

The impacts of major transportation infrastructure on the form and function of the urban space: the case of the "Athens urban freeway"

Maria Zifou and Constantinos Serraos

Department of Urban and Regional Planning
National Technical University of Athens, zifoumel@central.ntua.gr
phone: +030-210-7723796, fax: +030-210-7723817

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1. Introduction

In the summer of 2004, the newly constructed Athens urban freeway was put into full operation. The freeway is the first concession roadway project (Public-Private Partnership, PPP), and the first urban toll road in the country and is considered one of the major urban highways to be constructed at the European level not only because of its size and scale, 65,2 km long, but also because of the fact that a large section of the freeway is bisecting the dense urban fabric of a city such as Athens which has a population of over 4 million people and 5000 years of history. The new freeway was built with the purpose to bypass the city center and the expectation to relieve the overly congested roadway network of the city of Athens that was suffocating by everyday traffic gridlocks and high air pollution levels thus, achieving substantial traffic, environmental and economic gains.

The construction of new highways has always been a prominent, though much debated, transportation policy response to address the continuously increasing traffic congestion problems that point to the automobile dependence of the contemporary city. The construction of new highways, which in the 1950's and 1960's mainly took the form of peripheral and radial routes, was mainly justified on the basis of their implied ability to reduce travel times, to save fuel and to reduce emissions mainly due to improved travel speeds. Moreover, assumed savings in travel time were translated into economic gains which were calculated at different rates in accordance with the assumed value of travel time in each particular city that was under study.

However, the policy of evaluating transportation projects only on the basis of their effectiveness to improve mobility has substantially changed reflecting changes in the transportation planning approach as well as the prevalence of the environmental agenda. The first major factor impacting the way transportation systems are evaluated relates to the adoption of a different definition for the urban transportation problem that is being redefined from a problem of congestion to an accessibility problem (Banister, 1994). In this new context, the goal is not the ease of traffic movement but the improvement of accessibility to people and facilities, putting an emphasis on the equitable distribution of access and the minimization of discrepancies in personal mobility.

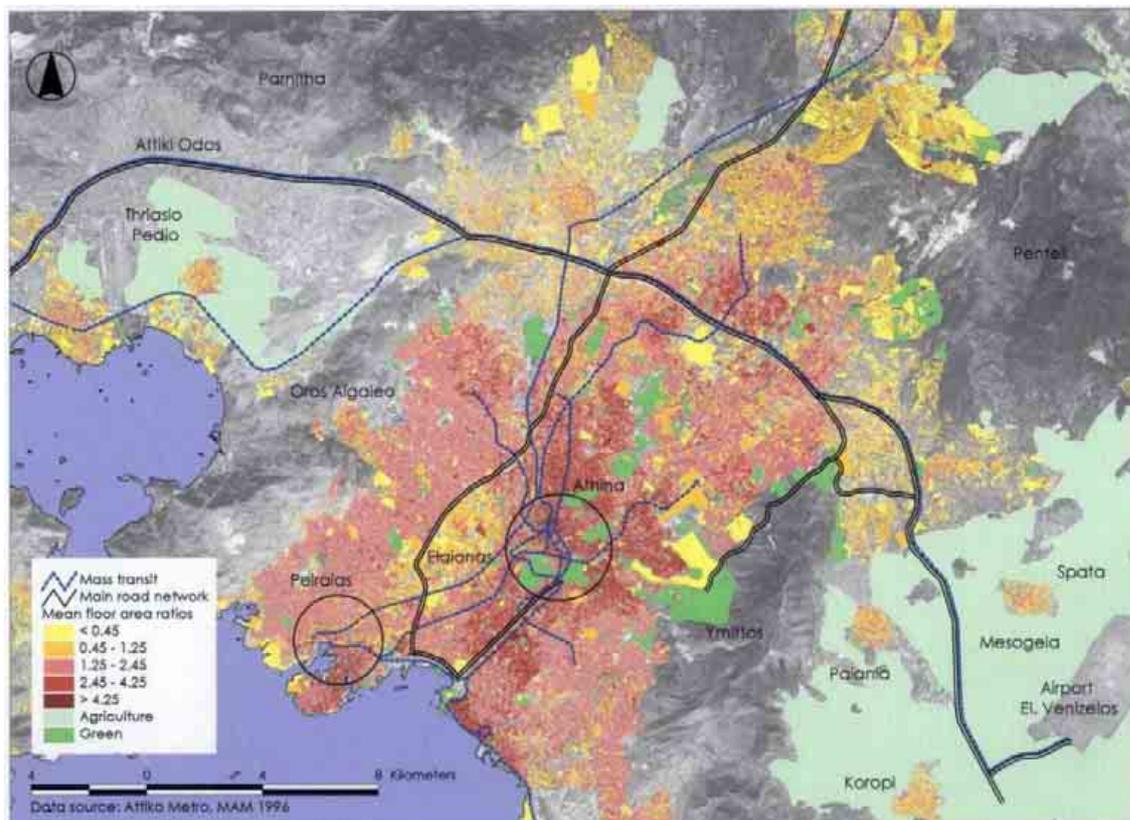
The prevalence of the sustainability agenda is the second factor that has influenced not only the nature of the transportation policy but also the evaluation of individual transportation projects by pointing out the external effects of transportation systems and projects on both environmental functions as well as on the structural organization of urban areas. Thus, at one level, the environmental agenda has forced transportation systems to meet sustainability criteria which means that transport planning must minimize the external effects of transport by not only acknowledging "the long term steering role of spatial structure and dynamics" but also by integrating issues related to the environment, safety and security and public health (Himanen, Lee-Gesselin & Perrels, 2005). At a second level, by focusing on the important interrelationship that exists between travel patterns and urban form it emphasizes the enormous impact transportation policies and choices of transport mode have on urban structure. More specifically, increasing evidence – drawn from research on sustainable cities - has shown, among others, that automobile dependence promotes road expansion and sprawling growth patterns both of

which spur new travel (Williams, Burton & Jenks, 2000; Newman & Kenworthy, 1999), that there is a critical density point, of about 20 to 30 persons per hectare, "below which automobile-dependent land use patterns appear to be an inherent characteristic of the city" (Newman & Kenworthy, 1999: p.100) or that there is a statistically significant positive relationship between the amount of urbanized land area and energy consumption. The purpose of this paper is to make an assessment of the impacts of the new Athens freeway on urban form, the urban environment as well as on travel demand. Because of the short operating period of the project and the lack of relevant raw data, only a qualitative assessment will take place at this point regarding the short range effects of the freeway, that is the direct construction impacts and first year operating conditions.

2. Urban development parameters in Athens and related problems

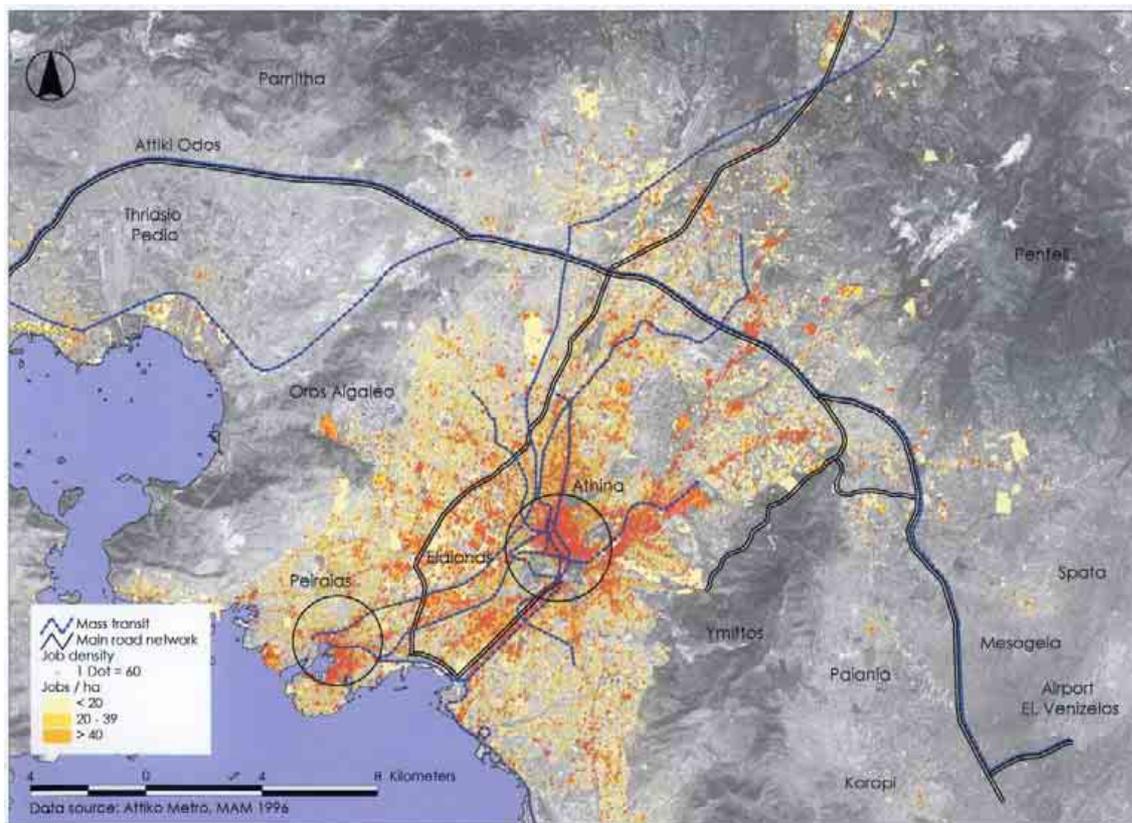
The greater Athens area was originally shaped by the two important growth nodes, those of Athens and the port of Piraeus, and was gradually expanded at great densities to the immediately surrounding areas within the Athens Basin. The mean floor area ratios (as depicted in Map 1) indicate that the central areas developed during the first decades after the Second W.W. around the centers of Athens and Piraeus have the greatest building intensity, and in consequence the highest densities. The suffocating building intensity of these central areas, the accumulation of a number of planning, social and traffic problems as well as the continuing increase of residential and development pressures during the last decades pushed urban development to the new peripheral / suburban areas of the Athens basin, i.e. Marousi, Glifada, Voula.

Map.1. Mean floor area ratios in the Athens basin.



However, the gradual saturation of these suburban areas in combination with the attractive characteristics and the improved accessibility of the exurban areas that lie beyond the Athens basin lead to the "sprawling" of the urban fabric to the eastern area of Mesogeia which was a primarily agricultural area, to the north along the national highway and to a lesser degree to the western industrial areas. At the same time, the southern coastal areas recorded high growth rates of residential, vacation homes and recreation activities (Serraos & Skortsis 2003). The structure of economic activities in the Athens basin, as well as the corresponding employment positions, followed and in turn influenced, as expected, the basic urban development pattern. The corresponding primary business, service and employment nodes were therefore located in the 'traditional' central business districts of Athens and Piraeus. However, the gradual expansion of residential development to the outlying suburbs has led to the development of business activities and services primarily in a linear pattern along the main road network (National Technical University of Athens, 2000 & 2001) which extends radially from the center of Athens – and to a lesser degree from the center of Piraeus – to these outlying suburban residential areas (Map 2).

Map.2. Job density in the Athens Greater Area.



3. The project

The concept of constructing a ring road bypassing the center of Athens was originally conceived in the 1950's and even though substantial land expropriations were made, the official political decision to construct the project was made in 1990 by the Ministry of the Environment, Physical Planning and Public Works, whereas the completion of the required nominating procedure was finalized in 1996. According to the official policy, the conceptual design criteria of the "Attiki Odos" urban freeway were set within the general development framework of the Athens Greater Metropolitan Area with the purpose to meet specific transportation and spatial needs. The design criteria included the following:

- the provision of a peripheral ring road that would bypass the Athens city centre and interconnect inter-urban traffic
- the upgrading of the connection between existing links of the National Highway Network and the facilitation of the commercial transport, thus incorporating the project into the Trans European Transportation Network
- the successful combination of this new infrastructure network with all modes of transportation
- serving the new Athens International Airport which was located in the eastern part of the urban region
- the improvement of the connection and service of the Thriassio industrial area which is located in the western part of the urban region

The freeway is 65.2 km long and consists of two main motorways: the 50.4 km long *Elefsina-Stavros-Spata Airport* Motorway which connects the eastern and western parts of the Athens metropolitan area and the 12,9 km long *Imittos Peripheral* Motorway (Map 3). The remaining two km constitute the access roads that lead to the Athens airport. In addition, a total of about 32 km of access roads were constructed in locations where the freeway crosses with other major highways. Finally, a complete network of service roads running parallel to the freeway along with local roads totaling 150 km was constructed in order to achieve to accommodate local transportation needs and to maintain the continuity of the urban fabric.

Its main corridor is a dual-carriageway urban motorway with three lanes plus an emergency lane (13m) per direction, a median corridor for suburban railway & metro (up to 37m wide) as well as a parallel network of service roads thus occupying a total width ranging from 63m (urban sections) up to 100m (rural sections). It operates with 39 toll stations providing a total of 195 toll lanes, one operation & maintenance center, nine customer service locations, and four motorist service stations (rest areas) occupying an area of 12 Ha.

Map.3. The Athens urban freeway routing and its interchanges connecting it to the existing road network. Source: Attiki Odos S.A.



The rationale behind the construction of the freeway rested on the achievement of a variety of benefits that did not only relate to transportation issues but were also of economic, environmental and spatial nature. The major premise of "Attiki Odos" was that it would modernize, improve and upgrade the existing inefficient and congested highway and road infrastructure network. The additional traffic lanes that would be provided were expected, first and foremost, to improve existing traffic conditions by absorbing 10% of the urban region's daily traffic load, thus decongesting main road arteries. Moreover, due to its routing, the new freeway was expected to connect more than thirty municipalities as well as all the major transportation infrastructure such as the new airport, the train depot and the different ports which are dispersed in the coastal areas of the region. Finally, the inclusion of the suburban railway in the freeway median was expected to promote the interconnection - and ultimately the increased use - of all the alternative mass transportation means, that is the metro and the suburban and inter-city railways.

The expected improvement of the original congested conditions was in turn estimated to have substantial benefits both to the local environment and the economy. The decrease in travel times and the improved traffic conditions were estimated to reduce fuel consumption by 2 million liters per year. In addition, the project was expected to produce savings of approximately 270.000 hours per day of productive and leisure time which in turn equaled, along with the estimated energy savings, to about 420 million EURO per year of social and economic benefit. Finally, the design and construction of such large scale and complex infrastructure project was expected to provide thousands of employment positions and greatly support the Greek construction industry by introducing new technologies and know-how in relation to the financing, construction and operation of PPP infrastructure projects.

4. Preliminary impacts of the "Attiki Odos" freeway

4.1 Urban development impacts

The transformation of the urban structure of Athens, as it was briefly described above, has led to increased rates of population growth and urban development intensity mainly in the outlying areas of Mesogeia and to a lesser degree the western industrial areas (Polychronopoulos & Serraos, 2001), a trend which is being greatly reinforced by the construction and operation of the new freeway. More specifically, as far as the location of service, business and commercial activities is concerned, there is evidence that they are increasingly attracted towards the wider outlying areas of the freeway as well as the corresponding interchanges.

The location of industrial and storage facilities as well as logistic services in the outer urban areas in the western part of the region is promoted by the construction of the freeway since it greatly improves the accessibility of these mainly agricultural and open space areas¹ (Photo 1). The ad hoc and piecemeal dispersion of these activities along the freeway is facilitated by the absence of land use controls. The consequence of these locational

patterns have already marked the landscape of Athens: construction of large scale shopping and entertainment malls around a major interchange and development of chain department stores as well as warehouses along the freeway¹. These trends correspond with recent research findings that claim that 'real estate development gravitates to improved freeways' thus producing 'induced growth' and 'induced investment effects' since people and firms locate to exploit the accessibility benefits associated with the construction of the freeway (Cervero, 2003).

Moreover, in parallel with the above mentioned development patterns, the operation of the freeway promotes another increasing trend that of the dispersion of development activities, which are not based on an adopted plan and in many cases are illegal, in the center of these exurban and until very recently undeveloped, agricultural areas with great negative consequences for the physical as well as the manmade environment. More specifically, the eastern area of Mesogeia, which has increased its population by 58% over the last decade, attracts mainly residential and commercial activities, whereas the western areas of Thriasio attract more polluting light industrial and commerce activities.

4.2 Traffic circulation effects²

At the end of the first year of its full operation, the freeway carries 225.000 vehicle trips daily as opposed to 180.000 that were initially estimated, pointing to the immediate response of travelers to the new road. These trips represent 3% of the region's total daily traffic load, lower than the originally estimated 10%. The difference may be attributed to the fact that the estimated percentage ratio was calculated for a longer operating time period, while at the same time it indicates a rapid increase in total travel in the region.

The undeniable conclusion regarding the effects of the freeway on the overall traffic conditions is that it has greatly reduced travel times in the urban region, and more specifically for the estimated 70 million drives that take place within a year. According to a recently conducted interview, 67% of the users choose the freeway for journeys-to-work. Of these over half estimate that they save between 16-30 min in each entry while 35% estimate that their time savings are more than 30 min. long and even reaching the 1 hour mark. These reductions in travel time have been estimated to correspond to approximately 150.000 productive labor hours per day so far or a savings of 1,5 million euro per day for the Greek economy. In addition, the freeway has undeniably improved the accessibility to the western suburbs of Athens as well as to the industrial areas that lie outside the Athens Basin.

The other major traffic gain attributed to the new road is mainly redistributive in nature in the sense that the use of the freeway has caused some route changes that have diverted trips from parallel routes, thus substantially decongesting certain outer city collector roads. These roads were mainly connecting the national highway network with various destination points in the eastern part of the region and were carrying heavy traffic loads through suburban residential areas, even though they did not possess the appropriate geometric characteristics.

It is difficult at this point in time and without the benefit of quantitative data, to make any definite conclusions regarding the overall impact of the new road on the operation of the existing road network especially in terms of improving overall mobility and reducing travel demand. On the contrary, however, there is some indication that the improved driving conditions on the freeway have produced some generative effects in the sense that the motorists are now willing to make some longer and previously suppressed trips, as in the case of visiting the eastern coast for leisure and entertainment activities, thus increasing the amount of new travel and ultimately the amount of total vehicle kilometers traveled.

The first indications regarding the generative and redistributive effects of the freeway point to the finding of the extensive new research being conducted on the subject of evaluating the effects of induced demand of new highway projects (Cervero, 2003; DeCorla-Souza & Cohen, 1999; Noland & Lem, 2002). The results of this research indicate that there is substantial evidence that new roadway capacity "induces increased travel, both due to short run effects and long run changes in land use development patterns" (Noland & Lem, 2002: p.1). The short term effects are associated with 'behavioral shifts', such as mode switches, change of routes and or making of previously suppressed trips, whereas long term changes refer to 'structural changes' that are associated with the decision of people and firms to locate near the newly constructed or upgraded freeways in order to 'exploit the accessibility benefits' (Cervero, 2003: p.146). Moreover, this research claims that the reduction of travel times and the corresponding increase in travel speeds achieved by road improvements, spur new travel that is, induced demand which in turn promotes road investments over time by increasing total traffic volumes (Cervero, 2003).

Finally, it is of importance to note that so far there is very limited use of the suburban railway that runs in the median of the freeway. The extremely low ridership is attributed to both the high cost of the ticket but mainly due to the inadequate access the prospective users have to the railway stations.

4.3 Environmental impacts

The final physical characteristics of the project were partially revised from the initial design mainly due to the vocal objections raised by local authorities, concerned citizens and other agents concerning the impact of the project on the physical environment and the quality of life of the affected communities.. As a consequence, the section of the freeway that cuts through the densely populated suburban areas of Athens was constructed entirely in cutting below the existing ground level in order to maintain community cohesion and minimize noise levels. For that purpose, 32 multi-level road interchanges (fly-overs), 104 road bridge overpasses and 25 underpasses, 95 railway bridges and 38 railroad grade separated crossing and 15 pedestrian bridge overpasses were constructed. At the same time, interchanges and road crossings were constructed at the surface level while cut & cover sections were developed for public use in the form of sport facilities, children's playgrounds, parks and recreation areas. Moreover, for the added protection of scarcely populated residential areas that abut the facility at the same surface level, special noise barriers 18 km long were installed (Photo 2).

Photo 1. Location of new development in the western part of the urban region, in areas abutting the freeway. Source: Geomatics Ltd.



Photo 2. The integration of the freeway into the urban fabric through road crossings and cut & cover sections. Source: Geomatics Ltd.



The physical characteristics of the western peripheral section of the freeway were also changed in order to minimize its impact on the natural terrain and vegetation of the Imittos Mountain by constructing a total length of 15,5 km of tunnels and cut & cover sections. Additional measures and works undertaken to mitigate the environmental impacts of the construction and operation of the facility included:

- the construction of 38,5 km of flood prevention works as well as improvement of stream, torrent and river flows 22,5 km long
- the use of excavation materials for the restoration of inactive quarries which led to their reforestation and the creation of planted green areas
- the planting of 16,000 trees, 67,000 bushes and the creation of 4,5 hectares of turf

The impact of the operation of this highway on air pollution is still not adequately evaluated. However, there are some initial observations indicating that the 'Athens freeway' has a dual impact on the quality of air. It is being argued that the operation of the freeway has contributed to the decrease of overall air pollution levels at the metropolitan level that is, at the level of the city region. This conclusion is based on the premise, not evidence, that almost 250.000 cars per day now circulate at a constant speed thus reducing the total amount of exhaust fumes that are released in the air while at the same time greatly reducing fuel consumption. At the micro scale, though, that is at the municipal / neighborhood level, air pollution measurements point to a different phenomenon, that of the redistribution of air pollution levels among the different areas of the region. According to recent measure-

ments, it is observed that air pollution levels have slightly increased along the axis of the freeway over the first year of the freeway's operation, thus deteriorating the microclimate of residential areas that were not previously exposed to high air pollution levels (YPEXODE, 2004).

5. Conclusions

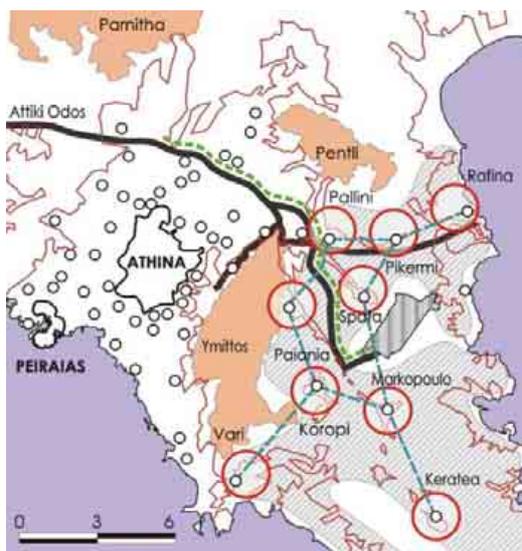
Evaluating the full impact of the 'Attiki Odos' freeway is an undertaking that cannot be attempted at this point, and certainly not within the framework of this paper, mainly due to the short operating time period of this roadway and the lack of relevant raw data. However, the following general conclusions are attempted.

First, the reduced travel times and the improvement of driving conditions, associated with the improved road provision, have substantially improved the mobility within the Athens metropolitan area only as far as interurban traffic is concerned. This impact along with the traffic redistributive effects and the improved access provided to both the outlying western and eastern parts of the urban region as well as to other major infrastructure, such as the new airport, are justifying the generalized belief that the new freeway has filled a substantial gap of the pre-existing traffic network of the city. However, two important points must be noted. Firstly, the improved accessibility offered by the new freeway is dependent entirely on the exercised pricing policy, that is by the adjustment of toll prices which raises serious equity concerns related to the provision of equal access to all travelers. Secondly, initial observations verify that there is some generation of new travel that might eventually lead to an increase in both travel demand and ultimately to the total vehicle km traveled within the urban region to the detriment of the already high air pollution levels.

As far as the impact of the project on the urban environment, it can be observed that despite the improvement of its physical characteristics in order to maintain community cohesiveness and the unity of the urban fabric, a major 'wound' has been inflicted on the Athenian landscape, especially on the Imittos mountain range.

Thirdly, it can be safely concluded that the construction and operation of this freeway is promoting the existing sprawling urban development patterns. The dispersion of urban activities into the newly developing exurban areas which are further exacerbated by new development activity along the freeway indicates that there is a need for 'thoughtful land use planning and growth management around new interchanges and along newly expanded highways' in order to minimize their induced growth effects (Cervero, 2003). This need of utmost importance and relevance for the Greek capital for urban development patterns evolve without the benefit of land use controls, since the existing planning system provides mainly a regulatory framework for building control. Consequently we would conclude, that today there is an urgent need for developing of a new urban growth model, that will organize the urban activities around the cores of existing settlements, ensure the connection between them and the suburban railway, using an efficient public transport system, and prevent the region from the urban sprawl danger (Map.4).

Map. 4. A possible new urban growth model for the eastern part of the Athens Greater Area.



Finally, it has to be noted that the widely adopted policy of increased investment in roadway construction which has been facilitated by new financial schemes, such as the joint public-private partnership scheme, must be evaluated more closely in terms of its tendency to promote the automobile dependence of cities, especially the ones such as Athens which exhibits behavioral patterns that promote the ownership and use of private vehicles.

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1. The growth potential of these areas is greatly promoted by real estate interests that claim that the improved access provided by the construction of the freeway will transform these "forgotten cities" into suburbs of Athens. This will be achieved, according to their estimates, by the economic growth that will follow the development of business and storage facilities that have already been built along and near the freeway and the increased demand for housing, while they point to the substantial real estate surplus value that the initial investors can gain (excerpts from newspaper articles, "To Bima", 2003).

2. The qualitative assessment of the transportation effects of the "Attiki Odos" freeway presented in this paper is based on the preliminary analysis of relevant traffic data which is carried out by the Department of Transportation of the National Technical University of Athens and is expected to be finalized in October 2005.