The rising water level in Lake Van: environmental features of the Van basin which increase the destructive effect of the disaster

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Abstract Lake Van, the largest in Turkey and fourth largest in the world is situated in a closed basin. The water level in Lake Van has increased by about four metres since the mid-sixties causing serious environmental damage. It is known that this problem does not only pertain to Eastern Anatolia, but changes in water levels of lakes in Iran and Azerbaijan are also being observed. Thus, the problem seems to be regional rather than local. Research was conducted in order to evaluate the existing physical features of the Van Basin and to develop a proposal for allocation of the Van residents which are under flood threat. This paper presents the general features of the basin associated with water fluctuations and evaluates the settlement condition relative to the change in the lake water level.

Keywords Disaster; environment; flood; Van Basin; Lake Van

Introduction
Lake Van, which is the largest lake in Turkey and fourth largest in the world, is situated in the Van Basin and is overlooked from the north by two extinct volcanoes: Nemrut and Süphan. The lake resembles an inner-sea with an approximate surface area of 3600 km², a volume of 600 million m³ and a depth reaching 450 metres. The level of Lake Van has fluctuated in the course of history. An increase of 75 metres was observed as well as a decrease of 350 metres relative to mean level of the lake, 1646 metres.

The water level which was almost stable at the beginning of the 20th century has increased by about four metres since the mid-sixties. This recent level rise of the lake water caused serious environmental damage. The area around the lake with a level below 1655 metres was declared a disaster area by a decree of the Council of Ministers issued on 8 June, 1995.

The local authorities have requested assistance from academics on two basic subjects: first, as a short-term solution, the subject of allocating those populations living under flood threat in the area. The second subject regarded the long-term study, to determine the main features of the basin which cause the water fluctuations.

In order to produce solutions to the urgent request for allocation of the habitants under flood threat, in a short period of time, Istanbul Technical University has given support to a project titled The Fluctuations in the Water Level in Lake Van and its Effects on the Settlement Pattern. The project was initiated in May 1996 and completed in November 1997 (Kılıncaslan, 1998) with the aim of minimising the adverse effects of the disaster by understanding the main features of the area and developing a proposal to allocate the Van residents.

This paper presents the study mentioned above. The problem is presented in the introduction section. In later sections of the paper, consecutively, research methods and procedures, general features of the basin associated with the water level rise, water level rise and its effects on the surroundings, Van: the city under flood threat, determination of appropriate areas for residential use, have been presented. Conclusions and recommendations have been given at the end of the paper.
Research methods and procedure
The aim of the research was to develop a proposal for allocation of the residents of the city under flood threat. As a first stage, literature survey and document analysis have been completed in order to gather basic information about general features of Van Basin associated with the fluctuations and the city of Van as the main settlement in the province. Literature surveys were conducted in Istanbul, Ankara, Van; the scientific publications on the subject were carefully studied and more information was gathered through consultations with the scientific communities interested in the topic. Representatives of the local and central authorities in Van who are familiar with the problem, as well as the technical personnel of the public institutions, were consulted and documents were obtained. During the research, it was found that the local authorities lacked sufficient information and data.

In the second phase of the study, the location of the residential areas was evaluated according to the present data available. The maps indicating topographical, morphological, geological, hydrological, tectonic features, and meteorological aspects of the area were provided from the report prepared by the Union of Turkish Engineers and Architects. The infrastructure maps were provided from the municipality and the statistical data were obtained from State Institute of Statistics. The Association of Small Entrepreneurs, Chamber of Commerce provided basic information about their activities in the area. Department of Agriculture provided the maps and data about agricultural land classification, wetlands, woods and water reservoirs. This information was used as parameters for the evaluation of the residential land usage in Van.

General features of the basin associated with the water level rise
It is estimated that the closed basin of Lake Van, the largest natural lake in the country, was formed roughly 100,000 years ago (Barka and Şaroğlu, 1995). The fact that there has been continuous tectonic activity in the area throughout the geological periods has resulted in the development of a very complex structure. In ancient times, the Muş plain and the area which today is the basin of Lake Van constituted a single entity. Initially, this whole area had an outward drainage for its waters, but in the eastern parts the lava from the Nemrut Mountain slowly began to block the way and water started to collect and gradually form the present Lake Van (Türkelli, 1995).

Lake Van and the region surrounding it have been included in the map defining the Earthquake Regions in Turkey as the “major earthquake area”. The records of earthquakes that have occurred in the area during the present century do not show an earthquake activity centred below the lake. No data pertaining to any deformations or collapse in the tectonic sense is found for the period of 1967–1993, during which time important alterations occurred in the water level of the lake (Barka and Saroğlu, 1995). A review based on the available data has indicated that there seems to be no correlation between the earthquake activities in the region and the alterations in the water level of the lake.

It has been determined that the most obvious mechanism responsible for the control of the water level of the lake is the hydrometeorological changes observed in the region (Avcı, 1995). The analyses carried out with the meteorological data available indicated that there had been an increase in precipitation, a fall in temperatures and a decrease in evaporation at the time of the rise in the water level of the lake. It has been observed that at the time of rise in the water level of Lake Van, the height of snow in the region was excessive. Thus, there is a close relationship between precipitation in the form of snow and the water level of the lake (Union of Turkish Engineers and Architects, 1996).

However, according to simple calculations, the water level of the lake should continuously decrease until the lake would cover a much smaller area and have much less evaporation taking place. However, it is assumed that there is a water source that cannot be directly
measured which is responsible for maintaining the water level at a certain point (Kaynak, 1995).

There are tectonic water resources at the base of tectonic lakes which undergo alterations in their water level independent of the climatic changes. It has been proposed that as the water level of the Lake Van rises, the pressure at the bottom increases and serves to resist the in-flow of water into the lake. The validity of this proposal could be checked by an examination of the sediments collected from the bottom of the lake (Kaynak, 1995).

**Water level rise and its effects on the surroundings**

The water level of the lake was 70 metres higher as compared to its present level during the most recent ice age, 15,000 years ago. In the course of the drought period which began 12,000 years ago following a continuous increase in the temperature of the earth, the water level of the lake rapidly decreased by 350 metres. Nearly 6000 years ago, as the climate began to get milder, the water level underwent at first a rapid, but then a rather slow rise and reached its present depth (Kempe and Degens, 1978).

In the first half of the 20th century the lack of significant change in the water level gave way to uncontrolled settlement on the lake coast and beyond the lake’s dynamic shoreline. Water level which was almost stable since the beginning of the century increased by a amount of 1–1.5 metres in the period of 1968–1974 and after remaining stable during the period 1975–1986 began increasing again in 1987 exceeding its previous value by 1–2 metres. At present the water level is 3.5–4 metres higher than its value in the early 1960s (Avcı, 1995).

The permanent increase in water level in the 1960s which exceeded 1 metre has not been taken seriously, and during the last 39 years urbanisation along the coast has even increased. In the absence of rules and regulations pertaining to coastal planning, wrong choice of location and settlements continued around the lake. Even public authorities have made large investments along the shoreline. Some of which are highways, railways, airport, treatment plants, educational and leisure complexes (Avcı, 1995).

The new level rise beginning in 1987 caused anxiety in the town centres of Van and Tatvan. Water level rise affected the regional transportation. The main highway which connects Tatvan to Van city centres was demolished by the flood, railway stations and airport runways were flooded and became out of use.

Water level rise in the lake affected the underground water level. The rising underground water level caused serious problems in the sewage systems in the city centres. One neighbourhood in Van comprised of 13 houses was completely demolished and a total of 454 houses have been removed because of unacceptable conditions which occurred in the area.

A fertile agricultural land measuring 55 km² around the lake was flooded. Since the lake water contains soda, even if the water level decreased, the flooded area will not be rehabilitated for a certain time (Yılbaş, 1995). The precious ecological balance was disturbed by this sudden change.

**Van: the city under flood threat**

Van, established in 850 BC on the eastern shore of Lake Van at a height of about 1655–1600 metres, was the main center of Urartu civilisation. During the course of history, the city always kept its importance, being in the intersection of the main roads connecting Persia to Anatolia in the east-west direction and Black Sea Coast to Mesopotamia in the north-south direction. Lake Van always provided an access for transportation. The city of Van is located in the most fertile agricultural land surrounded by high rise mountains which accumulate rain water and melted snow.
During the 19th century, Van settled at a height of about 1719 metres with a population of 30,000. After World War I, the city settled at the eastern side of the old city and extended toward the south at a height of 1700 metres (Dumont and Georgoen, 1996). Since the early history of the province, the city has been living under flood threat.

In the second half of the 20th century, the population increased rapidly in the city reaching 153,111 in 1990 and city expansion toward the shoreline continued at a height of 1646. Residential buildings as well as other services such as recreation and transportation facilities, health and education buildings, and factories preferred locations along the coast. Rapid and uncontrolled development of the city increased the destructive effect of the disaster.

**Determination of appropriate areas for residential use**

In the presence of persistent water level rise, it would be urgent to allocate large number of residents to more secure areas. The municipality requested the physical planners to define appropriate land for residential use.

The study aimed to evaluate the natural environment as well as the built environment in order to define appropriate land for allocation to the residents. Topography, climatic control elements, agricultural land classification, natural habitat are accepted as natural environment determinants. Settlement features, accessibility, infrastructures are accepted as built environment determinants. Residential areas in Van and its adjacent land were evaluated according to these determinants. Expert opinions were obtained in order to reach objective results.

Results were classified as: (a) areas appropriate for residential use; (b) areas appropriate with certain precautions; (c) areas inappropriate for residential use. These areas are all indicated in the city plan.

**Conclusions and recommendations**

The reasons of the water level increase during the recent years are not known exactly. Probable reasons may be changes in hydrometeorological parameters due to climatic changes in the region, changes in the bathometry of the lake and changes in groundwater in- and out-flow due to tectonic movements, increase in the amount of sediment transported into the lake by streams and as a consequence of shore erosion by wave effect. Comprehensive research is needed in order to determine the exact cause of the sudden changes in the water level seen in recent years.

In order to define the cause of the disaster, it is necessary to obtain continuous data that would be used in the evaluation of the occurrence. Also, field studies are needed in order to find answers for various hypotheses. Coordination and cooperation among related bodies is needed. A multidisciplinary group would provide a better understanding about the cause of the disaster.

The losses of residents due to the water level rise will be prevented by the development and execution of appropriate coastal management plans for the lakeshore and appropriate allocation of the residents in the peripheral area of Van. The rise of water level in Lake Van will occur in the future. Therefore, city development plans should consider the water level changes as a requisite for land use determination.

**References**


Yüzüncü Yıl University Printing Office, Van (in Turkish).