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Monitoring City Lands Use Changes toward Hazardous Areas (Case Study: City Area of Islamabad of west)

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Abstract

Urban development and growth have been some factors of land use change in recent years. Awareness of the amount and the process of the made changes is essential in order to future planning. Therefore, this research has proceeded to the monitoring and analysis of land use change in the city area of Islamabad and the process of residential areas development towards hazardous areas. This research has used satellite images (Landsat 4, 7 and 8) of 1990, 2000, 2010, and 2018. After providing the land use map in ENVI software, the made changes has been analysed by using IDRISI software and Also, the process of development of residential areas for 2035 and 2050 has been predicted. Eventually, the research has evaluated the development process of residential areas in hazardous areas. The results of the study indicate that during a period of 28 years (from 1990 to 2018); the residential use has increased from 7.7 km^2 in 1990 to 13.8 km^2 in 2018. Moreover, the result of the change process prediction of residential areas suggest that these areas will increase to 16.5 and 18.7 km^2 by 2035 and 2050. In addition, the results of the evaluation of residential areas development towards hazardous areas indicate that about 0.9 km^2 of the whole residential areas have been in hazardous areas. This amount has increased to 1.5, 1.9, and 2.6 km^2 for the years 2000, 2010 and 2018 the most of which relates to northern areas of city area of Islamabad of West.

Keywords: Islamabad, land use, LCM

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1. Introduction

Todays, according to the increasingly growth of population, lands use changes with regard to human needs and its influence on the environment, monitoring and modeling of the lands use changes are counted as some of the main subjects of the research in universal changes of the environment field and permanent development (Yousefi and Sharafi, 2015). Growth and development of urbanization in recent years had been among the factors of lands uses changes (Yu et al, 2011). This quick growth has caused the horizontal development of cities in all countries in the world and serious problems in cities (Soleimani et al, 2015). Therefore, awareness of different ground surface cover and human activities in its different parts, or in other words, the way of using ground as basic information for different planning is highly important (Karimi et al, 2017) and causes to understand possible future changes (Jokar et al, 2011). In fact, time and place patterns of changes of ground surface cover, lands use, and efficient factors on these changes are highly important in development of economic, social, and environment politics (Dewan and Yamaguchi, 2009, Serra et al 2008). In this regard, one of the guidelines, which has caused optimization of physical texture and reduction of environmental damages, is using remote evaluation technique, which could play an efficient role in management and improvement of city lands use (Pourahmad et al, 2015). Development changes of residential uses and the process of their development is different in various cities. One of the cities that has faced with a major development is Islamabad of west. However, according to the fact that the northern parts of the city is consisted of mountain unit, this development had faced with limitations. According to the hastily process of physical development in of Islamabad of west and the movement of its residential areas toward hazardous areas, this research has dealt with monitoring the lands use changes of Islamabad of west by using multi-time images of Landsat satellite.

In case of lands use changes in recent years, there has been various studies in Iran and the whole world of which we can refer to Roy et al (2014) who dealt with forecasting lands use changes in various time scales in Mediterranean Sea catchment in east-south of France. The results had shown the high growth of city area and of course reduction of agricultural lands. They identify the use of land use modeling as one of the most practical forecasting models of lands use changes. Ramachandra et al (2013) proceeded to survey of the changing process of Bangalore city in India. In this research, they have used Markov chain model and land change model (LCM) and eventually, they have forecasted the process of urban growth of the region by year 2020. Singh and Khanduri (2011) proceeded to decryption of lands use changes in Punjab of India. In this research, they have used remote evaluation data and GIS. They also used have evaluated the generated changes between years 1991 to 2006 and eventually specified the most changed regions. Maithani et al (2007) generated a model according to artificial networks in a research with the goal of forecasting the spatial changes of Saharanpur city during 1993 until 2001. In this research, remote evaluation in order to achieve to lands uses changes, they used GIS to provide lands use changes map and input variables to enter them to the ANN model. The results of the evaluation show that the model with 66.56 percent of general accuracy is capable of forecasting city region growth. Shayesteh et al (2018) proceeded to modeling the city growth of Kurd Kouy City by using logistic regression based on Geomod model. In this research, they have evaluated the process of lands use changes during 1987 to 2015 and its result show that Kurd Kouy had 517 hectares of area, which will have reached to 861 hectares by the year 2041. In a research, Safari et al (2018) proceeded to identifying suitable regions for developing residences of Faresan city. In this research, they used parameters like, slope, slope direction, height, geology, lands use, distance from fault, distance from river, and distance from city areas, to evaluate the land suitability. The results of the research express the fact that a major part of Faresan city vastness is located on the areas, which does not have suitability for urban development purposes in terms of at least one of the intended factor. In a research, Nayyeri et al (2017) proceeded to the evaluating the potential of physical development of Sanandaj, identifying obstacles and existing

limitations and then suitable and unsuitable areas of urban development. In this research, after identifying prohibited areas, they studied other areas of the region by using fuzzy logic models and they divided AHP to three level of almost suitable, suitable, and highly suitable. Moreover, the results of this research show that the estimated zone of the prohibited areas is almost high. Gholamalifard et al (2014) proceeded to modeling the lands cover changes in middle coasts of Bushehr state. In this research, they used artificial nerve network and Markov chain and they evaluated a 23-year (1988 – 2011) period. The results of the research show that among lands uses, agricultural lands has changed the most. Azizi Ghalati et al (2014) proceeded to lands use changes of Kuhmaresorhi in Fars state. In this research, they have used logistic regression and LCM model. At first, they have evaluated the lands changes from year 1987 to 2012 and then, they have forecasted the amount of these changes for the year 2024.

2. Theoretical Foundations

After the 1960s, horizontal development of city became a universal problem related to growth of metropolis and it became an issue not only in North America, West Europe, and Japan, but also in some big cities of developed countries. The most important effect of population increase and urbanization phenomenon is landscape changes, which are arising from some environmental problems like, agricultural lands destruction, heat island, a frequency of hydrologic features, and reduction of biologic species (Arakhi et al, 2015). This phenomenon in addition to the fact that it has widely affected urban planning politics, it has also played fundamental role in intensifying economic, social, political, and managerial issues and society environment (Soleimani et al, 2015).

We can define physical development as the increase of quantitative and qualitative uses and physical spaces of a city in horizontal and vertical dimensions that accomplishes during course of the time, which includes any operation or modification on land by man in order to attempt for creating a habitable and comfortable environment. Physical development represents itself as human activities or lands uses in cities and towns (Ahmadi, 2017).

Physical development in cities of Iran has been always changing in city structure due to geographical features, human density, and also increase population and villager's immigrations. In addition, it has had too much efficiency in forming the urban unbalanced development. For this purpose, urbanization increase, during recent decades, has not been appropriate to capability of equip city spaces and development of infrastructures. It has also caused problems as severe as possible like, housing expensiveness, unemployment, and unofficial accommodation in the appearance of cities (Abedini and Moghimi, 2012). On the other hand, on time and accurate revelation of appearance and ruggedness of earth provides a foundation for better comprehension of relationships and interactions of man and natural phenomena in order to better management and use of sources (Azizi Ghalati et al, 2014). We can mention LCM model and Markov chain among the usable methods of revelation of lands use changes:

LCM model (available in idrisi application and extensionally in ArcGIS) or Land Change Modeler provides instrumental modeler for lands use change to evaluation and designing change of earth surface cover and analyzes lands use or earth cover. This model is capable of creating lands change scenarios by merging the environmental, physical, and social-economic factors, which are efficient in lands use change (Azizi Ghalati et al, 2014).

Markov chain is a sequence of random variables all of which consist of equal sample space, however, distribution of their possibilities could be different, and meanwhile each random variable in a Markov chain only depends on its previous variable (Ghobadian Nejad and Fallahi, 2018).

3. Study Area

The study area includes city area and city suburbs of Islamabad of West. Islamabad is placed in Kermanshah state in terms of political division. This city is 16 km^2 vast. According to 2016 census, this city has a population of about 90,000. This region, in terms of morphotectonic division, is placed in north-west Zagros and the wrinkled Zagros (Alaei Taleghani, 2004). Topographically, study area is between 1300 and 1800 meters high from the sea surface, which the middle areas of Islamabad consist of field unit and the marginal areas consist of mountain unit. In terms of whether, according to Köppen climate classification system, this city contains of cold winter and long hot summers (Barghi et al, 2018). In figure 1, the location map of study area has been displayed.

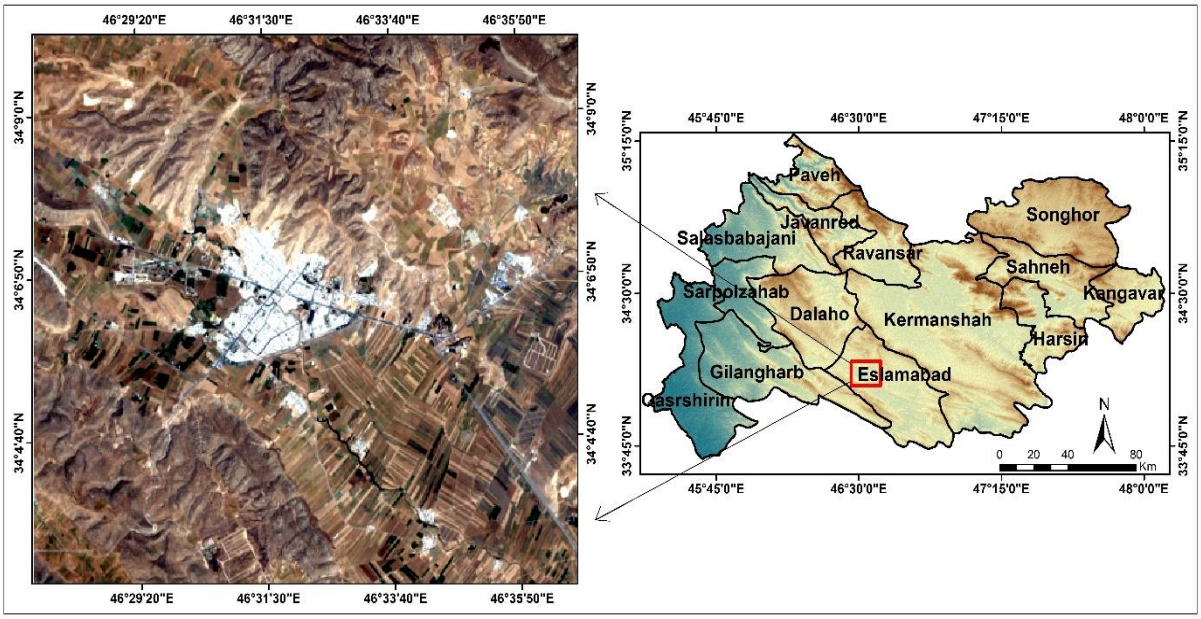

Figure 1. The location map of study area

4. Materials and Methods

This research is quantitative which proceeded to gathering information after specifying the intended goals. The information of this research includes satellite images (Landsat 4, 7, and 8) of years 1990, 2000, 2010, and 2018, information layers include river, road, and DEM[1] is 30 meter STRM, and, the 1:50000 map is the topography of the study area. The used tools in the research include ARCGIS software (providing information layers, the final map and receiving output), IDRISI (analyzing the lands use and generating the LCM model), google earth (surveying the region's situation), and ENVI (processing and providing lands use map of years 1990 to 2018). The research method is like after providing information and preprocessing them, it proceeded to analyzing the produced maps and according to these, the process of residential areas development is predicted by the years 2035 and 2050. Eventually, this research evaluated the process of residential areas development in hazardous areas. In the following, we proceed to explain the stages of the work:

[1] Digital elevation model

4.1. Preprocessing and providing lands use map:

This research, at first, has provided satellite images of study area, which are related to the years 1990, 2000, 2010, and 2018, in June. Then, after providing the images, the research has proceeded to correct the geometric, atmospheric, and radiometric errors of images in the ENVI software. And after preprocessing the images, the lands use map of study area by using the method of supervised classification of maximum possibility. False color combination has been used in order to provide the lands use map. The combination used are (R:3-G:2-B:1) for the year 1990, (R:3-G:2-B:1) for the year 2000, (R:3-G:2-B:1) for year 2010, and (R:4-G:3-B:2) for year 2018. Moreover, in order to verify the obtained results, 200 random samples has been used which the results shows 84 percent accuracy for the year 1990, 87 percent for the year 2000, 88 percent for the year 2010, and 92 percent for the year 2018.

4.2. Analysis and prediction of changes:

After providing the lands use map, the research has proceeded to evaluate the amount of changes in lands use by using LCM[1] model. For this purpose, at first, every changes must be evaluated from each use to another one. After evaluating the changes, the research has used the Markov chain model in order to predict the changes of residential regions of study area according to which the research has evaluated amount of changing potential of each use to residential use. This means that how much does each pixel of the image capable of change from on use to another one (Heidarian et al, 2014). After evaluating the amount of transfer potential of each use to residential use, the research proceeded to predicting the process of residential areas' development by the years 2035 and 2050, based on variables like slope, height, distance from road, and distance from residential areas.

4.3. Analyzing the process of residential areas' development toward the hazardous areas:

In this research, at first, the map of hazardous areas has been provided in order to evaluating the process toward the hazardous regions. Regions with more than 30 percent of slope, more than 1500 meter height, 200-meter river range, and 1000 meter of fault range have been considered for this purpose. The process of residential areas' development in hazardous areas has been evaluated after providing the map of hazardous areas.

5. Discussion and results

5.1. Proving the lands use map of study area:

In this research, Landsat images 7, 4, and 8 has been used in order to provide the lands use map of the study area. After providing the images and performing the necessary preprocesses, the lands use map of study area during 1990, 2000, 2010, and 2018 has been provided, which is shown, in figure 2 in ENVI software by using the method of maximum possibility. In chart 1, lands use area during the study area years has been shown based on which residential areas during study area years have contained ascending process. On the other hand, agricultural lands and gardens have contained descending process. The results indicates that residential use has increased from 7.7 km^2 in 1990 to 13.8 km^2 in 2018. Gardens use has decreased from 14.6 to 5.4 km^2. Irrigated farming use has

[1] Land change modeler

increased from 29.1 to 68.1 km^2. Dryland farming use has decreased from 71.6 to 33.1 km^2. In addition, pasture use has decreased from 75.6 to 75.3 km^2.

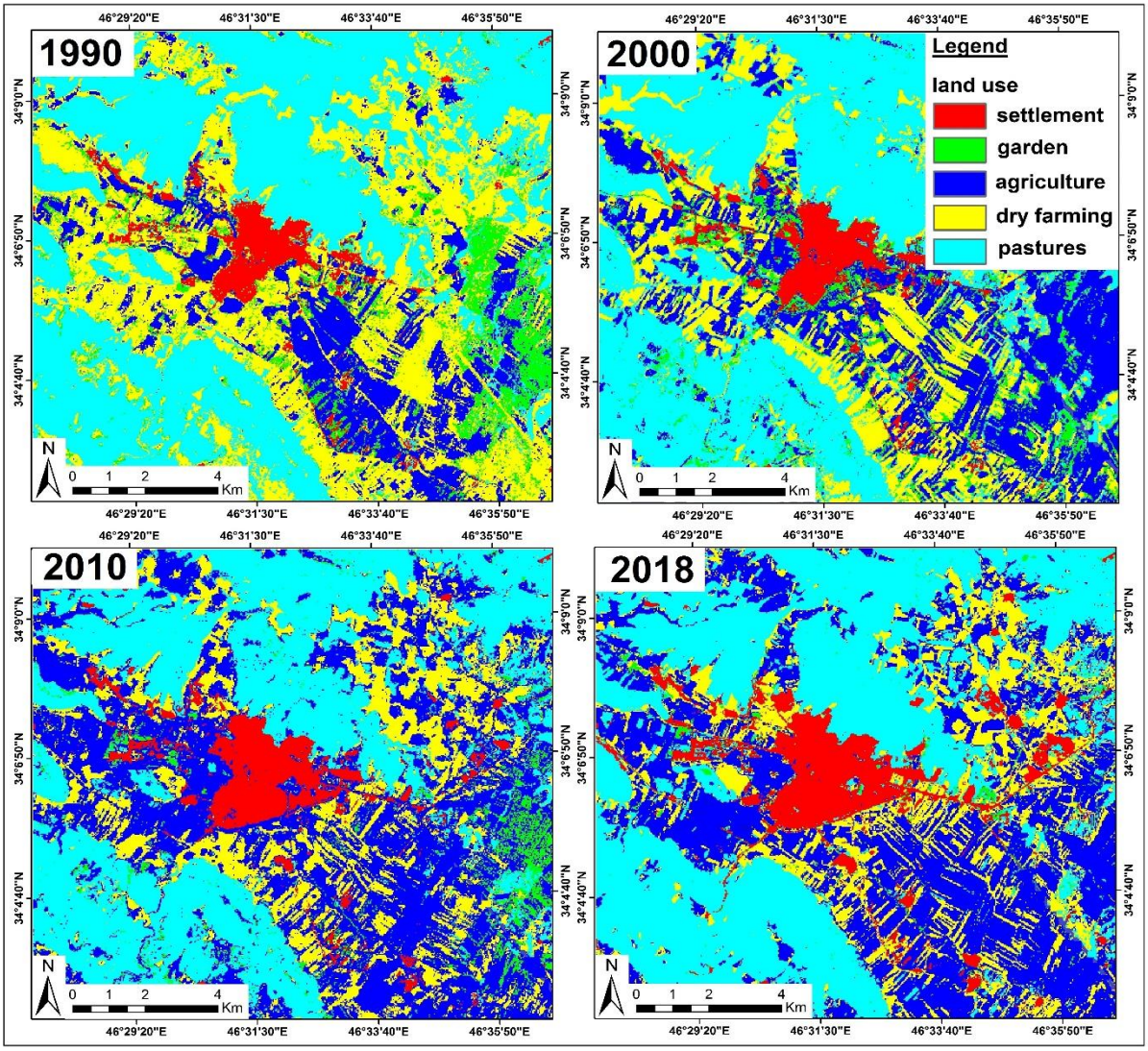

Figure 2. Lands use map of study area during 1990 to 2018

Use type / Year	Residential	Gardens	Irrigated Farming	Dryland Farming	Pastures
1990	**7/7**	**14/6**	**26/1**	**71/6**	**75/6**
2000	**10/1**	**14/1**	**44/6**	**44/2**	**82/5**
2010	**12/2**	**7/6**	**68/7**	**34/5**	**72/6**
2018	**13/8**	**5/4**	**68/1**	**33/1**	**75/3**

Chart 1. Lands use area of study area during 1990 to 2018

5.2. Analysis of lands use changes of study area:

In this research, in order to analyze the made changes during 1990 to 2018, after providing the lands use map in ENVI software, the provided maps has been entered in IDRISI software and the way of changes has been analyzed by using LCM model which is displayed in figure 3. The changes of each use to another one during 1990 to 2018 has been displayed in the mentioned figure. In accordance to the figure in marginal areas of Islamabad of west, the highest amount of change has included the change of dryland and irrigated farming use to residential use. In addition, in out-of-bounds areas of city, the highest amount of change has included use change of dryland farming to irrigated farming.

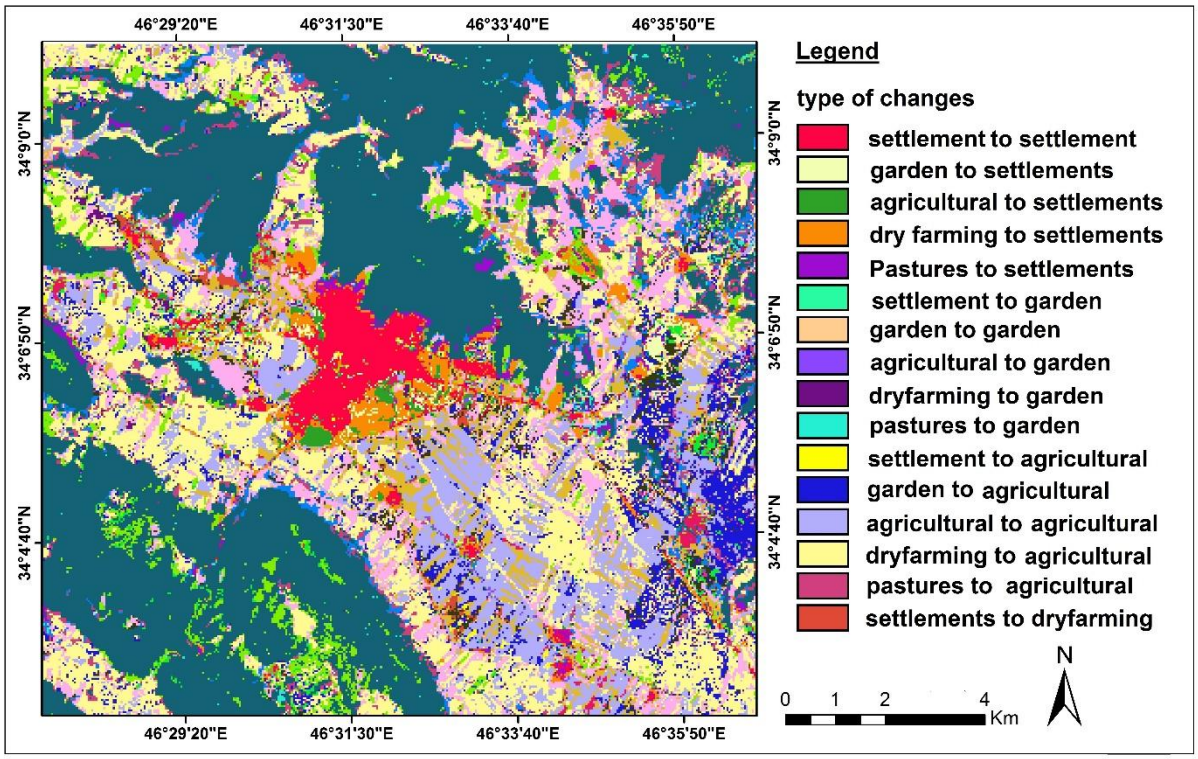

Figure 3. The map of changes of each use to another one during 1990 to 2018

According to the fact that in this research, the process of other uses changes to residential area use is being noticed, the map of changes of gardens, irrigated farming, dryland farming, and pasture use to residential use has been displayed in figure 4.

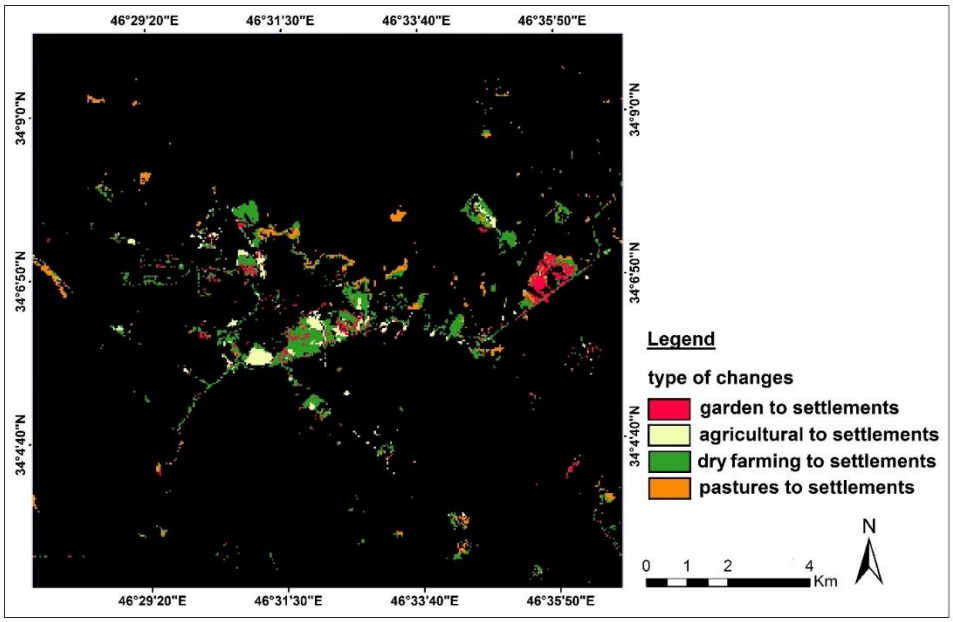

Figure 4. The map of changes of other uses to residential use during 1990 to 2018

5.3. Prediction of the development process of residential areas:

Monitoring the development process of lands use, especially residential areas, play an important role in region planning, especially city planning. According to the importance of this subject, after analyzing lands use changes, the research has proceeded to development process of residential areas by years 2035 and 2050 by using Markov chain. The results of the analysis of lands use changes indicates that residential areas has increased from 7.7 km^2 in 1990 to 13.8 km^2 in 2018 and this areas will increase to 16.5 km^2 by 2035 according to predictions and in the following process in 2050, this amount will reach to 18.7 km^2. In figure 5, the prediction map of development process of residential areas by 2035 and 2050 has been displayed according to which eastern and southeastern areas of study area contain the most potential in order to develop the residential areas.

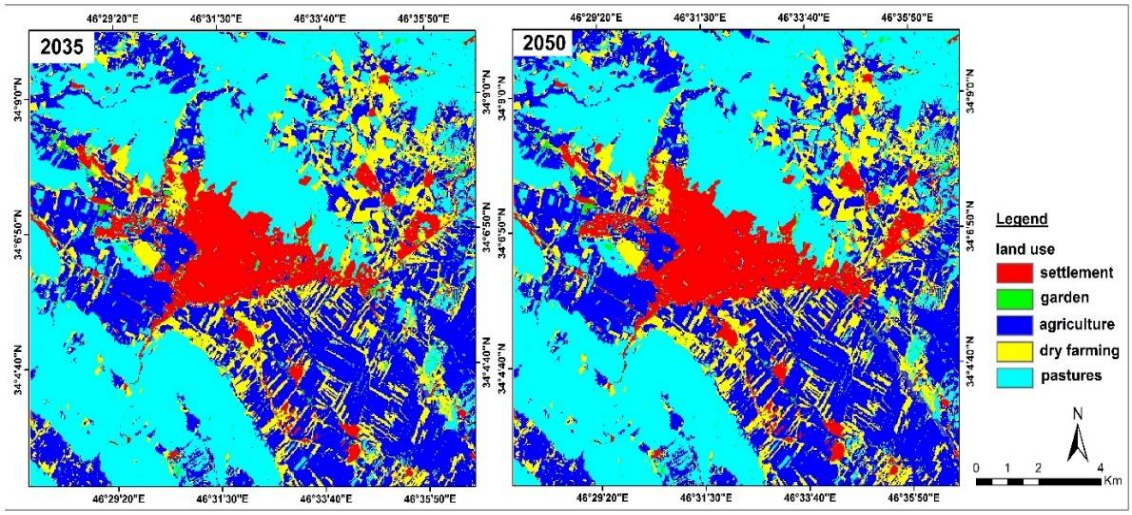

Figure 5. The map of development process of residential areas by the years 2035 and 2050

5.4. The development process of residential areas toward hazardous areas

According to the geomorphological condition of study area, the development process of during the recent years has caused the population movement toward areas, which are highly potential vulnerable. According to the fact that Islamabad of west ends to mountain unit in northern margin, the development of settlements could increase people's potential vulnerability of that area. Based on this, this research proceeded to geomorphological condition of study area in order to monitoring the movement process of residential areas toward hazardous areas. In figure 6 and 7, the map of height and river, and the map of slope and fault has been displayed in accordance to which the most part of the study are surrounded by mountain unit and inclined areas.

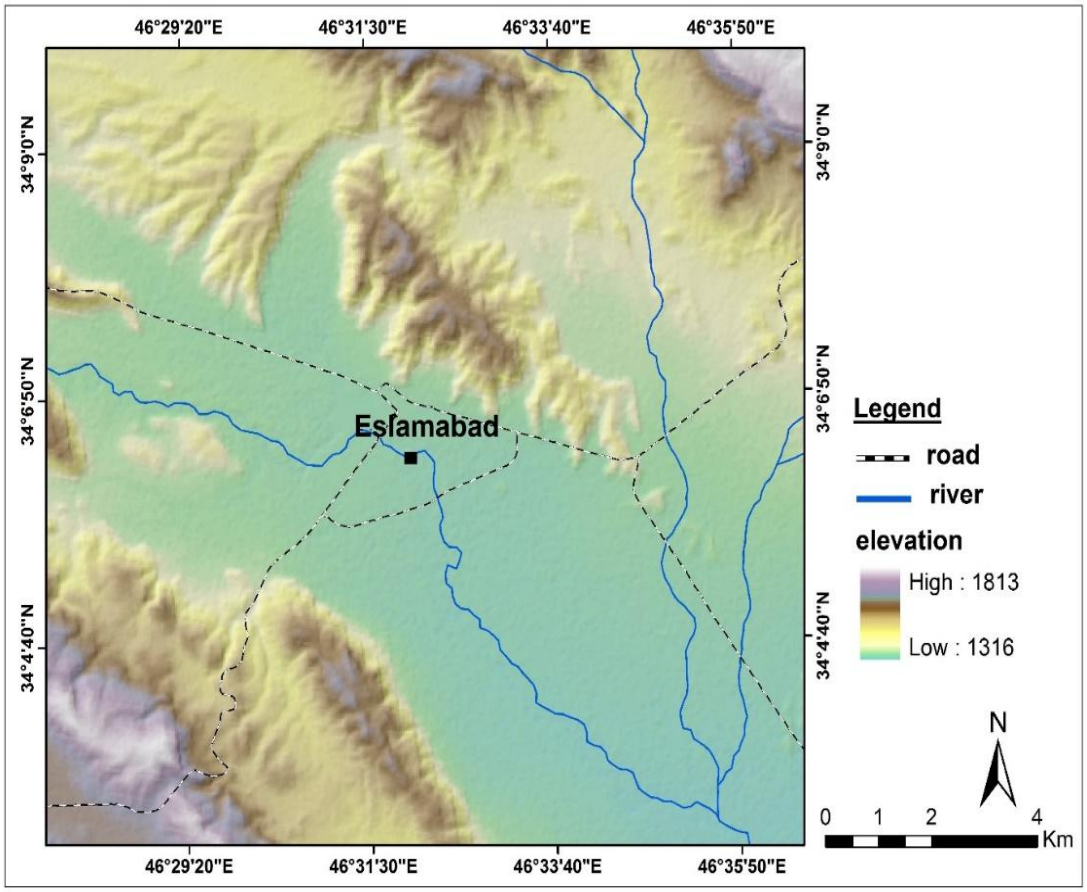

Figure 6. Map of height and river of study area

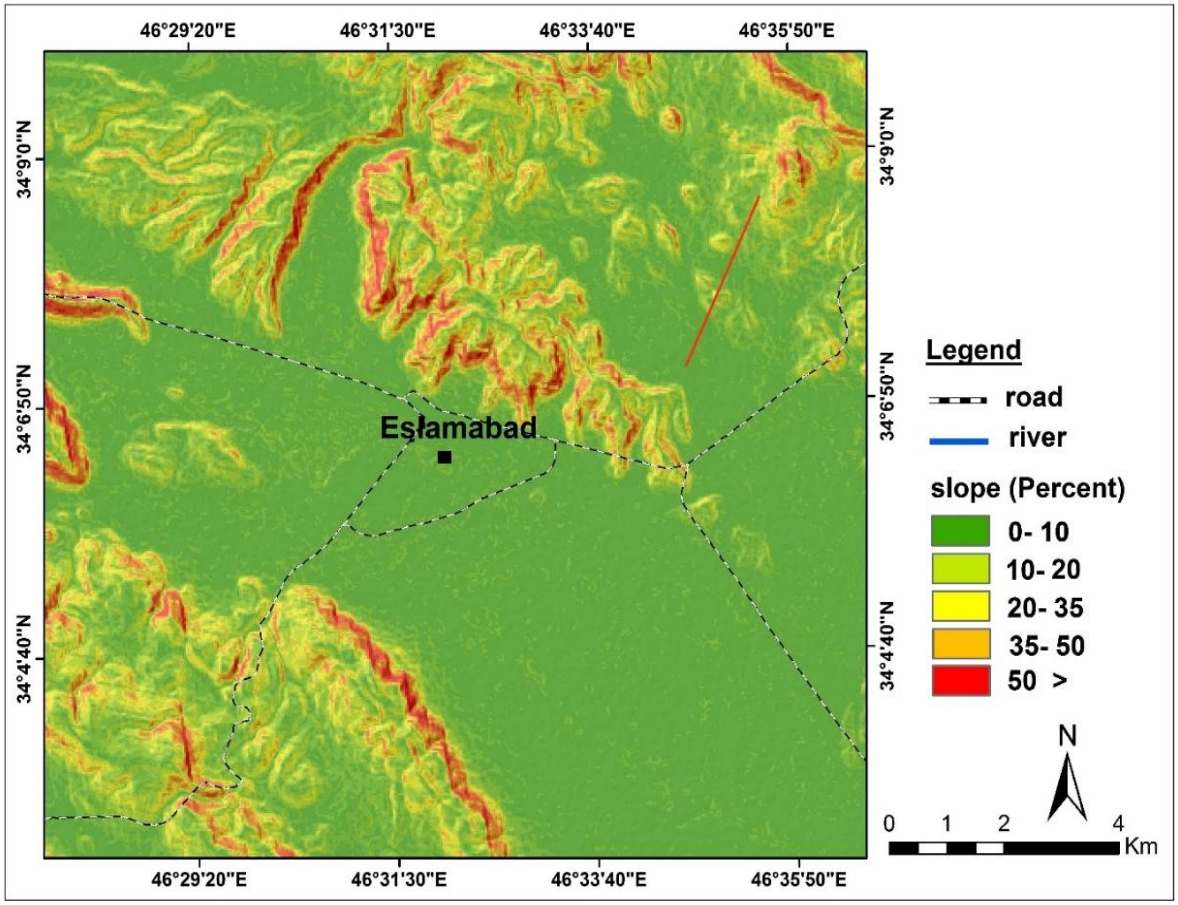

Figure 7. Map of slope and fault of study area

In order to peruse the movement of residential areas toward hazardous areas, first the map of hazardous areas has been provided in order to which the research considered areas that are higher than 1500 meters, with more than 30 percent slope, and 1200 meters frontage from river and fault. Figure 8 displays the map of hazardous areas and the development process of residential areas in these areas during 1990 to 2018. The results indicate that about 0.9 km^2 of the whole scope of residential areas in 1990 has been in hazardous areas, which this amount in 2000, 2010, and 2018 has been increased to 1.5, 1.9, and 2.6 the most of which relates to northern areas of city areas of Islamabad of West.

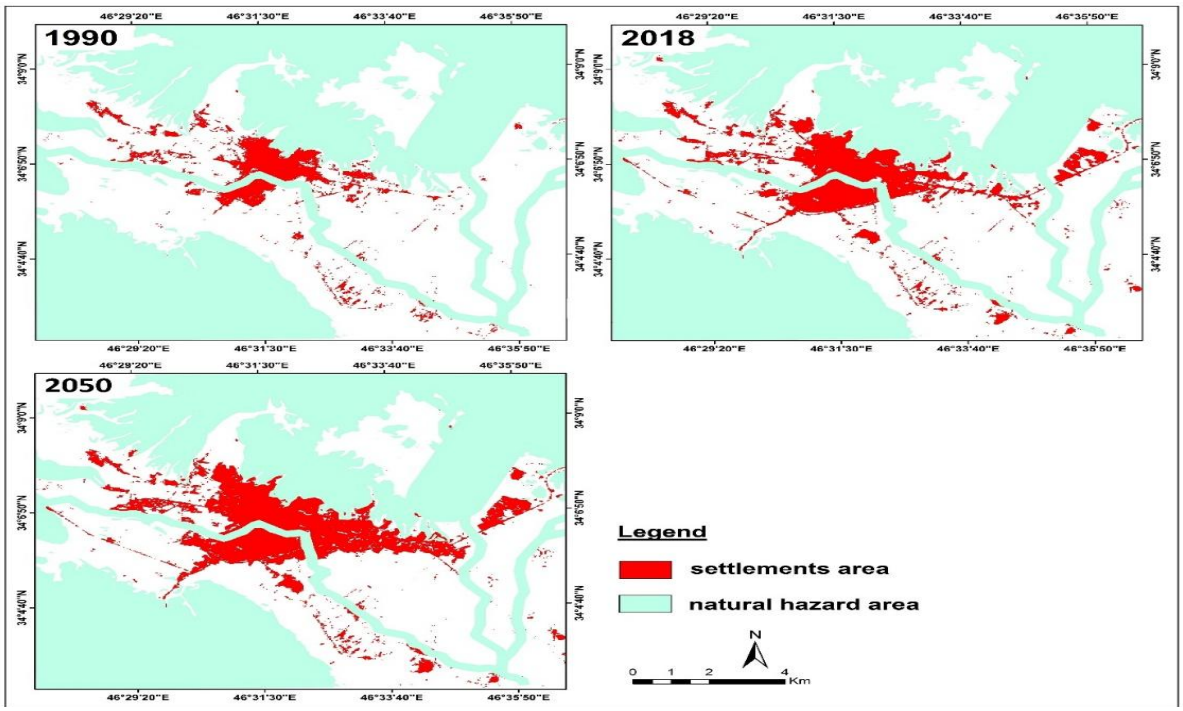

Figure 8. Map of development process of residential areas in hazardous areas during 1990 to 2018

6. Conclusion

Unprincipled lands use changes without attention to environmental condition in future could lead to risks. Therefore, the mentioned changes, especially residential areas changes must suit to environmental conditions and observe the related principles. In case of lands use changes, there has been different studies. This research has proceeded to lands use conditions during 1990 to 2018 and in addition to analyze the changes, predicted the changes process by 2035 and 2050 and in oppose to most of the former researches, this research has analyzed the development process of residential areas and possible hazardous areas. The results of the research indicate that during the 28-year time period (1990 to 2018) lands use of study area has changed in a way that during these 28 years residential uses has increased from 7.7 km^2 in 1990 to 13.8 km^2 in 2018. Gardens use has decreased from 14.6 to 5.4 km^2. Irrigated farming has increased from 26.1 to 68.1 km^2. Dryland farming has decreased from 71.6 to 33.1 km^2. In addition, pasture use has decreased from 75.6 to 75.3 km^2. The changes analysis indicates that the most amount of change in different marginal sides of Islamabad of West has included the change of irrigated and dryland farming use to residential use. Moreover, in out-off-bound areas of city area, the most amount of changes has included the changes of dryland farming use to irrigated farming use. In addition, the result of the prediction of the changes process of residential areas indicates that these areas in accordance to the prediction will increase to 16.5 km^2 by 2035 and in the following of the process, this amount will reach to 18.7 km^2 by 2050. The eastern and southeastern areas of study areas have the most potential to develop the residential areas. Moreover, the results of the analysis of development process of residential areas toward hazardous areas indicate that 0.9 km^2 of the whole scope of residential areas in 1990 has been in hazardous areas. This amount in 2000, 2010, and 2018 has been increased to 1.5, 1.9, and 2.6 the most of which relates to northern areas of city area of Islamabad of West. The total results of this research indicate that residential areas, especially in northern areas of city area of Islamabad of west, grow and develop without paying attention to geomorphological principle, which in case of not paying attention; this can cause risks in future.

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