



A Drynet Science & Technology Expertise:

SIRAF- A Successful Traditional Way of Water - Harvesting in Iran

Soheil Mohajeri,
Professor, Science and Technology University of Boshehr

January 2010



**EUROPEAN
COMMISSION**



drynet is a project funded by the European Union and supported by The Global Mechanism

Abstract

Siraf port city used to be one of the main maritime trade and commercial center of Iran at the coast of Persian Gulf for about 8 (3rd to 11th) centuries. It was as big as Shiraz city at that time and had accommodated hundred thousands of population. Due to hydro-geological and topographic characteristics of the area, the city had no access to rich underground aquifers as well as permanent rivers. However the archeological researches have indicated that they had developed almost 500 ha of irrigated farms for fruits and crops production. So how they were able to secure the required fresh water for such a big city? Analysing the historical and archeological literatures as well as field work in study area shows that the ancient Sirafies had developed state of the art water management techniques for rain water harvesting, water storage and irrigation measures.

Keywords:

Siraf, traditional knowledge, rain water harvestings

Introduction

Water is an essential element of life with special economic, social and environmental importance in drylands. Securing fresh water for human consumption and agricultural products used to be one of mean concerns of drylands inhabitant. However, increasingly population growth along with global warming and frequent drought are aggravating the problem and forming one of the main feature challenges.

In Iran, the average annual rainfall is 252 mm, which is less than one-third of the world- average. About 85% percent of the country consists of dry lands where water is scarce, and habitation has been made possible only through traditional water management technologies, systematically developed over the centuries. With an average annual precipitation of 250 mm over Iran's entire surface area, the total amount of precipitation received, is 413 billion cu.m annually. Of this amount, only 44.5 billion cu m are controlled and managed for various uses. At present, about 55 percent of the water consumed in the country is from underground sources and 45 percent from surface water sources (UNDP 2001).

In the last 40 years, the population of Iran has increased by 45 million people from about 25 million in 1966 to more than 70 million people in 2006. There is inevitably an increased need for potable water in population centers. Indirect impacts include increased demand for agricultural products, development of irrigated lands, and the need for job opportunities and more income, especially in the agricultural sector (Ardakanian 2005).

The water crisis is expected to intensify in the future. On the basis of studies conducted by United Nations (UN) experts, the per capita water resources of Iran are projected to be about 726-860 m3 in 2025, as compared to 2,200 m3 in 1990. This shortfall is expected to sharpen the water crisis before the year 2025 (Mousavi 2005).

In the last 30 years, over exploitation of groundwater - primarily through wells - has resulted in a decrease in water levels. Although the problem in Iran is not as severe as in other countries, information provided by the Groundwater Department of the Ministry of Energy indicates an average long-term annual decrease in water levels of 0.4 m. As a result, the net present value of the damage cost associated with underground water depletion in terms of incremental fuel costs and well replacement is estimated at US\$332 million (0.29 percent of GDP) (Bank Word 2005).

However, beside the scarcity of water, and ecological fragility, drylands have potentially various resources and opportunities which could wisely be use for their sustainable development.

Ancient Siraf - An example of dryland development

On the northern shore of the Persian Gulf the ancient cultural site of Siraf is found in Bushehr province (Figure 1). In this region of the West-Iranian chain of mountains the climate is semi-arid with erratic rains and rare vegetation. Mean annual rainfall, is about 230 mm and the temperature reaches up to 50 degree centigrade during the summer months.

The earliest reference to Siraf occurs in the writing of Ibn-al-Fagih (850 AD), who notes that Siraf's ships traded with India. About the same time Sulaiman the Merchant recorded that Middle Eastern Goods bound for China were sent first from Basra to Siraf, whence they were dispatched by way of Muscat and Quilon, an important entrepôt on the Malabar coast (Masomi 2005). In 950 AD, Istakhri provides the fullest surviving account of the city. In the district of Ardashir (south-west Fars), he wrote, Siraf was second in importance only to Shiraz and was almost as large as the latter. He notes that despite its location in the hottest part of the coast and scarcity of drinking water, Siraf was a flourishing city with imposing buildings. In the early tenth century, more than 2.5 million dinars worth of goods passed through Siraf annually (Afshar 1990).

Reports by David Whitehouse - one of the first archaeologists to excavate the ancient ruins of Siraf, who has conducted six subsequent excavations in this port city between the years 1966 and 1972 - provide evidence of Siraf's importance as described by the various writers. The excavations revealed that Siraf was one of a series of ports in the Persian Gulf, providing the Sasanians with a profitable share of the maritime trade which carried luxury goods from the entrepôts of Ceylon and South India to the markets of Western Asia and the Mediterranean Sea during the Sasanian period (224-651 AD). The walls of Siraf, as found during the excavation, enclosed an area of more than 250 hectares. By the time it was first mentioned (850 AD), it was already a flourishing port and continued to prosper during the next hundred years. Sirafi merchants traded with the Red Sea, East Africa and Madagascar in the west and with India, the Malay Peninsula and China in the East. In 977 the city was damaged by an earthquake and thereafter declined. After its fall in 1055 AD most of the trade was diverted to Qais and by 1218, Siraf was in ruins (Whitehouse 1968).

2. Research Objective

As mentioned above Siraf used to be a prosperous and big city in its time although it has no access to permanent ground and surface water resources due to its topographic and hydro-geologic characteristics. Therefore the objective of this research is to study the way that the city provide and managed the required water for its population. Thus it will address the following research questions:

1. How the people living in Siraf region provided for themselves drinking water for urban usages?
2. How they harvest and managed the rain water for urban and agricultural usage?
3. Why were these incredible ingenious water harvesting systems thought to be simply the graves of their ancestors and predecessors?
4. What technical qualification they took into consideration while designing and implementing the water harvesting system?

3. Methodology/approaches

To answer these questions two steps have been taken. At first, the available information about Siraf's

water management system has been explored from the historical books and archeological investigations reports. The majority of them highlight the importance and development of Siraf in 7th and 8th centuries. They further stressed on its extremely hot climate and the lack of water resources, so that in some references it is called "*the entrance of the hell*". Mainly there were two methods for supply water for Siraf in the references, namely rain water harvesting, and transferring water from Jam plan which is located mover 70 km away from Siraf.

In the next step, the information collected in first step has been crosschecked with the field work and studying the remaining water management structures and their geological and topographic characteristics.

4. Results

Many historical reports have highlighted Siraf's harsh climatic conditions and provided evidence on its water management system. Moghaddasi who had visited Siraf rise, named it "*the iterance of the hell*" because of its extremely hot temperature and indicated that they transferred the required water from long distances (Jam Plain). However his followers, e.g. Istakhri, Ebn-al-Balkhi 1231 AD and Mostofi 1361 AD, who mainly wrote after Siraf fall emphasised on collecting and storage of rain water in special structure as main water resources of the city (Afshar 1990).

On the other hand, the archeological research by David Whitehouse shows that the city had developed appropriate farming system to produce required food. He wrote, "and we wished to find out whether the area could have yield sufficient grain, vegetable and fruit to feed the city or whether food had to be imported." The soils of the Siraf area are cultivable and it was not surprising, therefore, despite the limit extant of cultivation today to find extensive traces of earlier field system. Today (even after the advent of the diesel pump), 75% of the cultivated land of Taheri region is dry farmed, with cultivators depending on the winter rains which may be insufficient or, even if the total amount of rainfall is adequate, it might cause the crop to fail by falling at the wrong time. With their greater reservoirs of capital and manpower, the farmers of Siraf were able to produce reliable, high-yield crops by irrigation in over 500 ha of farmlands (Whitehouse1974).

Unlike the water harvesting measures, we couldn't find any indication of transferring water from Jam plain to Siraf on the field. Furthermore the two elevated mountains i.e. Haft Chah and Kangan with the height over 1200 m are blocking Siraf access to Jam plan so that, along with the hot clime and the high evaporation potential, limit the possibility of transferring water for such a long distance.

The remaining of water harvesting structures in Siraf ruins indicates that former inhabitants of Siraf have employed all common techniques and methods of their time in order to harvest and efficiently manage the rainwater, the only available water resource, to maintain and preserve life. The traditional water supply system in Siraf is a combination of rainwater harvesting system, underground water reservoirs and underground gardens.

David Whitehouse writes that they examined several systems of catchment in the city, designed to conserve storm water and to prevent it from sweeping down the escapement and flooding the town. A gully, for example was dammed at three points, with a conduit leading from the highest barrier toward an aqueducts which entered Siraf though Kunarak gorge. Associated with it continued two or more well-like structures, which presumably served as settling tanks to remove silt and other barrier from the water. One of the large quarry-cemeteries in Shilau valley contained conduits associated with three large cisterns designed to collect storm water from the quarry floor.

As shown in figures 2,3, and 4, the puddles dugout on the mountain to the north of Siraf, which were mistakenly understood by Whitehouse and his team of archaeologists to be graves, are originally water pounding to harvest rainwater. The whole rocky southward face of the mountain

has been dug to make rectangular water poundings.

Most of them have been designed with outlets to transfer extra water to the next pounding and the final outlets direct water to wells and underground water reserves through man made channels(Figures 5 and 6). These reservoirs are believed to have been built at the end of natural water sheds, deep in the ground and with minimum construction material -- maintaining a considerable amount of running water for a long period of time.

One of these, for example, was about 5 meters long, 8 meters wide and 20 meters deep. Furthermore in Siraf, this clever water harvesting technique was combined with agricultural know-how to produce stunning agricultural products. The rare flash floods are discharged into an underground cistern half filled with topsoil. Rich harvests of tree crops such as date and grape are achieved in this manner. In the case of grape vines, underground cultivation chambers of about two to three meters across are dug six meters in depth until they reach a "greasy" soil which is called "shol" in the local language. Expert well diggers who use simple digging bars are employed for constructing the underground chambers. As soon as they reach the "shol", they fill the chamber half way with top soil. In January, at the beginning of winter, farmers select suitable branches of vine, and plant them in good soil to sprout. In March, they transfer the sprouting branches of vine in the underground gardens. In the dry months of the first summer, they irrigate the young vines five or six times. In the following years, the vines need no more irrigation(Figure 7). Vine branches creeping out of the underground chambers, are led atop a stone stand about a meter high called "khan", which is filled with local stones(Figure 8). Workers pass under the branches to harvest the bunch of grapes.

A severe earthquake which lasted for seven days damaged Siraf city in 977 AD, but the knowledge of underground garden is still being used in the neighboring city of Bushehr.

5. Evaluation and Analysis

It is being realized, albeit slowly, that the time tested techniques developed by people living in drylands for sustainable management of limited available water resources, are more efficient and economical than the new systems that have been introduced in this Century. But unfortunately traditional knowledge is already becoming extinct. On the other hand, increased demand on water resources cannot be met by existing traditional systems alone. Identification and integration of traditional science and knowledge with modern technology would be an effective and efficient way forward for sustainable land management. National and international research organizations need to allocate higher priority to the study and investigation of long-established traditional know-how.

6. Conclusions

As discussed earlier, this study was mainly based on literature review and field visit from water management structures in Siraf ruins. However the details of water harvesting and management methods in Siraf required a comprehensive study. Furthermore, the structure and form of puddles dugout on the mountain in Siraf clearly specify its original aim of water harvesting. However the rationale for burying dead bodies in some of these puddles needs further archeological investigation.

7. References

1. **Prinz, D. und Singh, A.** *Technological Potential for Improvements of Water Harvesting*. s.l. : <http://www.dams.org>, 2001.
2. **Afshar, I.** *MASALEK-Va-MAMALEK from Estakhri*. Tehran : Scientific and Cultural Publication Com, 1990.
3. **Masomi, Gh.** *Siraf (Bandareh Taheri)*. s.l. : Society of Cultural Heritages, 2005.
4. **Whitehouse, D.** *Excavation at Siraf, Sixth Interim Report*. s.l. : Journal of Persian Studies, British Institute of Persian Studies, XII, 1974.
5. **Whitehouse, D.** *Excavation at Siraf, First Interim Report*., s.l. : Journal of Persian Studies, British Institute of Persian Studies, VI, 1968.
6. **UNDP.** *Final Report of Iran - Regional seminar on drought mitigation*. Tehran : <http://www.reliefweb.int/rw/RWFiles2001.nsf>, 2001.
7. **Mousavi, S.** *Agricultural Drought Management in Iran*., s.l. : <http://books.nap.edu/openbook.php>, 2005.
8. **Word Bank.** *Islamic Republic of Iran Cost Assessment of Environmental Degradation*. s.l. : <http://earthmind.net/marine/docs/wb-2005-iran-cost-environmental-degradation.pdf>, 2005.
9. **Ardakanian, R.** *Overview of Water Management in*., s.l. : <http://books.nap.edu/openbook.php>, 2005.

8. Annex

tables, figure captions, figures (graphs, charts, drawings, pictures)



Figure 1: Siraf Location on Percian Gulf



Figure 2: Puddles dugout on the mountain in Siraf



Figure 3: Connection between Puddles

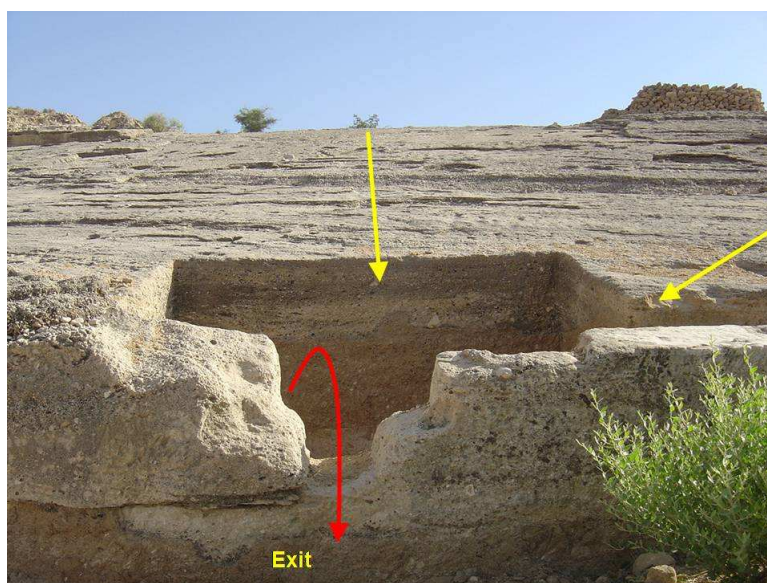


Figure 4: Designed outlet on puddles



Figure 5: Manmade channel transferring water to reservoirs

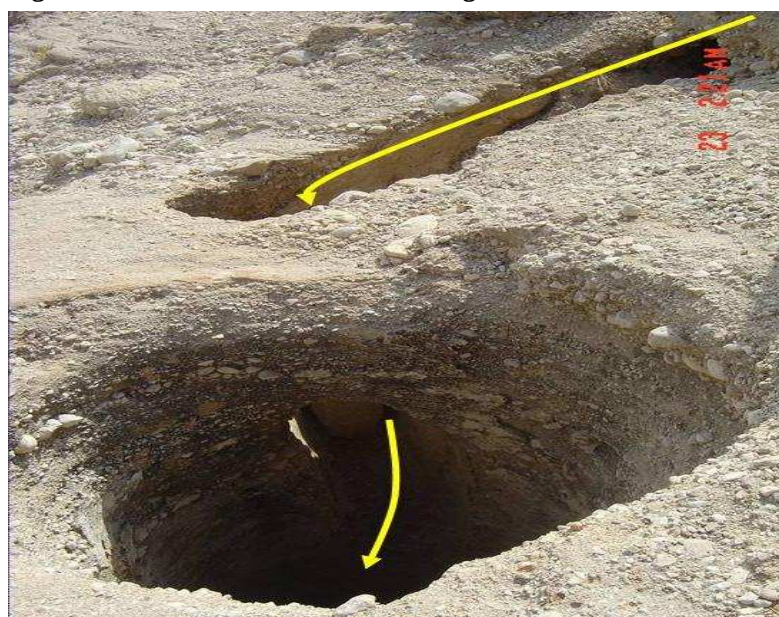


Figure 6: Manmade channel transferring water to reservoirs



Figure 7: Grape vines planted in the well



Figure 8: Khan- the garden of grape vines planted in the wells