ANALYSIS OF RELIEF IASI CITY AND URBAN ENVIRONMENT QUALITY, USING GIS TECHNIQUES

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Abstract

The local variation of terrain properties causes profound changes in urban environment, influencing urban planning due to the restrictions imposed by the suitability of the terrains for a specific type of use (buildings, roads, green spaces location). With the dawn of computerized technology, the terrain is currently represented in a digital form only for large areas and new methods are needed to effectively describe, evaluate and quantify terrain properties, due to the terrain characteristics have an enormous impact on the natural environment and socio-economic activities.

Taking into account that our town is located in an hilly area, the present study analyzes six morphometric parameters like: DEM, slope, aspect, hillshade, drainage density and depth and landslides areas for a better understanding of how urban terrain geomorphology influence some land uses, especially for buildings expanding in geomorphologic unfavorable areas (slopes over 18 degrees), using topographical plans,1964 edition.

Digital terrain data obtained from this analysis can be correlated with other spatial information in order to determine the influence of both land ecosystem properties with other variables, as well as better implementation in urban planning.

Key words: DEM, GIS, Iasi city, urban area, buildings

Relief analysis represent the first step in urban planning, being a restrictive factor, dividing land in two categories: favorable and unfavorable land for urban development, due to its characteristics (geology, slope, aspect, drainage density, drainage depth, curvature, landslide occurrence, soil compaction, groundwater levels fluctuation, land-use etc.), adding the increasing human pressure. So that on unfavorable land the costs to build any house, road or for infrastructure would be higher than a flat land, so the decision to extend the urban area represent an important decision, that must be based on studies realized by a multidisciplinary team.

Consequences of landslide occurrence are various loss of life and livestock, damaging or destroying residential, industrial area, agricultural areas and forest land and influencing the quality of water in rivers.

Urban areas are more vulnerable at consequences of landslide, due to the high concentration of population and activities on a limited area of the city. Moreover, the presence of infrastructure, buildings, different functional areas important in the city damaged or destroyed after landslide triggering cause major financial losses, environmental quality negative impact and landscape transformation. GIS represent one of the most powerful package with many functions on relief analysis, being a real help on visualizing the spatial extension of a harmful geomorphological phenomenon.

For landslide evaluation methodological framework includes inventorying landslide and susceptibility (basically where landslides may occur in the future), as well as the assessment of hazard (basically where and when or how often) and risk (potential damage or losses) (Grovazu et all, 2012).

This paper focuses on relief analysis, applying a model for landslide hazard zonation hazard evaluation according to Ahmad et all. (2004), by overlaying three different thematic layers with ranks for each identified category, where there is a significant possibility of landslide occurrence. This study will provide more information and data for understand the role of relief in urban planning and environment quality and understanding landslide processes due to the impact on urban area of Iasi city, that is affected by landslide processes until 1911, when were realized first works for drain excess water in hilly area (actual Botanical Garden area).

The problem of relief and landslide occurrence in different environment was approached in different studies starting with

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geomorphology and cartography (Ungureanu I., 1978, Evans 1990, Cruden et all, 1996, SurdeanuV., 1997, Ionita I., 2000, Radoane et all, 2002, 2004, Prima et all, 2006, Gustavsson et all, 2008, Condorachi D., 2011), urban planning and sustainable development (Donisa et all, 1998), landslide susceptibility (Cascini et all, 2008, van Westen et all, 2008, Bălteanu et all, 2010, Grozavu et all, 2010, 2012), zonation (Soeters et all, 1996, Saha et all, 2002, Ahmad et all, 2004), hazard and risk assessment (Carrara et all, 1995, Aleotti et all, 1999, Fressard, M, 2009) and landslide effects (Clark et all, 2000, Asadian et all, 2010).

MATERIALS AND METHODS

Contour map was realized after digitizing from the topographic maps scale 1:5000, used as the input in GIS software for the studied area, delimited after official boundaries of build up area of Iasi city. Digital Elevation Model – DEM (figure 1) were generated and other geomorphometrical parameters as slope, aspect, hillshade, drainage density map realized and the data were processed for obtain the surface and the percent for each category.

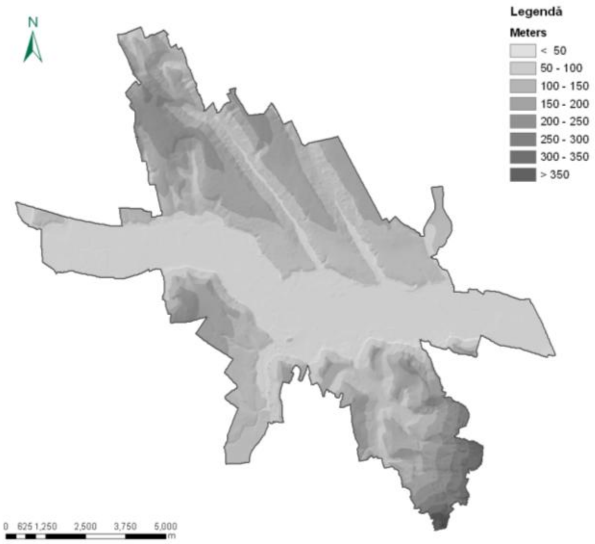

Figure 1: **DEM for Iasi city area**

For landslide hazard zonation were used three thematic layers (geology, slope and land-use). Land use categories were established using ortophotoimages 2005 edition, scale 1:5000 and geological deposits were delimited after Geological map of Romania (1966). For each category, were established ranks (tables 1 - 3) due to its relevance for occurrence of landslides.

Using raster calculator, all three maps were overlaid one to each other and landslide hazard map was obtained, integrating all ranks, divided into five zone of landslide hazard (table 4), revealing prone areas for landslide occurrence.

Geology:

Table 1

Geology ranks

Geological deposits	Rank	Age
River terraces	1	Quaternary
Alluvium	2	
Clay	3	Basarabian

Slope:

Table 2

Slope categories ranks

Slope categories	Rank
< 3^O	1
3 – 5^O	2
5 - 10^O	3
10 - 15^O	4
15 - 20^O	5
20 - 25^O	6
> 25^O	7

Land use map:

Table 3

Land use ranks

Land use category	Rank
Vineyards	2
Administrative and commercial areas	2
Storage areas	2
Industrial	2
Agro-industrial areas	2
Green spaces/Forest/Swamp	2
Arable land	3
Orchards	3
Residential	3
Airport	3
Transportation	3
Lakes	3
Pastures	3
Bare land	4
Cemetery	4
Quarry	4

Landslide zonation

Table 4

Landslide hazard ranks

Landslide ranks	Zone
4	Very low
5	
6	Low
7	
8	Moderate
9	
10	High
11	
12	Very high
13	

RESULTS AND DISCCUSIONS

a. Relief analysis/ morphometric characteristics

Elevation can be separated into 8 intervals between higher value in the flat areas of the plateau's Bucium hill (381 m) and lowest (32.5 m) in Bahlui river valley. Figure 2 reveal that 67.06% of the area have under 100 meters elevation being located along Bahlui river and it main tributary Nicolina river, and only 4.28 % with elevation over 200 meters. Higher elevation land are located in northern and southern part of the city on hill (Copou, Şorogari, Ciric in north and Bucium and Galata in south).

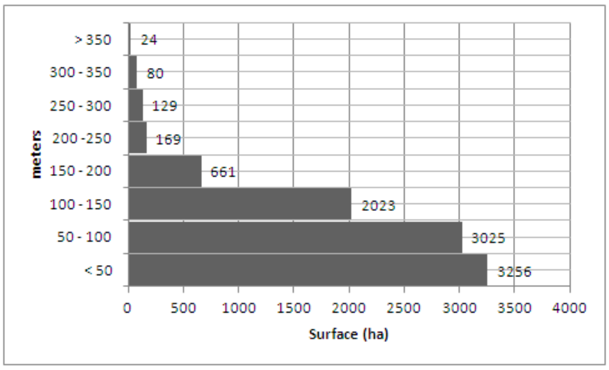

Figure 2**: The altitude variation (m)**

Slope represent an important factor in landslide triggering, land suitability for building, infrastructure costs and soils erosion because lands with slopes over 5% are vulnerable to erosion (M. Motoc, 1983).

Analyzing the morphometry of the Iasi city, it must be noted that, overall, slopes under 5 degrees are dominant in the study area 62.6% corresponding to the flat areas of the rivers valley and higher slopes (over 10 degrees) 10.5% being related with hilly land.

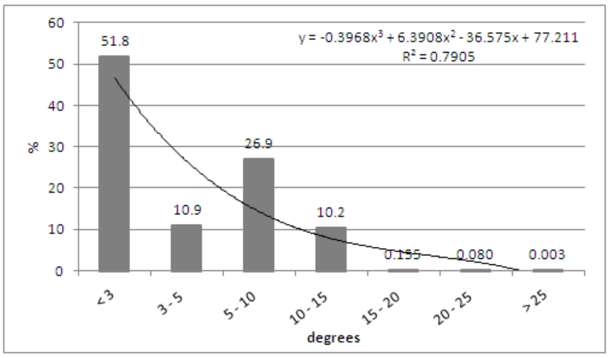

Figure 3**: Slope classes (degrees) variation (where x= 1, 2 … 7 according to each slope class)**

Aspect (Figures 4 and 5) represent another characteristic relevant for relief analysis due to its influence on microclimate determining the persistence of soil moisture, snow cover and groundwater level fluctuation on hilly land affected by landslide, as NE hill represent 15.9% (1439 ha) and SV hill 15.8% (1520 ha).

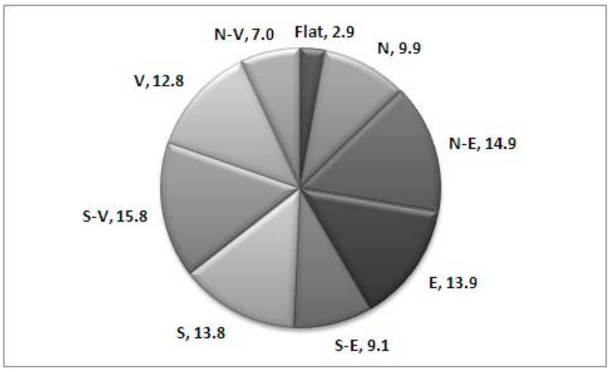

Figure 4**: Aspect classes variation (%)**

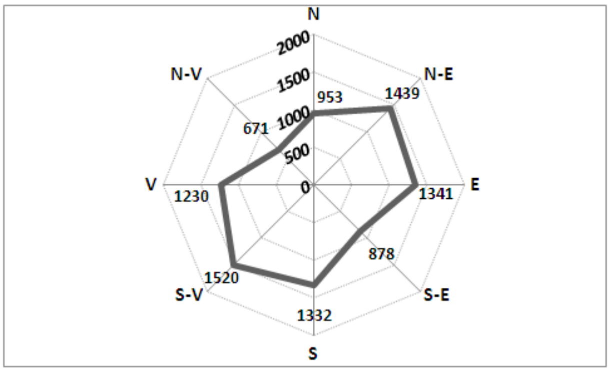

Figure 5**: Aspect and surface occupied by each class (ha)**

Drainage depth (figure 6) express the relative altitudinal differences between the watershed and thalweg (S. Bilasco et.all, 2011), with influences in landslide formation and occurrence in a quite similar manner as the elevation does, that vary between 0 and 88.36 m/km^2. Only 16.85 % of the area corresponding to the hills fit into category over 40 m/km^2.

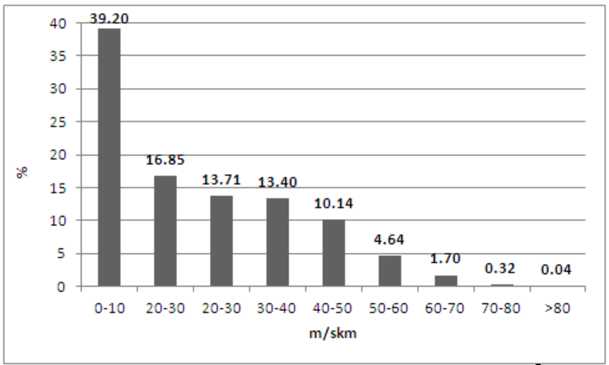

Figure 6: **Drainage depth variation - m/km^2**

Drainage density is the degree of horizontal fragmentation in a territory, by permanent and temporary channels (Figure 7). It influences urban planning by increasing the costs for infrastructure and its route, influencing the accessibility in certain areas and also landslide formation in a very specific way, fragmented a territory has also steep slopes that would be exposed to the above mentioned processes, with values between 0 located in flat areas of hill's plateau and higher values in Bahlui river Valley and its tributaries, maximum value 3.96 km/km^2 were located in the area of confluence of Bahlui river with tributaries from south (Vămăşoaia river).

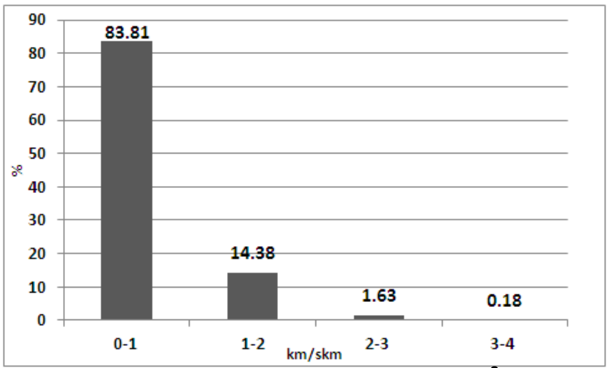

Figure 7: **Drainage density km/km^2**

b. Landslide hazard zonation

Land use (figure 8) represent an useful tool in relief analysis giving supplementary information about the human activities impact on actual geomorphologic processes, delimiting natural vegetation areas, water bodies, and functional areas of the city as residential, transportation, administrative and commercial, industrial.

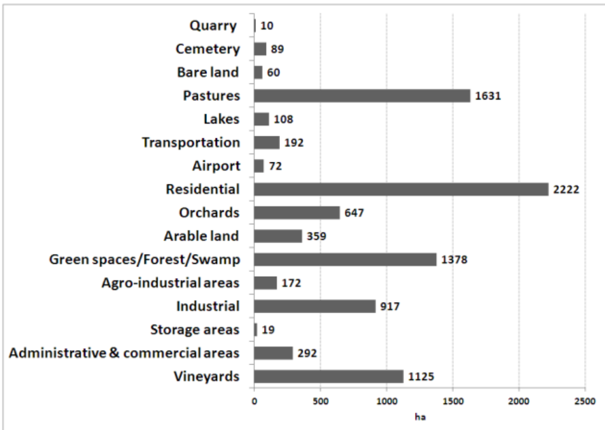

Figure 8: **Land use (ha)**

The most significant changes in the natural landscape occurred mainly as a result of the vegetation cover change, having implications on slope stability and soil moisture interfering in the geomorphological processes dynamics, causing reactivation of older landslide or increasing the stability thanks to the vegetation (trees, vineyards, no orchards due to the possibility of reactivation of landslide in autumn when orchards are bearing).

Residential areas are dominating the urban space with 23.91% (with higher among of individual houses), followed by 44.47% (forest, green spaces, pastures and vineyards).

Including this indicator in general landslide hazard zonation would be useful to identify the real areas where landslide could appear.

Landslide hazard zonation represent a method that use three thematic layers (slope, geology and land-use) to reveal five zones of landslide hazard such as very high, high, moderate, low, very low (figure 10). 62.2% of studied area is included in very low and low categories, and 5.3% (502 ha) in high and very high categories (figure 9), representing areas where new buildings raising should be restricted.

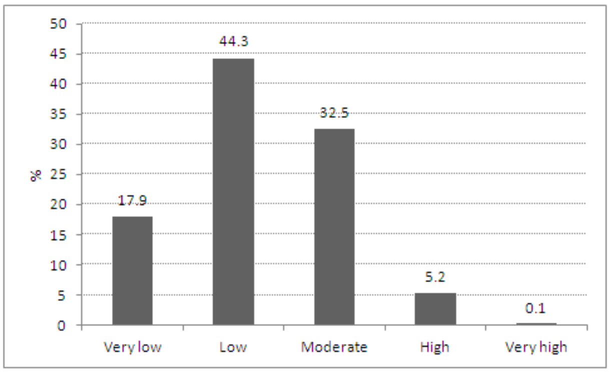

Figure 9: **Landslide hazard categories**

CONCLUSIONS

The analyze of the relief of Iasi city highlight the following:

- Morphometric characteristics (elevation, slope, aspect, drainage depth, drainage density) represent the first step in relief analysis and land suitability for different functionalities on the city.
- Land use map show that residential areas are dominant in the urban environment 23.91%
- Landslide hazard zonation reveal five zones of landslide hazard such as very high, high, moderate, low, very low, with 5.3 % of the included in two first categories, the map represent a real support in the prevention and control of these phenomena and limiting destructive effects on human society.

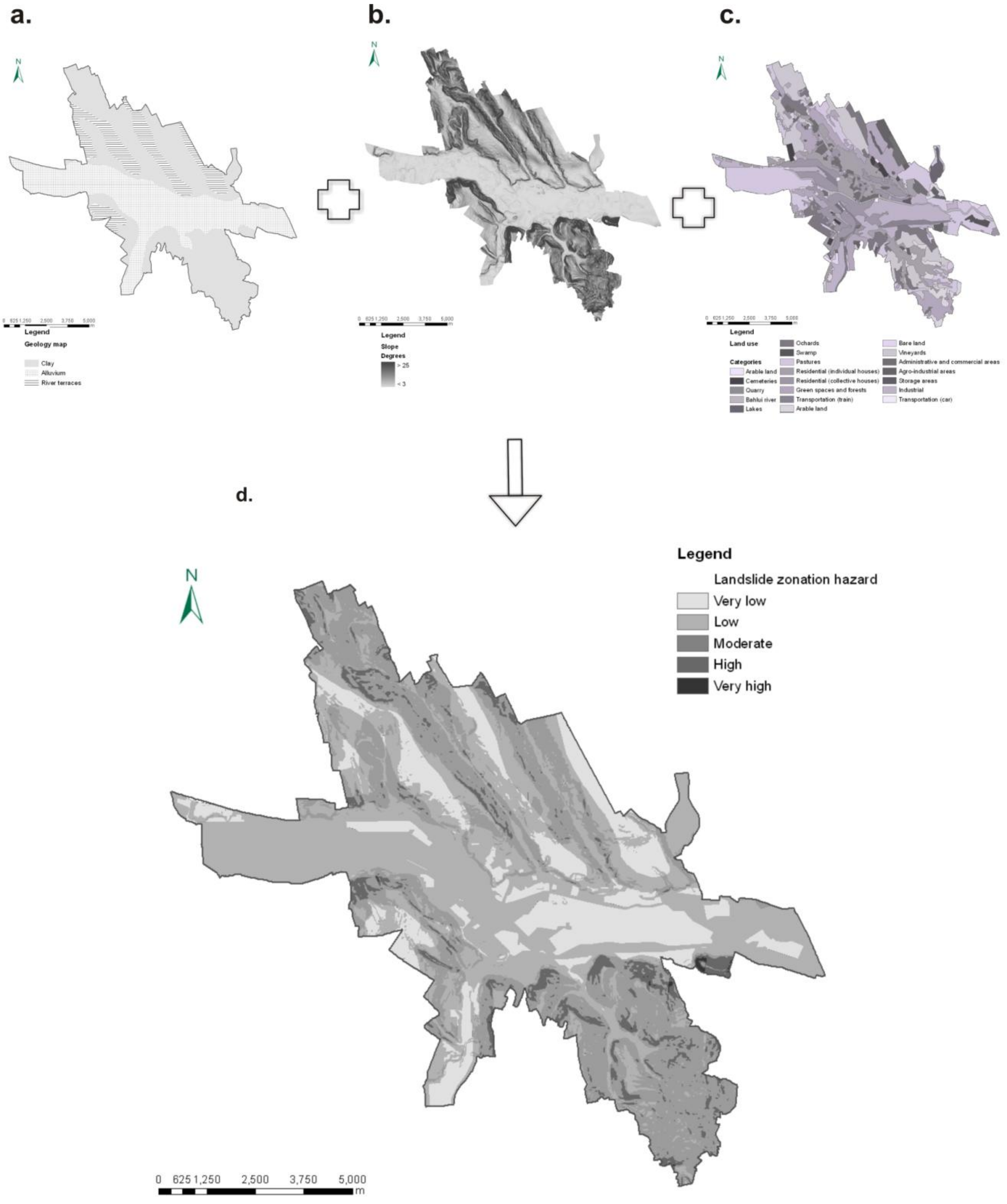

Figure 10: **Landslide zonation hazard map (d) obtained through overlaying geology (a), slope (b) and land use (c) maps**

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