

## Campus Landscape Design Based on Resilience Approach in Water Shortage State (Case Study: Campus of Malayer University)

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### Expanded Abstract

#### Introduction

Water shortage is a crucial challenge threatening future of landscape development in Iran. Naturally it can be intensified by climate change that will lead to water stress of ecosystems. The water stress have confronted university campus landscapes with serious challenges especially those that located in arid and semi-arid areas such as center of Iran. Malayer University has experienced serious challenges due to water shortage in green space development in spite of fast growth. Local adaptation and mitigation actions have a high priority in dry context.

Successful adaptation and mitigation need to increase ecological resilience and provide appropriate water resources without threat to other places and species in meeting their needs. Adoption strategies emphasize on ecological resilience and mitigation strategy stress not only on improvement of ecological functions against climate change but also on reduction of the intensifying climate change agents such as greenhouse gases (GHG). Thus, ecological resilience improvement will assist the continuation of ecosystem functions and will support mitigation movements. Therefore, it is an essential and vital role of planning to cope with wicked problems due to the climate changes.

Climate change has faced our society with complex problems and simultaneously increasing uncertainty. Resilience is an ideal option to cope with the uncertainty. It attempts to recover systems from disruption. As Friend and Moench (2013) pointed, the goals of development is resilience or "an aspect of what development is". But resilience here is defined as the ability of absorbing shocks and increasing system ability to cope with challenges and retain the system integrity and sustainably, although it may pass from one situation to a new one. This does not mean as bouncing back the system. The emphasis is on continuation of sustainability of ecological structure and functions. However, the system could experience some changes.

Iran has experienced great dryness challenges. Thus, water shortage change into an ongoing threat of a dry country is a sign of wide spread crises through the country in the near future. Malayer University founded in 2005 has been developed rapidly. It tackled with water limitations for all kind of uses. Water limitation is also a main obstacle in green landscape design of the university campus. The article attempted to review resilience concept in water shortage conditions and present solutions for water deficit by rain harvest and reuse of gray water in campus landscape design in one side and to increase efficiency in water use by wise and ecological planting and reduce water needs by selection of the appropriate plant species requiring low water on the other side.

#### Materials and Methods

University of Malayer is located at Malayer County (Malayer) in northwestern part of Hamadan Province. The area has a semi arid climate. The area receives about 300 mm annual precipitation in average. The average of minimum temperature is -4 and the average of maximum temperature is 34.7 degree of centigrade. Total area of the campus is about 55 hectare. It was established in 2005. Total built area is about 46000 square meters up to now. Slope of campus fluctuate between 3 to 7 percent. Up to 70 percent of 55 hectares is in cult. Soil tests indicated the presence of clay soils in combination with organic materials. The soil salinity is low and without restrictions. The existing vegetation cover can be divided into two categories:

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1. Herbaceous species, mainly in under developed parts of the campus, have the following characteristics: wild plant, seasonal growth and short growing period. The plants are drying by beginning of warm season with increased water stress. These plants include species such as: *Peganumharmala*, *Achilleamillefolium*, *Descurainia Sophia*, *Gundeliatournefortii* and *Fritillaria sp.*

2. planting trees and shrubs include limited species such as: black pine, cedar and cypress, *sycamore*, *mulberry*, *willow usual*, *walnuts*, *grapes*, *Cotoneasternummularia*, *Crataegusaronia*, different types of roses, lavender, and rosemary.

The main problems of green space of the campus are: Planting of the vegetables sensitive to drought, water resources shortage and low efficiency in water irrigation systems.

This research has been done based on ecological design principles that expressed by Van der Ryn and Cowan in 1996. The study tries to use the ecological resilience based on global warming trend and water shortage in order to design more effective green landscape for the campus.

## Results and Discussions

The results can be presented in four steps:

1. Analyses of water resources in campus
2. Analyses of water irrigation efficiency
3. Analyses of plane species resilience against water shortage, ecological diversity and diversity in ecological functions.

The result shows that the area could annually reserve about 19000 cubic meters of water from precipitation. This volume is enough for irrigation of the green space during the year. Moreover, harvest runoff is possible from pedestrians and streets. We could receive up to 90000 cubic meters of water by construction of primary waste water treatment systems.

In addition, change of traditional irrigation system is necessary to promote irrigation efficiency. Meanwhile, mulching can reduce surface evaporation and decrease water needs. The flexibility of main dominant plant species has been analyzed based on Hunter Model (2008). As a result, vulnerable species have been identified and new native species has also been chosen. The native species were selected that have following characteristics: Resistance against water stress, adopted by ecosystem conditions, diversity in ecological function, quality of growth and reproductive with less water requirement. Finally, campus landscape has been designed based on rain harvest and reuse of gray water (Fig. 1).

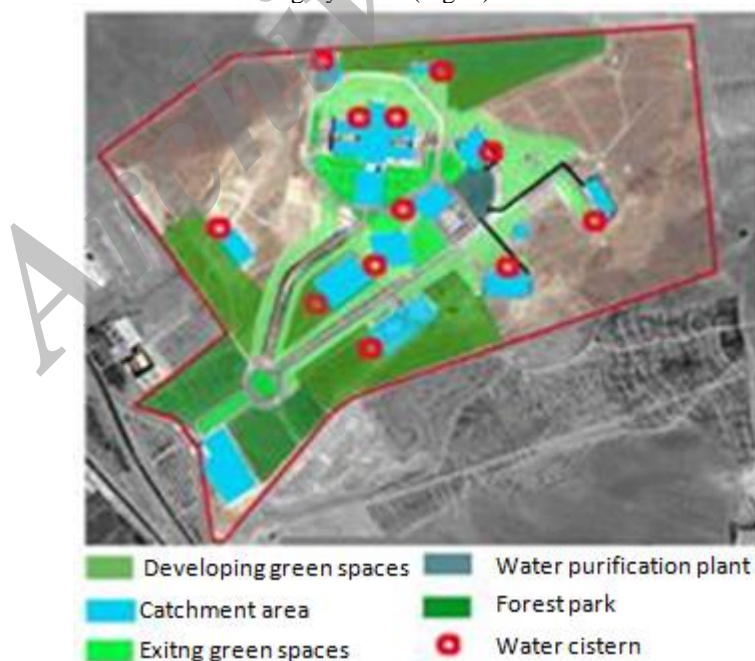


Fig. 1. Strategic design of campus green space based on rain harvest and reuse of gray water

## Conclusion

Landscape design is an alternative and additional tool to keep green spaces sustainable against climate change and global warming. Landscape design could apply ecological principles in order to cope with climate change

threats especially in arid areas. Campus landscapes of Malayer University as sample is selected to examine the ability of ecological design. The results showed that the green space of the campus could be developed by utilization of potential water resources. Campus landscape could be improved by wise selection of plant species. The species should be resistant against water stress and climate changes. As a result, ecosystem service will be improved by wise development of campus landscape through ecological design principles. Is this experiment applicable in more complicated places such as urban landscape? Simultaneously other approaches such as carbon sequestration are applicable? These two questions are new subjects for further practical research especially in the arid areas faced with climate change threats.

**Keywords:** climate change, landscape design, Malayer University, resilience, water resources, water shortage.

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