LAND USE CHANGE DETECTION AND WATER QUALITY MANAGEMENT IN ISTANBUL'S WATER BASINS BY USING IKONOS IMAGERY

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KEY WORDS: IKONOS , Project , DEM/DTM ,Mosaic ,Urban , Building , Classification, Database

ABSTRACT:

The aim of the study is producing 1/5000 scaled ortho-images by orthorectifying the monoscopic IKONOS images in the duty area of the Istanbul Water and Sewage Administration(7500 km^2 area),change detection within the catchment areas protection boundries between 1996-2003 using the previous orthophotos (that are produced with photogrammetric methods) and ortho-images,producing ortho-images using Stereo IKONOS imagery in a 250km^2 area that has no DEM and collecting information about the hydrodynamic structure of the B.Çekmece lake by classifying the 1 m resolutioned IKONOS image and using the real-time field data(field data gathered at the same time of the IKONOS image acquisition).ISKI will take images of the catchment areas, which includes a 5990 km^2 area, 4 times a year(March-June-September-December) in order to determine structural change and to protect these areas.The aim is to digitize the structural changes and to transfer these to a database created for catchment areas in order to supply the up to date data flow for a dynamic catchment area information system.

1. INTRODUCTION

The aim of the study is producing ortho-images by orthorectifying the monoscopic IKONOS imagery inside the duty area of Istanbul Water and Sewage Administration(7500 km^2),in order to determine the change within the catchment areas protection boundries.IKONOS imagery will be taken periodically 4 times a year beginning at March 2004.

Furthermore,a correlation is established between the near IR band of the IKONOS image and real-time field data(measuring the TSM,clearness and chlorophyll concentration at the same time of the image acquisition) in order to classify the water.

For the study IKONOS RGB Geo product with 1m geometric resolution was taken.50m grid spaced DEM with a 1/5000 scale precision produced with photogrammetric method,1/1000 scaled topographic map produced with photogrammetry,1/5000 scaled orthophoto map,DEM produced using 250m grid spaced elevation maps with 1/25000 scale precision and 1/25000 scaled raster map(RASTER-25) were used for the orthorectification process.

The study can be grouped in 3 titles;

1.1 Orthorectification

Orthorectification and orthoikonos image production in Istanbul city boundry(5500km^2 area) with +/- 1 m RMS, Orthorectification and orthoikonos image production outside Istanbul city boundry(1750km^2 area) with +/- 5 m RMS.

1.2. Water Quality Classification

Determining and interpreting water quality parameters at the B.Çekmece catchment area that can be determined with real time field measurements(Collecting data with field measurements at the same time of the acquisiton of the satellite) and IKONOS imagery.

1.3.Monitoring structural changes

Changes occured in the catchment areas,which are obtained by the July 2003 orthorectified ortho-images and will be obtained periodically within a 5990km^2 area every 4 months (March-June-September-December),will be transferred to the Catchment Information System for supplying up to date raster and vector data.
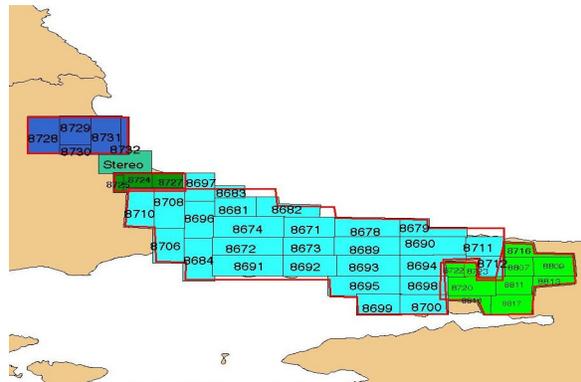

Figure1.7500km^2 ISKI Study Area and IKONOS PO ID

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2. ORTHORECTIFICATION

General attributes of the data used in orthorectification process of the IKONOS imagery:

Digital elevation data:
The DEM used within the Istanbul city boundry(5343,02 km^2) was obtained using photogrammetric methods. The data is regular grid data. It has a ASCII file format(dtm extensioned and x,y,z coordinates is present). It is made according to the 1/5000 scaled map areas and has 50m spaced points. Using Erdas Imagine 8.6 the ASCII file was mosaicked and an img extensioned raster grid DEM was created.

The DEM used outside the Istanbul city boundry (2157km2) was produced by General Command of Mapping of Turkey. The ArcINFO Export e00 extensioned file(YÜKPAF-25) was converted to coverage format and united.Then a img extensioned raster grid DEM with a 1/25000 scale precision was produced from this data.

Reference Map Data:
Dgn extensioned 1/1000 scaled topographic maps within the Istanbul Metropolitan Municipality duty area(1850 km^2),which is in the boundry of Istanbul city,were converted to shp format according to the IKONOS imagery strip areas. Sis extensioned and 1/5000 scaled orthophotos were converted to img format and then mosaicked in the rest of the areas within the boundry of Istanbul city. Tif extensioned 1/25000 scaled raster maps that were taken from the General Command of Mapping of Turkey archive were converted to img format outside the boundry of Istanbul(2157km^2).

Ortho-IKONOS product obtained after rectification:
Using the map data mentioned above, IKONOS HDD(PO ID) strips with approximately 350 km^2 areas were orthorectified within the 7500 km^2 project area. Associate points both on the image and topographic map were found and selected. For each orthorectification process approximately 22 reference points were collected. These points were selected from ways and low buildings. After the orthorectification process the precision found in the technical specification that was formed during the adjudication of the project was supplied. After the orthorectification process a $\pm$1m RMS in the Istanbul city boundry and a $\pm$5m RMS was obtained outside the city boundry.
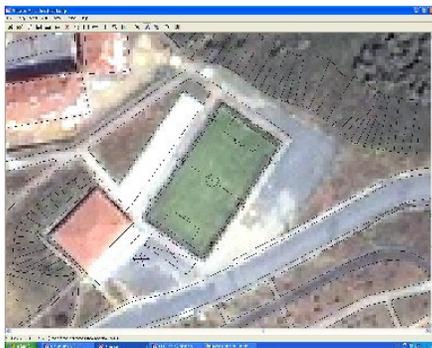
Figur2. Overlayed image of the orthorectified IKONOS image and topograhic map.

3.WATER QUALITY CLASSIFICATION

3.1 Aim

The objective of the study is to form a correlation between the pixels of the IKONOS image and water samples which were collected from the intersections of the lake and polluter carrier main stream branchs at the same time when the image was taken .The points that were to be used in sampling the water were determined by field study one day before the acquistion date 25.03.2004.The sample points coordinates were determined by the help of a preinstalled IKONOS image on a notebook and the Erdas Imagine 8.6 software GPC Controller feature.Personnel went to collect the water samples at the previous mentioned points before the acquistion time 25.03.2004 11:16-11:17 (local time) and took the samples during the acquisition time.The water samples were brought to the laboratory of ISKI in 3 hours for the determination of the 32 water quality parameters.

3.2 Study Phases

IKONOS imagery(Seperately recorded bands in Red,Green,Blue and Near IR) was used in this study. To avoid spectral mixture, the part containing water was cut out of the image according to the maximum water elevation boundry of the lake. The image that was cut out of the original image was classified with the unsupervised classification method.
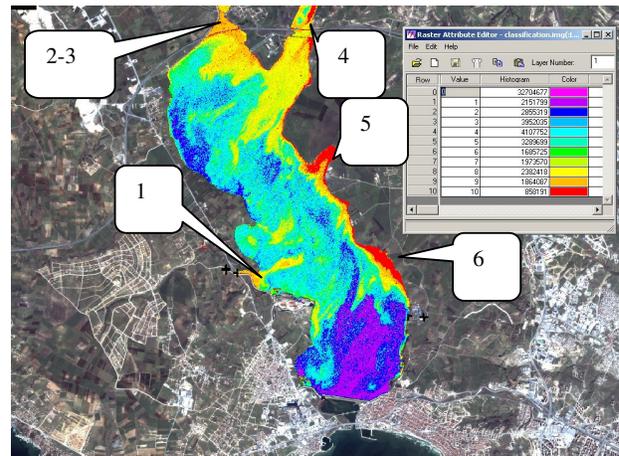

Figure-3 The thematic map of B.Çekmece lake obtained by unsupervised classification showing change in water (Total study area:2753.63 hectares)

The red areas show the high TSM concentration while the purple areas show low TSM concentration. With the help of field study ISKI Map Department has found that there are 4 main stream branches that flow into the lake in the study area.In addition to this, 2 main stream branches not decsribed as stream main branches according to the 20/02/2003 dated ISKI catchment areas protection and control regulation were taken into consideration as main stream branches after understanding from the thematic map (Produced from IKONOS imagery) that these 2 were causing the pollution in the lake.
It was seen that the 5 and 6 numbered streams carried higher TSM concentrations to the lake than the other streams that were taken into consideration.With the help of the examinations it was seen that when comparing with other streams, the 5 and 6 numbered streams were not under protection and the 4

numbered stream had not yet finished the required work although it was under protection.

It is being thought that the most important factor for the pollution that the streams bring into lake is the factor that the streams are not under protection Furthermore,it has been observed that the muddy water coming from the settling pools in the refining facility near to the 6 numbered stream has no effect to the TSM concentration at this point.

Point polluters like used water coming from houses,industrial waste and irrigation water leaks with rich nitrogen and phosphate compounds which show spread polluter charecteristics and are carried from hydrologic catchment area farming areas are the other sources of water pollution.

The fact that pollution of the areas is caused by the fact that the streams are not under protection,it can be understood that the most important reason of pollution is not protecting the streams. In addition, the low TSM concentration observed at the places where the streams(under protection) and lake intersect supports this idea.

It was observed that there were more agricultural areas near the polluted areas   than the other non-polluted areas.These agricultural fields can be also taken into consideration as an important factor.

The pollution arised at the image acquisition date(25 March 2004) from the activities done at the agricultural fields and settlement should be examined.
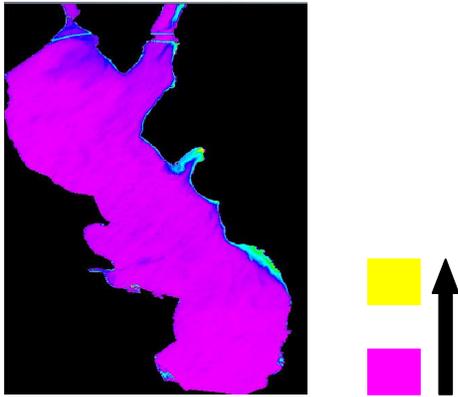.

Figure 4:Chlorophyll index map produced from 1 m geometric resolutioned IKONOS image.(The direction of the arrow shows the increase in chlorophyll concentration.)
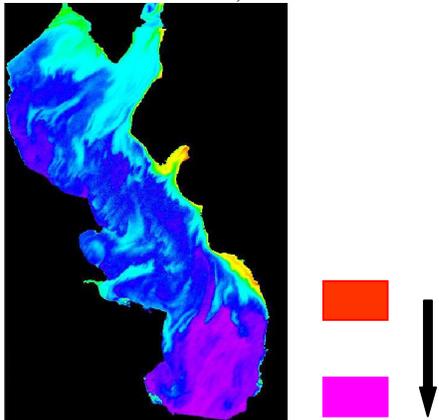

Figure 5: Clearness index map produced from 1 m geometric resolutioned IKONOS image.(The direction of the arrow shows the increase in clearness.)

The possible effect of the chemicals found in the artificial fertilizer to the high chlorophyll concentration at the points where the 5 and 6 numbered streams flow into the lake should be examined. The pollution that can be arised from agricultural fields and settlements should be investigated more detailed.

It was observed that clear areas have lower TSM concentrations than polluted areas.

3.3 Advantages of The Study

With this study we understood that it was suitable to use water clearness values in determining the water quality in the lake.

It is necessary to do the SDT(Sechi Disk Transparent) measurements at the image acquisiton time in order to relate the field measurements with the water clearness values that are obtained from the IKONOS image.

To prevent spectral mixture, the points should be chosen far from the shore.

Because the SDT method is an easy measure method and doesn't need laboratory work, it is economic. The field work data that will be obtained, will be related with the IKONOS image data using statistical methods and the distribution of the water quality in the B.Çekmece lake will be determined

4.MONITORING STRUCTURAL CHANGE AND ANALYSES

Periodically taken and orthorectified IKONOS images are cut according to the zones of the catchment areas and the buildings are digitized with ArcINFO 9.0. Digitized buildings are transferred with their charecteristics to form the Catchment Area Information System. With this system the temporal change in structure can be observed in the catchment areas. Work done in the desktop environment is going to be transported to ArcGIS server environment.
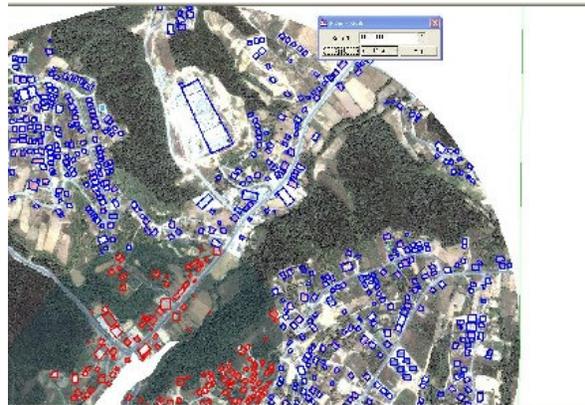

Figure 6: The View of The Digitized Buildings

With this study the catchment areas are protected with field work supported remote sensing and integrated GIS.

5. Conclusions

With IKONOS imagery our administration gained raster and vector data in a quick,effective and economic way.With the fact that the illegal construction is dynamic in the catchment areas a conclusion can be drawn that remote sensing and integrated GIS is essential with this project which is continuing .

While we feel that current remote sensing technologies have many actual and potential applications for assessing water resources and for monitoring the progress of clean-up efforts,limitations in spectral and spatial resolution of current sensors on satellites currently restrict the wide use of satellite data for monitoring water quality.New satellites(IKONOS,etc.) and sensors(hyperspectral,high spatial resolution)already launched or planned to be launched over the next decade will provide the improved spectral and spatial resolutions needed to monitor water quality parameters in surface waters from space platforms.

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