Environmental Design for Ecological Infrastructure of Urban Landscape through Aggregate with Outlier Principle (AWOP) in Order to Enhance the Quality of Urban Life (Case of District Two, Tehran City)

Tahereh Kookhaie¹, Mohammad Reza Masnavi²

1. MSc. of Environmental Design, Graduate Faculty of Environment, University of Tehran, Iran
2. Associate Professor, Graduate Faculty of Environment, University of Tehran, Iran (masnavim@ut.ac.ir)

Received: Jan., 2014 Accept: May., 2014

Expanded Abstract

Introduction
The urban population experienced rapid growth in the recent decades, particularly between 1975 and 2000 when it has reached from 1.5 to more than 2 billion people. By turn of the century, half of the world's populations are concentrated in cities. This would severely affect the quality of life in urban areas. Accordingly, cities will be faced with significant challenges in infrastructure and environmental issues to support urban population growth. At present, there is no balance between urban and natural patterns, and urban networks are immensely dominating ecological networks.

There are many researches indicating the critical role of cities and their environmental impacts on their natural resources due to cumulative effects of the above issues. Tehran, the capital city of Iran is no exemption; it is seen as a metropolis dealing with many environmental problems; that keeps it far from sustainability indices. To provide the cities with urban improvement, there is a general consensus among the international community about new theories of urban development within the framework of sustainable development as new solutions. These solutions are supported by the world's metropolises network as the major solution to encourage global participation and efforts to reduce the negative impacts of urbanization and population expansion.

In parallel, the concepts such as urban green networks and ecological urban networks have attracted considerable attention. Urban ecology as a scientific discipline is rapidly developing throughout the world to discuss the possible environmentally sound solutions for the design and management of cities to move them towards sustainability. Hence, the urban ecology theory is turned to the Eco-city concept by some architects and urban planners. The core idea here is that it is necessary to provide the city with economical spatial infrastructures to make them more compatible with environmental concerns or natural characteristics of the cities. As many researches in the past, focused on the ecology of the city based on the concepts of ecosystems, more recently the role of landscape ecology within and beyond the city are emphasized in this field.

Much attention, therefore, has been given to landscape ecology approaches to improve the quality of urban environment in different cities around the world. This study is discussing and presenting the new strategies for eco-city infrastructures, through landscape ecology approach based on the AWOP (Aggregate-with-outliers principle). This is to investigate the design of urban ecological infrastructure networks to protect and enhance natural aspects in urban landscapes and provide the sustainable development of urban areas. In this research the district number two of Tehran city is examined as the study area in terms of these approaches.

Materials and Methods
The study area in the present research is Tehran district number 2 as the most developed zones located in center and north of Tehran city. Natural landforms of Alborz Mountain Chain are the most significant aspect of structural elements in this district. There are five major river valleys in Tehran City and two of the valleys (Darakeh and Farahzad rivers) are located in this district. Natural features such as river valleys and streams, network access as air circulation corridors and existence of faults and power lines as the potential to create green corridors, play significant role in sustainable development and design of ecological infrastructure networks in district 2. A large area of urban constructions involves dense and fine-grained textures as the other features of the district.

To formulate the theoretical framework and principles of the present research, the required data have been
collected and analyzed through literature and library documents. After reviewing the theoretical literature, urban ecological infrastructure network has been analyzed to find a conceptual framework on the basis of ecological landscape design.

Forman and Godron introduced concepts such as patches, corridors and matrices as basic elements in landscape ecology. Some layers of district land use map including, river valleys, streams network, access network, faults and power lines, green spaces, semi-private green spaces and reserve lands are required for development and urban renewal. The required data have been derived from preparation of land-use mapping using GIS application.

Using Aggregate with Outlier Principle, landscape ecological infrastructure network in district 2 has been designed. The principle, offered by Forman, proposes the optimum arrangement for land use in landscape. AWOP also emphasizes on appropriateness of the distribution, composition and extent of open and green spaces as structural landscape in urban areas. In addition, a range of direct benefits to humans is suggested by such spatial approach.

Ecological infrastructure network is obtained through an overlaid patches and corridors (as facilities layers) and urban construction (as limitations layer). Finally, using the results of field study, some strategies and measures have been formulated within the framework of designing urban infrastructures in various ground of this network.

Discussion and Results
Using GIS, maps for landscape structural elements in district 2 have been derived from land use map as follows:
1. Patches of Landscape Structure: the patches include green spaces, semi-private green spaces and reserve lands for development and urban renewal.
2. Corridors of landscape structure:
   Generally, two types of corridors in district 2 can be classified as follows:
   - Corridors of water flow, which include Darakeh and Farahzad river valleys, west flood inversion channel and ground water corridor network (Aqueducts network).
   - Corridors of energy flow and humans’ and other organisms’ movement that includes network access (humans and other organisms movement) and faults and power lines (energy flow).
3. Matrix of landscape structure:
   Matrix is a homogeneous mass that involves different and small structural elements and included more than half of the land. Thus, dense, fine-grained and impermeable urban construction which comprises a large area of the study area forms urban landscape matrix.
   After identifying the ecological landscape elements (corridors, patches and matrix), and representing them as distinct layers, network formation requires the overlaying of them. Identified patches and corridors are considered the facilities of designing ecological infrastructure network and landscape matrix layer as limitations of forming the network.
   After overlaying the layers, 5 critical ecologic areas have been determined in network (Fig. 1).

Fig. 1. Five major zones were identified after overlaying the layers
Following the field studies and observations, the required strategies and measures within the realm of improvement, conservation, optimization and restoration have been formulated in these zones. Finally, using AWOP, ecological infrastructure network as a method to design network of ecological infrastructure in Tehran’s district two has been established (Fig. 2) as follows:

1. According to this principle, natural corridors of Darakeh River Valley (1) and Farahzad River Valley (2) have been preserved as the main components of the network structure.
2. Large patches of vegetation (Pardisan Park) (3) were included in the network as a vast and central green patch.
3. Small natural patches such as Tarasht gardens (4) and Farahzad gardens (5), located in developed urban areas, have also been included in the network.
4. To provide more than one large patch of vegetation, natural garden patches of vegetation have been connected to a large green patch (Pardisan Park).
5. Semi-private green patches have been included in the network as small vegetation patches and connected to large patches of vegetation.

Conclusions
The increase in population of the world and subsequently increase in urban population has led to an imbalance between nature and cities, which caused numerous environmental problems such as air pollution, lack of vitality, contaminated water, soil and public environment pollution. Therefore, attention to the quality of urban life and its promotion with regard to urban population is also necessary.

The aim of this study is to design ecological infrastructure of landscape in district number 2 of Tehran City in order to enhance the quality of urban life. Thus, to conclude this research, the spatial structure and function of the study area are examined and categorized based on the patch-corridor-matrix.

Based on the landscape ecology approach, the other natural patches and corridors in the urban environment are to be preserved and restored to increase their ecological functions in the city so that natural flows can continue and penetrate into the built environment and built patches. These are the most influential factors in the densely built-up and high populated city regions.

Using the principles of landscape ecology framework, AWOP and land use map, matrix, patches and corridors, the study area has been recognized and by using GIS application the necessary factors have been extracted as separate layers. After overlaying the layers of facilities (patches and corridors) and removing in limitation layer (urban construction matrix), five major zones have been identified in the final maps as falling: Darakeh and Farahzad River Valleys, Pardisan Park, West flood inversion channel and Tarasht gardens.

Design strategies and basic environmental initiatives in the areas of promotion, protection, rehabilitation and restoration of the network have been introduced in order to protect the integrity between structural elements and preserve the original patterns of ecological networks. Finally, landscape design of ecological infrastructure network in district number 2 is also presented (Fig. 2).

Fig. 2. Landscape ecological infrastructure network in District 2
Part A demonstrates how semi-private green spaces have been connected to the network.

Keywords: aggregate with outlier principle, district number 2 of Tehran city, ecological design, ecological infrastructure, landscape, quality of urban life.