USING SATELLITE IMAGES TO DETERMINE ENVIRONMENTAL CHARACTERISTICS OF AN AREA : AN APPLICATION

G. Atay[a], E. Ayhan[a]

[a]KTU, Engineering and Architecture Faculty, Dept. of Geodesy and Photogrammetry,61080 Trabzon, Turkey – (gatay,eayhan)@ktu.edu.tr

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ABSTRACT:

For agricultural and environmental applications remote sensing techniques can be very important by providing information on processes such as land use, land cover, residential areas and monitoring areas which were influenced from flood. Availability of high-resolution imagery, such as IKONOS, has opened new possibilities for satellite based mapping. The whole study focuses on a selected river called Değirmendere in Trabzon, TURKEY. This study aims to get a visual risk zone state for this area and to investigate performance of IKONOS image such an application. At the end of the study, information about environmental characteristics and settlement of the workspace was gained and for a probable flood disaster a risk zone was defined for the workspace. And then possible precautions that can be taken in this area discussed. This application is only a sample study for more detailed applications.

1. INTRODUCTION

Flooding is a localized hazard that is generally the result of excessive precipitation. Floods can be generally considered in two categories: flash floods, the product of heavy localized precipitation in a short time period over a given location; and general floods, caused by precipitation over a longer time period and over a given river basin. Flooding is the most common environmental hazard, due to the widespread geographical distribution of river valleys and coastal areas, and the attraction of human settlements to these areas. (URL 1).
Earth observation techniques can contribute toward more accurate flood hazard modeling and they can be used to asses damage to residential properties, infrastructure and agricultural crops. (Van der Sande, de Jong and de Roo, 2003).

1.1 Definition of Problem

Flood disaster is one of the most important problems of Trabzon. The first flood disaster in Trabzon occurred on 5-8 July 1929 and by the reason of this disaster 146 people lost their lives. Then hundreds of people also lost their lives in 1939 and 1959 because of flood disasters too. The disaster in 1959 occurred in Değirmendere. In this flood disaster, between Black Sea and Değirmendere remained under water. On 19-20 June 1990 a big flood disaster occurred and as a result 65 people lost their lives, 1005 residences and 82 offices were demolished. (Trabzon Environment Situation Report). In 2000 a flood disaster also occurred.
By the reason of climate, physical characteristics of the region, flood disasters occur very often. The aim of this project is to obtain a visual risk zone state for this area. With probable water height values of Değirmendere, we aim to get a visual result of movement of water. Under the lights of these result we aim to guide people to think alternative settlement places except risk zone.

1.2 Project Area
1.3

The project area covers an area of approximately 8 square kilometers in Trabzon in Turkey. The name of the project area is Değirmendere. It is the biggest river in the city. Near Değirmendere river and also in the same valley (Değirmendere) there is a road. This road provides connection between the city and the east of the country. Drinking water of the city (Trabzon) is obtained from this river. These characteristics make this area very important. But such an important area has a problem "flood disaster". The reason for choosing this area as workspace is being a probable flood area. The area comprises agricultural land, residential areas and a few industrial sites. The whole project area was imaged with 1-meter resolution panchromatic and 4-meter multi-spectral IKONOS Imagery. The area is a rolling, hilly terrain, characterized by hills and valleys with elevations going from 0 to 320 meters above sea level, so the maximal variations reach about 320 meters. Figure 1 shows the location of workspace.

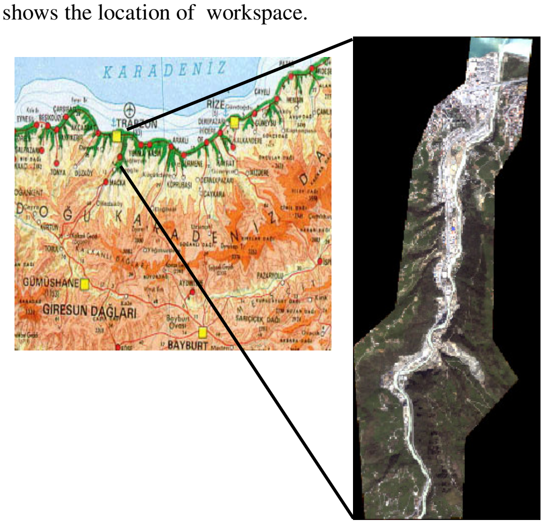

Figure 1. The location of workspace

2. DATA

2.1 Ikonos Image

Ikonos images are acquired as 1-meter resolution panchromatic and 4-meter resolution multi-spectral images. While the panchromatic images represent the visible range of the spectrum, the four bands of multi-spectral images represent the red, green, blue and near infra-red range of spectrum.

Sensor Name	IKONOS-2
Date and time of acquisition	05 February 2003
Spatial Resolution	1m. panchromatic, 4m. multi-spectral
Spectral wavebands	0,45-0,53 µm (blue) 0,52-0,61 µm (green) 0,64-0,72 µm (red) 0,77-0,88 µm (near IR)
Nominal collection azimuth	7,55^o
Nominal collection elevation	64,87^o
Sun angle azimuth	153,62^o
Sun angle elevation	62,35^o
Projection	UTM north zone 37
Ellipsoid	WGS 84
Bit/pixel/band	11 (stored on 16)
File format	Geotiff
Processing Level	Standard geometrically corrected

Table 1. Most important characteristics of the Ikonos Image (from product metadata file)

2.2 Topographic maps

To get digital elevation model (DEM) of the workspace topographic state must be known. In this study we used maps of scale 1:25000 covering the totality of the workspace. Our workspace is at the intersection of three topographic maps. These maps which are include our workspace were scanned . Then contours were digitized by using R2V(Raster to Vector) program.

2.3 Digital Elevation Model (DEM)

Digital contour lines of the above mentioned 1:25000 topographic map database have been used to calculate DEM of the study area. The topographic maps contain one contour line on every 10 meters, with the values of the current elevation above sea level. After digitizing all of the contour lines of entire geocoded topographic map database, line coverage has been created containing every contour line and appropriate elevation value. By using ERDAS Imagine 8.6. DEM of the area gained from digitized contour lines. Linear rubber sheeting method was used for this process. Figure 2. shows DEM of the workspace.

Figure 2. DEM of the workspace

2.4 Software Used

Geometric correction of Ikonos image, creating DEM and image classification were carried out using ERDAS Imagine 8.6.

2.5 Other Data

We got documents about water height of the river in 2002 Directorate of State Hydraulic Works (Primary executive state water agency responsible for water resources development in Turkey.) obtained from hydrographs.

3. METHODOLOGY

3.1 Image Geometry Evaluation

Image rectification is a process by which geometric distortions in digital remotely sensed data are corrected. (URL 2). Geometric correction is undertaken to avoid geometric distortions from a distorted image, and is achieved by establishing the relationship between the image coordinate system and the geographic coordinate system using calibration data of the sensor, measured data of position and attitude, ground control points, atmospheric condition etc. (URL 3).
In this study firstly image was rectified. The rectification process was done by using topographic maps scale 1:25000. For rectification 15 ground control points and 5 check points were used. The distribution of points is a very important issue during geometric correction . The distribution must be homogeneous. But because of physical characteristics of the land, sometimes it can't be possible to distribute points in a homogeneous structure. The workspace is also such a place. Because of that reason, the distribution of points done the most appropriate position. All the points were carefully selected and positioned that can be clearly identified both on the satellite image and topographic maps. Figure 3. shows configuration of points used.

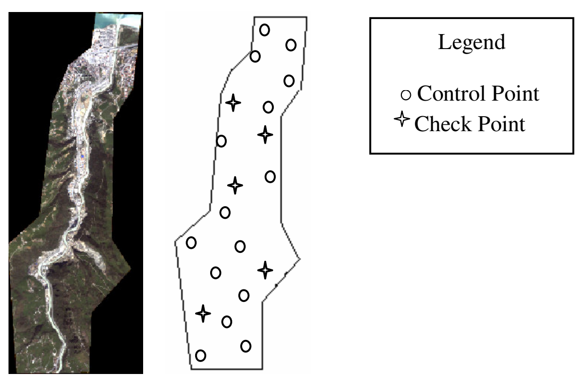

Figure 3. The workspace and distribution of points

Simple 1st order polynomial is used for image transformation. For image, RMS errors for all of the GCPs were calculated. Table 2 shows RMS errors for control and check points.

POINT	X (Residual)	Y (Residual)	Total RMS Error
Control Point Error	0,4007	0,5131	0,6510
Check Point Error	0,5452	0,5985	0,8096

Table 2. RMS errors

During image resampling, nearest neighbor resampling method was used.

3.2 Image Classification

Supervised classification method was used in order to examine digital data extraction possibilities. Training areas were selected using ground truth data and visual image interpretation. We determined four classes for classification. The classes were water, settlement , vegetation and road. Classification was carried out using Maximum Likelihood algorithm.

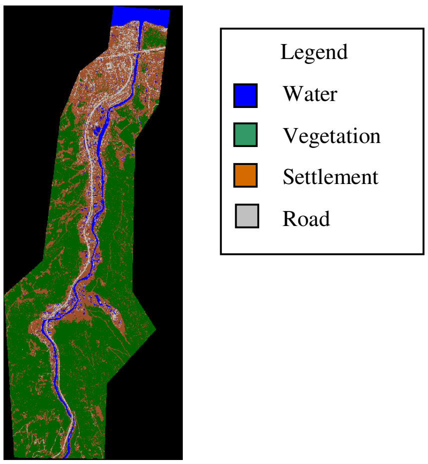

Figure 4 . Classification map of the workspace

4. RESULTS AND DISCUSSION

4.1 Combining Data

Firstly, obtained DEM (Digital Elevation Model) and rectified satellite image were joined. In this way 3D model of the workspace was achieved.

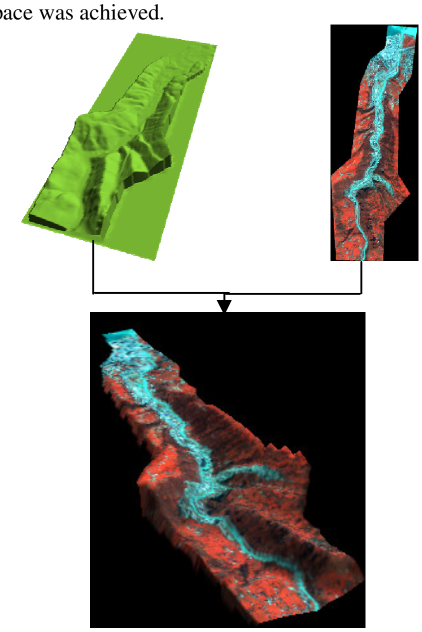

Figure 5. 3D model of the workspace

4.2 Water Height Elevation And Visual Implementation Of Flood

We got documents about water height of the river of 2002 from Directorate of State Hydraulic Works (Primary executive state water agency responsible for water resources development in Turkey.) obtained from hydrographs. We determined the maximum water height in the year. According to the values of the height of the water we set 291 cm. and 284 cm. as the maximum values. These values belong to on 19 Sept. 2002 and 17 Apr. 2002. These values are not very high so these values did not cause a flood disaster in this year . We add about 2 meters to this value to show a probable risk zone. With Erdas Virtual GIS module by using a water layer the calculated value of water height was shown on the image. For this visual implementation classified image was used. Because the aim of this study is to show risky residential area. So we used an image showing residential area.

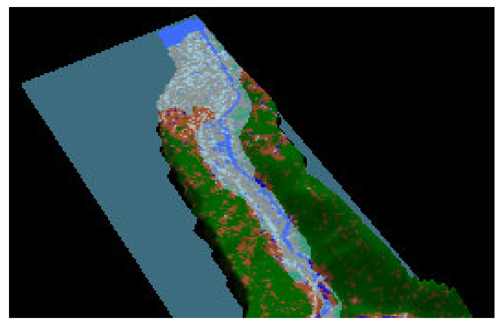

Figure 6. Visual implementation for flood disaster

5. CONCLUSIONS

The aim of this study is to get a visual risk zone state of an area by using Ikonos image. In this project only water factor used but for a detailed project addition to this, extra factors such as geological characteristics and slope of the area must be taken into consideration.

It is also important to note that high spatial resolution doesn't facilitate spectra-based classification. (Kristof, Csato, Ritter, 2002). But for this study the classes are very general and don't need details. So we did not meet such a problem.

Such a study the topographic state is very important. It means DEM of the area must be reliable. Because for this study interrogation was based on DEM.

We investigated only flood disaster for this area but landslide is also a problem for the area. For this area such a study can be done.

In this study we investigated only residential areas. With a cadastral data this study can be turned into detailed. Flood disaster is also very important for cadastral state. Such a study, cadastral parcels in the flood risk zone can be defined. A lot of interrogations such as; which parcels will be affected from a probable flood disaster, who belongs these parcels, if the parcels are agricultural land how the crop will be affected can be done.

At the end of the study we got a visual result. According to this result residential area which is in the risk zone was determined. This visual result showed us most of the residential area near the river in the risk zone.

After like a result, to take some precautions is the best way. The best and useful precaution is to change the position of the residential area. Local administrations mustn't allow structuring here. People must be instructed about flood disaster problem of the area and how people deal with this matter.

6. ACKNOWLEDGEMENTS

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