RIZE DISASTER MANAGEMENT AND METEOROLOGICAL EARLY WARNING SYSTEMS

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Abstract

The Rize province is located in the northeast of Turkey. The total annual rainfall in this region is about 2200 mm, which is quite greater than the average rainfall of Turkey. Therefore, this region is largely affected by flood and landslide disasters. In order to minimize the impact loss of property against the disasters that will affect Rize city and provincial area, a new system will be established using GIS, remote sensing and meteorological early warning systems. This project consists of four sub-study groups: establishment of disaster information system, remote sensing studies, installation of a meteorological early warning system and geological studies. With the realization of the study, a system which can be used for disaster management, loss estimation, planning and application of emergency response will be established. Also a decision-support system functioning for governmental and local authorities will be ready. The first proposal of the project was prepared and submitted to the Scientific & Technical Research Council of Turkey in the beginning of 2006 and was funded in the beginning of 2007 after a long evaluation by the Council. This paper will give an overview of the scopes of the project and works carried out since it was funded. The project period is two years.

Introduction

The fast and efficient accessibility to the data belonging to the hazardous regions is very important in order to be prepared to and able to mitigate the damage before the disaster happens and be able to organize the response and recovery phases after and during the disaster. In this aspect disaster management plays an important role to overcome the adversities of all kinds of disasters (www.fema.gov, Waugh 2000). Therefore, there have been various methods used by the decision makers to coordinate the disaster dependent life. In the past few years a relative new technology "Geographic Information Systems" shortly referred as GIS has come up as a new method to be used in disaster management (ESRI, 2001).

In this study a GIS based system is tried to be established in order to generate a disaster management system. The major inputs to this system are remote sensing images,

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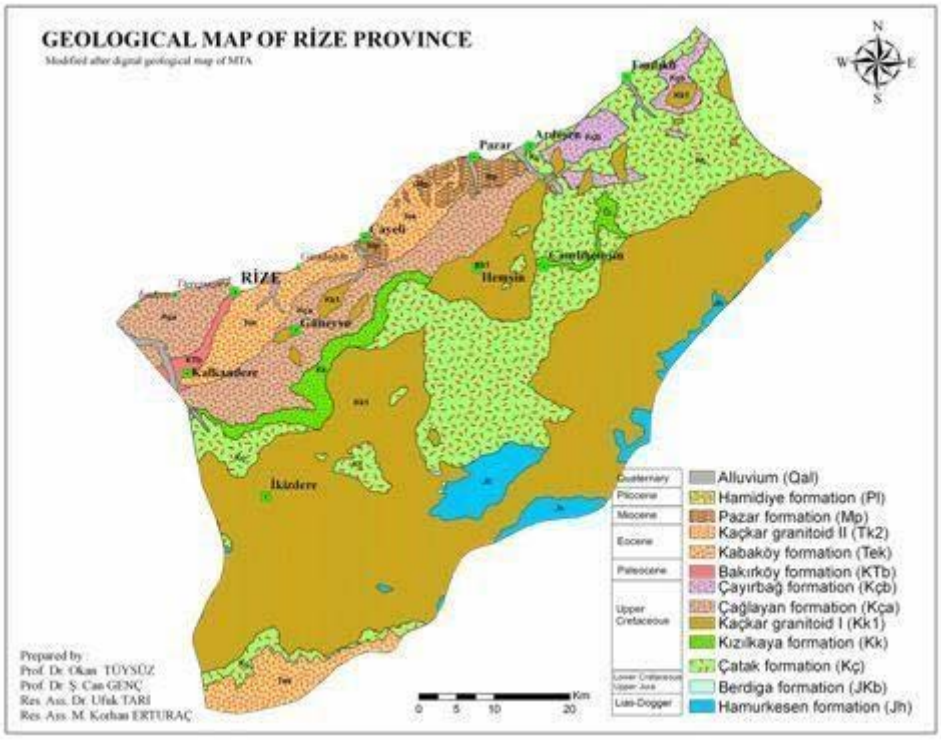
meteorological data acquired from the Automated Weather Observation System and geological data. The realization of the project, will form a system which to be used in disaster management, loss estimation, organization of emergency response. Also a decision support system functioning for governmental and local authorities will be created. This system is going to be a standard model and also a prototype for Turkey. Project will also include the standards described in Turkey Disaster Information System (TABIS) catalogue which is first and unique in Turkey (TABIS Standards, September 2002; Karaman and Sahin, 2005). Besides, as this study requires a great amount of data to be collected from the governmental and local administrations and will establish a system depending on these data, the project will provide a standardized database for these administrations. On the other hand the services of these corporations will be more efficient and transparent in the relationship with citizens. The cooperation of the corporations will be easier, faster and more reliable. By this way the e-state project will be applied in a city basis for the first time in Turkey. In addition, this project can be assumed as a model for Turkey in the future. In means of technological development, the wireless communication systems will be used in a very different aspect as they will be used for early warning systems on a very rough terrain. So, such systems will be able to be established in other cities of Turkey benefiting from the experiences during the project.

Geography And Geology of Rize Province

Rize is located on the southeast coasts of the Black-Sea between the 40°22' - 41°28' eastern longitudes and 40°20' - 41°20' northern latitudes. It is surrounded by Trabzon province in west, Artvin province in east, Erzurum province in south and Black-Sea in the north direction. The area of Rize is about 3920 km^2 and 78% of it is covered with mountains. In Rize three forms of morphologic structures are seen from north coast to south border (Fig 1). The coastal line in Rize is almost 80 km and the depth of the coastal band varies between 20-150 m. In this part, there can be seen some alluvium plains which are formed by the rivers flowing in the south-north direction and pouring to the Black-Sea.

Figure 1 – Geological Map of Rize



The second part is the mountain area split by the valleys. The height in this region increases sharply to 150-200 m. after the coastal band. Sharp and adjacent mountain shoulders create "V" profiled valleys that are almost 2000 m. high. The third part is defined as high mountain and glacier area. It starts from 2000 m. and rises till 3000 – 3200 m. high. The area above 3000 m. is the roughest terrain that can be seen in Rize and usually formed of "U" type valleys. In geological means, Rize is located on East Black-Sea magma plate. The rivers in Rize are mostly short and have horizontal tendency. There are 23 rivers longer than 5 km. 16 of these rivers reach Black Sea while the others connect to these main rivers as arms. The rivers in Rize have regular regime and carry less sediment compared to other rivers in Turkey (www.rize.gov.tr).

Natural Disasters In Rize

It is possible to mention that Rize province is affected from two main types of disasters which can be categorized as geological disasters and meteorological disasters.

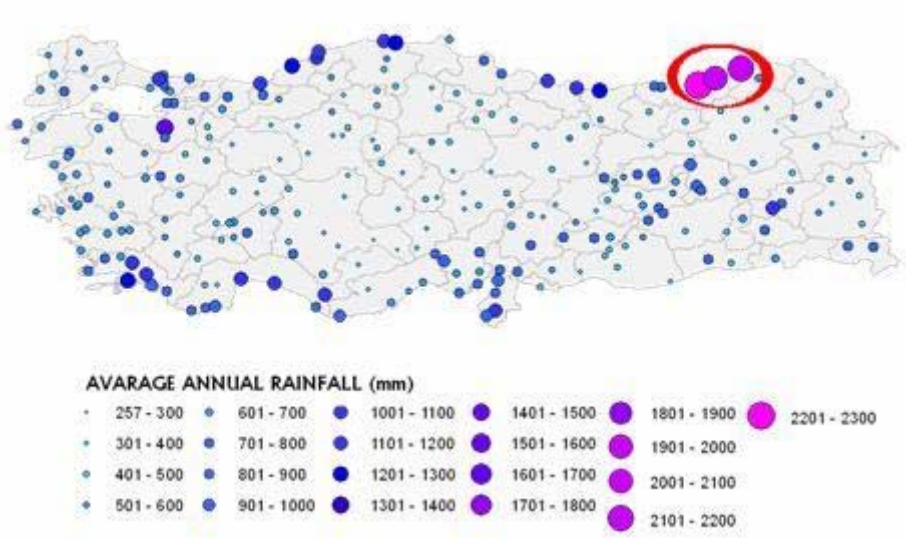
Geological Disasters:

Earthquake is the main natural disaster in Turkey. On the contrary Rize is one of the luckiest cities in Turkey. According to the geological data, there are no active faults that can cause a destructive earthquake in Rize. The closest fault to Rize is the North Anatolian Fault and it is quite far from the city. According to the records the biggest earthquake this fault created had the force of 7.9 Mw. Although such earthquakes are not taken into account in means of creating a big damage in Rize, it is known that they can trigger landslide and rock falls.

Meteorological Disasters:

The most destructive disasters occurred in Rize province are landslide and flood. Landslides can happen when the ground substance loses its stability and slides in the suitable geologic and meteorological conditions. The high slope values in Rize province causes these slides very often. This type of morphology makes it more possible to generate a landslide. On the other hand the most important factor is the rainfall. Rain makes the ground much more unstable than usual and triggers the landslide. The other disaster, flood is also mainly dependent on the meteorological effects but it is also affected by geological and geomorphologic parameters. Impervious soil structure, large feeding area, narrow discharge section and the amount of carried sediment are important factors in floods. Taking into account that Rize has very high rainfall values (Fig 2) and sharp geography, these disasters are the most hazardous ones affecting Rize.

Figure 2 – Annual Rainfall Values in Turkey (mm)



Objective

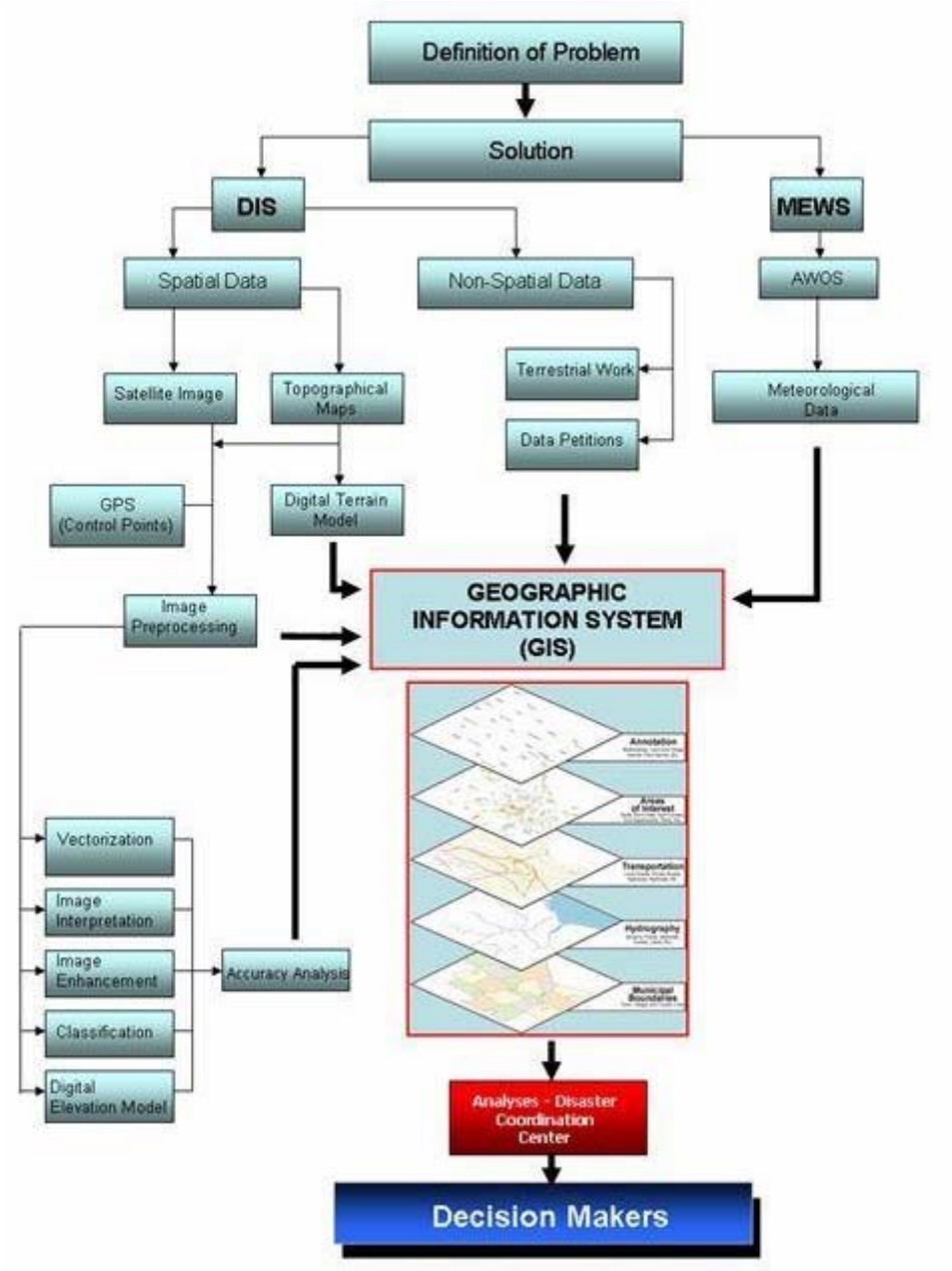
In this study it has been planned to create a system especially using GIS, Remote Sensing Techniques and Meteorological Techniques, to lower the loss of human life and physical losses which occur as results of natural disasters.

The aim of this project has been, using the methods mentioned above, to apply a GIS based information and administration system model to serve for planning and applying of the emergency preparations, disaster management, loss estimation and decision support for local authorities.

Method

Although there are various and many stages in the project process, the project can be considered in two main parts (Table -1).

Table 1: General Work Flow of the RABIS Project



In this sense, a Disaster Coordination Center (AKOM) will be established and this center will be coordination station of the system. The two parts of the project are as below:

1. Establishment of disaster information system (DIS)
2. Establishment of meteorological early warning system (MEWS)

Disaster Information System (DIS):

Firstly, the DIS planned in this project is a GIS based model. It will serve to make analyses in means of reducing the disaster effects. Additionally it will also include a city information system which will be very helpful for municipality administration in means of organizing the services. Shortly to mention, in this structure a city information system will be established with an integration of disaster aspect.

The DIS will be formed according to the standards of Turkey Disaster Information System (TABIS). Naturally there will be two types of data needed: Spatial and Non-Spatial. Gathering the spatial data has been planned in two options. The first one is remote sensing images and the next one is topographic maps in 1/25000 scale. These data are one of the most crucial parts of the system as the DIS and all kind of maps (landslide, flood, geologic, urban etc.) will depend on these two. Non-spatial data are thought to be gathered in two ways. Firstly it is planned to obtain the current data which were already had by the governmental administrations and then it is planned to organize a field work which will provide the most important input to project since the non-spatial data recorded in state corporations are mostly useless or inaccurate. Based on these non-spatial data any sort of emergency analyses will be made. The other non-spatial data will be the meteorological data which will be obtained from MEWS.

The design of the software that will be used (NetCAD) is going to be made by a national software and mapping firm ULUSAL CAD A.Ş. (www.netcad.com.tr). The creations of the maps, information systems, analyze modules and databases will be carried out by ULUSAL CAD A.Ş. in cooperation with DIS workgroup constituted in ITU structure.

Meteorological Early Warning System (MEWS):

Firstly MEWS will have a hydrometeorology database and it is thought to include:

1. Vegetation data with high resolution
2. Ground soil type with high resolution
3. Precipitation and temperature data recorded in various points for a long period
4. Soil moisture measured in different points and at different depths for long period
5. The flow data of the rivers

In addition to these data each landslide will be recorded to database with the location and date that the event occurred. Just like landslides, flood events will also be recorded in database in the same manner. The automated weather observing system (AWOS) stations will be established to record the desired data in selected regions which will represent the height zones covering 500m wide area.

Furthermore, estimations will be made intended to flood and landslide events. In this aspect both dynamic and static stochastic modeling techniques will be used. In order to that a mezzo scale atmosphere model is planned to be used. The model for that is chosen as MM5 model which is also widespread in many countries around the world. Once the model starts to process, low resolution data gathered from European Center for Medium Range Forecasts (ECMWF) will be benefited to generate high resolution weather forecast data for Rize province. Afterwards these data will be evaluated with the data in database and landslide and flood estimations are going to be made. The database needed in this system will be integrated with the DIS. While vegetation will be acquired from remote sensing images, soil type will be

composed from literature. The sensors that will be used in stations will be compatible with the automated stations of DMI (State Meteorological Administration).

Progress

It has been almost fifteen months since the RABIS project has started. As mentioned above there are some goals that are expected from the responsible corporations. There are four sub-study groups from ITU and ULUSAL CAD A.Ş. as itself working on the project. These are DIS& Software (NetCAD) workgroup, Remote Sensing workgroup, Geology workgroup, Meteorology workgroup. Although the groups work in coordination between each other, all has different aspects and aims. Naturally there are term based goals and so that some of the goals mentioned above have already been achieved. In order to give a perspective the project period can be divided into two parts as: progress until now and progress from now.

DIS & Software (NetCAD) Workgroup:

DIS workgroup is focused on mainly designing the system's database and compatibility with TABIS standards. In addition data acquisition is in the responsibility of this group. In this aspect, TABIS catalogue was refined according to the needs of the Rize province. There have been some additions to cover the geological and meteorological data needed and reductions in the catalogue due to the redundancy of some attribute existing in TABIS catalogue. Afterwards the data acquisition forms that were sent to local governmental administrations in order to obtain current data were created and most of them returned with a surprising data quality. The DIS workgroup works mostly in coordination with Software (NetCAD) Workgroup.

Furthermore since this workgroup consists of mostly surveying engineers (ITU Geodesy & Photogrammetry Eng. Dept.) the geodetic surveys needed for the project's datum and projection parameters were carried out by this group. After the surveys were finished, a web-based coordinate transformation interface was created for any client to use. All of the coordinates were calculated according to the GRS80 ellipsoid and Transversal Mercator projection with 3° slices depending on the Regulation of Big Scale Map and Map Information Production used in Turkey (Regulation of Big Scale Map and Map Information Production, Turkey).

Beside every study mentioned above, the software part is the structure that will be used by the end users and it is the system that integrates every workgroup. Because of that, the substructure of the system is crucial. The database design is therefore the most important part. In means of developing the system, ULUSAL CAD Company has developed the DIS model for both governorship and municipality. In addition, the vectorization of the satellite images are 50% finished and the geological maps were all integrated to the system. The city information system module and data acquisition module based on TABIS catalogue has been completed which is very important for the data acquisition field work. Also there has been designed a web portal at http:\\213.139.195.66\vportal address. From this portal the updated news about the project can be learned and followed.

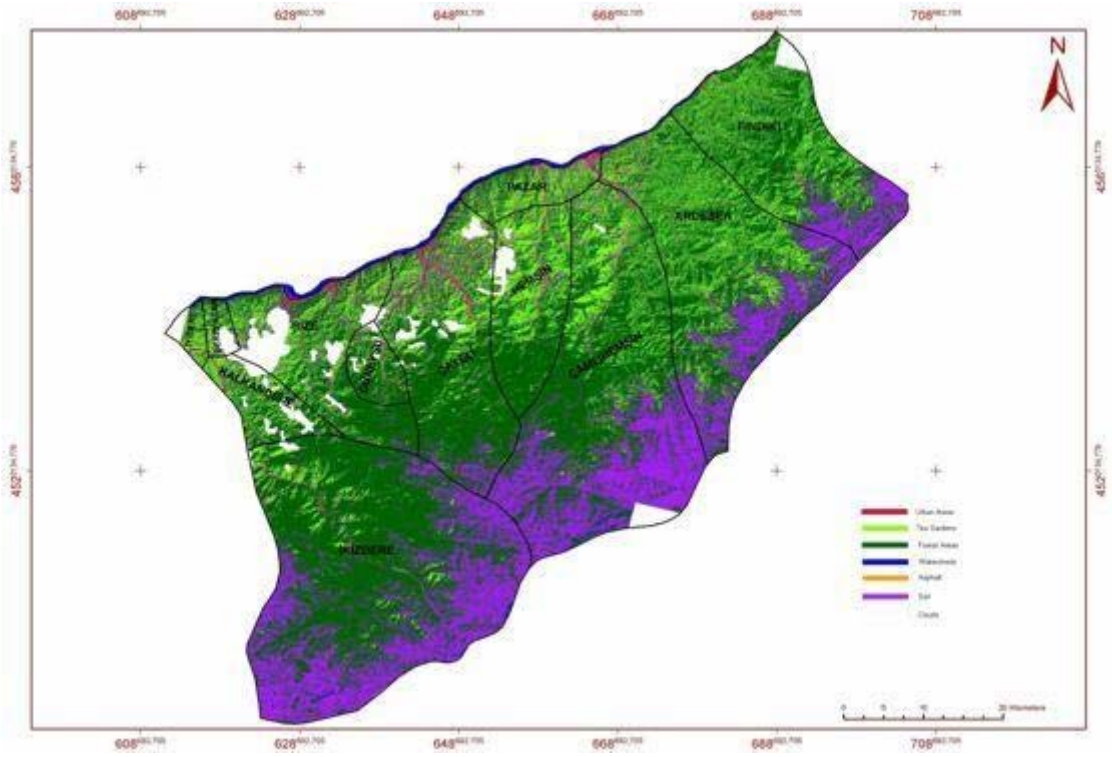
As there have been problems in obtaining remote sensing images, the vectorization process could not be handled quiet efficiently and there occurred some lack of mapping urbanized area. These problems are expected to be solved mostly in two months. In addition there have been some lacks of data acquisition from the state corporations. Although the acquired data were quite better then expected the absence of some data will have to be overcome in the future. Software workgroup will be responsible for developing the DISs built for governorship and municipality. In addition to that installation of WebGIS, generating disaster models will be main goal of these groups in the next term. On the other hand the process of improving the system and data acquisition will always be the main issue for the groups. In means of data acquisition, there will be made a field work starting with the first week of April

and it is expected to last in 3 months. In this field work the attribute data for the spatial features will be obtained. Naturally this will be the most crucial part of the project. The work will be organized by DIS workgroup mainly. NetCAD Workgroup will mainly focus on the database design and efficiency. A module for data recording into the database is already finished and database design is also mostly completed by the company.

Remote Sensing Workgroup

Remote Sensing workgroup is mainly responsible of gathering, analyzing, evaluating the satellite images and forming meaningful geodetic based images of Rize province from them. In this sense, workgroup used the geodetic survey results for geometric transformation. After that the mosaics were constructed but because of the time difference between the acquisition dates, there occurred some contrast variances. This problem was overcome by using image enhancement techniques. The distributions on the images and the object properties are taken into account so that the multi-spectral and panchromatic images could be evaluated together. During the evaluation, images were integrated with digital terrain model and analyses depending on heights could be carried out. Lastly the classification process was done in two ways: unsupervised using ISODATA algorithms and supervised. In supervised classification, 6 classes were obtained consisting of water, urban, asphalt roads, tea fields, forest areas, soil areas and blank areas (Fig 3). During this whole remote sensing process, IKONOS and SPOT images were used.

Figure 3: Supervised Classification

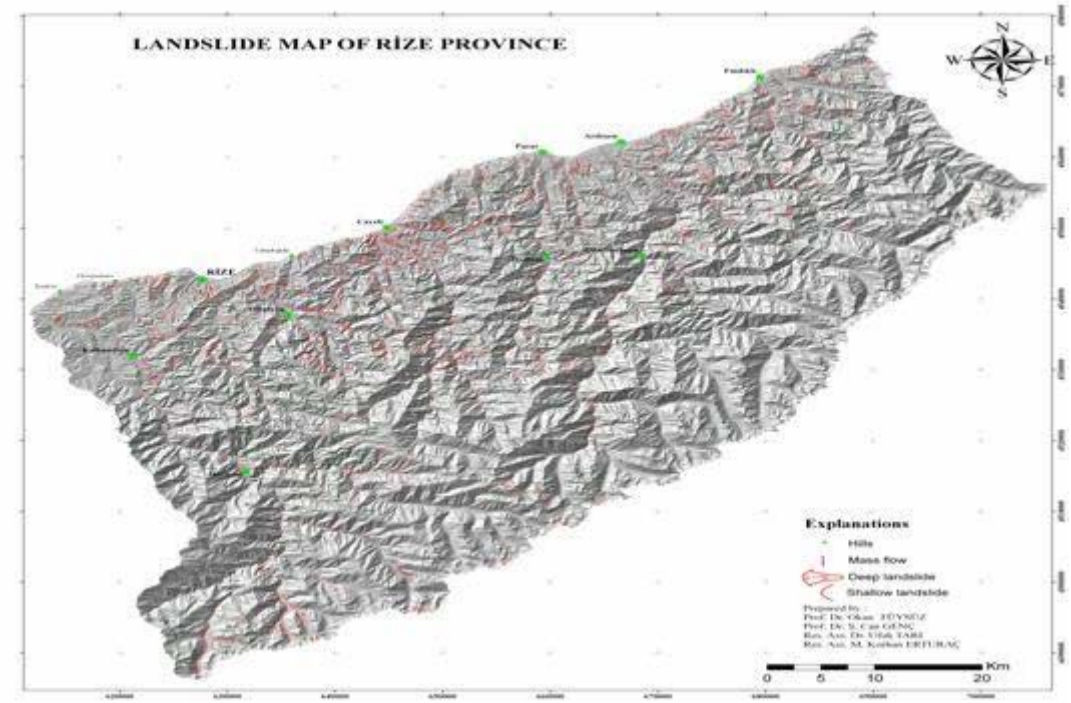


One of the major problems for this group was gathering the satellite images. In the project proposal it was aimed to obtain QUICKBIRD images but because of some bureaucratic processes the images could not be obtained. Instead of these images, SPOT5 images are gathered and they were used. But still there are problems in means of covering whole Rize province and to overcome this situation, IKONOS images are ordered and they will be supported with aerial photographs. After this process is completed the Remote Sensing Workgroup will start to enhance and analyze the images. This will make the images ready to use for any other group. Especially DIS and Software Workgroups are looking forward to get these images in order to complete the vectorization.

Geology Workgroup

Geology workgroup has been generally responsible of making geology map, digital elevation model, geomorphology map and landslide map of the Rize province. Through the period, digital geology map and soil thickness map with 1/25000 scale, were formed. In order to create these maps various reproduction processes and geophysical methods were applied.Besides, 3D Digital Elevation Model and 1/25000 scaled slope and aspect maps of Rize were made. Geomorphology maps were produced in 1/25000 scale and digital elevation model was analyzed in means of geomorphology. Lastly benefiting from all these maps, the landslide map was constituted (Fig 4).

Figure 4 – Landslide Map of Rize



Meteorology Workgroup

Meteorology workgroup is totally focused on constituting the MEWS. But the complete establishment of the MEWS needs more time due to setting up the AWOS on the field.

Figure 5 – Probable AWOS Station Locations

So far, some works have been carried out in order to test the compatibility of the system to the Rize terrain. In this aspect some field work have been carried out in selected points whether they are suitable (electricity availability, GSM availability, meteorological representation capacity) for the automated systems to operate ther. After that the bid for the AWOS stations had been made and it is assumed that in 6 months, the establishment of the stations will be finished (Fig5). The stations will measure wind direction and speed, weather temperature, moisture, rainfall, pressure, soil moisture. Mezzo scale atmosphere model has been started to be tested in relatively simpler terrains and it will be tested in rougher terrains soon. Benefiting from the current meteorological database archive, there has been made some climate analyses intended to past. Meteorology workgroup could not complete the installation of AWOS stations although it was planned. The reason for that was the bureaucratic process during the purchasing the stations. Because of that there will be a delay of 9 months. Although this seems like a major and serious problem, workgroup indicates that this will turn out as an advantage because in this period, the coordination between the governmental administrations will be removed with contracts and after the establishment of the stations, there will be no legal issues to overcome. Since the station points are selected the only part is the intake of the stations and installation of them to the system. After the stations are established the control and calibration of measurements will be carried out and the meteorological system will be modeled lastly.

Results & Suggestions

As a result, in the forthcoming 10 months the project is expected to be finished with satisfactory results. As mentioned, the main aim of the project is to create a GIS based disaster management system for Rize province. For doing this, a multidisciplinary work has been carried out and will be carried out. These disciplines are mainly geomatics, geology, and meteorology and software development. So far the coordination has worked well and the project has reached to an expected level although having some difficulties in some points as cited above. For now the groups are all focused on the field work process that will be started as the beginning of April. This period will be very important since the database will be formed with these data. In this sense it will be quite significant to obtain accurate data from this field work. As the field work is finished the AWOS stations will be installed to the system with the start of summer. Lastly the tests and configuration of the models will be carried out and the system is expected to be established completely at the end of 2008.

In Turkey such a project has never been applied or tried to be done before. It will have a database which depends on national standards; it is very unique in means of interdisciplinary coordination and it will serve for the good of the citizens. On the other hand, it is a good example of co-operation of a university and a private company. It can be clearly said that with the hard work, patience and coordination of the workgroups as done until now, it is not so far to achieve the expected results in the end.

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References

www.fema.gov, last visited in 10.03.2008

Waugh, W.L. 2000. Living With Hazards Dealing With Disasters: An Introduction to Emergency Management. M.E. Sharpe Inc. NewYork. USA

ESRI, 2001, "*GIS for Homeland Security*", ESRI White Paper, November, 2001

Sahin, M. et al, 2002 Türkiye Afet Bilgi Sistemi (Turkey Disaster Information System) – TABIS Standards; September 2002.

Karaman, H., Şahin, M., 2005, "Step by Step Constitution of an Emergency Management Based Object Model and Database System on Linux for the I.T.U. Campus Disaster Information System", First International Symposium on Geo-information for Disaster Management (Gi4Dm) March 21-23, 2005, p.585-598, Delft, the Netherlands, Springer

Author Biography

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He is born in 10.11.1965 in Rize province of Turkey. He has been the head of Surveying Techniques Department since September 2004. He has accomplished HAZTURK project and has been carrying out RABIS and ISTABIS projects. His primary profession is GIS based disaster management and loss estimation models. More information can be found in http://atlas.cc.itu.edu.tr/~sahin/muhammed_sahin.html