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Full Length Research Paper

Effect of Green surface on the Climatic Variables in Rasht City (Iran)

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Abstract
Detection of changes including the use of multi temporal data set to determine those areas where its land cover and land use have been changed in the different dates of imaging. These changes may result from short-term changes in cover such as snow, floods and land use changes such as urban development and converting agricultural land to residential and industrial land use. In view of this the climatic variables are very important to consider the land use and land cover. In this study twelve climatic variables *viz*., the average of rainfall, the average of 24 hours rainfall, the number of rainy days, the number of frost days, the mean annual maximum temperature, the mean annual minimum temperature, the annual absolute maximum temperature, the annual absolute minimum temperature, the mean annual temperature, the mean annual minimum relative humidity, the mean maximum annual relative humidity and the mean annual relative humidity were subjected to the know their relationships with green surface. The results of regression analysis clearly showed that green surface has positive correlation with the average of rainfall, the number of rainy days, the annual absolute minimum temperature and the mean annual minimum relative humidity only.

Keywords: *Green surface, Climatic variables, Rasht city (Iran), Land cover, Land use*

Introduction
The world in which we live is urban world that's away from the natural environment and the unwanted adoption of unbalanced situation that comes from the inharmonious relations between humans and urban space and the city is a reflection of organized thoughts in a cultural and space area with its own rules (Ebrahimzade , 2006).

Followed by changes in the economic and social situation in the world as well as industrial development and expansion of services, Iranian cities also have been rapid growth since 1920's. Although the growth and development of the cities of Iran were delayed, but it is facing the problems of Western countries which have been involved with it. Emerging urban problems since 1960's onwards in the country and anomalies arising from the urbanization system led to a series of measures in the context of urban planning that pattern of urban project is the cornerstone of this planning (Rahnamaei, 2008).

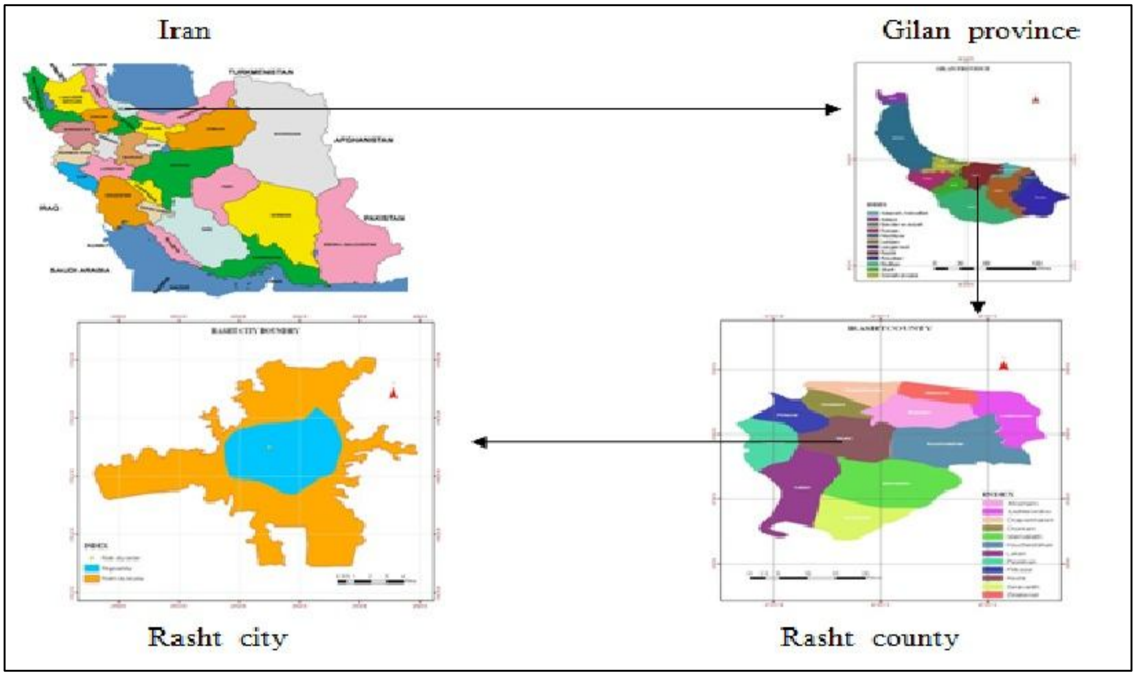
Increasing urbanization and the need to land on the one hand and limitation of the supply at the other hand in modern cities caused the Issue of how land use has become the major challenge in the field of world urbanization and in developing countries. Issues of land use and how land management constitute as an important axis of modern urbanization. Therefore, urban planning land use and urban land use regulations have become one of the main element of urban planning (Rahnamaei, 2008). But in the process of urbanization in Iran today, yet the principles and practices of land use are based on the same traditional models and functional urban planning methods that both in terms of property rights and land economic and buildings and methods of preparation of urban development plans and division method and land distribution faced by significant deficiencies and bottlenecks which has faced a serious threat life in our cities with major problems. In this regard, sufficient attention to the criteria and standards of land use and incorporating them in the urban projects could be an important step in organizing the chaos in our cities and these cases are faced with basic problems (Yousefi , 2001).

Development is an expansion of Rash due to population growth and rural migration to the city has led to unplanned construction and many changes in spatial structure, particularly, the expansion of city in the agricultural land and unpractical use of the land around the city.

In general, urban development in addition to changes in temperature has significant effects on precipitation and humidity on air quality and in the long term will change local climate. Due to these large variations, it is not surprisingly that urban areas illustrate the most tangible signs of changes and climate modifications (Kavyani , 2001).

The Study Area
Rasht city is Located in central part of Gilan province and it is surrounded by villages like Pasikhan, Sanghar, Islamabad, Saravan in North Eastern parts respectively. The Shaft, Roudbar county are in western and Southern parts of Rasht city.

The geographical extent of the Rasht city lies latitudinally between 37° 20′ 6.28″ to 37° 12.5′ 4.87″ N ,and longitudinally it spreads between 49° 39′ 54″ to 49° 29′ 10.2″ E . Rasht city spreads in area about 137 sq.km and its population is around 594619, and it is largest city of the coast of Caspian Sea (COIRI , 2010). The map 1 shows the location of Rasht city in Iran.



Map 1 : The location of Rasht city in Iran

Materials and Methods

In this study tried to find green surface impact on climate variables in Rasht city (in three decades :1981-1990, 1991-2000 and 2001-2010) until with an essential guide and main organizing on designing suitable living spaces and as a whole by optimal planning prevent useless waste of agricultural land and urban development in the wrong directions. And in this way, we provided qualitative and quantitative improvement of the urban development plans and to witness sustainable development in the city. The relationship between green surface and twelve climatic variables including : the average of rainfall, the average of 24 hours rainfall, the number of rainy days, the number of frost days, the mean annual maximum temperature, the mean annual minimum temperature, the annual absolute maximum temperature, the annual absolute minimum temperature, the mean annual temperature, the mean annual minimum relative humidity, the mean maximum annual relative humidity and the mean annual relative humidity were analyzed through SPSS by one way ANOVA, (Fisher, 1953) ,Scheffe's post hoc (Scheffe, 1959) and linear regression analysis (Walker, 1943) wherever they were applicable.

Results

Effect of green surface on the climatic variables:

1 - The effect of the green surface on the rainfall variable:

According to the table 1 and figures No. 1 and 2, it is clear that there is a relationship between the green surface area and the average of rainfall variable in Rasht. Therefore, increasing the average of rainfall variable is quite evident with increasing of green surface level. And conversely, with the loss of green surface in the study area, the average of rainfall variable is decreasing.

Table 1: Green surface and the average of rainfall in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The average of rainfall (mm)
1981 – 1990	11078	1481.5
1991 – 2000	3075	1438.3
2001 – 2010	4330	1126.5

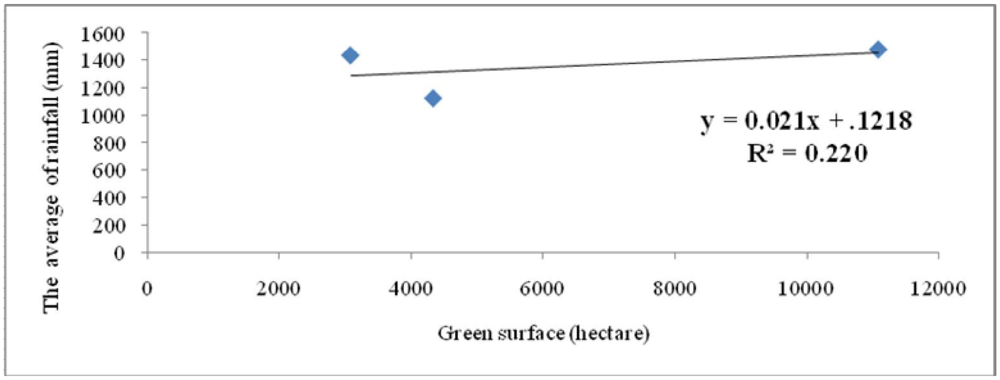


Figure 1: The relationship between the green surface and the average of rainfall in Rasht station in 1990-2000-2010

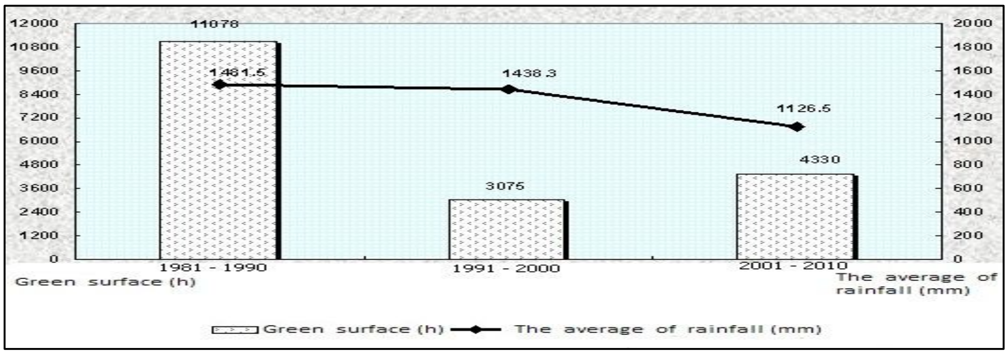


Figure 2: Comparison between the green surface and the average of rainfall in Rasht station in 1990-2000-2010

2 - The effect of the green surface on the average of 24 hours rainfall variable

According to the table 2 and figures No. 3 and 4, it is clear that there is a relationship between the green surface area and the average of 24 hours rainfall variable in Rasht. Therefore, decreasing the average of 24 hours rainfall is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the average of 24 hours rainfall is increasing.

Table 2: Green surface and the average of 24 hours rainfall in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The average of 24 hours rainfall (mm)
1981 – 1990	11078	90
1991 – 2000	3075	139
2001 – 2010	4330	99

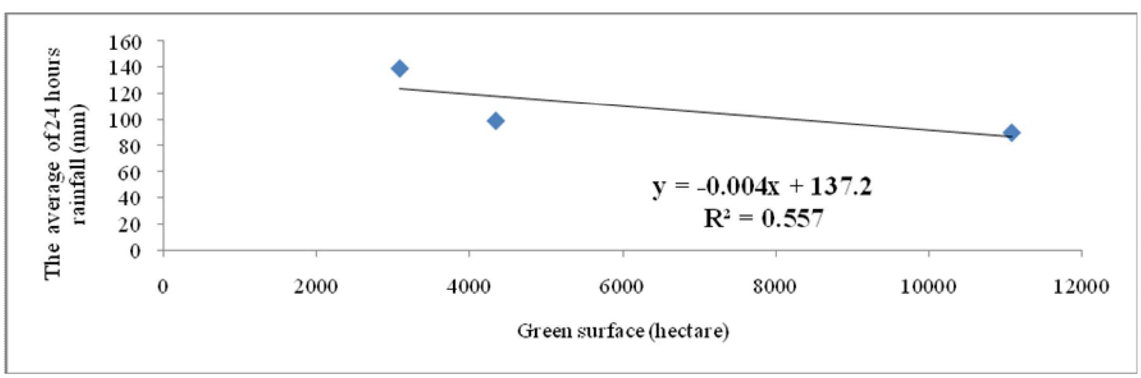


Figure 3: The relationship between the green surface and the average of 24 hours rainfall in Rasht station in 1990-2000-2010

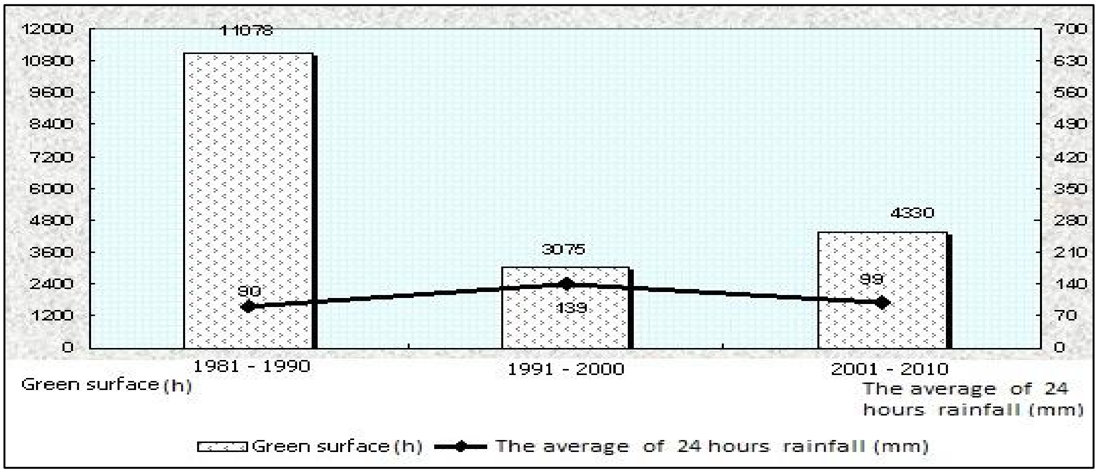


Figure 4: Comparison between the green surface and the average of 24 hours rainfall in Rasht station in 1990-2000-2010

3 - The effect of the green surface on the number of rainy days variable

According to the table 3 and figures No. 5 and 6, it is clear that there is a relationship between the green surface area and the number of rainy days in Rasht.

Table 3: Green surface and the number of rainy days in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The number of rainy days (mm)
1981 – 1990	11078	134
1991 – 2000	3075	135
2001 – 2010	4330	120

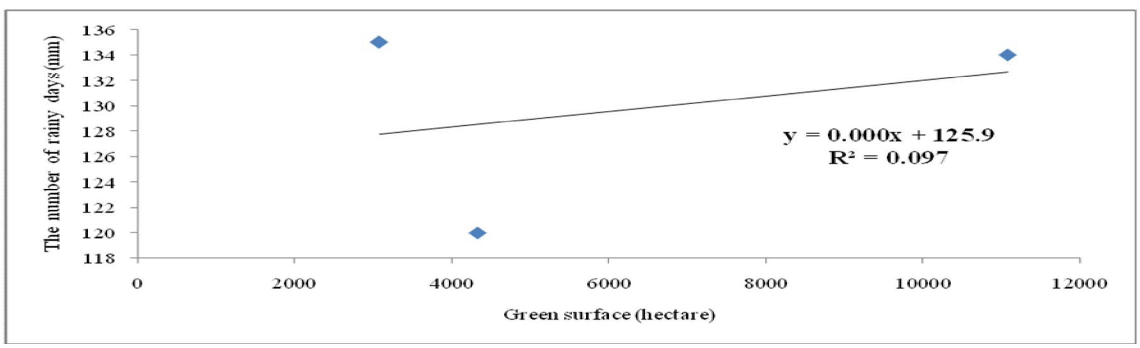


Figure 5: The relationship between the green surface and the number of rainy days in Rasht station in 1990-2000-2010

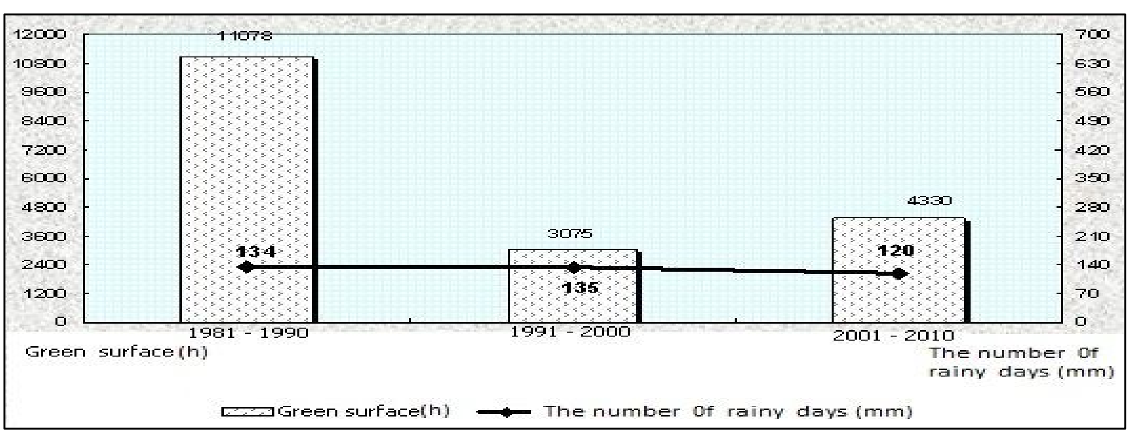


Figure 6: Comparison between the green surface and the number of rainy days in Rasht station in 1990-2000-2010

4 - The effect of the green surface on the number of frost days variable

According to the table 4 and figures No. 7 and 8, it is clear that there is a relationship between the green surface area and the number of frost days in Rasht.

Table 4: Green surface and the number of frost days in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The number of frost days (mm)
1981 – 1990	11078	4
1991 – 2000	3075	6
2001 – 2010	4330	7

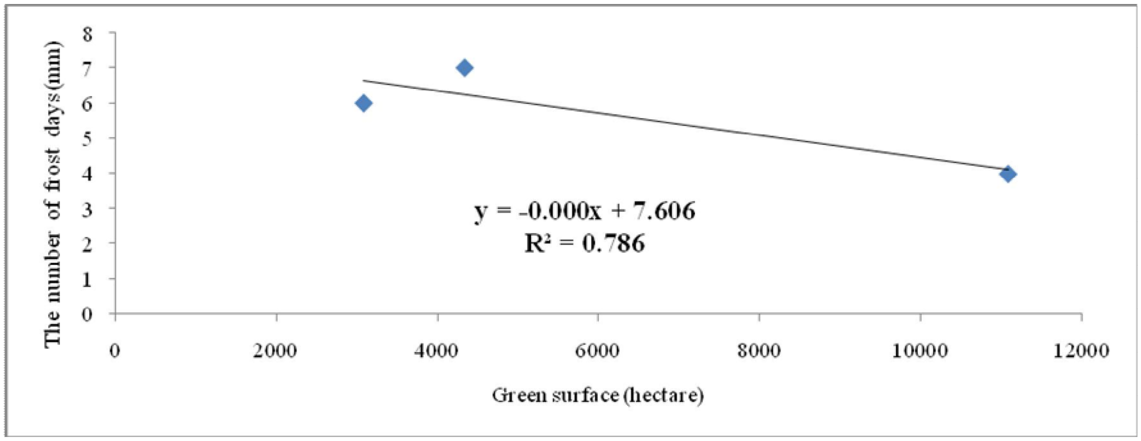


Figure 7: The relationship between the green surface and the number of frost days in Rasht station in 1990-2000-2010

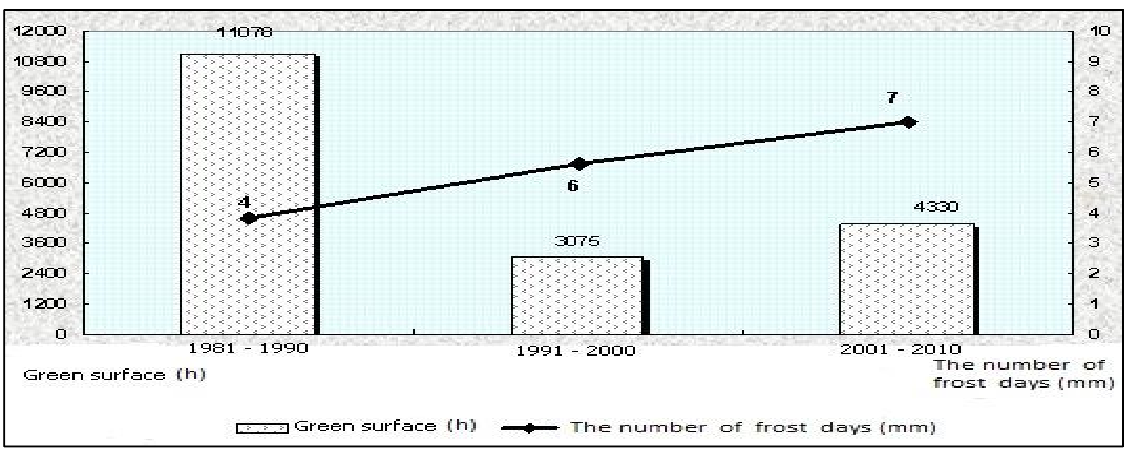


Figure 8: Comparison between the green surface and the number of frost days in Rasht station in 1990-2000-2010

5 - The effect of the green surface on the mean annual maximum temperature variable

According to the table 5 and figures No. 9 and 10, it is clear that there is a relationship between the green surface area and the mean annual maximum temperature in Rasht. Therefore, decreasing the mean annual maximum temperature is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the mean annual maximum temperature is increasing.

Table 5.: Green surface and the mean annual maximum temperature in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The mean annual maximum temperature (0C)
1981 – 1990	11078	20.6
1991 – 2000	3075	20.7
2001 – 2010	4330	21.9

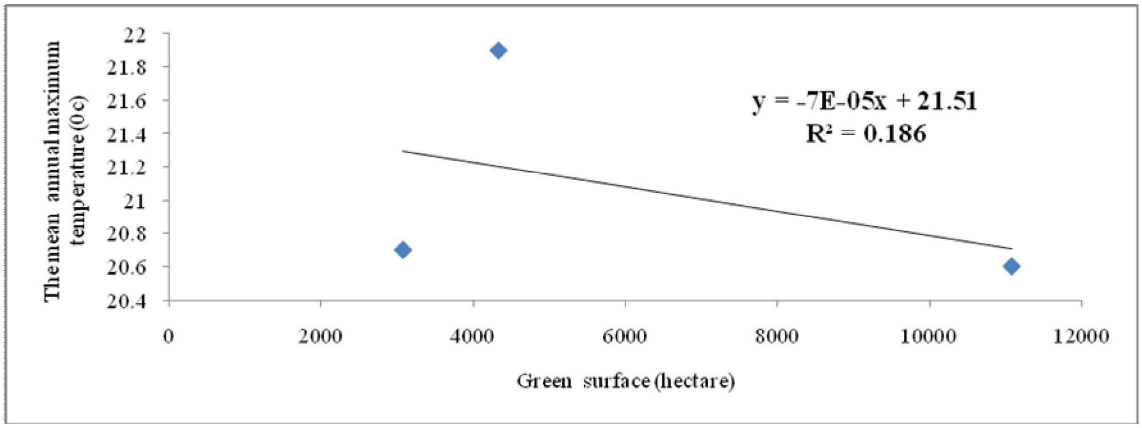


Figure 9: The relationship between the green surface and the mean annual maximum temperature in Rasht station in 1990-2000-2010

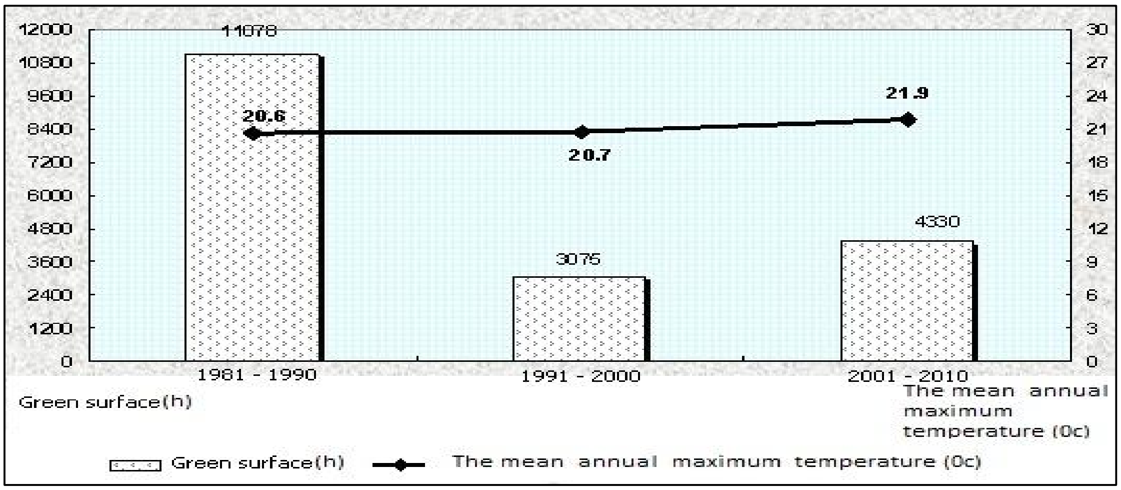


Figure 10: Comparison between the green surface and the mean annual maximum temperature in Rasht station in 1990-2000-2010

6 - The effect of the green surface on the mean annual minimum temperature variable

According to the table 6 and figures No. 10 and 11, it is clear that there is a relationship between the green surface area and the mean annual minimum temperature in Rasht. Therefore, decreasing the mean annual minimum temperature is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the mean annual minimum temperature is increasing.

Table 6: Green surface and the mean annual minimum temperature in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The mean annual minimum temperature (0c)
1981 – 1990	11078	12
1991 – 2000	3075	12.4
2001 – 2010	4330	13.2

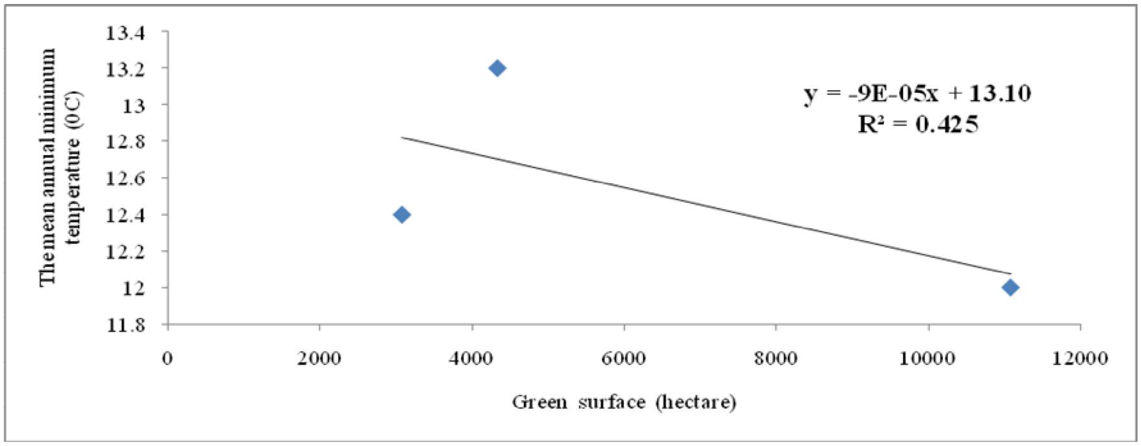


Figure 11: The relationship between the green surface and the mean annual minimum temperature in Rasht station in 1990-2000-2010

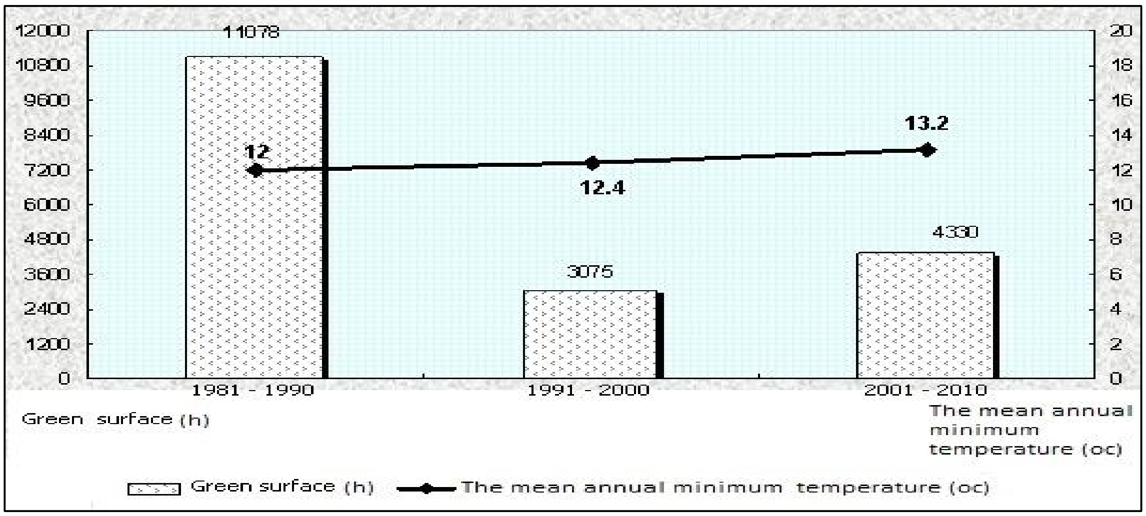


Figure 12: Comparison between the green surface and the mean annual minimum temperature in Rasht station in 1990-2000-2010

7 - The effect of the green surface on the annual absolute maximum temperature variable

According to the table 7 and figures No. 12 and 13, it is clear that there is a relationship between the green surface area and the annual absolute maximum temperature in Rasht. Therefore, decreasing the annual absolute maximum temperature is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the annual absolute maximum temperature is increasing.

Table 7: Green surface and the annual absolute maximum temperature in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The annual absolute maximum temperature (0c)
1981 – 1990	11078	35
1991 – 2000	3075	36.5
2001 – 2010	4330	36

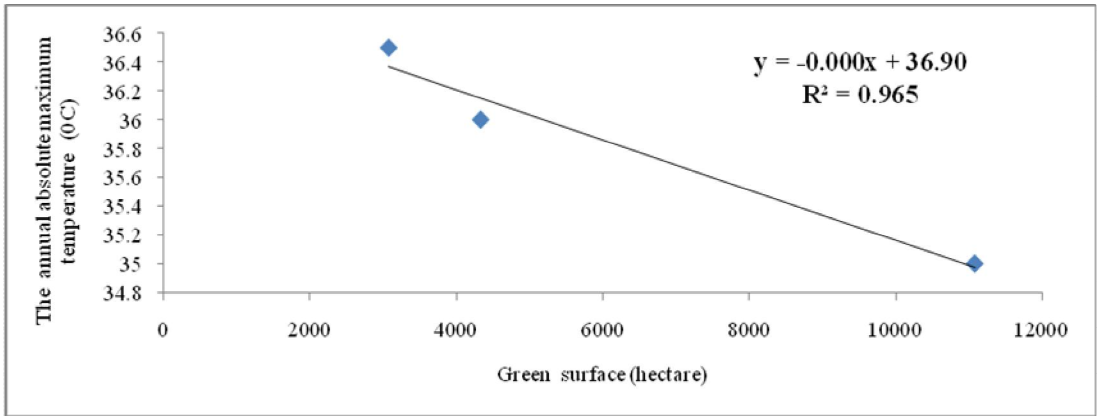


Figure 13: The relationship between the green surface and the annual absolute maximum temperature in Rasht station in 1990-2000-2010

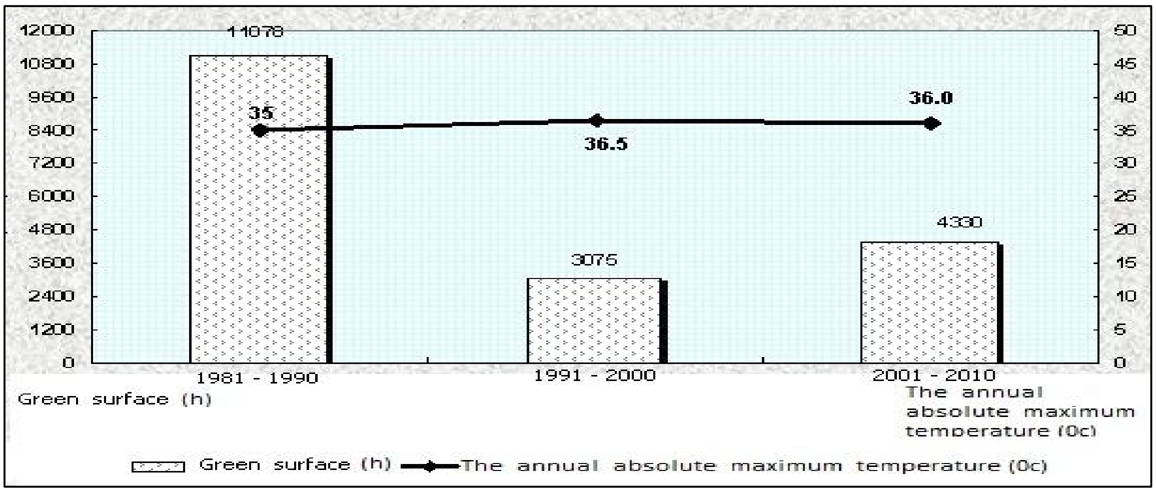


Figure 14: Comparison between the green surface and the annual absolute maximum temperature in Rasht station in 1990-2000-2010

8 - The effect of the green surface on the annual absolute minimum temperature variable

According to the table 8 and figures No. 14 and 15, it is clear that there is a relationship between the green surface area and the annual absolute minimum temperature in Rasht.

Table 8: Green surface and the annual absolute minimum temperature in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The annual absolute minimum temperature (0c)
1981 – 1990	11078	-3
1991 – 2000	3075	-4.4
2001 – 2010	4330	-1.4

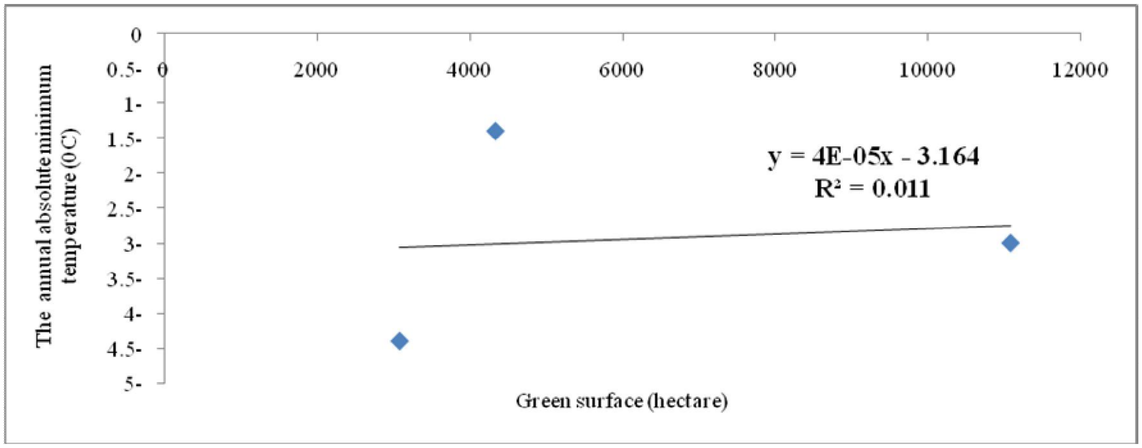


Figure 15: The relationship between the green surface and the annual absolute minimum temperature in Rasht station in 1990-2000-2010

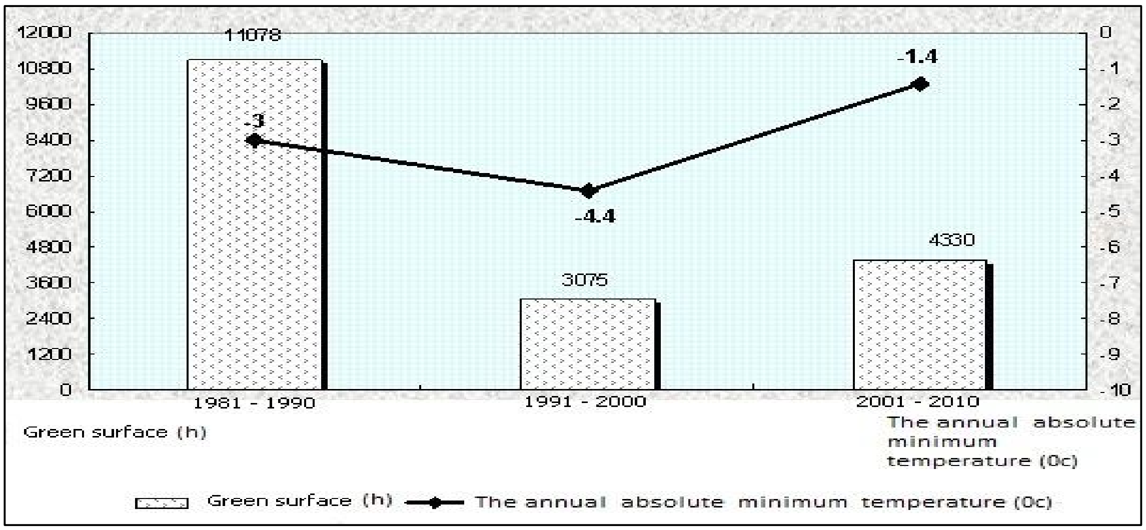


Figure 16: Comparison between the green surface and the annual absolute minimum temperature in Rasht station in 1990-2000-2010

9 - The effect of the green surface on the mean annual temperature variable

According to the table 9 and figures No. 16 and 17, it is clear that there is a relationship between the green surface area and the mean annual temperature in Rasht. Therefore, decreasing the mean annual temperature is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the mean annual temperature is increasing.

Table 9: Green surface and the mean annual temperature in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The mean annual temperature (0c)
1981 – 1990	11078	16.3
1991 – 2000	3075	16.6
2001 – 2010	4330	17.5

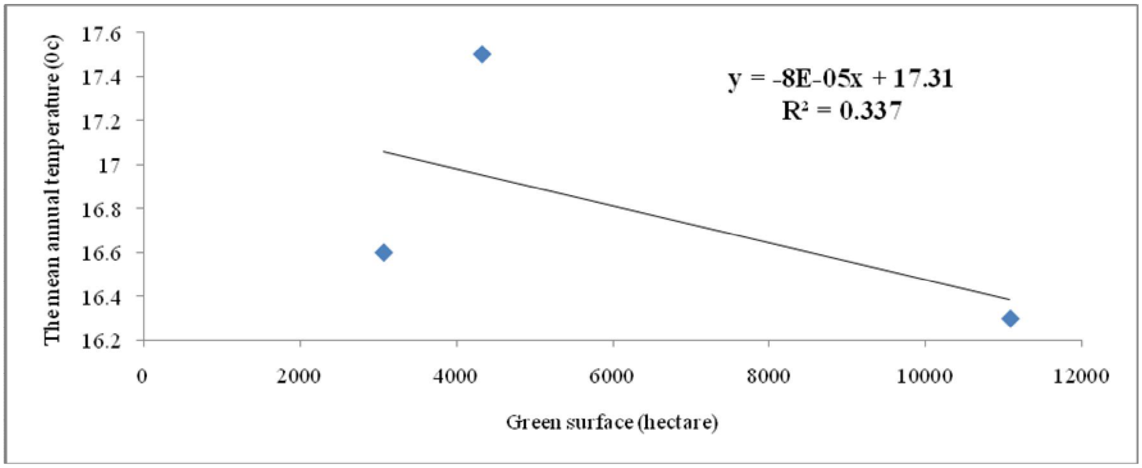


Figure 17: The relationship between the green surface and the mean annual temperature in Rasht station in 1990-2000-2010

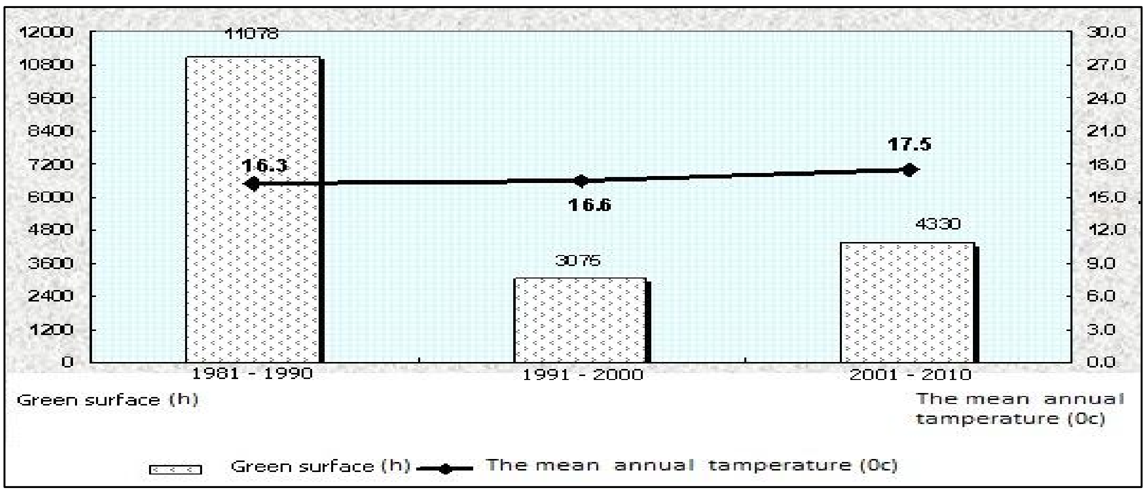


Figure 18: Comparison between the green surface and the mean annual temperature in Rasht station in 1990-2000-2010

10 - The effect of the green surface on the mean of minimum annual relative humidity variable

According to the table 10 and figures No. 18 and 19, it is clear that there is a relationship between the green surface area and the mean of minimum annual relative humidity in Rasht. Therefore, increasing the mean of minimum annual relative humidity is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the mean of minimum annual relative humidity is decreasing.

Table 10: Green surface and the mean of minimum annual relative humidity in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The mean of minimum annual relative humidity (^{0}C)
1981 – 1990	11078	65
1991 – 2000	3075	65
2001 – 2010	4330	64.8

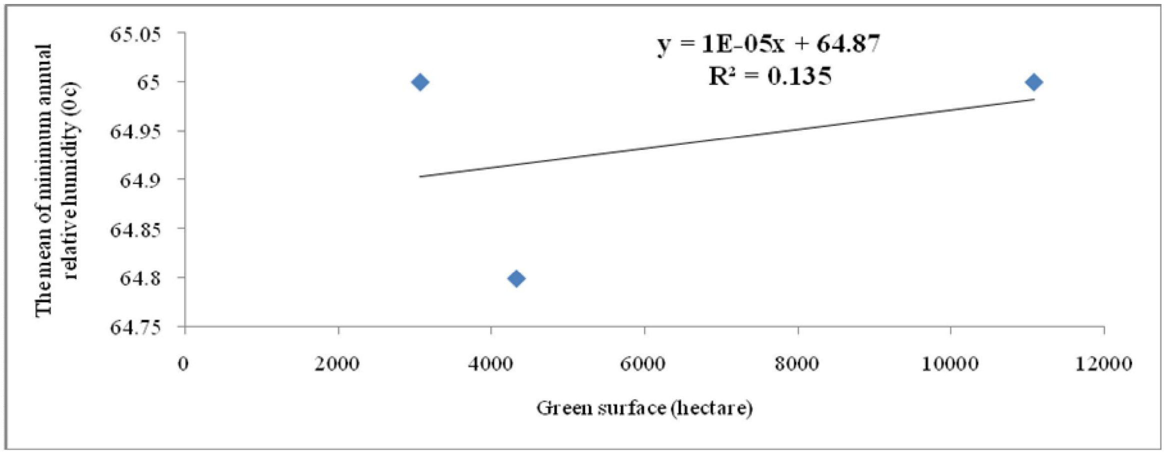


Figure 19: The relationship between the green surface and the mean of minimum annual relative humidity in Rasht station in 1990-2000-2010

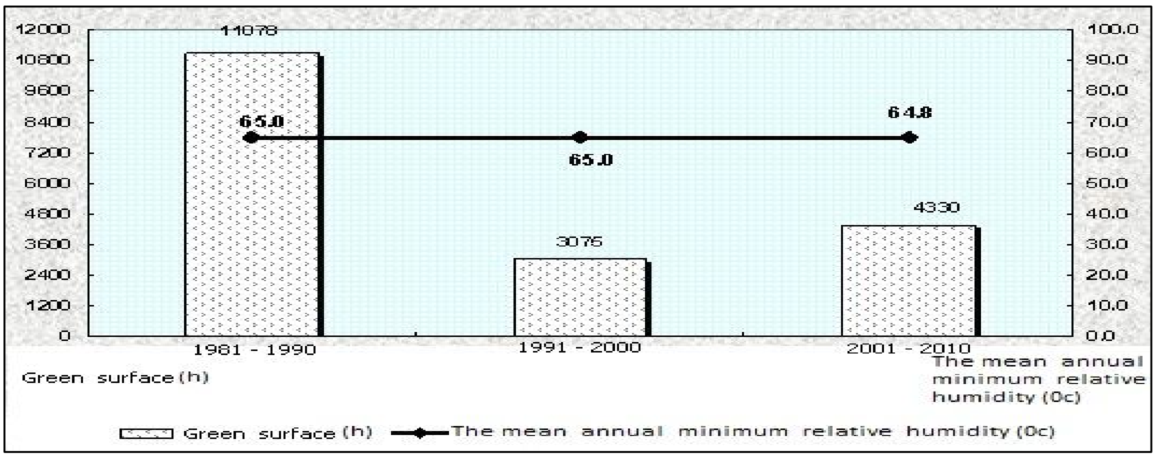


Figure 20: Comparison between the green surface and the mean of minimum annual relative humidity in Rasht station in 1990-2000-2010

11 - The effect of the green surface on the mean of maximum annual relative humidity variable

According to the table 11 and figures No. 20 and 21, it is clear that there is a relationship between the green surface area and the mean of maximum annual relative humidity in Rasht. Therefore, increasing the mean of maximum annual relative humidity is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the mean of maximum annual relative humidity is decreasing.

Table 11: Green surface and the mean of maximum annual relative humidity in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The mean of maximum annual relative humidity (0c)
1981 – 1990	11078	96
1991 – 2000	3075	97
2001 – 2010	4330	95.9

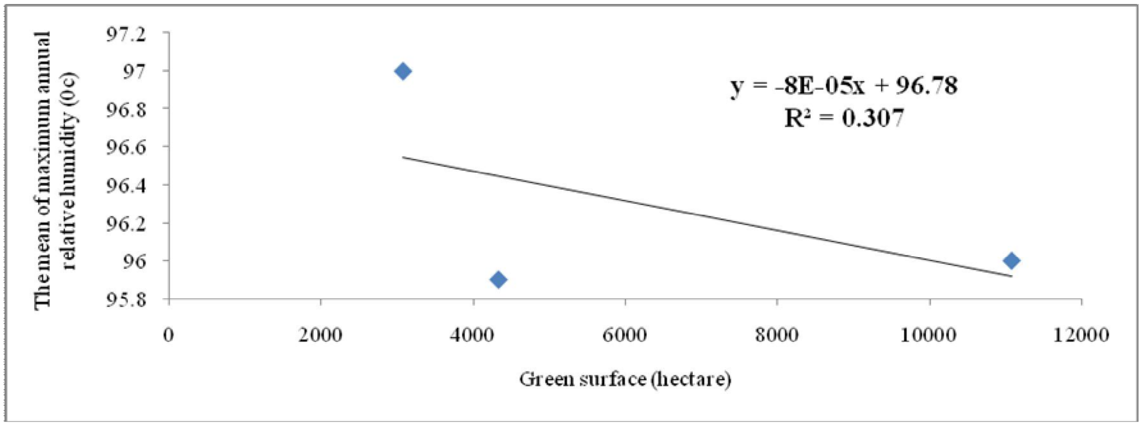


Figure 21: The relationship between the green surface and the mean of maximum annual relative humidity in Rasht station in 1990-2000-2010

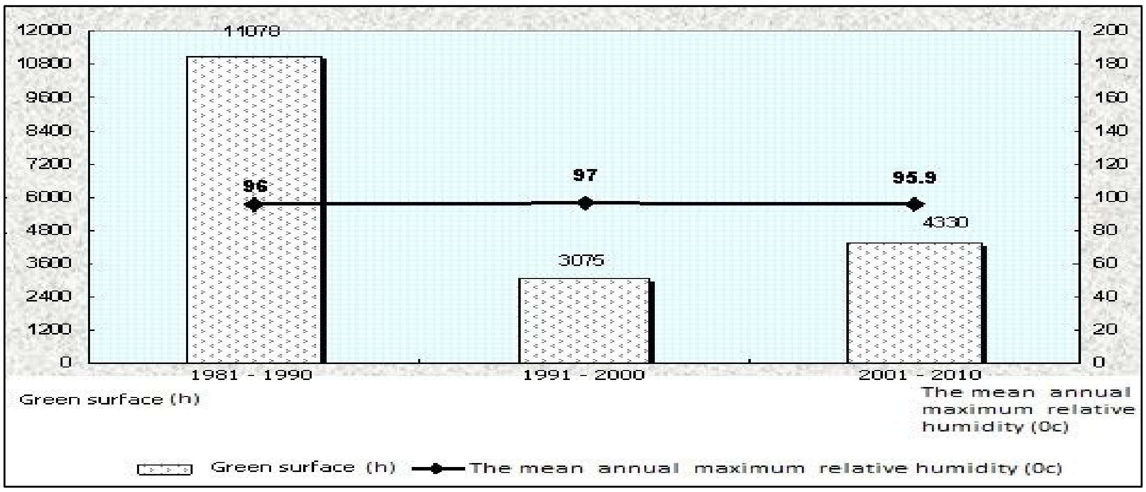


Figure 22: Comparison between the green surface and the mean of maximum annual relative humidity in Rasht station in 1990-2000-2010

12 - The effect of the green surface on the mean of annual relative humidity variable

According to the table 12 and figures No. 22 and 23, it is clear that there is a relationship between the green surface area and the mean of annual relative humidity in Rasht. Therefore, increasing the mean of annual relative humidity is quite evident with increasing of green surface. And conversely, with the loss of green surface in the study area, the mean of annual relative humidity is decreasing.

Table 12: Green surface and the mean of annual relative humidity in Rasht station in three decades of 1990-2000-2010

Year	Green surface (h)	The mean of annual relative humidity (0c)
1981 – 1990	11078	80.5
1991 – 2000	3075	81.0
2001 – 2010	4330	80.4

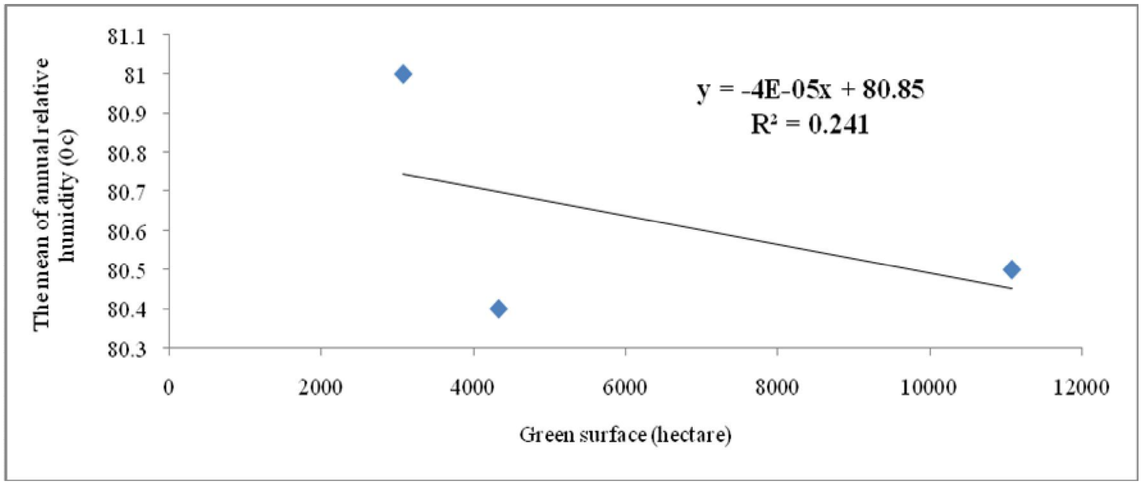


Figure 23: The relationship between the green surface and the mean of annual relative humidity in Rasht station in 1990-2000-2010

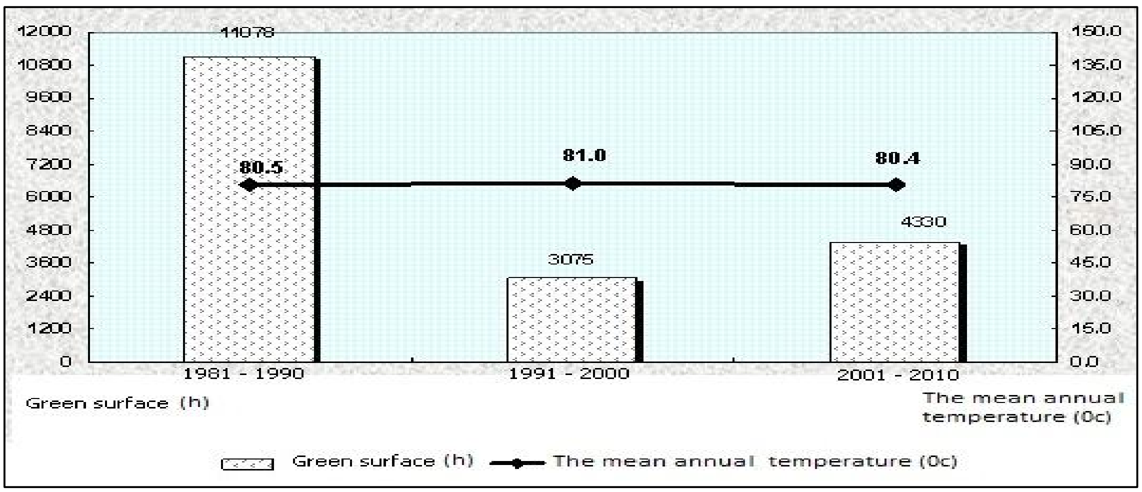


Figure 24: Comparison between the green surface and the mean of annual relative humidity in Rasht station in 1990-2000-2010

Discussion

Urban green space offers significant potential in adapting cities for climate change, through its important role in ameliorating the urban climate (Solecki & etal, 2005). However this potential has not been explored. In addition, little is known about the impact of climate change on urban green space, and how this may impact back on its functionality. Urban green space offers potential to help adapt cities for climate change. Urban green space helps to reduce both the rate and volume of surface water runoff. Incoming precipitation is intercepted by the vegetation (Lazaro, 1990) (Ovington, 1965). The leaves of plants, and in particular trees, have a far greater surface area than that of smooth surfaced buildings and other built surfaces. The efficiency of precipitation interception depends on the nature and amount of precipitation, as well as vegetation characteristics such as stand architecture, density and area of foliage (Oke, 1987) (Hall, 1984). Since urban green space generally occurs on unsealed surfaces (the exception is street trees where the surfaces around them may be sealed) when the water reaches the ground it can be stored in surface hollows and can also infiltrate, depending on soil type and wetness, into the ground (Oke, 1987) .

The results of this research can be stated as follows. Urban expansion and development of urbanization is one problem of human civilization. Indiscriminate destruction of agricultural land, forests, pastures and converts it into residential areas is not just limited to Iran. But the extent of this change is very noticeable in Iran. In this regard and due to the results of this research for three decades, approximately 1,938 acres of agricultural land around the city of Rasht has been converted to residential areas. On average, each year 67 hectares of land have been destroyed that is noteworthy in terms of sustainable development. The rapid growth in urbanization and population growth in Rasht led to significant changes in some meteorological quantities.

Without a doubt, accurate, rapid and economical estimate of these changes is impossible without a modern technologies and environmental studies. In this regard, remote sensing and GIS have important roles. It is recommended that further studies be conducted in this area. Time is a very important and decisive factor in the detection of changes that are often overlooked. This factor is influenced on atmospheric correction, radiometric, selecting training sample and either in classification or detection and also evaluates the results.

Conclusion

The experience and knowledge gained from these studies would be useful in specifying the trend in climate change impacts and suggesting corresponding adaptation measures. There is need to strengthen these studies further covering many other new areas. Summary of some of the important direction and future action plans in these fields are as follows.

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