

## Hydraulic Systems as Critical Element in Ecosystem and Structure of Historical City of Shushtar

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**Abstract:** Shushtar hydraulic systems which includes over thirteen dams, bridges, mills and waterfalls is considered as one of the great Persian architecture works which has been registered as Iran's 10th cultural heritage site on the United Nations' list in 2009, and now, it is indeed recognized as the heritage of the whole world. This collection, from the beginning of the formation in the 9th century BC, had a significant influence on urban ecology, urban spatial structure and the promotion of residents living besides supplying drinking water and agriculture in the region. It should be noted that the huge collection is the concrete realization of environmental technology, as one of the basic conditions for sustainable development in the urban structure. In this paper, after reviewing the effects of these structures on Shushtar ecosystems, their role in the development of the city have been analyzed.

**Key words:** *Ecosystems; Shushtar Historical City; Hydraulic Structures; Environmental Technology; Urban Structure; Museum of Water Engineering*

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### Introduction

Several factors such as geographic and social conditions, ritual and religion, defense and security, trade and the government and the like were effective in the emergence and spread of cities and it should be noted that for their life and continuity, in addition to proper position, cities need the proper conditions of urban ecosystems, cultural, social relations and economic life that the agents are intertwined in traditional cities of Iran in an effective manner according to various environmental conditions [1].

And now, Shushtar, as one of the most historic cities in Iran, has adapted itself in a way with the environment, as if it is the environment and it is due to guidelines that have been done over the years to improve the living conditions using the environment assistance and combat with disadvantages by using techniques and tricks. One of these strategies is water supply and irrigation in this region, which in the following after a brief introduction of this system as an example of the environmental technology; we will discuss its role in the city ecosystem and physical development of the historic city.

### Reasons for formation of world's greatest aquatic museum in Shushtar ecosystems

According to historical sources, in pre-Islamic periods, due to the limited water resources in areas away from rivers, by the ancients and by taking

advantage of the favorable natural conditions, and using the techniques of the time, streams were divided from the upstream of these rivers to the land that after irrigation, their water returned to the river again. As a result of this strategy, while distant lands were taken advantage of drinking water, arable lands were also irrigated [2].

A notable point is that to bring water to distant lands, the water level should be raised, so the water can flow on the plain. So by constructing small dams called "weir", while bring the level of high irrigation water up and irrigating agricultural lands, water flows were saved in streams and rivers for the case of dehydration.

In introduction of Khuzestan channels, Dr. Esmail Shieh refers to "Daryon". He writes that Daryon which is also known as "Daryam" or "Darbyan" or "Minoab" and it existed since the Achaemenid period, is bifurcated from Karun to irrigate the Shushtar lands, and has channels with a width of 3 to 5.4 meters. The main branch of the canal flows into Shotait after 33 km, the second branch is led to GarGarand both Shotait and GarGar rivers join the Karun River in Band-e-Ghir (Fig. 1).

Social issues, helping people living with mobilization of multiple grinding wheels, the ease of access, electricity supply, as well as urban aesthetics should also be added to the cases referred in the expression of the need for the formation of Shushtar water system.

It is also noteworthy that the rivers and seas adjacent to habitats has greatly helped to dampen

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the effects of the earthquake and Shushtar a city prone to earthquakes could be able to take most advantages in reducing the effects of this

unavoidable phenomenon by placing beside Karun River as one of the parts of this ecosystem.

1. Gorgor Water
2. ruined dam – Band-e-Makhroube
3. Bakhtian Road and Ahwaz
4. Band-e-Mizan
5. Shrine
6. Pond Aqueduct
7. Aqueduct
8. Dezful Road
9. Karun
10. Band-e-Khak
11. Road to Band-e-Qir
12. Band-e- Shah Gol bridge
13. Channels to Arab Hassan
14. Sasani Bridge
15. Plain
16. Bandar-e-Lenge bridge
17. Channel length 22 km
18. Diversion channel
19. Shushtar
20. Salasel castle
21. Shotait
22. Daryion channel
23. Sub-basin
24. Branch
25. Mino-ab

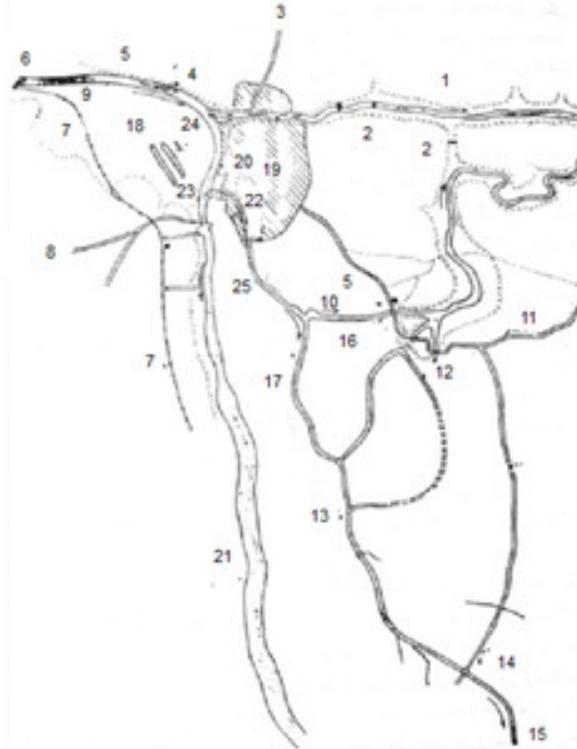


Fig. 1: Map of the historic city of Shushtar water facilities [3]

### Hydraulic systems and Shushtar physical development

"The history of cities has been heavily dependent on water and proximity to it over thousands of years"[4] and among which plain of Khuzestan, which is one of Iran plains has been dependent on water at all times.

In fact, Khuzestan plain that a part of civilization of Mesopotamia is formed in it, from the start because of waterfall rivers as Karkheh River, Karun and Jarahi has provided a good place to live for its residents .

It is worth mentioning that the onerous heat and shortage of non-river water resources and its particular climate has led to witness the formation of towns and villages along the rivers in the history including Shushtar historic city, which from the beginning of its formation, according to Professor Ghirshmanit dates back to 10 thousand years ago, [5] has joined its life and its inhabitants live with Karun River, which implies the formation of the first germ of Shushtar hydraulic systems in Median and Achaemenid era in the 9th century BC.

Many historical texts indicate the presence of Salasel Castle and Dara or Darius Creek in Shushtar. At this time, Kohandezh encompassed the entire city and Karun was divided into two branches at the beginning of the city, and surrounded the city as an island.

At the time of the Sassanids in centuries 3 to 7, we have witnessed the most glorious era of Shushtar. At this time, Shushtar was highly regarded by the government, so that the Sassanid Shapur I has assigned Emperor of Rome, who had been in bondage to build and develop the city that Band-e-Shadirwan bridge (Band-e Kaisar ("Caesar's dam")) has remained from those days (A wide river in Shushtar/pass).

Following the Sassanian rule, massive and complex water plants were established in the city of Shushtar that now the system, including over 13 water systems such as dams, bridges, mills and channels is remembered as the largest museum of water engineering in the world.

With the expansion of the city in Sasanian period, government center is transmitted from Salasel Castle to Mian Shahr. At this time, Karun River had a significant effect on the urban context to improve the urban ecosystem, so that most of the city's main thoroughfares were ended to two branches of Karun River to benefit from the river cool breeze and disposal of surface water, and of course the buildings surrounding the river have been enjoy edits sceneries.

During this period, with the help of complex hydraulic systems, residents were well managed to take lands around the river and adjacent to the city under cultivation which resulted in the city's prosperity and boosting the quality of living of the people in that period.

It is worth noting that at the scale of housing units, the ecosystem is well developed so that the

proper orientation of buildings, construction of bedchamber or Shavad anandusing the wind catcher

that face the flow of the river are visible in many parts of the city.



Fig. 2: Shushtar Salas! Castle at the time of prosperity [Source: Archives of the cultural heritage of Shushtar]



Fig. 3, 4: Picture of Shadriwan bridge in prosperity and today's demolition, Shushtar [Source: Archives of the cultural heritage of Shushtar]



Fig. 5: Aerial view of Shushtar waterfalls in 1935 AD [7]



Fig. 6: Picture of Shushtar waterfalls as an important element in Shushtar urban ecosystems

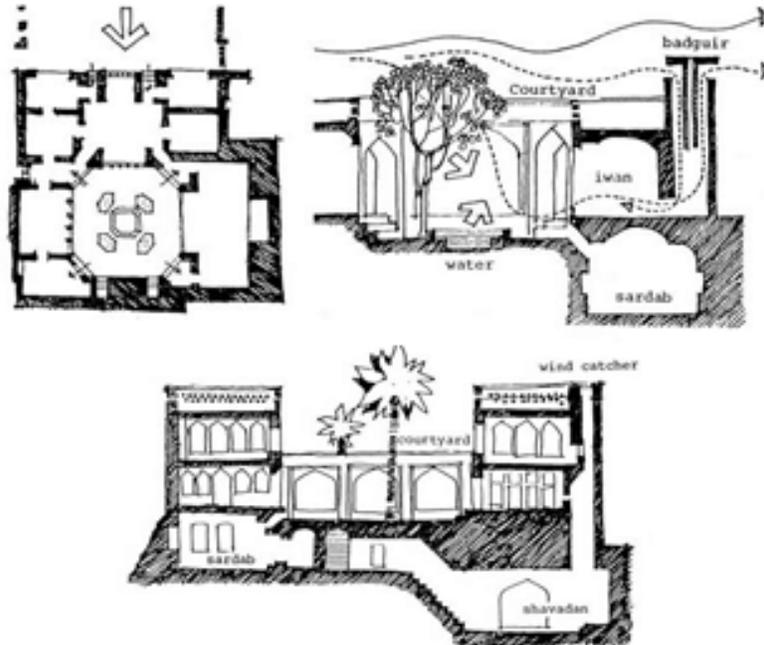


Fig. 7, 8, 9: examples of residents benefiting from the structures and watermills in traditional architecture and urban ecosystems of Shushtar

Considering the importance and role of the biosphere of Shavadan is very significant so that the construction of this space is a significant step in conformity with the urban ecosystem. Shavadan on the lower floor of city as platens and connected with each other create a valuable urban network and it is considered as a way to gain access to the river and to protect the people against the dangers and hardships of the life.

After the reign of the Sassanian, the city continues to expand, it was while two branches of Karun have embraced the city as two strong arms, and prevents the expansion of it out of the island. Also the presence of waterways around the city was considered as very strong factor in preserving and protecting the city [9].

This has been still in place until the fifth century AD during Buwayhid, so that from then on we can observe the formation of Caravansaries (inns) across the river and the city port

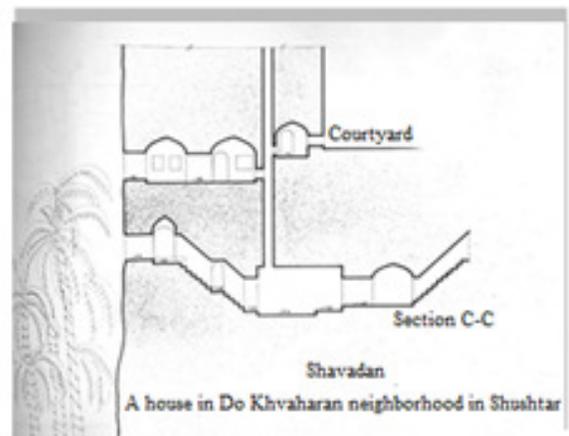
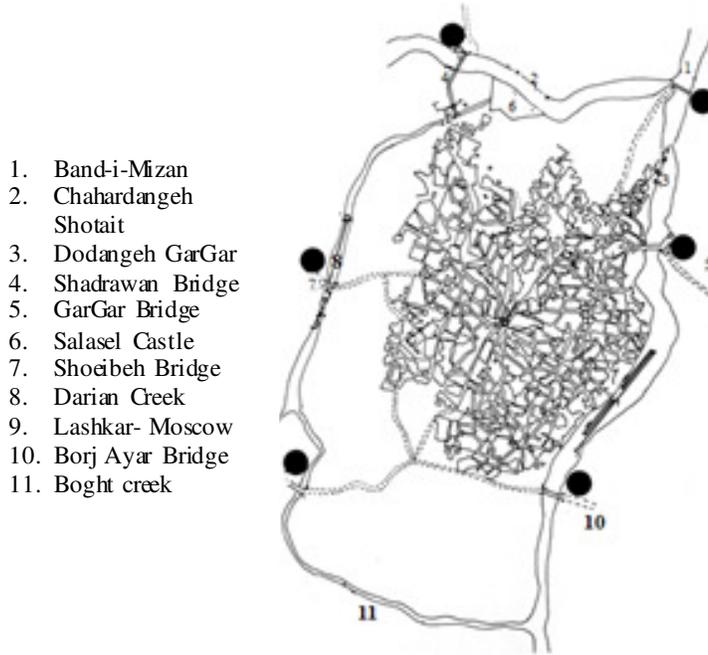


Fig. 10: Shavadan house in Shushtar in the vicinity of the Karun River [8]



**Fig. 11:** The orientation of the streets and position of theentry of historic town of Shushtar [10]

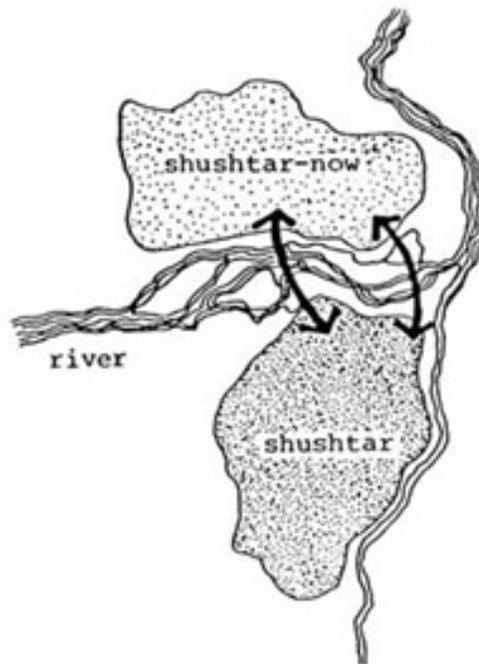
During the Safavid and Zand, in addition to the expansion of the city, we witness the demolition and reconstruction of some hydraulic systems such as bridge of Band-e-Shadriwan and Band-e-Mizan levels.

In the Qajar era, with the construction of the railway and not passing from Shushtar and the water transportation non - prosperity in North Karun, Shushtar lost its former glory.

At the Pahlavi time, again with the help of Shushtar water systems and fertile lands, the region has witnessed a new season of development, by

cultivating Shushtar surrounding lands and establishment of Karunagro-industrial plant as the largest factory of sugar in Middle East.

It is noteworthy that in the 50's, we have witnessed another change in a Shushtar and it was the implementation of worthy project of Shushtar No by Kamran Diba for accommodation of Karun agro-industry workers that with his insistence, the town is transmitted from the middle of the desert to the vicinity of the Shushtar to take advantage of water and favorable ecosystems and to be continuation for the historic city.



**Fig. 12:** The position of Shushtar old context and Shushtar-now town to the Karun

After the victory of the Islamic Revolution, by spreading the city to the outside of the arms of the Karun river, it can be seen that waterfalls -the main effect of Shushtar hydraulic systems-are not only in the vicinity of the city, but also the city has embraced this valuable element and while spatial overlapping as a desirable urban ecosystem and also considering that the collection is the second national monument after Naqsh-e-Jahan Square in Isfahan which is in the urban space, has caused a suitable situation to in addition to the considering such valuable monument, to overwhelm the urban space around the system as part of the national and cultural heritage and to be recognized, repaired and reconstructed.

## Conclusion

Now, more than 15 centuries have passed since the formation of Shushtar hydraulic systems and the global monument has always as part of the ecosystem of the region served the inhabitants and the urban area.

It must be said that Shushtar hydraulic system, by utilizing advanced water engineering and with the significant impact on the formation and promotion of the city ecosystems as well as raising the quality of living of the people, it is noteworthy that the great structure is the concrete realization of environmental technology, as one of the basic conditions for sustainable development in the urban structure. Now, after placing the name of Shushtar hydraulic system as the Iranian Tenth National Monuments among the world historical monuments with proper and futuristic planning of officials and with the help of residents is ready to once again be a bridge to develop urban area and promote further the name of Shushtar and Iran.

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