Urban Planning for Tehran, By Using Environmental Modeling and GIS/RS

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Key words: GIS, Environmental Planning, Remote Sensing, modeling, development

SUMMARY

The "environment" is a universal concept. While urban aspects and urban planning often reveal a limited and fixed idea of the concept of the "environment" in our minds, the "environment", in my opinion, is in fact a much wider concept than that. In this article I want to emphasize the complexity of the environment and to show how an urban development model for identification, analysis, assessment and planning can be created by applying environmental models in this wider "environmental" context, with the help of GIS and remote sensing for a part of Tehran, the Iranian capital city. The area observed is district 22 in north-western Tehran, an a region of about 10 000 hectares which is restricted by the Alborz mountain chain in the north, the Kan River in the east, the Tehran-Karaj freeway in the south and the short mountains of Karevansarasangi in the west. Like many cities in other countries, the city of Tehran is experiencing that increasing pressure of improper land use and incorrect land management policies have exacerbated the problems by disregarding the limitations and potential of land, and its vulnerability and fragility against possible changes. The use of GIS and remote sensing techniques during the last decade are increasing being applied now for identification of natural resources and for the management of urban and environmental projects for the major cities in Iran, But the practice of analyzing The development models with the use of GIS in urban development planning is a new experience.

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1. DETERMINATION OF CHANGE

Before presenting an urban development model, the results of satellite image processing related to the main land use changes in District 22 are presented aiming to study the past and the processes of changes that took place. This analysis resulted in environmental models. Aspects that were taken into account in the satellite imagery analysis were changes in physical condition of e.g. water, 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 with PCI software using 10 locations in the Tehran region. 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.

Table 1: Statistics related to land use changes (per Km2) between 1984 to 2001 of district22 (North-West of Tehran) Land Sat (TM and ETM+) Satellite images

No.	Year	Construction	Green Area (public &Private)	Farms & Gardens	Open Area	Water
1	1984	8.12	11.76	3.53	88.81	0.23
2	1994	10.46	11..35	3.19	86.79	0.23
3	1998	10.82	11.75	3.20	86.43	0.23
4	2001	20.48	12.50	2.96	74.00	.020

Analyzing the satellite images reveal a reduction of farmlands and gardens in District 22 due to the expansion of the urban limits. The other fixed natural resources of the district too have been overused resulting in environmental destruction of the area. The amount of construction areas during 1984 -2001 show about 15% growth while there is no increase in the number of green areas. The amount of farmland and gardens declined and open areas have been reduced thus leading to the conclusion that most of the construction activity took place in open areas and some in previously existing gardens. The results of analyzing the satellite images reveal a proper data for planning with environmental modeling and GIS facilities.

2. URBAN DEVELOPMENT MODEL

In order to present the urban model, the ecological specifications of Iran and District 22 have been studied and then assessed and classified. Then through comparison and by considering

the specifications of the studied area, the urban development model is produced and the locations for urban development with residential and administrative applications, recreational, industrial and workshop etc. location applications are presented as maps in Arcview. Arcview has not only the capability of search and data retrieval but is also able to analyze the spatial information together with network and three-dimensional analysis capabilities. To create the urban development model, the studies that were undertaken over the last 30 years were applied for the determination of the best potential of land having the optimal ecological parameters for assessment of urban development. This resulted in a number of charts per category. At the same time, a lot of basic studies have been used to improve the quality of the models.

3. SOME ADDITIONAL SOURCES UESD IN THE URBAN DEVELOPMENT MODEL

- Ecological model of urban, rural and industrial development of Iran and other ecological studies in urban development filed
- Executive procedures and regulations of new comprehensive development projects in Tehran
- Urban development suggestions presented by the Centre of Studies and Research of the Ministry of Housing and Urban Development
- Qualitative standards in urban development provided by the Urban Planning Studies group of the Ministry of the Interior
- National Physical Plan of Iran and research of development possibilities of water resources and population distribution
- Data available in the National Atlas of Iran, Atlas of the Environment and the Atlas of Urban Planning
- Data from the Geological Survey of Iran and data of meteorology of Iran
- Data available in international level about the urban planning with a land use planning approach

4. ASPECTS OF THE URBAN DEVELOPMENT MODEL

It should be clear that presenting an urban development model to be used in a GIS has a lot of restrictions and limitations whose description would lead too far here. 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.

The priority of the mentioned parameters are different in the model. It is clear that north-west 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 without considering the social and economic activities in the district. Some environmental standards considered in the urban development model are; extensive vibration, smoke and other air polluting factors, smell, radioactive radiation, solid and liquid wastes are all prohibited in the area and all ecological parameters such as physical environment geological and

geomorphology specifications, fauna and flora, soil, water resources, climate and weather quality, topographical situation (slope, direction and height analysis) in district22.

5. SUITABLE PATTERNS IN DISTRICT22

Based on the analysis performed there is no doubt that the natural and ecological capacity of Tehran's District 22 is the proper place for combined housing construction, recreation and cultural purposes while trading, administrative and industrial operations have limited future potential in the area. But how did I come to these conclusions? To clarify this I will describe in detail four applications and present the two flow charts -as an illustration- which are resulting from the urban development model.

6. SUITABLE PATTENT FOR GREEN AREA

A 25% slope as well as an east and south geographical orientation and the altitude of 1800 meters are acceptable. Creating green areas suitable to co-exist with the present industrial areas as well highway spaces and big installations with a width of 10-100 meters to keep the bio-environment in good shape. To produce a comprehensive tree planting plan –both fir as well as leaves trees- near lakes and mountains in the range of 1400-1800 meters where there exists suitable soil and water accessibility. It is recommended to keep the existing private and public natural parts in place as well as the surrounding orchards.

7. SUITABLE PATTERN FOR OPTIMAL RESIDENTIAL PLANNING

A slope lower than 9%, a height lower than 1600 meters, south foot of the mountains as geographical direction, and as underground bed rock, sand stone, basalt run, alluvial fan, lime stone, clay stone, granite, crack tuffs, runs between pleats are suitable for residential applications. On top of that at least the availability of 150 liters of water per day for each individual person as well not to be located into the direction of whirlwinds, seasonal winds or fault lines of earthquake areas, not be located in dry beds of rivers, flood ways and natural waterway passes, are prerequisite. Electricity supply must be available and the site must have the lowest distance to urban services and commercial areas, and be far from the industrial and workshop area. The area must have the nearest accessibility ways to other urban areas through public transportation systems. Residential areas will have to be at a distance from highways, main streets and surrounding places of industrial centers as well as those areas creating noise and air pollution. Service facilities for the residential areas should be within a radius of 5 kilometers.

8. SUITABLE PATTERN FOR WORKSHOP AND INDUSTRIAL APPLICATION

They should be placed at slopes under 9%, in southern, eastern and western directions at heights up to 1400 meters. Industrial centers should not cover underground water reservoirs and do not occupy agricultural zones. They should not hazard or pollute the safety of natural areas nor should they be placed at the borders of parks, tourist areas and recreational clubs, and be located far from rivers, lakes, orchards and at a standard distance of residential and commercial centers.

9. SUITABLE PATTERN FOR RECREATIONAL APPLICATION

The topographic conditions here should be between the height of 1000-1800 meters with a slope up to 15% acceptable, but not located in the neighborhood of industrial workshops.
The former sight seeing and tourist situations kept and empowered at concerned area; neighboring area of rivers and lakes was used; Suitable area such as parks,
Attractive area and public green areas should be included 9%-25% slope with any soil and rock conditions at the view of recreational places is acceptable and for mountain climbing slopes higher than 25% is acceptable .

10. MATHEMSTICAL LINEAR PLANNING MODELS FOR SUITABLE URBAN APPLICATIONS

Before presenting simplified conceptual models for different applications of urban planning by using environmental modeling, suitable patterns for recreational and green areas and residential applications in the form of mathematical linear planning models are presented and then the simplified positioning conceptual model of residential and recreational development in district22 are presented:

Y1=
[(SL<9%)+(SL>1%)]+[(AS>112.5)+(AS<202.5)]+[1000<EL<1600]+[(DTw>0)+(DTw2>0)+(DTp>3000)+(DTm>50)+(DTr>1000)]
Y2=
[(SL>1%)+(SL<15%)+[(EL>1000)+(EL<1800)+(DTs>5000)+(Re)+(Pa) OR
[(EL>1000)+(SL>25%)+(DTs>5000)]
Y3=
[(SL<30%)+(AS>112.5)+(AS<202.5)+(1000EL<1800)+(0<DIS-TO-POW<200)+(0<DIS-TO-HW>40)+(0DIS-TO-IND<50) OR (SL<50%)+(EL>1000)
Y1=S(1,2,3)+H(1,2,3,4)+A(1,,3,4,5)+QA(2,3,4,5)+MA(3,4)+AR(WS(1,2,3,4,5)+H(1,2,3,4,5,6,7,8,9) +WS(1,2,3,4,5)+NI(2,3,4,5)+VR(1,2,3)+SO(1,2,3,4,5,6,7)
Y2=S(1,2,3,4,5)+H(1,2,3,4,5,6,)+A(1,2,3,4,5)+HW(1,2)+SO(1,2,3,4,5,6,7,8,9,10,11)+WS(1,2,3,4,5,6)+QA(1,2,3,4,5) +NI(1)+MA(2,3,4)+VR(1,2,3,4)+HP(1,2,3,4)
Y3=S(1,2,3,4,5)+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)if S(5,6)+NI(2,3,4,5)+QA(2,3,4,5)
Y4=SW(3,4)+HP(3,4)+QA(2,3,4,5)+S(1,2,3,4)+H(1,2,3)+WS(1,2,3,4,5)

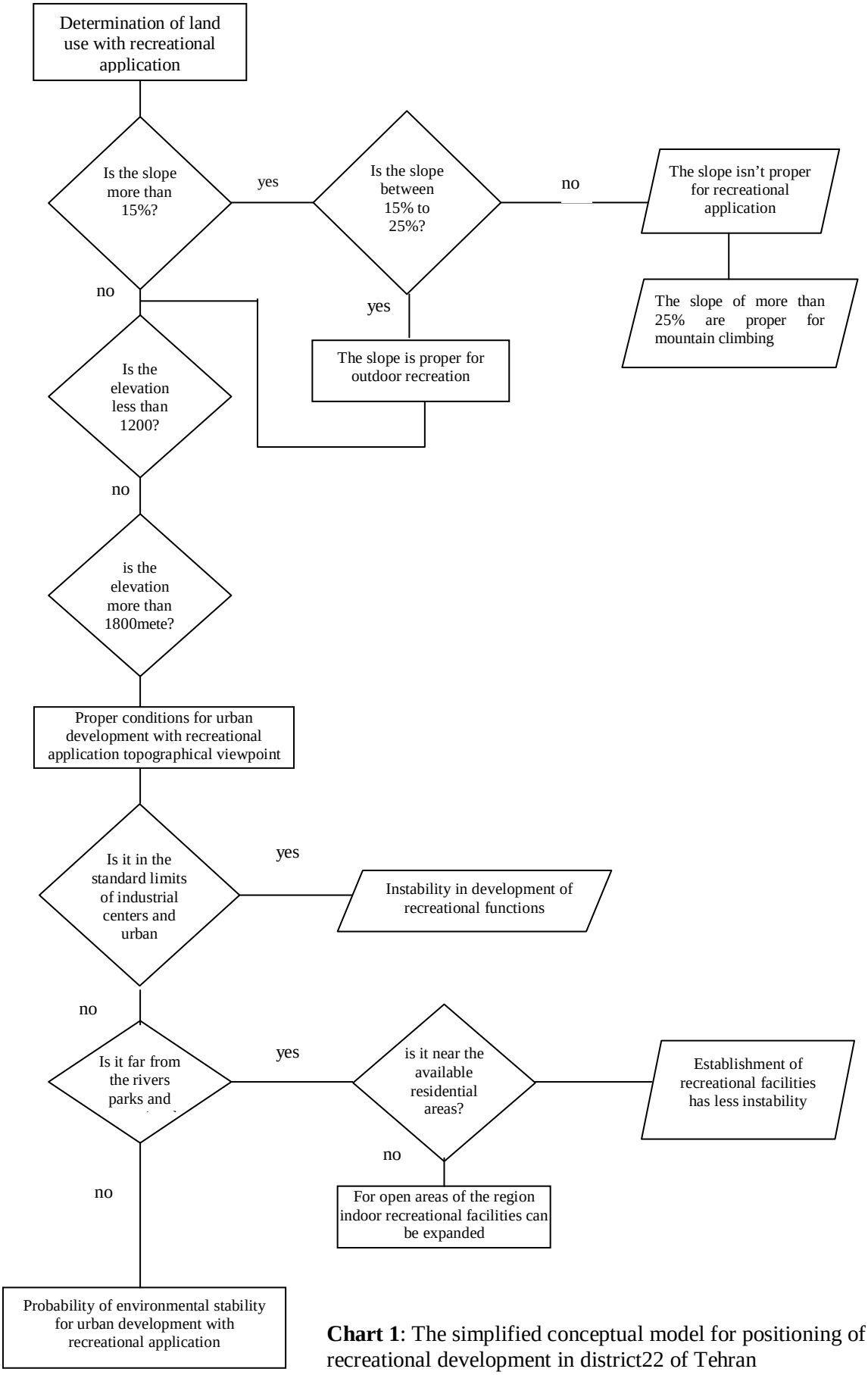

Chart 1: The simplified conceptual model for positioning of recreational development in district22 of Tehran

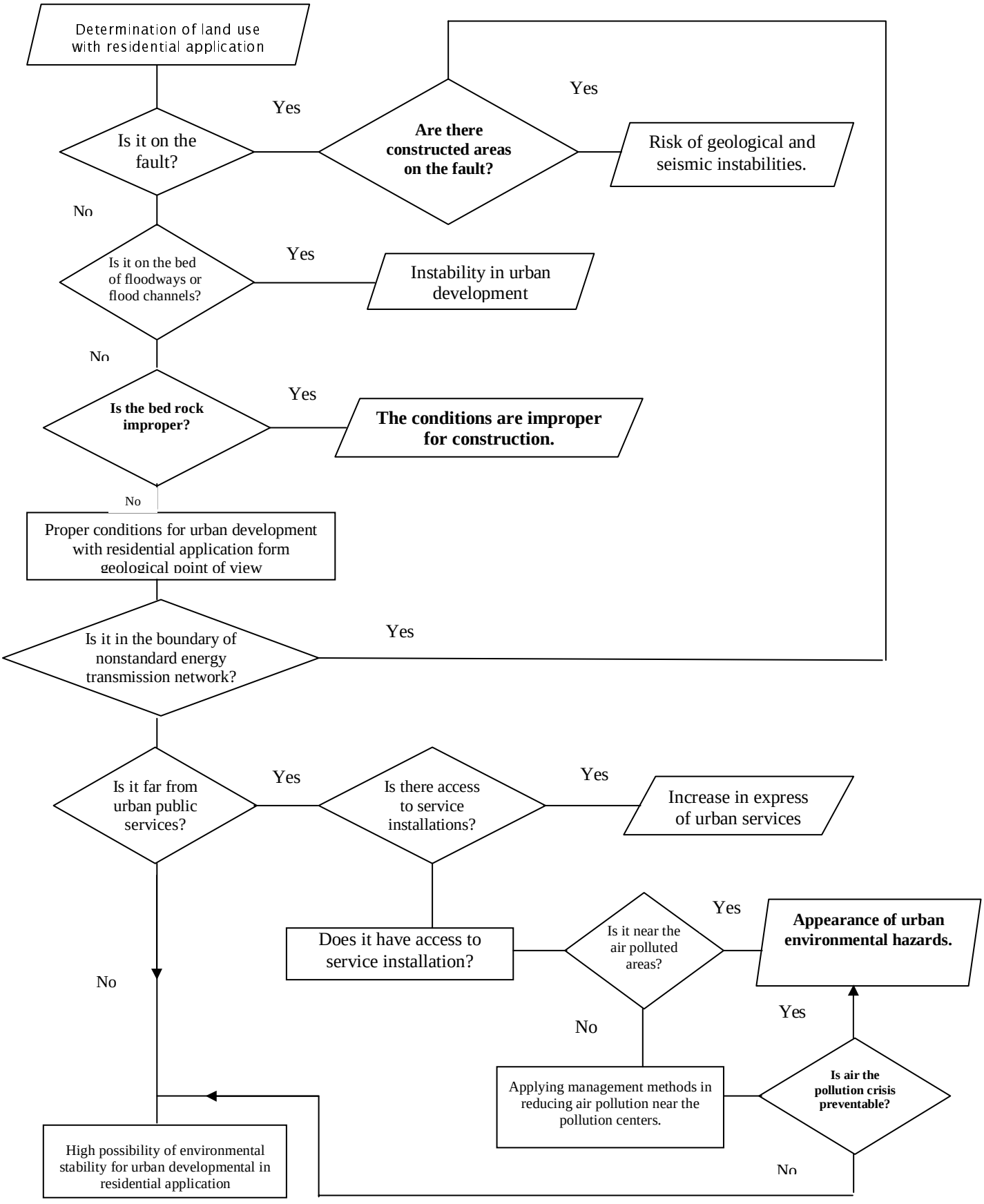

Chart2: The simplified positioning conceptual model of residential development in district 22 of Tehran by considering geological conditions and air pollution

11. SUMMARY AND CONCLUSION

In the conclusion, first some innovations are introduced: Innovations in the filed of urban development models which are based on environmental models and are applied for analysis in GIS. Considering the presented outstanding characteristics in the models, one of the obvious and prominent aspects of innovations in this paper, are the patterns and models.

Positioning of proper places for urban development applications based on the environmental models with emphasis on determining the natural and ecological potentials of different districts of Tehran, is presented by considering the results of 30 years research in Iran in this field. At the same time, the joint application of RS results in order to review the past and present situation of the territory to apply for optimal urban planning in future and also linkage of these results with GIS analyses, have also been among the innovations of this project.

Comparison of the results of the analyses with future development plans such as the comprehensive development plan and the comparison of the natural potentials of the territory with the predicted plans in the comprehensive plan to result in better decision makings is of the other innovations in this paper.

The results of this research are presented in the most creditable magazines and conferences proceedings of the United States, European and Asian countries.

District22 in the northwestern of Tehran with an area of about 10000 hectare is located at the West part of Tehran and is restricted by Alborz mountain chain in the North, Kan River in the East, Tehran-Karaj freeway in the South and short mountains of Karevansarasangi in the west.

The foot heels of Alborz mountains chain, proper topographic situation, forest park of Chitgar, three major valley rivers which all are located in this part of metropolitan city of Tehran, provides a unique environmental sightseeing. The existing urban construction have occupied less than 15% of this area.

Three major east to west highways and two highways from the north to the south and three major south to north highways together with Tehran-Karaj subway has provided a proper network to connect this area to other parts of the capital.

Based on drawings from GIS analysis there is no doubt that natural and ecological capacities of Tehran district22 is proper place for construction, recreation, tourism and cultural and green areas development purposes. The existence of the natural gardens and recreation centers and also considering the results from RS analysis shows that urban development plans in the field of trading, administrative and industrial operation have limited the capacities in that area.

The maps of environment pollution control have been provided by using proper models and GIS which are presented in the model and this is in addition to determination of natural potentials of the district which its related maps have also presented.

On the other hand, using advanced systems for identification, organizing and planning in development projects such as GIS systems seem to be of great importance at present and future.

In this paper modeling for urban development and applying efficient systems of RS and GIS for this purpose are jointly presented.

Presenting proper models for determination of ecological capabilities and methods of determination for ecological 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 are of achievements of this paper. Also emphasize on identification of the background of the land and urban changes term through Remote Sensing systems is recommended as the most suitable method in urban studies and development plans.

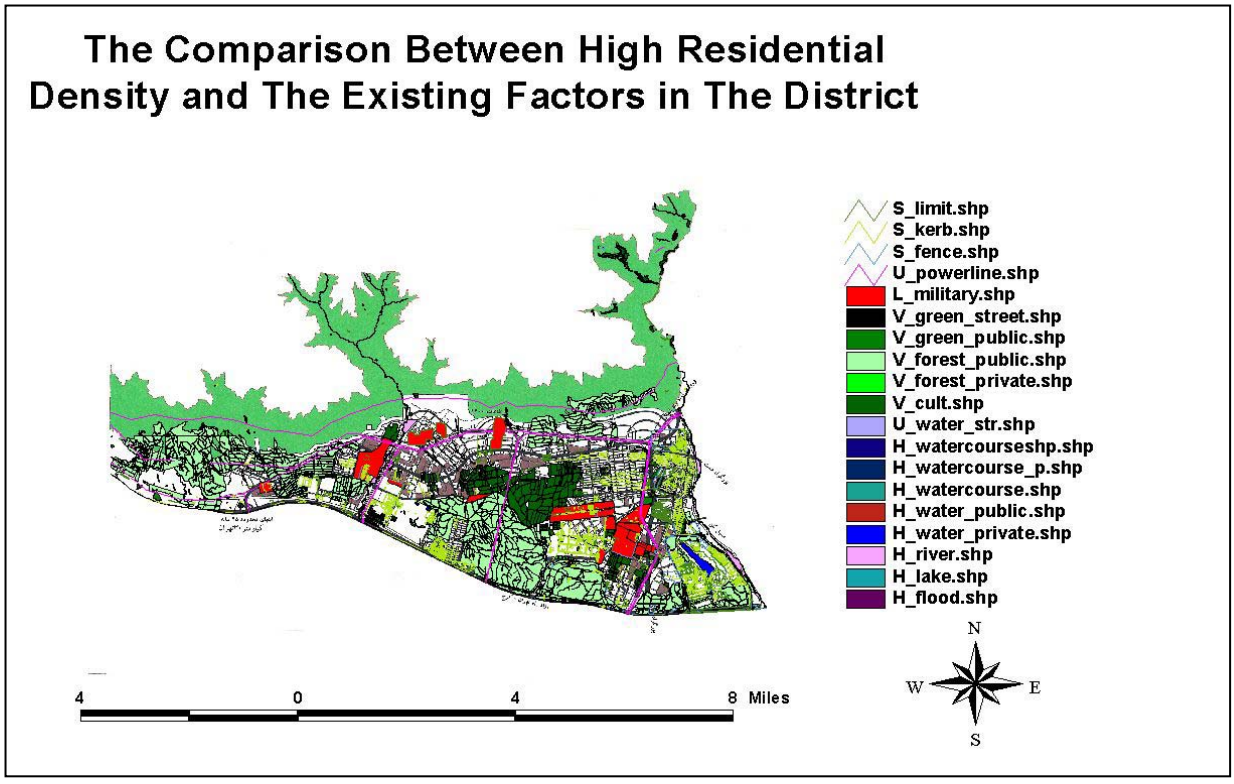

Figure 1: The Comparison between the high residential density and the existing factors

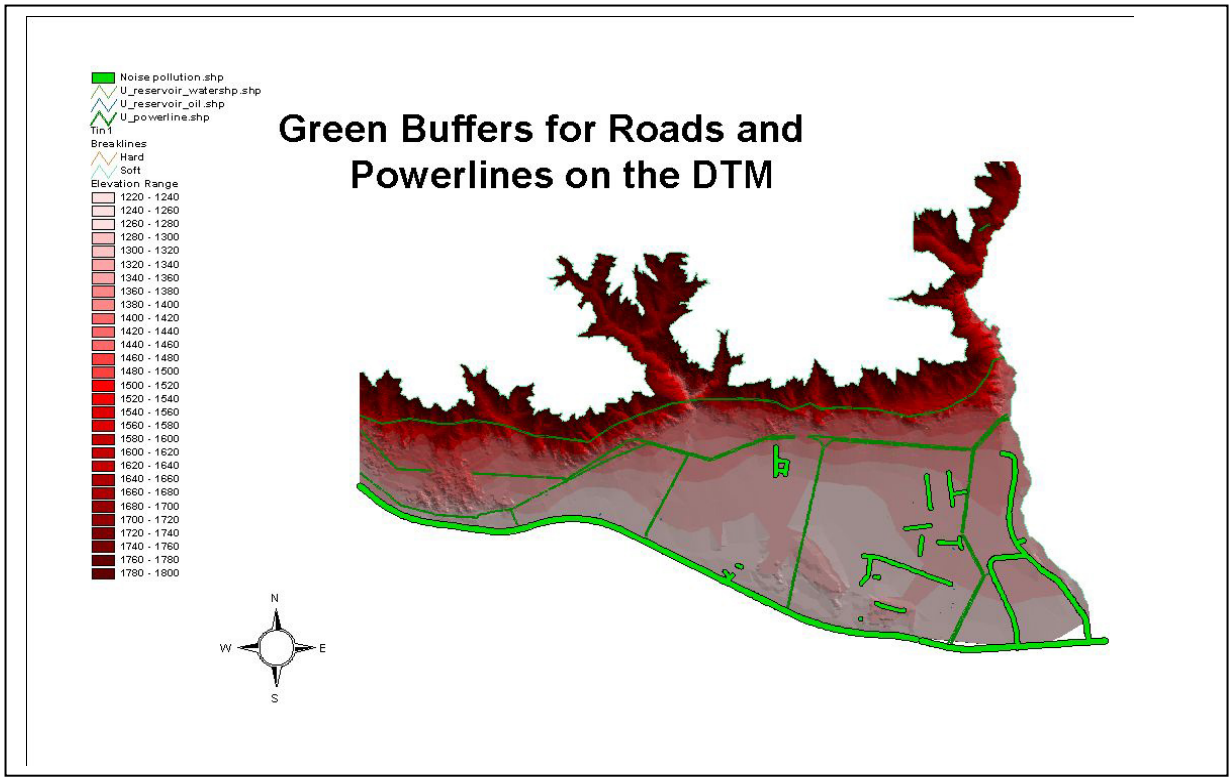

Figure2: Green buffers for roads and power lines on the DTM for control of noise pollution

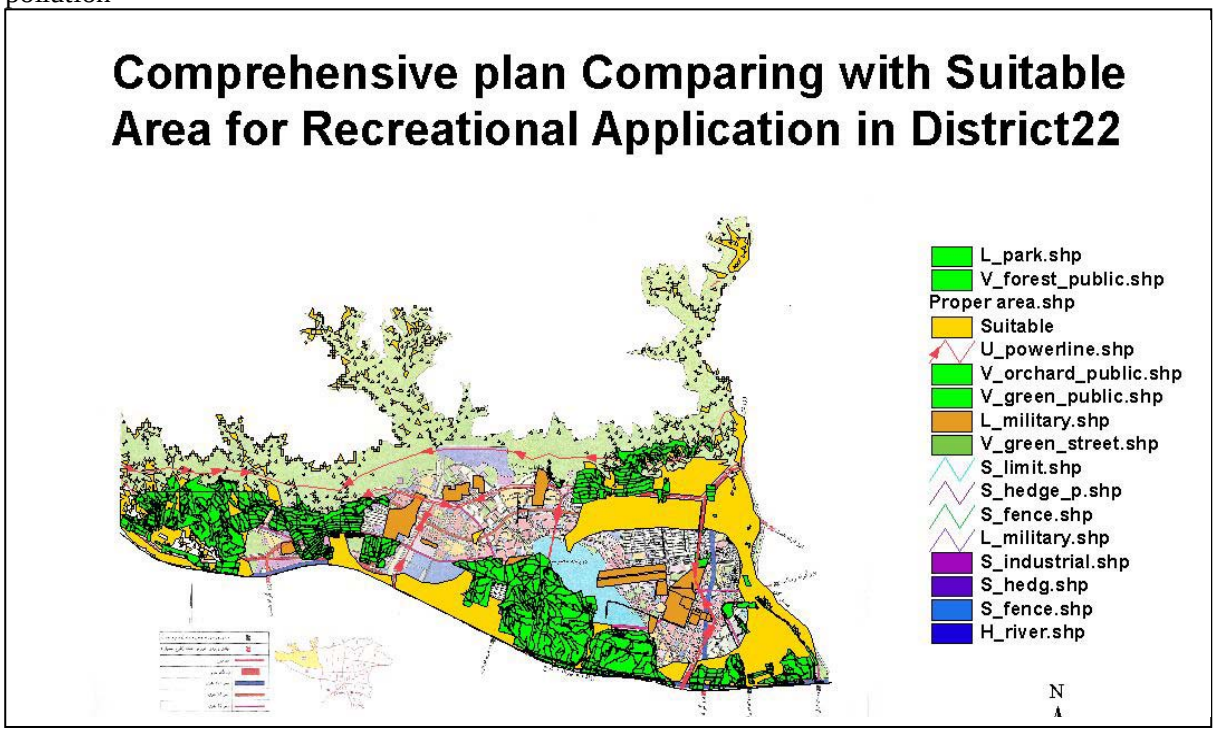

Figure 3: Comprehensive plan comparing with suitable area for recreational application

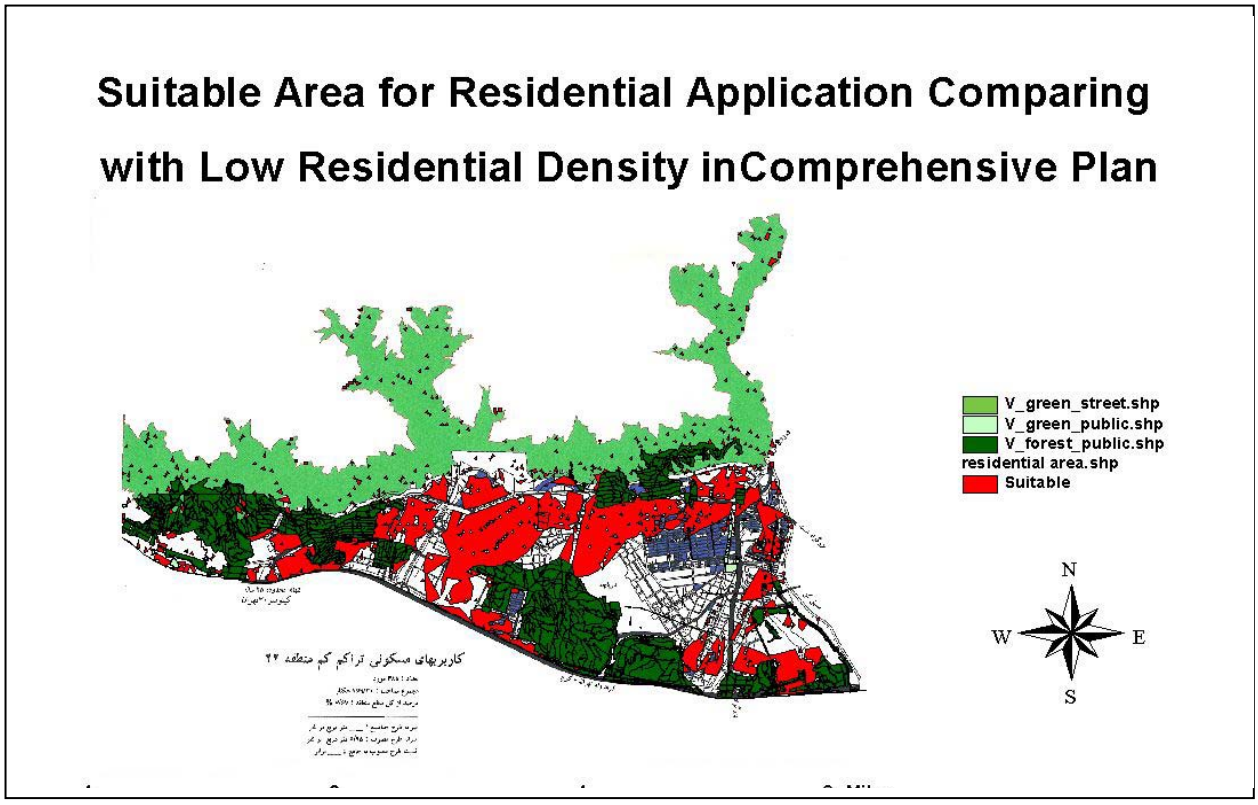

Figure 4: Suitable area for residential application comparing with low residential density in comprehensive plan

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