World Water Diplomacy & Science News

WWDSN -1- 2017 (1-4) EN

ENISSN: 42016-10005 www.hidropolitikakademi.org

Traditional Water Harvesting In Anatolia; Water Harvesting Prospects For Turkey

Hamza ÖZGÜLER

Senior Hydrological Expert

Retired, General Directorate of State Hydraulic Works (DSI)

06100, Ankara, Turkey

hamza.ozguler@gmail.com

SUMMARY

It is a well known fact that the total amount of water on earth has remained constant. However, the rapid growth in population, extension of irrigated agriculture and industrial development are putting stress on the natural ecosystem. Therefore, it is now accepted that water should not be regarded with the philosophy of "use and discard'.

Especially in the dry areas, water is the most limiting resource for improved agricultural production. Therefore, maximizing water productivity is a better strategy for dry farming systems. In this context, water harvesting as supplemental irrigation is considered as a highly efficient practice with great potential for increasing agricultural production and improving livelihoods in the dry rain-fed areas.

Giving information on the historical findings about the traditional water harvesting methods in Anatolia where water harvesting had being applied since the very old times, this paper tries to highlight the effectiveness and productivity of existing water harvesting techniques and its future prospects in the dry rain-fed and arid regions of Turkey. The study shows that substantial and sustainable improvements in water productivity can only be achieved through integrated management. In this context, conventional water management guidelines should be revised to ensure maximum water productivity.

1.INTRODUCTION

The world population is growing fast. The impact of this growth on water resources is experienced as "water stress". Parallel to this, the demand for water is steadily increasing throughout the world. However, freshwater resources are limited and unevenly distributed both in time and place. In addition to this, there are seasonal variations and climatic irregularities in flow.

Rapid population growth, combined with industrialisation, urbanisation, agricultural intensification and water-intensive lifestyles is resulting in a global water crisis. Water security, like food security, is becoming a major national and regional priority in many areas of the world.

Water is life, water is a wish, water is a dream. The theme of International Water decade is "*water for life*". But, we need to read this phase adversely also: "*Life for water*". Everyday, we need to consume water for "*living*". But, people never think of "*living for water*". If protecting water resources should be a wish, we should change the philosophy in this direction. Under this headline theme, much more attention is needed for the sustainable usage of water.

Today, we still have some difficulties to be able to tell about the real and actual meaning of "water", which was however briefly explained as "proverbs" written only in a few words. Here are the English translation of some water-related proverbs used daily in my Country:

May you be blessed like water; Be precious like water; **Don't tuck up your trousers before seeing a stream**; Water can sleep but the enemy never; **There is strangely no difference between the one who brings water safely and the one who breaks the pitcher**; The pitcher is broken on trips to the fountain; **If one does not swim in the current direction he will get exhausted**; A person shouldn't change the horse while crossing the stream; **Water can do without fish, fish cannot do without water**; The earth cannot smile unless the heavens cry; **A dry tree bears no fruit**; Little drops add up to a lake; **What bores into rock is not the water's strength but the continuation of drops**; Water finds its own way as it flows; **River mouth cannot hold sand**; and Water is like a rampant lion.

Among the various alternative technologies to augment freshwater resources, rainwater harvesting and utilisation is an environmentally sound solution, which can avoid many environmental problems often caused in conventional large-scale projects using centralised approaches.

2.WATER HARVESTING

Rainwater harvesting, in its broadest sense, is a technology used for collecting and storing rainwater for human use from rooftops, land surfaces or rock catchments using simple techniques such as jars and pots as well as engineered techniques. Rainwater harvesting, a process of concentrating precipitation through runoff and storing it for beneficial use, has been practiced for more than 4,000 years, owing to the temporal and spatial variability of rainfall. It is an important water source in many areas with significant rainfall but lacking any kind of conventional supply system. It is also a good option in areas where good quality fresh surface water or groundwater is lacking. The application of appropriate rainwater harvesting technology is important for the utilisation of rainwater as a water resource (UNESCO, 2004).

Precipitation in the drier environments is generally low compared to crop basic needs. It is unfavorably distributed over the crop-growing season and often comes with high intensity. As

a result, rainfall in this environment cannot support economical dryland farming. In the Mediterranean areas, rain usually comes in sporadic, unpredictable storms and is mostly lost in evaporation and runoff, leaving frequent dry periods during the crop growing season.

Capturing rainwater and using it efficiently is crucial for any integrated development. Water harvesting is an ancient concept with a wealth of indigenous knowledge available. Indigenous systems such as *jessour* and *meskat* in Tunisia, *tabia* in Libya, *cisterns* in north Egypt, *hafaer* in Jordan, Syria and Sudan and many other techniques are still in use (Oweis et al., 1999). Water harvesting may be developed to provide water for human and animal consumption, domestic and environmental purposes, as well as for plant production.

2.1.Basic Concepts, Advantages and Techniques of Water Harvesting

Water harvesting is a kind of reserving of water for a special use. The word of "reservoir" is originally stemming from "to reserve". In the general meaning, this word implies to keep something for a special purpose. In this regard, keeping the water for some special purposes, water harvesting is considered as a source of agricultural and domestic water supplies in the rural areas.

Rainwater harvesting systems can provide water at or near the point where water is needed or used. The systems can be both owner and utility operated and managed. Rainwater collected using existing structures (i.e., rooftops, parking lots, playgrounds, parks, ponds, flood plains, etc.), has few negative environmental impacts compared to other technologies for water resources development. Rainwater is relatively clean and the quality is usually acceptable for many purposes with little or even no treatment. The physical and chemical properties of rainwater are usually superior to sources of groundwater that may have been subjected to contamination.

Regarding to the benefits of rain water harvesting, followings can be mentioned (Oweis et al., 1999):

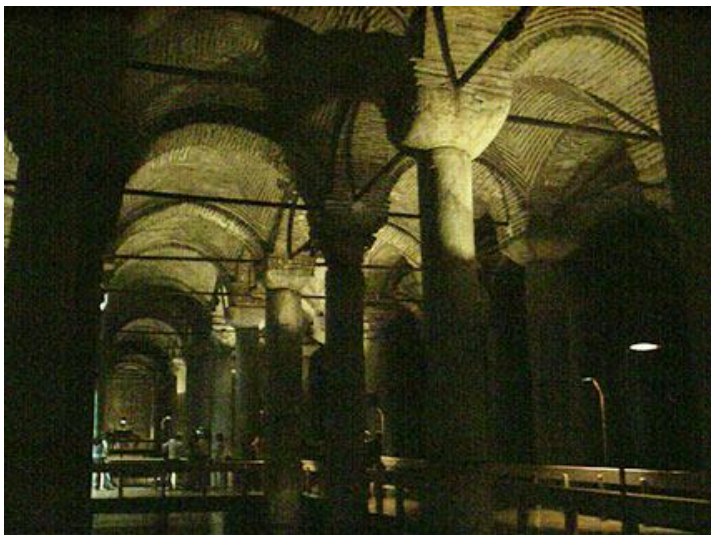
- Water harvesting can serve as a supplement to municipal water.
- Harvested water contributes to water conservation and reduces water demands in urban areas.
- Rainwater harvesting can reduce storm drainage load.
- Rainwater harvesting technologies are flexible and can be built to meet almost any requirements.
- Construction, operation, and maintenance of water harvesting systems are not labour intensive.
- Some buildings divert rainwater to help with functions such as toilet flushing.

Water harvesting refers to methods used to collect water from sources where the water is widely dispersed and quickly changes location or form and becomes unavailable or that is occurring in quantities and at locations where it is unusable unless some intervention is practiced to gather the water to locations where it can provide benefits. There is a number of water harvesting techniques that are practiced in many of the water scarce areas of the world, such as rainwater collection, terracing, small dams, runoff enhancement, runoff collection, flood spreading, water holes and ponds and tanks (UNESCO, 2004).

2.2. History of Water Harvesting Worldwide

The ancient Romans became masters in rainwater harvesting and the construction of reservoirs. It was this new technique of building closed cisterns, and at the same time the urbanization within the Roman Empire around the Mediterranean, which resulted in the development of a rainwater catchment culture at all those places where water resources were limited. This is why old rainwater cisterns are to be found on the islands of Capri and Malta and at places of historical interest in Spain and Turkey, in the Lebanon and on the island of Sicily.

Probably the world's largest cistern is the Yerebatan Sarayi (Picture 1). On the European side of Istanbul in Turkey, it was constructed under Caesar Justinian (A.D. 527-565) and measures 140 by 70 metres. It can store 80,000 m^3 water. The underground structure is based on intersecting vaults. Nowadays it has turned into a tourist attraction which can be visited by boat, drifting through a forest of columns. Another cistern in Istanbul is called Binbirdik and has a capacity of 50,000 m^3. Both cisterns served as centralized storage. The water was collected from roofs and paved streets and a sophisticated system of filters assured clean water.



Picture 1. Yerebatan Cistern Water reservoir, buildt in the 6th century

However the municipal underground cisterns in Istanbul are probably the only examples of urban centralized rainwater harvesting of their kind. There are probably two major reasons why this technique was no longer used. Firstly, the construction of underground cisterns is considerably more expensive than the construction of dams. Secondly, there is a danger of accidental pollution through human excrete in dense urban areas and therefore a risk of epidemics.

Although rainwater harvesting and storage in closed cisterns were never used again to the same extent as in ancient Rome, they were occasionally employed where circumstances demanded an appropriate technology. This happened in semi-desert areas where people wanted to build homes without springs or wells in the vicinity.

3.HISTORICAL WATER HARVESTING IN ANATOLIA

Anatolia is a territory where many civilisations were developed in the history. Especially, the richness in the historical water structures is much more than the others (Bildirici, 1997).

A great variety of hydraulic structures were implemented during the last four thousand years on Anatolian soil, which was at the crossroads of civilizations, making Turkey one of the foremost open-air museums of the world with respect to ancient water works.

There are remains of several water works from the second millennium BC Hittite period in Central Anatolia; from the first half of the first millennium BC Urartu period in Eastern Anatolia; from the second half of the first millennium BC to the first half of the first millennium AD Hellenistic, Roman, early Byzantine periods in Western and Southern Anatolia; from the second millennium AD Seldjukide and Ottoman periods throughout Turkey (Özis, 1999).

Figure 2. Major River Basins of Turkey

Generally symbolizing “abundance” and “plenty”, the availability of water had been taken as a reference point or criteria source for establishing cities. Even some of the towns are still called as “water city”. Going to the further beginning of the written history, several civilizations such as Mycenaean Greece, Indus Valley India, Maya, Roman Empire, Chinese Empire, Egypt, Gardens of Babillion, Mesopotomaya and Hittite Anatolia along the rivers, can be considered as the big examples of water-dependant communities.

In the Anatolia, dating from the Hittite period in the central part, from the Urartu period in eastern part, from the Hellenistic-Roman-Byzantine periods in Western and southern side, from the Seldjukide and Ottoman periods in different parts of Turkey, some of what are still in use after several centuries, ancient water works is very common along the Aegean coast line territories of Anatolia. These civilizations could be flourish only by utilizing water for their development.

3.1.Hittite And Urartu Periods In Central & Eastern Anatolia

The most ancient remains of hydraulic works in Turkey date back to the second millennium BC, the Hittite period in Central Anatolia. These include the Karakuyu dam, other dams like Gölpınar, Köylütolu, Eflatunpınar, Yalburt, the springwater collection chamber in Boğazkale, conduits at Alacahöyük, Korucutepe and some other sites (Belli, 1996).

Dams were first constructed by Hittites in Anatolia. According to the Hittites, water was a holy subject. Accordingly, most of the water structures carried some religious motifs. Hittites constructed some small dams o collect water. In the villages in this area, main source of water was well (Bildirici, 2004). As for the Urartu periods, theye built mostly cisterns in castles to store water for people living around.

3.2.Hellenistic, Roman, Early Byzantine Periods In Western & Southern Anatolia

Remains of Hellenistic and especially Roman and early Byzantine hydraulic works in Western and Southern Anatolia, from the second half of the first millennium BC and the first half of the first millennium AD, are very numerous and new discoveries add to the rich variety of them (Özis, 1999).

Figure 3.Cavdarhisar dam area

Dams like the 10 m high Çavdarhisar, 16 m high Örükaya and certain others date also from the Roman period, whereas Dara and Löstügün date from the early Byzantine period. It is still unclear, whether the 1988 half collapsed Faruk dam near Van dates from this period too, or is as early as the Urartu or as late as the Seldjukide periods.

Covered and open cisterns in İstanbul, with side lengths in the order of 150 to 250 m, are extraordinary examples of antique cisterns.

3.3.Seldjukide & Ottoman Periods In Anatolia & Thrace (10th - Early 20th Centuries)

From the 10th to 13th centuries Seldjukide period in Central and Eastern Anatolia, there are quite few remains, like the water conveyance canal to a mill in Çermik, the Sahip Ata

irrigation canals in Konya, irrigation systems in Ereğli and elsewhere (Özis, 1999).

Among the ancient hydraulic works from the 14th to early 20th centuries Ottoman period in Turkey, those for İstanbul and Edirne deserve particular interest.

It can be concluded that rainwater harvesting has been carried out in Turkey in previous decades and it has been shown that it can serve the poor by supplying water for domestic use and supplemental irrigation, thus ensuring both water and food security.

Ancient water works, dating from the Hittite period in Central Anatolia, from the Urartu period in Eastern Anatolia, from the Hellenistic-Roman-Byzantine periods in Western and Southern Anatolia, from the Seldjukide and Ottoman periods in different parts of Turkey, some still in use after several centuries, even millennia, make Turkey one of the most outstanding open-air museums of the world in this respect.

Moreover, based on a 4-millennia-long tradition of hydraulics technology and engineering, the ultimate development of water resources in Turkey during the early decades of the 21.st century, will greatly contribute to the welfare of the country as dealt with more detail in other papers of this issue.

4.WATER HARVESTING PROSPECTS FOR TURKEY

Turkey has a subtropical, semi-arid climate with extremes in temperatures. In the east, summers are hot and dry, winters are cold, rainy and snowy. Along the coastal area, a Mediterranean climate is dominant with long, hot, dry summers and short, mild, rainy winters. Rainfall shows great differences from one region to another. Average annual rainfall is 643 mm, ranging from 250 mm in the north-east to over 3 000 mm in the north-east Black Sea area. About 70% of the rain falls in the winter and spring seasons. Central Anatolia is a vast high plateau and a semiarid continental climate with extremities in temperature.

In the drier environments, most of the rainwater is lost by evaporation; therefore the rainwater productivity is extremely low. Considering that water is the key factor in changing the fundamental conditions for the existence and development of the poor areas, water harvesting can improve agriculture by directing and concentrating rainwater through runoff to the plants and other beneficial uses. It is generally assumed that considerable amount of lost water can be recovered with some appropriate harvesting techniques at a very little cost. However, socioeconomic and environmental benefits of this practice are far more important than increasing agricultural water productivity.

And now, when climatic change starts to be felt in recent years and their impact on rational use of water, water plays much more effectively a vital role in economic and social development. In the developing countries, communities mostly depends on the water resources development, conscious of the indispensable nature of water to all aspects of life, it can be concluded herewith that based on a four thousands year – long tradition of hydraulics technology and engineering, the planning and full development of water resources in Turkey, where the climate conditions and water regimes are very changeable, will greatly contribute to the welfare of the people in the Country, during the early decades of the 21st century.

Unevenly distributed precipitation makes irrigation a must in almost all over the country. Drinking, agricultural and industrial water uses have direct effects on the development of countries and all human activities. Therefore, together with today's new technologies, it is beneficial to develop further the traditional water harvesting techniques.

5.CONCLUSION

Watershed management issues are receiving more attention in Turkey. More progress was achieved in protecting water provisions areas, increasing water harvesting and construction of hydro-dams in the Country. The main problems in watershed management are water supply, erosion, droughts and flooding. Additional financial resources are needed to improve the water harvesting techniques and capacities of existing dams, as well as to monitor and formulate watershed management plans and to train national staff.

Possible innovations could include the initiation of "water harvesting" efforts through the construction of micro-scale dams and aquifers to gather rainfall and storm run-off. Possible innovations could include the initiation of "water harvesting" efforts through the construction of micro-scale dams and aquifers to gather rainfall and storm run-off.

As conclusion, it can be definitely stated herewith that rainwater harvesting has a potential use for poverty alleviation in the arid region of Turkey. Turkey faces great challenges to alleviate poverty as it has already started the negotiations with European Community. Unfortuately, there are many people living below the poverty level. They are concentrated in the mountainous areas of interior and eastern Anatolia, where the driest and poorest conditions are always valid. However, due to the topographical nature of the area, a major water delivery project would be difficult to build and be economically unfeasible. Rainwater collection may be seen as the most easy-to-use water source with the highest potential. Rainwater harvesting is also beneficial to the recovery of the ecosystem and environmental conservation in the arid and semi-arid eastern region of Turkey. Therefore, it is reasonable to consider rainwater harvesting in integrated water resources management in the Country.

REFERENCES

[1] Oweis, T., Hachum, A., and Kijne, J., 1999. Water Harvesting and Supplemental Irrigation for Improved Water Use Efficiency in the Dry Areas. SWIM Paper 7. Colombo, Sri Lanks: International Water Management Institute.

[2] Öziş, Ü. (1999) Historical dams in Turkey (Ankara, Turkish National Committee of International Commission on Large Dams - TRCOLD, 100 pp.

[3] Belli, O. (1996) Doğu Anadolu bölgesinde keşfedilen Urartu barajlarına toplu bir bakış, Belleten, No.229, pp.638-751.

[4] Bildirici, M.; Bildirici, Ö. (1997) Konya ve çevresinde çağlar boyu tarihsel su yapıları, in: Türkiye İnşaat Mühendisliği 14. Teknik Kongresi (İzmir, İnşaat Mühendisleri Odası), pp.1115-1128.

[5] Bildirici, M. (2004) Tarihi Sulama, Su Depolama, Taskin Koruma Tesisleri, DSI Genel Mudurlugu, 2004, Ankara

[6] UNESCO (2004), IHP-VI Project, Task Force on Rainwater Harvesting, Paris

Biography

Hamza Özgüler

After receiving his B.Sc. Degree from Department of Meteorological Engineering, Istanbul Technical University, in 1984, he started serving for the General Directorate of State Hydraulic Works (DSI). He has received MSc degree from the Environmental Department of Hacettepe University, Ankara.

He has more than 25 years of professional experience in the State Hydraulic Works, His engineering specialisation area mainly includes project hydrology, water resources assessment, planning and management, environmental impact assessment as well.

After retirement from DSI, he has been dealing with project hydrology as a senior hydrologist. Presently, he is serving for water resources planning and designing of hydraulic structures.

(Recieved :16 March 2017 Accepted: 2 April 2017)