Tehran Megacity analysed using Population and Climate change

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Abstract

The present paper is an attempt to consider some positive and negative aspects in regard to Tehran's physical and human environments. It is located in vicinity to historical town Rey. Rapid urbanization of this capital city was started since more than 1000 years ago. Unprecedented population load (11 million in 2007) distributed over 650 km^2 is responsible for affecting its micro-climates. These phenomenal changes seem to favor the effect of *Alborz*, *Dasht-e-Kavir* and west winds in Tehran as well as the vegetation cover, specifically the urban green belts. The main purpose of this paper is to show the geographical and historical specifications of Tehran as a populated and polluted megacity in the Middle East Asia.

1. Introduction

Tehran is situated at the foot of the *Alborz sierra* between 35^{0}38'-35^{0}50' latitude and 51^{0}18'-51^{0}31' longitude in the southern foot of *Alborz*. The undulating land surface varies with its elevation from 1060 m in south to 1800 m in north with 740 m fluctuation (Kariman, 1972). This city is bordering a part of *Alborz sierras* known as *anti Alborz* which is geologically formed by Jurassic and Cretaceous sediments. Another significant geological feature of Tehran is its surface and subterranean water drains which ultimately flows to the southern plains owing to specific geological features such as slope, soil type, and structure of soil profiles. The *Tajrish* square is in north of Tehran, just 7 km away from the peak of *Tochal* mountain (4000 m). The famous *Damavand* summit sits 50 km away to the east (Said Nia, 1989). Northern part of Tehran is situated 70 km away from *Dasht-e-Kavir*.

Alborz sierra has been formed as a result of orographic movement in tertiary era in three phases. Tehran plain has been developed due to *Alborz* erosion (Khaledi, 2003). Two rivers namely *Karaj* and *Jajrood* mark the border of the city and form its natural limit. *Palan Gardan* with its 4475 m altitude is the source of important rivers**,** viz. *karaj*, *Jajrood*, *Lar* and *Haraz* in the area (Figure 1).

2. Descriptive Analysis

Tehran is the capital and most important city of Iran. From geographical point of view and importance among the gulf countries, its study is useful and essential. In this paper, descriptive-analysis method, statistical study and field methods in analysis of identical study of plains, mountains, and geographical and natural effects were used. The purpose of this paper is to clarify on the methods and models of vegetation development, the climate and hydrology, geographical features and the topography of Tehran. The optimal place to start with the investigation would be the historical background.

Unfortunately, the mindset of most people concerning the history, culture and origin of Tehran is not proper. Therefore, this paper endeavors to clarify on the historical outlook of Tehran first.

According to ancient documents, this city dates back to more than 1000 years. Rey, an ancient city**,** is situated at several miles south of Tehran. The southern slopes of *Alborz* had pleasant and mild fresh air with fertile lands for agriculture in *Teimourian* dynasty (1394 AD). Tehran was bigger than a village. It was a small town with orchards, patches and groves. As a result of *Turks*, *Mongolians* and *Sultan Mahmood*'s invasions, *Rey* turned into the brink of devastation changing to pilgrimage village. Owing to this historical destruction, Tehran and other villages began to flourish, developed and populated. Walls, gates, orchards, gardens and agricultural lands are the remaining of ancient period (Takmil Homayoun,

2000). The ancient Tehran village was comprised of 12 boroughs**,** and the houses were subterranean. This kind of architectural design was considered as a defensive mechanism against invaders and marauders.

The periodic construction of buildings, sky scrapers, pavements, streets, and *albedo* effect has changed the general outlook of the city. This alarming rate of construction of impermeable surfaces, newly established industries in western Tehran as well as heavy traffic and air pollution have adverse impact on microclimate of Tehran. However, the traditional occurrence of environmental phenomenon has undergone tremendous changes. Due to the geographical bearing of *Alborz* mountains, *Dasht-e-Kavir* in the south and also vast differences in the altitude of the northern and southern terrains, Tehran climate fluctuates at a high scale. Chiefly affected by the penetration of warm and dry air of *Dasht-e-Kavir* and also cold and cool air of *Alborz*, climatic elements in Tehran happens to be remarkably precarious. Urbanization also creates important effects on Tehran microclimates. Vast green *Chitgar* forest is present in western Tehran and *Lavisan* park in the east. *Sorkheh Hessar* and *Khojir* along with the 30 km wide agricultural land determines the southern and south-west of Tehran including *Behesht-e-Zahra* of about 424 ha dense vegetation. All these also play an important role to its microclimates. *Alborz sierras* make up a basic natural landscape in northern horizon of Tehran areas. The mixture of mountains, gardens and vegetation bands in the streets and paramount buildings have changed the general outlook of Tehran. The waterfall that flows from *Tochal* mountain, 7 km north of the city pours to the gutters of *Valiasr* streets, a main street in Tehran that stretches out from *Tajrish* square and continues southwards. *Valiasr* is considered as one of the three longest streets in the world. One can generally find beautiful connected trees creating a remarkable green bands that reminds the ancient vast trees rampant once in the capital. In fact, the UNESCO has drawn a special attention to it. In general, Tehran enjoys cold weather in winter and warm and dry temperature in summer (Figure 2 and 3). The amount of water vapor is less in center of city than the sub-urban areas of the county. Generally, increasing rate of gaseous emissions, atmospheric pollution and increasing temperature influence about 10% of the overall mass and volume of cloud and rainfall. Vagaries of weather parameters lead to more precipitation in suburbs than the city center. The overall climatic condition of Tehran is as mountainous, semi-arid, semi-desert and desert. As per the Koppen classification, it has climatic index- Bsks where 'B' stands for warm and arid, 's' for semi-arid (steppic), 'k' stands for mean annual temperature less than 18^0C, and 's' represents dry summer. Owing to the vapor pressure difference between city and rest of the country, breeze flow fluctuates in size and intensity. Breeze flow other than Tehran circulates, mild wind spreads well in the calm nights in clear sky. When the air is warmer and turbulence is high, wind blows faster. Wind speed in night in city center is higher than the suburbs. Wind intensity and direction change inside the city areas (Figure 4 and 5). In the city center, a warm nucleus is created and the country breezes move toward warmest parts of the city. The flowing breeze when reaches Tehran act like a cold front. Cool air usually slips under the warm air, which is frequent in winter. When climate is stable, a low pressure center is formed in the atmosphere above the city. Inner layers of atmosphere become warmer than upper outer layers. Consequently, we may find disturbance in the wind velocity and more precipitation may take place in city than the country.

Mean annual temperature is 16.7^0C ranging from -14.8^0C to 44^0C. Mean precipitation is 250 mm varying in the range of 100-400 mm. On an average, frosting days vary from 48 to 72 days annually. Generally, a number of factors play an essential role in forming Tehran climates:

1. *Dasht-e-Kavir* carries huge amount of heat and dust to Tehran, however vegetation in southern Tehran mitigates.
2. *Alborz sierras* carry humidity and coolness to Tehran.
3. West winds play an important role in yielding coolness and decreasing temperature. Therefore, west winds and *Alborz sierras* are the principal factors against the negative effect of *Dasht-e-Kavir*.
4. Human activities play in two ways, a) hydrocarbon fuel and pollution contributing negatively to microclimatic change, and b) vegetations such as, park, forest, garden, green band, green belt, green wedge and agricultural lands (in south of the city) have a constructive effect in creating appropriate plant cover and favourable microclimates.
5. Influence of humidity load from Caspian or Mediterranean seas cannot be totally ignored.

Warm seasons show warm, sunny and dry weather whereas, in cold seasons, Siberian cold wind having high pressure lead to lower the temperature with dry air in Tehran. The Siberian high pressure and humid west winds during cold season cause high precipitation (Table 1). The amount of frosty days in comparison to the past years has declined in Tehran. Moreover, urbanization development, growth and consequently heat island effect play an important role in frost decreasing. The main origin of Tehran precipitations is Mediterranean air movement, sometimes cause intense inundation (Khaledi, 2003). Inundated precipitation of north of Tehran had lead to huge damage during summer, 1986. In spring 2007, the total precipitation has increased upto 30% when compared with last five years data.

On the other hand, massive air penetration is the chief determining factor in heat regime in Tehran. The existence of surface water resources, buildings, traffic, and industrial centers also play an important role in Tehran heat regime distribution. Tehran heat island in the morning is high and in the evening lowers in intensity (Figure 6).

Generally, precipitation in southern parts of *Alborz* is not regular and its variability index changes annually. The role of Mediterranean Sea is very important in Tehran climate; in fact among Mediterranean climate factors, we can name Polar (in

the way of north Europe), continental polar (in the way of Siberia) and warm and dry (in the way of Arabia) (Hadissi, 1992). We can often observe snow covers in winter, and specially frost factor is available in the nights, while we observed heavily random snow fall in February 2004 and its rate become more than 1500 mm in north of Tehran. This snow fall created so many difficulties and municipality activities and their services were inadequate.

3. Conclusion

Climatic oscillations are very important in determining social specificities and special urban physical response. In the last several decades, Tehran city has grown not only in terms of buildings or roads, but also gardens and agricultural activities. Overpopulation growth (birth and immigration) along with both horizontal and vertical development threatens the environment. Therefore, we need to commit ourselves to the damage control procedure. Appropriate strategies are necessary for solving the burgeoning problem. It is essential to put in force of decisive laws in order to stop the waning rate of green space and elimination of gardens, increasing plant cover from 1800 m and more heights and stopping on construction in these high areas.

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Table 1: Details of wind types			
Wind kind	Period	%	Speed
W	Feb to Jun	22	12.7
NE	Summer	17.4	6.5
NW	Sep and Oct	16.2	5.4
N	Oct and Nov	13.9	3.8
Adopted from Iran Meteorology Organization			

Figure 1: Location of the Tehran territory in Iran

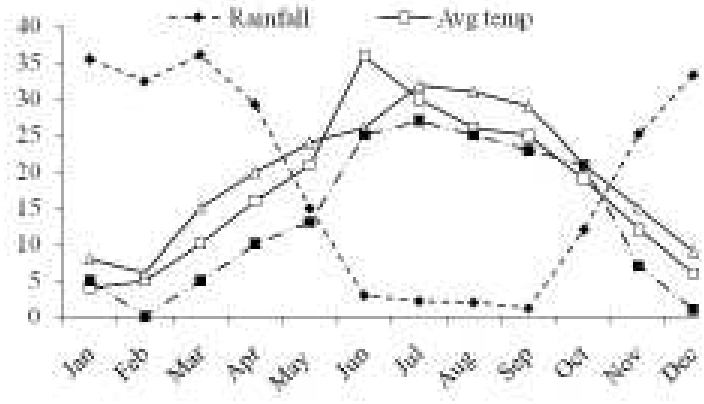

Figure 2: Average. weather parameters of Tehran city (1951-1991)

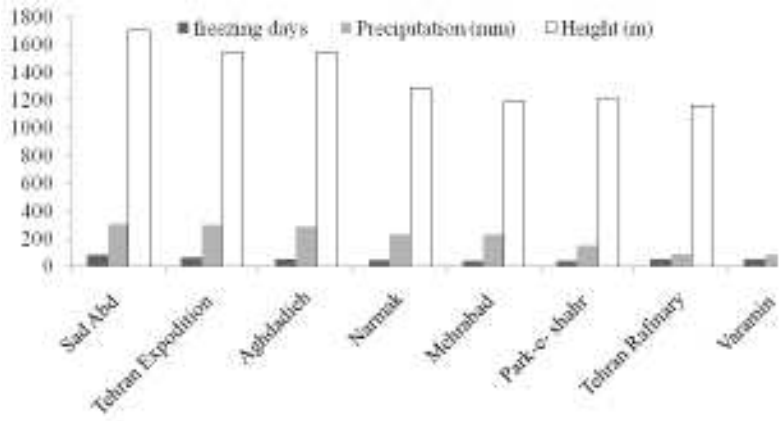

Figure 3: Precipitation, frost and height of weather stations in Tehran (Adopted from Iran Meteorology Organization)

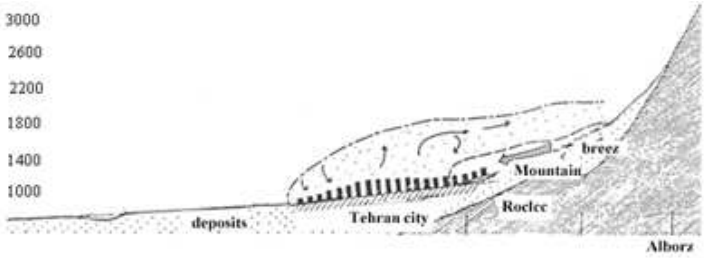

Figure 4: Geographical features of Tehran.

Figure 5: Tehran air current-heat island (Source: Atak Consulting Engineering)

Figure 6: Heat dome and precipitation (Khaledi, 1998).