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## Environmental Impact Assessment of the Largest Man Made Lake of Iran

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**Abstract:** Like many other cities, Tehran is experiencing the increasing pressure of improper land use and incorrect land management policies which have exacerbated the problems by disregarding the limitations and potential of land and its vulnerability and fragility against possible changes. The implementation of suggested plans and projects will be carried out for north-western of Tehran, such as the establishment of the west urban man made lake as the largest man made lake of Iran, based on the detailed feasibility studies. In the present study, on Environmental Impact Assessment study (EIA) for the largest man made lake in Iran by using environmental modeling and using overlay method in Geographic Information Systems (GIS) with a land use planning approach and regards to the ecological environment and by considering the results of satellite image processing was performed. The area observed is in north-western of Tehran, a region of about 10, 000 ha, which is restricted by the Alborz mountain chain in the north. This study aims at considering major changes on human environments, caused by proposed project execution in the north-western of Tehran by using satellite data. Then, by using environmental modeling and using GIS and overlay method for using environmental impact assessment analysis, decision can be made based on the capacities and environmental balances of the area by applying the results of different analyses in GIS, regarding whether the projects are operational and where is the best location for making the largest man made lake of Iran and how they could be improved. The socio-economic and cultural situation of the District-22 has also been described. The interactive effects of the activities and suggested actions of the implementation of the plan have been specified during the constructional and operational phases. Finally, the strategic and management plans for the location of man made lake and environmental impact assessment of the man made lake in north western part of Tehran are presented by considering the overlay analysis results and proper actions are suggested to reduce the negative effects.

**Key words:** Environmental impact assessment, remote sensing, GIS, environmental modeling, urban man made lake

### INTRODUCTION

Nowadays, using and exploiting natural resources in every region, in order to achieve sustainable development and promoting living quality, are inevitable. The structure of the region under control of Tehran Municipality, District-22, is such that several recreational places could be established by taking advantage of the natural resources existing in the area. Meanwhile, establishing the west urban lake, as the vastest man made lake in the Middle East as well as Iran, is a big step in reaching such goals. On the other hand, environmental preservation, especially paying attention to human,

cultural and socio-economic structures, in order to avoid any instability and socio-economic imbalance, is one of the subjects that are related to sustainable development<sup>[1]</sup>. In general, in the study of assessment of the effects urban development projects by using GIS and for determining the effects resulted by project, some factors, such as community health, educational facilities, entrepreneurship, economic conditions, suitable and standard housing, cultural and artistic centers, recreational facilities including commercial centers, which avoid extra transportation and demographic issues are considered<sup>[2]</sup>. The main aim of this study was to considered major changes on human environments, caused by man made

lake in the north-western part of Tehran from 1998 to 2001 by using remote sensing technology and analysis of Satellite data and using GIS for environmental impact assessment by using graphical data (digital map) and attribute data and using environmental modeling and overlay method, decision can be made based on the ecological capacities<sup>[3]</sup> and regarding whether the projects are operational and where is the best location for making the largest man made lake of middle-east and Iran and how they could be improved.

### MATERIALS AND METHODS

In order to achieve the environmental impact assessment of the largest urban man made lake of Iran by using environmental modeling and apply overlay method in GIS, the base information has earned from the field studies and using digital maps and geo-reference information of Tehran. It should be clear that presenting an urban development model to be used in GIS to EIA has a lot of restrictions and limitations<sup>[4]</sup> whose description would lead too far here (Fig. 1). Some factors that have been considered in presenting the model include; weather and climate data, landform, elevation, geology, bedrock, soil, water resources, vegetation, installations and buildings, energy transmission stations, transportation networks, natural resources, gardens, forests, parks, industrial sites etc. Also the priority of the mentioned parameters is different in the model. It is clear that north-west of Tehran has an urban development context and is under the interactive effects of the large city of Tehran. It is thus impossible to correctly analyze the environmental conditions of district and man made lake impacts without considering these parameters.

The socio-economic situation of the district has also been described in the form of implementation of the plan. Finally, for choosing the better choice, all aspects of different analyses for sustainable development in urban planning has been used for analysis and assessment

### RESULTS AND DISCUSSION

**Determination of changes by using satellite images processing:** Before presenting an environmental model to apply in GIS, the results of satellite image processing related to the main land use changes in district-22 in north-west of Tehran are presented aiming to study the past and the processes of changes that took place. This analysis resulted in environmental models to determine layers that are needed for overlay method. Aspects that were taken into account in the satellite imagery analysis were changes in physical condition of e.g. water sources

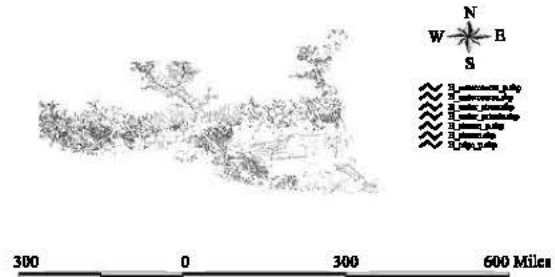


Fig. 1: Surface water resources layers in GIS for using overlay method in EIA



Fig. 2: Satellite image of north-western of Tehran, ETM+ 2001

and open areas, gardens, fields, green areas, installations and buildings during the years 1984-2001. The satellite images were extracted using land sat TM and ETM+. By using the digital map of Tehran the coordinates of specific points could be identified in the satellite images and the geometrical correction was done<sup>[5]</sup>. Geographical and water networks, political boundaries and population centers, transportation networks, elevation, topographic lines and names of the locations were extracted from maps of the district and used to identify the region. By performing supervised classification methods, the results of changes in land use for a defined period of time were calculated and extracted and presented in Table 1.

Analyzing the satellite images reveal a noticeable reduction of farmlands and gardens in district-22 due to the expansion of the urban limits (Fig. 2). The other fixed natural resources of the district too have been overused resulting in environmental destruction of the area. The amount of residential areas during 1984-2001 shows a 15% growth while there is no increase in the number of green areas. The amount of surface water in district has been reduced after 1998. Therefore recreational application is

**Table 1: Statistics related to land use changes (km<sup>-2</sup>) between 1984 to 2001 of district-22 (North-West of Tehran) (TM and ETM+) Satellite images**

Year	Residential	Non residential	Green zone (public)	Green zone (private)	Farms/gardens	Open lands	Water
1984	2.07	6.05	9.38	2.38	3.53	88.81	0.23
1994	3.71	6.75	9.41	1.94	3.19	86.79	0.23
1998	4.00	6.82	9.41	2.34	3.20	86.43	0.23
2001, ETM+	7.6	12.80	9.00	2.47	3.00	74.00	0.20

proper for district based on the results of remote sensing processes.

**Environmental modeling:** In urban development studies, from the ecological and environmental viewpoint, there hasn't been proper models for determining the urban applications<sup>[6]</sup>, specially for man made lake in urban environment, in order to estimate the capabilities of each region and especially in cities which have very quick development, the ever increasing rate of the environmental problems have also been uncontrollable and have caused the proper planning and decision making for the development of the region be impossible according to application of the models based on the ecological studies and applicable in GIS. In the following, the proper precisely refers to the parameters and factors and necessary requirements which have been applied in designing of the urban development models for recreation application and using for man-made lake are presented. It is clear that all parameters must present oriented layers for applying overlay method in EIA by GIS<sup>[7,8]</sup>.

- The base geological and meteorological data
- Applying the last experiences of the country such as the ecological model of Iran and some other environmental studies
- The quantitative standard in urban planning of the civil planning, office of the department of urban development studies in the civil coordination of the Ministry of Interior
- The suggestions of Ministry of Housing and Urban Planning in Urban development according to the environmental patterns
- The comprehensive plan of the urban development belonging to the Municipality of Tehran and its specified items related to the environmental restrictions in this plan
- The studies of a large group of the scientists and environmental researchers in the field of ecological and environmental modeling for urban development in international level
- To consider the elements and factors and the ecology of the under study region and physical constitutions of the environment, different factors such as temperature, wind, soil, climate and weather conditions, registrations, fauna and flora and also anthropological content and analyzing the topographic data and historical heritage and private symbols of the region

**Proper model for recreational application (man made lake):**

In order to present a proper and effective model for the assessment of urban applications based on conservation of the environment and land use planning viewpoint and sustainable development approach, first the ecological and environmental specifications of application in urban development for recreational application and man made lake are presented in the followings:

In the slopes put to 10%, by considering the bioclimatic of the region and also geographical direction and climatic specifications with the aim of enervation of natural and forest parts in urban areas, establishment and development of green areas according to bioclimatic of the region according to the neighboring urban application (man made lake) with considering the existing executive regulations of environmental conservation in the comprehensive plan of Tehran.

Establishment of buffers of trees or other kinds of evergreen trees around the areas with urban recreational applications around the man made lake location and as buffers of transportations facilities that generate noises which stands outside the noise conservation standards in noise generating urban environments that this buffer varies from 10 to 100 m considering the position and the kind of neighboring urban development applications<sup>[9]</sup>. This buffer should be also considered in design and construction of future highways in urban development in district (Fig. 3).

Based on the analyses made for the conditions of the slope, direction and regional elevation for recreation application, unto 1800 m elevation with the slopes up to 10% for those tourists in closed areas is applicable, for open area recreation the slopes up to 25% and for man made lake tile 10% and more with consideration of different applications is applicable. All geographical directions and regions with wind speed up to 10 m s<sup>-1</sup> and with more than 15 sunny days in a month in spring and summer, every kind of soil and rock condition is applicable for other recreational applications. The minimum distance of 5 km from industrial centers and basic urban should be considered in development of recreation and tourism centers. Now the mathematical linear models to explain different aspects of patterns for recreational application (indoor and outdoor recreations) are presented:

$$R_1 = S(1,2,3)+H(1,2,3,4)+A(1,2,3,4,5)+HW(1,2) \\ + SO(1,2,3,4,5,6,7,8)+WS(1,2,3,4,5,6)+QA(3,4,5) \\ + NI(3,4,5)+MA(2,3,4)+VR(1,2,3,4)+HP(1,2,3,4)$$

$$R_2 = S(1,2,3,4,5,6)+H(1,2,3,4,5,6)+A(1,2,3,4,5) \\ + WS(1,2,3,4,5)+SO(1,2,3,4,5,6,7,8,9,10,11) \\ + S(5,6)+NI(2,3,4,5)+QA(3,4,5)+HP(2,3,4)$$

To explain the above mathematical relations slopes are shown with S, direction with A, height with H, wind speed with WS, amount of rain with VR, ravine with MA, under water resources with SW, industrial sites with NI, soil with SO, historical places and unique symbols with HP and fault with QA. QA (fault) and considered area in planning, based on the distance from it, are classified in 5 classes. Class 1 is from 1 to 10 km, class 2 from 10 to 20 km, class 3 from 20 to 30 km, class 4 from 30 to 50 km and class 5 for more than 50 km. A stands for geographical directions, including directions: Northern, Southern, Eastern and Western and no direction. S Stands for slope and includes 6 classes, from 0 to 2% is the class 1, from 2 to 5% class 2, from 5 to 8% class 3, 8 to 12% class 4, 12 to 15% class 5 and more than 15% is in class 6. H stands for height including 6 classes, less than 1000 m, between 1000-1200, between 1200-1400, between 1400-1600, between 1600-1800 and more than 1800.

HP stands for historical places which classifies the historical places based on the distance from them including 4 classes, class 1 up to 5 km, class 2, 5 to 10 km, class 3, 10 to 20 km and class 4 is more than 20 km. SW stands for water resources which show the distance of water resources including 4 classes, class 1 shows up to 100 m, class 2 100 to 500 m, class 3 shows 500 to 1000 m and class 4 shows more than 1 km. NI stands for industrial sites and shows the classification of distances from industrial sites which include 3 classes: up to 5 km, 5 to 10 km and 10 to 20 km. About classification of SW, NI, HP the classification is based on the circles having the same center. MA represents the classified distances from ravine areas that include 4 classes: until 50, 50-300, 300-500 and more than 500 m. HW stands for highways and shows the districts situated around city highways which should be strictly considered in environmental assessments also in development plans, the establishment of buffers by planting evergreen trees proper for the region is designed and includes 3 classes: class 1 up to 10 m., class 2 from 10 to 100 m. and class 3 more than 100 m. By presenting the establishment plan, it is considered the improvement of environmental and socio-economic situation of the area with results of

GIS analyses that shows a lake, with a measurement of 220 ha in the neighboring region of Chitgar Park (Fig. 4) can play an important role in the air refreshment of Tehran. Plant and water cause the pollutants to be removed and suitable oxygen would be substituted beside favorable humidity.

The satellite image processes and GIS results by using environmental modeling with a land use planning approach show that potential of development in district 22 will have as the nature of an urban recreation center. It should be noticed that considerable measurement of Chitgar complex on one hand and existing potentials for attracting neighboring people on the other hand, explains why most of urban facilities and utilities shall be established in this region (Fig. 5).

This will have effect on the climate in winter and summer and makes the vast area of the city to look attractive. This will help attracting tourists and improving cultural, social and economic conditions of the region. With due regard to the various defined projects in Tehran Municipality, district 22, the projects demand extreme water supply. This should be added to the required water resource of the lake and its tourists as well as green environments around the lake (Fig. 1), which may cause worry among the people from shortage in water supply by considering satellite image processing analysis, (Table 1). In fact, this may affect the success of the project due to the refusal of the plan by the residents of the region<sup>[10]</sup>. Following sources supply the water for the proposed urban man made Lake that can change the environment of district and north-west of Tehran:

- Since Vardavard river has no specific water right, therefore, it is a considerable source for supplying water for the lake. However, it has some technical problems due to the great sediments, low hydration and lack of a position for better using from the river.
- Surface runoffs of the urban region; these runoffs are not suitable as a water supply due to their low water source and unfavorable quality.
- Middle runoffs of urban region; since the rivers of the mentioned region are seasonal and lack basic debris, therefore, underground waters of the above runoffs are not considerable in dry months of the year and they may not have an effective role in water management.
- Purified waste waters of urban region; these wastewaters are not recommended due to the general gradient of other areas and expensive cost of pumping and transfer.

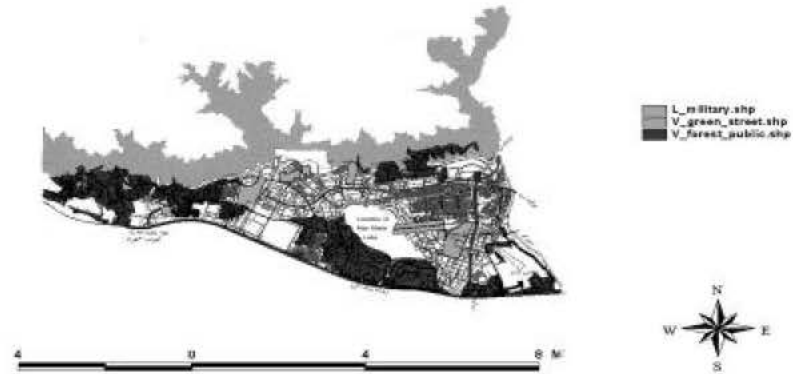


Fig. 3: Suitable area for indoor recreation application by using environmental modeling in GIS

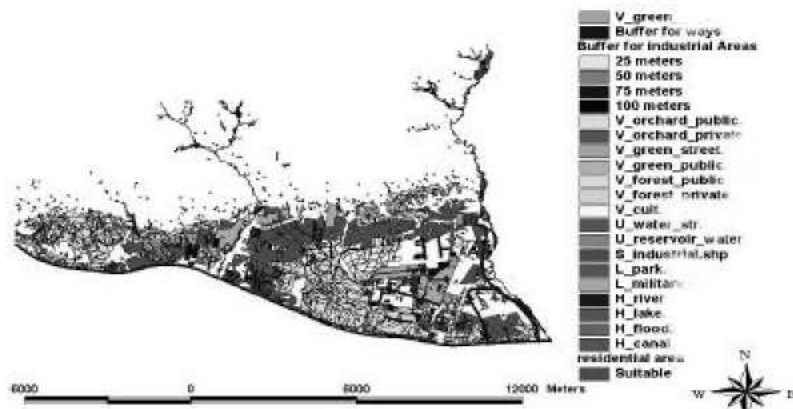


Fig. 4: Suitable area for man made lake by using environmental modeling and overlay method in GIS

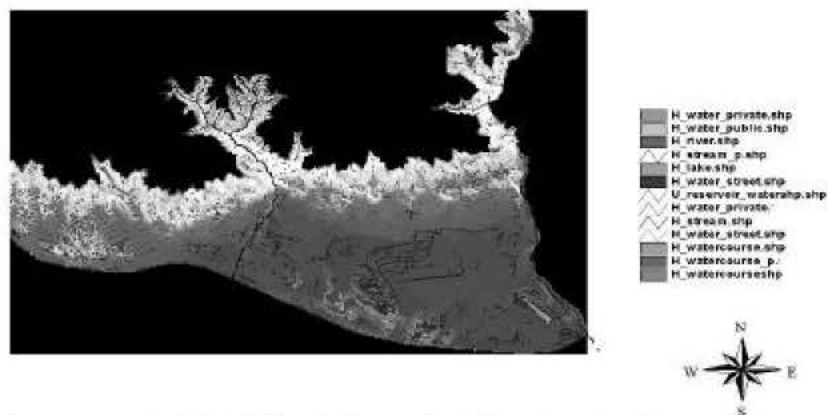


Fig. 5: Existing water resources in district-22 and slop analysis, by using elevation modeling

Kan river is considered as one of the main rivers of Tehran plain and the most important source for supplying water of the proposed lake. The studies map of region in GIS and using overlay method show from the route of the river that the main water right holders of Kan River have been located at Hydrometer\ Station of Soolghan Bridge and there is no official water right holder below the mentioned Station. Informal water right holders' just use the water in the rainy seasons of the year and most of water for farmlands is supplied from underground water. One of the main subjects in this choice is employment. The amount of entrepreneurship nature of a plan (directly or indirectly, temporary or permanently) affects, socially, the decision making for execution of a plan. In economic assessment and cost-benefit analysis of a plan by private sector, mainly the focus is on the economic profitability and entrepreneurship as well as its role in providing new job opportunities is mainly ignored. But in the assessment of civil plans, this factor is considered one of the most important ones due to its public and social aspects. This grows in importance when is accompanied by the emphasis of policymakers and the local structure for providing new job opportunities. By providing a semi-natural place, the lake can meet the demands of the nature loving persons and eco-tourists. Economically, tourism development in this region causes increasing hard currency absorption, avoiding hard currency exit, facilitating monetary circulation, increased employment, increasing income per capita and finally increasing living standard. Indeed, local tourists strengthen cultural ties in the national level while protecting hard currency exit. Implementing the Lake in the neighboring area of Chitgar park (the result of analysis of overlay method in GIS) brings a beautiful and accessible area for the people of the region and Tehran citizens. Outdoor recreation in such place can fresh up the air and the people of the area as well as attraction of tourists (Fig. 4). Meanwhile, this place will promote the relation of the people of the area and other parts of the world. This will enhance cultural exchange and can provide a suitable base for cultural exchange in local fields. Also presenting proper models for determination of ecological capabilities and methods of determination for urban and social capacities as well as environmental conditions of the city and applying

standards and proper models at final analysis in making urban development plans while using GIS for assessment, planning and urban development management and comparing the results of land use planning and comprehensive plan in district especially for recreation application and man made lake by using overlay method in GIS are of achievements of this study. Also emphasize on identification of the background of the land and urban changes term through RS systems is recommended as the most suitable method in urban studies and development plans.

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