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Explore the ability to cycle in Greek modern cities.
The case study of Kallithea.

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Abstract

During the past decades, unlike other countries of the European North, Greek society isolated the bicycle from its everyday life, both as a means of sports and recreation, as well as a means of transport. However, in the last few years, maybe due to the economic crisis, Greek people start to include cycling, again, in their daily routine. In the context of the reintegration of the bicycle into the Greek city, the aim of this article is to study and evaluate the ability to cycle in modern Greek cities. This paper presents a methodology for assessing accessibility by cycling, based on international literature and corresponding walkability methods. Initially, a bibliographic review was made to identify those factors that positively affect bicycle routes. The mathematization of these factors was then made in order to compare with quantitative data different parts of the road network. Finally, the bikeability index was applied in a case study. This paper presents the methodology, its results, the problems that have arisen and the conclusions from its implementation. The purpose of this methodology is to make it easy for researchers and citizens to understand which parts of the city are offered for cycling, which results to high quality cycling routes. The chosen case study is the Municipality of Kallithea, a city that combines all aspects of a modern city: points of attraction, university campus, high population density and traffic jam.

Keywords
cycling, urban environment, green spaces, spatial data, GIS

1. Introduction

Bicycle is a modern solution between various means of transport, with significant benefits in health and environment. Over the last decades, European cities developed new infrastructure taking into consideration the cyclists and adopted policies to improve the conditions of use of the bicycle.

On the other hand, in Greece and especially in Attiki, the transport planning remained auto-oriented (Milakis, Athanasopoulos, Vafeiadis, Vasileiadis, & Vlastos, 2012). The policies of previous decades increased the traffic and parking spaces, which led to the reduction of the space that belonged to pedestrians and cyclists. Only the last few years, efforts have been made to create the necessary conditions in order users to be able to use bicycle both as means of sports and recreation, but also as a main means of transport.

During the last decade, with the rapid development of technology and Geographic Information Systems, more spatial data became available to researchers. This data was used by scientists to evaluate the suitability and attractiveness of cities for walking. The most cited walkability index was developed by Frank et al. in 2005 in Canada, which used as parameters connectivity, land-use mix and population density (Frank, Schmid, & Sallis, 2005). Less studies have been made, however, to explore the ability to cycle in modern cities and are mainly based on audits and questionnaires. There are only a few bikeability indexes that are based on GIS data. Winters et al. (2013) created an index that consisted of bike route density, bike route separation, connectivity, topography and destination density as components, was mapped in the city of Vancouver and its aim was to detect bicycle friendly areas and areas where conditions needed to be improved. In Europe, Krenn et. al (2015) created an index for bikeability for Graz in Austria, which consisted of three environmental components – cycling infrastructure, bicycle pathways and green areas, that were positively related and two components that were negatively related to the actually used route – main roads and topography.

The aim of this study is to develop a GIS-based index for the ability to cycle in a Greek modern city – Kallithea using the existing road network and to visualize the result in a map.

2. Methodology Applications

2.1. Setting

The study area is the city of Kallithea in Greece, which has a population of almost 100,000 inhabitants (de facto) and an area of about 4.5km^2. Kallithea is a municipality of the metropolitan area of Athens, belongs to the South Sector of Region of Attiki and it is one of the most densely populated cities in Greece with more than 21,000 inhabitants/km^2. Kallithea holds a privileged position due to its central location and constitutes a natural continuation of the historical center of Athens. There are many points of interest inside the municipality that attract not only visitors from neighboring areas, but from the whole Region of Attiki. A decisive role in the promotion of the identity and physiognomy of the city played the creation of the Stavros Niarchos Foundation Cultural Centre, which is an important pole of attraction and a landmark not only for the locals, but for the visitors.

2.2. Components of the bikeability index

In order to explore the ability to bike in Greek cities, a number of components suggested by international bibliography were selected. All of them are related with:

a. Safety: It's one of the most crucial parameters for cycling, as it is directly connected with accidents. A road that it's not safe and there is high risk of accident will not be used by cyclists.
b. Directness: Cyclists prefer the shortest paths for their routes and usually these routes include the main road network. Other alternatives are routes within green parks, which are more safe and more attractive for users.
c. Comfort: It is directly related to the slope of the ground. Intense slopes are a deterrent for many cyclists. However, the difficulty is different between experienced and inexperienced users and is proportional to the distance to be travelled.
d. Quality of urban environment: Cyclists come in direct contact with the natural and built environment and as a result, they are affected more in relation with other users of the road network. A pleasant environment is more attractive for cyclists and has a positive effect in their psychology.

The components that were finally used were similar to the criteria Milakis et al. (2012) suggested for the planning of the Athens metropolitan cycle network and include:

- Slope: It is one of the main parameters that affects the energy consumption of a cyclist. Energy consumption is also affected by the coefficient of friction of the surface material. However, this calculation was beyond the scope of this research. Three levels of slope were defined (low| 2 – medium| 1 – high| 0). Other studies show that flat terrain is a major factor for bicycle-friendly areas (Parkin & al., 2008).
- junction density: It describes the level of safety and continuity of a cycle route. We defined a node as the intersection of a route with a road of equal or higher hierarchical level. It was calculated based on the length of each road section. For better accuracy, the signalized nodes should be taken into account at 50% level, given that cyclists in roughly half of them will pass during the green period. For the purpose of this research, this condition was omitted.
- traffic density: It describes the pressure and discomfort that a cyclist feels due to the traffic. The calculation is based on the hierarchical level of the road. Wahlgren et al. (2012) suggest that low traffic volume will increase the suitability of an area for cycling. Three levels of traffic volume were defined (low| 2 - medium| 1 - high| 0). Thus, motorways and primary roads correspond to high traffic volume, secondary and collector roads to medium and local roads to low.
- traffic speed: It refers to the average speed of vehicles on a route and therefore the feeling of insecurity caused to cyclists. Three levels of traffic speed were defined (low| 2 - medium| 1 - high|0). The calculation is based on the geometrical characteristics and the congestion level of the road.
- natural environment: It describes the degree of presence of natural elements (e.g. stream, coastline, forest, urban park) along the route. Three indicator levels were defined (Important contact| 2: route in landscape or in large parks, medium contact|

1: route beside urban parks or streets with dense hedgerows, little contact| 0: route along a road with minimal presence of green spaces).

- built environment: It describes the quality of urban-architectural environment along a route. Three indicator levels were defined (High quality| 2: route in high quality urban-architectural environment, medium quality| 1: route along railway lines, tramlines, pedestrian streets, traffic calmed roads, low quality| 0: route in low quality urban-architectural environment).
- activities coverage: This component regards the number and type of urban activities that a road section serves. The calculation was based on specific urban activities – sport facilities, education and green spaces. We examined how many road sections fall into a buffer zone of 250m of each activity.
- centrality: This component regards the number of road sections that fall into the urban centers. We first identified the location of all municipalities' centers. Urban centers exert greater attraction to cyclists given the higher intensity of activities.
- accessibility to public transport stations: It describes the number and type of public transport stations that affect road sections. We first examined how many of the road sections fall into a buffer zone of 250m from each public transport station. For better results, the stations should be weighted based on their hierarchical level (metropolitan, regional, and local stations). For the purpose of this research, this condition was omitted.

2.3. Calculation of the bikeability index

The index takes values from 0 to 15, with sub-categorization as follows: low accessibility: 0-5, moderate accessibility: 6-10 and high accessibility: 11-15. It resulted from the sum of individual grades attributed to each component for each road section separately. Each road section is colored based on its categorization. Road sections with low accessibility are presented in red color, road sections with moderate accessibility in orange color and sections with high accessibility in green color.

3. Results

3.1. Bikeability index

The bikeability index comprised the nine aforementioned components:

Bikeability index = slope + junction density + traffic density + traffic speed + natural environment + built environment + activities coverage + centrality + accessibility to public transport stations

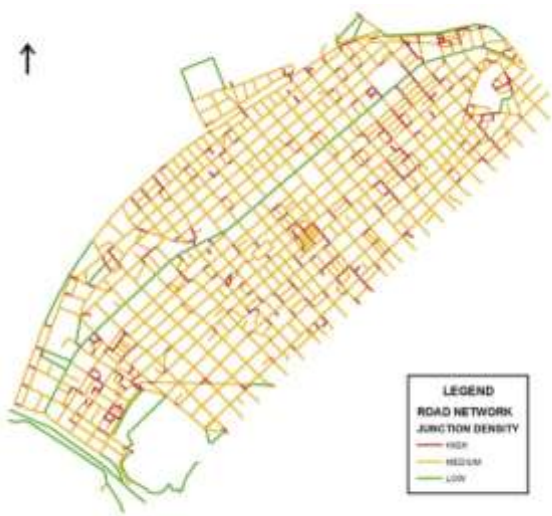
3.2. Component results

Kallithea is a flat city with average slopes less than 3%, except for a part in the north east side of the municipality. Most of the road network presents medium junction density (almost 80%), while 14% of the network presents high density. Eleftherios Venizelos Avenue, which has total length more than 4km, is a primary artery of the road network and therefore is graded with 0 points. Davaki Str., Agion Panton Str., Charokopou Str., Dimosthenous Str., Megaloupolews Str. and L. Katsoni Str. are secondary roads and are graded with 1 point each for this component.

In Kallithea, there are no road sections within urban forests. Only 12% of the road network is beside urban parks, while in the rest 88% there is minimal presence of green spaces. Regarding routes along high quality urban architecture environment, only the road network along Stavros Niarchos Foundation Cultural Centre is graded with 2 points. Routes in pedestrianized roads are also minimal and consist just the 3% of the total network – these sections are graded with 1 point for this component.

The center of Kallithea is Davaki Square, at the intersection of Venizelou and Sivitanidou Str., which is 4km away from the center of Athens (Syntagma Square) and 6km from the port of Piraeus. The road sections that are within the center of the municipality are graded with 1 point for this component.

Regarding accessibility to public transport stations, the municipality of Kallithea is served by two metro stations (line 1 – Kallithea & Tavros), which are located in the north west side of the city, 2 TRAM stations (Kallithea & Tzitzifies), which are located in Poseidonos Ave. and 101 bus stations with very good distribution in the area. Almost 97% of the road network is within the 250m. buffer zone of the stations.



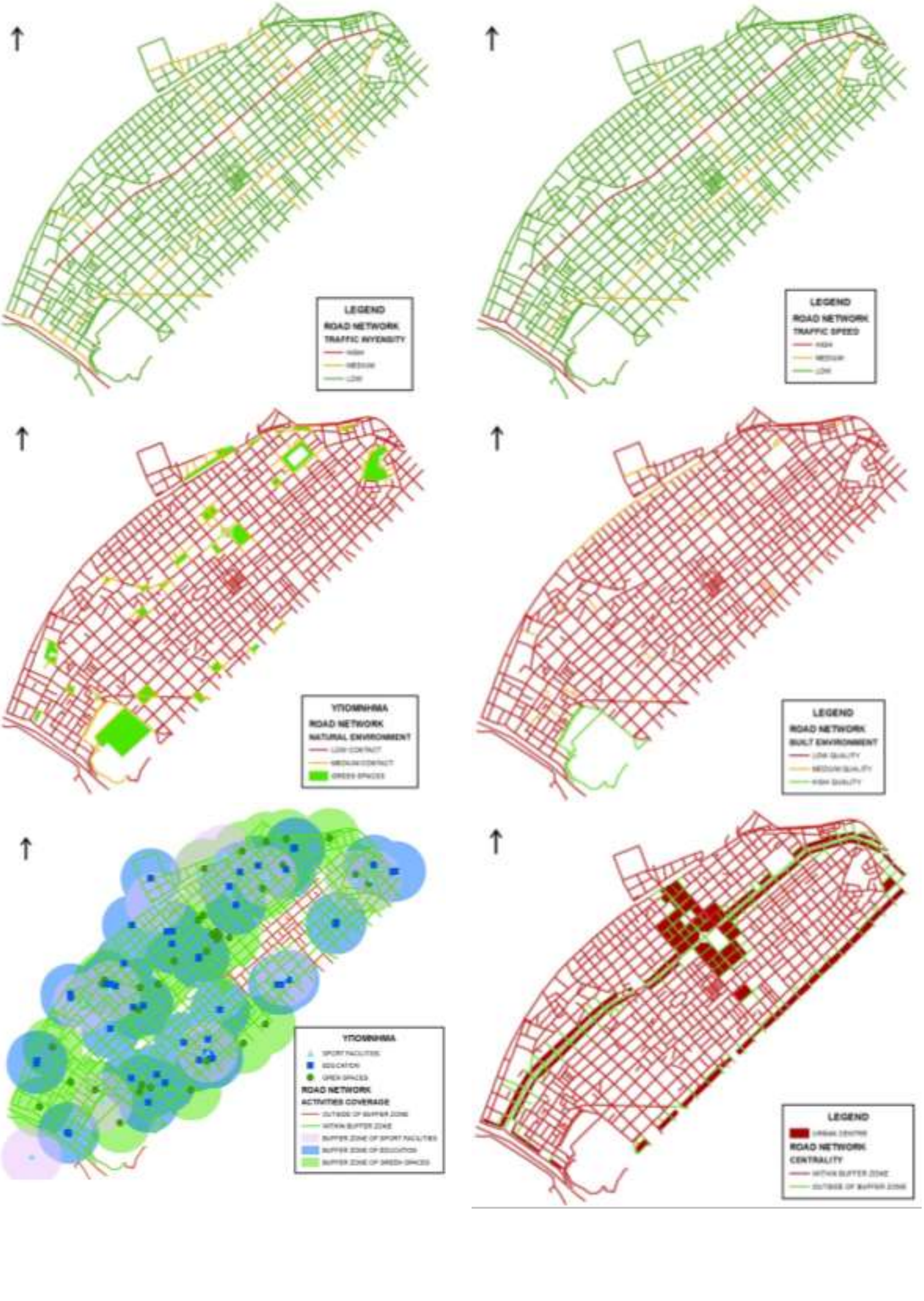

LEGEND
ROAD NETWORK
TRAFFIC INTENSITY
LEGEND
ROAD NETWORK
TRAFFIC SPEED
ΥΠΟΜΝΗΜΑ
ROAD NETWORK
NATURAL ENVIRONMENT
LEGEND
ROAD NETWORK
BUILT ENVIRONMENT
ΥΠΟΜΝΗΜΑ
ROAD NETWORK
ACTIVITIES COVERAGE
LEGEND
ROAD NETWORK
CENTRALITY

Fig. 1: Component maps

3.3. Bikeability Map

As shown in the above bikeability map, Kallithea presents moderate accessibility for cyclists in the biggest area. The road network around Stavros Niarchos Foundation Cultural Center is more suitable for cycling, while all other places with high accessibility are spare within the municipality. Slope, activities coverage and accessibility to public transport stations affect positively the index, while high traffic speed and lack of green spaces and routes in high quality urban environment affect negatively the index.

Fig. 2: Bikeability map

4. Conclusion

The cycling accessibility index consists of nine components that include spatial data. The index is related to the possibility of cycling in specific areas and the resulting mapping is a powerful tool, which identifies where traffic conditions should be improved. The assessment map should be combined with other spatial or administrative data and can be a complementary design tool to develop a cycling-friendly transport environment in modern urban cities.

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