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Urartian Water Constructions and Hydraulics

[1]Ahmet Hamdi Orhan, [2]Taner Özdem¥r and [2]Ecevit Eyduran

[1]Ahmet Hamdi Orhan, [1]Department of Civil Engineering, Faculty of Engineering and Architecture
[2]Department of Animal Science, Faculty of Agriculture, University of Yüzüncü Yil, 65080, Van-Turkey

Abstract: Dams, loches and irrigation canals set up by Urartian Lords had vitalized agriculture done at savanna and valleys of East Anatolia region. Constructions related with irrigation had protected their existance by conscious election of place and construction material. Altough they were in most intense earthquake band. There is no other place in the world having water constructions working since 2700-2800 years. That is why Urartian Kingdom is named as biggest Hydraulic Civilization of Anatolia and Old Foremost Asia. The many dams, reservoirs and irrigation canals built by Urartians enabled agriculture to flourish in the plains and valleys of the region. These structures were built to withstand the violent earthquakes shich occur frequently in the region, which is why they have survived in relatively good condition to the present day. The traditon of building water works which began with the Hittites and Assyrians lived on in Urartu and survived into the mediveal and Ottoman times in Anatolia. The Urartians thus represent an important bridge in the development of agricultural irrigation and dam building in Anatolia up to the present day. The Urartian dams on streams and small rivers built nearly three thousand years ago are the forerunners of the modern dams on the Euphrates and Tigris rivers in Eastern Anatolia today[4].

Key words: Dam, canal, irrigation, civilisation, Urartian, limestone, construction, hydraulic.

INTRODUCTION

Urartian Kingdom, capital of which was Tusba (Van Castle now) and Rusahihi (Toprakkale now) in Van meadow, prevailed East Anatolia, Trans Kafkasia and North-West I ran regions between 6-9 centuries B.C. (Fig. 1). First irrigation canals, loches and dams of East Anatolia region were built at the first half of first milennium B.C. during Urartian Kingdom period. It is obviously seen that these constructions have not been influenced as much as other civilizations architectural constructions. If water engineers of Urartian Kingdom did not take conscious precautions, water constructions would not be present nowadays. They used sledge hammer, lever, stone masonry chisels from iron to built water constructions. Constructions were built with loading technique by stones. Clay was used as connecting material. Urartian water constructions are dams, loches, water canals and kehriz. One of the wealthiest water source of East Anatolia region is Erek mountain which surronds Van meadow's east part like a crescent and which has 3200m heigth. During period of Urartian Kingdom totally 14 loches and dams were built on water sources of this mountain's fringes. All this dam and loches had been used to irrigate 150 km^2 agricultural area from west part of Erek mountain to Van Lake[4]. The first irrigation canals, reservoirs and dams in eastern Turkey were constructed by the Urartian state in the first half of

Fig. 1: Settlement map of Urartian civilization (B.C. 9-6 centuries) (www.anadolu.iwarp.com).

the first millenium B.C. The first millennium was a turning point for the Eastern Anatolian Region where up until that time the main ecconomic source had been herding. From this time on we know that agriculture took centre stage. The many dams, reservoirs and watering systems are proof of the modern adn sucesstul agriculture that ensued. Some of the Urartian water works built 2700 or 2800 years ago have been badly damaged by floods, earthquakes and erosion over the millennia. Others have been destroyed in the process of constructing modern dams and reservoirs during the past forty years, indeed more have been submerged under the waters of the Euphrates, than nature had managed to destroy in three

Corresponding Author: Ahmet Hamdi Orhan, Department of Civil Engineering, Faculty of Engineering and Architecture, University of Yüzüncü Yil, 65080, Van-Turkey

thousand years. Therefore one of the fundamental objects of this research project has been to study the remaining hydraulic structures and chart their historical development before they could suffer even more damage.

Eastern Turkey lies in a region subject to violent seismic activity which has done untold damage to the monuments of the Urartian, Armenian, Hellenistic, Roman, Byzantine, Seljuk, Beylik and Ottoman states which have ruled there over the centuries. The Roman and Byzantine hydraulic structures in eastern Turkey have collapsed like a pack of cards in the earthquakes which have struck them. For example, the dam of Roman or Byzantine origin known today as the Faruk Bendi 10 kilometres east of Van clearly displays the marks of earthquake Damage, while structures of Urartian origin have suffered noticeably less, despite their greater age.

One of the main factors in the tecchnological progress of Urartu was its advanced mining industry and knowledge of metal working. In the early first millennium B.C., the Urartians were the formeost miners of not only Anatolia but the entire ancient Near East. The rich reserves of silver, lead, copper and iron in eastern Turkey were extensively mined by the Urartu state, particularly from the eighth to the sixth centuries B.C. Sledge hammers, levers, chisels and other iron tools enabled the Urartians to excavate and dress the millions of cubic metres of stone used in the construction of dam, reservoir and canal walls quickly and easily. Meanwhile, picks and spades also made of iron were used to dig out the canals and reservoirs, which again entailed excavating millions of cubic metres of soil. Due to the harsh climatic conditions pertaining in the region, work could only continue for five months of the year, heavy snowfall and severe cold preventing such activity for the remaining seven months. If it had not been for iron tools, construction of so many hydraulic structures would have been impossible in such a short time[4].

Dams and loches: Oldest dams of this region are Bakraçli and Harabe dams belonging to protoperiod of Urartians. Bakraçli has been destroyed where 1.5-2m heigth walls of Harabe are present now. 30x30cm dyke of this dam is one of the smallest example of dam dykes.

Another important water construction is Rusa dam made by Urartian King II.Rusa (685-645 B.C.) (Fig. 2-7). This dam is on Erek mountain which surronds Van meadow like a crescent. Rusa dam, which is 2544m over the sea level, is discipiated to 7km^2 area. Water that accumulates in this dam is more than 40 million m^3. Rusa dam has two separate walls. One is at west end other is north-west end of dam. West wall which is on a very narrow and rocky valley, is composed of two successive walls with 7m width. Between these two walls 13.40m area is filled with filling up material. By this way a wall

Fig. 2: Rusa dam (2004)

Fig. 3: Ground picture of Rusa dam (2004). Masonry wall construction of Rusa dam

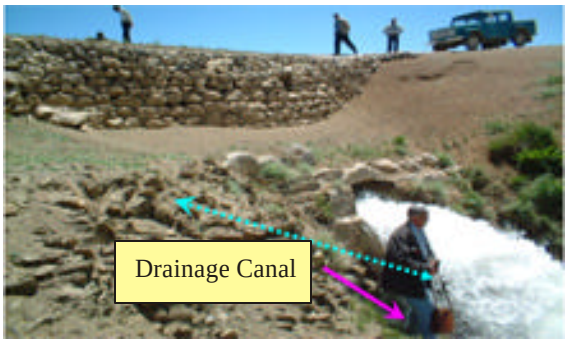


Fig. 4: Rusa dam water drainage canal GWA (2004).

Fig. 5: Dyke of Rusa dam (2004). Used stones are limestones

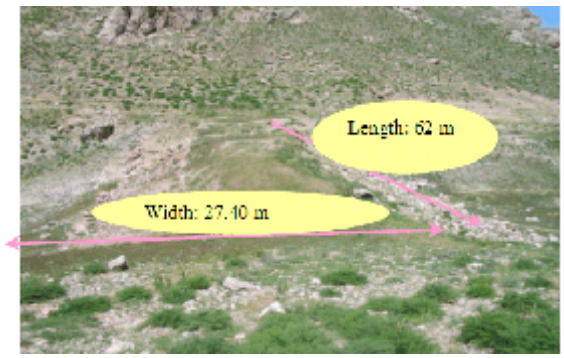


Fig. 6: Main body of water capture (2004)

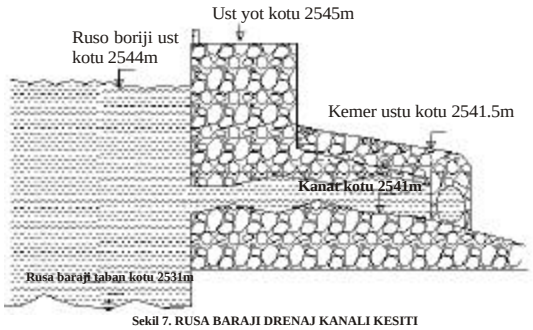


Fig. 7: Section of drainage canal of Rusa dam

which is 62m in length and 27.40m in width has been formed. This monumental wall exterior of which is made from limestones is now 4.5-5m in length. Dyke on east end of wall which is 70x1.1m is the biggest known dam dyke of Urartian. Water coming from dyke through west direction was passing fast froma narrow and rocky valley to Doni loch and set aside there. Wall of Doni loch was 69m in length, 2.5-3.0m in width and 4-7m in heigth. Water coming from this loch again in west direction was supplying south-east part of Van meadow which was not irrigated by Menua Canal. Water continuing its vacation on west direction was accumulating at Sihke (Bostaniçi) loch on north-east fringe of Toprakkale. Kösebasi dam was made at 6-6.5 km east part of Sihke loch; to prevent this loch to be filled with soil land. Another aim of Kösebasi dam was to store dam water coming fast from 2544m heigth Rusa dam to 1750m Van meadow with 4% slope and to supply a regular flow rate to dam water. Distance that water flows from Rusa to Kösebasi dam is 14-15km. Wall of this dam is composed of two seperate walls built one after another. This wall which has its basis on the main rock is 15m in width and 3.5m in heigth. Second wall is 11.5m in width. Filling sheet between these walls is 5m in width. So with 31.5m wall width it is the broadest dam wall of East Anatolia region. Sihke loch which is on north-east fringe of Rusahihi (Toprakkale) city – second capital city of Urartian Kingdom– is the last accumulation area of water which comes from Rusa dam

Fig. 8: Sihke loch

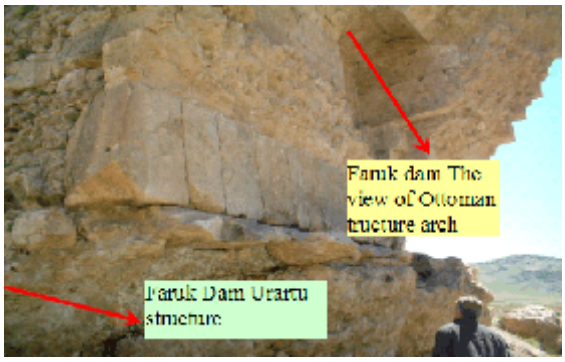


Fig. 9: Faruk dam (2004). Ottoman arch. Urartian construction.

and set aside at Kösebasi dam. Distance from Rusa dam to Sihke loch is 21 km (Fig. 8). Its wall is 342m in length and 6-17m in width. Canal named as Akköprü stream which flows from loch through west direction irrigates north-east part of Van meadow which is not irrigated by any other source nowadays as were in Urartian period[4].

Faruk dam: It is a dam without dyke which was made to collect water (Fig. 9-11). Aim of inexistance of dyke is to strengthen underground waterlevel with exurbant cutting, also main structure of it has been used for transportation during favourable time periods. Lime daub and cas daub (limestone, sand, goat hair) has been used as connecting material. Cutting stones have been used in arch system (Öztürk, 2002). First duty of Faruk dam is to prevent flood. The second is to be used as a bridge for transportation. It is an interesting water construction which got two civilisations (Urartian and Ottoman) together. Unfortunately, because of earthquakes occured 50 years ago it is divided into two parts.

Menua (samran) water canals: The Menua Irrigation Canal is a marvel of hydraulic engineering. Fifty-one

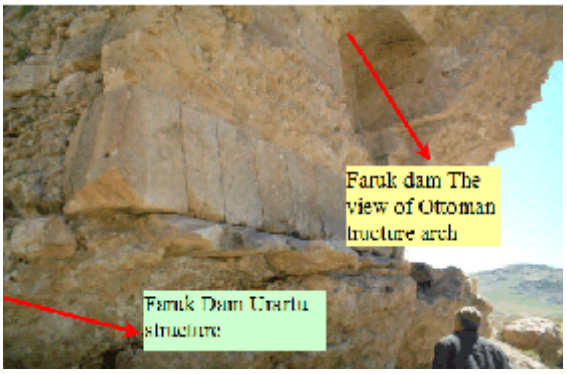


Fig. 10: Faruk dam (2004). Limestone cutting stone. Clay fill up

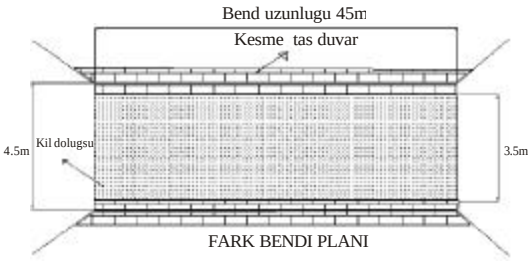


Fig. 11: Plan of Faruk dam

Fig. 12. Samran water canal (www.anadolu.iwarp.com)

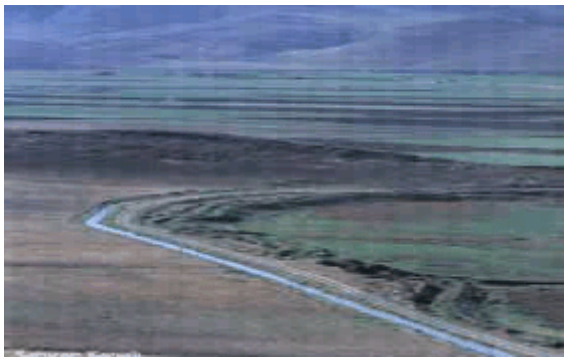


Fig. 13. Samran water canal (www.anadolu.iwarp.com)

kilometres in length, the canal is also a reminder ofthe legends surronding the elusive Assyrian queen, Semiramis. The hanging gardens in the form of artificial terraces built by King Menua (ca. 810-786 B.C.) at the place known today as Kadem Basti for his daughter Tariria were intended to rival the hanging gardens of Babylon which were built for Semiramis and became one of the seven wonders of the world. It is due to his association with Semiramis that this famous irrigation canal is known by local people as the Samran or Semiramis Canal.

Because; dams and loches did not meet water requirement of Van meadow, famous Menua (Semiramis/Samran) water canal which is 51km in length and which comes from Gürpinar meadow was made for fruit and vegetable gardens at south part of Van meadow (Fig. 12 and 13). Menua canal which brings fresh water from Gürpinar meadow - that is 50km distance to Van - to Van meadow, vitalizes aggriculture done at areas that it passes from. This canal; which has an average flow of 2.5m^3/s has a water capacity of 75 million m^3 that it carries to Van meadow. Area more than 5000 hectare can be irrigated along the canal. Origin of this canal is Semiramis/Samran water which is 6km south-west of Gürpinar, 1km south-east of Yukari Kaymaz village. This water source which comes from a karstic area with 1760m heigth and 37-38m radius, has 6-10 m^3/s volume of flow. During dry seasons this volume decreases to 2m^3/s. Water coming from this source is directed to north via a soil land canal first, then it passes over Hosap brook which flows from east to west via a water arch. This canal –that is 3.5-4m in width, 1.5-2m in depth - then passes from an area made fromlimestone. A big part of this canal passes from main limestone rock. By this way it has not been affected fromearthquakes and has protected its existence for 2800 years. Million cubic metres of stones which were needed to build supporting walls in rough and inconvenient parts of terrain were obtained from limestone mines at Edremit and Harabedar. Supporting walls which made from huge limestones and which are 1.5-2m in heigth have protected their existence upto now. Only exterior parts of stones have been roughly corrected. They have tried to strengthen these walls which were built by loading technique. There are two reasons how this canal remained undamaged for 2800 years and remained unaffected from severe earthquakes; canal had passed from main rock and it had been strengthened by supporting walls. Basis of canal had been made on main rock. Clay was used as connecting material between stones, this also increased strength of canal. Areas where canal passes have very wealthy clay sources like limestone sources.

Cisterns: Cisterns are special constructions which are generally built underground and are used to collect water (Sözen). They are generally built at castles and settlements at hot regions to collect water and there are a

lot of cisterns at different cities and castles of Anatolia. Rocky stairs which goes to upper castle and which are at ground floor of multifunctional cistern, belong to Urartian period. Underground fresh water level of region was skimpy, this has prevented building a lot of cisterns. When location and functionality of cisterns at Van castle and old Van city are considered; it is obvious that cisterns are one of the most important architectural constructions which came upto now. This systems have been built with different plans according to location and form of reaching to wate of castles.

Plan types: There are two cisterns which are different in terms of plan and function (Öztürk,).

Closed multi functional natural system: Cistern which is located at south middle part of ancient Van castle supplies vertical communication between old Van city and Van castle. Natural water source of cistern which is composed of three parts is 1500m under the ground level. This cistern has been built multi functionally to provide security of castle from south part to meet water requirements and to ensure the communication. Such cisterns can be seen at antique Rome city which is located at south east part of Mardin and at Hasankeyf which an ancient settlement. Cistern which provides the only connection between Van castle and old Van city carried great importance every time because it supplied water to people remaining in the castle during besieging of castle and city.Closed circular planned system: The only circular planned cistern of this region has been built by carving rocky ground of inner parts of Van castle. Material Stone, brick and mud brick has been used to build two cisterns of this region. Connecting materials are lime daub and cas daub.

Stone: During construction of multi functional cistern rubble stone, rough dressed stone, cutting stone and raft stone had been used. Cutting stone can be seen at arches of inner passage ways, vaults, door frames and front corners. Rubble stone can be seen at east and south walls and inner gallery walls. Raft stone can be seen at ground casings.Brick: It had been used at supportive walls of multi functional cistern and paved road, dome and wall of circular planned cistern. Measurements of brick are 0.05x0.21x0.21m.Mud brick: The only water architectural construction at this region in which mud brick had been used is upstair walls of multi functional cistern. Measurements of mud brick are 0.1x0.3x0.3m.Wooden: It had been used at lintels and upper couverture joists of multi functional cisterns. Isolation by using pitch had been done to protect wooden lintels of second floor of cistern from interior and exterior harmful effects. Inscription

There is a hollow inscription garnish which is 2.10x2.35m in south front of multi functional cistern. It is limited with a border which is 0.30m in width and which surronds from four direction. It has been left hollow without completing both writings and garnishes of it. But arch located at upper mid part which has two lines having one slice at upper, two slices at lower part, had been emphasized with an indentation. Remaining part is lined with smooth cutting stones and it is hollow.

Kehriz: Kehriz was firstly built in Middle Asia with the name of Kares. It is known that a lot of kehriz were built with obvious spaces along silky road which starts from China and comes to Anatolia to meet water requirements of caravans in the middle ages (Kali, 1999). In the Turfan region (Uighurs) and Taklamakan desert of Middle Asia kehriz is still being used (Fig. 14-17).

Kehriz which is in concordance with Middle Asia water tradition and which is located in cross road of ancient silky road had been built in Van city. 50m topographic heigth difference between Erek mountain fringes and Van lake coast had made building of kehriz easy. Presence of a lot of kehriz in Van is quite interesting because kehriz is built to prevent water loss in the desert and in very hot climate. We cannot determine plan types of kehriz because all of them had been built underground and most of them are not present today. Routes of 22 kehriz from 36-48 kehriz present in Van city are known today. In Saray country there is a kehriz which is semi flowing. Also it is possible to see remnants of kehriz present in Taskonak (Kasrik) village of Van city center and Asagi and Yukari Dönerdere villages of Özalp country (information from authorities in GWA XVII Region Directorship).

There are some ideas that kehriz had been built during Urartian period. But there is no certain information about this (Ögünç,). It is clearly known that all water necessities of Van were met by kehriz during Ottoman period. Kehriz institutions appear in different districts via starting from fringes of Erek mountain by special canals and being collected through underground oozing routes. Kehriz canal length changes between 6-20m, volume of flow changes between 15-140lt/sn.

Upto 1970's, kehriz was used drinking water and also to irrigate gardens and fields by canals. By the way kehriz reflects sound and happiness effect physcologically, conversation and solidarity effect sociologically, cleanliness and beauty effect in terms of city planning. Kehriz which was functional almost upto now had decorated a lot of streets (Old Iskele Street) with willow and poplar trees and make them ornate.

Upto 1980's, water of Zeki Adigüzel and Soydan Hammams', which are now in Van city, was supplied by kehriz. Recently, cafes which were using kehriz water were privileged and tea of them was preferred. Adil cafe

Fig. 14: A view of kehriz

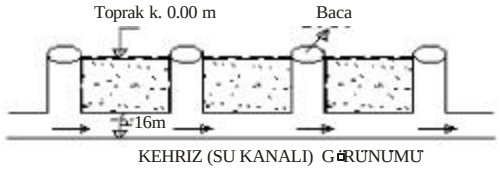


Fig. 15: A view of kehriz (water canal)

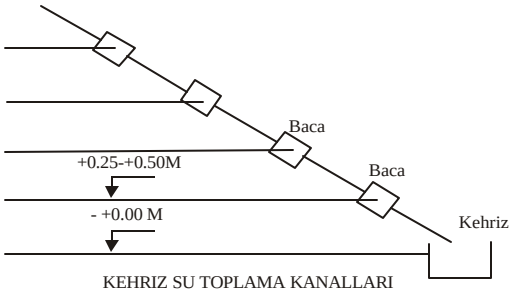


Fig. 16: Water collecting canals of kehriz.

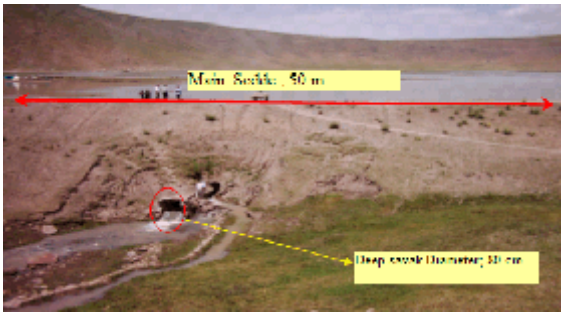


Fig 17. Map of water constructions of Urartian period.

in Besyol area is an example of these cafes. It is estimated that annual and monthly care and repair of kehriz were made by dedications or special assigned teams. During first years of republic period this duty had been performed by municipality of Van. After 1965, GWA XVII Region Directorship has performed this duty. Kenkan teams had been constituted under GWA and they have done all care, cleanning and repair studies of all kehriz periodically.

All experienced workers who dig well and who perform cleanning, care and repair studies are named as Kenkan in Van region. Kenkan team contains four persons; kenkan, kenkan helper, pailor and grinder. Equipments used by kenkan team are wooden grind, hemp rope, carbide torch, special hoe and shovel, helmet, boat, glove, pail and dressing fleece.

Kenkan is an experienced master who is responsible from well or kehriz cleaning, care and repair of which will be done. He plans the work, knows land structures and has strong presentiments and discipline.

Kenkan helper makes carbide torch, hoe, shovel, glove and pail ready to work, goes down to kehriz with kenkan, fills pail up with soil land, calls out to upper part and sends the pail.

Grinder sets up wooden grind with pailor, leads grind, gives directives to pailor to prevent possible accidents.

Pailor sets upgrind with grinder, makes necessary preparations before working and pulls pail to upper part.

Meydan loch: Meydan loch is located on north part of Van lake, north-west part of Ercis country, 1km north of Meydan village. Meydan loch which is 2300m higher than sea level, is surrounded with compressed mountains which are 2500-2700m in heigth[4].

Since there are no plant and tree population in loch drainage area; water collection area is taking waste water mostly. Loch had been formed from water source, small brooks, snow, rain and spring water. Coming waste water is decreasing drainage area every day and forming small islands. There is appriximately 9km^2 loch area. This the greatest water collection area of Urartian hydraulic at the same time. In summer, 3000 persons and nearly 3000 sheeps or goats are spending approximately 100 days around this loch. Water collected in loch is given to irrigation areas by bottom dyke action. Dam of loch had been obtained from andesit rocks. We have seen that land soil had been filled between reciprocal walls which are 9-10m in thickness. By this way bend dams had formed a dam example alike todays landsoil filled dams. System planned before 2700 years is used nowadays.

A building technique directed towards water collection had been thougth. By using big stones, a wall and another supportive wall had been built in dam structure. These show that hydrostatic pressure of collected water had been perceived in a true way. Calculation of hydrostatic pressure was impossible at that time; a dam durable to this pressure was built with estimation and intuition. Big andesit stones which were used in the basis of dam trunk show that importance of

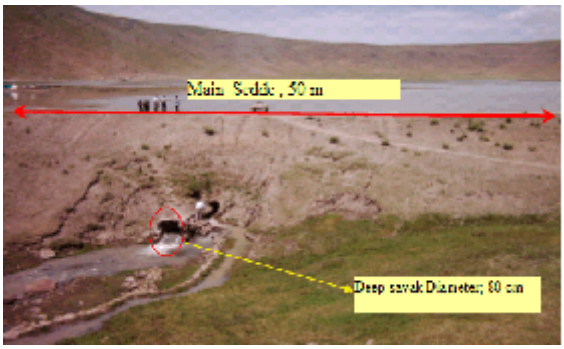


Fig. 18: Dam trunk of Meydan loch (2004). Radius of dyke. Main dam trunk

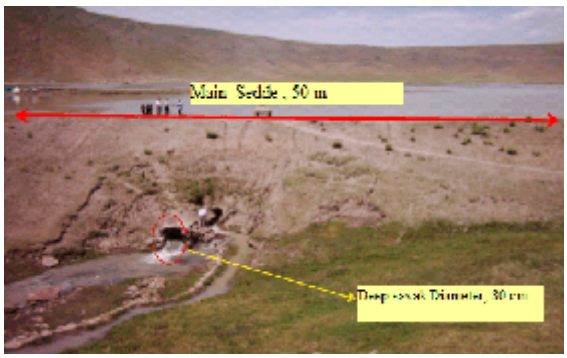
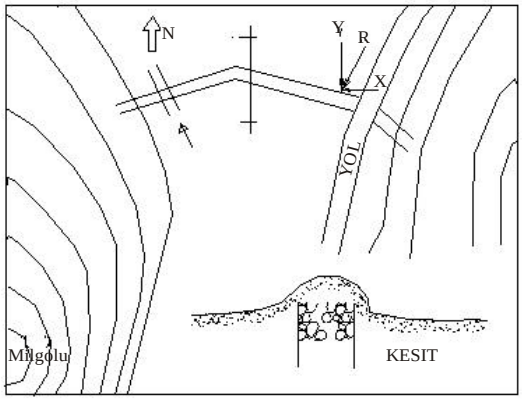
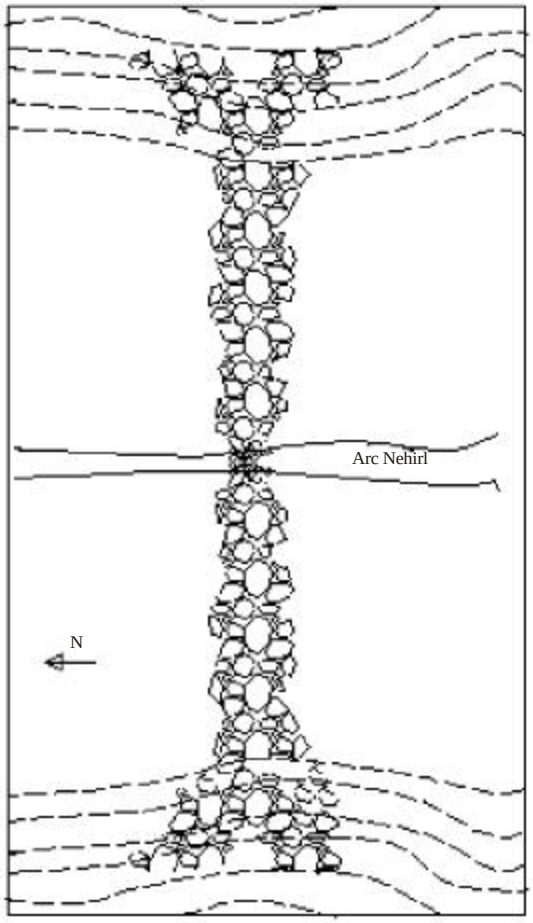


Fig. 19: Dam trunk of Meydan loch (2004). Control valve-dyke distance



Arpayatagi Golu[4]

Fig. 20: Connecting material of Meydan loch (2004) Clay is used as connecting material

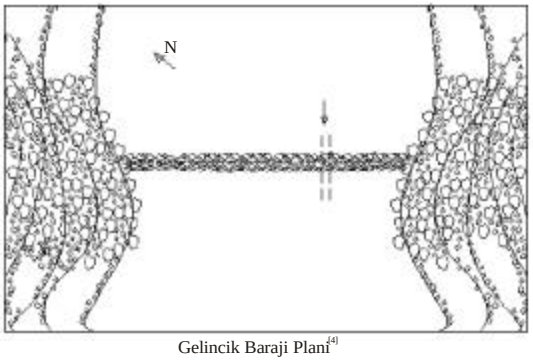


Arc Baraji Plani[4]

Fig. 21: Arpayatagi Lake[4].

water pressure had been considered. It is seen that walls had been built on dam trunk in the area where water collection potential of basin is very high. This shows that water hydraulic of Urartian was very improved. Because even today area selection can be done in a wrong way although developed techniques and maps. It takes attention because selected areas are very narrow and deep, walls are 5-6min heigth, stones weighing tones had been lifted without any machine. In Meydan loch; walls which are 140m in length, 6m in heigth had been built with an obscure way (Fig. 18-20). We have seen that in some Urartian walls stones got smaller by using Horasan stones as connecting material. But in regions where water bend touches to water very huge, big and orderly stones had been used. This is an example of rip-rap stone which is also being used in dam construction nowadays.

Urartian Meydan loch had been done widely and one after one. Sudden inundation which can be caused by million cubic metres of water and casualties and estate losses which can be arose by these inundations had been thougth with great attention and care. A very improved dam building technique had been used when compared with early period Urartian dams. By terracing system in irrigation areas and areas exposed to sun, more benefits had been obtained from dam water in middle age and Ottoman period. Hammullah EL Mustavfi Kazvini who dealt with this region in terms of history and geographics, glowingly talked about this event in 1340. In areas at



Gelincik Baraji Plani[4]

Fig. 22: Plan of Arç dam[4]

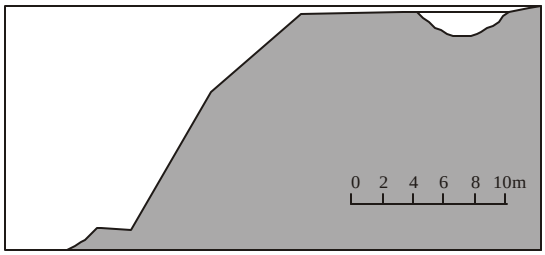


Fig. 23: Plan of Gelincik dam[4]

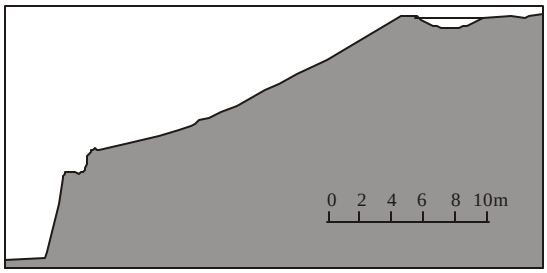


Fig. 24: Map of Urartian water sources[4]

south-east part of castle there are obsidien cots. These areas which were wine gardens 90 years ago are all destroyed today[4].

There is a castle at 250m north-east part of dam wall to protect dam drainage basin and for security. Today castle can be seen as two lines of stones. Big and little obsidiens can be seen in this area which is like a coal field. Obsidien bulbs taken from this area had been brougth to Meydan hill castle which is 100-120m far and treated here. Fully treated and semi-treated obsidien pieces on and around the castle show that castle was an important production center of the region. Superficial archeological studies have shown that it is an important obsidien center. A lot of Urartian graves at Meydan hill castle are now like mole trails because of being peeled. Gelincik dam is 140km to Van. Rusa dam is the widest water collection area after Van lake. Water collected in dam is formed from rain and snow water coming from mountains and from a lot of springs and small Hanasor brook flowing to west direction. Dam wall had been built to a narrow and rocky sound. It is very suitable to todays place selection of dam building technology. Gelincik dam had been used to grow up grass like Kirmizi Düzlük and Yukari Argit dams (Fig. 21-24). By these grass lands 10.000' of sheeps are being nourished today in winter. There is an Urartian castle here. But because it has been destroyed no plan can be taken from the castle.

RESULTS AND DISCUSSIONS

Water is one of the basic component which is inalienable. Life cannot go on without water. From the beginning of life different civilizations had used this basic necessity material in different ways. In this level; Urartian civilization had used water in the most beautiful way and ligth the way to coming generations by place selection and building techniques which helped water constructions to arrive to our period.

By this study some basic constructions of Urartian hydraulic which is the most important leg of Urartian civilization have been examined at a close range. Especially presence of water springs and their drainage basins draw attention. Selection of a suitable place during drainage basin formation is very coherent with todays water construction techniques.

They had built castles near dams to appreciate water sources and to provide security and utilization. These castles were also used to keep tools which are necessary for care, repair and management of water accumulating in the dam.

Urartian people thougth that creation of water civilization would be possible by mine processing and dealt with mining firstly. They have produced iron and bronze aggriculture tools to cultivate landsoil. We can say that Uratian civilization is the biggest minor population seen in history.

Today 98 units of water constructions in different scales have been determined. 12 of them are functional even today. They contribute to agricultural activities.

Today our duty must be repairing water constructions and increasing life duration of them.

Arch dam systems thougth 2700-2800 years before lightens our way.

Afforestation is necessary especially around Gelincik, Meydan and Rusa dams. High plateaus should be done in a controlled way around these loches.

Repairs and cares on water constructions must be done very carefully and coherent with their original state.

We have to protect these worths belonging to humanity and transfer them to coming generations with their original states and functions.

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