

GIS BASED NATURAL DISASTER MAPPING: A CASE STUDY

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ABSTRACT:

Sebinkarahisar Township which has been selected as study area is located between Black Sea and Central Anatolian Regions. Not only geological characters but also social life in the township had been affected by these two regions. History of the settlements goes back to early Hittite period. Even it was a province in the first years of Turkish Republic, today it is a township belongs to Giresun province. Landslide is one of the most effective natural disasters in the region. Due to wrong decisions of local authorities caused lots of damage, during the last two decades. Firmly some part of the city, which has the highest landslide risk, is prohibited for new settlement, and some studies (still at beginning level) had been carried out. In this study, morphology, geology, land cover, slope inclination, elevation of the region is investigated. 1:25000 standard topographic and 1:25000 standard geological maps are scanned and referenced geographically by using Topol software. Contours, settlements, roads, meadows, and forests are digitised from the geo-referenced topographic map and different geological formations are digitised from the geo-referenced geological map. These layers are saved as blocks. By extrapolating method, the third dimensions of these blocks are reedited from the contours using QuickSurf module of AutoCad software. These blocks are added to ArcView software and digital elevation model is produced. Also the reasons of the occurred landslides are investigated and they are added to ArcView software. Finally the region classified by the amount of their potential landslide risks and risk map is produced. The aim of this study is; producing a landslide risk map and giving some precautions before the planning of the settlement.

1. INTRODUCTION

Landslide is defined as a slide of a large mass of dirt and rock down a mountain or cliff. Landslide is the exterior and downward movement of the natural rocks, every sort of soil and artificial filling. In another words, the movements of the masses on the slope sides by the grounds. Usage of industrial, agricultural and settlement areas causes some geological events. Landslides are examples of these geological events. Naturally occurred landslides may cause lost of lives and wealth and also communication and transportation interruptions. Therefore; stages of landslide constitutions and causes should be researched.

In this study, the occurred landslides in Sebinkarahisar Township were examined. There are many active and potential landslide zones in this region. Morphology, geology, land cover, slope inclination, elevation of the region is considered. The aim of this study is; producing a landslide risk map and giving some precautions before the planning of the settlement.

2. CAUSES OF LANDSLIDES

For the landslides, water flow, excavation, dissociation of the rocks and changing of plant cover are the main reasons. The along effects of these causes facilitate the landslide occur. According to topographical conditions and excavations, sliding movements turns to fall downs. Because of not doing stability analysis for excavations for settlement and transportation constructions, there are many landslide occurs in potential landslide zones. Also, changing the plant cover for earning new agricultural fields or growing up more beneficial crops improves the landslide risk. In addition to them natural

(earthquakes), artificial (explosions for road and mine constructions) vibrations, rain dose, fountains and churn waters are the other effects. (Tarhan, 1991)

According to researches; landslides are caused by %42 water effects, 26 % excavations, 26 % dissociation, 4 % changing of plant cover and 2 % other effects. When these effects are considered together, the numbers on table 1 are appeared.

Causes	Percentage
Dissociation	3
Water	9
Excavation	11
Water + Excavation	20
Water + Dissociation	22
Excavation + Dissociation	11
Water + Excavation + Dissociation	10
Water + Dissociation + Plant Cover Changing	9
Others	5

Table 1. Causes of Landslides

3. FORMS OF LANDSLIDES

Snaps

As a result of snapping of soil and rocks, mass falls, leap, hop or roll freely. There is a little or non effect between the units during the snapping. Movement may change from fast to very fast. There may be little movements before the main movements. The main reasons for snaps are climate, frost, and dissociation of the blocks by hydrostatic effects, dynamite explosions and carvings of the waves.

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Slips

Slips may occur because of the decrease of the sector resistance by one or more surface. This surface can be seen or predicted. Slips are separated two classes according to the mechanical properties. In the first one; there is no big changing on the moving mass. This group is called as rotating slips. Collapsing of the surfaces are the main kinds of rotating slips. In the second one; there are big changing on the moving mass or arise by to many small pieces. Sliding of the rocks and trashes are the main kinds of the second one.

Flows

Volcanic eruptions and big rock landslides are mainly include dry pieces. These flows called as flows of rock pieces. Moist flows mostly occur in riverbeds and follow it. Rain dose affects these types of flows. Solid matters (soil, rocks, stones, trees, branches, bushes) constitute the 60-70 % of the weight. They stop by leaving their load to a leaning valley or floor of a mountain.

Complex Landslides

Most landslides display different movements during their progress. Then most landslides are complex. Complex landslides can be classified because they indicate the main characteristic type. Controlling the landslides and determining the most useful knowledge to protection form the landslides are the main reasons for classifying. (Atalay and Bekaroglu, 1973)

4. STUDY AREA; SEBINKARAHISAR

Sebinkarahisar is a township belongs to Giresun province. The centre of township is $38^{\circ} 25' N$ and $40^{\circ} 17' E$. The settlement is on the valley between Meryem Mountain (2008m) and Kale Hill (1568m). The altitude of the township is 1350m. There are too many streams and little lakes located in the region.

Climate of the study area shows warmth and terrestrial characteristics, Anatolian climate is dominant. On the other hand; a crossing climate to Black Sea climate is dominant about evaporation, moisture and raining conditions. Approximate yearly temperature is $8,9^{\circ}C$ and amount of rain is 572,2 mm. The main wind direction is north-east and second one is south-west.

On the north side of the township there are half-moisture and dry but spoiled forests with xerophyte. The other areas are covered by bushes and grassy places. However, there are some tree groups on the south side. (fbe.ktu.edu.tr)

5. TOPOGRAPHIC AND GEOLOGICAL MAPS

As seen in figure 1, 1/25000 scaled standard topographic map (H40b3) of the region is geographically referenced by calculating and entering the Hayford-50 coordinates of the intersection points of the coordinate network (148 points). Contours, settlements, grassy places, lakes and roads are digitised as blocks by the Topol software.

Because Topol software does not support third dimension, contours are exported in dxf format and in AutoCad software the third dimensions, height information, are entered.

Settlements, grassy places, lakes and roads, also exported in dxf format and by QuickSurf module of AutoCad software their height information is processed. QuickSurf module uses extrapolation method.

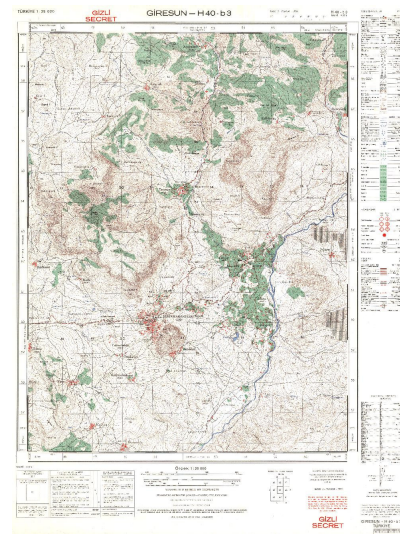


Figure 1. Standard Topographic Map

The standard geological map (H40b3) (figure 2) of the region is scanned as six parts. All parts separately geographically referenced by calculating and entering the Hayford-50 coordinate of the intersection points of the coordinate network. These parts are combined by Topol software. 5 different geological formations of the region digitised as blocks by Topol software. These are:

- Qa : Alluvium,
- Te : Andesite Basalt,
- Tk : Conglomerate, Sandystone, Siltstone, Mudstone,
- Ty : Tufa, Sandy Limestone, Conglomerate, Basalt, Andesite, Aglomerate,
- Krf: Morn, Micritic Limesstone, Andesite, Basalt, Sandystone, Aglomerate, Tufa

All digitised blocks are used as different layers and entered to ArcView software.



Figure 2. Standard Geological Map

6. DIGITAL ELEVATION MODEL

Digital elevation model is produced by linear interpolation of contours. Interpolation was used to determine the not known heights between contours. TIN (triangulated irregular method) was used for digital elevation model. The used DEM was produced in ArcView software. Obtained DEM is given in figure 3.

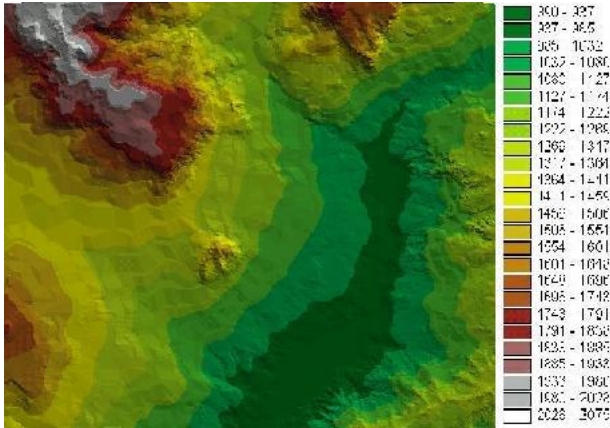


Figure 3. Digital Elevation Model of the Study Area

7. EVALUATION OF THE OCCURRED LANDSLIDES

Avutmus, Akbudak - Agriculture Technician Office, Gümüşhane - Kavaklar, Yıldız, Kırkgöz, Dereli-Küntük, Dereli-Karahanlılar, Çamlık and Kulacık landslides are evaluated with their time, forms, average width, length, slope, consistency limits and damage.

The main causes of these landslides are determined as:

1. Hard and cracked clays, whose dry and self resistance is high, may scatter and break into pieces easily when they contact with water.
2. Slip resistance parameters of rocks are decreasing because of dissociation.
3. Because irrigation is done by ditches, water leaks under soil.
4. Slope arrangements by roads are insufficient.

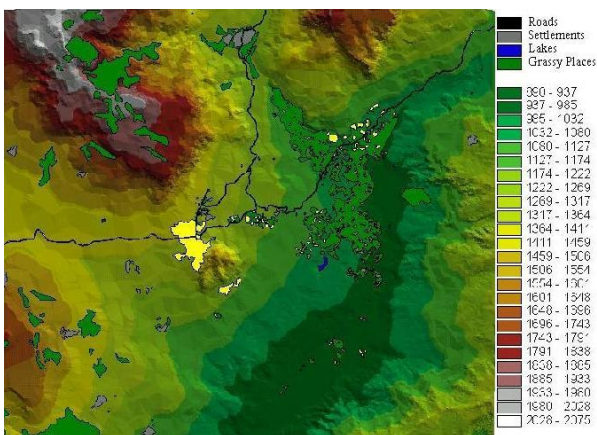


Figure 4. Occurred Landslides on DEM

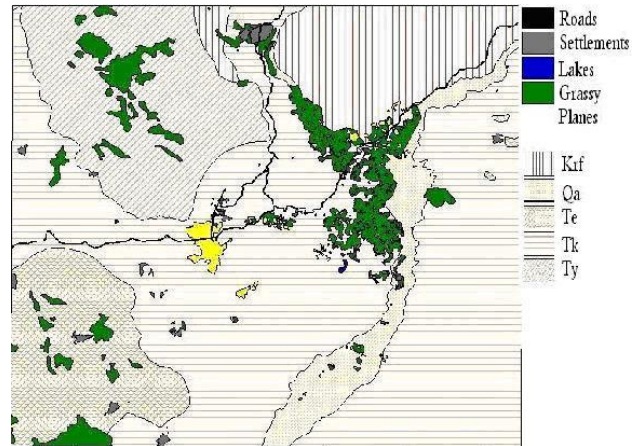


Figure 5. Occurred Landslides with Geological Formations

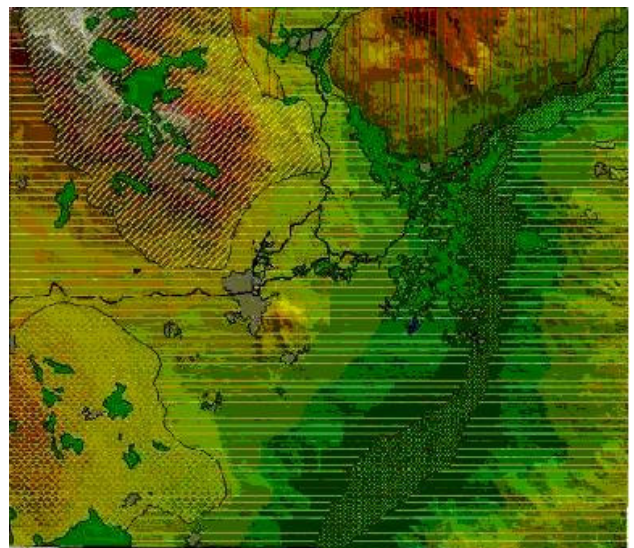


Figure 6. Geological Formations on DEM

8. RISK MAP

Township may divide 5 parts after evaluation of occurred landslides:

1. Rock Fall Zones: Rock falls and slips are occurred at the north and south sides of the township. Buildings at these regions are under risk. Settlement should permit after the emergency distance.
2. First Degree: This zone includes the areas that were affected by the slipping and flowing movements. Active movements occur at the melting and rainy seasons. Slopes are higher than average slope at this zone. Settlement should be banned in this zone.
3. Second Degree: This zone includes the areas that were affected by the slip and flow movements. Topography is wavy. There are vertical deviations. Settlement is inconvenient. Present constructions should be stopped and buildings should be under observations.
4. Third Degree: This zone is not widespread. But there are slipping symptoms, swelling and gathering movements in this zone. Settlement should be

- permitted according to strong substructure and obtaining drainage of surface water.
- Inactive Zones: Topography is almost smooth. Settlement should be permitted according to obtaining drainage of surface water. Otherwise slips and flows may occur.

9. RESULTS AND SUGGESTIONS

The study region is very risky because of its geological formations, climatic attributes, and high amount of slopes. The other reasons are:

- Tectonic movements at the North Anatolian Fault zone effects the landslides.
- Inclination of the study area is very effective on the landslides.
- Because of Black Sea climate, amount of rain is very much, and it increases the relation between water and underground units.
- Churn waters and irrigation waters make extra load on the slopes.
- Because the daily temperature difference is high, water in splits freeze and melt.
- Slope of the study area to effective on occurring landslides.

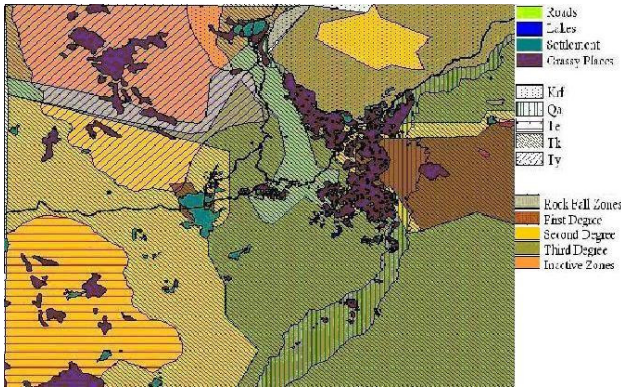


Figure 7. Risk Map of the Study Area

Before the suggestions for preventing landslides; it is useful to investigate the expense for covering the damage of a landslide: 1 % Engineering, 1 % Nationalisation, 20 % Re-construction, 38 % Restore, 40 % Losses and indirect costs (Schuster, 1986). It is clear that, expenses of preventing or correction of landslides are more economical than the after-costs. Successful precautions depend on complete and true knowledge. Risky zones should examine technically.

For this region these suggestions should be exposed:

- Analysis of stability of slides and slopes should be done.
- Slopes by the roads should be planned carefully.
- Drainage of surface and underground water should be done.
- Changing of plant cover should be prevented as far as possible.
- Rock mines should be far away from risky landslide zones.
- Churn water should attach to sewer system.
- Alternative irrigation methods should apply.

- First degree zone should afforest.
- Settlements should be constructed according to risk coefficient.

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