

River-Valleys as an Intra-city Natural Feature

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ABSTRACT: Intra-city natural structures have always had a key role in creating sustainable urban greenspaces. Adapting to natural features and relating the intra-city greenspaces to such natural structures as river-valleys, hillsides, lakes and forests, guarantee the endurance, sustainability and longevity of the natural quality of city. This paper looks at intra-city natural structures which have undergone wholesale changes and been ruined, and considers the lives of these invaluable natural structures which have been endangered due to gross human interference and pressure, regardless of physical and biological features. River-valleys in Tehran have always had a significant role in offering valuable bio-environmental services to the city. From the time of Qadjar era, villages enjoying favorable climate were built outside the city, and the villa of the governors and affluent people were built near hillsides across river-valleys because of the abundance of running water, cool weather in the summer and natural plant life. Little by little green corridors of Shemiranat were built near river-valleys, which formed the axes of the development of the city at the time Pahlavi dynasty. From then, the development of the city towards hillsides, regardless of these natural structures, increased and the destruction of these urban natural spaces have posed serious problems nowadays. Familiarity with these natural structures, their preservation and organization, and making the optimum use of them seem to be a very critical issue. Taking an ecological approach in this paper, is an attempt to look at the intra-city river-valleys. To do so, the data collected from a natural river-valley is used as evidence to back up any claims made in this regard.

Key words: River-valleys, Ecological Restoration, Jajrood, Darband

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INTRODUCTION

The human interference in rivers has been far from a success. River-valleys and floodplains have always been regarded as suitable places of residence. Changing and straightening the course of rivers by means of simple Euclidean geometry figures have caused occasional floods whose prediction is not easy. Another problem which often arises at local levels is the effect of canalization systems in areas leveled for residence and road making. The leveling of these areas speeds up the flow of flood and rain. This issue is a stumbling block in the way of storing water and prevents the natural drainage. Likewise, it exacerbates the impacts of flooding (Bell, 1999).

Therefore, getting to know the natural structures of this system and riparian plants patterns can enormously help protect river-valleys within the city and avoid dreadful disasters.

Owing to the sharp increase in construction work in Tehran, the ecological structure of the city has undergone sweeping changes, so creating ample greenspaces as the main bio-environmental balancing factor is a must. At present, although Tehran river-valleys are regarded as the most favorable areas of the city enjoying great climate due to the existence of private gardens and old trees near the hillsides, unfortunately they do not lie in the urban

landscape and most of them have been either covered or changed into sewage canals (Behbahani, *et al.*, 2002).

Taking into account different dimensions and combining art and science, environmental and landscape design has opened up a new window towards sustainable design of landscape. The scientific basis of the issue can be landscape ecology which focuses on the structures and patterns of landscapes and horizontal relationship between elements. Considering aesthetic factors, visual variables, the way they are organized, and also using natural forms and materials account for the artistic dimension of the designing. As a result, the structures and the interior relationship between different parts of the environment are understood, the hidden patterns are revealed and the change of spatial arrangement of the structures which is the result of natural processes, is interpreted (Shafie, 2003).

The spatial-temporal data (in terms of place and time) about a given case, helps us make a sound decision on the restoration of a ruined river-valley. The data can also be used as a reference in the future. This will lead to putting forward principles and approaches which, once adopted, will preserve the riverbed, riparian plants and its connection to the urban greenspaces. As a result, the preservation of the natural and man-made ecosystems is guaranteed. A river or river-valley system is a continuum one which usually exists in natural connection with the flow of water, the movement of alluvium, temperature and other variables which are called dynamic equilibrium (NTIS, 2000). These ecological corridors are complex ecosystems consisting of the earth, plant lives, animals and the fluvial network between them. They offer ecological services like balancing the fluvial flow, saving and purifying water and providing a residence for aquatic and terrestrial animals and plants. Moreover, they are quite

different features and characteristics from the neighboring areas and uplands, in terms of the type of soil and plants (NTIS, 2000).

The plant life structure of river-valleys ensures the success of fluvial systems. The movement and the flow of the river and the increase in the number of twists at the end of the river course bring about topographical varieties. The flow of water and even flooding often have greater impacts on lower areas than higher ones and the preservation of alluvium depends very much on the relative slope of the lands (Bell, 1999). Some areas are inundated much more than others and the trees and bushes which grow on the dykes level the river banks and gather the detritus while flooding. Therefore, the existence of various and plentiful plant patterns, are in close relation with such processes as flooding, erosion and sedimentation (Fig. 1). The protracted and curvilinear patterns of the river-valleys are also reflected in the plants patterns and configuration. The intensive growth of plants on the dykes across the old bends, contributes to the continuum of the pattern (Bell, 1999). From an ecological point of view, landscape is a heterogeneous land consisting of groups of ecosystems or spatial units which influence each other and has similar form all over it and its three basic and fundamental features are structure, function and change or dynamism (Forman and Gordon, 1986). Therefore, landscape is a highly complicated system which reflects different patterns according to its scale and parts (Farina, 1998). These natural and structural patterns have been transformed due to human destruction and interference.

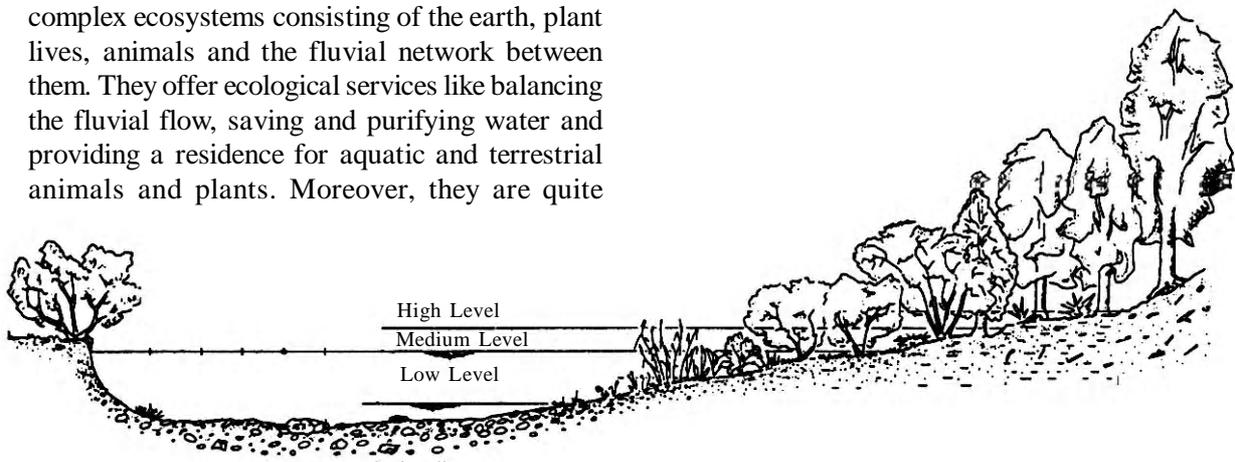


Fig. 1. A common plants configuration in river-valley

Source: Di Fidio, M. (1995) *Icorci D'acqua*. Pirola

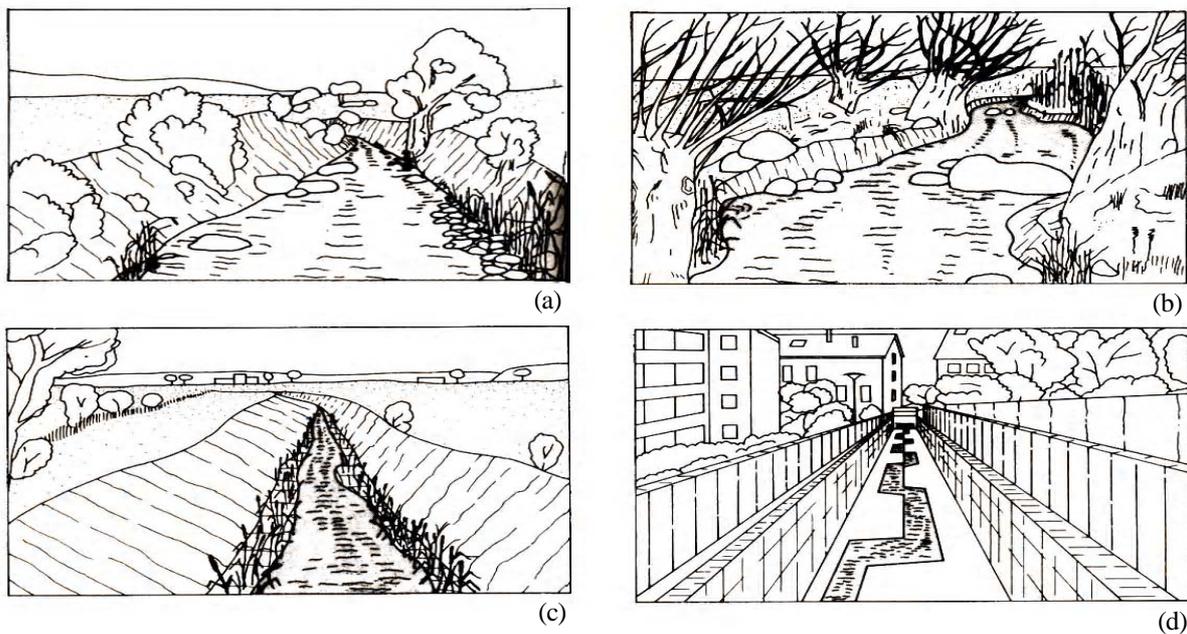


Fig. 2. Degradation of river-valley due to human disturbance

Source: Di Fidio, M. (1995) *Icorci D'acqua*. Pirola

As a result, the natural performance of the river system has been thrown into disorder after the destruction of plant life of the river-valley because of the leveling and canalization of the river and its transformation into a canal (Fig. 2).

Therefore, intra-city river-valleys are seen as minor elements beside urban patches and corridors. In fact, the form of the river follows of urban structure and man-made patches. The river structure is a natural corridor which usually flows in a rubble bed, and the plants around it and their configuration, follow the natural form of the river and this pattern continues for several kilometers in the same way. When the natural patterns are not repeated in the river-valleys, warns of an event or disturbance, which has given rise to a structural change in the river-valley in the city. In fact, the landscape of the river-valley inside the city has deteriorated and degraded. It is a clear indication of the fact that they are in dire, need for restoration so that, they can take on their original patterns prior to disturbance (Shafie, 2003). Ecological restoration is, in fact, bringing an ecosystem back to its original conditions and performances prior to disturbance as much as possible (Harker, 1999). As far as river-valleys are concerned, this issue goes beyond growing various plants with the express purpose of leveling the soil, preventing erosion or creating landscapes by growing

indigenous plants. In fact, it is an attempt to make nature produce a reaction (S.E.R., 2000).

In this regard, the physical and biological features of a river-valley that still flowing in a natural bed outside a city, are explored as evidences for intra-city river-valleys, in order to comparative study. In order to understand the physical and biological changes of the intra-city river-valleys, the natural structure of an extra-city river-valley (i.e. a part of the Jajrood river in the Khojir national park) and the Darband river-valley, from the Sarband square up to the Shahid Hemmat is examined. Then with a comparative study of the cross-sections of the Jajrood river-valley and the Darband river-valley, an intimate knowledge of the changes of this natural structure in the city is acquired, and on the basis of that acquired knowledge, some suggestions are put forward regarding ecological planning and programming (Fig. 3). The main branch of the Jajrood river, as long as 140 km, rises in the heights of the Kharsang mountain in the southern part of central Alborz heights in the north-east of Tehran and continues southwards. The water supply of this river is provided by some tributaries, springs, underground waters and precipitation. Having passed the Latyan dam, this river flows only through the Khojir national park. However, its branches flow outside the national park.



Fig. 3. The scope of study in Darband and Jajrood river-valley

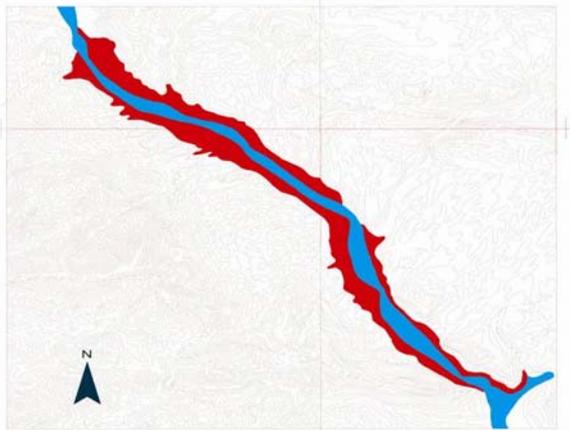


Fig. 4. The area of study in Khoir (Jajrood river-valley)



Fig. 5. Plants configuration in Jajrood river-valley

Having passed the Khojir national park, this river joins the Damavand river in Mamlo and flows towards Varamin and the plains in the south of Tehran. The waterways of the Jajrood river in the Khojir national park are mostly used for agricultural purposes. Also some wells have been dug alongside.

The area of study has 300 m width, according to park management comprehensive plan in Khojir and Sorkhehessar national parks (Makhdoum, *et al.*, 1987). Then, it was corrected by contours and land form (Shafie, 2003). So, width of the area varies from 50 to 500 m (Fig. 4). The dry and cold climate of the area has given rise to the woody and herbaceous plants. The woody types of trees and shrubs include *Populus nigra*, *Salix sp.* and *Tamarix sp.* (Fig. 5).

Among the main communities of bushy plants, *Rubus sp.* is outstanding. *Rubus sp.* increases considerably as one approaches the southern areas of the park. *Salix sp.* and *Populus nigra* are indigenous to the region and there are various communities of them alongside the river-valley. *Tamarix sp.* is the main indigenous shrubs alongside this river-valley. *Tamarix sp.*, along with *Salix sp.*, has formed unique riparian communities. The spatial arrangement of these plant communities shows the most important structural pattern in this river-valley (Shafie, 2003). The plantation of *Ailanthus sp.* and *Pinus eldarica* in this region proved a total success. However, they are not among its indigenous and riparian communities. The plantation of *Ailanthus sp.* and *Pinus eldarica* in this region proved a total success. However, they are not among its indigenous and riparian communities.

Phragmites australis, *Bromus sp.*, *Achillea sp.*, *Reseda lutea*, *Ajuga chamacitus*, *Hypericum sp.*, *Allium sp.*, and *Artemisia sieberi* are among the other herbaceous and bushy plants which grow alongside or far from the river.

The Darband river rises in the Toochal heights. It has some branches on top, the most important of which flow downwards near the Shirpala castle and from the Doqolou (twin) waterfall. Another branch is the Oosan river. These two branches converge into one to form the Darband river. The Darband river is 4723 meters long and 7 meters wide on average. This river has water all the time and its mountainous area is measured to be about 2200 hectares. The Darband river has a steep slope which decreases in gravity as it approaches the castle. This part up to the Sarband square is 1500 meters long, 9 meters wide and 6 meters deep on average. The bed of the river in this part is stony (Baft-e shar consulting eng. , 2003).

From the Sarband square, the presence of the river is felt in the urban area since those regions whose heights are higher than 1800 meters are excluded from urban planning and programming. From the Sarband square up to the northern angle of the Saad Abad palace, a concrete canal, which is about 1000 meters long, has been built. From this area onwards, the river enters the complex of the Saad Abad palace (which is also Jafar Abad). This part is about 500 meters long. Most of the stream is natural except for 70 meters which have a stone wall. This river enters the Shahid Jafari street from the south of the palace and flows alongside it. Then under the Tajrish bridge, it joins the Golab Dareh stream to form the Maqsoud Bak stream. Alongside the Dr. Shariati street, this stream continues to flow through the Elahiyeh, Zargandeh, Davoudiyeh districts and the Mother square to reach the junction of Pasdaran, Shariati and the Shahid Hemmat highway. In the end, having irrigated farmlands, it narrows down in the Band Ali Khan lagoon and disappears in a salt desert. The green space of this river-valley is not noticeable and most of it is in the southern part. Moreover, the construction work in the middle or the southern part of the stream is relatively sparse.

MATERIALS & METHODS

The reasons for choosing Jajrood and Darband river-valleys as subjects of the study are as follows:

- Being in the same climatic range (mountainous cold and dry to moderate)
- Both river-valleys rise in the southern heights of the central Alborz. Furthermore, both have rubble beds.
- Jajrood river-valley is one of those river-valleys outside Tehran which are used as outdoor recreation areas by Tehran citizens.
- That part of Jajrood river-valley which flows through the Khojir national park enjoys a rather virgin nature since, in accordance with the laws of the fourfold districts of the environment department, the natural entity and being of national parks should be kept intact and natural as much as possible. Therefore, it is a very appropriate case for study as a river-valley having remained intact in structure and entity. However, there are some parts which have been slightly damaged in this park.
- The Darband river-valley is one of those intra-city river-valleys in Tehran which are regarded as recreation areas by Tehran citizens from the old times. Because of its passing the Saad Abad museum-palace and some districts which mainly had gardens, garden-villas, residential places and the gardens of the embassies, its preservation as a natural and precious feature, has always been of tremendous importance.

However, its natural and genuine face has changed due to the construction development and an increase in the price of the lands. In order to gain a thorough knowledge of the structure of river-valleys, all the study sections of the Jajrood and Darband river-valleys were categorized into five continuous sequences. This categorization has been based on geomorphologic features which take into account land form, plant life, landscape grains, the flow of the river water and the way it is handled. The sequencing of the Jajrood river-valley in the Khojir national park mostly has been in accordance with present land use (Fig. 6). So that from the north to the south, the district allocated for plantation, agriculture and green houses were put in the first sequence; the Khojir forest park and the Khojir village were put in the second sequence; burnt areas were put in the third sequence, cultivation areas were put in the fourth sequence and finally those lands close to warmer and drier districts were put in the fifth sequence.

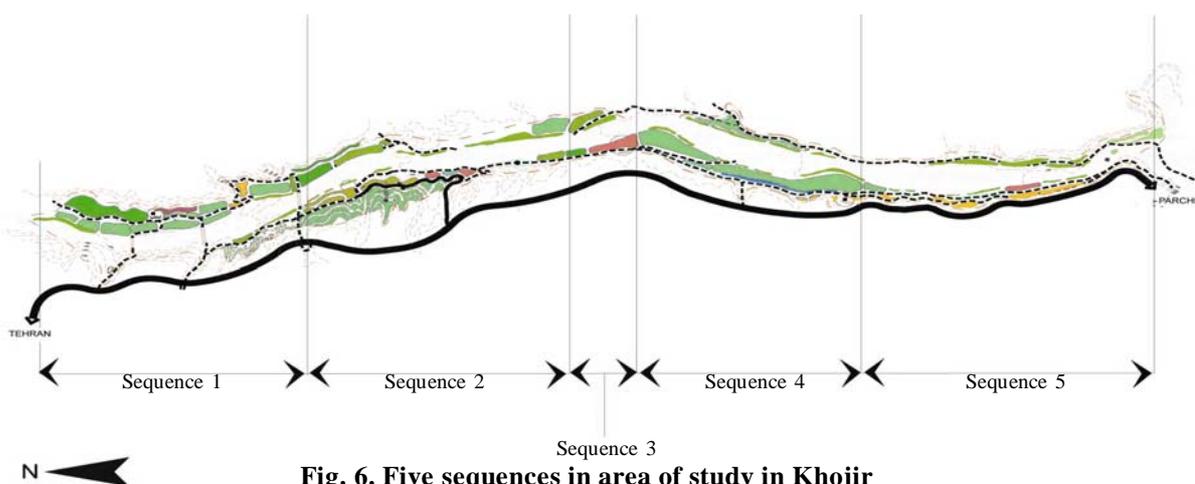


Fig. 6. Five sequences in area of study in Khojir

In the Darband river-valley, relatively virgin lands up to the very top were put in the first sequence. The Saad Abad palace and the areas upto the Tajrish square were put in the second sequence; areas from the Tajrish square up to the Elahiyeh district were put in the third sequence; the Elahiyeh district and the areas up to the north of the Shahid Ayatollah Sadr highway were put in the fourth sequence; and finally the Zargandeh, Davoudiyeh, and Mirdamad districts which are more populated residential areas were put in the fifth sequence.

In every one of these sequences, a section of the river-valleys and nearby areas has been drawn.

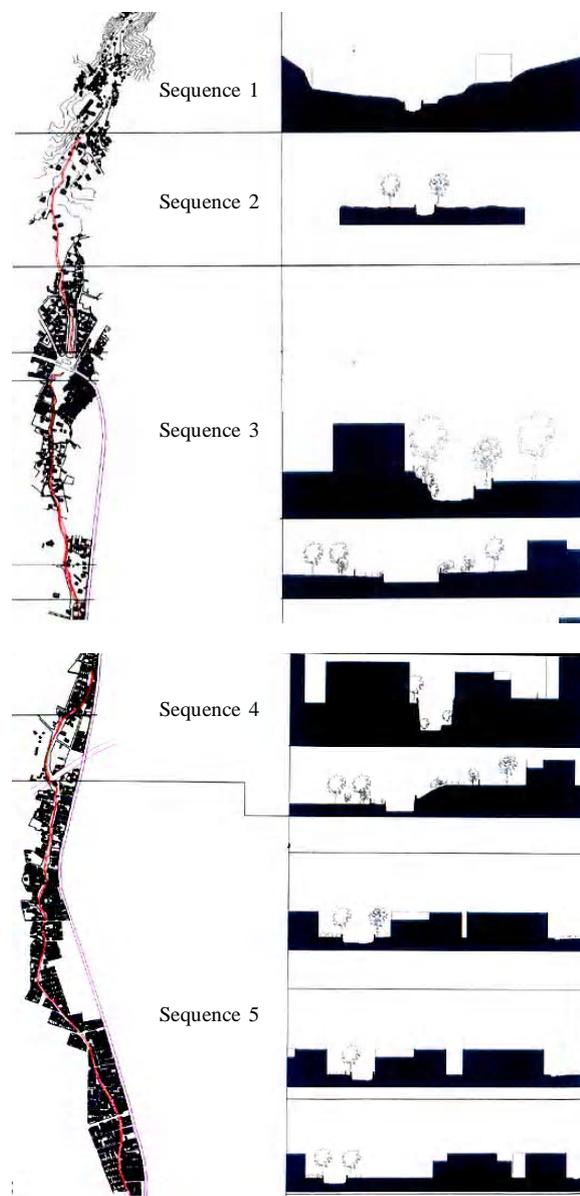
The comparison of these sections from the north to the south in each river-valley and the comparison of the sections of the Jajrood river-valley with that of the Darband river-valley reveal the changes and disturbances brought by human interference in the structure of the intra-city river-valley (Figs. 7 & 8).

A. Darband River-Valley First Sequence (Uplands)

The first sequence has retained its natural and integrity state. Landscape units are much wider and the structure of the landscape is coarse grain. Due to some masonry retaining walls, the riparian plants, especially herbaceous species, has almost been destroyed.

Second Sequence (Hillside Lands)

The majority of this sequence lies in the Saad Abad palace. The river-valley has retained its original and natural state in most its parts.



Figs. 7 & 8. Five sequences in area of study in Darband

Source: Hessamfar, M. Verons, J. (2002).

Landscape units are wide and the structure of the landscape is coarse grain. The riparian plants mostly include cultivated trees, and indigenous species, especially herbaceous ones, have decreased in number or disappeared. Outside the Saad Abad palace, the river has fully turned into a canal and has become more of a place for piling rubbish.

Third Sequence (End of Hillside Lands)

In this sequence, the Darband river-valley and Golab Dareh river have joined to form the Maqsood Bak canal, and the river-valley has been totally ruined.

The construction development has obscured the boundary of the river-valley. Also the landscape units are not wide and its structure is fine grain. In some parts, the presence of parks and urban green spaces has made the structure of the landscape coarse grain.

The plant life mainly includes cultivated trees and shrubs. Indigenous species, especially herbaceous species, either have disappeared or are in a poor condition.

Fourth Sequence (Middle lands)

The development of high-rise construction has made the structure of the landscape very fine grain and changed the river-valley completely into a canal, except some parts in Elahieh .

Fifth Sequence (Beginning of low lands)

According to the passage of the canal from residential areas or parks and green spaces, the structure of the landscape ranges from middle to fine in terms of grain.

B. Jajrood River-Valley

First Sequence (Hillside Lands)

The natural bed of the river has been retained. riparian plants, especially *Salix sp.* and *Tamarix sp.* communities, have been retained as well. And in addition to the indigenous *Populus nigra*, cultivated poplars serve the function of hedges in the farms (Fig. 9).

Second Sequence (End of Hillside Lands)

The natural bed of the river has been retained. Herbaceous riparian plants have been destroyed or become sparse due to human interference in this part. The riparian plant life, including trees and shrubs, ranges from average to high in quality.

Salix sp. and *Tamarix sp.* Communities mainly account for the plant life in this part.

The Khojir forest park has cultivated with *Pinus eldarica* and their rapid and strong growth has made the coarse grain landscape unit (Fig. 10).

Third Sequence (Middle lands)

The natural bed of the river has been retained. The riparian plants, especially *Salix sp.* and *Tamarix sp.* communities, have been destroyed or weakened by human interference and the fire started by arsonists. Herbaceous plant life enjoys steady and strong growth around the river (Fig. 11).

Fourth Sequence (Beginning of low lands)

Aside from minor changes in the bank due to human interference, the natural bed of the river has been retained on the whole. Fertile soil and great width from the river frontage to the road, have set agricultural lands. Riparian plants, especially *Salix sp.* and *Tamarix sp.* communities, has been retained and even cultivated *Salix sp.* and *Populus nigra*, being used as hedges for the farms, have increased in number. The most coarse grain landscape unit in this sequence is the agricultural lands (Fig. 12).

Fifth Sequence (low lands)

The natural bed of the river has been retained. Due to its great width, getting close to the plain and the gentle slope of the lands, the river is broad and landscape unit is coarse grain in this sequence. The riparian plants have been changed and *Salix sp.* and *Tamarix sp.* communities have been replaced by *Rubus sp.* community (Fig. 13). Comparing the higher parts and lower ones in both of the river-valley, one can easily find out the process of formation, human interference and destruction. Comparing intra-city river-valleys with extra-city river-valleys from a structural and littoral plant life point of view, one can easily explore the differences between a destroyed river-valley and a natural one. A brief look at the cross-sections of this river-valley makes it clear that the destruction of the littoral plant lives has had a dramatic impact on the structure of the river-valley and its transformation into a stream. The plant life of the Jajrood river-valley in the Khojir national park mainly includes *Salix sp.* and *Tamarix sp.* communities.

The spatial arrangement of these communities is after the fashion of the pattern of the river and it continues for several kilometers nonstop. In addition to their contribution to the beauty of the landscape, these plant communities control most of the hydraulic processes, and even flooding or the overflowing of the river. The presence of *Rubus sp.* community is a clear indication of getting close to another microclimate and getting through to another landscape. Therefore, the climate and the pattern of the riverbed are in close relation with the riparian plants and the plant life plays a key role in the performance of the ecosystem of the river. The landscape units, which are the ecosystems, enjoy coarser grain in the Jajrood river-valley. As the components of these units around the river mostly include plant lives (like riparian plants, forests and farmlands), building up a horizontal relationship between the ecosystem of the river and the ecosystems of the plants around the river and building up a vertical relationship between every one of these ecosystems contribute to the stability of the riverbed, the components and the units of the landscape. On the other hand, due to gross human interference, the Darband river-valley has lost its natural plant life, and the natural bed of the river

has lost its natural and rubble form and turned into a stream with masonry or concrete walls in most parts. As a result, the ecosystem of the river has changed in form and not only is building up a vertical relationship inside it is in danger, but also building up a horizontal relationship between the ecosystems is impossible due to the destruction of the riparian plants. As the patches near the canal are urban patches with fine grain, the destruction of the riparian plants has led to a breakdown in the relationship between the ecosystem of the river and the ecosystem of the city. It should be noted that the landscape in the Darband river-valley is mostly fine grain and this greatly threatens the sustainability of system. In fact, whatever we face today is the result of a structure established yesterday and what is waiting for us depends on the structure which is being established today (Yavari, 2006).

RESULTS & DISCUSSION

Considering the analysis based on landscape ecology and the comparative approach of this study, these river-valleys can be used as reference sites and the findings of the study, which originates from the landscape ecology knowledge, can be applicable in similar cases.

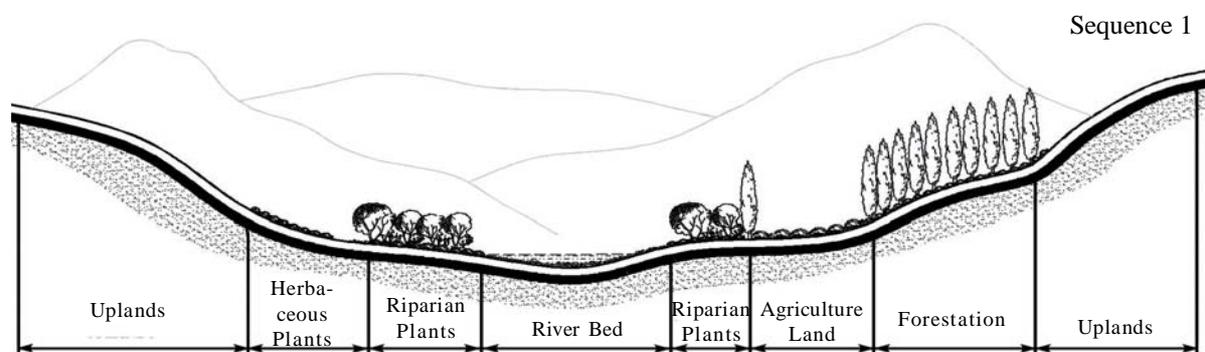


Fig. 9. first Sequence in Jajrood river- walley

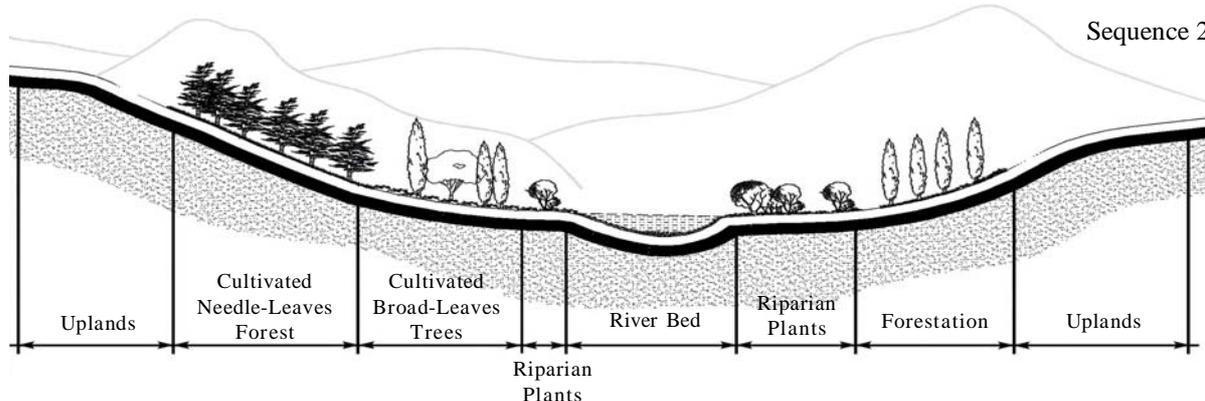


Fig. 10. Landscape elements in Second Sequence in Jajrood river- walley

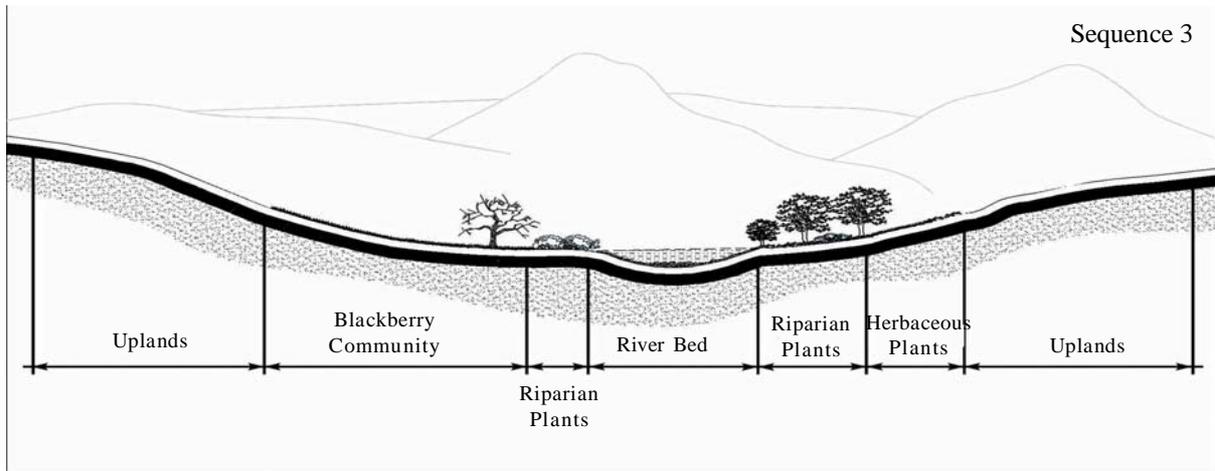


Fig. 11. Third sequence in Jajrood river-walley

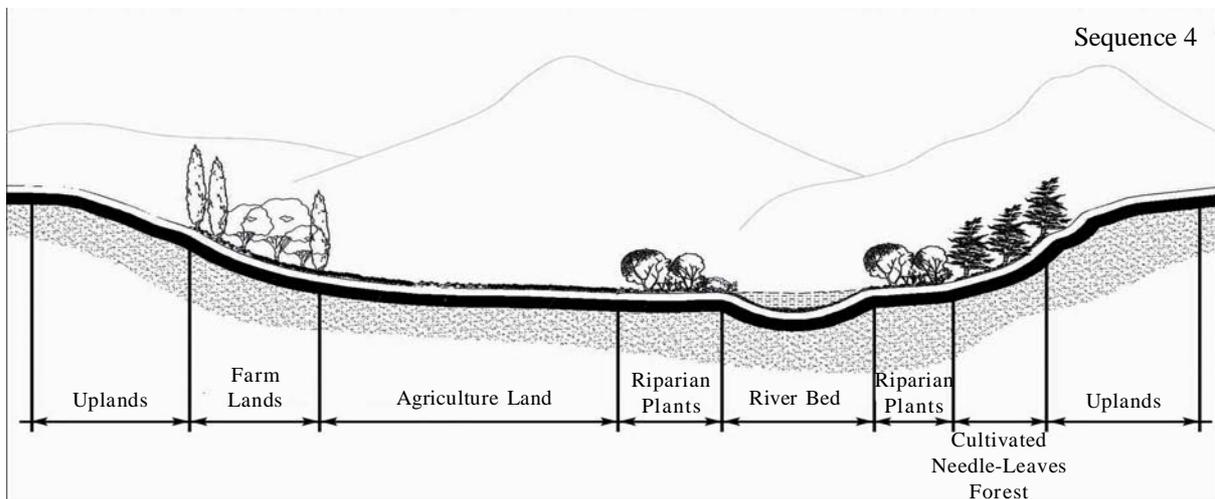


Fig. 12. Landscape elements in forth sequence in Jajrood river-walley

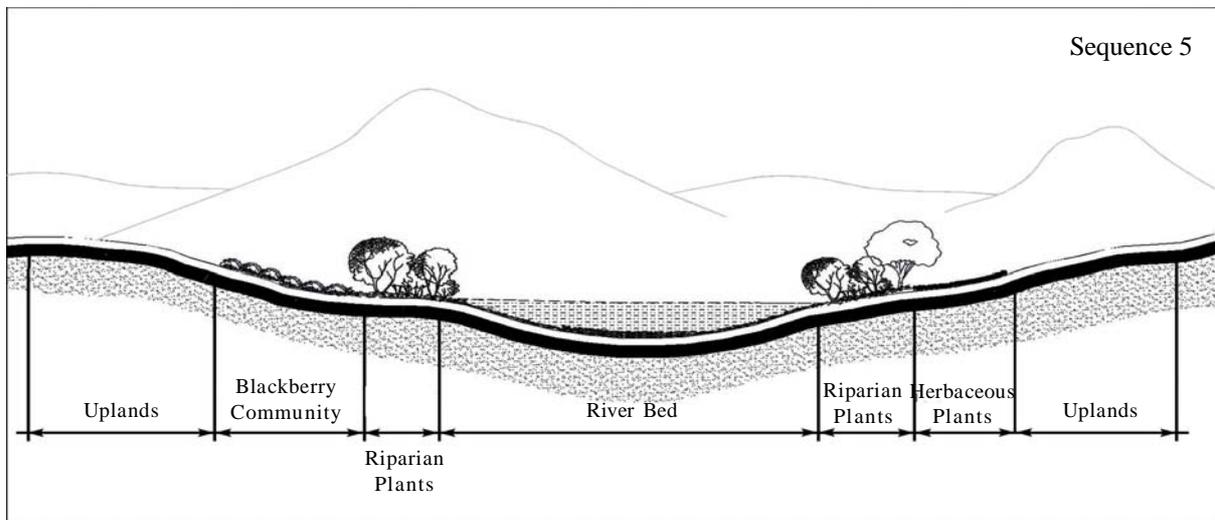


Fig. 13. Fifth sequence shows different grains

In this study, the river-valleys were explored and the approaches to find out the landscape patterns, the causes of destruction and scientific approaches to restoration were scrutinized. Therefore, a couple of suggestions and objectives based on landscape ecology and ecological design are put forward for river conservation and utilization inside the city as follows:

- Being heedful of the boundary of the river and providing buffers in the fragile areas.
- Protecting the natural features of the rivers such as the twists and turns of the rivers and trying to restore them, once damaged.
- Controlling floodwaters and setting up artificial lagoons and wetlands for refining waters and purifying them from added pollutants (they can be set up either in the higher or lower parts).
- Examining the physiology and morphology of the riparian plants as elements related to the hydraulic pattern of the river, and restoration and planting trees according to their orientation to rivers.
- Mimicing nature, selecting native species, paying attention to key stones and using pioneer species.
- Creating balance between outdoor recreational goals and the protection and restoration of river-valleys.
- Establishing an ecological connectivity between natural and green patches in the city by connecting greenspaces, parks, and cultivated plants to riparian plants in order to set up sustainable green urban networks.

CONCLUSION

Comparative study between disturbed river-valley and original one, shall clear what is lost, and what and how shall be done. Restoration is based on bioengineering approaches according to which materials found in nature are used as much as possible. Sticking to the above-mentioned operational principles and approaches has led to the ecological restoration of the higher areas of the Darband river-valley. Also around beginning of low lands, which mostly accommodates intensively populated residential and commercial areas of Tehran, the transference of pollution to the lower areas has been prevented by building linear parks around the river-valley and by sticking to the above-mentioned principles. Moreover, a

relationship between ecological processes in the environment has been built up by establishing green urban networks. Connecting green urban networks to open and green lands around city, which is possible through river valleys, leads to the continuum and sustainable matrices of the city. Also, utilization of water and land resources, with protecting, enjoying and improving the environment goals, shall be possible by process approach with use of the past structures for future plans as invaluable reference.

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