



Review of Mudies' Role on sustainability of Isfahan City

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Abstract

Historical development of Isfahan city is due to presence of Zayandeh Rood. Since this is a shallow water area, water division, streams and brooks construction were considered as the most important solution for solving this problem which after centuries it has transformed the desert city into the garden one. Through the history especially in 16th century (Safavi era) accompanied by vast flourishing in development of the city; water division, designing and organizing of the Mudies and brooks in the city has been effective in quality of the urban spaces and designs. Although the streams and brooks initially spread in order to irrigate the agricultural lands and gardens, growth and development of the city and substitution of gardens and farms with urban areas make these channels act as green axis or linear park and conducted performance combined to other centers has led to develop the urban axis and complete their hierarchy. The generated streams and greenery around them moderate the air and bind residential region with the nature. This research is based on evidence and library studies as well as analytic-descriptive method and tries to answer the question "what is the role of mudies in sustainable development of Isfahan city?" The result of the research is that Isfahan city has the potential to achieve the grades of sustainability because of its fundamental and permanent properties. It is necessary to revive the role of streams and retain their historical-personal values such as approaches to reach this purpose.

Key words: Isfahan, Mudi, Sustainable city, Zayandeh Rood.

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1. Introduction:

Water has been like a precious gem for a long time which has created natural and artificial habitats around it. Water is the first factor of human adherence to the ground in order to meet the basic needs, also it is one of the main factors of locating cities. As we can observe this fact for ages that wherever there was a river, there was development around it too. Iranian, just like other people, have always considered water to be sacred as a valuable material and regarding region climate and lack of water tried to use it in a best way. That's why they have used rivers as a vital artery for formation and location of cities and also relation of different spaces, and have coordinated urban fabric and perspective with water according to region climate. Zayandehrood is one of these rivers which is the main reason for creation of a sustainable city called Esfahan. This river has caused beauty, elegance and urban design.

In El Bouyeh era, Zayandehrood bank was in the suburb and in Ebn Houghel era(Fourth century AH)it was specified to mills, palaces and quarters, and a lot of celebrations and entertainments were held beside the river.(Taban, Pashtounizadeh, 1389: 53). In Saljoughian era, riverside was in the city limits and Zayandehrood was considered as a suburban recreational axis. In Safavi era, city moved towards the river gradually and surrounded it, so Zayandehrood axis became very important and due to its beauty and having natural facilities its dominant cultural and recreational aspect appeared. In Safavi, this river took over a different role seriously and permanently and flows in the city like organ vessels. Hence it is not possible to imagine Safavi city fabric without the streams derived from Zayandehrood. In this era, Sheikhabahai brings river and its branches called Muddi into urban spaces and structures. In Pahlavi era, developing city in the south borders of river, water self-specified a special situation in structure, so green and open space around the river, which is one of the main kinds of urban open spaces, forms in the main structure of Esfahan. (Saadati, 1388: 42). Nowadays, Zayandehrood and its branches have a major role in keeping the city live and dynamic in addition to maintain required water for drinking, agriculture, industry and energy production. River and muddies flowing in the city exert a strong influence on city perspective and landscape, also they cause the development of beautiful and live strips of greenness and freshness. That's why brooks and streams flowing from the southwest to the northeast cause the city fabric to be coherent and considered as important elements of Esfahan architecture and urban planning. It is reasonable to know this remarkable characteristic, as local and partial green axis effective on natural identity and physical structure of the city, the main factor of Esfahan sustainability.

2. Research Methodology

This research is based on evidence and library studies as well as field and analytic-descriptive method with the assumption that Esfahan reaches sustainability through reviving the role of muddies in the city. Since muddies need to be evaluated as urban elements, analytic-descriptive method has been used in this research and for gathering information in theoretical part of project , library method has been used, also structural data are gathered through field method, eventually this article tries to answer this question if sustainable development of Esfahan is affected by muddies derived from Zayandehrood?

This research reveals the necessity of study and recognition muddies network through a pervasive discussion regarding historical, cultural, ecological values and their coherence with structure of Esfahan in order to develop and maintain sustainability aspects in Esfahan.

3- Appearance and development of muddies in Esfahan

3-1.Appellation

In local language muddi means wide streams derived from Zayandehrood river. The following are the meanings of muddi :

- mudi is a word in local language of Esfahan and means a stream of water.(Honarfar,234)
- water is taken out from the river through some brooks which their water is used for irrigation, and these brooks are called muddi. (Jenab, 1371:258).
- some researchers believe that the word of mudi originates in Mud tribe, it means muddi is a brook produced by Mud people.(Heidari Bani,256).

3-2.History

Building muddies was one of the old tricks of Esfahan residents to solve the problem of lack of water and optimum use of water. So water was divided carefully regarding its quality in

different seasons. Many historians such as Ebn Rasteh, Hamzeh Esfahani, Ebn Houghel have written about division of Zayandehrood water and its rules. Hamzeh Esfahani believes that water division belonged to pre-Islamic period. Studying Ebn Houghel handwritten texts, it is concluded that Zayandehrood water was divided specifically in an organized way ten centuries ago, and each block had a specific amount of water based on geographical situation and place and time conditions. (Talebi Rizi,1383:19).

Also tourists have made a mention of Esfahan muddies in their logbooks. Peter Delavalle compared Zayandehrood river with other rivers in 17th century:

...after flowing a long distance, it is divided to small branches and it goes to the ground again, without reaching the sea. (Delavalle, 1350: 179).

French Shovallieh Sharden mentioned about muddies in late 11th century AH : Zayandehrood in springtime has the same amount of water as Sen river in wintertime. Zayandehrood flooding is in winter and in other seasons it is used to irrigate gardens and farms through brooks and streams.

In 17th century, Kampfer described mudies in more details in comparison with other tourists : Zayandehrood is divided to a various network and some amount of water is used to irrigate farms outside the city and some to maintain water of numerous pools and ponds of houses and palaces....Each branch specified to irrigation owns special technical expression which associates with its meaning. The first branches are called muddi. The next branch derived from it is called Jadval. A narrow stream derived from Jadval to irrigate farms and houses is named Joui. Each division of first and second branches has a specific name based on its place. (Kampfer, 1363:187).

It is certain that technique of building muddies and dividing Zayandehrood river belong to the past. According to the location of muddies in relation with city situation, specially old quarters before Safavieh located in high places with impossibility of passing water, it is observed that muddies didn't pass through the city structure before Safavieh and mostly its function was farms and fields irrigation. Regarding low level of underground resources, water was accessible in very low depth to maintain required water for residents.

A sample of muddies usage in the past was construction of Tabarak castle as army barracks next to muddi in Deilamian era and irrigation of Karan garden in Saljoughian era.

In safavieh, developing city towards south and west caused agricultural lands around mudies to join the city and new districts were formed so it was required to divide water by an organized method according to the extent of Safavi capital. Sheikhbahaii, the famous scientist of Safavi, set a written role to make minor changes observing and emphasizing water division issue.

According to this written role, river water was divided to three parts general, small, smaller and in the first part the river was divided to thirty three main shares and each share had other branches too.

In conclusion, this amazing and complicated method of water division based on two principles of time and place is one of the most remarkable samples of Iranian cultural heritage in water resources management and it is human innovation in the past which has been altered due to city development, land limitation and authorities decisions.

3-3.Cognition of muddies and their expansion in the city

Muddies are separated from the river as large gutters in the upstream and after passing 10 km with a slope of 10 percent reach the fields and in this part flow on the ground as small narrow streams. Muddies irrigate a lot of villages on their way and in the downstream wastewater gets to the other muddies or springs. In written role of Sheikhbahaii the number of brooks derived from Zayandehrood was estimated 78 that at the present time only 10 muddies flow in Esfahan from the southwest to the northeast. (Hosseini Abari, 1379:52).

These muddies which flow in all parts of Esfahan are the following: in the north of the river: Niasarm, Farshadi, Fadan, Tiran, Ghomeish and in the south of the river: Shayej, Nayej and abdollahkhan and in the center: Niasarm, Farshadi, Fadan, Jouishah.

In safavi era, muddies made a strong connection with city fabric as Kampfer, a tourist in Shah Soleiman time, believed that freshness, elegance and development of Esfahan were due to Zayandehrood river.

Muddies network and its branches have a major role in forming urban quarters and accessing paths as structure and skeleton of the city. Using Zayandehrood water through muddies has so important impact on sustainable design of landscape in Safavieh that Sharden and Tavarnieh simulated Esfahan to a "city in the jungle ". Actually, Esfahan muddies reflect accuracy and order in urban planning and show the vital role of this running network in creating " garden-city" and the importance of water order in this city.

4. The role of muddies in city sustainability

4-1. Definition, history and concepts of sustainability

Sustainability roots in principles of perseverance in harmony with nature that shows futuristic technologies have to perform based on local and regional patterns, the concept of sustainability depends on morality, the procedure which doesn't reduce next generations' abilities to meet their needs in addition to being intolerant towards damaging environment.

Sustainable development aims to meet all needs, promote the level of life and preserve ecosystems in order to have safer and happier future.

The first concepts of sustainability were presented by Aldo Leopold since 1950s. He considered environment capability for absorbing and bearing human influences.

Later in 1970s, recognizing ecological crises some movements were formed in the world that sustainable development was one of them. (Mahmoudi, 1388:2)

Sustainability concept tries to notice present needs: need for economic development and overcoming poverty, need for protection ecological resources, need for justice and cultural variety to strengthen local communities because of their values. (Tabibian, 1387:79)

Long- term abuse of environment has caused sustainable development to be not only appealing and attractive but also as a pattern against damaging effects using environment and fossil fuels by architects and urban planners.(Steele,1997:185)

In the mid 1990s, sustainable development idea expressed that economic growth and social development should be achieved so that they don't diminish ecological resources and development requirements for next generations. Until the end of 1990s, it was found that a better understanding of development is necessary to observe ecological, economic, socio-cultural, functional and structural issues simultaneously. (Pug, 1383:36)

In summary, the following are sustainable development principles: Usage of renewable sources such as solar and wind energy, minimum use of non-renewable and polluting energies such as fossil fuels, attention to future generations, attention to environment and reduction of pollution. (Keshtkar ghalati and associates, (1389:22-23)

There are several definitions for sustainable cities:

- Sustainable city or self-reliance cities are spaces in which economic activities run in relation with inner environment, development, environmental regionalism and economic independence are these cities features. (Haughton, 1997:190)

- Having a sustainable city is possible when there is a mutual relationship among three environmental, social and economic factors, a city in which all citizens feel satisfied. (Munasinghe, 1997:2)

- Being volunteer in sustainability experiments is one of the criteria for a sustainable city in addition to being reflective of meeting basic needs such as health issue, economic, social and

environmental issues and also this city has to be protected for next generations. (Macloren, 1990:185)

- Realization of city sustainable development is possible through three economic, social, ecological and structural components, collection of modern needs have been appeared in cities more than other places. Cities are the most important centers for sustainable development. (Tabibian, 1387:79)

Totally, a sustainable city is a city that can be responsive to physical-biological needs, social and cultural needs of urbanites and also create spiritual emotional composure as well as meeting material and spiritual needs.

4-1-1. Ecological sustainability and the role of muddies in city sustainability

With increasing population, harmful influence of human on nature and in fact ecological crisis appeared. This crisis has been the cause of destruction of natural environment and consequently public defiance to natural and artificial environment that are the main reasons for environment pollution.

Pollution is one of the main threats of life quality. To some extent pollution issue is related to the way of constructing and using cities. (Mugtin, 1387:5). Ecological sustainability put emphasis on reducing usage of natural resources and non-renewable energies, preventing waste of energy resources, reducing wastes production and reusing and recycling them, using nature- returnable materials and reducing pollution production in resources.

In order to achieve sustainable development goals, ecological sustainability in relation with architecture is very important and ecological issues which endanger human future have made architects to contrive a plan. (Elliott, 2006:98)

Esfahan city is located in the middle of plain in the north of Soffeh mountain, where the river passes through it with a west-east direction and city historical axis extends perpendicular to this direction to southern parts of the river.

Water usage through muddies branches has been so effective on sustainable design of urban green areas in Safavieh era that Sharon and Tavarnieh calls Esfahan a city in the jungle.(Talebi Rizi, 1383:19). Social-economic evolutions of past decades changed city economic infrastructure from agricultural base to industrial one, although the main function of muddies altered, today the role of psychological and physical refinement of this network for noise and vision pollution and overcrowding is undeniable. Muddies with their branches and small streams present freshness, coolness and life to hot fabric of city, and adjust urban environment in hot and dry climate along tens of kilometers with their green borders. These spaces are called Esfahan lungs and actually have been a natural protector against hot desert winds. Muddies accompanied with a continuous green boder flow inside alleys, streets and districts.

Flowing water in muddies, branched gutters and density of trees have a significant impact on air purification and blowing cold breeze made by water and trees presents very fine and enjoyable weather. (Esfahan the city of muddies- Nama: 161-162)

Muddies have created high-dense tracks of trees beside the river which is a new kind of urban space in Esfahan. Plants and green areas around muddies are so effective on air pollution control. Plants delete suspended particles and pathogens through photosynthesis and producing oxygen also through transpiration and increasing moisture. Live green covers, due to the form of their leaves, reduce and absorb sound waves even solve the problem of light reflection.

Green vegetation is variously used due to color variety, density, dimension and fabric of environmental design. And trees are live and dynamic unlike the artificial spaces. Being live causes freshness and variety of space. (Mahmoudi, 1388:34-35). In fact muddies just like capillaries spread moisture all over the city and take greenness into urban space.

4-1-2. Economic sustainability

Economic sustainability is prepared when population and total inventory of material wealth are constantly kept in a desired level. The world is limited and ecosystem is in a sustainable status too. Human economy is a subset of ecosystem with a sustainable status. So in a same level and a same period of time, subsystem has to reach sustainability in natural dimension and natural wealth. Therefore sustainable economy is a sustainable necessity. (willer, beatly, 1384:70,75)

Economic sustainability means keeping and promoting current economic status without destruction of natural resources and in this regard economic activities should cause society to improve with justice and efficiency. (Keshtkar and associates, 1389: 21)

Economic vitality of a city is considered through employment range, net income and standards of living in an area, annual number of tourists, performance of retail trade, value of land and citizens' finance.

In the past, economy of Esfahan was based on agriculture and farming, Zayandehrood and branched muddies had a major role in irrigation of agricultural lands, so they were considered the main factors of city economic vitality. Today industrial city doesn't violate economic role of muddies, because presence of these green capillaries in fabric of the city raises standards of living, value of land in these areas and development of neighborhood business performance along green axes and also attracts tourist attraction to city fabric and all of them guarantee economic sustainability of Esfahan.

4-1-3. socio-cultural sustainability

Developing urbanization, urban life needs a cultural approach which is one important factor of sustainability and it is proposed as cultural development. In sustainability concepts cultural development means providing facilities and conditions for all people to achieve cultural development indicators which promote cultural life in society, it means it provides cultural values achievement. The most powerful forces to reach a sustainable city are reviving concept of citizenship, having dynamic, wise and lively people.

Man and human societies are main axis of sustainable development. Multilateral development is the aim of sustainable development and multilateral development is not possible without social development. Some goals are emphasized in social development such as cultural identity, organizational development, contribution of citizens, empowerment of people and possibility of social replacement. (Keshtkar, 1389: 22).

Generally speaking, the goal of sustainable development is achieving a dynamic and persistent society which is possible only through preservation of environment. (Delbarrio, 1998:241-242)

A city identity is directly effective on success rate and impression of city potentials. Living potential, identity, originality and urban opportunities are positive urban specifications that have to be at individual, citizen and small social units service. City must follow significant social goals. City structure needs to be incentive of public life. Individual and social belonging rate to city and its structure confirm urban identity. (Behzadfar, 1382)

Zayandehrood is creator and identifier of major urban spaces of Esfahan. Linear parks extended beside the river, muddies and branched streams are all producer of very strong urban spaces with social function. Moving and stopping along pathways and pause spaces in districts next to muddies are daily events which create memories and consequently make city identity.

Muddies distinguish Esfahan from other cities of Iran and somehow they give identity to central parts of city and distinguish these parts from new districts. The word of muddi reminds many residents of these areas of their childhood memories, manifestation of living

and life. Many people still use muddie route as their guide to go around. Muddies as one of the meaningful key elements of Esfahan cause this city to be unique and also cause Esfahan residents to have sense of belonging and affiliation towards them. The expression of "sense of place" is truly obvious in this case. (Majedi and Ahmadi, :44)

These spaces based on their social and interactive role in reunion of human and environment can motivate people to meet and discuss and also invite residents from private areas and isolationism to public and cheerful spaces in order to strengthen and associate memories and create sense of belonging for future generations. These kinds of spaces are effective in city identity and its cultural promotion due to their role in transferring memories to present and future generations. (Saadati, 1388:45).

4-1-4. Structural sustainability

Coherent urban structure, visual characteristics and clarity of city form are part of structural sustainability. Structural and functional sustainability offers a range of possibilities to residents to change spaces regarding their own definition of desirability and considering their needs, willing and personal desires in order to reach a form to satisfy them.

Muddies have an important role in forming Safavi city therefore they perform as an element of urban design. The relationship between muddies network and different parts of the city as well as the role of them in relation with city structure and fabric are remarkably noticeable.

Extending from the southwest to the northeast, this network acts as the most convenient axis in urban fabric, actually a minor axis separated from the main and central ones (Talebi Rizi, 1383:21) so that most parts of this network cut the city as a shortcut from the southwest to the northeast.

Muddies are used in structural design of Esfahan as following:

- 1- In Chaharbagh axis as they are truly designed to create geometry-linear urban space.
- 2- in other pathways such as alleys which move windingly towards out of the city. Muddies have defined green axis in organic fabric of Esfahan, in alleys and passages which has changed Esfahan to a garden-city in many people opinions. (Ahari, 1380)

Moreover, muddies and branched gutters are expanded like a network all over the city and provide security against natural disasters. In fact, muddies are basic elements of city against flood danger and disposing surface water so they are inseparable elements of city and perform as a drainage network.

Increasing the number of muddies in Safavi era, palaces, mosques, inns, bazaars, public baths and houses of many rich people were built along muddies in order to use water. So morphology of residential spaces has been affected by muddies curves, houses located beside muddies and branched gutters have been built east-westward or west-eastward based on muddies directions which a remarkable sample could be seen in Charkhab district beside Niasarm muddi. (Norouziyan, 1383:26). Although houses are not opened to muddies in some districts, water flows in all gutters through muddies, so a city with natural organic architectural forms has been created.

Interaction of muddies with buildings along them is different, so that in some public buildings except baths, muddies are inward and inner courtyard of the building surrounds water flow, Safavi palaces have spectacular view to muddies and in Jolfa district, wherever possible, houses have some porches over muddi in addition to openings to muddies therefore architectural forms are identified based on definition of muddies and garden-city spaces.

5. Conclusion

Sustainable city requires welfare, social justice of citizens and human development as well as improvement of ecological quality and optimum dispersion of service and urban facilities in order to increase social satisfaction. Urban sustainable development causes not only improvement of city spatial structure but also restoration and reconstruction of urban environment.

Historical city of Esfahan is a city that makes the best and the most complete connection with earth and sky and plants and animals and people and water and wind and light and soil. A city in which there are dark and light, hard and soft, water and stone, earth and sky, compression and aperture, dryness and freshness all together.

The natural element of Zayandehrood and nature around it and branched streams (muddies) have played a significant role, so four elements of water, soil, plant and wind have come together and merged.

And that's why Esfahan has coherent soul and body due to presence of natural elements – Zayandehrood and its branches- and it has left a sustainable figure.

So, considering remarkable background of Esfahan that includes city formation in relation with natural and climatic factors on one hand, and on the other hand water management system of muddies with people cooperation in executive activities, expresses type of fabric revival in order to realization of sustainable development goals.

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