FIG WORKING WEEK 2012

May 6–10 2012
Rome, Italy

A STUDY ON THE ASSESSMENT OF BATHYMETRIC CHANGES VIA GIS: ALTINAPA DAM (KONYA) EXAMPLE

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INTRODUCTION

- Population growth and increasing life standards lead to increased consumption of potable water, which requires more effective and cautious use of water resources.

Therefore, water sources should be protected, water pollution should be prevented, water sources should be managed and water that is not used should be stored in environments such as a dam/pond.

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One of the serious factors of environments !!

- Accumulation of sediment is one of the most serious factors that threaten aquatic environments such as reservoirs, lakes and ponds. Sedimentation causes some lakes, ponds and reservoirs to be filled and polluted within a short time. It also causes loss of area and volume, and reduces the lifespan of facilities

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Why Hydrographic Survey ?

- In order to store more water in reservoirs, lakes and ponds, prevent water pollution, protect water sources and extend the service life of these facilities, it is important to know the current topographic conditions and any changes in the capacities of these facilities.

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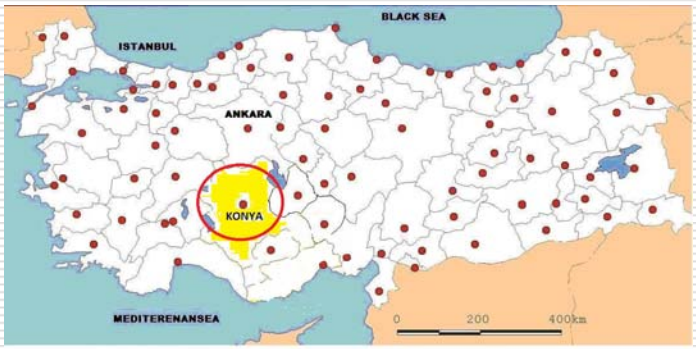
Aim of the study

This study identified changes in water volume of the Altınapa reservoir, as a result of sedimentation over a 25-year period, by comparing topographic and bathymetric data from 1984 and 2009.

The study also aimed to present the Dam Information System (DIS) for use by relevant institutions, involving data on the geological structure, plant cover, physical and chemical features of the water of Altınapa reservoir and its surrounding area, and updated topographical and bathymetric information of the dam.

Study Area

The study area is Altınapa Reservoir, located in the Meram district of Konya province, Turkey.



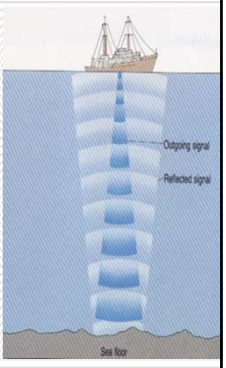
Study Area

Altınapa Reservoir is 20 km from the western part of Konya province . Altınapa Dam is a rock-fill dam built for potable water, flood control and irrigation, which has been operational since 1967.

General View of Altınapa reservoir

Bathymetric Measurements

- In bathymetric measurements, depth and location measurements should be conducted simultaneously to detect the location of the point in both horizontal and vertical planes. The updated method used in horizontal location measurements are Real Time Kinematic (RTK GPS) or Differential GPS (DGPS). Acoustic methods are generally applied in depth measurements. Since the reservoir bottom is not directly visible, bathymetric measurements are conducted according to a previously determined direction, and at certain time intervals, and the resulting data is related to the water level at the time of measurement.



Topographical and Bathymetric Measurements

Topographical measurements were made using Topcon Precision GPS Hyperpro GPS receivers (RTK-GPS) and Topcon GPT 3007 electronic tachymeter.

Depth Measurements

Depth measurements were made using a double-frequency Echo-sounder (Matrix GPS 97 Humminbird).

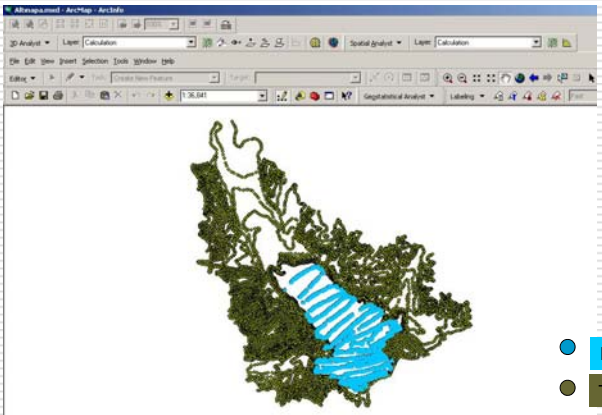
Horizontal location

Horizontal location information of the depth measurement points was acquired by an RTK-GPS with Topcon Precision GPS Hyperpro receiver. One of the GPS receivers was established on reference point while the other was mobile and used on the hydrography boat.

Topographic and Bathymetric Measurement points

Topographic measurement points are shown in green and

Bathymetric measurement points are shown in blue



Gathering Attribute Information

Attribute information of Altınapa Reservoir such as meteorological, plant cover, geological and forest features was gathered from the institutions shown in Table

Table 1.Institutions and attribution data

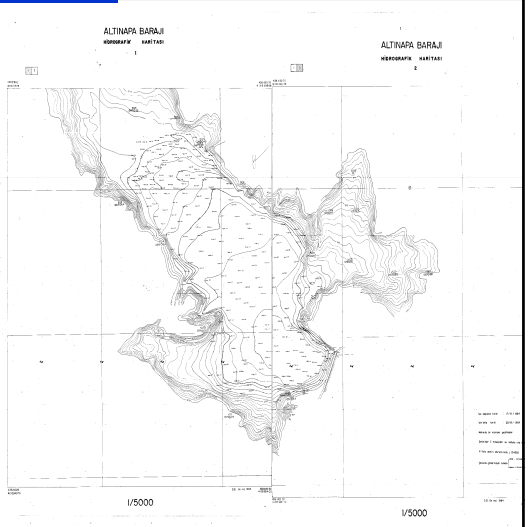
Institutions	Received Information
SHW 4th Regional Directorate	Bathymetric map from 1984, average water level values, water supply values of Meram stream, vaporization values of the dam, precipitation
Konya Special Provincial Administration	1:25.000 scale map of Konya and transportation roads of the dam
Konya Water and Sewage Administration	Basin border map of the dam
Central Anatolian 2nd District Office of Mineral Research and Exploration	Geological map of the region of the dam and geological information
Konya Regional Directorate of Forestry	Forestry maps and information about plant cover
Konya Provincial Department of Environment and Forestry	Information about trees in the region
Konya Directorate of Meteorological Service	Meteorological values of Konya province

Water Quality Measurements

Water quality measurements were conducted in conjunction with bathymetric measurements. Samples from 31 locations gave pH, turbidity, dissolved oxygen and temperature values of water. A WTW 340i multi-parameter device and a 30 cm diameter Secchi disc were used in measurements.

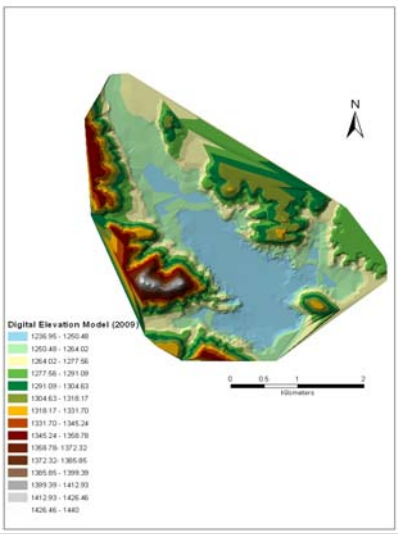
Digitalizing of Present Maps

A geological map, forest map and bathymetric maps (1984) were scanned at 300 dpi resolution and converted to TIFF (Tagged Image File Format) format. Then, these maps in TIFF format were converted to vector maps with the Affin transformation routine within NetCad software.



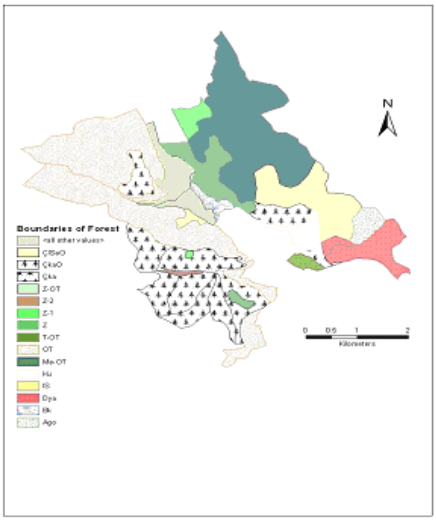
Integration of Data to GIS Medium

Location and attribute data of the study area was integrated into version ArcGIS 9.2 software. To achieve this, first vectorial data (X, Y, H) acquired in Netcad was exported to ArcGIS 9.2 software in ESRI shape format (Figure. Digital land model data were converted to GRID data with TIN to raster module of 3D Analyst module.



Integration of Data to GIS Medium

A forestry map of tree species, features and regions was produced with Add XY Data within the Tools module of ArcGIS software (Figure); the geological map was similarly transferred to ArcGIS. The layers in the study area, their symbols and formation times were integrated into the program

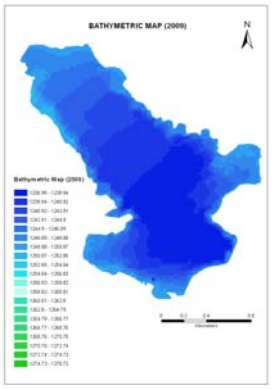


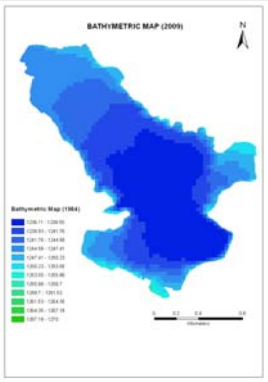
Integration of Data to GIS Medium

Physical and chemical features (pH, dissolved oxygen, temperature and turbidity data) of reservoir water were transferred to ArcGIS as point data. Average water level of the reservoir, water supply data of Meram stream, evaporation values and precipitation data of the reservoir were added as GIS data layers. Plant species in the study area added to the GIS system as points. The elevation of the plants, their Latin names, local names, the elements they belong to and their locations were transferred to the GIS.

Results and Discussion

Within the scope of this study, digital terrain models and bathymetric maps of Altınapa Reservoir for the years 1984 and 2009 were obtained using ArcGIS software (Figure).





Results and Discussion

The surface areas and volumes of normal and maximum water levels of Altınapa Reservoir were examined using GRID data of digital elevation models of 1984 and 2009. Surface areas and volumes and changes have been given at table.

Year	Normal water level (1253.40m)		maximum water level (1254.80m)	
	Surface areas m^2	Volumes m^3	Surface areas m^2	Volumes m^3
1984	3255995	28939682	3590478	33724776
2009	2796428	25472674	2887413	29444382
Changes %		12		12.7

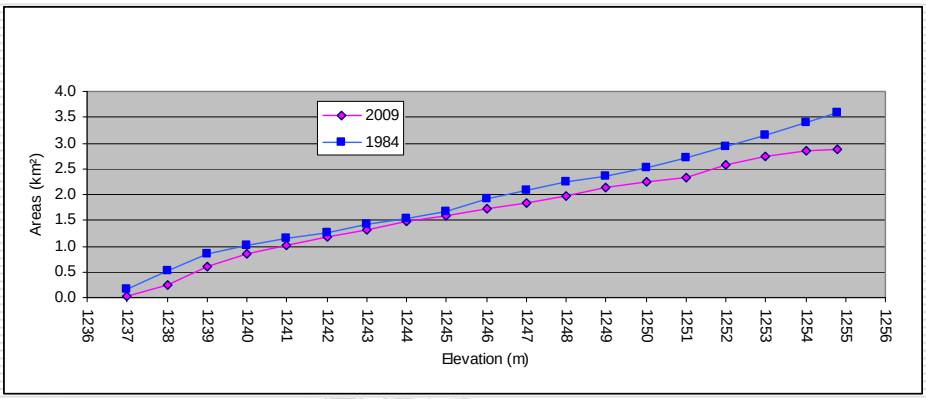
Results and Discussion

In this study, these results represent a reduction in volume of 12% according to normal water level and 12.7% according to maximum water level. The capacity of the reservoir (normal water level) was found to have decreased by an average of 0.51%/year.

Based on these values, it can be suggested that sedimentation is a serious threat to the continued operation of Turkey's Reservoirs.

The surface areas at various water elevations

Surface areas at various water elevations are shown in Figure



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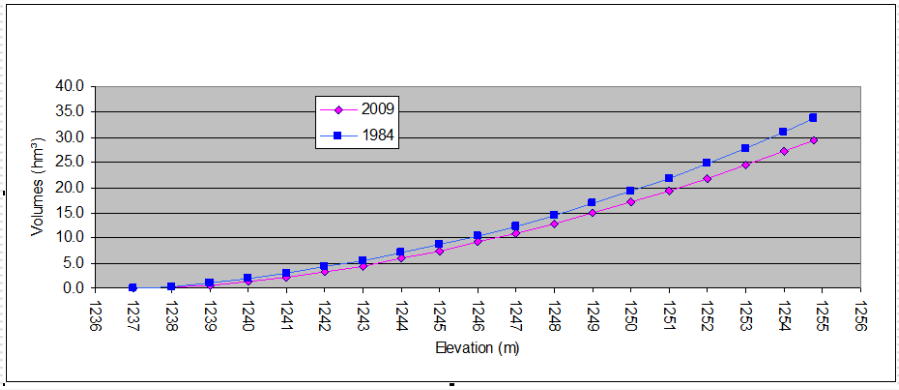
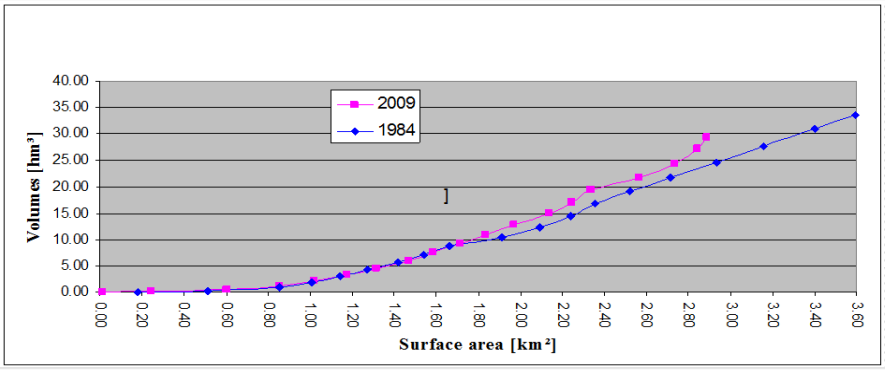
The volumes at various water elevations

Volumes at various water elevations are shown in Figure



The surface areas versus volumes

Surface areas versus Volumes are shown in Figure



Results and Discussion

In GIS medium users are able to investigate questions such as;

- Which tree species are present?
- What is the age structure of the stand?
- Where are the borders of tree species?
- What is the elevation of tree species?
- What is the location of tree species?
- What kinds of formations are observed?
- What are the formation years of these formations?"

Results and Discussion

To determine changes in the reservoir bottom due to sedimentation, five distinct sections were taken from the reservoir (Figure).

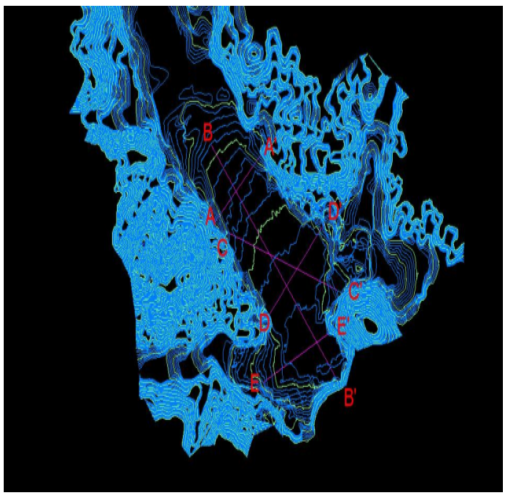


Figure 9. View of cross-section lines

8. Results and Discussion

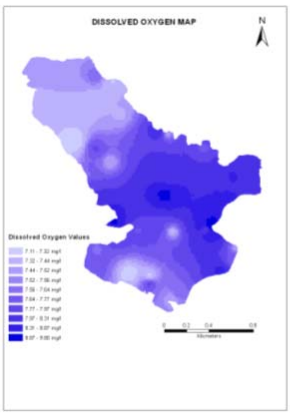
Maximum sediment thickness, average sediment thickness and standard deviation are shown in Table 3.

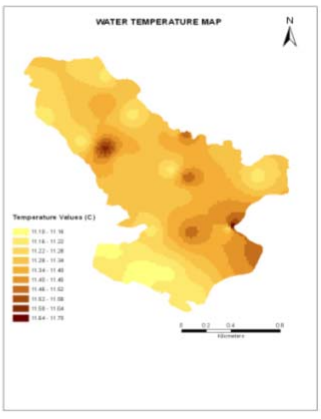
Table 3. Standard deviations and sediment thickness on the cross-sections

Cross-sections	Max. sediment thickness (m)	mean sediment thickness	Standard deviations
A-A'	4.23	0.95	±1.15
B-B'	0.97	0.65	±0.20
C-C'	3.24	1.07	±0.63
D-D'	1.61	0.69	±0.37
E-E'	3.53	0.74	±0.77

Results and Discussion

In addition, GIS data layers were produced, allowing the examination of reservoir water quality data (temperature, dissolved oxygen, Secchi disc, pH).





Conclusions

For effective management of water sources, first, water that is not used should be stored in environments such as dams or ponds, wherever possible. In addition, prevention of water pollution, up-to-date topographic and bathymetric information on reservoirs, changes in reservoir storage capacities due to erosion and sedimentation are given priority. In this context, this study was carried out to determine the current topographic and bathymetric situation, and the changes in the surface areas and volume due to sedimentation and erosion, in Altınapa reservoir.

Conclusions

- Calculations were made on ArcGIS software using digital elevation models of the lake based on date from the years 1984 and 2009. The data indicated that, over the 25-year period between the two datasets, the storage capacity of the reservoir decreased 12.7 %.The capacity of the reservoir therefore decreased 0.51% /year on average. This value is consistent with the results of previous studies and is much greater than global and European averages.

Conclusions

- A series of 5 cross-sections were taken from the reservoir, to analyze bathymetric changes in the reservoir bottom. The data indicated that, in coastal sections of the reservoir, the depth was reduced by between 0.97m and 4.23 m, inner sections of the reservoir, where the reservoir bottom is lower, there were changes of between 0.15m and 0.95m. The mean sediment thickness was obtained to be 0.82m.

- The General Directorate of State Hydraulic Works, which is the only authority regulating all functions related to dams in Turkey, has important roles in operating and conserving the reservoirs.

Conclusions

In this respect, State Hydraulic Works should perform the following activities to create a Dam Information System, similar to those in several countries.

- Topographic and bathymetric measurements of each reservoir and its surrounding should be renewed at five year intervals. The storage capacity of a reservoir can be determined by evaluating these measurements.
- Deformations occurring in the dam embankment due to underground tectonic movements should be monitored. These deformations should be analyzed to determine whether they threaten dam safety.

Conclusions

- Physical and chemical properties of reservoir water, water quality measurements, climate, plant species and environmental factors should be determined. Evaluation of these data will contribute significantly to prevention of water pollution; conserve and increase the biodiversity in and around the reservoir; and allow people involved in fishery activities to make better use of the reservoir.
- Measurements should be made to determine the amount of sweeping material carried by the rivers and creeks that supply water to the reservoirs. The degree and quality of the threat to the reservoir caused by sedimentation should be determined and reservoir improvement activities should be conducted.

Thank you for your attention….

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