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National Land and Housing Organization  
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## **Tehran spatial structure: Constraints and Opportunities for Future Development**

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### **A Executive summary**

Three priority objectives expressed by the Municipality of Tehran are directly related to the city's urban spatial structure. These objectives are:

- reducing pollution,
- improving the efficiency of transport, and,
- Developing cultural amenities worthy of a large regional capital.

The current spatial structure of Tehran – a high density city without a dominant CBD – presents a number of constraints and opportunities to achieve the municipal objectives.

At the central government level, the option of freezing the population of Teheran at 7.6 million people (its population in 2002) has been discussed. This is not a viable option because government cannot control demographic growth and because a city with a administratively mandated fixed population is condemned to stagnate economically. Economic stagnation for Tehran would mean that none of the current problem of pollution and transport could be solved.

#### Reducing pollution

There are only three ways of reducing urban pollution due to transport: reducing the number and length of motorized trips, decreasing the number of private vehicle trips by increasing the share of public transport trips and decreasing the amount of pollutant emitted by vehicles through technology improvement.

Tehran with about 146 people per hectare in the built-up area is a dense city by world standards; it is therefore not possible to reduce significantly the number and length of trips through further densification. Switching a large number of trips from private car to public transport might be difficult given that already about 60% of all the trips are done by public transport (including collective taxi). The only effective solution to relatively quickly decrease pollution is therefore to use technology: switching most public transport and taxi to CNG (compressed natural gas). This is being done with increasing success in many metropolitan areas of the world. There is also the possibility of using fuel cell buses as it is now being done in Sweden and other countries (see reference 1).

Converting public transport vehicles and taxi to CNG will reduce pollution only if the share of public transport trips remains above 50% of all trips. However, because of the constraints presented by the spatial structure of Tehran, just to maintain the present share of public transport might become a challenge in the future. Maintaining transit market share can

be achieved by improving public transport services and taxing private cars or restricting their access in the city (in Tehran already, private cars from outside the area are banned in some centrally located neighborhoods)

#### Improving the efficiency of transport

Tehran's type of urban structure presents a dilemma for the design of a modern transport system. The high density of Tehran suggests that a mass transit system would be justified. However the dispersion of employment and commerce throughout the city, and the lack of a strong CBD as a destination for a large number of trips, makes mass transit difficult to operate until the networks covers the entire city.

Tehran has 2 options to improve the efficiency of transport depending on the possibility of reversing the current dispersion trend of employment and shopping areas:

1. Assuming the spatial structure of Tehran cannot be reversed, the best transport option is to further develop collective taxis to serve trips on a large number of routes with multiple origins and multiple destinations;
2. Assuming that the spatial structure of Tehran is able to evolve, and that resources are available to fully develop the planned metro, public transport should be developed by creating a dense network including metro, buses and collective taxis.

For both option, because of the high density of Tehran the share of private car trips should not increase above 40%. This can be done by congestion toll pricing on urban highway and charging market price for street curb parking and creating unsubsidized privately operated parking garages.

#### Option 1.

If the extension of mass transit was proved to be too costly, then the only efficient transport mode compatible with the spatial structure of the city would be the development of bus lines, but with emphasis on collective taxis and minibuses. Because of the dispersion of origin and destination of most trips, few transport corridors will prove to be efficient and smaller public transport vehicles would be the only ones to be able to provide the nearly "door to door" service that the consumer requires in a city like Tehran. If this option was selected, then the city land use policy would be different from the "metro option":

- Systematic redesign of curb line and sidewalks at the minibuses and collective taxi stops
- Completion and addition to the urban highway system, possibly with the introduction of congestion pricing, i.e. tolls collected by transponders and varying with time of days. Special tolls could be given to collective taxis and minibuses.
- Allowing densification and development wherever the existing infrastructure permits it or where it is cheaper to develop (no need to favor transport corridors) or where there is a strong demand;
- Favoring the extension of the built-up area in the western part of the city as yet undeveloped.

#### Option 2

The current 43 metro stations are accessible from only about 10 % of Tehran built-up area and by about 14% of the municipal population. To be efficient the Tehran metro should be accessible to at least 50% of the population. The extension of the metro from the current 2 lines to the planned 9 lines would indeed provide about 56% population coverage and therefore might make a significant difference in reducing the number of surface vehicles and therefore both improving traffic flow and reducing pollution. However, given the topography and seismic constraints in Tehran, the extension of the metro will represent an enormous capital cost and a commitment from the government to support with subsidies high transport O&M costs indefinitely into the future. If the mass transit option were adopted, then land use policy should be amended as follow:

- Large increases in floor area ratio should be allowed around existing and planned metro stations.
- An impact fee could be recovered from developers and used to finance a part of the construction of stations.
- An area of high accessibility by metro should be selected as a future CBD and commerce and offices should be allowed to develop within that area using a high floor area ratio as an incentive.
- In general, higher floor area ratio should be allowed for both commerce, office and residential to encourage development along the mass transit stations, existing or planned.
- Vacant or abandoned construction lots within the transport corridors should be heavily taxed “ad valorem” until they are turned to full utilization compatible with the desirability of their location.

#### Developing cultural amenities worthy of a large regional capital

This objective would normally require the development of a part of the city highly accessible by public transport. Empirical evidence shows that cities with a weak CBD have difficulties creating world class cultural amenities, while being able to have a prosperous economy. It seems that the development of a vibrant cultural life in Tehran would require a focal point, not necessarily corresponding to the business district but at least linked to a major commercial center and highly accessible by transport from all part of the city. The development of cultural amenities requires clustering of establishments such as exhibition halls, museums, concert halls, art galleries, bookstores, libraries, cinemas, restaurants, café, etc. Some would be publicly owned, like most museums and concert halls some would be private.

This cultural objective is therefore more compatible with the mass transit option which would provide automatically a point of high accessibility in the center of the city. But it could also occur if the main mode of transport were collective taxis and minibuses. The specific action the government could take would be:

- Selecting a high accessibility neighborhood where 2 or 3 large state or city owned cultural establishment would be created.
- Allowing a rapid “recycling” of land in the areas around the main cultural facilities to allow private entrepreneurs to respond to the demand created for ancillary cultural facilities like galleries, bookstores, cinemas, etc.
- Municipal investing in urban design for pedestrian space in the city blocks around the major cultural facilities, this may include pedestrian streets.

#### Conclusion:

Tehran has a high potential for economic development, being the largest urban concentration between Istanbul and Mumbai. Once a public transport option has been selected, land use regulations, infrastructure investments and land taxes should be internally consistent and reinforce the option selected.

## **B Why spatial structure matters**

The spatial structure of a city is very complex. It is the physical outcome of the subtle interactions over centuries between land markets, and topography, infrastructure, regulations, and taxation. The complexity of urban spatial structures has often discouraged attempts to analyze them and ad fortiori to try to relate urban policy to city shape.

The spatial structure of a city has an important impact on economic efficiency and on the quality of the urban environment. However, the evolution of urban form, shaped by the complex interaction between market forces, public investment and regulations, is not often monitored. Consequently, the significant inefficiencies due to a poor spatial structure are often ignored until it is too late to do anything about it. Too often urban planners have relied on Master Plans prepared typically every ten years to insure that cities would develop according to municipal objectives. A city, however, is not similar to a very large building and is never build according to blue prints. A city development is constantly influenced by external economic forces. Cities’ survival depends on finding rapidly imaginative solutions to new emerging problems which could not have been anticipated by the author of master plans.

In the case of Tehran, for instance, a major restructuring of central government financial transfer in 1985 obliged the municipality to look for alternative source of funds. Decision was taken to charge developers for any increase in floor area ratio over a maximum established by the master plan of 1991 This decision, taken to fulfill a financial objective, had more impact on the spatial structure of the city than the master plan itself. It could not have been anticipated, and it resulted in a structure which cannot be reversed even in the middle term.

From an economic point of view, a city is a large labor and consumer market; the larger the size of the market and the lower the costs of transactions, the more prosperous is the economy. A deficient spatial structure fragments labor and consumer markets into smaller less efficient markets; it contributes also to higher transactions costs by unnecessarily increasing distances between people and places. A deficient spatial structure increases the length of the city infrastructure network and therefore increases its capital and operating costs. A deficient spatial structure can render a city economically uncompetitive.

From an environmental point of view, a deficient spatial structure decreases the quality of life by increasing the time spent on transport, by increasing air pollution, while contributing to the unnecessary expansion of urbanized areas in natural sites. A poor environmental quality could also contribute to render a city economically uncompetitive.

In market economies, municipalities can influence the shape of urban development, not through direct design, but by implementing a coherent and consistent system of land use regulations, infrastructure investments, and land related taxes. In the long run, the shape of a city will depend on the way the real estate market reacts to the incentives and disincentives created by these regulations, infrastructure investments and taxes. Because external economic conditions are continuously changing and are unpredictable in the long term, the planning department of municipalities should constantly monitor the evolution of the spatial structure of their city, and adjust eventually the balance and nature of regulatory incentives and disincentives, plan new and different infrastructure investments and reform local taxes if necessary.

A city's spatial structure is constantly evolving. Because of a lack of political consensus or a clear vision on spatial development, land use regulations and infrastructure investments are often inconsistent and their combined effects might contradict each other. It is therefore important that municipalities monitor the spatial trends of development and take regulatory remedial action when this trend contradicts municipal objectives.

In the case of Tehran, the municipality has clearly formulated its priority objectives: reducing pollution, increasing intra city transport efficiency, and increasing the availability of parks and cultural facilities. The question to be answered is what type of regulatory changes, infrastructure investments and taxation reform will have the most chance to achieve the municipal objectives?

### **C Spatial structure and municipal objectives**

Tehran Municipality Strategic Plan – Tehran 80 – set 6 priority objectives to guide its strategy. These objectives are:

1. “Clean City: a city in which pollution is under control”
2. “Smoothly Moving city: an efficient intra-city traffic and transportation”
3. “Green city: an expansion of green areas”
4. “A high cultured City: expansion of cultural and educational space in order to enhance the city's culture”
5. “Dynamic city: the needs of citizens for administrative services are met as quickly as possible”
6. “Modern-Traditional texture: the realization of an intermixed urban fabric of traditions and modernism.”

All the above objectives have direct implications for the development of the spatial structure of Tehran Metropolitan Area (TMA). However the first four priorities are particularly relevant to spatial development. It should be noted also that first two objectives are in fact a precondition to the economic prosperity of the TMA. It should also be noted that

the fourth objective, “a high cultured city” has spatial implications which will be discussed below.

To achieve the municipal objectives the current urban spatial structure presents both challenges and opportunities. I will review briefly the spatial characteristics of Tehran metropolitan area and will follow by discussing a number of spatial issues directly related to the objectives. Finally I will recommend a course of action on specific topics which should allow the municipality to meet the municipal objectives.

## **D Tehran municipality**

### **1. Tehran spatial structure**

Three main features characterize urban spatial structures: the consumption of land per person, the spatial distribution of population in the built-up area and the pattern of daily trips within the city. The data available shows that Tehran has an exceptional spatial structure. It has a high density combined with a mildly polycentric structure. The absence of a strong center and the spatial dispersion of employment are usually associated with built-up densities below 30 people per hectare. Tehran average built-up density at 146 p/ha is uncommon for a polycentric city. This unusual feature, not necessarily negative, suggests it would be necessary to be cautious in recommending solutions which have been successful in other cities of the world with a completely different spatial structure.

#### Land consumption per person

The land consumption per person defines the area that a city requires for its development. It is usually measured by its inverse, the density per person measured in people per hectare of built-up area<sup>1</sup>. The density in the built-up area within the municipal boundary of Tehran is 146 people per hectare (p/ha). Compared to the built-up density of other cities of the world, this is a rather high density (see [Figure 1](#)) however, when compared to other cities of Asia, Tehran density is only close to average, and about twice lower than the built-up densities in East Asian cities like Seoul, for instance. From this comparison it appears that the density of Tehran should not be an issue. It could go either higher or lower without major environmental or infrastructure problems.

From the data available, it is possible to calculate the evolution of Tehran built-up densities between 1891 and 1996 ([Figure 2](#)). It can be seen that, as it has happened in most metropolis of the world, the built-up density of Tehran has been decreasing with the years, stabilizing around 1950, increasing slightly between 1970 and 1976 and stabilizing again at its present level between 1987 and 1996 (no data is available to calculate the built-up density in the years after 1996).

The historical decrease of density in Tehran seems counterintuitive. Residential high rise buildings have appeared since 1960 and have multiplied since 1980. This increase in

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<sup>1</sup> Most of the time densities are measured by administrative area rather than built-up area. For instance, the area of Tehran municipality is about 700 square kilometers. As the population in 1996 was 6.751 million, the administrative density in 1996 was about 96 p/ha. However only a part of the land within the municipal boundary is developed, as a consequence when more land is developed the administrative density is bound to increase although the new development might be at a density lower or higher than the current average density. Using the built-up density allows to monitor the amount of land which is used per person over the years, it also allows comparison between cities. In this report all densities are built-up densities which is defined as all areas urbanized, including streets and industrial areas but excluding parks larger than 4 hectares and airports.

building height have resulted in lower density – and not higher densities as would have been expected – because simultaneously as building were getting taller, Tehran's households consumed more floor space per person. The increase in floor consumption per person has been higher than the increase in floor space density, hence decreasing the population density.

The possibility of constructing high rise residential buildings tends to reduce housing price and therefore increase floor consumption per household. The present average floor consumption in Tehran is 25.5 m<sup>2</sup> per person, similar or above the consumption of several cities of Europe with a per capita income<sup>2</sup> several time Iran's. (see [Figure 3](#)) The high consumption of floor space in Tehran can be explained by several factors: housing might be a high priority in the average households budget, the construction industry is probably efficient, and last, the recent policy of increasing floor area ratio in many areas of Tehran has resulted in a large increase in the supply of floor space and therefore in reducing the price of housing.

#### Spatial distribution of population

The distribution of population in Tehran does not follow the usual pattern with a decreasing density as ones get farther from the city center. The map of [Figure 4](#) shows that most high densities are located in the Southern part of the city while lower densities are in the northern part, which, incidentally, has also the highest proportion of high rise buildings. The map of [Figure 4](#) shows the center of gravity of the city, which is the point with the shortest distance to the population spread across the municipal area as measured from census data. This center of gravity is located at about 600 meters South East of the crossing of Enqelab and Vali-ye-Asr Avenues. For convenience I have taken this street crossing as the center of the city for further spatial analysis.

In most cities, the central business district (CBD) and the center of gravity coincide. This is the case in Tehran if one considers that the intersection of Enqelab and Vali-ye-Asr Avenues is the center of the CBD. However, the intensity of business use and retail which characterize CBDs is absent from central Tehran. The map of [Figure 4](#) shows that densities follow a crater like pattern around the CBD. In some cities – London and Tokyo, for instance – this crater pattern indicates that business and retail so dominate the area that residences have been pushed toward the periphery of the CBD. This does not seem to be the case in Tehran. It appears that the relatively low density in the CBD area is more due to an under-use of land, either because of abandoned buildings or large institutional holdings.

#### (a) *Density profile*

The density profile of Tehran, shown on [Figure 5](#), confirms the diagnostic made above. Densities increase on a distance of 6 kilometers from the center to fall again toward the periphery showing in a different form the crater pattern observed on the map of [Figure 4](#). This pattern, in the absence of strong and dominant commercial and business activities in the center suggest a weak CBD, i.e. a CBD which do not contain many jobs and which is not very attractive for retail either. On [Figure 6](#), the density profile of Tehran is compared to 8 other

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<sup>2</sup> In [Figure 3](#), PPP or Purchasing Power Parity is used instead of GDP as a more accurate way of calculating relative wealth between countries. See

<http://www.worldbank.org/depweb/english/modules/glossary.html#ppp> for a more complete definition of PPP.

large cities located in Asia, Europe and North America. Tehran highest density is not particularly high compared to other cities of Europe and Asia, although its average density is much higher than all the other cities shown on the graph of Figure 6 with the exception of Barcelona. Note the crater like pattern of Jakarta density profile, but in the case of Jakarta the pattern is due to a large cluster of office skyscrapers and large department stores in the CBD areas which are absent in Tehran.

The demographic trend seems to reinforce further the observed crater pattern of densities and the tendency in Tehran for densities to become uniform at a high level in the periphery rather than at the center. The map of [Figure 7](#) shows that the districts in the center and to the South west of the center – districts with the highest densities have lost population during the 10 years between 1986 and 1996. Simultaneously, the districts with the lowest density have gained population. People living in the oldest and densest parts of the city are leaving for the newest and less dense parts. In the long run, this suggests that densities in Tehran are going to become more uniform. Uniform densities are normally associated with polycentric cities, i.e. with cities where jobs and retail are dispersed throughout the urban area.

(b) *Land prices*

The pattern of land prices confirms the diagnostic made earlier: Tehran has a weak CBD not very attractive to business or retail ([Figure 8](#)). Land prices around the center of gravity of the city are significantly lower than in the northern part of the city. Tehran is possibly the only large city in the world where land in the center is cheaper than in the periphery. In Tehran the difference in price between various locations can be explained purely by environmental quality. The areas located in the Northern part of the city are less polluted, the climate is better, being at higher altitude (about 300 m differences between Northern and southern part). Accessibility and proximity to the center does not seem to play a role in the formation of land prices.

In most cities of the world, the land price profile follows closely the density profile; there is an abundant literature both theoretical and empirical on the subject. In Tehran the density profile and the price profile varies in opposite direction. Note on [Figure 9](#) the difference between Tehran's price and density profile and Paris'. This confirms that the CBD is a weak attractor and that the city is in fact dominantly polycentric with a high dispersion of jobs and retail. We will see below that this peculiar spatial structure has implications for the design of future transport system and will limit the options available to reduce pollution due to transport.

(c) *Spatial Pattern of housing consumption*

The spatial differentiation of Tehran is not so much from center to periphery but from North to South as seen above. Households' income and households' floor space consumption follows the same North-South pattern ([Figure 10](#)). The spatial social segregation of Tehran is stunning; household's expenditures are 3 times higher in the northern district as compared to the Southern districts, and residential floor consumption is 4 times higher in the North as in the South. While many cities of the world show a spatial bias in the distribution of households' income (for instance there is a western bias for high income in London and Paris) these bias are not as pronounced as in Tehran. While social integration is not an objective of the municipality, given the spatial reality, it might be worth considering social segregation as an issue for future development.

### Pattern of daily trips

Origin and destination matrices for vehicular job commuting and shopping trip shows that districts 6 and 12 constitute indeed the closest thing to a CBD in Tehran (Table 1 and Figure 11). But these 2 districts attract only 27% of all shopping trips and 30% of all job commuting trips. If jobs were uniformly distributed between all 20 districts surveyed, each district would get 5% of all the trips. The 2 districts (6 & 12) which appear to constitute the CBD are the destination of only about 2.7 times the number of shopping trips that they would receive if the trips were uniformly distributed. It should be noted that the matrix shows only vehicular trips, not all trips. Given the high density of Tehran, a large number of shopping trips are done on foot to neighborhood shops and therefore the 27% of vehicular shopping trips to the CBD are probably an overestimate of the percentage of all shopping trips. The weakness of the CBD as an attractor is confirmed by its low density and its low land price.

### Spatial Structure Summary: Tehran is a high density, mildly polycentric city

We have looked at a number of spatial indicators to define the spatial structure of Tehran. Let us summarize the results:

1. High average built- up density by world cities standards, but medium density as compared to other large Asian cities;
2. low density in the center, high density in dispersed areas outside the center;
3. low prices in the center, much higher prices in northern suburbs, lower land prices in the southern suburbs;
4. social segregation along and East-West axis with higher income and higher floor consumption in the North and lower income and consumption in the South;
5. High consumption of floor space per person;
6. districts 6 and 12 constitute Tehran CBD, but this CBD is a weak attractor of jobs and shopping facilities;

While most cities are structured around a centrally located CBD and residential suburbs, Tehran is structured around a East West axis following roughly Enqelab avenue. It possess a well accessible CBD close to the center of gravity, but this CBD has a low land value, low density and is a weak attractor of commuting and shopping trips. For this reason, Tehran can be defined as a high density, mildly polycentric city. This type of spatial structure limits the number of options which are available to meet the municipal objectives set in the master plan

## **2. spatial issues: opportunities and constraints of current spatial structure**

The exceptional spatial structure of Tehran creates opportunities and constraints which will have to be taken into account in developing the strategies to fulfill the municipal objectives described above. The constraints and opportunities will appear to be different depending on the objectives. The recommendations contained in this report are based on the assumption that Tehran municipality is going to continue to attract people and enterprises in the years to come. The changes proposed will require a dynamic city, i.e. a city where new opportunities are arising because its constant adaptation to changing circumstances, many of these circumstances being not only exogenous to the city but also to the country. For instance, changes in world oil prices, the possibility of regional international trade, progress in communication technology are exogenous factors which cannot be predicted but which will affect the welfare and development of Tehran.

However, it appears that at the National government level the possibility of freezing the population within the municipal boundaries of Tehran at 7.6 million is seriously envisaged. If that was the case, the current report will lose its usefulness. A city whose population is frozen by government fiat has no future and no flexibility for change. It could be compared to an elderly person retiring to a nursing home. In such a no growth city, the priority would be to prevent the situation to deteriorate further, but there would be really no need to envisage plans for the future. The nursing home analogy for Tehran is a particularly apt one, in this case, as freezing population at its current level would require younger people to leave the city to try to make a living elsewhere. As a consequence, after a few decades only old retired people will be left in the city.

Before addressing the spatial issues directly linked to the municipal objectives, it is necessary to seriously discuss the desirability of freezing the population of Tehran at 7.6 million as it has been mentioned. I hope to convince policy makers that this is not a serious option.

#### Freezing the population of Tehran Municipality at 7.6 million, is it really an option?

The idea that cities have an optimum size is an old one, and at first glance may seem to make sense. If it could be established that cities had an optimum size, it would be sensible to prevent further growth when this optimum is reached. However, there are many practical and theoretical reasons why nobody has ever been able to demonstrate that cities may reach an optimum size and that further growth beyond this optimum would lead to a deterioration in environmental quality and a decline in economic vitality.

In the 50s and 60s practically every major city in the world had a maximum target population with projected population overflows going to satellite towns and secondary cities. All of these cities have grown far beyond their maximum targets. Even in command economies like the Soviet Union or Maoist China, where people required a residency permit to migrate to large cities, cities grew faster than planned.

Cities are dynamic, they need to change and adapt quickly to new circumstances. With a stable or falling population, they lose their dynamism as there is no reason to build anything and no possibility of creating new jobs. Preventing deterioration is the only possible activity. In an economy like Iran's, the government cannot control migration or the number of babies born each year as it has been done in China until recently. Government can control only land use and infrastructure. In order to keep the population at a set figure, government can only prevent new floor space from being built. We have seen that there is a big difference in floor space consumption between the Southern and Northern part of Tehran. Banning new construction to keep municipal population stable means in fact that households living in small apartments in the southern part of the city could never hope to ever get larger dwellings, unless they leave the city.

The growth rate of Teheran between 1980 and 1996 has been around 1.36% annually. Therefore, if new construction is frozen at its current state, floor space consumption per person is going progressively to decrease as the new population is unlikely to abandon Tehran. It has been argued that freezing infrastructure capacity at its current level in Tehran and increasing it in satellite towns would force "surplus" population to move out of the municipal boundaries. But people move or choose to stay in Tehran, in spite of its pollution and congestion problems for many good reasons other than infrastructure: among them, better job and education opportunities. People would be discouraged to remain in Tehran only when the economy and the amenities of the city deteriorate to the point where the most dynamic among them would

decide to leave the city. This is not a politically viable solution, and it is unlikely that any government would deliberately risk creating 8 million discontents and scuttling its most efficient economic engine just to attain the abstract objective of maintaining the city population at a set figure.

The following analysis and recommendations are made assuming that the idea of keeping Tehran at a fixed target population has been abandoned. The three main objectives of the municipalities, reducing pollution, improving the efficiency of transport and creating the cultural amenities worthy of a regional capital remain therefore the framework for the recommendation contained in this report.

#### Objective 1: Reducing Pollution

There are only three ways to reduce urban pollution due to transport: reducing the number and length of motorized trips by changing the spatial structure of the city, decreasing the number of private vehicle trips by increasing the share of public transport trips and decreasing the amount of pollutant emitted by vehicles through technology improvement.

The number and length of motorized trips can be reduced by increasing density, or at least maintaining current built-up density while the city expands. When a city expands, distance between households and jobs and facilities increases. If the average density decreases while the population increases, the city built-up area expands at a faster rate than its population and therefore trips also become longer at a faster rate than the population increases. Maintaining a stable density while a city built-up area expands means that trips length are increasing at the same rate as population.

Tehran with about 146 people per hectare in the built-up area is a dense city by world standards; it is therefore not likely that the number and length of trips will be reduced through further densification. However, maintaining current densities might be a feasible goal. This would require increasing the floor area ratio in new and in renovated buildings so that every year the additional floor space per hectare roughly matches the increased floor consumption per households. We have seen that the density of Teheran after decreasing continuously until 1950 more or less stabilized until 1970 when density went up again (Figure 2) . Since 1985 average density has again stabilized, in spite of the large increase in floor consumption per person. This is due to an increase in high rise buildings. If this increase had not been allowed the built-up area would be much larger than it is now, vehicular trips would be longer and more numerous, and pollution due to transport would be even worse than it is now.

The government however cannot mandate a stabilization of density. It can only allow it. Whether in the long run density stabilizes as the city expands depends on households' demand for apartments in high rise buildings as compared to demand for low rise or houses. Government could allow a stabilization of density by increasing the permissible floor area ratio in some areas under certain conditions, in particular by requiring the payment of an impact fee as discussed below. Allowing a stabilization of density is only a part of a strategy to reduce pollution due to transport.

Another way of reducing the number of vehicular trips is to promote a policy which will result in switching a large number of trips from private cars to public transport. This might be difficult in the short run in Tehran for two reasons:

- About 60% of all the trips are already done by public transport (including collective taxi) ([figure 12](#)). This is a comparatively high percentage for a city with Tehran income, it is unlikely to increase much even if public transport investments and performance were to be increased (the full completion of the planned metro could probably stabilize the ratio of public transport at 60%, this issue is discussed below).
- The current spatial structure of Tehran with its polycentric shape and job dispersion is not favorable to public transport, in spite of its high density. Because the CBD is a weak attractor, transport routes have multiple origins and multiple destinations. As a consequence, public taxis are the more efficient type of public transport. As households' income increases and the city expands, private cars might well become the most convenient and affordable mean of transport on many routes.

The most effective mean to quickly decrease pollution due to transport is to switch to less polluting fuel. For instance, switching most public transport and taxi to CNG (compressed natural gas) would immediately reduce pollution. This is being done with increasing success in many metropolitan areas of the world. Switching public transport from gasoline to CNG requires some government stimulant, in the form of legislation and initial subsidies to retrofit engines and to install distribution stations.

There is also the possibility of using fuel cell buses as it is now being done on an experimental basis in Sweden and other countries (see reference 1).

#### Objective 2: Improving the efficiency of transport

Tehran's type of urban structure – a high density city with a polycentric pattern of trips – presents a dilemma for the design of a modern transport system. The high density of Tehran would justify a mass transit system. However the dispersion of employment and commerce throughout the city, and the lack of a dominant CBD as a destination for a large number of trips, makes a limited mass transit network difficult to operate. Under the current spatial structure it appears that collective taxis are the most effective means of transportation. The diagram of [Figure 13](#) illustrates the dilemma. The effectiveness of public transport depends on the spatial structure of a city. In most cities, there is a positive correlation between the density and the dominance of the CBD. Public transport is most effective in high density and strongly monocentric cities (example Shanghai). By contrast, individual transport is the only practical solution in very low density highly polycentric cities (example Atlanta). Most cities lay in between these 2 extremes, they have middle range densities and they are mildly monocentric. In this case, public transport is more efficient for the trips having the CBD as destination or origin and individual transport is more efficient for trips from suburbs to suburbs.

Tehran with its high density and mildly polycentric structure make it a clear outlier. The high density precludes having individual transport as the dominant form of transport and the dispersion of jobs and shopping trips make high capacity public transport inefficient.

However, the spatial structure of Tehran is not immutable (unless its population stops growing). It is therefore important to consider more transport options, assuming that the spatial structure could evolve. In addition, a change in the transport system could affect in the middle and long term the spatial structure of the city.

I would therefore consider the following 2 options:

1. The spatial structure of Tehran cannot be reversed and the best transport option is further development of collective taxis to serve trips on a large number of routes with multiple origins and multiple destinations;
2. The spatial structure of Tehran is able to evolve and resources are available to fully develop the planned metro.

For each option, I will recommend the type of urban planning legislation and investment and taxation which is the most consistent with the municipal objectives.

The dominance of individual cars as the principal mode of transport in Tehran is to be excluded for both options because even if the current density decreases over the years, it is unlikely to reach such a low level (say below 30 p/ha) that car would become an efficient mean of transport. The current density of Tehran – 146 p/ha – corresponds to an average land consumption of about 68 m<sup>2</sup> per person. A private car used as a main mean of transport requires about 55 m<sup>2</sup> of land to park and maneuver around the city at a speed of about 35 km an hour. There were about 700,000 private cars in Tehran in 1996 or about 105 cars per thousand persons. Some of these cars may not be used for daily commuting, but if we assume they are, they require about 6 square meters of land out of the 68 m<sup>2</sup> used per person in Tehran. When the car ownership reach 400 per 1000 as it is likely considering world trend in this matter, private cars in Tehran will require about 24 m<sup>2</sup> per person or about 35 % of the total land area available per person. In the competition for space between people and land, cars have usually the first choice. If energetic measures are not taken to limit the use of car to recreation and out of town trips, inhabitants of Tehran will be pushed into a constantly shrinking space. For this reason it is important to take measures to limit the use of cars and prevent them from becoming the main mode of urban transport.

#### Option 1: Development of collective taxis and minibuses as dominant transport mode.

I assume that the current trend toward dispersion of jobs and retail continue and that density stabilize or possibly decrease but stay above 100 p/ha in the next 20 years. In this case the only efficient transport mode compatible with the spatial structure of the city would be buses, but with emphasis on collective taxis and minibuses. Because of the dispersion of origin and destination of most trips, few transport corridors will prove to be efficient and smaller public transport vehicles would be the only ones to be able to provide the nearly “door to door” service that the consumer requires in a city like Tehran. If this option was selected, then the city land use policy would include the following components:

- Restrictive parking policy for private cars, fee for parking in public space, encouragement of private parking at market price.
- Systematic redesign of curb line and sidewalks at minibuses and collective taxi stops
- Completion and addition to the urban highway system, possibly with the introduction of congestion pricing, i.e. tolls collected by transponders and varying with time of days. Special tolls could be applied to collective taxis and minibuses.

- Allowing densification and development wherever the existing infrastructure permits it or where it is cheaper to develop (no need to favor transport corridors) or where there is a strong demand;
- Favoring the extension of the built-up area in the western part of the city as yet undeveloped.

#### Option 2 : completion of the planned metro network and development of a dominant CBD.

The current 43 metro stations are accessible from only about 10 % of Tehran built-up area and by about 14% of the municipal population<sup>3</sup> (Figure 14) . To be efficient the Tehran metro should be accessible to at least 50% of the population. The extension of the metro from the existing 2 to the planned 9 lines would provide about 56% population coverage and therefore might make a significant difference in reducing the number of surface vehicles, therefore both improving traffic flow and reducing pollution. However, given the topography and seismic constraints in Tehran, the extension of the metro will represent an enormous capital cost and a commitment from the government to support with subsidies high transport O&M costs indefinitely into the future. However, these capital costs could be reduced by selling air-rights above and around stations to commercial establishments.

If the mass transit option were adopted, then land use policy should be amended as follow:

- Large increases in floor area ratio should be allowed around existing and planned metro stations.
- An impact fee could be recovered from developers and used to finance a part of the construction of stations.
- An area of high accessibility by metro should be selected as a future CBD and commerce and offices should be allowed to develop within that area using a high floor area ratio as an incentive.
- Large well designed pedestrian zones will be created in high accessibility area increasing the market value of land in and around the CBD and other sub-centers.
- In general, higher floor area ratio should be allowed for both commerce, office and residential areas to encourage development along the mass transit stations, existing or planned.
- Vacant or abandoned construction lots within the transport corridors should be heavily taxed “ad valorem” until they are turned to full utilization compatible with the desirability of their location.
- Restrictive parking policy for private cars, fee for parking in public space, encouragement of private parking at market price.

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<sup>3</sup> Accessibility to buses and metro station is calculated by drawing an 800 meter buffer zone around each station and calculating the population residing in the zone using 1996 census data. It is assumed that the average users of public transport would walk a maximum of 800 m (about 12 minutes walk) to reach a metro station .

- In general encouragement for the redevelopment of existing built-up areas at higher floor area ratio, more investments in reinforcing the infrastructure in built-up areas compared to the extension of new areas.

### Objective 3: Developing cultural amenities worthy of a regional capital

This objective would require much more intensive development of a part of the city highly accessible by public transport. In most of the world, cities with a weak CBD may have a flourishing economy but are not culturally very developed. It seems that the development of a vibrant cultural life in Tehran would require a focal point, not necessarily corresponding to the business district but at least linked to a major commercial center. The development of cultural amenities requires clustering of establishments such as exhibition halls, museums, concert halls, art galleries, bookstores, libraries, cinemas, restaurants, café, etc. Some would be publicly owned, like most museums and concert halls some would be private.

This cultural objective is therefore more compatible with the mass transit option which would provide automatically a point of high accessibility in the center of the city. But it could also occur if the main mode of transport were collective taxis and minibuses. The specific action the government could take would be:

- Selecting a high accessibility neighborhood where 2 or 3 large state or city owned cultural establishment would be created.
- Allowing a rapid “recycling” of land in the areas around the main cultural facilities to allow private entrepreneurs to respond to the demand created for ancillary cultural facilities like galleries, bookstores, cinemas, restaurants, etc.
- Municipal investing in urban design for pedestrian space in the city blocks around the major cultural facilities, this may include pedestrian streets.

### Does Tehran needs a CBD ?

The absence of a dominant CBD is a striking feature of Tehran’s spatial structure. One may speculate on the historical circumstances which have stunted the development of a CBD as Tehran developed into one of the largest city in the world. The practical question is whether Tehran needs a CBD? Some affluent cities of the world survive very well with a weak CBD; for instance, many North American cities have a CBD which account for less than 10% of trips. However, the Iranian tradition of the bazaar – a large and unique concentration of commercial activities in a semi enclosed pedestrian area – suggests that the absence of a strong CBD in Teheran is more an historical accident than a deliberate cultural rejection.

The municipal objectives concerning transport and culture would be easier to achieve with a dominant CBD than with a weak one. The question is whether the municipal government should intervene in stimulating the concentration of new commercial space – a matter which is normally left to the private sectors? Although I am usually skeptical of government direct intervention in land development, I think that in Tehran a good case can be

made for stimulating the creation of a strong CBD. The location should be in district 6 or 12, close to the center of gravity of the city and around and between existing metro stations.

The government would intervene in 3 manners:

1. legislation: increasing allowed FAR with adequate impact fees, while promoting public pedestrian open space by limiting footprint intensity or allowing to count as unbuilt any covered public pedestrian space like shopping gallery or plaza. Remove curb parking privilege for private cars within the CBD perimeter, this would increase the space available for pedestrian, and improve traffic flow.
2. infrastructure investment: redesign of metro entrance stations to take into account the flow of pedestrian toward and from commercial areas; redesign of wide sidewalk in the entire CBD designated area; eventual redesign and reinforcement of water, sewer and electricity networks to take into account a higher use intensity;
3. taxation: tax land within the perimeter of the CBD “ad valorem” i.e. tax land at its market value whether it is built or not. Tax vacant land or vacant buildings at the same rate as built land. This will stimulate the disposal of vacant land and unfinished building and would put them on the market while avoiding the spatial fragmentation of emerging new commercial ventures.

The above actions plan does not involve any subsidies or direct incentive for private construction, only a strong indication to the private sector that any concentration of investment in the area will be supported by adequate infrastructure.

During the implementation of the project, the municipality should monitor the evolution of real estate prices within the CBD perimeter and in adjacent area. Ad valorem tax base for real estate property should be adjusted yearly to reflect changing values.

The dominant mode of public transport selected – metro or minibuses and collective taxis – will greatly influence the feasibility of creating a vibrant CBD. Simultaneously the deliberate creation of a modern CBD in a high accessibility area could reinforce the demand for mass transit.

#### Summary of options and objectives

The implementation of the 3 municipal objectives of reducing pollution, increasing transport efficiency and creating a cultural city are very much linked to a coherent policy requiring the coordination of investments in transport and land use. To reduce pollution the most efficient short term measure would be to shift public transport vehicle from diesel and gasoline to CNG. To increase the efficiency of transport, two options should be explored: the first one assuming the continuation of the present dispersed polycentric spatial trend and relying on the extension of collective taxis and minibuses, the second option consisting in trying to partially reverse past trend by giving a major role to a dominant CBD and relying on mass transit as a major transportation mode. Whatever option is selected, the city should adopt a strong parking policy stopping the current subsidies to private cars in the form of free curb parking. Another policy common to the 2 options will be to redesign more pedestrian space to make the city safer to pedestrian and more attractive.

### **3. The control of density: benefits and costs of past practice**

The past Municipal practice of selling zoning variance allowing a floor area ratio (FAR)<sup>4</sup> increase wherever there was demand has been discontinued for 7 districts since April 2002, resulting in a sharp increase in land prices. Land price did increase as the decrease of allowable FAR resulted in a potential increased demand for land as more land would be required for building the same amount of floor space.

The selling of zoning variance over the densities of the Master Plan of 1991 was legally based on an ordinance allowing the municipality to do so.

This practice had some positive and negative side. Because of the very serious environmental and financial side effects, a reform of the system was certainly needed. However, a freezing of density (or floor area ratio) at the level fixed by the Master plan of 1991 might not be a good idea given the development objectives of the municipality.

The negative effects of selling FAR increases in an indiscriminative way have been well documented. The main problem comes from the way the FAR increase was established and the way the fee went into the general municipal budget as if the fees were a net recurring income.

An increase in FAR in already developed areas usually requires an increase in infrastructure capacity to service the increased population. In some part of the city this increase in infrastructure capacity might not be possible. Whenever an increase of FAR is given in such low service area, the existing and future population will enjoy a lower level of services and amenities than was available before the increase. In this case the increase in FAR results in a loss of welfare for the population of the neighborhood where a density increase has taken place.

In areas where an increase in infrastructure capacity is feasible, the municipality will incur a cost to adapt the infrastructure and social services to the increased number of population. While the municipality receives a fee for the increase in FAR, it also incurs a cost because the municipality has an implicit obligation to maintain an adequate level of services. Unless the cost of providing services to an increased population is calculated and taken into account when establishing the fee, the municipality has no way of knowing whether by allowing an increased FAR it is making a profit or losing money in the long run.

It appears that the fees proceeding from the FAR increases were representing about 90% of the municipal revenues and were often spent for operation and maintenance as well as for capital expenditure. This practice is of course very risky because the liabilities linked with the FAR increase were never taken into account. In addition, fees coming from FAR increases cannot in the long run represent a steady source of revenues. The real estate industry is extremely cyclical and any municipality relying mainly on FAR impact fees for its O&M spending is bound to face recurring serious financial crisis.

However, the practice of allowing a higher FAR against an impact fee had also a positive side. And this positive effect should be kept in a reformed system. By allowing an increase in floor area ratio for a fee the municipality is able to respond to market demand for floor space in a way that no master plan can possibly anticipate. From a spatial point of view, an increase in building density is positive as it decreases the area urbanized and therefore reduces distance between various parts of the city. The fee obtained by the municipality to

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<sup>4</sup> The practice is often referred as “selling density” or “selling air rights”, in fact it consisted in allowing an increase in the floor area ratio in exchange for a fee. Air rights can be sold only by the owner of a property.

allow an increase in density does not increase housing costs (see annex 1 bibliography on the subject). The impact fee decreases the market land price by an equal amount. The higher average FAR resulting from the past practice has contributed in increasing the supply of residential floor space within the existing urban area, and as a consequence should have contributed in decreasing housing prices and therefore increasing floor space consumption for Tehran's households. The average consumption of floor space per person in Tehran is about 25.5 m<sup>2</sup> per person; this is a rather high consumption for a country with Iran's income and for a very large city like Tehran (see Figure 2). The selling of FAR increase may have contributed to this positive outcome.

There is a way, however, to reform the past system in order to keep its demand driven approach to planning without jeopardizing the people's welfare or the city's budget.

- First, the municipality should study the infrastructure constraints in the city and should "redline" districts for which no increase in density is feasible because of topographical, cultural or other environmental constraints;
- Second, the map of the redlined districts should be published and be the object of public debate; the final map of redlined districts where no increase of density above the maximum would be authorized by the zoning plan should be made public.
- Third, the authorization to increase FAR above the level fixed by the 1991 Plan should be subject to fixed and explicit rules describing how an "impact fee" would be calculated and what would be the obligations of the developer in terms of linkage and access of his building with the existing network of streets, sidewalks and utilities.
- Fourth, the fees collected should go into a special capital expenditure account which should be used exclusively for augmenting the infrastructure capacity and social services in neighborhood affected by densification.

This proposal will not of course solve the immediate problem of finding new sources of revenues for the municipality capital and O&M budget. In the long run, a well designed property tax might bring a sizable amount of revenue to the municipal budget. However a much diversified source of municipal revenue is the best approach to future financial sustainability, this would probably include a sales tax but is beyond the scope of this report.

## **E Tehran metropolitan spatial structure**

### **1. Metropolitan demography**

- a) Until about 1980, the municipality of Tehran completely dominated the region and little growth was happening outside the municipal boundaries. Since about 1980 the demographic rate of growth of Tehran has slowed down while the growth rate in the rest of the metropolitan area has dramatically increased (Figure 15). It is projected that in 2020 more than half of the residents of the metropolitan areas will live outside Tehran municipal boundaries.
- b) This raises several questions affecting the structure of the region; first, will the population in the TMA be spatially integrated to the point of constituting a unified labor and consumer market? And second, what type of spatial organization is more

likely to meet the first 2 municipal objectives, “pollution under control” and “easy movement of people and goods across the region”?

- c) In 2020 Tehran Metropolitan area will constitute the largest concentration of urban population in the region between Istanbul and Mumbai. The integration of its large labor market will give it a chance serve as a service and manufacturing center for a large part of Central Asia.

**2. Tehran metro is spread over an exceptionally large area compared to other metro areas in the world**

- a) Tehran metropolitan structure as planned is characterized by several high density urban cores spread over a distance of about 200 km. This is a larger distance than most other metropolitan areas around the world (see comparison between the span of Tehran metropolitan region with other major metropolitan areas on [Figure 16](#)). Most metropolitan areas in the world consist of a dense urban core surrounded by low density sprawl. By contrast, the density of the various settlements projected by the regional plan for 2020 are rather high, they range from 90 p/ha in the new town of Roudhen-Pardis to 140 people per hectare for the settlement of Islam Shahr-Robot Karim. Tehran municipality is projected to reach an average density of 120 p/ha<sup>5</sup>.
- b) The Pearl River delta in China consisting of the cities of Hong Kong, Shenzhen, Guangzhou and Macau is the only example around the world of a region made of a cluster of high density cores spread over about 200 km ([Figure 17](#)). The current population of the Pearl River Delta is around 22 millions. It has become the fastest growing and the most successful economic region of East Asia.

**3. metropolitan transport will be key to integrate labor markets between the various urban areas of the region**

- a) A cluster of high density core has some advantages over the traditional lower density shape. It allows fast linkage between the core by public transport and therefore good integration between the various parts of the region. However, it requires also a more decisive and early development in public transport (in the case of the Pearl River Delta, private toll roads, water ferries and rapid trains are linking the various elements). The success of the spatial arrangement chosen for the TMA will depend on the ability of the government to invest early in a rapid mass transport network between the various parts of the region. Already a new railway line is linking Karaj to Tehran metro network. But to integrate the economy of the region will require much more transport investments.
- b) However, if public transport investments were not able to keep pace with the development of the region, two possible outcome could be foreseen; either the region will stay fragmented and the TMA will miss the economic benefits and

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<sup>5</sup> The density is defined here as administrative density, i.e. the total urban population divided by the area within the municipal boundary. According to this definition Tehran Municipality had a density of about 96 p/ha in 1996. In the following section I will use the built-up density rather than the administrative density. The built-up density is the population divided by the area actually urbanized, excluding vacant land, agriculture, large parks and airports. According to this definition Tehran built-up density was around 146 p/ha in 1996.

increasing return to scale provided by large labor and consumer markets, or private individual transport will become a substitute for mass transit and the region will probably develop on a wider area at lower density. The resulting pollution due to transport would also likely increase.

- c) Maintaining a unified labor markets with all its economic advantages for the region depends on the ability of the transport system to work.

#### **4. The green belt and the structure of local authorities in the metro region**

- a) The metropolitan area of Tehran is planned in dense urban clusters separated by “green zones” where agriculture and the rural character of settlements are to be preserved. The metropolitan area is therefore divided into two types of administrative units, urban municipalities and rural areas. The administrative bodies of the two types of zones do not have the same power to tax, regulate and control development. In addition, rural areas do not have technical bodies to create and maintain infrastructure.
- b) This metropolitan area is therefore, de facto, divided into “hard” and “soft” administrative zones. The objective is to preserve the rural character of the areas between the dense urban clusters. The outcome might well be the opposite of the objective.
- c) Some developers catering to the lowest segment of the housing market, when faced with costly regulatory constraints within urban municipalities have a tendency to look for constraint free land within the jurisdiction of weaker local authorities. However, the constraint free land is of course without infrastructure or community facilities! As a consequence rural local authorities located at the urban fringe are often urbanized faster and at higher densities than the suburban part of a municipality. There is often a border effect between local authorities invested with different power, the weakest one having more development and higher densities and receiving lower income groups. When the settlements are reaching a large size the government is obliged to provide the infrastructure that the rural local authority do not have the financial means nor the technical ability to provide.
- d) The government should avoid creating discontinuity in local authority structures: the discontinuity and lack of homogeneity in local authority structure will create spatial distortion, and border effects which will prove costly in the future. The metropolitan area of Tehran should be composed of local authorities with similar power of land use control and taxation. The possibility of having an elected metropolitan authority dealing with broad land use guidance, primary infrastructure investments, taxation and fees should be explored.

## **F Conclusion**

Tehran possesses a large number of assets which can in the future be fully utilized to make it an important economical and cultural regional capital in Central Asia. Teheran municipality is now at a crossroad in its spatial development. It could continue developing as a

high density polycentric city with a weak CBD, or it can utilize planned investments in metro transport to transform the current CBD into a vibrant regional center for finance, technology and commerce. The transport system selected for the future, either a dense network of minibuses or a complete network of metro-lines will decide on the future spatial development of the city. Either option is feasible. It is important however, that depending on the option selected, the municipality implement a coherent set of land use regulation reforms, infrastructure investments and real estate taxes which are consistent with the spatial option selected.

Finally, a large part of the pollution problem of Tehran could be solved by switching public transport vehicle from gasoline and diesel to CNG. Simultaneously, measures should be taken to maintain the present mode split between public transport and private car at about 60% by charging a market fee for street curb parking and by progressively charging congestion tolls on urban highways.

## G Figures

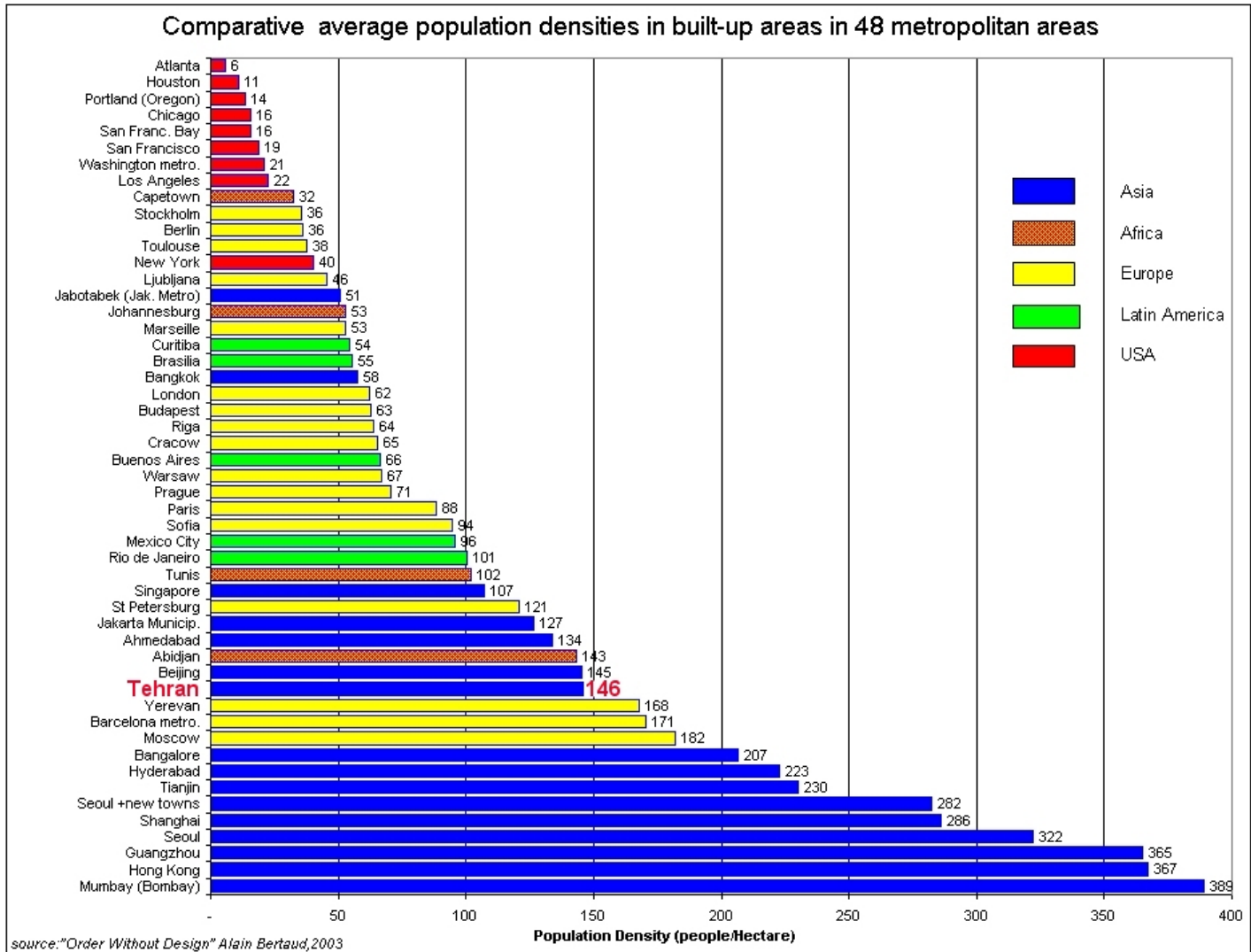


Figure 1: Average Densities in Built-up Areas

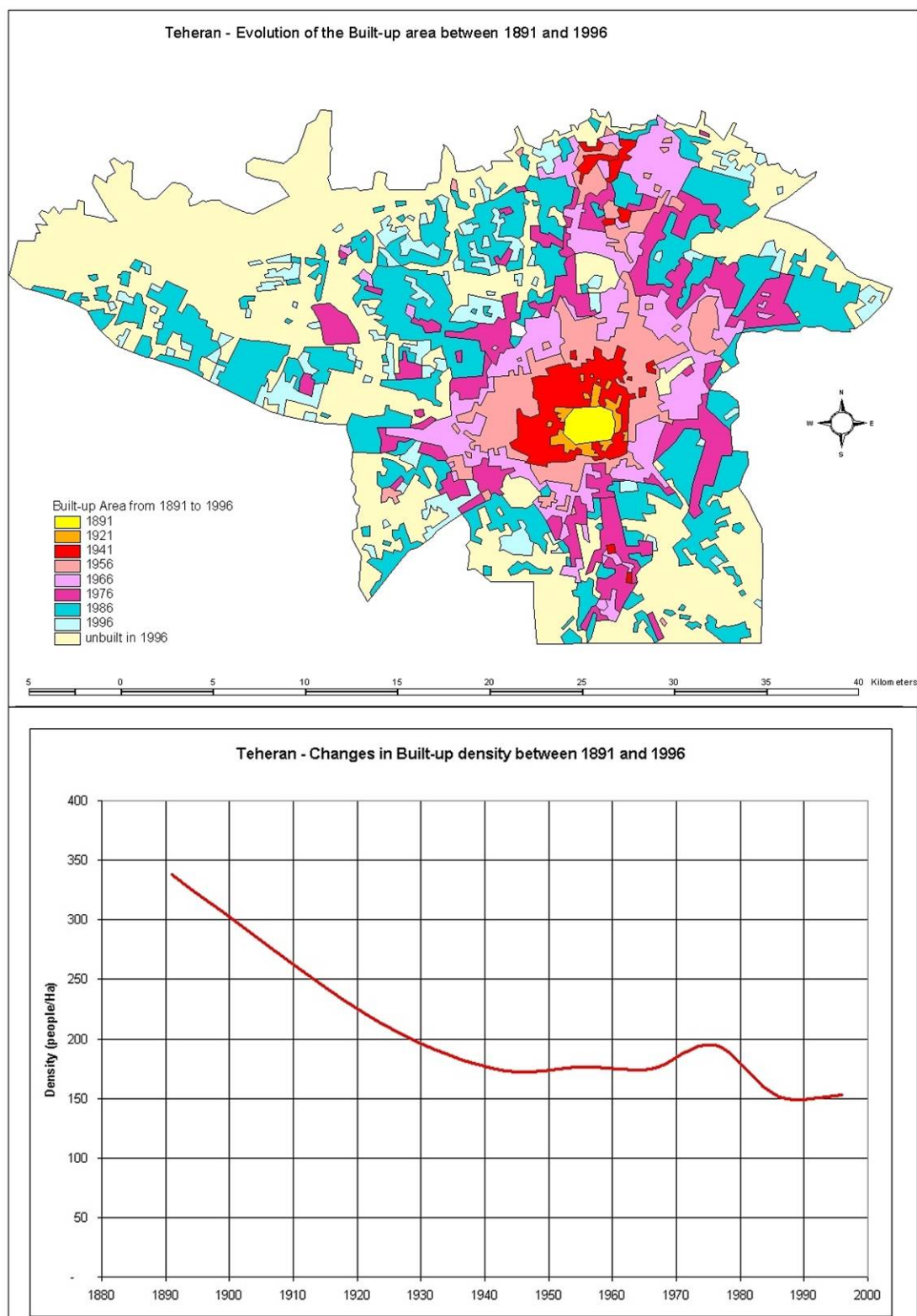


Figure 2: Change in built-up density in Tehran Between 1891 and 1996

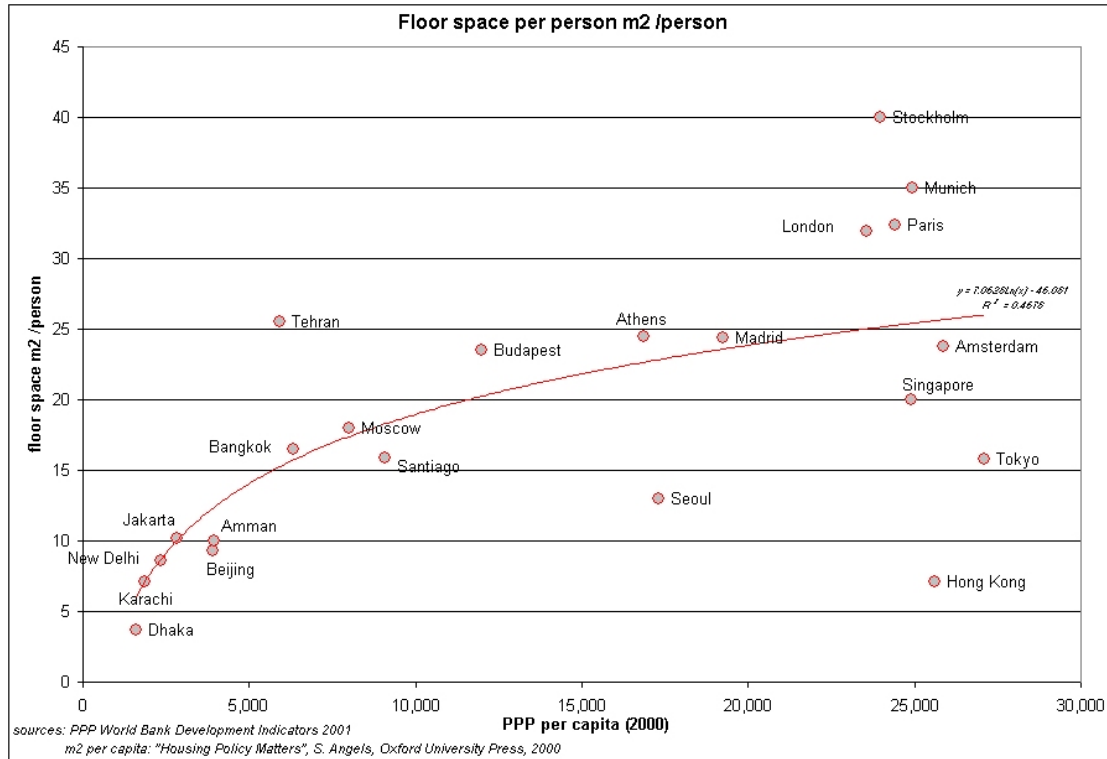


Figure 3: Floor space and PPP per capita

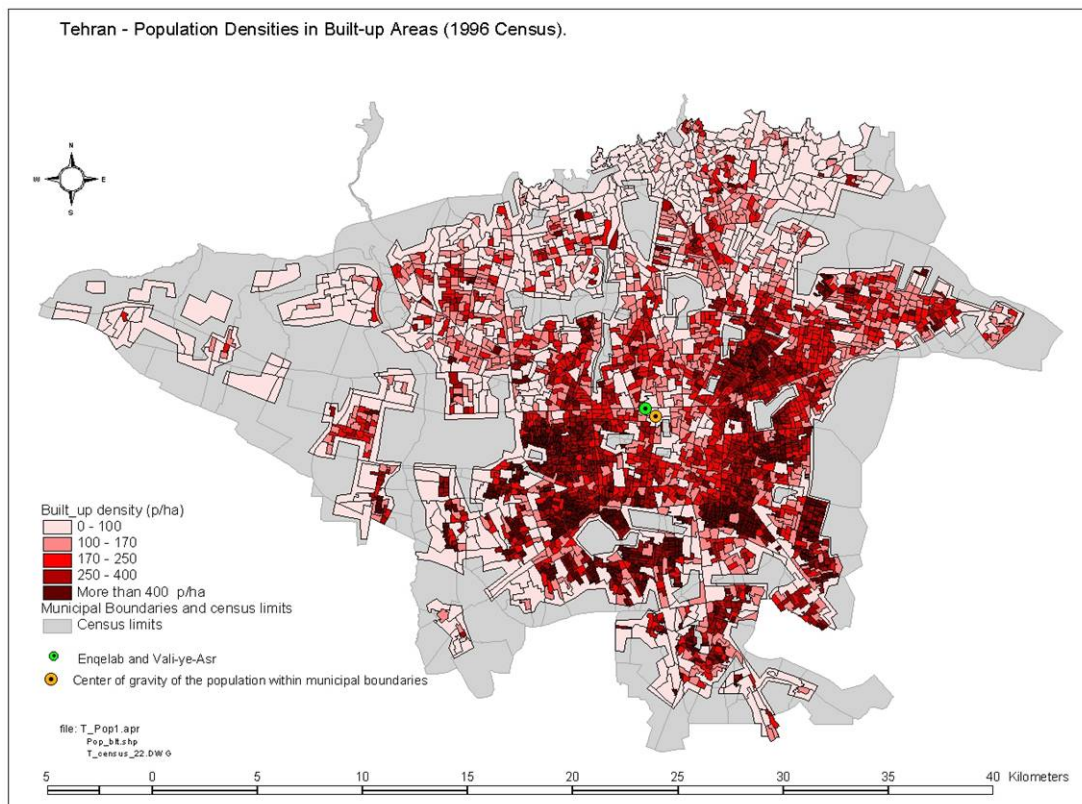


Figure 4: Tehran- Densities in built-up Areas

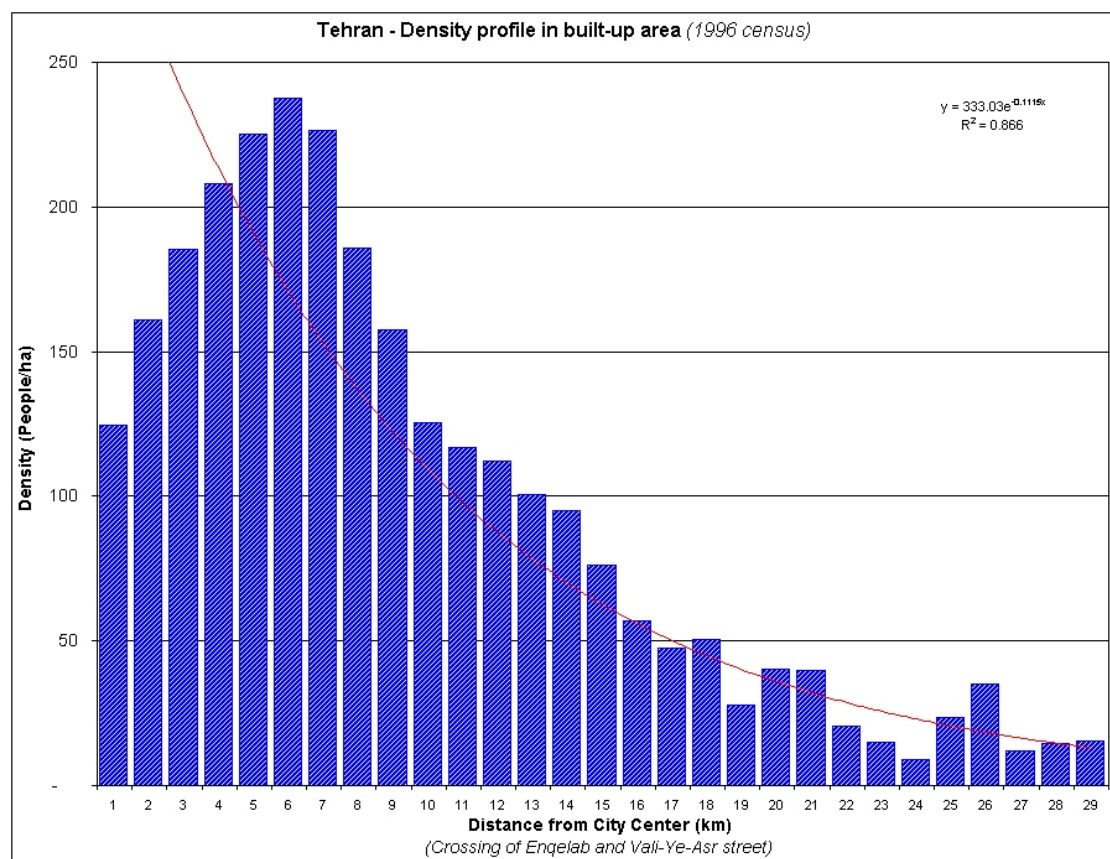
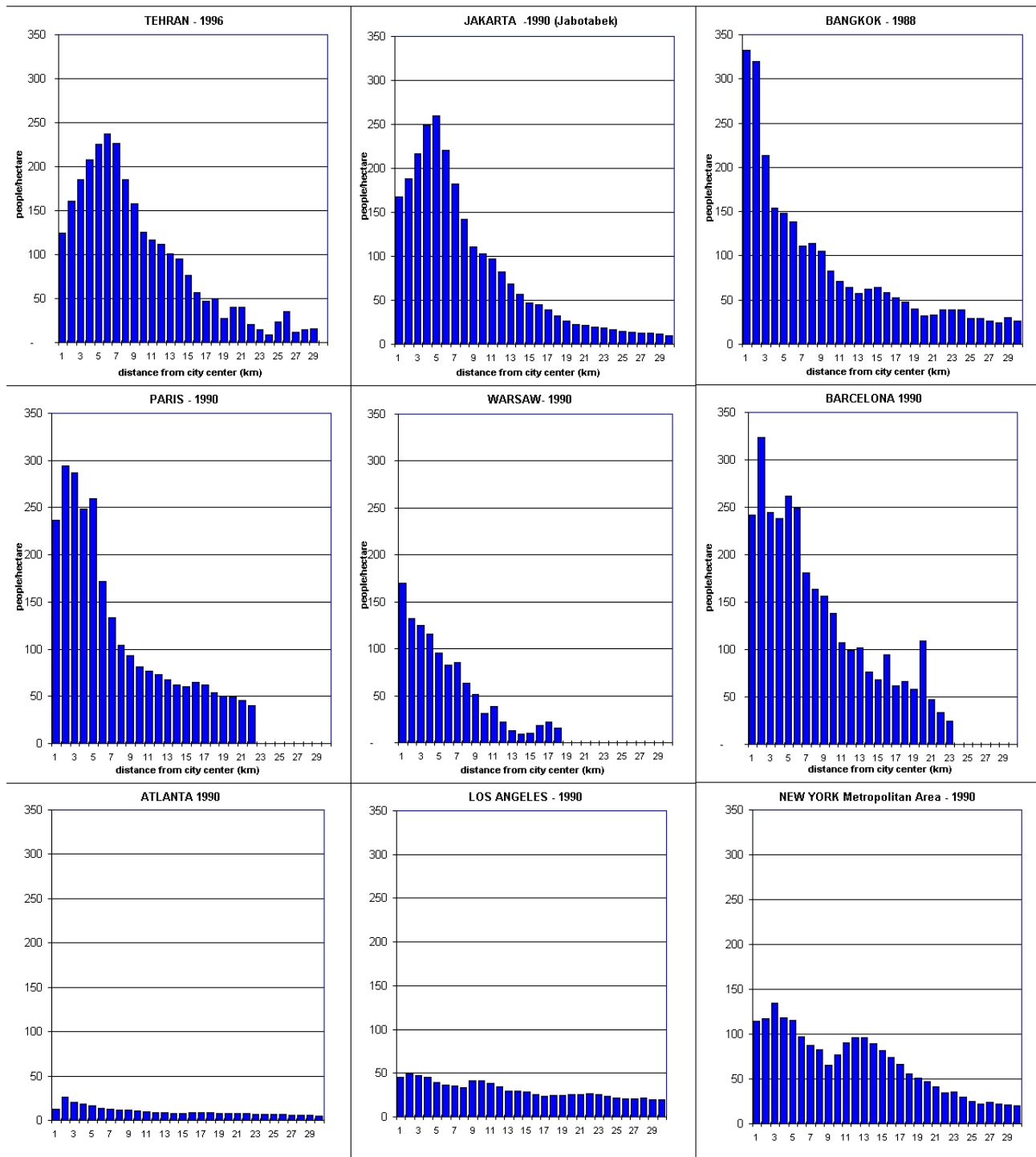


Figure 5: Tehran - Density Profile in Built-up Area (1996)

## COMPARATIVE POPULATION DENSITIES IN THE BUILT-UP AREAS OF SELECTED METROPOLITAN AREAS



from "Order Without Design", Alain Bertaud, 2003

Figure 6: Comparative density profiles in selected metropolitan areas

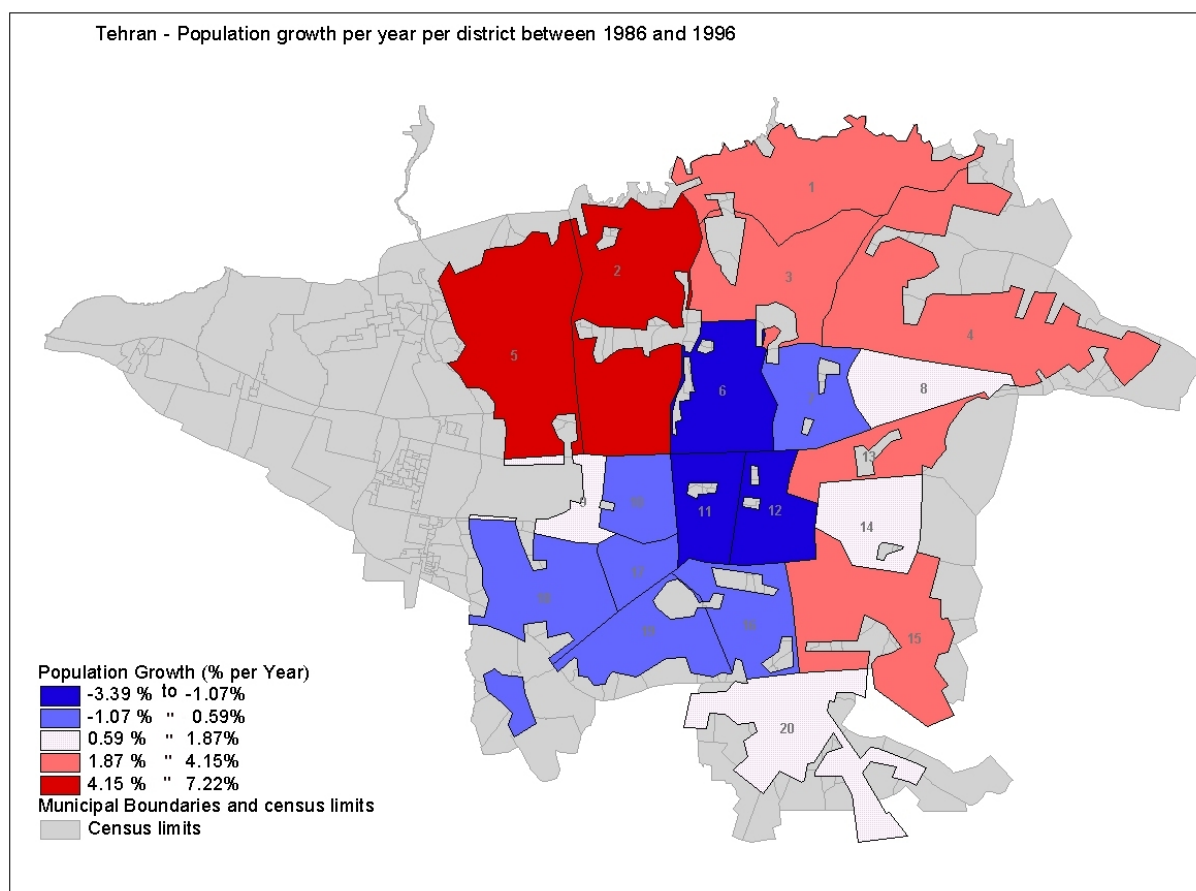


Figure 7: Tehran - Population growth per year per district between 1986 and 1996

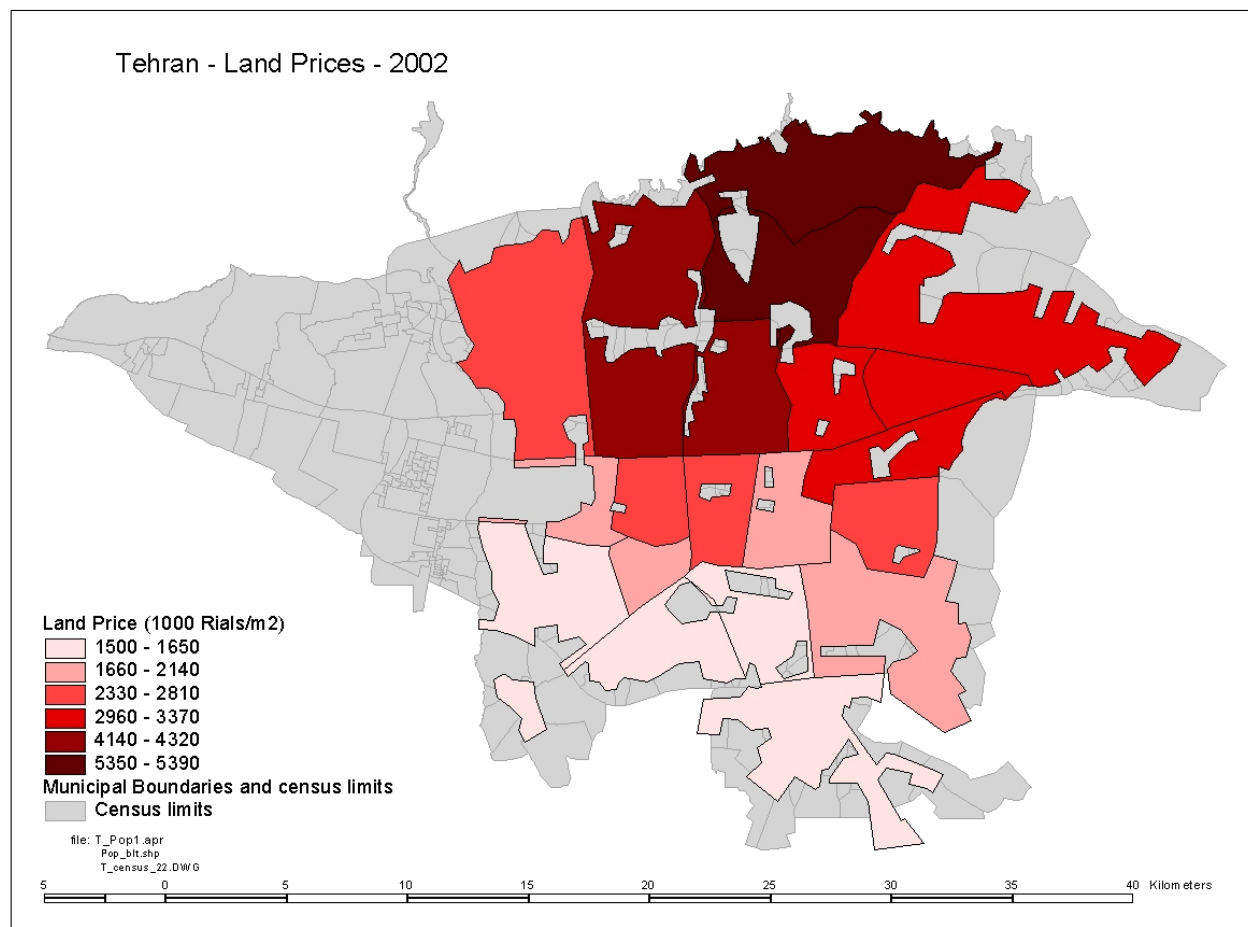


Figure 8: Tehran - Land Prices - 2002

**Percentage of total destination per districts for vehicular trips in 24 hours in 2002**

District Number	number of shopping trips ending in district	% of total trips	number of job commuting trips ending in district	% of total trips
1	38,383	5%	72,602	3%
2	44,214	6%	96,748	4%
3	53,972	7%	151,162	7%
4	46,689	6%	131,102	6%
5	27,075	4%	102,168	4%
6	110,112	15%	287,683	13%
7	58,731	8%	147,532	6%
8	27,762	4%	55,659	2%
9	28,824	4%	161,185	7%
10	21,175	3%	53,235	2%
11	43,258	6%	141,765	6%
12	93,668	12%	389,393	17%
13	23,480	3%	43,338	2%
14	28,127	4%	64,962	3%
15	28,217	4%	89,348	4%
16	24,407	3%	64,791	3%
17	14,969	2%	54,271	2%
18	13,728	2%	69,163	3%
19	7,697	1%	35,602	2%
20	24,077	3%	68,283	3%
	<b>758,565</b>	<b>100%</b>	<b>2,279,992</b>	<b>100%</b>

Source: Origin-Destination matrix for all vehicles in 24 hours in 2002,  
home-based employment trips and shopping trips

Table 1: Distribution of vehicular trips in a period of 24 hours in 2002

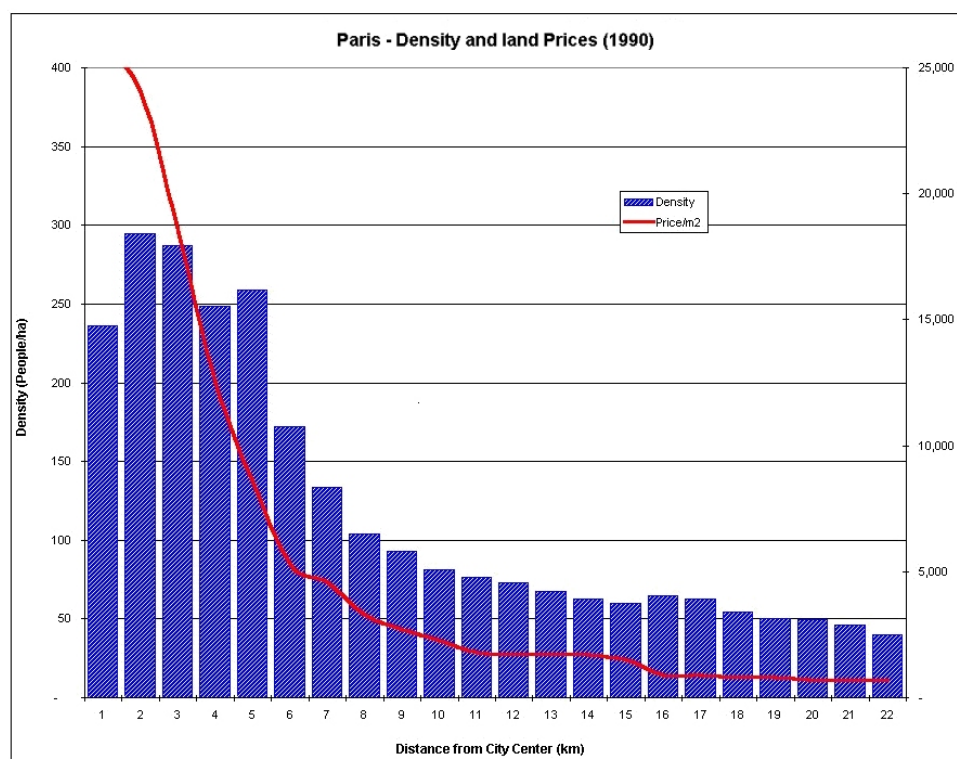
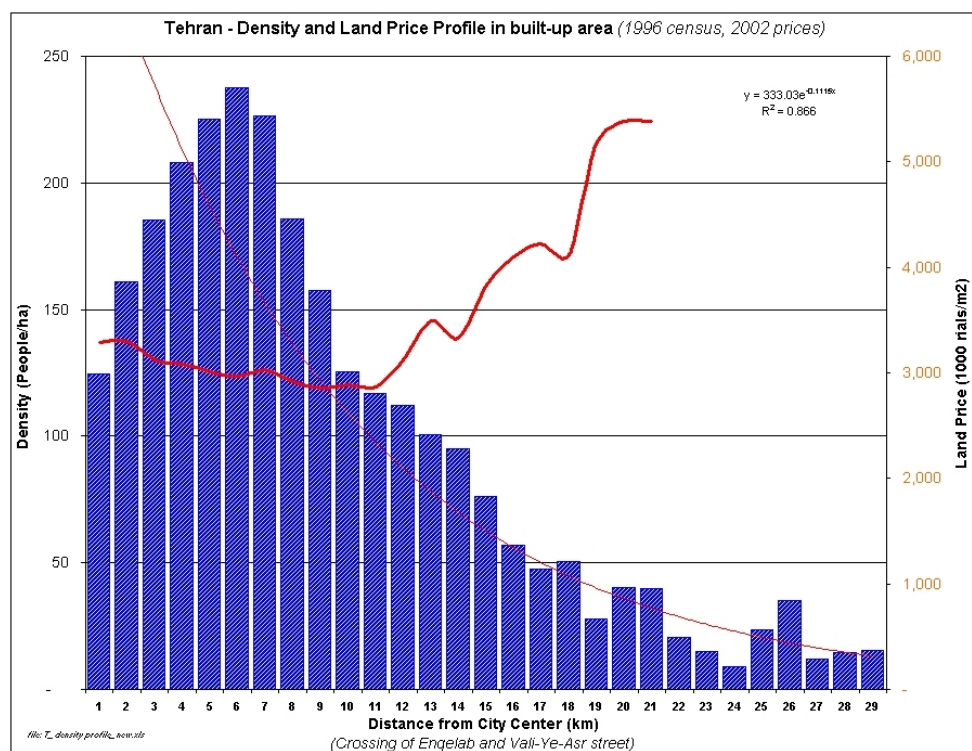


Figure 9: Comparison between Density profile and Land Prices in Tehran and Paris

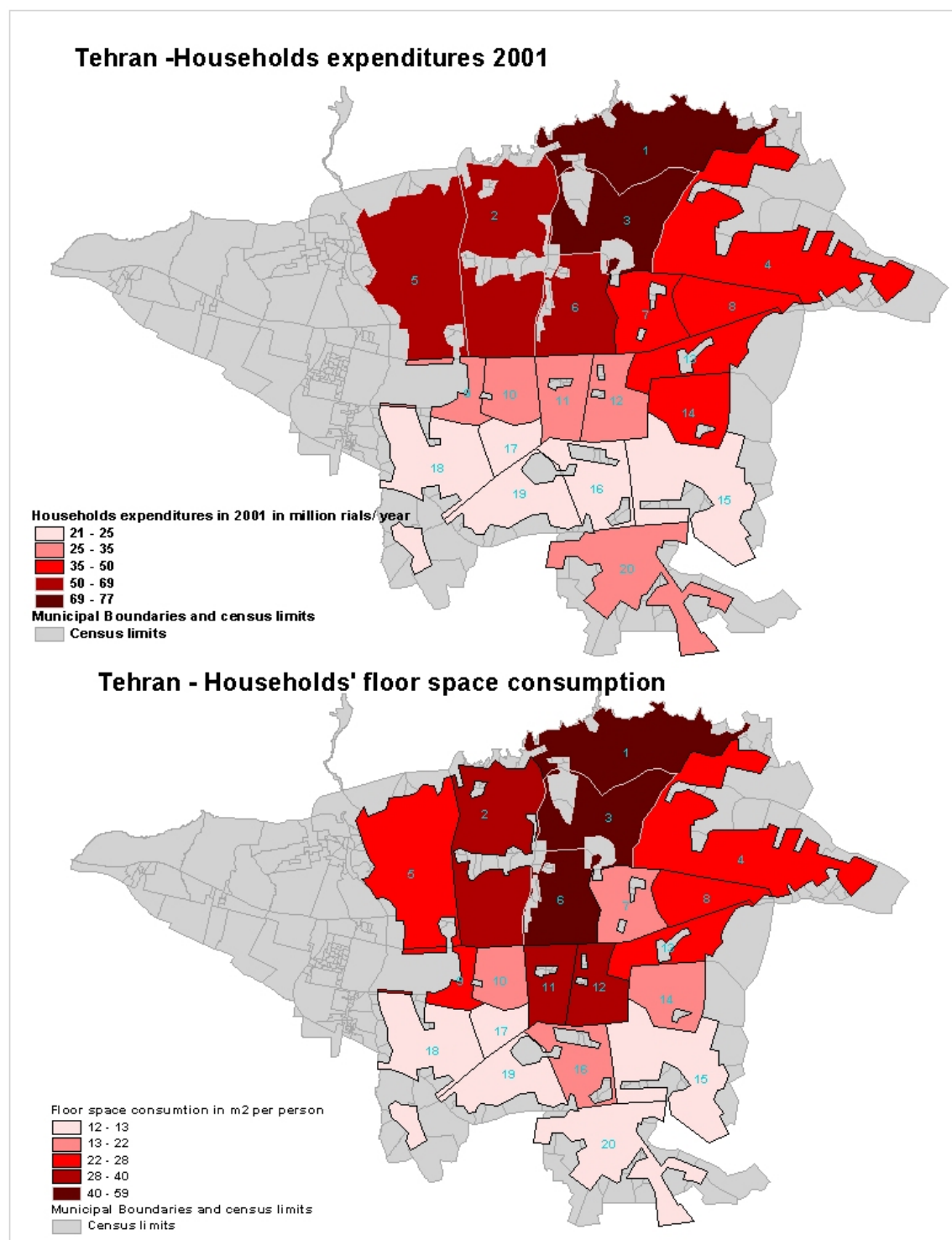


Figure 10: Tehran - Households' expenditures and floor space consumption

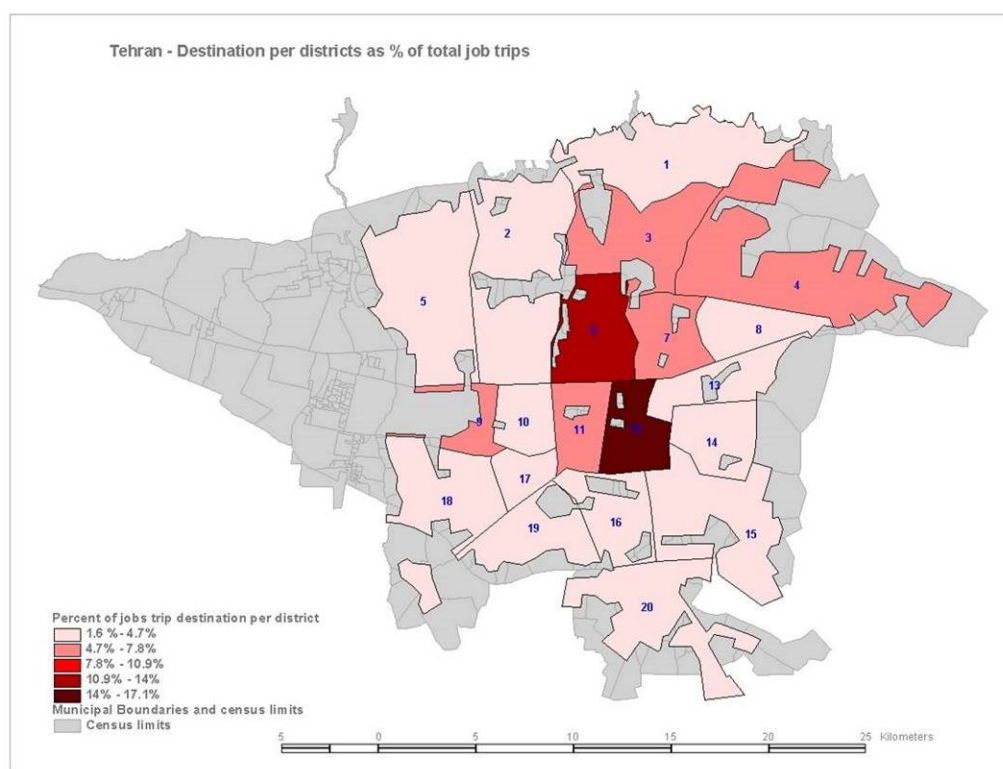
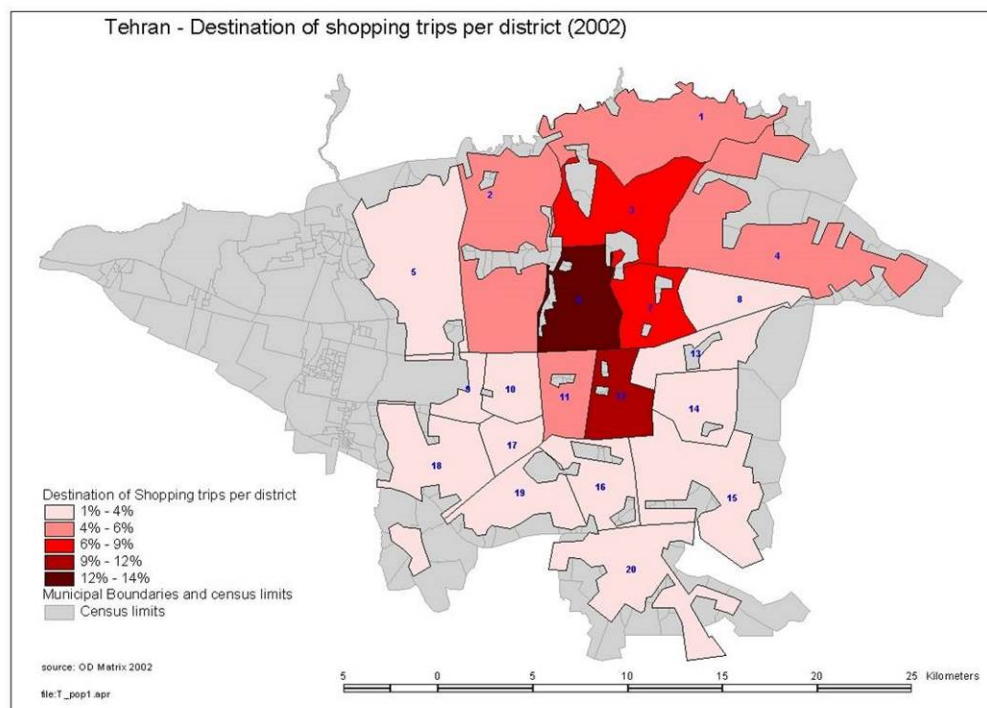


Figure 11: Tehran - Destinations of shopping trips and job trips per districts

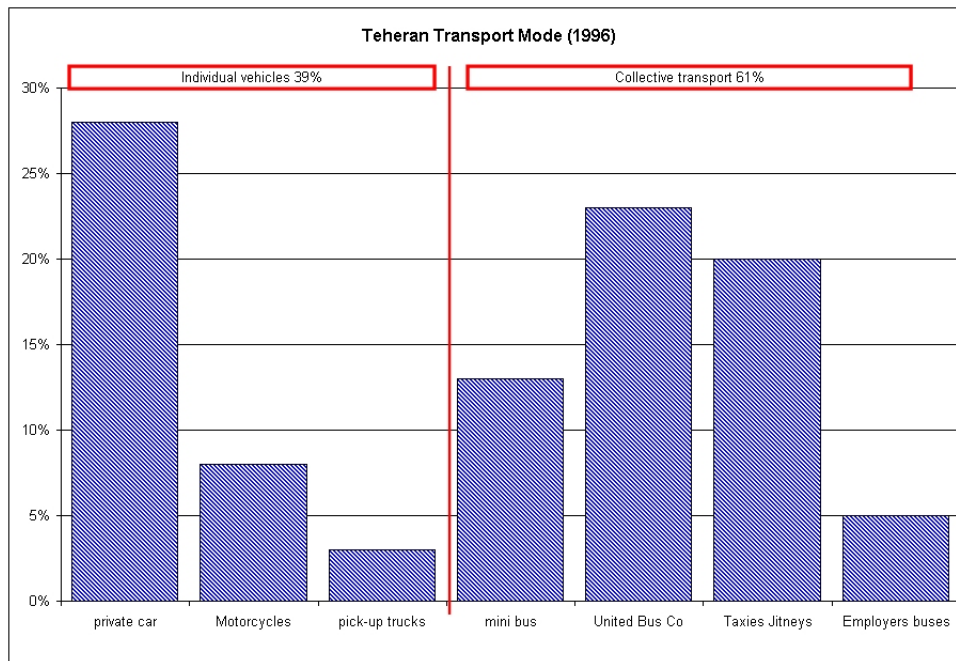


Figure 12: Tehran - Transport modes (1996)

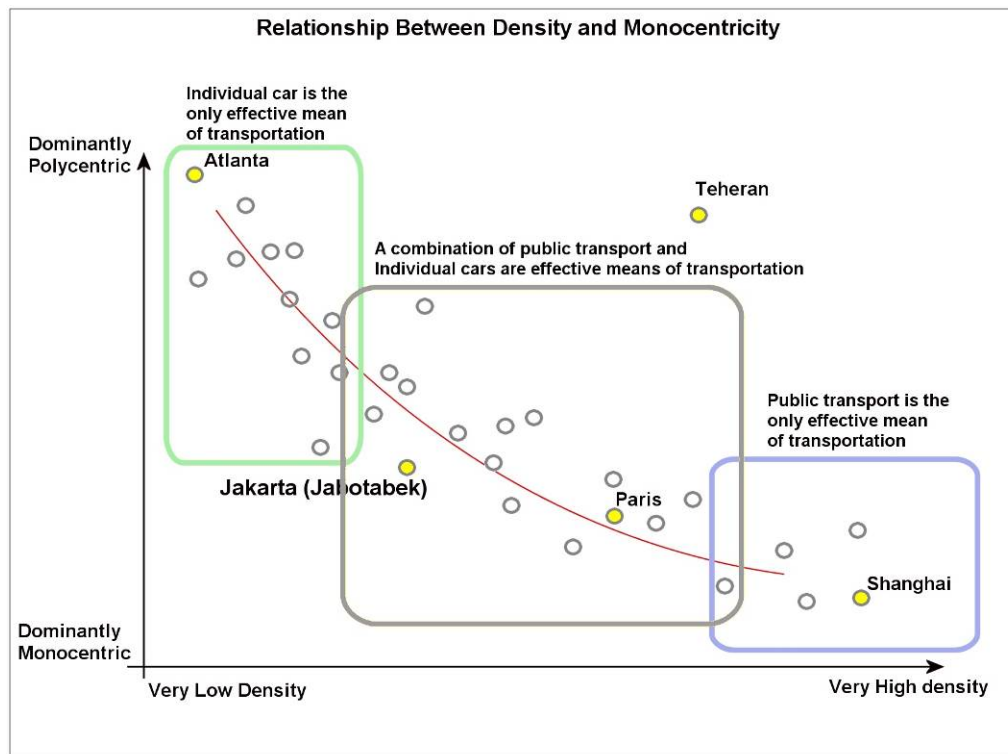


Figure 13: Relationship between spatial structure and the effectiveness of public transport

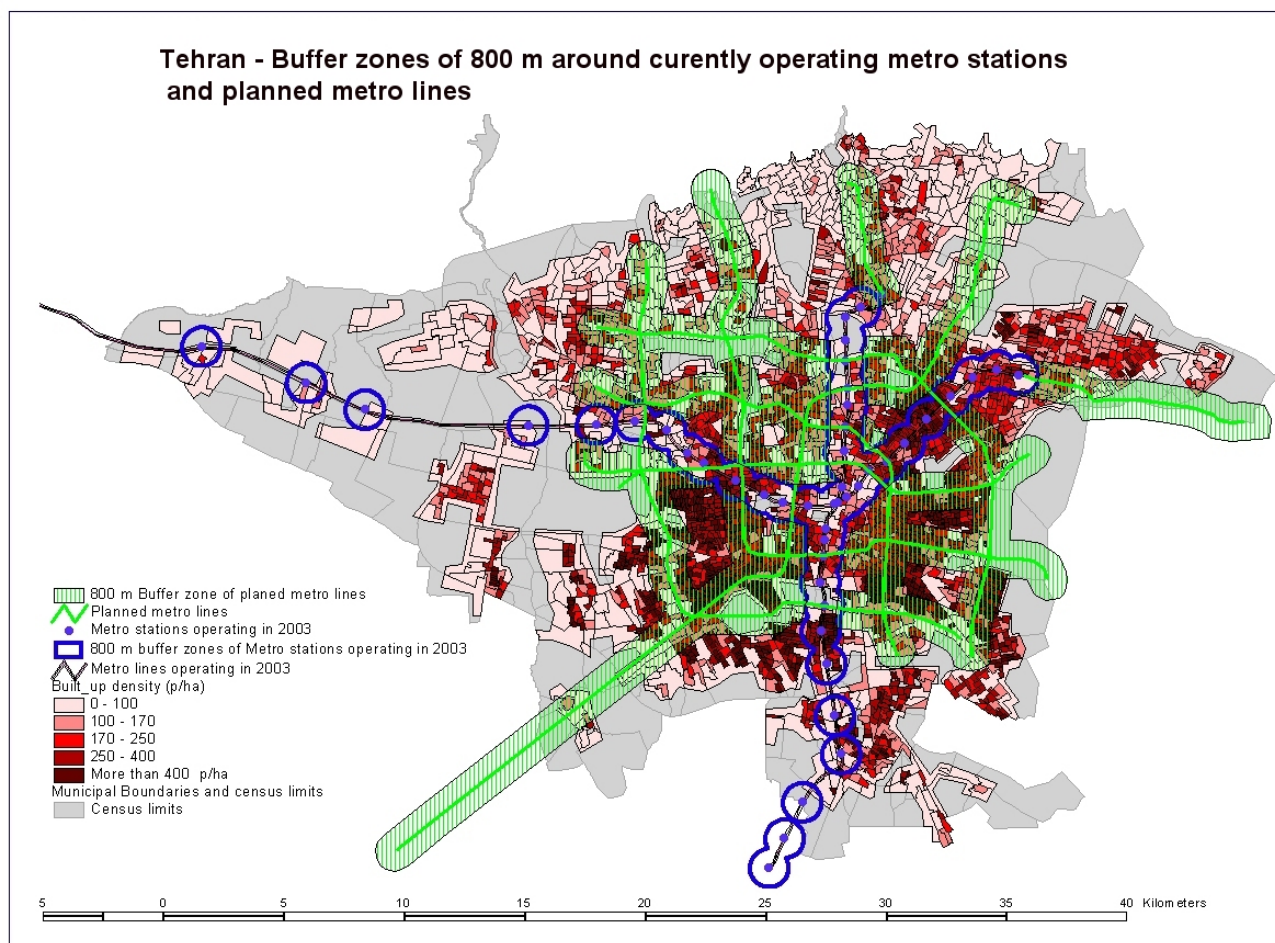


Figure 14: Buffer zone of 800 m around current metro stations and planned metro lines

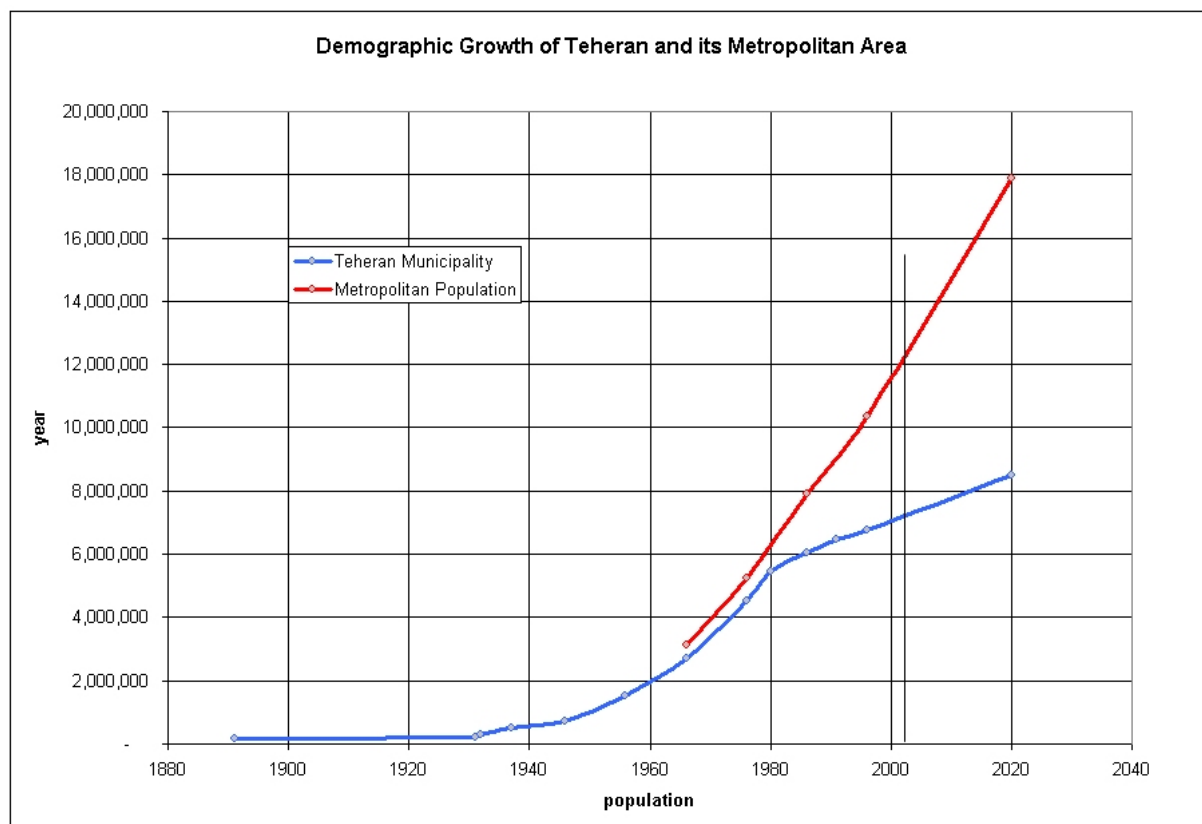


Figure 15: Tehran - Demographic growth

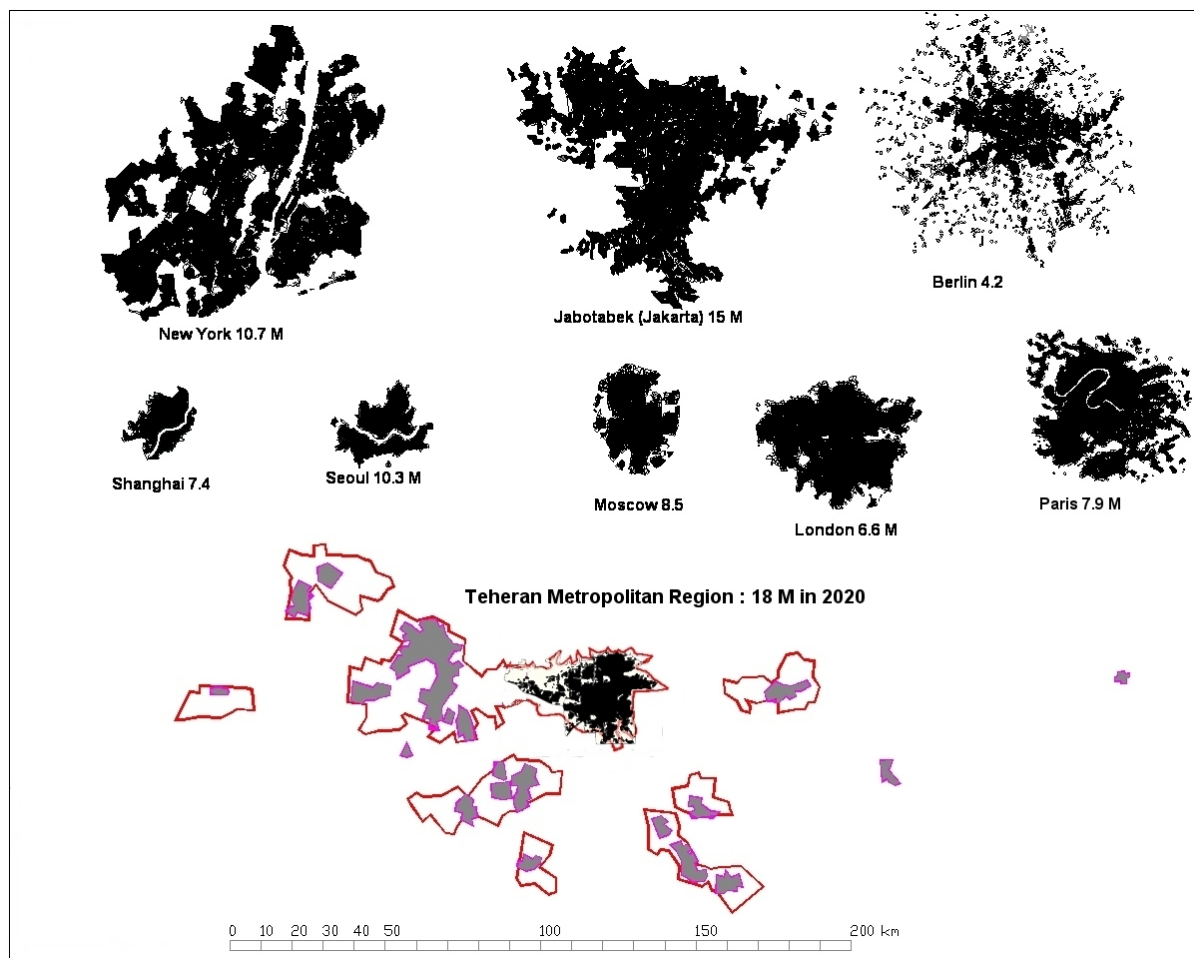


Figure 16: Comparison of the extent of Tehran metropolitan region with other metropolitan regions

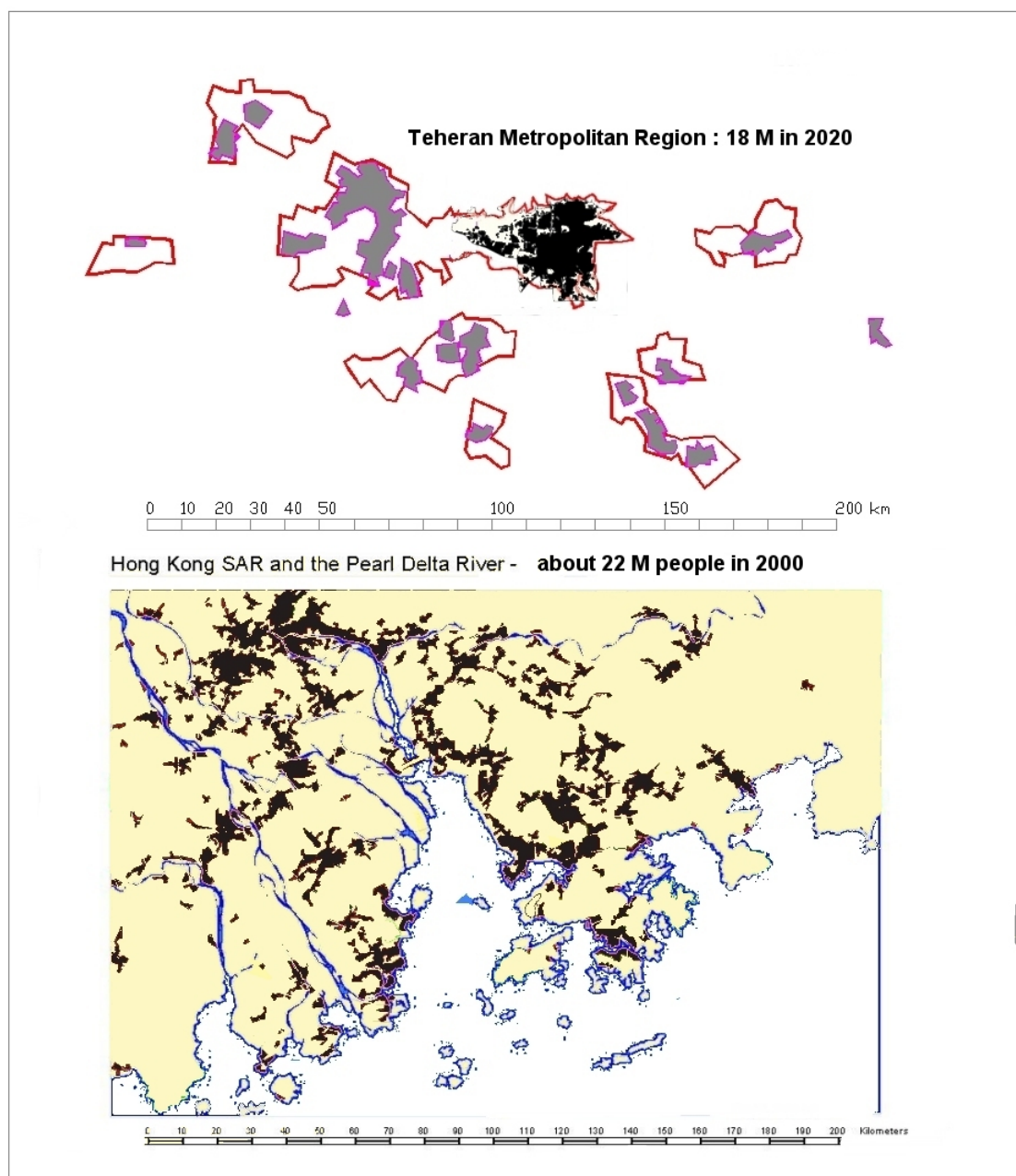


Figure 17: Tehran Metropolitan Region and The Pearl River Delta

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