

The Impact of Urban Sprawl up on Air Pollution

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ABSTRACT: About half a century ago, following the introduction of urban sprawl up concept, various studies have been conducted to describe the mechanism and the formation of this phenomenon. Some of these studies aimed at finding the negative and positive impacts of such phenomenon on urban area with emphasis on how such concept may be looked open from environmental, economical and social perspectives. The main research objective, in this article, focuses on adverse impacts of urban sprawl on air pollution in a mega city such as Tehran. Therefore, attempts have been made to show a relationship between urban sprawl up and the increase in air pollutants concentration. Three methods have been investigated to validate such a concept methodologically. Tehran has been chosen as a case study to further demonstrate validity of such a correlation between urban sprawl up and rise in air pollution scientifically. The results confirmed a function relating air pollution increase to urban sprawl up.

Key words: Air Pollution, Sprawl, Tehran, Transportation, and Urban

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INTRODUCTION

Urban “sprawl” is a word that has entered into the literature of urban planning since half a century ago, and up to now; various definitions have been presented such as:

“A pattern of land use in an urbanized area that exhibits low levels of some combination of eight distinct dimensions: density, continuity, concentration, clustering, centrality, nuclearity, mixed uses and proximity (Glaster *et al.*, 2001)”. The term is also used variously to mean the gluttonous use of land, uninterrupted monotonous development, leapfrog discontinuous development and inefficient use of land (Peiser, 2001).

According to the Vermont forum on sprawl: Sprawl is dispersed, auto-dependent development outside of compact urban and village centers, along highways, and in rural countryside (Menon, 2004). Dieleman and Wegener (2004) suggest that causes of urban sprawl can be grouped into two categories: the general drift of socio-economic change in developed societies and government

spatial planning policies, and conclude that in the absence of strong planning interventions at regional and local levels, further urban deconcentration is likely to occur (Dieleman & Wegener, 2004).

There is one basic difference between the causes of urban sprawl in a developed country and that of a developing country. Sprawl in developed countries is usually a matter of preference. It may have begun with the industrial revolution, and later reinforced by government policies. The entire culture in developed countries (especially the USA) is centered on automobile use. This coupled with government policies that encourage the move to sub-urban areas, and subsidize the use of private transport has fueled urban sprawl in the developed world to a great extent (Menon, 2004).

The story in developing countries is different. In a developing country such as Iran, sprawl is fueled more by necessity. A lot of the underlying causal factors are historical, and have built up over

a number of years. Sprawl, in Iran, is concentrated around certain pockets of dense human population the mega cities. The causes of sprawl here can be traced to historical reasons too.

Most often to the colonial legacy that some developing countries have acquired, for example in Iran mega cities, such as Tehran, were developed as administrative centers, transportation hubs, where people from the rural areas came in search of employment and stayed on. These became central cities after the colonial masters left. The growth of these mega cities was unplanned and gradual. This trend has continued into the post-colonial period too. Most of these mega cities remain the dominant source of employment, education and so forth. And therefore people still migrate from the rural areas. In certain developing countries, since the majority of the population is poor and in need of employment, they usually move to the cities to look for a better standard of life. This has led to burgeoning centers of urbanization that are growing outward, away from the city center. However, as these countries are urbanized at rapid rates, these pockets are increasing and so is the problem of sprawl (Taghvayee & Sarayi. 2003).

Studies and data show that in Iran, the capital Tehran has encountered with urban sprawl and the problems resulting from it. So population of this city has changed from 210 thousand people in 1921 to 702 million in 2000. At the same time, area has changed from 720 to 73950 hectare in this period of time. Better stated, the population has increased by 33 times but the area has become 109 times more. (The statistic center of Iran and comprehensive plan of Tehran). Urban sprawl in Tehran has resulted in many negative consequences in environmental, economical and social dimensions. One of the most important environmental effects of urban sprawl is the increase in air pollution.

In spite of the fact that the causes of urban sprawl in developed and developing countries are different, it has the same results and consequences. Some impacts and results of urban sprawl are: the extermination of desirable agricultural lands around the city, the cost increase in urban infrastructures and services, the cost increase time and length of inner city trips, the increase of energy consumption, the existence of

vacant and depleted lands in the cities, social segregation, the increase of road transportation specially private cars, air pollution and so on.

Studies in North American cities show that "sprawl" in those cities has caused the extermination of 1.5 million hectares of agricultural lands (Benfield and Raimi. 1999) or in Australian cities the cost of infrastructures and services has noticeably increased as a result of this phenomenon. (Frunk & Pivo. 1995). In Liverpool as a city inflicted by sprawled through the 20th century, the ecological and spatial segregation of social classes increased. Despite some counteracting policies this trend towards increased segregation seems to be continuing. (Couch & Karecha. 2006). Burton (2001) found that where there was a large proportion of high density housing, segregation tended to be low. Density seemed to be a key factor in limiting segregation; segregation would be less across the whole of a more compact city.

One of the most important environmental results of urban sprawl is the deterioration of air quality.

Studies carried out in various countries about sprawl, have shown that one of the main effective factors in air pollution of the cities is urban sprawl. Air pollution can be stated as the disturbance of mixed natural structure of air as the result of the entrance of pollutants into air. Inevitably, the entrance of pollutants into air means the reduction in air quality too. Air pollution originates in two ways:

1- natural air pollution which results from the entrance of natural pollutants like volcanic dust, pollen of plants, dust arising from desert zones in arid regions, gas arising from the disintegration of organic substance in the nature, etc.

2- air pollution as a consequences of human activities like transpiration, dwelling and residential areas, industries, productive units.

But today, what is known as the main factor for air pollution is the humanity activities related air pollution that has influenced the earth in different ways.

MATERIALS AND METHODS

It seems that urban sprawl in Tehran is one of the most important factors resulting in air pollution.

Because the main sources of air pollution in the city of Tehran are pollutants from transportation, in this research, studies are divided into three distinctive sections as follows:

A) Studying Changes in the distance and the length of urban travels arising from urban sprawl
 B) The impact of urban sprawl on the mode of transportation (private or public transportation system).

C) Changes in the number of urban travels arising from sprawl pattern in the city of Tehran.

With attention to changes in the length, number, and mode of travels, the measure of fossil fuels consumption such as diesel fuel, gasoline and CNG in various periods studied, that all of them effect on pollutant measure in the city air.

RESULT & DISCUSSION

With reference to data of population and area of Tehran metropolitan area, (presented in Table 1), it can be understood that the urban sprawl in this city is evident. As shown in Table (1), the population of the city was 210,000 people while

its area was 720 hectare in 1921. But after 8 decades, its population became 7,020,000 and its area has risen to 78,900 hectare. This means that as the population has become 33 times of the past, at the same time, the area has increased by 109 times more. In other words, its density has decreased from 291.6 in 1921 to 88.9 persons per hectare in 2000, and now urban sprawl has brought about many problems.

According to studies, after the Second World War, the city grew in a disjointed manner in all directions along the outgoing roads, integrating the surrounding towns and villages, and growing new suburban settlements. This intensified social segregation, destroyed suburban gardens and green spaces, and left the city managers feeling powerless. A Deputy Mayor of the city in 1962 commented that in Tehran, “the buildings and settlements have been developed by whoever has wanted in whatever way and wherever they have wanted”.

Creating a city that “in fact a number of towns connected to each other in an appropriate way” (Madanipour, 2006).

Table 1. Population, area and density in the city of Tehran

| Year | 1921 | 1931 | 1941 | 1956 | 1966 | 1976 | 1986 | 1996 | 2000 |
|-----------------------|-------|------|------|-------|-------|-------|-------|-------|-------|
| Population (million) | 0.21 | 0.3 | 0.69 | 1.51 | 2.71 | 4.5 | 6.04 | 6.7 | 7.02 |
| Area (hectare) | 720 | 2420 | 4500 | 10000 | 19000 | 32000 | 62000 | 73950 | 78900 |
| Density (p/h) | 291.6 | 124 | 154 | 151 | 143 | 141 | 97.4 | 91 | 88.9 |

Source: The Statistics Center of Iran and the Municipality of Tehran

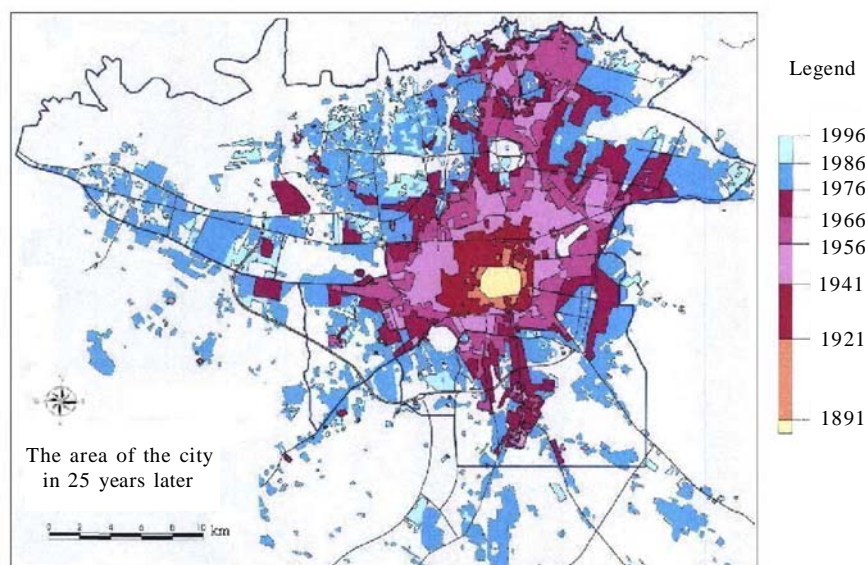


Fig. 1. The physical development of Tehran

Source: Ministry of Housing and Urban Development.

For better understanding of urban sprawl of this city and its impacts, the map of physical development of Tehran in various years is shown below.

After studying the magnitude of Tehran sprawl, for the purpose of testing this hypothesis, the impacts of urban sprawl on air pollution in this city has been studied using three different methods:

- The impact of urban sprawl on the length and distance of urban travels.
- The impact of urban sprawl on the mode of transportation (private or public).
- The impact of urban sprawl pattern on increasing urban travels.

Here three methods for the hypothesis of the research have been studied.

1-The impact of urban sprawl on the length and distance of urban travels:

One of the cardinal features of sprawl is driving, reflecting a well-established, close relationship between low density development and more automobile travel. For example, in the Atlanta metropolitan area, one of the nation's leading examples of urban sprawl, the average person travels 34.1 miles in a car each day—an average that includes the entire population, both drivers and non drivers. More densely populated metropolitan areas have far lower per capita daily driving figures than Atlanta, such as; 16.9 miles for Philadelphia, 19.9 for Chicago, and 21.2 for San Francisco in the USA (Texas Transportation Institute. 200).

In the city of Tehran:

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. (As it can be seen in Table 2).

Table (2) shows that the average length of travels in Tehran greater area has changed from 8.29 kilometers in 1986 to 33 kilometers in 2000. In Tehran city, it had an increase 2.4 to 8.1 kilometers within the same time period.

Relation between these two variables (density and the length of travel) is shown in the Fig. 1. So you can see, with the decreasing density, the length of travel is increasing.

Motor vehicles are leading sources of air pollution. Even though automobile and truck engines have become far cleaner in recent decades, the sheer quantity of vehicle miles driven results in large emissions of carbon monoxide, carbon dioxide, particulate matter, nitrogen oxides, and hydrocarbons into the air.

2-The impact of urban sprawl on the mode of transportation (private or public)

Many studies reveal that urban development pattern (compact or sprawl and spread city) has many effects on the mode of transportation (private or public vehicles) that are used in urban traffic. Urban sprawl or scattered pattern cause extended use of private vehicles and less walking and cycling because of further distance (Balsas. 2003). According to the Strategic Plan that produced by municipality for the period 1996- 2001, known as Tehran Municipality's first plan, or "Tehran 80", main problems of the city are the pace and the pattern of urban growth; environmental pollution, and the absence of effective public transport (Madanipour. 2006).

Table 2. The average of the length and distance of urban travels in Tehran city and Tehran greater area

| Year | 1986 | 1996 | 2000 |
|---|------|------|------|
| The average of the length of travels in Tehran greater area. (km) | 8.29 | 9.55 | 33 |
| The average of the length of travels in the city of Tehran (km) | 2.4 | 4.7 | 8.7 |

Source: The Studies and Researches Centre of Architecture and Urban Development of Iran, and also Tehran great area, Transportation and Traffic Studies, (2003)

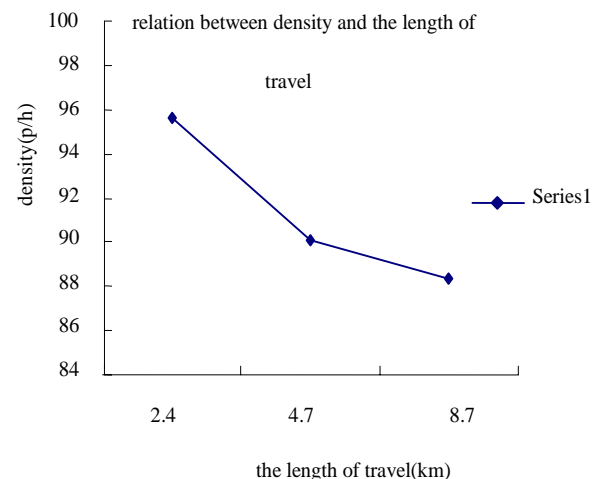


Fig. 1. Relation between density and the length of travel

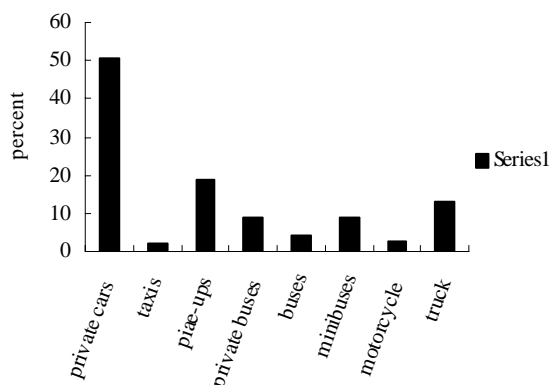


Fig. 2. the share of the sorts of transportation vehicle in traffic.

Source: Tehran Traffic Organization, (2003)

Studies about the share of modes of transportation in Tehran traffic show that more than 50 percent of urban travels are met by private vehicles. But the share of bus and minibus is around 15 percent. Underground is one of the best modes of transportation in cities because of its high speed and lesser pollution. The share of modes of transit vehicles are shown in Fig.1. According to data of studies conducted by Tehran Transportation Organization, the ownership rate of private car used to be 19 for one hundred family in 1971 but it reached 42 in 1996(Tehran Comprehensive Transportation and Traffic Studies of Tehran, 1999).However, the remarkable phenomenon is the increase in the number of motorcycles in this city. In fact, because of heavy traffic in most of the time and easier transport action of motorcycles given their compact size, and being cheaper, now people are inclined to utilize more this kind of transportation, in such a way that the number of motorcycles has risen from 520,000 in 1996 to 2 million in 2006. This mode of transportation is one of the most polluting transportation (The Problem of Group of Urban Traffic. 2006).

Moreover, more than 81 percent of private cars used in Tehran have been manufacture more than 10 years ago (The Center of Studies and Planning of Tehran Municipality, 2005). So their fuel consumption level is very high.

More dependence on private cars in urban transportation, cause increasing in consumption of gasoline, CNG and other fossil fuels and afterward that dispersion of pollutants in the air. Because of that, city planners and managers that believe in sustainable development have a straight decision

Table 4. Quantity of daily consumption of fossil fuels (diesel fuel, gasoline and CNG) in Tehran city (million liters)

| | 1986 | 1996 | 2006 |
|--|------|------|------|
| | 6 | 16.5 | 32 |

Source: Fuels and Oil Products Company in Iran, Tehran,(2007)

to decrease the urban transportation dependency on private vehicles.

3. The impact of urban sprawl pattern on increasing urban travels:

Sprawl pattern in Tehran is different from many other cities in the world, such that the settlements and town in the outskirts of the city center are more dormitories and satellite units. It means that its settlers travel to the city core for work in the mornings and return to their settlements in the outskirts or suburbs in the evening. Studies show that in the American cities, having over sprawl, about 65 percent of the suburb settlers have their working places in the suburb too. This means that the need for city travels has minimized (Richmond, 2001). But in Tehran, only 28 percent of suburb settlers work in their residential areas and the rest of the working places are a away from their residential areas or in the city center (Tehran Municipality, 2004).

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CONCLUSION

Tehran, as capital of Iran, has today encountered with urban sprawl, scattered and

spread, and this phenomenon has had very undesirable effects on environmental, social and economical dimensions. One of its most important undesirable environmental effects is air pollution in this city, such that today, Tehran is one of the most polluted cities in the world. The relationship between two variables, urban sprawl and air pollution, in this paper is considered in three methods. In this paper urban sprawl in Tehran as a cause of the increased length of urban travels, a desirable public means of transportation in this city has not been implemented or urban sprawl causes more and more use of private cars, in other words, this has prevented a desirable public transportation being implemented in this city, settlements and towns in the periphery and suburban of Tehran are the kinds of dormitories and satellites settlements, and because of this much transportation and traffic in early and ending hours of work between city center and towns and surrounding areas and settlements are taking place.

These three factors cause the increase of fossil fuels used in motorized vehicles and the increase of many pollutants emission in the air of this city air and this causes air pollution of Tehran city.

Result of this research can help to urban planners to gain urban sustainable development. Consequences of this study may conduct to modify the physical pattern of urban development for reducing urban sprawl. Some strategies such as: compact city, urban smart growth, increasing population and building density are used to controlling this phenomenon as an efficient approach.

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