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Investigating the spatial variation of heat Islands of Tehran

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Abstract- The purpose of this study was to identify the autocorrelation spatial variations of heat Islands of Tehran. For this purpose, network database of minimum and maximum temperature of Tehran was created. Then, the database was used to consider a 33 years statistical period in daily interval of 1/1/1983 to 31/12/2013. Based on the present study and a cell with dimension of 18×18 Kilometres was developed on under study region. The modern methods of spatial static such as global method of Moran spatial autocorrelation, and local Anselin Index of Moran and Hot spots were used to gain with year changing by programming software of GIS. The results of the study showed that spatial variations of heat Islands of Tehran have up word cluster pattern. Among them , according to the local Index of Moran and Hot spots heat Islands have positive spatial autocorrelation pattern (hot heat Islands) in East and Northeast of Tehran and west and South west parts of Tehran have negative spatial autocorrelation pattern (cold heat Islands). In most cases, a large part of province in almost half of total area of province didn't have any significant pattern or spatial autocorrelation during under study period. Moreover, it was founded that heat Islands are generated and controlled by affecting from two systems: 1- local factors controlling the place (geographic arrangement of Islands), 2- external factors controlling the time (the region of heat Islands).

Index Terms- Heat Islands, spatial autocorrelation, Moran Index, Hot Spots Index, Tehran.

I. Introduction

Temperature is one of the most important climate factors which its result is some parts of solar radiation energy that is absorbed by earth surface and changed into heat energy. [3] Nowadays, energy security and global heat increasing has become one of most important problems 21th century. [24]

One of the linkage aspects of this climatic element is its basic role in forming human and natural ecosystems ; in a way that the effects of this element is observable is ecosystems responds. In the other words, the minimum fluctuation of it cause to severe and slow reaction by elements of ecosystems. [22]

In recent 50 years, most of statistical studies have been performed with considering traditional statistic study approaches such as Kendall's test, Spearman's test and linear and multiple regression tests. [6, 17]

But in this regard, realizing spatial distribution of heat is necessary to determine the energy balance of the Earth and climatic, evaporation and transpiration studies and for this reason it is interested to study by researchers. However, traditional methods were not determining in this matter. Often, in environmental studies we deal with observations which are not independence from each other and their dependency is due to the positions in which observations are located in under study space. Hence, the traditional methods should not be used for this kind of observations, because these kinds of data have spatial concomitant structure.

For this reason, these kinds of data are named spatial data in environmental studies and studying them needs a proper method to respond of these data behaviour in location and time. [23]

According to this need and due to the existence of spatial correlation between the data, common statistical methods cannot be considered as a desirable method to analysis such kind of data. [28] Hence, it is necessary to consider the correlation structure of these data in analysing them. [15] For this purpose, spatial statistics can be investigated as a proper alterative to analysis these kinds of data. Spatial statistic is used to various analyses include pattern analysis, shape analysis, surface modelling, surface calculation, locational regression, statistical comparison of locational data collection, statistical modelling and estimating locational interactions. [28] For the needs of close environmental studies, climatic changing has been also posed as an important environmental matter in different fields. Subjects such as water pollution, raining, temperature and … have different effect on human life such as accommodation, agriculture products and energy using. Heat Islands that are because of temperature effect on human health and environment and lead to airflow decreasing, pollution level increasing and increasing diseases risk and death related to the heat.

Since the Ozone of earth surface is generated with light and heat increasing, hence Ozone pollution may reach the level that threats people health, especially children, old men, asthmatic patients and other vulnerable people. [21] Moreover, heat Islands increase energy consumption. High temperatures due to the heat Islands increase energy consumption to cooling houses, offices, administrations and other buildings. Similar matter exists for low temperature and therefore demands' increasing for energy leads to price increasing and can impose more expensive price to costumers. Since heat Islands don't have special and stable condition, they represent periodic and non-regularly fluctuation. [21] Therefore, investigating spatial autocorrelation of heat Islands can be a proper approach to provide optimized patterns in order to study heat Islands in Scales greater than urban level. The present study is the basis of identifying spatial changing of heat Islands of Tehran in a 33 years period.

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The results of this study can be a proper pattern to compare the results of advances statistic analytical and Modern spatial method with traditional statistics method. The basis of such goals and needs and trends of quantities studies based on geographic information system principles have provided new insights to climatologists and able them to identify and analyse the elements of climate and spatial patterns. [19] Modern studies of climatology look for such kinds of modern statistical methods which uncover the climate area facts with minimum level of error. In the newest methods of environmental phenomenon behaviour, experts and scholars have used advances spatial statistics methods to identify the autocorrelation of homogeneous regions. Theoretical foundations of these methods and the way of using them have been described in studies related to environmental Sciences. [4] In another group of studies, traditional statistic approaches which were common in climatology and environmental science studies of last 50 years have been focused which among them, one can refer to the studies of Zhou et al (2009), Jolliffe and Philips (2010), Modares and Sir Hadi (2011) and Shahbood et al (2012). In Iran most of studies related to temperature were also followed from the last statistics approach, such as the studies of Masudian (2005) that whit emphasizing on increasing procedure of temperature has pointed that daily temperature have approximately increased equal to 0.5 degree of Celsius during recent decades. It can be also referred to the study of Azizi and Roshani (2008) that have investigated the temperature procedure of southern shores of Caspian Sea by Men-Kendall test. Spatial statistics have special value in approach of modern environmental science studies, in a way that it has been considered as a core subject of studies related to environmental science topics, especially climatology and temperature studies in recent decade. Latte et al (2009) have used from minimum and maximum ultra-thermometers of daily temperature of 65 synoptic stations to identify cold and hot sports of Catalonia region in Spain in a period of 54 years (1954-2004) by spatial patterns statistics and spatial statistics like Gits-overdo-G statistic. Ohioan (2011) has comprised the results of traditional and spatial statistics methods by using medium climatic ultra-thermometers and measuring the monthly temperature degrees and minimum and maximum daily temperature of Palestine in a 37 years period. The results of his research showed that the temperature of under study region follows from a complex pattern.

In addition , Dell Rio et al (2011) have used from ordinary least-square (OLS) method – an optimized method to modelling spatial relationships in spatial statistics – to analyse the temperature changing procedure of 473 climate station of Spain in a statistical period of 1961-2006. De Lockney et al (2013) have investigated the heat fields of Rio de Janerio region in Brazil by analysing hot spots. There are numerous cases of such kind of studies which among them , one can refer to the studies of Hummer et al (2010), Ajani et al (2013), Nampak et al (2013) and Kim and Sing (2014) as outstanding patterns of this kind of studies. Therefore, according to the importance of the subject, this study has investigated the spatial autocorrelation of spatial changing of temperature Islands in Tehran.

II. MATERIALS AND METHODS

UNDER STUDY REGION

Tehran province with the centrality of Tehran city is the capital of Iran and with 12.981 square kilometres area is located between 34 to 36.5 degree of North latitude and 50 to 53 degree of East longitude. This province is surrounded to Mazandaran province from North to Qum province from south, to MARKAZI province from Southwest, to Alborz province from west and to Semnan province from East.

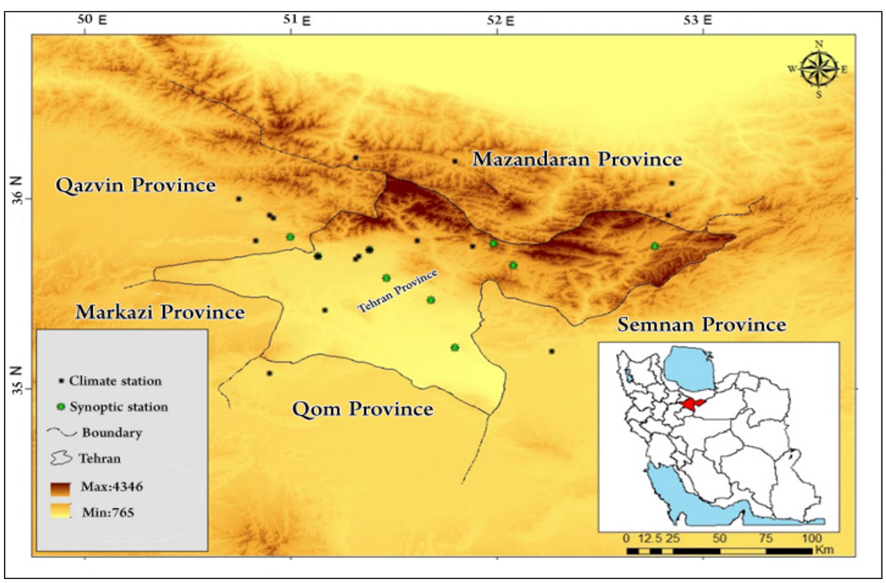

Fig. 1: Location of understudy region

In this study, the common and homogeneous statistic of daily average maximum and minimum temperature of 25 synoptic stations of Tehran province and its neighbour provinces in a 30 years statics period in daily interval of 1/1/1983 to 31/12/2013 were considered. The Kolmogorov - Smirnov test and SPSS software were used to investigate the homogeneity of stations temperature. Since climate data are usually measured discretely in one point, i.e. climate stations, so this spotty nature of climatic monitoring leads to the matter that the generalization of results of stations data analysis is not correct for all of area, even with increasing the number of stations. This problem is more observable is a case with higher place changing of climatic elements. For this reason, a net with proper cells was developed in under study area and the amount of climatic elements in nodes was calculated. This calculations which covered all of the area, were the basis of judgments in this study. Finally, the data of the stations were used as observations to evaluate the level of certainty of used analysis results and stations data were developed to area data with a cell had 18 × 18 kilometres dimensions by Cringing interpolation method and ArcGIS 10.2.2 software.

In order to select the dimensions of cells, firstly the data of daily minimum and maximum temperature of 25 synoptic stations of Tehran and its neighbour province which had common statistics were collected and then, the matrix of raining data of country was created by Cringing (common) method. Two statistic techniques of R^2 and RMSE were used to evaluate the calculating methods. Among them, the Cringing method with the lowest level of RMSE (3047) and highest level of R^2 (0.82) was identified as a most explicit method among evaluated methods in under study region.

After that, the matrixes with 1.1 kilometre dimensions started. In next stage, the average of maximum and minimum temperature of Tehran and its neighbourhood provinces were calculated for each month and the diffract graph of data was drawn. In this diffract graph, the horizontal axis was the dimensions of cell and the vertical axis was the average of raining. The results showed that diffract graph of raining cells of Iran with dimensions of 18*18 square kilometres had the lowest level of diffraction.

Therefore the dimension of 18*18 kilometres was selected to zoning the temperature data of Tehran. Since , the information were related to the level of temperature with spatial correlation , the model of temperature could be obtained by spatial statistic methods and then desirable prediction could be conducted by cluster and non-cluster statistics and hot spots analysing. Spatial analysis usually has a set of space or spatial data which includes three parts: descriptive analysis of spatial data, spatial modelling (change log analysis and determining the model of change log) and spatial prediction. [27] The first phase includes descriptive investigation of spatial data which initial analysis of spatial data itself includes two parts:

1) Measurement locations analysis and 2) descriptive analysis of under study variable (temperature), the second phase includes: spatial modelling. The next stage is appearing the factors changes in dependence variable and the level of each variable effect and distinguishing the model of experimental change log. In spatial model , changing can be generally related to two factors of mean structure and spatial dependency structure which changing of descriptive variables can be modelled in mean structure and the changing of spatial dependency can be modelled in spatial dependency structure. In the other words, the spatial model of changing decomposes data in following form: *Changing of spatial dependency + changing of mean structure = data changing*

Here, existing some small-scale changing maybe due to the factors such as measurement error or changeability inside the observed location. Small scale changing can be considered as an error statement in model. Existing great scale changing can be due to the changeability between observation locations. For spatial data, changeability between observations locations are modelled as a function of distance between observation locations, because when observation locations are near to each other, the observed amounts of them are more similar to each other. This similarity is called spatial dependency. In present study, temperature data were modelled by defining linear model with spatial dependency error and with spatial data of $Z(s_1), \dots, Z(s_n)$ which were observed in locations of $\{s_1, \dots, s_n\}$, as equation of (2) :

$$Z(s) = \sum_{l=1}^{q} \beta_i x_i(s) + \delta(S) \quad (1)$$

$$s \in D \subset R^d$$

Where, {xi(s), i = 1, q} is a grade of non-random descriptive variable of q which can depend on location and S(s) is the error process with average of zero and limited variance and it may spatial dependency. Different methods have been provided to spatial pre-finding. In this study, the cricking method was identified as a proper method to pre-finding based on performed investigations and comprising total squares of errors of different pre-finding models. Therefore all of investigations related to pre-finding of data temperature of the province were provided based on this method. In fact, this method is the best method for non-diagonal linear pre-finding which is also called, optimized pre-finder. Pre-fonder which is obtained from cringing method is linear, non-diagonal and has the lowest level of variance compared with all of other non-diagonal linear pre-finders and exists in two forms of usual and common cringing. In usual cringing: $s \in D, \mu \in R^d \; Z(s) = \mu + \delta(s)$ is stable and uncertain.

$$p(\sum s_0) = \sum_{i=1}^{n} \lambda_i z(s_i) \quad (2) \qquad \sum_{i=1}^{n} \lambda_i = 1$$

Where, P (Z; s_0) is the pre-finder of Z variable in location of s_0 . The condition of total coefficients of linear pre- finder equal to 1, ensure the non-diagonally of predictor. In usual cringing $\mu \in R^d$ is considered as unknown content. Common cringing is the generalized form of usual cringing, in a way that $E[Z(s)] = \mu(s)$ (in this equation, E is expectancy) is not content value, rather than it is an unknown linear combination of known functions of $\{X_i(s) \dots X_d(s)\}$. Common cringing is pre-founded under two consumptions:

$$Z(s) = \sum_{l=1}^{q} \beta_i x_i(s) + \delta(S) \qquad s \in D \quad (3)$$

Where, $\beta = (\beta 1 \dots, \beta_q)$ € R^q is an unknown vector of parameters and S(s) is an inherently static random process with average of zero

$$p(\sum s_0) = \sum_{i=1}^{n} \lambda_i z(s_i) \quad (4)$$

$$\lambda' X = x'$$

The condition of λ'X=X' is required condition for non-diagonally of pre-finder. Modeling the spatial dependency: the change log was used to describe the spatial relationship between the amounts of a location variable in different locations. The most nature way to comprise two amounts of Z(S) and Z (Sth) in two locations, one with coordinate of S and another Sth (which is located in h distance from point S) is to investigate the mathematical expectancy of these two amounts. The non-similarity or change log function of two points with distance of h is defined as follow:

$$2\gamma(h) = E(Z(s) - Z(s+h))^2 \quad (5)$$

Generally, the quantity of 2y (h) is a function of (S_i – S_j) difference. In present study the equation (6) was used to describe the spatial relationship of temperature data from change log relation:

$$\operatorname{var}(z(s_i) - Z(s_j)) = 2\gamma(s_i - s_j) \quad (6) \quad \forall s_i, s_j \in D$$

The classic estimation of half log change is defined as equation (7):

$$2\hat{\gamma}(h) = \frac{1}{|N(h)|} \sum_{N(h)} (Z(s_i) - Z(s_j))^2 \quad (7)$$

Where, the sum of under measurement parameters was done on N (h) = {(i,j) : S_i – S_j = h }. |N (h)| is the number of distinctive elements of N (h). This is a non-diagonal estimator. The third phase: pre – zoning: the pre-finding of temperature on points without existing amount was performed after extracting the best half change log model. In present study, the cringing pre-finder was used to calculate the variable in location of s_0.

In this study, the local pattern analysis method of Morgan was used to better understanding of data and close decision making about the level of statistical confidence. Different scenarios have been developed about analysing the patterns of spatial data in recent decades. For this purpose, one can refer to index of Global Moran 1. This statistic results a number (called standard score or 2-score) which can be used to measure the level of sporadic or concentration of effects or spatial data. [22, 12]

Moran spatial auto correlation investigates the spatial auto correlation based on the transmittal location of two amounts and analysis the considered characteristic of geographical condition. [10] Firstly the standard score of Z and P-value are calculated to estimate statistic or Moran index and then in next stage the significantly of index is evaluated. The equation of (8)

$$I = \frac{n}{s_0} \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j} z_i z_j}{\sum_{i=1}^{n} z_i^2} \quad (8)$$

In equation (8), z_i, is the difference between the amount of condition i with its average of $(x_i - \bar{x})$.

The cluster and outlier analysis which is known as Anselin Local Moran is an optimal pattern to display the statistical distribution of phenomenon in space. [9, 4]. The value of local Moran index, Z-score and P-value were calculated to cluster and outlier analysis for each condition exists in layer which indicates the significant level of calculated index. The local Moran statistic can be calculated by equation (9):

$$I_i = \frac{x_i - \bar{x}}{s_i^2} \sum_{j=1, j\neq 1}^{n} w_{i,j} w_{i,j} (x_i - \bar{x}) \quad (9)$$

In above equation, X_i is the condition characteristic i , $\bar{x}$ is the average of related characteristic.

Hot spot analysis uses Getis-Ord-GI for all of conditions exist in data. [29] The calculated Z score indicate in which regions data are clustered with high or low amounts. The conceptual framework of this analysis is that if a condition has high value, it is important, but it doesn't mean that it is hot spot. The condition is hot spot that not only itself, but also its neighbourhoods be significant in the statistical term. For final output, Z score will obtained when , local sum of condition and its neighbour can relatively compared with total sum of conditions. [13] The Getis – Ord G_I, statistic is calculated by equation (10):

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} - \overline{x \sum_{i=1}^{n} w_{i,j}}}{s\sqrt{\frac{[n\sum_{j=1}^{n} w_{i,j}^2 - (\sum_{j=1}^{n} w_{i,j})^2]}{n-1}}} \quad (10)$$

In above equation, X_1 is the amount of characteristic for condition of j, $W_{i,j}$ is spatial weight between i and j conditions and n is the total number of conditions.

III. Results

The out puts of Moran spatial autocorrelation have been provided in numerical form in table (1). Generally, if Moran index is close to +1, data have spatial autocorrelation and clustering pattern and if Moran index is close to -1, then data are separate from each other. In global Moran, the HO (Null hypothesis) is that: there is no spatial clustering among the amounts of elements related to geographical conditions. If the amount of P-value is very low and the calculated Z is very great (located out of confidence area), then null hypothesis can be rejected. If Moran index be greater than Zero, data will show a kind of spatial clustering. If it is lower than Zero, the under study conditions have sporadic pattern. According to the table (1), the value of global Moran index was higher than D.X for all of 12 months of year. This point indicates that in under study period, temperature of Tehran have upward clustering pattern in the levels of %95 and %99 based on global

Moran index. The statistic of Z for all of 12 month of under study statistic period was high and the levels of 14 and 15. Therefore, according to the global Moran it can be concluded that inter-year temperature of Tehran follows from upward clustering pattern. Therefore, the hypothesis of non-existence of spatial autocorrelation between data in all of 12 months of year can be rejected based on low level of Z-Score and high level of P-value. Now, if temperature for months of year in Tehran would be distributed normally, then the amount of -0.007519 should be obtained to global Moran index.

Table 1: The output of Moran statistic in monthly form

P-value	Z-score	Variance	Expected Moran index	Moran index	month
0	14.743675	0.000444	-0.007519	0.697493	Jan
0	14.825847	0.800433	-0.007519	0.598018	Feb
0	14.681216	0.600433	-0.007519	0.097028	Mar
0	14.639610	0.700433	-0.007519	0.096765	Apr
0	14.721315	0.800433	-0.007519	0.097320	May
0	14.954936	0.000444	-0.007519	0.796903	Jun
0	14.669729	0.100433	-0.007519	0.796903	Jul
0	14.668709	0.300433	-0.007519	0.796913	Aug
0	14.717548	0.200433	-0.007519	0.297926	Sep
0	14.748468	0.600433	-0.007519	0.297478	Oct
0	14.649133	0.700433	-0.007519	0.396831	Nov
0	14.798439	0.900433	-0.007519	0.597841	Dec

As it can be seen in table (1), the level of global Moran index was higher than 0.96 in all of 12 months of year. This kind of data distribution indicated that spatial transmittal pattern of temperature changes in multifold intervals and scales and from one distance to another or from one scale to another scale. In fact, this matter shows the existence spatial differences in different distances and scales. Therefore, the increasing of this value leads to spatial clustering of conditions with size changing in neighborhood scale. Since the temperature increases in warm months for all of province, the significant temperature size changing occurred in neighborhood scale of province. But in cold months, the temperature was distributed in non-balance form in province.

In October and December it can be observed that they have allocated the highest level of value to themselves tis matter is because of the homogenous fluctuation of temperature in all area of province. As it was observed, global Moran spatial autocorrelation only determines the type of pattern. For this reason, the local Moran was used to indicate the pattern spatial distribution of heat Islands of Tehran during under study period. The results of the analysis indicated the form of spatial distribution of conditions, whether they have been distributed in random form, sporadic or clustering form. If the value of I is positive, it means that the considered condition is surrounded by its similar conditions therefore, AND THE considered condition is a part of that cluster. If the value of I is negative, it means that the considered condition is surrounded by a non-similar condition. This type condition is non-cluster. The value obtained from this statistic was calculated under standard score framework and the P-value can be analyzed. In this statistic, HH indicated clusters with high amounts or positive spatial autocorrelation at the confidence level of %99; LL indicated clusters with low amounts or negative spatial autocorrelation at the confidence level of %99. HL indicates non-clustering in which high amount is surrounded by Low amounts. LH is a single cell in which conditions with low amounts are surrounded by conditions with high amounts and are statistically significant (at low level of %5). Figure (2) shows the inter-year changing of spatial autocorrelation clustering pattern of heat Islands during under study period (1983-2013). In three months of winter (January, February and March) there was no pattern on most regions of province and they didn't have spatial autocorrelation. This condition with the value of 62.04 was equally distributed all over the province (Figure 2).

15.2, 8.82 and 8.87 percents of province regions which have synoptic stations with KhorbiabanAK and nomien, had high value upward clustering pattern (positive spatial autocorrelation) in January, February and March, respectively in this period of year, temperature pattern of LL or low values (negative spatial autocorrelation) were distributed in winter season at the levels of 86.3, 29.91 and 26.77, respectively; which indicated cold heat Islands. They were developed in the form of spots in Eastern areas of province (table 2). In spring, the average of temperatures with high spatial autocorrelation had %2.81 reduction compare with winter and had some location changing (Figure, 2). In a way that high value clusters were developed with trending to south of province (Varamin), while high values (HH) were limited to southern and sometimes central regions in winter and had high fluctuation. Low heat islands pattern changing (negative spatial autocorrelation) reduced in summer and were at the levels of %24.3, %25.6 and %20.11 in the area of low temperature patterns (negative spatial autocorrelation) had a little reduction and experienced neglect able changing in location term.

In summer, the areas of high and low temperatures pattern had the lowest level of numerical fluctuation compared with previous three seasons. Averagely, in three months of June, August and September, 67.03 percent of province didn't follow from any spatial pattern. Generally, since the amounts with positive spatial autocorrelation were limited to Varamin region in every four season of year (figure, 2), it can be concluded that local factors have significant role in sporadic distribution of heat Islands in Tehran.

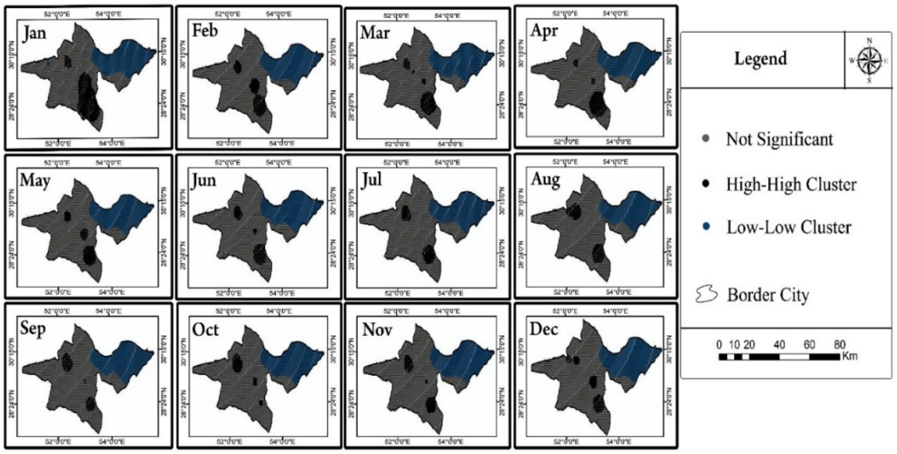

Fig. 2: The results of the distribution pattern of local Moran heat Islands of Tehran

Table 2: The percentage of area covered by the pattern of local Moran

Heat pattern	Jan	Feb	Mar	Apr	May	Jun
High-cluster pattern (HH)	15.2	8.82	8.87	7.01	8.98	8.54
Low-cluster pattern (LL)	26.3	27.91	26.77	28.54	27.57	23.4
Without pattern	58.5	63.27	64.36	64.45	63.45	68.6
Heat pattern	Jul	Aug	Sep	Oct	Nov	Dec
High-cluster pattern (HH)	10.35	11.2	7.34	9.1	6.16	8.5
Low-cluster pattern (LL)	20.11	25.6	24.3	26.82	27.66	2804
Without pattern	69.54	63.2	68.36	64.08	66.18	63.1

According to what has been said, the areas of province with positive spatial autocorrelation (high heat clusters) and negative one's (low heat clusters) were identified; but the GI index or Hot Spot was used to confidence about the regions with high and low clusters. The results have been shown in figures 5 and 6 and table (3). GI statistic which was used to each condition of calculated data is a kind of Z-score. For statistical positive and significant Z scores, high amounts are highly clustered and form hot spots in greater scores. For statistical negative and significant Z scores, the lower Z scores means more severe clustering of low amounts and indicate cold spots.

Ad it can be seen from figure (5), in January, warm heat Islands (at the significantly level of %99) were only limited to East parts in Khorbiabanak station which covered 10.09, 7.23 and 6.31 percents of province in January, February and March, respectively. In this season (winter), regions with cold heat Islands (at the significantly level of 99 percent) were in high area of province in a way that Daran and Golpaygan stations were identified as cold heat spots with the probability of %99 and the station in East of Tehran was identified as a cold heat Island with the probability of %95. The regions without significant patterns in January, February and March were calculated equal to %45.13, %44.28 and %45.06 respectively. Clustering pattern of spatial autocorrelation or in the other words, the warm heat islands which were at confidence level of %99, increased in spring (table, 3). But they had very poor location changing compare to February and March; in a way that sequence of area with positive spatial autocorrelation in confidence levels of %90 and %95 continued to Northeast parts of Ardestan (Figure, 5). In spring, areas with negative spatial autocorrelation had significant location changing compare to winter; in a way that cold heat spot with probability of %95 was continued from west to centre. As it can be seen from table (3), regions without significantly pattern , had very poor changing in spring compare to three previous months , in a way that %41.82, %42.57 and %43.38 of total area of province didn't have any statistical significant pattern in April, May and Jun, respectively (Figure 5). Clustering pattern of high amounts of spatial autocorrelation in confidence level of %99 increased in summer (Table 3) and it had significant location changing (Figure 7). Warm heat spots had more trend to centre or west of province in summer compare with other nine months of year; in a way that Naien and Northeast parts of Ardestan which didn't have significant pattern in previous 6 months, had warm temperature hot spots in summer. Cold temperature spots in different levels of confidence have moved and replaced from west to East in months of January, August and west in summer was because of the wind direction and overheating of Loot desert in East part of Tehran. According to the GI index, heat spatial autocorrelation changing of Tehran in autumn was similar to winter.

However, cold temperature spots had higher trend from west to east and north and south in this season compared with previous periods. Totally, in October, November and December the province had negative spatial autocorrelation (cold temperature Islands) in %37.40, %40.48 and %45.66 of its area.

In summer, the number of regions without significantly was in lowest level (%37.20 of total area of province in sum of three months). This value was reduced compared with winter, autumn and spring equal to %7.38 and %4.61, respectively. This matter was because of the lower fluctuation of heat in this season.

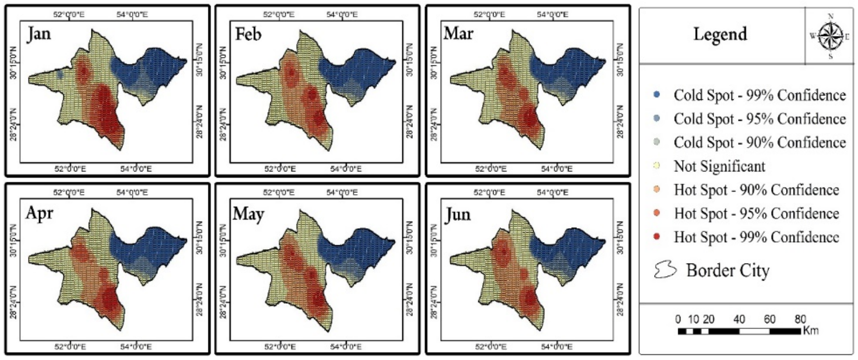

Fig. 5: The results of the dispersion model for heat hot spots during the studied (First six months of the year)

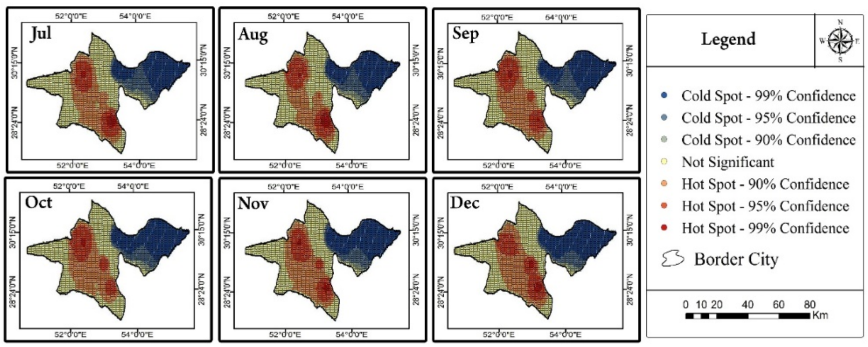

Fig. 6: The results of the dispersion model for the hot spot heat in the studied period (the second half of the year)

Table 3: The percentage of area covered by Tehran heat Islands (first six months of the year)

The type of heat Island	Jan	Feb	Mar	Apr	May	Jun
Cold temperature Island at the level of 99%	19.66	20.11	21.08	21.14	22.14	20.14
Cold temperature Island at the level of 95%	7.87	7.47	7.58	7.36	5.78	6.15
Cold temperature Island at the level of 90%	4.22	2.87	2.14	2.14	2.15	2.89
Without significant pattern	38.25	35.59	37.89	38.54	36.87	33.54
Warm temperature Island at the level of 90%	11.22	17.23	16.14	16.65	17.36	24.33
Warm temperature Island at the level of 95%	9.5	13.87	10.9	10.14	12.89	10.52
Warm temperature Island at the level of 99%	9.28	2.73	4.27	4.03	2.81	2.43
The type of heat Island	Jul	Aug	Sep	Oct	Nov	Dec
Cold temperature Island at the level of 99%	18.32	19.36	19.87	20.22	22.14	23.25
Cold temperature Island at the level of 95%	8.21	8.65	6.56	8.67	7.89	6.86
Cold temperature Island at the level of 90%	2.14	2.78	2.89	2.14	2.32	2.47
Without significant pattern	36.21	37.69	33.65	35.51	32.15	32.25
Warm temperature Island at the level of 90%	21.11	16.65	2014	23.43	21.32	20.89
Warm temperature Island at the level of 95%	10.17	10.25	13.35	10.59	12.36	11.58
Warm temperature Island at the level of 99%	3.84	4.62	3.54	2.24	1.82	2.7

IV. CONCLUSSION

According to the increasing important of heat , especially daily heats in human life and since it is necessary to adapt heat studies , the purpose of this study was to investigate the changing of spatial autocorrelation of heat islands of Tehran based on the last performed heat statistics. This kind of study is very important due to the Co_2 level increasing of atmosphere, changing in the amount of humidity and cloudiness, land use changing and development of urban lands. Since most of under study station were located in cities and suburbs and affected by urban weather, the importance of work was doubled, because it is possible to realize the fluctuations of heating islands by discovering the heat islands changing. One of the most interesting and developing fields of spatial statistics is spatial autocorrelation .it is related to the relationship between remained amount in the regression line. In statistical point of views a strong autocorrelation occurs when remained amounts have relationship with each other, in the other word their changing happen in a regular form. However, a strong autocorrelation will occur when the amounts of a variable are close to each other and are related to each other in geographical term. As it was said, this study emphasized a spatial autocorrelation patterns changing of heat islands of Tehran. For this purposes data heat of minimum and maximum value of 27 synoptic stations of Tehran and its neighbour provinces in a statistical period of 33 years (1980-2013) were used .in addition the global Moran method , local Moran method and hot spots of GI were used. Then the programming software of GIS was used to utilize from these methods. The results of global Moran method showed that spatial autocorrelation changing of heat islands of Tehran follow from upward clustering pattern .since global Moran only determine the type of pattern , local Moran index (Anselin local Moran's I) and Getis_Ord GI were used to investigate the spatial autocorrelation changing of heat Islands of Tehran . According to the both of the indexes, East and North East regions of Tehran with Khorbiabanak and Naien stations have significant role formation of heat islands of Tehran and the mentioned regions have positive spatial autocorrelation. Areas with negative spatial autocorrelation (cold temperature islands) were limited to high regions of province in every 12 months of year. Totally, great area of province had no significant pattern (without significant spatial autocorrelation) in statistical term in under study period. The results of the study showed that heat islands are formed under interaction of local factors and flow factors in a long term interval, but they have different role. In this way, the geographical arrangements of heat islands are formed by local factors, specially height and latitude. However, the role of external factors should not be neglected, because external factors, i.e. general flow of atmosphere play role in thermal regime and heat changing in long term. The maps of heat clusters of Tehran show that upward and down heat clusters aren't similar to each other. This difference is due to the effects of atmosphere flow elements. Therefore it can generally say that heat islands are created and controlled under the effect of two systems: 1) local factors controlling the location (geographical arrangement of heat islands) and, 2) external factors controlling the time (heat islands regime). The results of this study can present proper patterns to other spatial studies of climatic super-thermometers. Spatial statistic studies can provide new fields to climatologists.

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