IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 5 Issue 7, July 2018
ISSN (Online) 2348 – 7968
www.ijiset.com

A Study of the Effect of Road Transportation on Future Control Assignment with a Regional Developmental Approach

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Abstract

The development of Iran with regard to the realization of Iranian 20 years' perspective document is as the main troubles of the Islamic Republic. Inattention to the spatial dimension of development strategies over the past years has results in the occurrence of several problems such as congestion, injustice, demolition of the environment, and modification of the rural and urban structures. Land use planning is the manifestation of the strategy of the national development, which considers the land as the main factor. This subject over recent years has attracted the attention of the researches. The transportation system, and development through an element, called accessibility, has increased or decreased the value of surrounding lands; which, this has caused to change the arrangement of the controls. This study evaluates the role of accessibilities derived from road transportation and networks in determining the proportionality of the lands, and finally determining the control assignments. The case of this study is an area of Isfahan province. In this study, the cellular Automation (CA) method has been used to analyze accessibility data; also, the model was run, and analyzed, on MATLAB Software and implemented with the help of ArcGIS Software.

Keywords: Land use planning, sustainable regional development, transportation, cellular automation, future controls.

1. Introduction

The occurrence or augmentation of some negative and harmful effects of transportation, as one of the most crucial section in the country over recent years, has attracted the attention of most professionals and planners. For example, condense congestion of vehicles in the urban pathways, and high rate of consuming fossil fuels evokes the issue of approaching the finishing threshold of the non-renewable resources, and the propagation of environmental pollutants. On this subject, the statistics figure out that by 2025, the energy consumption in the transportation section, and the emission of greenhouse gases will be doubled than years 2000(Ostadi Jafari and Rasafi, 2013). In addition, about 500 thousand people in average will suffer from early death annually due to the air pollution as transportation (Ostadi Jafari et al, 2010).

For planning from the viewpoint of sustainable urban development, it is necessary to design the transportation system in such a way that agrees with the criteria of sustainable development. Using modern system, and new ways of urban transportation in the cities with heavy traffic and pollution has special importance (Hatami Nejad and Ashrafi, 2009).

Therefore, it can be said that one the most important subjects of sustainable development is the sustainable transportation strategy (Bakhtiary et al, 2009).

Interaction between transportation and land control is a thorough mutual relationship of the activities related to the land control, and is considered to be the accessibility that is related to transportation. The two variables are such interrelated that it is very difficult to determine which one initiates the change in the other. From one side, the number of cancelled or created journeys changes by creating a new control or changing a present control; from other side, the attractivity of the area increased by creating and facilitating a new transportation such as construction of a new highway, or the increase of public transportation facilities. The cycle always continues. The relationship is often called transportation-land control cycle or connection, which emphasizes on the relationship with the feedback.

Most of the transportation models include a part of land control, which is integrated with the model, or has at least a weak relationship to it (Shirzadi, 2007).

The accessibility is a concept which plays an important role in fields such as urban planning, transportation, and

Geography. It is also a tool which affects the urban decisions. However, the accessibility has gotten a weak definition and measurement structure; and it is very hard to find a comprehensive definition of accessibility; and, by its application, it can be evaluated from different viewpoints (Mousayi, 2012).

By application, the accessibility has several definitions. Hansen believes that accessibility is the potential of interacting with the opportunity Martin and Dokvi define the accessibility as the individual's ease to choose among the activities by the optimal transportation state in defined places. Other definitions of accessibility are as the following:

* Accessibility shows the ease of access to one place from other places, or the access from one place to other places.
* Accessibility determines the gained profit of a transportation-land control system.
* Accessibility shows the ease of access to one place from other places; so, in general, it can be said that it represents the related opportunities for the communications and interactions between the places.

Giving the definition of accessibility, as the main effect of transportation, the land use planning will be defined. The land use planning is a set of activities used by government, municipalities, municipalities, and in general, by the public sector to develop their own areas. This policy, which is beyond an urban policy, investigates the Men's layout and their activities in the expanded land, or actually, in their specific geographic space; Hence, it includes the economic development, dwelling and housing, mass communication, and transportation.

Mr. Majeed Makhdoum defines the land use planning as regulating the relationship between man, land, and his activities in the land in order to benefit self sustainably from all human and spatial facilities to improve his material and spiritual conditions in the society over time.

As it can be noted from the definition given above, the land use planning is affected by two major factors: demand, and proportionality. The demand means the area needed for different small-scaled land controls; and, it is calculated per demand unit; the demand units are usually based on political and management classifications. The areas can be determined by using statistical regression, Linear programming methods, and experimental indices derive from the population growth, and economic development. The land proportionality means estimation of the inherent capacity of the land unit to support a specific land control over a long time and with no destructions in order to minimize the social, economic, and environmental costs (Bhagat et al, 2009).

In different studies, a set of different environmental, economic and social criteria including environmental proportionality, neighborhood (interactions between controls), accessibility, and restrictions has been defined for land proportionality (Verburg and Overmars, 2009).

Therefore, the transportation system can change land proportionality through accessibility. In this respect, it plays a key role in the land use planning.

1-1-Transportation and economic development

Anyway, the development of transportation system results in the fundamental and criteria changes in the economic activities, and finally in the area specialism. For example, constructing a road leads to exploitation and extraction of the coal resources in the place, or to cultivate more agricultural lands. Also, establishment of the economic activities due to the expansion of communication lines heightens the absorption capacity of the area population through fortifying the migrations. This, in turn, leads to more development of the economic activities.

From other side, the more establishment and settlement of the economic activities lead in more demands for transportation (Tavalaee, 1996).

Generally, the effect of transportation on economy can be regarded two prospective. First, the effect of such activities on the spatial structure can be regarded; i.e. from one side, the development of transportation network results in the concentration of economic activities in some areas, and their consequent growth. From other side, it can result in stagnation of other areas. Second is the effect of transportation section on economy on macro-levels such as occupation, production, investment, etc. Transportation, like agriculture and industry, belongs to the infrastructure sections of the country, which can bring about occupation and generate services. In this respect, nowadays, the created value added in the infrastructure section is regarded to be of the important indices of measuring the economic growth and development of the countries (Sabagh Kermani, 2001).

1-2- Transportation systems planning

The transportation systems planning is of high importance in most of the regions. The planning has 3 levels in practice, which can be proportional in the design and planning of transportation. The coordination between the three levels is felt very strongly.

* Strategic planning
* Functional planning
* Path design

The level of strategic planning, i.e. the relationship between transportation services and the land control is very advanced. The type and level of planning services has been described by the corridors region as the minimum design of transportation, which should be involved. The level of strategic planning in the discussions of transportation which level of the details and analysis of strategic planning are various and diverse, will make the analysis to be very general.

Transportation functional planning: It provides information of place, or the interior path of the general corridor or the service region. Properly, the level of services affects the path, size, and regular capacity of truck transportation on the road, the timing of services, the main travelling centers, and the specific serviced destinations.

Also, the prepared analysis may be used in the transportation planning that is proportionate to the transportation design.

Transportation path design: It provides special information of transportation stop places, altering the vehicle, the covered places in the transportation path for the travelers to rest, transportation planning, and vehicle-drivers information. All these elements are necessary for the path design. It also includes these information travelers and general traffic, rooms and necessary buildings for transportation personnel such as terminals, etc.; Also, it needs to involve such things: drawing and designing a pavement in dangerous places, and physical improvements such as traffic centers, and local transportation functions that help the designers to design transportation (Maiga, 1995; 73).

1-3- Cellular automation

The cellular automation is appropriate for organizing models and self-automated behaviors. The cellular automation is in fact the discrete dynamic systems which behavior is completely based on the relationship. In CA, the space is defined as an one-dimensional or multi-dimensional network of cells. Each cell has specific properties which changes over time. The values of the cell variables over a time range show the cell status; and, the status of all cells over a specific time range shows the overall behavior of the system. CA modeling includes 5 main elements: cellular space, neighborhood, transportation law, status, and the time. In the following these elements will be shortly discussed.

Cellular space: In the cellular automation, the cells are arranged in a mosaic form, and create the cellular space. The mosaics can have different arrangements such as trilateral, quadrilateral, and hexagon forms with mono, di, and trilateral dimensions.

Neighborhood: In fact, neighborhood is the surrounding cells that affect the dimensional status of the cell. For two-dimensional state, there are three well-known neighborhood patterns.

Radial neighborhood that involves the cells located from a specific radius of the central cell. Neumann Von neighborhood consist of four surrounding cells: Top, down, right, and left. Moore neighborhood in which 8 cells surround the central cell. Figur1 is a representation of the neighborhood definition in the cellular automation model [Liu, 2009].

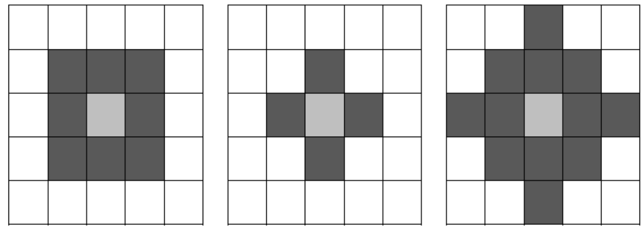


Figure1. A representation of neighborhood definition in the cellular automation model

The neighborhood size is an efficient parameter for defining the transition and accuracy functions. According to CA theory, the overall self-organized system behaviors are based on the definition of local laws. One major question is that based on the task, how much a process is local. The selection of some factors affect the small areas; but, the selection of some variables such as the development of roads and transportation affects the entire region. Hence, the selection of neighborhood size can have a considerable effect on the CA model accuracy (Karimi, 2010).

Transportation law: transportation law gives transportation algorithms of the cell changes from one state to the other state over time. In fact, they are laws that govern the transition of the cell states; since, the input of the laws is the cell neighborhoods, they are calls local laws. The transportation laws, and the way of defining them are the indexes of the model. So that the way of defining the laws discriminates between the CA models.

Status: Every cell can only have one status over time among the possible set of status. In the urban cellular automation, the cells status can be representative of land control or land coverage. In the cellular space, usually, the cells are discrete and their borders are clear, which is contrary to the reality; in these cases, it is recommended to use phasic sets.

Time: According to the definition of cellular automation, the status of the cell changes in subsequent time step with the repetition of CA law, and with respect to the status of the neighborhood cells. Of course, the time steps can have different paces for different cells.

2. Literature

Up to the present, several studies have been carried out about sustainable transportation, and the evaluation of its dimensions and systems.

Zuidegeest, in a study, Developing sustainable urban transportation with a dynamic optimization approach, makes use of the dynamic optimization model to dins out the optimum solution under restriction of social, economic, and environmental objectives(Zuidegeest, 2005).

Richardson, in an essay, sustainable transportation, uses the dynamic model system, which shows the relationships between the system elements, by making use of the analytical frameworks in the assessment of the sustainable transportation. In these models, he has identified the interactions between the effective factors on the sustainable transportation by using the causative analysis (Richardson, 2005).

Jonssin, in his study, Sustainability analysis of land-base and Transportation system, has used the cost-profit analysis (i.e. considering the monetary value of all the positive and negative aspects of a project) to evaluate the sustainability. Of course, it is almost difficult there to estimate the environmental and social costs (Jonssin, 2008).

Awasthi and Chauhan, in their article, Using Demster Chaupher Theory, and AHP method to analyze Solutions of Transportation sustainability, used multi-variable decision-making approach to choose among the sustainable transportation system under insufficient information (lack of confidence), and to evaluate the criteria of sustainable transportation (Awasthi and Chauhan, 2011).

Jeon et al., in an article, sustainability Assessment of Transportation design in plans: performance, size, and Variables, also considers the efficiency dimension of the system in evaluating the strategies of sustainable transportation (Jeon et al., 2013)

Hildago and Huizenge, in their study, Administration of sustainable transportation in Latin America, have suggested the trilateral design of avoidance-change-improvement for developing some transportation systems, and for preventing the negative effects of vehiclism of urban transportation (Hidalgo and Huizeng, 2013).

3. Theoretical foundations of the study

3.1.Sustainable transportation

There are different views about the definition and measurement of sustainability. Un world forum on Environment and Development (1987), in the report entitled “our common Future” defines sustainability as a kind of development that is appropriate to the present needs without endangering the possibility of the development of future generations (Awasthi et al., 2011). In fact, the sustainable development is a concept that appeared after increasing concerns a bout the negative consequences of ungovernable development. It indicates the inter-generations justice, the man attempting to develop, in parallel with preserving the environment and the present resources (Safi and Zarabadi pour, 2009).

The sustainability concepts are shown in three environmental, social economic areas. The sustainability subjects are often conflicting. For example, although construction of a new highway can in short term by planning and in long term by land development increase the economic growth, but it can also have negative environmental and social effects. (Lav, 2003), the conflict of sustainability objectives defines as sustainability paradox (Zheng et al., 2013). In other words, the sustainable development is to maintain an optimal balance between the economic, social, and environmental objectives (Zuidgeest, 2005). On the subject of sustainability, the economy describes the accessible resources, and the way of organizing the resources to meet the man’s needs and objectives. In this concept, by society it means a series of human activities, and the way of organizing them. By environment, it means the man’s surrounding; this restricts their activities by its own laws.

The environmental factors affect the present welfare, and determine the heritage of the future generations (Zandi Atashbari and Khaksari, 2012).

By adjusting Brotland commission’s definition of sustainability, we can define sustainable transportation as the ability to meet the present needs of transportation without disabling the future generations to meet their transportation needs (Richardson, 2005). The World Bank (1996) expresses that the sustainable transportation has tree dimensions (Zhou, 2012):

-Economic and financial sustainability: The use of resources and protection of assets take place effectively and properly.

-Environmental and ecological sustainability: paying attention completely to transportation outer effects such as energy consumption and emission of pollutants when deciding.

-Social sustainability: The benefits of transportation are accessible to all of the society strata.

Canadian Transportation organization (1997) has used the definition of sustainable development to define the sustainable transportation; i.e. the transportation system and activities, should generally have three economic, environmental and social dimensions. Also, Sustainable Transportation center gives a definition of sustainable transportation: A sustainable transportation system is a system that (Haghshenas and Vaziri, 2012).

*It provides the individuals and societies to meet in a safe way, and based on a method appropriate to the human and ecosystem health, their needs while observing the inter-generational and intra-generational justice.

*It is administrable, acts effectively, suggest transportation alternatives, and supports dynamic economy.
*It reduces greenhouse gas emissions, and dispensing of the wastage which recycle is not possible for the Earth planet, minimizes the use of none-renewable resources, restricts the use of renewable resources at the level of sustainable efficiency, recycles the remaining, and minimizes the land use and making noises.

In the viewpoint of transportation studies Association (2005), The sustainable transportation should consider the inter-related phenomena assessment, which can be effective on transportation sector: reduction of gas reserves, atmospheric effects in the world, death tolls and injuries, quality effects on the regional climate, congestion, noises, biologic effects, and justice (Zhou, 2012). Therefore, sustainable transportation is a set of policies and integrated instructions which involves economic, social, and environmental goals which accompany the effective use of resources to meet the transportation needs of the society and future generations (Ostadi Jafari and Rasafi, 2013).

3.2. Systems under evaluation

Walter Hook (2010), a member of institution of transportation development and policy (ITDP) scholars, in his book, our cities belong to us, has expressed 10 principles as the requirements of sustainable transportation in the urban life. They are as the following: creation of good spaces for walking, creation of a good space for bicycle-riders and other non-motor vehicles, inexpensive and massive public transportation, travels management with creating accessibility for clean walking by reducing number of vehicles with safe pace, load and commodity transportation in the cleanest and safest form, mixture of controls by integrating people with activities, buildings and places, condensation of buildings, public and pedestrian-oriented transportation, increasing the natural, cultural, social and historical scores, straighten walking paths by shrinking urban blocks, and annealing and stabling (Zandi Atashbari and Khaksari, 2012).

Hence, one of the ways of dominating the present crisis is that the urban transportation systems move toward public transportation systems with high efficiency. Public transportation is a key to solve the problems of urban congestion, and increases the quality of urban life and the environment. For greenhouse gases, a bus emits Co_2 only one-third of a private car per passenger in a kilometer. To improve public transportation, the activists should provide multiple strategies of delivering door-to-door services that are appropriately as effectives as private transportation.

The key print is that the efficiency of each public transportation system depends on its ease of usability; therefore, the delivered services should be coherent and comprehensive (Beltran et al., 2010).

Also, bicycle plays an important role in the urban planning by reducing congestion and pollution of the climate, and by reducing the propagation of pollutants. The studies show that bicycle-riding in Netherlands, Denmark, Germany, and Sweden, is 30%, 20%, 12%, and 10% of the local journeys, respectively. In these countries, the individuals, not desperately, but voluntarily choose to use the healthy, good, and economic vehicle (Mokhtari Malek Abadi, 2011).Using bicycle, not only reduces congestion and pollution; but also helps in the following: saving environmental energy without making noises or pollutions; preserving urban space, saving costs, improving health and welfare, making the individual’s journey more enjoyable, reducing time loss, and improving overall pace.

4. Methodology and its processes

The present methodology is descriptive-analytical; in the case study, the method of Assessment after administration (administration of transportation policies) has been employed. Also, this is an applied study which will be used to solve the administrative and real problems related to transportation in Barkhar and Meymeh.

First, based on library studies, the sustainable development of transportation will be described; and, its goals, principles, and strategies will be represented. Next, the role of integration in meeting the sustainability goals will be considered. Then, the literature related to integration is reviewed which involves the expression of the concepts, goals, principles, and also the strategies for its administration. Next, the managers’ and professionals’ viewpoints on the urban management activities in Barkhar and Meymeh are collected by using the questionnaire. The recommended strategies for making comparisons are scored by AHP method. Also, by using MATLAB software, they are exactly determined.

According to the nature of the study, eclectic approaches are employed. The main and necessary data are collected through documents, questionnaires and interviews.

5. Implementation

In this study, Barkhavar and Meymeh Township in the middle northen-east of Isfahan has been chosen as the studied area (Figure 2). The area has a 116mm raining mean precipitation annually, and has a cold and dry climate (Isfahan Agricultural comprehensive Development Plan, 2016). According to 2016 statistics, the Township which involves 3 parishes, 6 counties, 9 cities, and 31 rural districts, has an area equal to 6,957 km^2, and population of

279,788 people. Also, due to being in the border of Zayandeh Rood river, it has many plains and country sides which compromise one of the agricultural poles of the region. Annual population growth of 2.58% from 1996 to 2016, and the annual growth of 2.39% from 1996 to 2016 is representative of the population congestion in the region (Isfahan province Land use planning plan; 2016).

First of all, it is necessary to prepare the data in the following manner:

- determining the effective elements on place process
- gathering necessary data for the elements
- forming raster layers
- assimilating the studied area
- building 100*100m rasters

Then, the rest of the participating element will be studied and modeled.

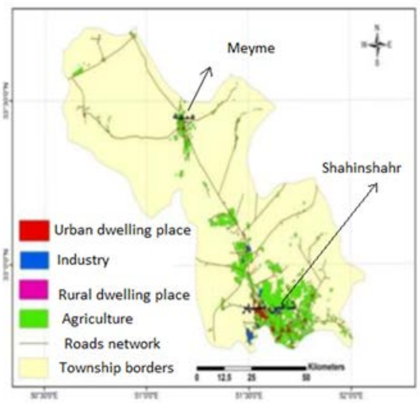


Figure2. The studied Region

According to the regulations of the Ministry of housing and urban development, the road transportation is classified to three general groups: arterial, main, and accessory. The arterial road is classified in to two groups: freeways and highways; main roads are classified into grade1, and grade2; and the accessory roads are classified into three groups: grades1, 2 and 3. In this study, the same classification is applied.

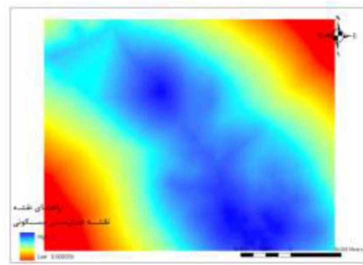
By producing the questionnaire, with the help of experts, the significance of the accessibility of each type of control related to the various types of the roads was evaluated, and the information were codified in the following table.

Table1. The significance of accessibility of each control related to the road types

	Freeway	Highway	Main Road Grade1	Main Road Grade2	Accessory Road Grade1	Accessory Road Grade2	Accessory Road Grade3
Residential	0.5	0.4	0.8	1	1	0.8	0.5
Industrial	1	1	0.7	0.5	0.2	0.1	0
Agricultural	0.6	0.6	0.7	0.8	1	1	1

At first, by using spatial analyzers in Arc GIS software, the shortest Euclidean distance of each point of the study's region from every road type is calculated. Since, the base cell is the model; the software output will be entered into the environment in raster from. The model is developed in MATLAB environment; for this reason, the analyzer output is entered into the model. It should be reminded that, the accessibility significance of each control to road types has been applied in the model with regard to the expert decision. The given weights range from zero to one.

The accessibility model output for each control is in from of Figur3. As it can be noted, the residential control is inclined to be located at accessory roads, dead ends, and away from highways; on the contrary, the industrial control is more inclined to be developed near freeways.



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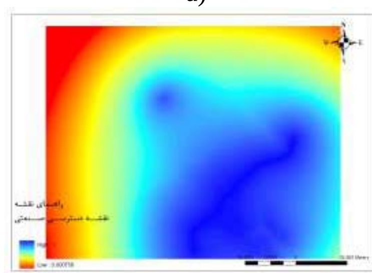

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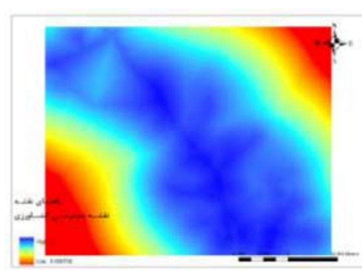


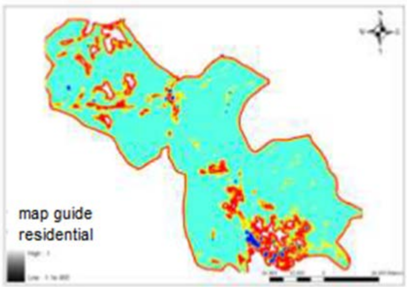
c)

Figure3. A representation of accessibility for a) residential control, b) industrial control, and c) agricultural control

Next, for modeling the neighborhood effect, the cellular automation is used. Each control that occurs in the cell, affects the future control of the cells in the neighborhood. The value of the effect is a function of the inter-cellular distance. In this study, to provide the map of neighborhood

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 5 Issue 7, July 2018
ISSN (Online) 2348 – 7968
www.ijiset.com

effect, we will need the map of the present controls over the province. In this manner, raster layers related to the urban controls with 100*100m dimensions in four classes of residential, industrial, agricultural, and other groups are entered into MATLAB programming environment. The neighborhood radius has been considered in the form of 8 pixels. Figure 4 represents the neighborhood effect for each one of the controls. As it can be noted, the similar controls are inclined to be in neighborhood.



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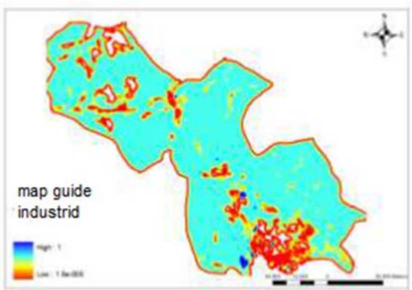

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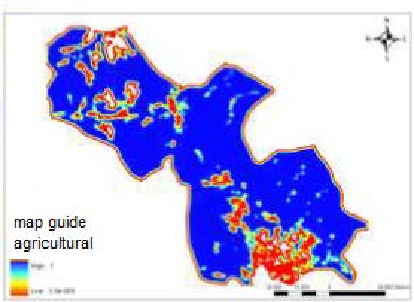

c)

Figure4. Neighborhood effect a) residential b) industrial and c) agricultural

The restriction evaluates the effect of environmental planning and laws on the land control. In this study, to implement the restriction effects, Bolin's model was used. The restricted cells are scored1, and the unrestricted ones are scored0.

The proportionality quantifies the effect of the physical elements on the land control. The proportionality is calculated by using weighted average method, and the results are scored in a range of 0 to 10. In this section, to measure the physical proportionality, two variables of inclination and height, among several effective variables on the land topography, are selected. According to the data of Isfahan Province Mountains, they are between the raster heights layers of 148m to 3618m. First, the height layer is transformed into the three classes: [2700-3618], [2100-2700], and [1486-2100]. Then, each class is scored 1, 6, and 10, respectively. By this, it has been tried to normalize height in the range [1-10]. The process of normalizing the raster layers of inclination, which has been provided by spatial Analyst model of Arc GIS software by using height map, is also carried out. Finally, using the two layers, with the help of overlay Analyzer the physical proportionality is produced. The produced out put is a raster map with $100*100m^2$ cellular dimensions, with a color spectrum which represents scores from 0 to 10. It has been represented in Figure5. Necessary to add that, the map has been renormalized, and is entered as the range [1,0] into the module of proportionality control.

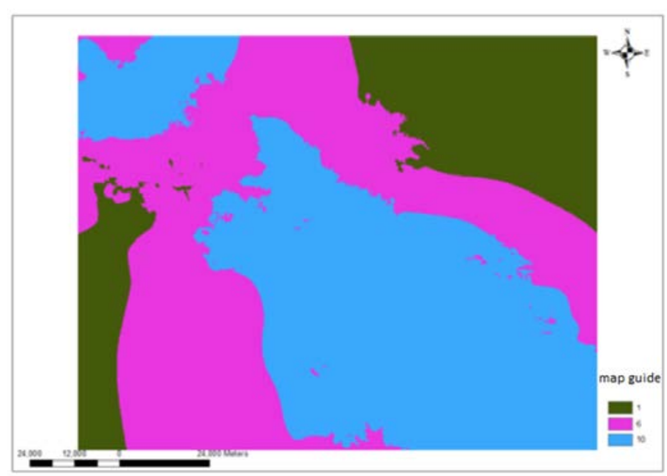

Figure5. Physical proportionality map of the Region

5.1. Demand

In the process of land use planning, the area needed for each control, is one of the effective elements. Usually, in the demand step, the area needed for different controls in smaller scales with higher levels, is determined in separate demand units. The demand units are usually appropriate to the political and management classifications.

In this study, the statistical regression has been used. In this, manner, the average demands for numbers of controls over different years are available. According to these statistical data, the average demand for the mentioned years has been calculated.

5.2. Land control

As it was mentioned earlier, land control is a process of interaction between land proportionality and demand control, in the ruling condition of the studied region. In the previous section, we measured proportionality that was affected by four elements of accessibility, restriction, neighborhood, and physical proportionality, with the help of MATLB programming. Next, considering the demand rate, the output data of proportionality program was entered into land control program, which was written in MATLAB. Finally, MATLAB output was entered into ArcGIS environment which resulted in Figure 6.

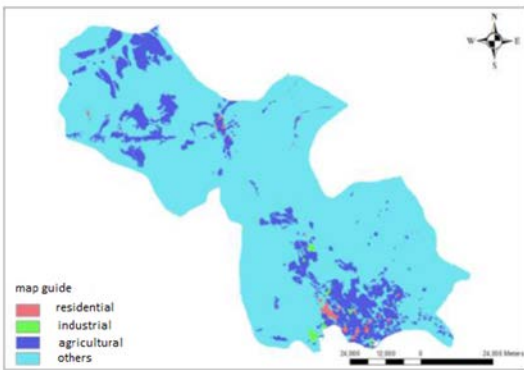

Figure 6. Map of land controls and land use planning

6. Conclusion

Land use planning is a kind of programming aimed at optimum distribution of population with regard to the natural resources and economic activities. The cities in the modern world are affected by several factors. This has caused the problems of city and urbanism to be difficult to solve. Of the recent important urban phenomena is the problem of transportation. In this article, the relationship between transportation system and land use planning has been studied. Due to the expansion of the subject, we have concentrated on the accessibility element, as a criterion of transportation system.

In this study, land use planning has been considered with respect to two elements: proportionality, and demand. The proportionality has 4 parameters: restriction, neighborhood, physical proportionality and accessibility. The accessibility is a result of transportation system. In the present study, road transportation has been investigated. So, the effective parameters on the extent of accessibility were studied initially. The distance from pathways network was considered to be of the most important factors determining the accessibility. It was tried to model the effects of road transportation system on the accessibility. According to the regulations of the Ministry of Housing and Urban Development, the road transportation was classified in to 7 groups; which, the effects of each group on each one of the controls were studied.

In this study, the cellular automation was used to model the effect of neighborhood. The obtained results showed the role of accessibility and its importance in the land use planning. They also showed that more valuable controls tend to be located in the areas where the accessibility is more appropriate.

In this research, only the road transportation has been investigated. In the future research, the map of all or other transportation system can be studied. Their results can be compared to the results of this study.

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