Corbeni on the upper Arges River in Romania. Architect Richard Bordenache reconstructed the village on an upper location (since the village is located in the mountains, close to the Transfăgărășan, a high laying road and one of the most beautiful in Romania crossing the highest mountains of the country). The village followed traditional architecture in a time of functionalism (Fig. 4). Later, in communist time, in order that such catastrophic floods do not repeat, a dam has been built upper river, in the road direction,.

The landscape over there is one of the most beautiful in Romania. Currently European funds are available to revitalize the tourism in the region, since without a private car it is quite difficult to get access. However, as said, the Transfăgărășan road up the mountain was voted the most beautiful road in the world European project on putting in value the landscape values of the region ("Adevărul", 2012). The road crosses high mountains and is accessible only in summer, however every winter an ice hotel at Bâlea Lake. Lower the dam there are some villages, including Corbeni, the one affected by the flood I wrote about above. On the way from Corbeni to Vidraru Lake there is the fortification of Poienari, told to be Dracul's. Therefore the dam protects a valuable landscape in the immediate vicinity. In the lower regions it also has its good consequences, including the protection of the capital city of Bucharest, where the river passes by.

From the point of view of energy, Romania, with its rivers, can assure hydro renewable energy in a fashion similar to Canada (Frey and Linke, 2002).

Of course the security of the dam has to be considered. Dam breaks can cause disasters, as the example of Val di Stava dam collapse, the Vajont dam collapse. However, the Vidraru dam proved safe in the almost 50 years of existence. Dams like this protect against floods but can cause another catastrophe. A huge dam like this can prevent from creating microdams on mountain rivers, which were criticized in the 2014 Annual of Architecture, which destroy landscape without a major energy win.

Best practice is the traditional building in the village of Corbeni. This can be brought in connection to traditional building today in the reconstruction after the red slum chemical disaster in the villages of Kolontar and Devecser at Ajka, Hungary (Bostenaru, 2014). Such traditional building can relate well to participatory methods. The Kós Károly society which built in Kolontar and Devecser also built after the Tisza floods. The reconstruction of Corbeni is an early example of such a reconstruction.

We shall learn from tradition with these mills integrated in the landscape, as we should generally from the rural landscape and the heritage coming from the past.

DISCUSSION AND CONCLUSIONS

In the online lectures of COST RELY (2016) we saw a lot on wind mills, however little on water mills, maybe because hydropower might be taken out of action as wind energy is more popular. But also thermal water is used as renewable energy. Traditional wind mills can be UNESCO sites, as shown by Stremke (2016) near Rotterdam, who also talked about social issues of the hydropower landscape later on. Stremke finds the large hydropower as not being sustainable (biodiversity, inhabitants and landscape). In the conceptual framework hydropower is a renewable object, while the mill is a renewable layer. Large hydropower also does not maintain the floodplains and as such jeopardizes flood protection in case the dam breaks.

While from the traditional romantic wind mill the contemporary one with much more efficiency in land requirement, as later shown by Stremke, then solar power has been developed, from the traditional water mill there are no modern water mills.

Even if the way hydropower is used in Vidraru does not rely on tradition, the way the village affected by the flood was built does rely, so in this case the point I want to make related to water is the value of tradition.

The lecture of Golobic (2016) showed the participatory impact of modern wind mills. Their presence may affect not only landscape, but also the protection area of monuments in case of cultural heritage. In the cases of use of hydropower through monument water mills or the traditional village reconstruction the use of hydropower generated cultural heritage per se. This is a new dimension apart of landscape quality.

The case studies were integrated in the overall analysis of the COST action and are the subject of a travelling exhibition, which was presented in Romania at Marie Curie events: the kick-off of the Marie Curie chapter and the Marie Curie action Researcher night, thus to a non-specialist audience as well as at a national symposium with the Romanian Academy of Technical Sciences (Fig. 6).

Concluding, we would like to stress that both cases are on use of water in mountain regions, one third of Romanian territory being mountain region. Other rules apply as we saw for sea and plains.

ACKNOWLEDGEMENTS

The research presented in this article uses data collected for the TU1401 COST action "Renewable energy and landscape quality". The part on the Danube is also used for investigation for the project DanURB.



Figure 6. COST RELY travelling exhibition at Marie Curie Alumni Association kick off of Romanian chapter (above) and at Researcher Night 2017 (middle) and at the Symposium on energy with the Romanian Academy of Technical Sciences (below). Photos: M. Bostenaru and S. Petrea 2017

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Erasmus+ in Cologne. Prologue

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Abstract. "Prologue" is the first article of the series "Erasmus+ in Cologne" and is intended mainly for students and researchers of the Faculty of Geography of the University of Bucharest, who want to take part in an Erasmus+ scholarship. It covers advice and relevant information regarding the Erasmus+ programme, the choice of the university, the selection process (including required documents) and the interaction with the future host university (in this case, Technical University of Cologne), all based on the personal experience of the authors (Erasmus+ alumni).

Keywords: *Erasmus+, TH Cologne, International Student*

1. INTRODUCTION

The series "Erasmus+ in Cologne" consists of three episodes (Prologue, TH Cologne and The City of Cologne) and outlines a four-month long Erasmus+ scholarship period (27.03.2017-28.07.2017) of the two authors, Vladimir-Nicolae Nechita (postgraduate student) and Cătălina-Teodora Stoian (graduate student) in the city of Cologne, in Germany. The purpose of the series is to present all the necessary steps before, during and after the Erasmus+ period and to provide hints and tips based on the personal experience of the authors.

The articles are intended for Bachelor, Master or PhD students and researchers mainly from the Faculty of Geography of the University of Bucharest that are willing to participate in the Erasmus+ Programme and are interested in topics such as disaster management, rescue engineering, resources management or geography.

While the first article (Prologue) introduces the reader to the Erasmus+ Programme, covering the selection process and all the procedures before the mobility, the second one (TH Cologne) will focus on the Technical University of Cologne, including the available study programme at TH Cologne, the

enrollment procedures and the study itself. The final article (Life in Cologne) will relate to the city of Cologne and to the student life there.

2. THE ERASMUS+ PROGRAMME

The **Erasmus+ Programme** (European Region Action Scheme for the Mobility of University Students) is a European Union Programme in education training, youth and sport. Since 1987, when it was established, the Programme has provided learning experiences for more than 2 million European students (European Commission, 2013). Erasmus of Rotterdam, the Dutch philosopher and humanist, was the person after whose name the programme is called. Currently, more than 4000 higher institutions from 37 countries are participating in the Erasmus+ Programme (European Commission, 2014).

According to the European Commission (2012), the Erasmus Programme was adopted on the 17th of June 1987 by the same institution and was based on the pilot student exchanges that took place between 1981 and 1986 (European Commission, 2013). 11 member states joined the programme at that time: Belgium, Denmark, Germany, Greece, France,

Ireland, Italy, Netherlands, Portugal, Spain and United Kingdom. As the programme was expanding, language courses were introduced in 1996 and one year later teacher exchanges were implemented. Romania joined the programme 1998. In 2000, the programme was including no less than 32 countries. On the 24th of October 2002 was celebrated the One Millionth Erasmus student and only 7 years later the Two Millionth Erasmus student (European Commission, 2012). In 2014 the new Erasmus for All Programme (Erasmus+ Programme) was launched, allowing students to participate more than once in the programme. This year (2017) the 30th Erasmus Programme Anniversary was celebrated.

Statistics of the European Commission showed that only in the academic year 2013-2014, 272,497 students chose another European country to study. The highest number of students sent abroad were from Spain (37,235), followed by Germany and France. Same year, Spain received the most exchange students from other European countries, almost 40,000, followed by the same two countries – Germany and France. Back then, the average duration of student exchanges was six months (European Commission, 2015).

Taking a closer look at the share of subject areas attended by the exchange students in the academic year 2013-2014, 40% percent of them were interested in social sciences, business and law, 20% in humanities and arts, 15% in engineering and manufacturing and the remaining 25% in other topics (European Commission, 2015).

The success of the Erasmus+ Programme contributed and led to several milestones (European Commission, 2012):

- Launch of the Bologna Process.
- Establishment of the European Credit Accumulation and Transfer System (ECTS), allowing students to earn credits when studying in a foreign country (an inter-institutional agreement between the home institution and the receiving institution is used, while the courses followed at the partner institution are equated at the home institution after the mobility through the above mentioned system).

- Internationalization of Higher Education Institutions (HEI).
- Improved services and methods of learning and teaching, including new opportunities for cooperation.

The programme also contributed to enhancing the academic knowledge and competences of the students, supporting their personal development.

3. CHOOSING THE RIGHT UNIVERSITY

When applying for an Erasmus+ scholarship, there are several criteria that have to be taken into consideration. Firstly, you have to be confident and sure that this type of scholarship is the right step you need and want. If you like to study, to research, to develop yourself and to improve not only your language skills, but also your academic experience, you sure are prepared to take part in such a programme. Also, if you have managed to save some money, the savings could help you during the mobility period, as the grant you will receive does not cover all costs.

Please also take into consideration that, applying and eventually obtaining the grant, and later, abandoning the selection process would imply negative consequences. If you quit the scholarship after you have been admitted, you will still be eligible to apply in the future, but you will not have credibility anymore and there are chances that you will not get another opportunity. That is why you have to be very confident and to inspire credibility.

To apply for an Erasmus+ scholarship you must be a Bachelor, Master or a PhD student and currently enrolled at the Faculty of Geography of the University of Bucharest. At this moment (2017) there are 18 European countries comprising partner universities you can apply for (<http://www.geo.unibuc.ro/mobilitati.html>).

The first criterion for making the right decision is the official language of the country your future host university will be located in. There are universities in Austria, Germany or Poland where some of the offered courses are in English. Given the fact that English is spoken by most of the students, it is good to keep in mind that this condition might just not be enough. Speaking the

official language of that country offers you a high variety of opportunities, such as getting easier in touch with the locals, gaining respect and even making a lot of friends. Most of the partner universities have language prerequisites – B1 or B2 level.

The second criterion is related to the cost of living of the country where your future host institution lies. In none of the cases will the scholarship cover the entire costs of your mobility, but going for Norway or the Netherlands for instance will imply additional costs for sure. Choosing Spain, Poland or Italy, where the cost of living is lower, would lead to fewer costs.

Finally, you have to decide upon the study programme that fits you best according to your present degree programme and to your future specialization. During the scholarship period, it is not necessary to attend only Bachelor modules if you are, for example, a Bachelor student. The programme allows you to attend any kind of module regardless of your current degree programme. Also, do not forget to get in touch with the professor responsible for the partner institution in your faculty and with Romanian alumni as well – they will surely have valuable information to share.

4. THE SELECTION PROCESS

Once you have taken the decision to apply for an Erasmus+ scholarship and talked to the professor responsible for that university, there will be specified a period (the period will be announced online – www.geo.unibuc.ro a couple of weeks before the beginning of the selection process) when you have to submit the following documents:

- A motivation letter (written in English/other language).
- A CV (Europass format, written in English).
- A proposed study programme to be followed during the mobility period.

Also, you have to meet the following requirements:

- Enrolled as a Bachelor/Master/PhD student at the University of Bucharest.
- Integralist after the last examination session (at least 7.00 average study grades).
- Pass a language assessment test.

Once you meet these conditions and provide the necessary documents, you are eligible for the interview that takes part usually a couple of weeks after the submittal process. During the interview you will be assessed by a special commission composed of members of the teaching staff. It is recommended to prepare for the interview, taking into consideration your motivation, your academic experience and background and the proposed study programme you want to follow.

After being selected by the Faculty of Geography, you will receive an e-mail afterwards from the Department of International Relations (Central Erasmus Office). You should submit here the following documents:

- Erasmus Exchange sheet x 2.
- Learning Agreement for studies form x 3.
- Dean's statement for the recognition of the studies.
- Curriculum Vitae (Europass format).
- Motivation letter (in a foreign language).
- Copy of the identity card.
- Official academic transcript.
- Translated version of the academic transcript.
- Copy of a valid language certificate.
- Academic calendar of the host university.

Please note that obtaining accommodation is strictly your responsibility. You can either choose to apply for a student dormitory (in this case through KSTW – Kölner Studierendenwerk, accessing the following link: <https://t11host.eu/SWK/index.html#admission>), a private dormitory or a private apartment. Places for student dormitories are limited, so it is advised to apply as fast as possible. After your submittal is complete, your application will be sent to the host university.

5. GETTING IN TOUCH WITH THE HOST UNIVERSITY

After sending the application, you will receive an e-mail from the host university (TH Köln). The e-mail will comprise valuable information related to your mobility: faculty you will be enrolled in, contact person for academic matters, contact person for administrative issues and a link to an online platform (called Mobility-Online, available at:

<https://www.th-koeln.de/mobility>), where you should create an account and a profile. There you will find actions that you must complete: prior to your stay, during your stay and after your stay (Figure 1).

There are 10 objectives prior to your stay that need to be completed, starting with accessing the link to the online platform you have received via e-mail and ending with the print of the admission letter. You have to upload the Learning Agreement Before the Mobility form (signed by the University of Bucharest) and a valid language certificate. After printing the letter of admission, this must be sent to the Department of International Relations (Central Erasmus Office).

Necessary steps		Done
Prior to your stay		9 / 10
Online application	<input checked="" type="checkbox"/>	
Confirmation e-mail online application	<input checked="" type="checkbox"/>	
Online registration	<input checked="" type="checkbox"/>	
Personal details completed	<input checked="" type="checkbox"/>	
Photograph uploaded	<input checked="" type="checkbox"/>	
Language certificate uploaded	<input checked="" type="checkbox"/>	
Application formally checked	<input checked="" type="checkbox"/>	
Learning Agreement Before the Mobility uploaded (only if applicable)	<input checked="" type="checkbox"/>	
Von der TH Köln unterzeichnetes Learning Agreement BTM herunterladen	<input type="checkbox"/>	
Letter of admission printed	<input checked="" type="checkbox"/>	
During your stay		6 / 6
After your stay		1 / 1

Figure 1 Mobility-Online platform for TH Cologne

6. FINAL PREPARATIONS

Before leaving, you must attend the OLS+ language assessment test according to the study language abroad (<https://erasmusplusols.eu/>). The same test must be attended at the end of the mobility, in order to find out if there have been language skills improvements during the mobility period. In the last step, you must open a euro bank account (preferably at Banca Comerciala Romana, where your grant will be paid). You must also sign and submit a financial contract and a guarantor's statement (in case you will not meet all terms and conditions during the mobility).

Prior to your stay, you should book your flight ticket in advance. There are multiple companies that are offering flights between the Otopeni International Airport (Bucharest) and the Cologne Bonn Airport (Cologne's main airport) such as Blue Air (low cost company for direct flights) or Tarom,

Lufthansa, German Wings and others (indirect flights). You can get to Cologne by plane from Craiova or Cluj-Napoca as well through Wizz Air.

There is also possible to reach Cologne by bus (Eurolines or Flixbus), but the travel time will be far longer. Do not forget about the medical insurance (European Health Insurance Card or a private health insurance). Book also a room in advance (www.booking.com) before moving to a student dormitory or to a private apartment and get in touch with your future landlord or dormitory administrator.

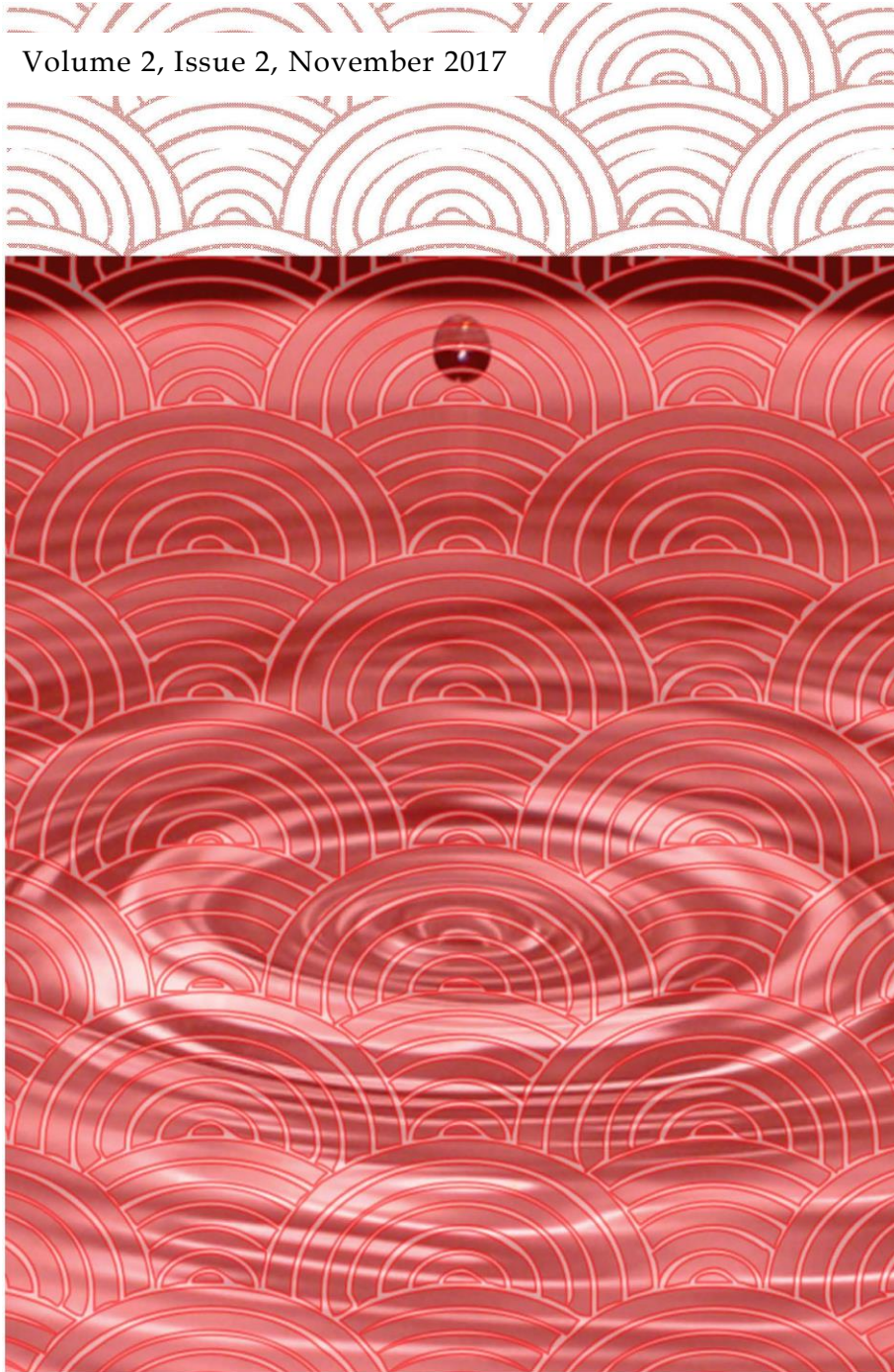
7. CONCLUSION

If you are convinced and want to take part in the programme, you can start preparing and we invite you to read the next two articles as well. In the following article you will find out more about the Technical University of Cologne, including relevant academic matters: how and what you will study, what are the advantages and the disadvantages of the study programmes and important steps to follow in order to achieve your goals.

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“Science is the millennial endeavor to identify the underlying patterns that form our world and explains the interconnectedness of the natural and social systems.”



GeoPatterns

