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Full Length Research Paper

Studying the effects of urban sprawl of metropolis on tourism - climate index oscillation: A case study of Tehran city

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The present research intends to identify the effects of urban sprawl of metropolis on tourism-climate index oscillation. To do this research, two types of data have been used. The first type includes climate data such as minimum monthly temperature average, monthly temperature average, minimum relative humidity rate and monthly relative humidity average, average of wind speed, duration of sunshine and monthly rainfall, and the second component includes parameters related to urban sprawl components of Tehran city such as number of population, density, expansion and number of automobiles per 100 persons. In this research in order to identify climate-tourism range for different months TCI coefficient has been used. Based on the results taken from the average of three 18-year periods using TCI index, it has been concluded that time oscillation is seen for the majority of months in qualitative and quantitative range of climate-tourism coefficient. In a way that these time oscillations of TCI has positive trend for some months and negative for others. In the next step after making correlation between the components of urban sprawl of Tehran city with TCI index, it has been concluded that in April, May, September and November, the results show that the components of urban sprawl of the city has direct effect on providing more suitable climate-tourism conditions, however in June, July, August and September, the components of urban sprawl of the city has had a negative effect on TCI index. But in general, considering the outcome results for annual statistics, we can conclude that urban sprawl of metropolis of Tehran has had a negative effect on TCI index and this factor can be followed by undesirable conditions for Tehran in view of climate comfort in future and it will be considered as a difficulty in view of biologic conditions for tourists.

Key words: Urban sprawl, climatic change, tourism climate index, metropolis.

INTRODUCTION

Today the relationship between human society and environment has been affected by urbanization and urban development. City can be considered as an ecological unit and studied in the framework of a data-retrieval system. That is, to meet various needs of citizens, the city is inevitable to apply data in a great mass, the most important of which are energy, food and water. Considering the increasing urban population, the result of applying such data is to make retrievals in the form of environmental effects such as climatic change, water pollution, air pollution, sound pollution, thermal pollution, and changes in hydrology system and pollution due to waste and rubbish (Tavallaei, 1994). However, one of the most important phenomena of urbanism and urbanization which could break-up the relation between human and environment and has great harmful and destructive effects on human environment is urban sprawl. Therefore, in the recent decades, urban sprawl is considered as one of the most challengeable subjects. This form which is now seen not only in the developed countries but also in the developing countries even has great undesirable socio-economic and environmental effects such as weather pollution (Pourahmad et al., 2007), degradation or pollution of soil recourses (Zhang, 2007), reduction of water quality, reduction or degradation of coastal, lake and aquatic ecosystems (Southerland, 2007), destruction of productive farming lands around the cities (Brabec and Smith, 2002; Zhang, 2000; Tan et al., 2005;

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Jeffrey et al., 2003, Zanganeh Shahraki, 2006), the increase of ecological footprint (Muniz and Galindo, 2005), the increase of economic and social disparity or the decrease of same access to urban amenities and services (Burton, 2001), absence of landscape protection (Jim, 2004), reduction of social capital and consequently social relationship (Brueckner and Largey, 2007), destruction of forest cover (Mcdonald and Rudel, 2005), climatic changes and expedition of global warming process due to great dependency to automobile (Hamin and Guran, 2008). Of particular concern in these 'sprawled' cities is both the loss of surrounding natural land, as urban development spreads rapidly into previously productive or environmentally significant land, as well as increasing concerns about the environmental effects of automobile emissions, particularly in relation to climate change (Arbury, 2005). In Iran as a developing country, due to different reasons, many of large, medium-size or even small cities have been affected by rapid area growth or urban sprawl. Tehran, the capital of the Iran, is considered as a sample of these expanded cities which has become the main target of immigration due to its great urbanization attractions and besides rapid growth of population, it also experiences rapid area and physical growth. This phenomenon has had very undesirable effects on different aspects of the city. But one of the most important environmental phenomenon which is occurring in Tehran city like other large cities of the world, is climatic changes.

This research intends to study the effect of urban sprawl of this city and its indexes in the recent decade on tourism-climate index which is a representative for several climatic components. But as it has been brought forth, Tehran city is one of the most attractive places for domestic and specially foreign tourists due to its great attractions whether in political, economic, cultural and historical view.

Tourism is a major sector of the global economy, with international tourism receipts US$ 439 billion in 1998 (Daniel Scott and Geoff McBoyle, 2001). It is projected that by 2020, there will be 1.6 billion international tourism arrivals, spending over US$ trillion worldwide (Scott and McBoyle, 2001).

Iran with its rich natural and historical resources is one of the 10 excellent countries of the world in regard to tourism-attraction (Iran Tourism Organization, 2008).

Climate has a strong influence on the tourism and recreation sector and in some regions of the world constitutes the resource on which the tourism sector is predicated. Inter- annual climate variability influences the length and quality of recreation seasons and the profitability of the tourism industry. In Canada Wilton and Wirjanton (1998) estimated that a 1°C above normal summer temperature increases domestic tourism expenditures by approximately 4%. Studies by Agnew (1995) and Benson (1996) in the UK also found that tourism spending was partially determined by climatic conditions. In both analyses, tourism spending abroad increased following a cold winter. Benson (1996) and Giles and Perry (1998) also found that domestic tourism spending in UK increased during and following a warm summer (Daniel Scott and Geoff McBoyle, 2001). Yet despite the importance of climate to tourism, Smith (1993: 389) indicated that, "There have been comparatively few investigations into the relationships between climate and tourism." Consequently, the vulnerability of the tourism sector to current climate variability and long- term climate change has not been adequately assessed.

Today considering the ever-increasing growth of societies and expansion of cities and their effects on urban climate, the subject of global warming has been brought up. One of the effects of this global warming is the changes in comfort climate conditions and time changes for this component. So this research intends to identify the effects of urban sprawl of metropolis of Tehran on time oscillation of proper climate for tourists. We mean that the case that in a time the climate comfort and suitable condition for tourist was in spring, but today due to global warming especially in the cities, this ideal situation has been transferred to last months of fall, or in a time a month had a proper climate comfort condition, but it has discomfort conditions at present, could have a significant importance for tourists to select proper time for their travels and consequently for the related authorities to make plans in regard to tourists' management issues.
Therefore to reach this goal urban sprawl of Tehran city and physical changes of this city from past to present have been glanced over. In the next phase, comfort-climate coefficient, its trend and time changes for three 18-year periods have been studied. Finally the relation between the indexes of urban sprawl of Tehran city and TCI was identified to determine the rate of significance and type of their statistical relations.

MATERIALS AND METHODS

In view of location, the studied zone is Tehran city which has been located between the orbits of 35º, 35´ to 35º, 45´of northern latitude and 51º, 17´ to 51º, 33´ of eastern longitude in the southern piedmonts of Alborz Mountain with an area of about 800sq/m. The average of annual temperature of this city is about 17.50º, its annual relative humidity is 41%, and the average of its annual rainfall is 233 mm.

In the present research, two types of data have been used to study the relation between elements and components. The first type of studied data includes climatic elements (equation 1) in a statistical duration of 54 years from 1952-2006. But the second variances or studied data are components relevant to urban sprawl of Tehran city among which we could point out parameters such as number of passenger cars (per 100 persons), density and number of urban population. The reason we have chosen

these parameters is the lack of access to other components related to urban sprawl of Tehran city.

In this research since we intend to find out the effects of parameters such as number and density of population, the increase of urban expansion and the number of automobiles on climate-tourism time oscillation, TCI index has been used.

The tourism climate index (TCI) was originally conceptualized by Mieczkowski (1985) as a composite measure that would systematically assess the climatic elements most relevant to the quality of the tourism experience for the 'average' tourist (that is, the most common tourism activity of sight-seeing and shopping). The TCI developed by Mieczkowski (1985) was based on previous research related to climate classifications for tourism and recreation (Heurtier 1968, Crowe 1976, Scott and McBoyle, 2001) and theoretical considerations from the biometeotological literature related to human comfort, particularly with reference to tourism activities (Burnet 1963; Dammann 1964; Hofer 1967; Heurtier 1968; Danilova 1973; Kandror et al. 1974, Daniel Scott and Geoff McBoyle, 2001). Initially, 12 monthly climate variables were identified from the literature as pertinent to the TCI.

Meteorological data limitations reduced number of climate variables that were integrated into the TCI to seven (monthly means for maximum daily temperature, mean daily temperature, minimum daily relative humidity, mean daily relative humidity, total precipitation, total hours of sunshine, and average wind speed). These seven climate variables were combined into five sub-indices that comprised the TCI. A standardized rating system, ranging from 5 (optional) to -3 (extremely unfavorable), was devised to provide a Common basis of measurement for each of the sub-indices. The five sub-indices and their relative contribution to the TCI are outlined Table 1.

Although devised on the basis of available biometeorological literature, the rating systems of the five sub-indices and their relative weightings within the TCI are ultimately subject. The biometeorological literature, upon which the weighting of the five climatic variables that comprise the TCI and the thresholds used to devise the rating systems for each of the five variables, has been described at length in Mieczkowski (1985) and the reader is referred to the original paper for additional details pertaining to the conceptual and methodological development of the TCI (Scott and McBoyle, 2001).

The TCI provides a method to systematically rate the tourism climate resource for locations around the world, using an easily interpretable scale (-20 to 100) that is divided into 11 categories. where shine duration (h), W the mean wind speed (m/s). Contrary to other climate indices all the contributing parameters are assessed, each factor can reach 5 points, because of a weighting factor (a value for TCI of 100). Values > = 80 are excellent, values between 60 and 79 can be regarded as Good to very good. Lower values (40- 59) are acceptable, while values (< 40) imply bad conditions for tourism (Abetz 1996; Mieczkowski, 1985; Daniel Scott and Geoff McBoyle, 2001).

In order to calculate TCI coefficient, the equation (1) is used:

$$TCI = 8 * Cld + 2 * Cla + 4 * R + 4 * S + 2 * W$$

Where; Cld is daytime comfort index, consisting of the mean maximum air temperature(°C) and the mean minimum relative humidity (%), Cla the daily comfort index, consisting of the mean air temperature (°C) and the mean relative humidity (%), R the precipitation (mm)., S the daily sunshine duration (h), W the mean wind speed (m/s) (Daniel Scott and Geoff McBoyle, 2001).

FINDINGS

Dispersed development, also referred to as urban growth or sprawl, is a pattern of low density development spread over previously rural landscapes) Southerland, 2007) or as mixtures of urban and rural land uses)Hara et al., 2004).

By the emergence of spiral term in urban planning literature, different definitions have been already presented for this phenomenon. However Nelson et al. summarized all definitions of urban sprawl to reach a single definition which is as follows: "An expansion without planning, control and coordination with single usage which does not provide a compound role of usage and in view of operation, it does not have any relation with suburban requirements and is regarded as a separated expansion, desultory sparse, strip or linear and low-density expansion". Urban sprawl occurs in a city when the growth of area and physical development is much larger than the growth of population. Considering this definition, analyzing the process of growth and expansion of Tehran city in different periods indicates that for different reasons, this city has had disintegrated and spiral-like growth since recent decades.

In Agha Mohammad Khan's age (1822) Tehran was selected as Iran's capital city (Habibi and Hurcade, 2005). In the first provided map of Tehran by French Mesu Kershish, the city had 6 gateways, 4 quarters and 100000 populations and a surrounded barrier around it. In this time, Tehran had extended 4 square km which ⅓ devoted to residential fabrics and ⅔ devoted to farming and gardening (Mehdizadeh, 2003).

In the consequent census which was done on Tehran city in 1921, the population of this city was 210000 persons, the city area was also 7.2 sq/km in this year. By this period, physical growth of the city was still silent and the city had relative compaction, as it has a very high population density (291 persons per hectare). But since then, due to different reasons, the rapid physical and population growth of the city commenced, in a way that in the first official census (1956), its population reached

Table 1. Sub-indices within the tourism climate index (Scott and McBoyle, 2001).

Sub- Index	Monthly variable	Climate influence on TCI	Weighting in TCI (%)
Daytime comfort index (CID)	Maximum daily temperature and minimum daily	Represents thermal comfort when maximum tourist activity occurs	40
Daily comfort index (CIA)	Temperature and mean daily relative humidity	The full 24 h period, including	10
Precipitation (P)	Total precipitation	This element has on outdoor activities and holiday enjoyment	20
Sunshine (S)	Total hours of sunshine	Rated as positives for tourist, but acknowledged can be negative because of the risk of sunburn and added discomfort on hot day variable effect depending on	20
Wind (W)	Average wind speed	Temperature (evaporation cooling effect in hot climates rated positively, while 'wind chill' in cold climates rated negatively)	10

1510000 persons and the city area was also increased to 100sq/km (Iranian Statistics Center, 2006). This rapid growth continues with greater intensity in the consequent periods. Due to rapid growth of city in these periods, a council for supervision on the expansion of Tehran city including 10 ministers and 3 department managers was established under the supervision of the acting prime minister to control better and prevent irregular expansion of Tehran city and make a plan for its future based on the act dated August 21, 1973. However in practice this council also failed to control such a discordant growth of city.

In a way that in 1980, Tehran municipality was forced to expand the range of its services, change valid expansion of Tehran city from 225sq/km to 520sq/km with the approval of supreme supervisory council for expansion of Tehran city and supreme council of architecture and urban planning and also change municipal districts from 12 to 20 (Dehaghani, 2002: 444). By this year, more than 120 villages and 2 cities joined Tehran. The process of rapid growth has been repeated in the next periods.

In the latest official national census (2006), this city had a population of 7900000 persons and expansion of more than 800 sq/km. Statistics show that in a period of 85 years, the population of this city has multiplied by 37, while in the same period; its expansion has been increased by 100. The population density of the city in all periods, except for the recent period has had a descending trend and has reached from 291 persons in 1921 to 95 persons in 2006 (Table 2). Besides rapid physical growth, the city expansion has been unplanned, desultory and sparse which are the characteristics of spiral (Figure 1).

After calculating TCI coefficient for long-term average of different months of year, the results have been taken as Table 3 and Figure 2. Based on Table 3, the best season of year for tourists in view of climatic conditions is spring in a way that the three months of April, May and June are in the range of excellent months. On the other hand, the late summer and the early part of fall which coincide with two months of September and October are in range of excellent months. But in view of tourism the most improper seasons are winter and the late fall which are in the range of acceptable months which have lower quality than other months and seasons of the year.

The outcomes of Table 3 conform to the present conditions and what is deducted based on experience. Because in general, the best season in view of climatic comfort in Iran, even in public opinion, is spring (Shakoor et al., 2008).

In view of meaning-based distribution of tourism climate, theoretically the source of tourism climate for each place can be one of the six annual distribution forms, one of which is Figure 2 that is bimodal-shoulder peaks. In places where the proper climate for tourism is spring and early fall, the mentioned figure is drawn.

Studying changes of TCI coefficient for three studied periods

In this phase, monthly changes of TCI coefficient for three 18-year periods have been studied and the results can be

Table 2. The statistics center of Iran and the municipality of Tehran.

Year	2006	2000	1996	1986	1976	1966	1956	1941	1931	1921
Population (million)	7.711	7.02	6.7	6.04	4.5	2.71	1.51	0.69	0.3	0.21
Area (ha)	80000	78900	73950	62000	32000	19000	10000	4500	2420	720
Density (p/ha)	96.3	88.9	91	97.4	141	143	151	154	124	291.6
private car (number for 1000 people)	90	83	74	61	31	25	5	-	-	-

Table 3. Qualitative & Quantitative Area of TCI Index for different months of year using long-term average (1952-2006) (Researcher, 2009).

Months	TCI values	Descriptive rank	Drawn class
January	52	Acceptable	Acceptable
February	56	Acceptable	Acceptable
March	62	Good	Very good and Good
April	82	Excellent	Excellent
May	91	Ideal	Excellent
June	83	Excellent	Excellent
July	74	Very good	Very good and Good
August	78	Very good	Very good and Good
September	92	Excellent	Excellent
October	89	Excellent	Excellent
November	66	Good	Very good and Good
December	55	Acceptable	Acceptable

can be seen in Figure 3. But before interpreting the considered figure, the process of long-term changes of TCI index has been identified for different months. Based on the calculations, 8 months have significant trend, 4 months have random trend. January February, March and October have random trend.

However significant trend of other months is as follows: April (R = 0.34), May (R = 0.58), September (R = 0.29) and November (R = 0.25) have acceptable significance. The results for these months indicate that as the time passes, the climate-tourism conditions of these months become more desirable.

Figure 3 is the average of three 18-year periods including 1952-70, 1971-88, 1989 -2006 for 4 considered months. In these four months, TCI average has been increased for each period.

But on the other hand, in the months of June, July, August and December, the significance trend is something different. In the month of June (R= -0.33), July (R= -0.25), August (R = -0.30), and finally R coefficient for December (R = -0.54). These coefficients account for the decrease of suitable climate-tourism conditions for the mentioned months. Based on Table 3, average value of TCI has been decreased steps by steps from the first to the third period for the months of June, July, August and December.

The followings are changes of TCI descriptive range for three 18-year periods which has been shown in Table 5 based on climate oscillation based on Table 5, some climate-tourism time oscillation is observed in TCI range for different months. In the month of January, considering that TCI coefficient is between 50-59, the descriptive rank for this month has not been changed and it has not been gone out of acceptable range. The same conditions are seen for three studied periods of the month of February. In the month of March also, considering that TCI coefficient is 60-69, the descriptive rank of this month is in the range of “Good”.

In April the conditions have been changed and with the lapse of time, the excellent conditions have predominated on the second and third period. This trend is different for the month of May. In the month of May, the first and second periods are in the excellent range, but in the third period, the TCI coefficient has had an increase from 90.08 to 98 that this range has been allocated to ideal conditions.

In June and July climate-tourism time oscillations have been constant for three courses with the difference that June is in the excellent range, but July is in the range of very good. In August TCI coefficient has been decreased for the second and third periods and in spite of the dominance of excellent conditions for the first period, for the third period very good conditions have dominated.

The trend of TCI changes for two months of September and October is almost the same, with this difference that September has experienced ideal conditions since the second period.

Finally, in November, the first period with coefficient of 65 is in range of good that ultimately with very little difference that is 69.9, we can place it in the range of very

Table 4. TCI descriptive range for the years 1952-70, 1971-88, 1989-2006.

Months / Averages	Jan.	Feb.	March	April	May	June	July	August	September	October	November	December
First 18-year average	Acceptable	Acceptable	Good	Very good	Excellent	Excellent	Very good	Excellent	Excellent	Excellent	Good	Acceptable
Second 18-year average	Acceptable	Acceptable	Good	Excellent	Excellent	Excellent	Very good	Very good	Ideal	Excellent	Good	Acceptable
Third 18-year average	Acceptable	Acceptable	Good	Excellent	Ideal	Excellent	Very good	Very good	Ideal	Ideal	Very good	Insignificant

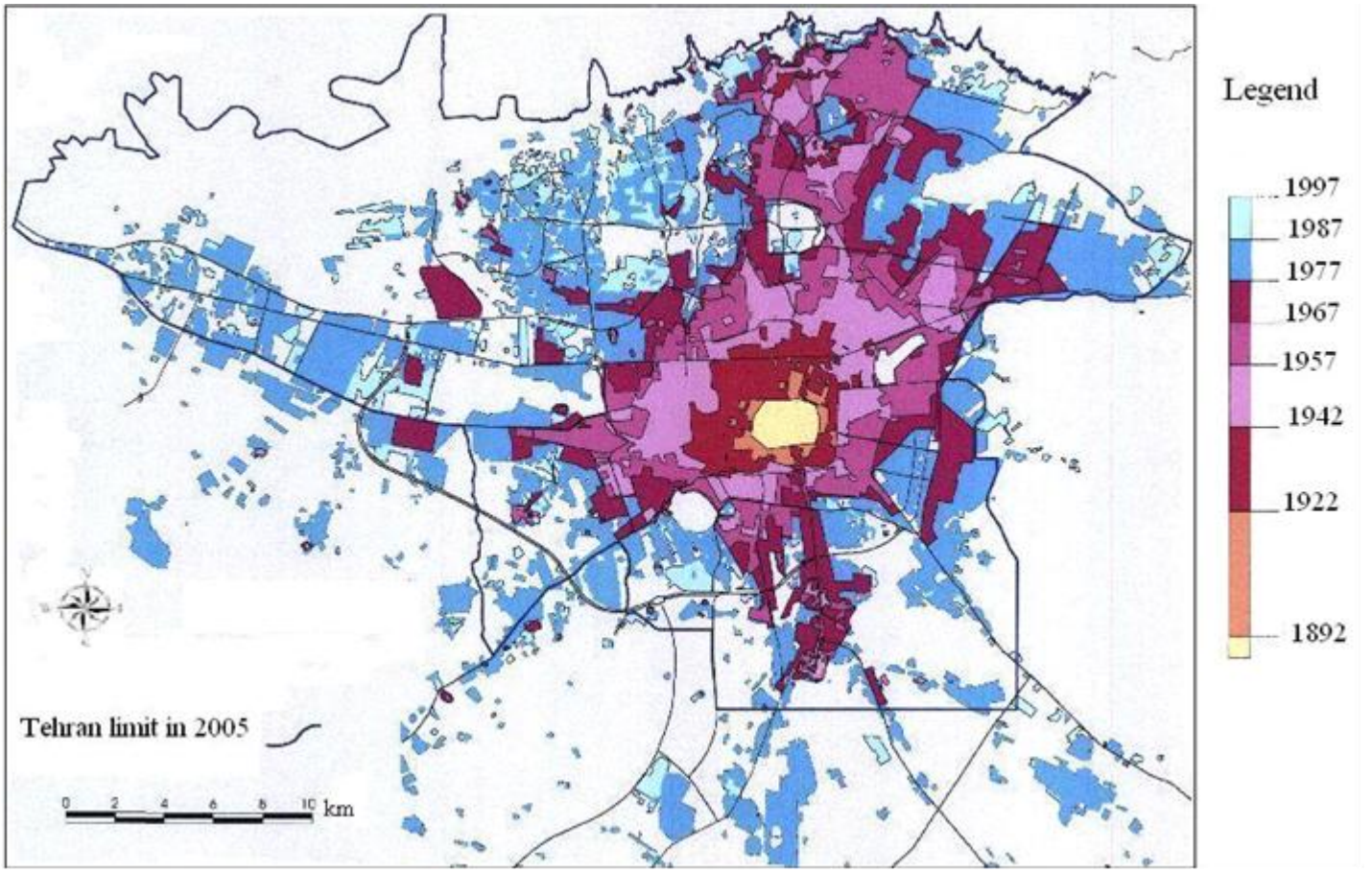

Figure 1. The physical development of Tehran (Zanganeh , 2006).

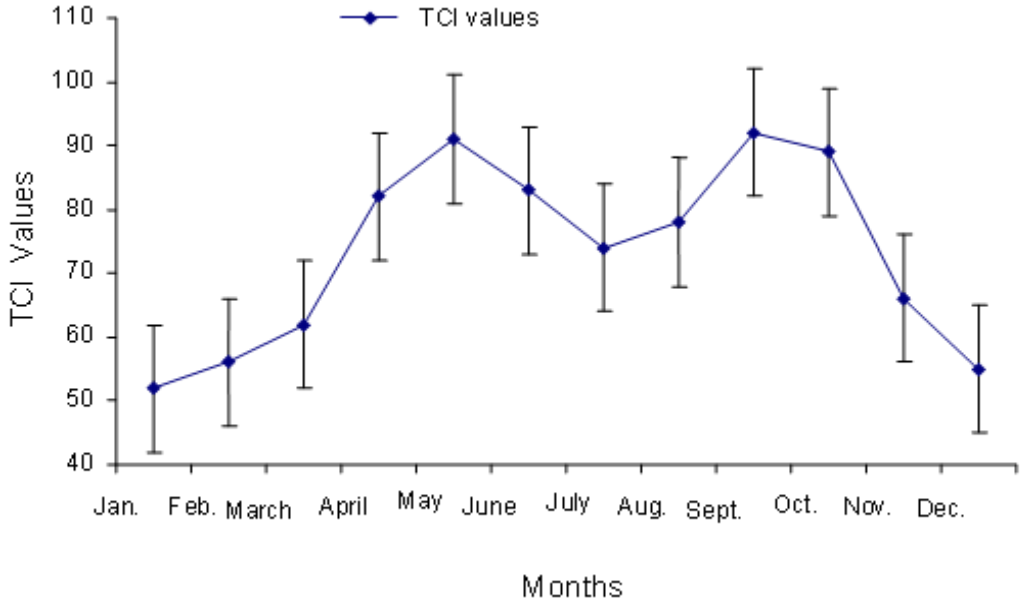

Figure 2. Figure of Peaks Bimodal-Shoulder, extracted from TCI index for different months of year using Long-Term Average (1952-2006).

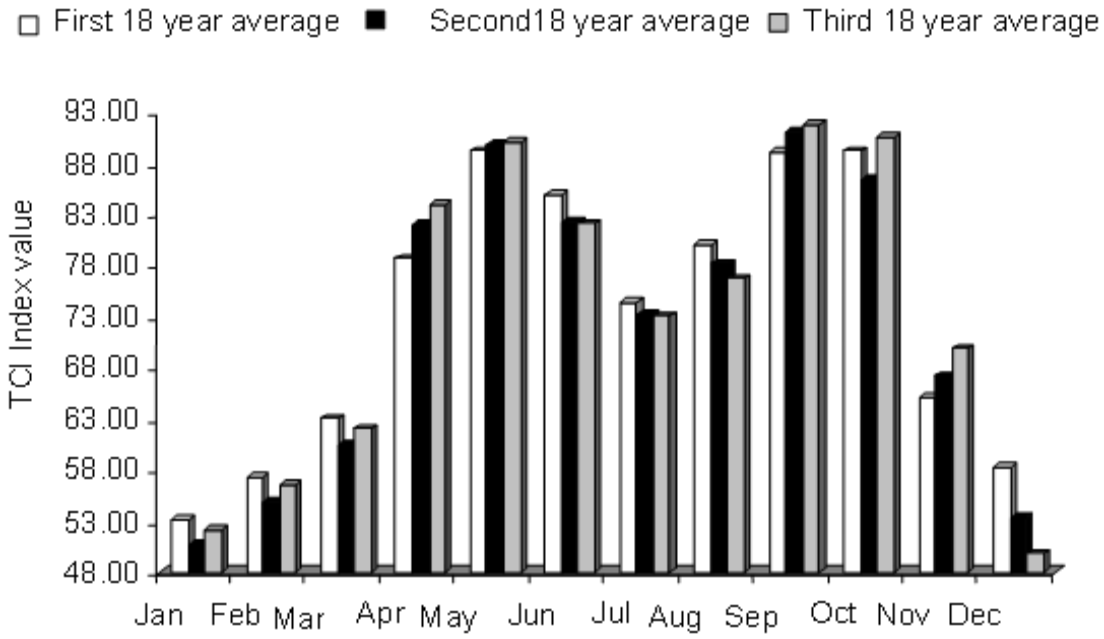

Figure 3. Monthly average of TCI index for 3 periods of 18 years1952-70,1971-88,1989-2006.

good in the third course. However, December like August has had a descending trend. This month has been initially in the acceptable range, but as the time passed, it has entered the insignificant range.

In TCI index, the highest mark with the sum of 50 belongs to components of temperature and relative humidity. So the change of trend of these components can have a fundamental effect on final TCI coefficient in a way that the main components in climate-tourism time oscillations are temperature and humidity. For this purpose, in this

part the changes of temperature and percent of relative humidity components have been measured for different months and three periods.

In general, first the trend of daily temperature has been accounted. The trend of daily temperature of Tehran station with R = 0.7 indicates the increasing trend of temperature of this city that this increasing trend of temperature is completely significant. Consequently the trend of daily temperature for different months has been calculated that the highest level of significance belongs to the warm months of summer. By identifying the changes of this component in three periods, the remarkable point is that the ascending shift of temperature in all months is seen in the third period (in order to summarize, Pierson coefficients, table and graph of temperature component have not been brought here).

In the next phase, the trend of annual average of relative humidity has been accounted. The remarkable point is the increasing trend with R = 0.3 with significance level of 2%. A subject which is discussed in universal heat and heat island of cities is the sink of relative humidity of cities in the scale. Because with the increase of temperature the capacity of air for absorbing humidity gets higher and this causes the decrease of portion of relative humidity to the capacity of air mass. But the significant point is the increasing trend of relative humidity for Tehran station that is contrary to the recent claim (in order to summarize, table and graph related to the percent of relative humidity have not been brought here).

In the next phase, the trend of oscillations of the percent of relative humidity for different months has been also accounted. What is significant is the ascending trend of relative humidity, especially with the greater significance for warm months of summer.

Eventually with the increase of temperature and percent of relative humidity, from the late spring to the middle of summer, this situation cause intensity of bad climatic conditions and considering the fact that Tehran climate is warm in this time of year, considering the intensity of heat and further humidity, TCI index has had a descending trend for the late spring to the middle summer. On the other hand, the same increasing trend of temperature decreased cold and provided more suitable conditions for the early months of spring, fall and late summer.

With regard to other climatic components, the trend of annual and monthly rainfall average of Tehran station has been studied, but this increasing trend of annual rainfall does not have significant level and is random.

However the annual and monthly average of wind speed has had a significant trend. For the trend of its annual component, R = -0.31 has been derived and in most months we can see the decrease of wind speed. Although we can see significant relation with R = -0.23 for annual duration of sunshine and significant and inverse correlation relation for warm months, in the most cold months of the year, the trend of duration of sunshine is random.

Correlation between TCI coefficient and urban sprawl components of Tehran city

Today one of the challengeable subjects in the area of urban area is climatic changes in which we can not ignore the role of urban sprawl of city. In this part, annual and monthly values of TCI index which is a combination of the most important climatic components are measured and correlated with parameters such as number and density of population, the increase of urban area and the increase in the number of automobiles and the results have been shown in Table 6.

Based on Table 6, four months of January, February, March and October do not show significant relation with the components of urban sprawl of city. In the previous part also, TCI coefficient for four considered months has not had a significant trend. But R coefficient for most months shows a significant relation. In April, May, November and September, the results show that the components of urban sprawl of city have a direct effect on providing more favorable climate-tourism conditions. But in June, July, August and December, the components of urban sprawl of city has played role as an intruding and unsuitable factor in establishing climate comfort conditions. That is with the lapse of time and based on city expansion, increase of population and number of automobiles and decrease of density of Tehran city, it is expected that the mentioned months experience more unfavorable climate-tourism conditions in future.

But in general based on the output of annual statistics, one can say that urban sprawl of metropolis of Tehran has had a negative effect on TCI coefficient and this factor can be followed by unfavorable conditions for Tehran in view of climate-tourism conditions in future. Considering the length of statistical period which has been from 1956 to 2006 with 10-year intervals, the minimum significance is r = 0.66 that is in significant level of 10%.

One of the main components of urban sprawl of city is transportation and the increase in the rate of ownership of personal car. As it is seen in Table 6, the component of number of automobiles has had a significant effect on annual and monthly TCI coefficient.

In fact, when the distance between residential and commercial places or between residential place and shopping centers increases as a result of the increase of the city area and low density, the length of urban travels increases.

Toady with the increase of the number of automobiles and release of pollutants and greenhouse gases, besides the intensity of greenhouse states and the increase of temperature, the release of water vapor and its increase in city air have been also increased. In the present situations, with urban sprawl of city, the city distances have been added and this factor caused further use of

Table 6. Correlation values between TCI index and urban sprawl components of Tehran city

TCI Index / Urban sprawl components of city	Population(million)	Area(hectare)	Density(p/h)	Number of automobiles
Annual	-0.79	0.66	-0.72	-0.70
January	-0.06	-0.11	0.01	-0.05
February	-0.21	-0.04	-0.11	-0.13
March	-0.30	-0.15	-0.09	-0.28
April	0.67	-0.67	0.72	0.74
May	0.68	-0.57	0.68	0.75
June	-0.69	0.66	-0.72	-0.74
July	-0.72	0.66	-0.75	-0.74
August	-0.69	0.52	-0.64	-0.72
September	0.69	-0.78	0.78	0.74
October	0.05	-0.09	0.09	0.06
November	0.67	-0.70	0.66	0.66
December	-0.71	0.52	-0.67	-0.70

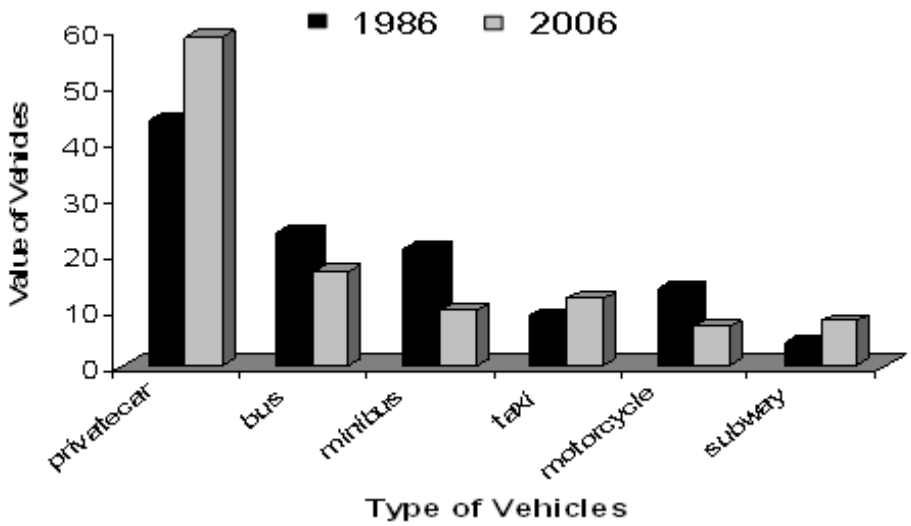

Figure 4. The Graph of various vehicles in transportation of Tehran city during 1986-2006.

motor vehicles which itself has been followed by climatic oscillations such as climate-tourism index.

Therefore, the decrease of density and irregular urban sprawl and its relation with transportation have caused TCI oscillations in Tehran city in two ways: 1) the increase of distance in city commuting. 2) further use of personal car and the lack of execution of suitable public transportation system in all regions of the city.

In fact, with the increase of urban sprawl of Tehran city, the distance between work place, housing or services and places required for citizens have been increases. In a way that based on the statistics taken from office of deputy of Tehran municipal traffic and transportation, the average of distance in city commuting in Tehran has been 2.4 km in 1976 that this distance has been increased to 8.7 km in 2000.

Besides the increase of distances in city commuting, the type of vehicles used in transportation has been also changed with urban sprawl of city. In a way that in one hand, methods such as using bicycle and walking have been decreased and there is more inclination to the use of personal transportation vehicles. In this case we can say that while till 1986, the portion of personal cars in transportation of Tehran city has been just 41%, in 2006 this portion has been increased to 59% and this ratio is increasing now (Figure 4).

On the other hand, it is not possible to execute a good, complete and serviceable public transportation system to all regions of the city due to overmuch expansion in the dispersed cities. For example subway of Tehran which is

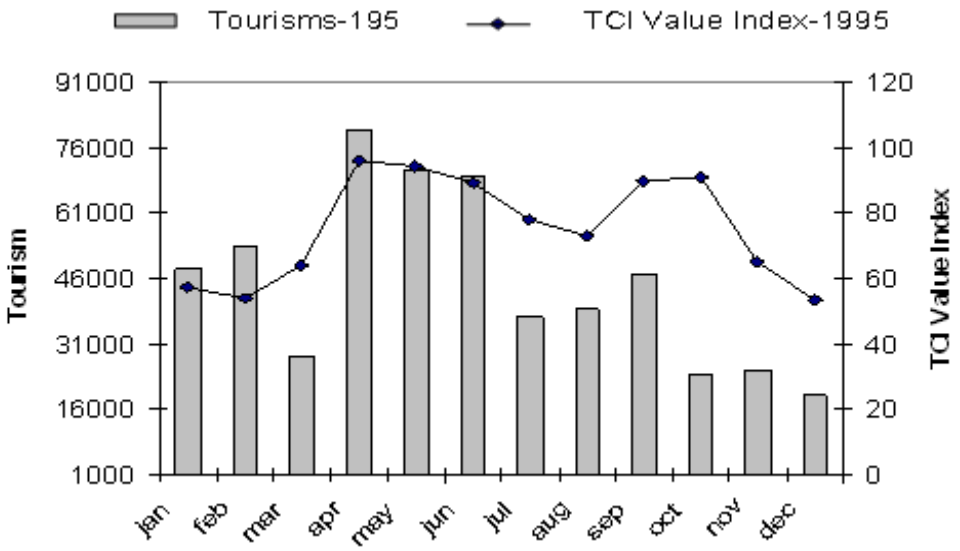

Figure 5. Monthly value of whole domestic and foreign tourism and TCI value index for 1995.

operating since 1995 covers just a small portion of the city and due to its great construction cost in such a expanded city, it is not possible for it to pass through and give service to the whole city. However, transportation system by bus has been more successful than subway; it has not also succeeded to give service to the whole city. The results of all these factors (the increase of distance in city commutes and the increase of using private cars), is the increase of consuming fossil fuels used in transportation. In a way that the daily consumption of various fossil fuels (petrol, gasoline and CNG) in Tehran city in 1976 was 6000000 liter which has been increased to 16500000 liter in 1996 and 32000000 liter in 2006 (Fuels and Oil Products Company in Iran, Tehran, 2007). The increase of consumption of fossil fuels in transportation section has caused the emission of greenhouse gases in the city air which has been finally followed by climatic change. Other findings of scholars in this regard, confirm the results achieved in this research.

Suggests that there are two important reasons why population density may reduce the ecological impact of mobility. First higher density patterns reduce average distances between home and place of work; second, high densities may be more amenable to public transport supply Banister (1998). For example, a new book by Ewing, Bartholomew, Winkelman, Walters, and Chen (2008) argues that we need to build more compactly to reduce vehicle miles traveled (VMT). Based on a summary of existing literature, the text identifies five key factors of urban design that will assist in reducing VMT: Density, Diversity, Design, Destination accessibility, Distance to transit (Ewing et al. 2008: pp. 70–71).

Newman and Kenworthy's (1989) tested the influence of population density levels on the consumption of gasoline. Although Newman and Kenworthy's work does not constitute a new line of research, it is useful as a starting point due to its great popularity. Documents also show that a compact city could decrease the usage of private cars to 70%, meanwhile it decreases the distances taken for commutes rather than work in comparison with sprawling and low-density cities up to 75% (Masnavi, 2002).

Statistical studies of domestic and foreign tourists for two studied periods

Considering its historical civilization, virgin nature, and climate diversity, Iran has been known as one of the 10 excellent countries of the world in the field of tourism. Tehran city as the political capital of Iran and its special place in the Middle East and considering its historical, cultural and economic records … welcomes thousands of domestic and foreign tourists every year. In this part in order to study the effects of time oscillations of TCI index (which is affected by urban sprawl of Tehran city to some extent based on Table 6, on the number of tourists, we have compared the statistics of tourists and TCI coefficient for the years 1996 to 2006 (Figures 5 and 6). It is to be mentioned that the applied statistics includes both domestic and foreign tourists.

As it is seen in Figures 5 and 6, TCI curve for both years is almost the same. But the only significant difference is that the second peak in 1996 belongs to October but in 2005 it has been transferred to September. In both years, the highest TCI coefficient is for April and May and its lowest rate is seen in December. But in the graph of number of tourists, it has greater changes. In general, the months of April, May, January, August, October and November, do not show any change in comparison with 1996, while considering the increase of its TCI coefficient in the recent years,

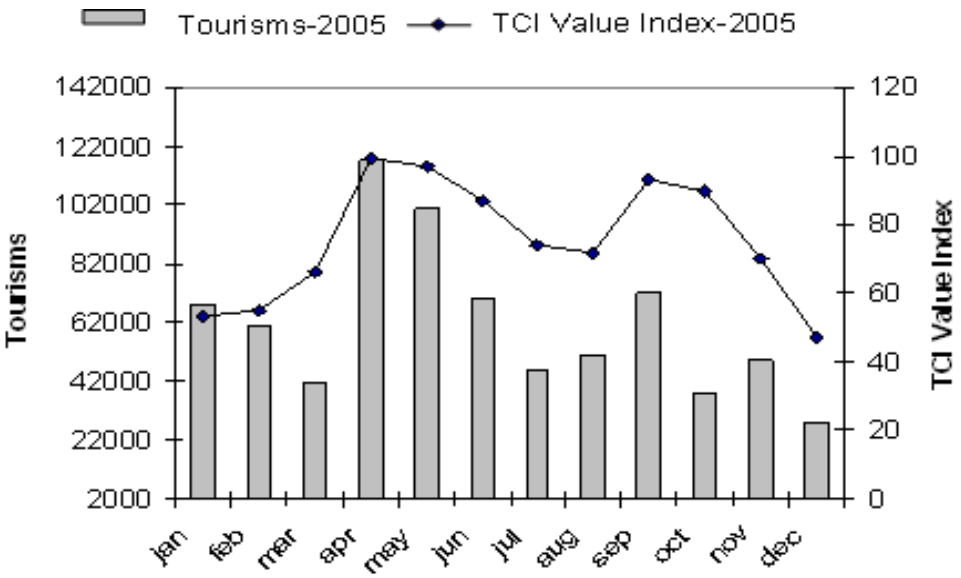

Figure 6. Monthly value of whole domestic and foreign tourism and TCI value index for 2006.

September has been transferred from six to third rank. And due to the negative effects of urban sprawl of city on TCI coefficient, June has been transferred from third rank in 1996 to fourth rank in 2006. Among other significant changes is the promotion of November rank in 2006 in comparison with 1996. In a way that this month has been transferred to the eighth place with two-step promotion, however the negative effects of urban sprawl of the metropolis of Tehran considering its effect in the decrease of TCI coefficient for July, has caused the drop of the rank of number of tourists in 2006 in comparison with 1996.

Conclusions

The purpose of this research is to identify the effect of urban sprawl of the metropolis of Tehran on climate-tourism time oscillations. To this end, two types of data have been used to study the relation between elements and components. The first studied data includes climatic elements and the second studied data or variable is related to urban sprawl of Tehran city. In the present research in order to estimate qualitative and quantitative coefficient of Tehran climate-tourism, TCI index has been used. Considering the present statistics and issues, it has been explained that Tehran city with its rapid physical growth, unplanned desultory and sparse city expansion and the increase of using personal cars and great city commuting has spiral characterizes.

Following that using climate-tourism index, TCI coefficient has been calculated for different months that the trend of changes of TCI has been a direct and significant trend just for April, Sept. and Nov. and for the months of June, July, August and December, it has shown a significant but reverse trend.

In order to study better the climate-tourism time oscillations of Tehran, quantitative coefficient and qualitative scope of TCI for three 18-year periods for different months have been accounted. It is concluded from Table 5 that qualitative scope for these three periods has had noticeable changes. Among significant changes we can mention the progress of qualitative scope of TCI coefficient for the months of April, May and September, but considering random trend of October, we should waive the results of this month.

In the next step, after making correlation between the components of urban sprawl of Tehran city with TCI coefficient, except for the lack of significant relation for the months of January, February, March and October, the significant relation is seen in other months.

In April, May, November and September, the results show that the components of urban sprawl of the city have direct effect on providing more suitable climate-tourism conditions. This situation has been explained in the next part using the comparison of TCI coefficient graph and number of tourists for the years 1996 to 2006. (Figures 5 and 6)

But in June, July, August and December, the components of urban sprawl of the city have played role as an intruding and unsuitable factor in establishing climate comfort conditions. In comparative statistical study related to the years 1996 and 2006, it has been found with the decrease of TCI coefficient for the mentioned months in the year 2006 in comparison with the year 1996, the place of the mentioned months in ranking number of tourisms has been dropped.

But in general based on the output of annual statistics, one can say that urban sprawl of metropolis of Tehran has had a negative effect on TCI coefficient and this factor

can be followed by unfavorable conditions for Tehran in view of climate comfort in future and is considered as a problem for tourists in view of biologic conditions.

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