Application of Driving Force - Pressure- State- Impact- Response (DPSIR) Framework for Analyzing the Human habitat in City of Tehran

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Abstract

Human habitat change is a complicated issue that many factors play different roles in its formation and distribution. Considering this complication, a more comprehensive and holistic approach is needed for a better understanding and management of those factors. The causal frameworks are among systemic and integrated methods for addressing the causes of environmental problems and the relationships that exist between the environmental systems for proposing proper solutions. The DPSIR model is a functional analysis framework to depict the cause-effect relationships that exist in creating environmental problems. Tehran is one of the major megacities in the Middle East that faces environmental consequences of over population and unplanned urban sprawl, and because of its location in arid region, its vulnerable to rise of environmental problem. In this research, by using the DPSIR framework, different aspects of habitat condition of Tehran are analyzed and later with the help of this conceptual framework, strategies for controlling urban environment.

The results show that urbanization is the major driving force that is induced by overpopulation and the need for further urban sprawl, which cause pressure on natural resources. The state of housing and rapid land use changes have brought about unfavorable living conditions that result in unfavorable impacts on public health and safety, which are the results of ineffective policies and solutions.

Keywords: Human habitat, Integrated Environmental Assessment, DPSIR framework, Tehran

1. Introduction

Human habitat is a place where people have modified it to fit their needs and requirements. As a result, human habitats are not only an ecological environment but also an environment that provide living and social requirements (Liangyong, 2002). Iranian plateau has the most diversity in terms of ecosystems. However, many of these places do not provide suitable living conditions and habitats. Nonetheless, there are many places that are providing suitable living conditions. Such conditions have been extremely instrumental in distribution of living habitats.

The metropolitan city of Tehran, one of the largest and the most populated habitat in the Iranian plateau, in its earliest days was situated in one of the best environmental setting (i.e., climate wise and natural conditions), however, in more than two centuries, the geographic and natural environment has been changed and modified to the extent that it is no longer providing a healthy environment

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2. Materials and Methods

The research method of this study was reviewing the documentary, analysis and comparing the statistics. This study is performed in City of Tehran, which is Geographically Located on the southern slopes of the Alborz Mountains, which gives it relatively rich resources of water and mild climate. A glance at the geography of Iran and the spatial distribution of population and settlement patterns, it clearly shows this excellent position. Today Tehran faces various bio-environmental problems such as pollutions, that is not because of its poor location, but because there is excessive pressure on the resources of the city and whose environmental limitations are violated (Atlas of Tehran metropolis, 2012).

The DPSIR framework is applied for analytical investigation over factors that affect and are affected by climate change in Tehran. This framework is a causal chain presented whereby a distinction is made between forces that act on the environment, changes that, as a consequence, take place in the environment and the societal reaction to those changes (Niemeijer & de Groot, 2008). It is made of 5 elements that form a causal chain. The driving forces are mainly human related factors that cause an environmental problem. These factors are usually related to

socio-economic developments which need to use environmental resources. Exploitation of natural resources and production of wastes cause pressure on the environment and as a result, the status of environmental parameters will change.

These changes will bring about unfavorable consequences on humans' welfare and ecosystem and will cause society to response for solving them (Smeets & Weterings, 1999; Svarstad, et al., 2008).
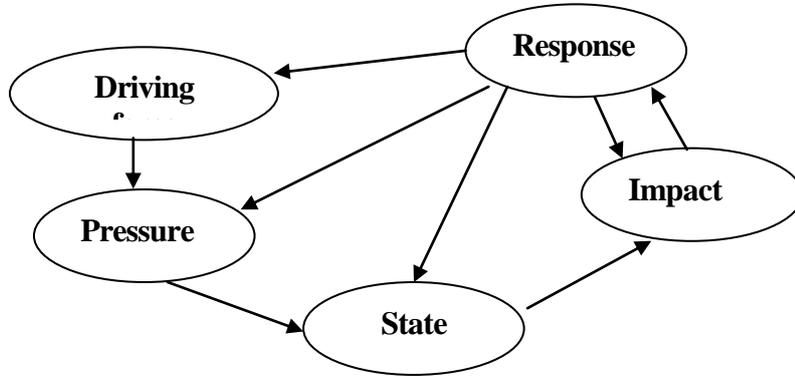

Fig. 1. Driving force- Pressure- State- Impact- Response frame work (Smeets & Weterings, 1999)

As it is illustrated in Figure 1, responses can address all parts of the DPSIR causal chain, but those responses that address the driving forces are more effective, because they are the main cause of environmental issues.

In this research, first, different issues and aspects of climate change in Tehran are identified according to the DPSIR framework. Later, those issues are translated to relevant indicators and quantities form those indicators are obtained from statistics and other reliable sources. Responses and strategies are proposed for indicators that have warning trends according to the DPSIR analysis.

3. Results and Discussions

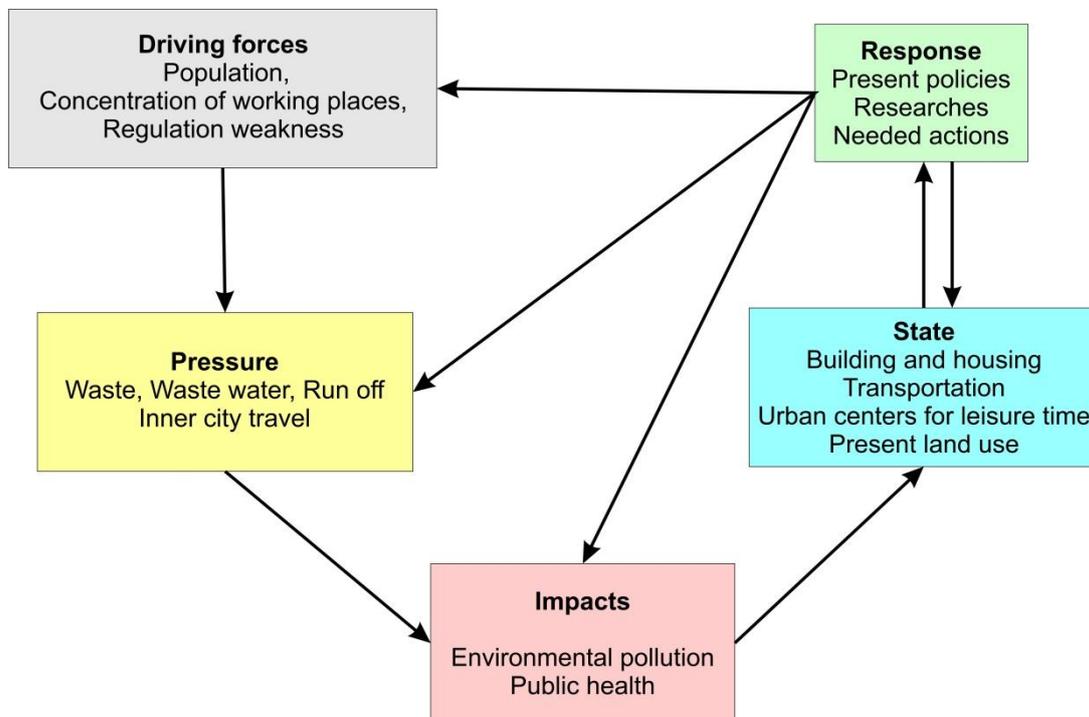DPSIR model for Human habitat factor in city of Tehran, is as below:

Fig. 2. DPSIR model for Human habitat factor in city of Tehran

Driving Forces

The most important recent characteristics and configuration of this city has been the "rapid urbanization". The city's growth and development during the past half a century has been stimulated or driven and consequently effected by "population growth" and also "establishment of employment/job and related activity" associated with "lack of comprehensive plan and efficiency and rules and regulation". These have not functioned and followed proper regulations, discipline and order.

Population is one of the most important and essential elements in human habitat. According to the year 1856 census, the population of Tehran was 155736. However, according to the last census that Statistical Centre of Iran undertook in 2011, the population was close to 8 million mainly due to human migration (Ministry of Health and Medical Education, 2012).

At the present time, most of the experts consider the area as overloaded in terms of population and the activity and carrying capacity. In fact, during the past few years, due to the establishment of the employment centers and activities in the country, the city of Tehran and its surrounding areas have been the main focal points for attracting job seekers in the country. As a result, growth of the population density ends up with increase in production of liquid and solid wastes per unit area and reduction in civil services per capita.

From the beginning of the industrialization, the city of Tehran has been the most important industrial center in the country. Although taking decisions and making policies such as decentralization and setting up restrictions, regulations and laws in building industrial centers within a 120 kilometers radius around Tehran at certain time periods made a gradual decrease in establishment of such centers. Instead the industrial centers in the area haves been concentrated in the surrounding of Tehran and furthermore new centers have been developed along the main roads which are connected to the city. Among these industrial areas, the western Tehran field is the longest and they are very dense in terms of population and establishment of industrial centers.

The city of Tehran follows a special pattern in terms of activity distribution. The residents of the southern part of the city are normally involved in industrial activities. In turn, the majority of the population in northern part of the city is mainly involved in governmental and special services (Secretary of Planning and Urban Development of Tehran Municipality, 2012). In addition, the most important industrial centers are located in the west and southern part of the city.

In 2009, the government lifted the ban on building industrial centers and complexes within a radius of 120 km in Tehran and made the announcement and informed the related organizations. Accordingly, permits were issued for establishing high-tech industries as long as they are operating with the established framework and set regulations.

Although urban planning laws and regulations and standards have been issued and legislated in the form of design and development and comprehensive plan to the municipalities in 2008, because of the pervasiveness and continuous difficulties from the time of` when there was no plan, such plans could not

be effective and showed no tangible signs (irregular development in the northern high grounds of the city, destruction of natural system, blockage of corridors moving masses of air, building and construction on fault district) were continued.

Pressure

Natural and ecological resources in Tehran region has been under immense pressures due to driving forces of "rapid urbanization" in the past decade, in spite of the fact that the main variables of these phenomena surprisingly have decreased (rate of population growth and the number of industrial workshops). Nonetheless, in addition to instability in urban ecosystems, much pressure has been exerted on the natural resources (i.e., air, water, soil and biodiversity) in the city and the surrounding areas.

At the present time, urbane ecological resources and municipality districts of Tehran have been under pressures from urban development challenges such as increase in solid and liquid wastes and increase in commuting such as intercity trips.

The increasing trend in total waste production from 1998 till 2010 has been about 2.77%. Furthermore, waste water disposal (in the absence of complete waste water network) has been constantly increasing because of the "rapid urbanization", while wells dug for waste water disposal have been utilized for such waste in the city's subsurface environment. In fact, one of the most important aspects of environmental pressures in the city of Tehran is the lack of balance or equilibrium between water treatment plants and waste water treatment plants and the lack of a healthy recycling and reuse and circulation systems.

In the city of Tehran almost 165 million cubic meters of runoff is produced by atmospheric precipitation and flowing over the city surface areas. Urban developments in the past few years have decreased the surface permeability of the soil which is covering the surface in the city. As a result, during the rainfall over the city, blockages of the canals which are responsible for carrying surface runoff occur very commonly.

Base on the first Tehran SOE report, during a period of 10 years, the number of daily inner-city trips have increased by about 26 %. This means that there has been a great increase in demand for travel for the residence in the city's passages and streets. According to the latest estimates the rate for such an increase is about 15.8 millions.

State

The main States or situation resulting from the driving or stimulation forces of "rapid urbanization" are reflected in the States of housing and living habitats, main land use, the statues of the old building and houses, transportation and infrastructures, green space States, city parks and recreational facilities and the health and welfare services.

Although for various reasons the number of issued permits for the city of Tehran in 2008 with respect to the year 2007 has decreased by 14.1 %, only 10878 permits were issued in 2009.

These permits accounts for 5.3% of the total number of permits issued by the municipalities in the same period.

At the end, according to the volume of residential buildings constructed in the city of Tehran after two consecutive years of slow down or decrease, finally, in 2010 had a substantial positive growth and in the same year, about 17017 building permits were issued. This number of issued permits showed a 56% increase compared to the previous year (Office of Construction Permits of Tehran Municipality, 2011).

Land use planning distribution in the city limits of Tehran demonstrates that the residential units (28.5%) is the most pervasive type of land use compared to the other types including services (8.1%) green space (11.3%). After residential use, a large part of the city is dedicated to passages, streets and roads (18.4%) .

Meanwhile, the total areas occupied by the old deteriorated buildings in the city of Tehran are about 3268 hectares which encompasses about 5% of the total area of the capital city of Tehran. In addition, according to the comprehensive plan of the city of Tehran, an estimate of about 35% of the total area consists of buildings with old deteriorated fabric with eroded characteristics and includes vast areas in the city.

During the time period from the year 2008 till 2010, from the 3268 hectares, about 5.1 % of the old deteriorated fabric was renovated and rebuilt. The highest portion of this renovated and rebuilt part was in municipality districts of #8, #11 and #10 with 9.7%, 8.1% and 7.1% of the total area respectively

As mention previously, due to lack of proper planning and management and irregular distribution of land use (i.e., Rapid urbanization) the demand for inner-city commuting and travel has increase drastically. This problem has also affected the other transportation variables such as number of private cars and vehicles.

Tehran is a car-dependent city and the number of cars and vehicles in the city of Tehran in 2010 were estimated to be around 4 million vehicles. Private cars made up more than 3 million and six hundred thousand and the total existing space for car parking till the end of the year 2010 in the city of Tehran for all the private cars was about 750 thousands (Tarahan Parseh Transportation Research Institute, 2013).

According to the information the total green space area in the 22 municipalities of Tehran in the year 2010 was around 101399 hectare, and compared to the data obtained in the year from 2007this area was 79903 hectares which shows an increase of about 21%. Therefore, based on these results, the green space per capita has increased to 12.54 square meters in the year 2010.

Furthermore, the non-homogeneous distribution of the green space in the 22 of districts of the city shows that till the end of the year 2010, district #22 has the most intercity green space per capitaanddistrict#10 had the least amount of green area per capita .

In addition to their ecologic functions, parks and the public green gardens in the city, have social benefits as well. Furthermore, they have good potentials for people to spend their leisure times in these spaces. In this regards and according information, and also during the SOE investigation and research time period, the per head area of these green spaces had an increasing and upward trend where they increased from 2.67 m^2 in 2008 to 2.95 square meters in 2010.

However, it is safe to say the per capita share of the green space, parks and gardens have not been according to a balanced pattern and spatial distribution in all the municipalities' districts in the city and the districts # 10, 9, 7, 8 and 11 have the most unfavorable conditions among other districts.

The health care system in the Islamic republic of Iran have made a great development in the past few decades and based on that the health care and health indicators have made a great progress.

The index of the total number of fixed hospital beds which is considered as one of the most important health care indicators have increased substantially. According to the first published report on environment, this increase in the city of Tehran, for every 10 thousand persons, has been 2%, meaning that this figure has increased from 54.3% in the year 2001 to 57.8 % in the year 2005. There were about seven nurses and 17 hospital beds per 10,000 populations.

However, according to statistical report published by the city of Tehran and the official information obtained from the health Ministry, the number of active hospital beds in the city was 28850 in the year 2009, while this number changed to 28769 in the following year which is 2010. Therefore, this information indicates that the active hospital beds in the city in the year 2010 decreased to 35.6 beds for every 10000 people.

Impact

The most important States of favorable and unfavorable parts and components of a habitat are in the form of pollutions and reflection of it in public health and safety.

One of the important Impacts of driving and stimulating forces on habitats are reflected in the index of air pollution. At the present time air pollution is the most important environmental challenge in city of Tehran. The air pollution in the city has a very deep effect on reducing the air quality and consequently on the life quality of the citizens. Information shows the number of unhealthy to very unhealthy days in Tehran's air during a time period between the years 2007 to 2010.

On a daily basis, about 4770 tons of pollutants were discharges into the air in Tehran in 2007. Carbon monoxide with an average daily discharge of 3463 tons into the air was the biggest and the most important air pollutant with 72.6 % share of the pollution. The single and the most important source of this gas were the vehicles.

Considering the results from the equi-potential curves and contour lines of noise pollution, it can be observed that due to driving and stimulation forces imposed on the habitats almost all the residential and commercial building specially places close to the roads and freeways and employment and job and activity centers are subjected to noise pollution much higher than the standard levels.

The total amount of waste produced in Tehran from 2006 to 2010 showed an increasing trend and from 2719145 to 2973186 tons. The rates of waste production during the studied period (2008 -2010) was under the influence of driving

and stimulating forces acting upon the habitats or the settlement (population growth and activities) associated with consuming pattern has even increased more than the population rates.

In addition, in Tehran habitat, the trend of production of
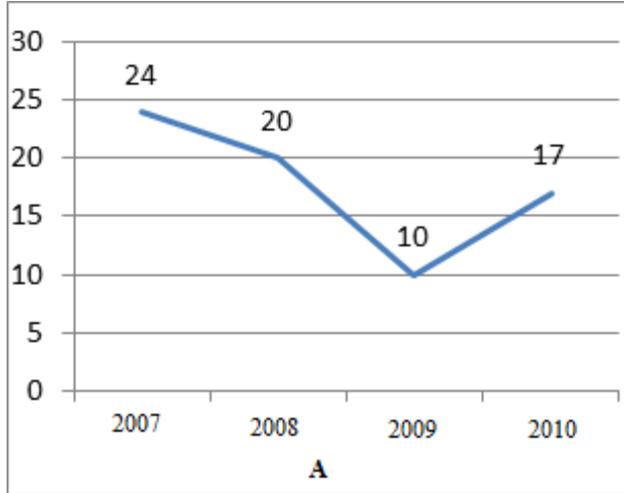
construction wastes is in direct relation with mass production of building in the city. Thus, according to information there is a noticeable relationship between the upward and downward trends in construction wastes from 2001 to 2010.
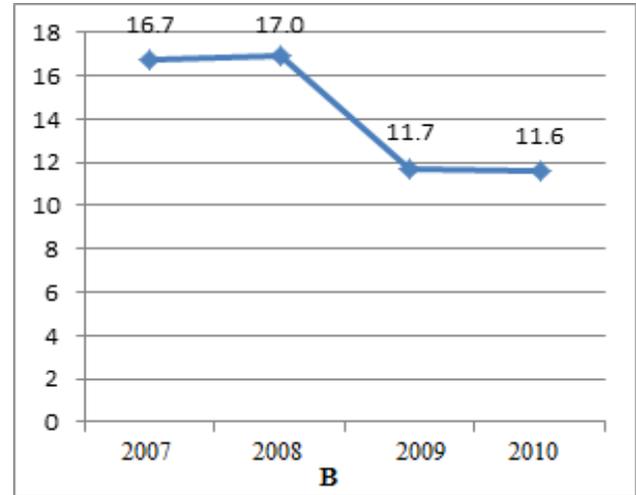

Fig. 3 & 4. Comparison of the trends of production of construction wastes (A) and volume of construction permit (B) in Tehran during 2007and 2010 (Tehran Waste Management Organization, 2012)

According to the expert opinions, the most suitable index for radiation population is the rate of reflective energy over the entire city compare to the standard levels. In this regards, during the period 2008 to 2010, no data or investigative results were available and generally such data were not even produced. However, based on existing documents for the summer of 2012, measurement in 1000 points or locations in the city, there is no point or location where the rate exceeds standard levels. Therefore from radiation safety point of view, the city meets the standard level and there is no point to be concerned (Organization of radio communications, 2011).

Nevertheless, the most outstanding points in this regards is that to point out the lack of any written regulations about setting up the transmission or telecommunication towers in the city. In addition, there are major information gaps (lack of data banks and maps of distribution of electromagnetic radiations) which create immense difficulties in expert interpretation of the data.

Among several indicators relating to the public health and safety, the followings are the most important ones which are described below:

Based on the official statistic, the death rates caused by traffic and driving accidents between 2007to 2009 showed an upward trend, however, in 2010 suddenly the death rate dropped by 10% with respect to the previous year. Nonetheless, the number of road injuries in 2009 also decreased and again in 2010, the rate increased to the previous levels.

The number of people infected with aids virus or HIV positive is 25 people in every 100 thousand people while the world average for this index is about 87 persons in many countries of the world. In 2008 the Municipality of Tehran carried out a research project called "justice in health". The results indicated that 34.2 % of the population has kind of mental disorders.

In the city of Tehran a large portion of the citizens have some

sort of insurance coverage (Talbei and Zangiabadi, 2001) and the municipality of Tehran, in the form of an organization of office of health (under the deputy of cultural and social affairs) is following people's health issues.

Responses

Policies and solutions reached during the period of this investigation are as follows:

- Approval of strategic master plan of the city of Tehran in 2008 and approval of detailed comprehensive plane in 2009,
- Necessitate for production of operational plans for municipality of Tehran (approved by the Islamic city council in 2009) and commencement and preparation of operational plan,
- Moving the illegal occupations and whole sale centers from the city centers (approved by the cabinet)
- Based on the approval of the cabinets and ministers, development approach in Tehran and directional change of knowledge-based industries with hi-tech was approved and announced,
- Industrial investment shares of the Tehran province balanced in favor of less developed provinces from 16.2% in 2005 to 5.6% in 2008,
- Preparation of comprehensive plan for cultural spaces, approved by the commission #5 in January 2008.
- Formation of city of Tehran health network with operation of 374 health houses during a 7 year periods (from the start of 2006, all the 22districts of municipalities of Tehran have offices of health and as a results all the districts ought to have a "health house".

Important activities and accomplished studies

- Publication of the first report on environmental States and condition of the city of Tehran,
- Production of Atlas of Tehran,
- Production of the project concerning organization of gardens and Green space of the city of Tehran,
- Between 2006 and 2011 in order to renovate the old deteriorated urban fabric, seventy special projects were prepared. In addition in the realm of easiness of renovation of the old deteriorated urban fabric 41 offices responsible for such a task were established since 2009 (Secretary of Planning and Urban Development of Tehran Municipality, 2012)
- Production of noise pollution level map in most part of the city,
- In response to the inner city commuting and trips, several actions were taken in order to develop public transportation, this include;
- o Development/ increasing metro tracks and lines: by the end of 2010, the length of the metro lines reached 125 kilometers with construction and completion of 70 stations. With such facilities the metro system has been capable of providing services and moving 2 million people per day and has been providing services for about 9% of the city commuters.
- o Development/ increasing bus services BRT (Bus Rapid Transit): bus routes used and dedicated for express buses services are considered as a new service for commuters in the city. Tehran Bus Rapid Transit was officially inaugurated in 2008 in order to facilitate the motor traffic in Tehran. As at 2011 the bus rapid transit (BRT) system had a network of 100 kilometers which transports 1.8 million passengers on a daily basis. The length of the rapid bus routes has increased from 19 kilometers in 2007to 85 kilometers in 2010.
- o Development and distribution of culture of using bicycles by establishing special bicycle booths and kiosk.

Suggested Policies and solutions

In order to solve issues related to different parts of the DPSIR framework, the following suggestions are presented:
- Following up the goals of the new detailed and comprehensive plan for the city and implementation of topic and locality projects.
- Development of geographical expansion and prolongation of the periodical reports on the environment (SOE) from the borders and limits of the 22 districts to larger Tehran's metropolitans[1]
- Taking action and supporting action plan and the implementation of 70 special plans for the renovation of the old deteriorated urban fabric.
- Preparation of integrated Guidelines and implementing Environmental impact assessment (EIA) and

environmental health Impacts (EIA) next to the social Impacts assessment (SIA) prior to implementation of civil projects in the city,
- To reach the goals for the comprehensive transportation plan regarding the share of the inner city public transportation[2]
- Follow up on strategic trends in environmental issues[3]
- Follow up on completion and operation of environmental facilities in industrial towns in the limits of the metropolitans of the province,
- Preparation of distribution of electromagnetic map of Tehran and the province,
- Development and expansion health system and health houses,
- Revitalization, renewal and strengthening of the operational mechanisms of the law pertaining the ban on the establishment of industries within a radius of 129 kilometers from the city.
- Reported policies and required solutions in previous SoE
- o Reconsideration and improvement of the law and regulations regarding the wastes and waste water,
- o Setting up the management system for control and prevention of waste water production (urban, industrial and hospitals)
- o Setting up the required facilities for participation of private sectors for waste management,
- o Making all the governmental organizations located in the capital responsible and to respect and obligate the environmental guidelines,
- o To distribute a stable and sustainable pattern for constructing buildings with special consideration to energy efficiency and efficient materials,
- o Organizing and creating professions and jobs with reduction of inner city travel in the mind and in the agenda,
- o Increasing the awareness, education and creation of culture of sharing in different layers of the society,
- o Strengthening scientific cores and sections for performing organized sound environmental research works,
- o Modification and improvement of environmental decision forming and decision making process,
- o Strengthening and enabling the organization and non-governmental environmental sectors in the city of Tehran,
- o Supporting and dedicating the required budget in order to speed up the city infrastructural development especially underground transportation routes in particular metro and also collection system for of waste water and network for collecting urban runoff,
- o Integrated management for urban environment,
- o Publication and promotion of all the local plans for facing the negative environmental Impacts, climate change and natural hazards by utilization local technology.

Notes

1- The city of Tehran and the surrounding communities including the major cities and villages at the present time are called the "Tehran Metropolitan". This large metropolitan area is heavily affected in terms of its environment, economic and social States by the city of Tehran. As a result it is essential with a systematic view and preparation of environmental periodic reports of the city of Tehran, the SOE should be covering larger areas including Firoozkuh and other urban area in the province portion and beyond the 22 municipality districts.

2- in the transportation comprehensive plan till the 1404 horizons the share of the inner city commuting or trips with public transportation has been accounted for 75% while the remaining 25% is carried out by private cars. Based on these data, 30% is the share of subway and underground metro transit while 22% is dedicated to buses, vans and taxis will be carrying 22 %. The remaining 3% is carried by mini buses while the main function of it is to provide transportation services for the bus terminals and marginal part of the city .

3- Follow up on strategic trends in environmental issues.
• Decrease in water consumption and energy, inner city pollution with respect to global indicators.
• Encouraging people to use the clean industry and services compatible with the environment
• Education and training of the work force with the goal and purpose of supporting the creation of clean and environmentally friendly and least polluting jobs
• Preventing the establishment of polluting industries in the immediate areas of the city
• Best effort to control polluting production processes
• Transferring information and public awareness in comparison with high cost of environmental pollution and short term benefit with the purpose of creating responsibility and self-controlling task in the citizens,
• Increasing social responsibilities of the industries in decreasing the industrial pollution, completing the cycle and process of recycling and decreasing the deteriorating environmental Impacts of the products in all the production points, the after sale services, and transfer of pollutant from outer city to the city environments,
• Elevating the place of the organization of environmental agency and respecting all the environmental laws and regulations in all aspects (urbane planning and construction, waste management, all aspects of transportation and traffic,(
• Harmonization of the city and urban fabric with natural

environmental (compatibility between urban texture and uniting it with urban ecology and environment).

Acknowledgement

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