

# TeMA

Journal of  
Land Use, Mobility and Environment

This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

# INPUT 2014

papers selected

## Smart City

planning for energy, transportation  
and sustainability of the urban system

## SMART CITY

## PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

Special Issue, June 2014

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# TeMA

Journal of  
Land Use, Mobility and  
Environment

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science, and complex systems.

The Italian National Agency for the Evaluation of Universities and Research Institutes (ANVUR) classified TeMA as scientific journals in the Areas 08. TeMA has also received the Sparc Europe Seal for Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists by their competences. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

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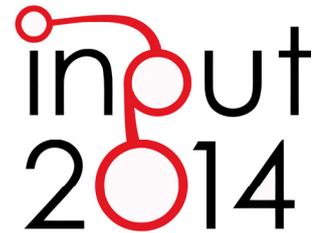
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# TeMA

Journal of  
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Environment

This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.



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## EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

### SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website [www.input2014.it](http://www.input2014.it) . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website ([www.tema.unina.it](http://www.tema.unina.it)). The codex is not present on the pdf version of the papers.

## SMART CITY PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM Special Issue, June 2014

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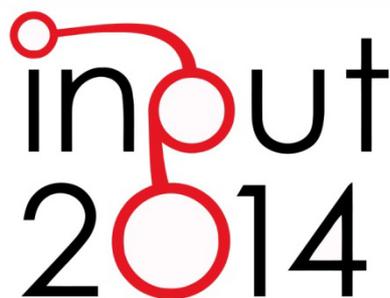
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## SPECIAL ISSUE

Eight International Conference INPUT  
Smart City - Planning for Energy, Transportation and Sustainability  
of the Urban System

*Naples, 4-6 June 2014*

The logo for the INPUT 2014 conference. It features the word "input" in a lowercase, sans-serif font, with the "i" and "n" connected by a red line that forms a stylized shape. Below "input" is the year "2014", where the "0" is a large red circle. The "1" and "4" are in a standard black font.

## DIACHRONIC ANALYSIS OF PARKING USAGE

THE CASE STUDY OF BRESCIA

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### ABSTRACT

The paper proposes a methodology for the investigation of the space-time relations between public services and individual mobility, by checking the space-time efficiency of the allocation of public and private parking areas. The methodology has been applied to the case study of Brescia, in northern Italy. The spatial distribution of car parking has been assessed as well as the usage variations during the day.

First of all, the location and the density of parking areas within the city has been taken into account, and represented to show the spatial coverage of car parking supply. Then, the temporal issue has been considered, since the degree of use of each parking area varies within the time of the day. Therefore, the degree of use of each parking area has been mapped at three significant instant of the day (10.00 a.m.; 01.00 p.m. and 04.00 p.m.). This kind of analysis is particularly helpful to highlight the availability of parking areas during the day. The results of the analysis, even if referred to a case study, can be extended to similar situations as the methodology of the analysis has a broaden sound meaning. The aim of the paper is to illustrate a method to develop mobility policies and plans.

### KEYWORDS

Urban and mobility planning; Car parking; Public services; Diachronic accessibility.

## 1 INTRODUCTION

Aim of the work is to propose a methodology to investigate the space-time relations between public services and individual mobility, checking the space-time efficiency of the allocation of public and private parking areas.

Urban mobility, that is an indispensable form of individual autonomy, most often results in the indiscriminate use of private car (Bertolini and Clercq, 2003), definitely for their comfort as well as they are perceived as a "status symbol". Nevertheless, mobility is a battleground between individual needs and public goods (Tira, 2001). So, urban planning – focused on the resolution of conflicts between private and public -, treats the issue of mobility also in terms of accessibility to (public) services and from the point of view of sustainable development. Mobility policies must include a set of provisions designed to encourage citizens to use alternative transport means (Busi and Tiboni, 2003), instead of cars, in order to decrease the impact to the environment and the economic system.

Accessibility to services is a part of the main objectives of sustainable mobility, that can be achieved both through the best location of public services and the highest possibilities to reach them. If the location can be influenced by the planning policy designed in the Municipal Town Plan (containing, for example, the requirements for the containment of soil consumption and the features to assess the proximity to existing settlements), accessibility should first refer to specific means of transport, designed to reach the service (Bonotti et al., 2012). Therefore, the knowledge of demand and supply of parking areas can be an indirect mean for to know the supply of the available means of transport: the highest being the accessibility by public transport, the least should be the car park filling rate.

## 2 THE ISSUE OF THE TEMPORAL ANALYSIS OF PARKING LOTS

The demand for parking is not readily measureable. A possible evaluation can be found in the scientific literature (see, i.a., Shoup, 1999; Axhausen, 2007; Roli and Medeghini 2007) with a first detection of the general behaviour of users searching for a free parking lot. The user generally looks for a parking lot very near the destination, focusing his research on a limited number of options - in case he knows the area - also taking into consideration the costs.

In other situations, when the environment is not known, the user prefers to go directly to free or cheap parking areas, although more distant from the destination, unless he needs a quick stop. In that case the user focuses its research in one place immediately next to the destination, accepting the risk of illegal stopping, if there are no other places available.

Shoup (2005) inversely correlates the hourly rate of parked vehicles with the walking path to and from the parked car: the higher is the hourly cost of parking, the lower is the average dwell time and the shorter is the distance walked from car to destination. This theory highlights how user behaviours and his choices follow several variables. For that reason, it is preferable to adopt a direct measure of available and employed parking places to define both the supply and demand for parking.

If the demand of parking plots is easily measured through the amount of cars dwelling on the road or inside parking structures, the supply will be defined as the amount of space devoted to regulated parking.

## 3 TOOLS AND DATA SETS FOR PARKING ANALYSIS

Some data need to be collected for the application of the accessibility analysis. The required database should contain at least the following informations:

- the geographical informations about the mobility system;
- the car parking filling rate during the day;
- data files of services and facilities (as the main attraction points of the city), both public and of public interest.

The spatial analysis has been performed in a GIS environment, using geo-referenced informations of the location of car parking areas (the free plots as well as the toll places, both on the road and in parking structures). These data can be obtained from the Municipality and the public transport companies.

The number of parking lots can be obtained from the size of the area, considering an average of 25 square meters each.

To link accessibility and time usage it is necessary to assess the temporal degree of park filling rate, analysing the data from the company that manages the parking fee service. There is usually a large and updated database that includes the location, the availability and the filling rate during each day of the last few years, for each parking structure and parking meters.

Otherwise, the filling rate of free parking areas is almost unknown, or hardly reliable and complete data exist. While spatial and temporal data are necessary for the accessibility analysis related to the whole territory, public service data files are asked for the last step of the assessment that aims at studying the accessibility linked to the opening hours of the services.

Therefore, the geographical location of the services and their opening hours must be known. The data files select qualitative and quantitative parameters, taking into consideration both the boundary conditions (roads, parking capacity, environmental features, etc.), and the characters of the structures (compliance minimum dimensional standards, maintenance and security conditions, minimum support structures, etc.).

As well as quantitative parameters, expeditious indices have been defined to assess the quality degree of environmental parameters.

#### 4 SPATIAL DEVELOPMENT OF THE PARKING SYSTEM IN BRESCIA

The case study of Brescia will be used to test the research method. Brescia is a medium sized city of nearly 190,000 inhabitants and a surrounding metropolitan of around 500,000 dwellers. Since 2013, a new light rail system has entered into operation (Bonotti et al., 2012). Such a big work has immediately reorganized the public transport network and will probably change the private mobility patterns too.

In 1931 Brescia had its first car park structure: a structure made to accommodate 200 cars including a warehouse for spare parts, a repair shop and a point for washing and refuelling cars.

During the sixties, roads were no longer adequate in comparison to the motorisation rate.

In order to find possible solutions to urban congestion of the road system and to promote a more sustainable urban mobility, in 1968 the Municipality of Brescia adopted a strategic plan called "Urban Traffic Plan". The Plan showed that 70% of work trips were made by cars, thus resulting in a high parking demand.

In 1990, the Municipality approved the new Parking Plan, aiming at regulating private mobility in the city centre and creating new parking areas and structures outside the centre, with the objective of removing illegal parking from the streets.

The Plan proposed a graduated cost of parking, to be coordinated with the development the public transport network and the accessibility.

In 1996 the Municipality of Brescia profoundly revised the parking system.

Following the experience of many European cities, particular attention was paid, through urban policies, to the connection between parking and sustainable mobility.

The main policies adopted were:

- different parking solutions for selected users: free parking far away from the city centre and rising costs and decreasing time limits approaching to the centre;
- realisation and extension of a limited traffic zone in the downtown;
- dedicated lanes for buses and taxis.

## 5 INDIVIDUAL MOTORISED TRANSPORT ACCESSIBILITY TO THE MUNICIPAL AREA

### 5.1 CAR PARKING SUPPLY AND SPATIAL ACCESSIBILITY

As already mentioned, one factor that certainly influences the choice of parking is related to the distance to be covered on foot from the parked vehicle to the destination and vice-versa: the higher is the dwelling time, the more acceptable will be the length of walking path. Dixon (1996), Miller (2000) and Litman (2011a) highlight the levels of service of urban walkability in relation to the walking distance after leaving the vehicle, depending on the characteristics of the user and the environment.

An analysis of car spatial accessibility has been made with regard to the availability of car parking in Brescia. The parking Plan for the city centre ensures a level of accessibility to any destination from the nearest car park equal to 300 meters. Considering all the municipal surface, all parking areas have been considered accessible if located at a distance (radial) of 350 m, corresponding to the average walkable distance in 5 minutes. The accessibility level is a linear function varying from 1, corresponding to the centre of the parking area, to 0 at the edge of the area of influence. The results are shown in Figure 1.

In Figure 2 each parking area is described by the number of parking lots.

So it is possible to quantify the available parking spaces within a radius of 350 meters from the chosen point. Both analysis took into account the presence of the Limited Traffic Zone (ZTL). Therefore, particular attention should be focused on this area during analysis and considerations.

### 5.2 FILLING TIME OF A PARKING AREA

How is it possible to link the temporal dimension with the spatial analysis already performed? The car parking is an indirect indicator of the degree of use of services. Despite the fact that the accessibility by private means in Brescia can generally be guaranteed 24 hours a day, the filling rate of the parking lots varies according to the time slot, as well as, in some cases, the opening hours of the car park.

Three thematic maps have been drawn. They focus on three significant time slots during a spare day:

- 10.00 a.m., critical time for toll parking;
- 01.00 p.m., lunch time;
- 4.00 p.m., afternoon rush hour.

In the following map (Figure 3), the degree of use of the toll parking places has been represented by using different colours for each filling rate. The green colour identifies parking lots with more than 75% vacancy, yellow between 75% and 50% vacancy, orange between 51% and 25 % vacancies, red with less than 25% vacancy, and finally black identifies completely filled parking areas.

Figure 3 shows the results for a limited area of downtown Brescia, including the historical centre.

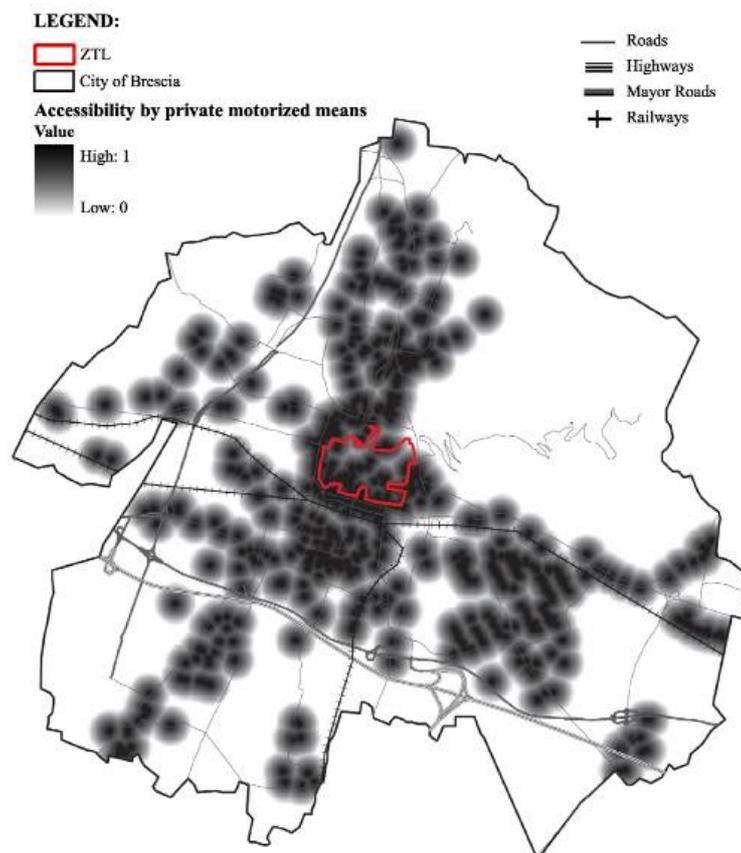


Fig. 1 Brescia and the accessibility rate of cars, described by the grey intensity

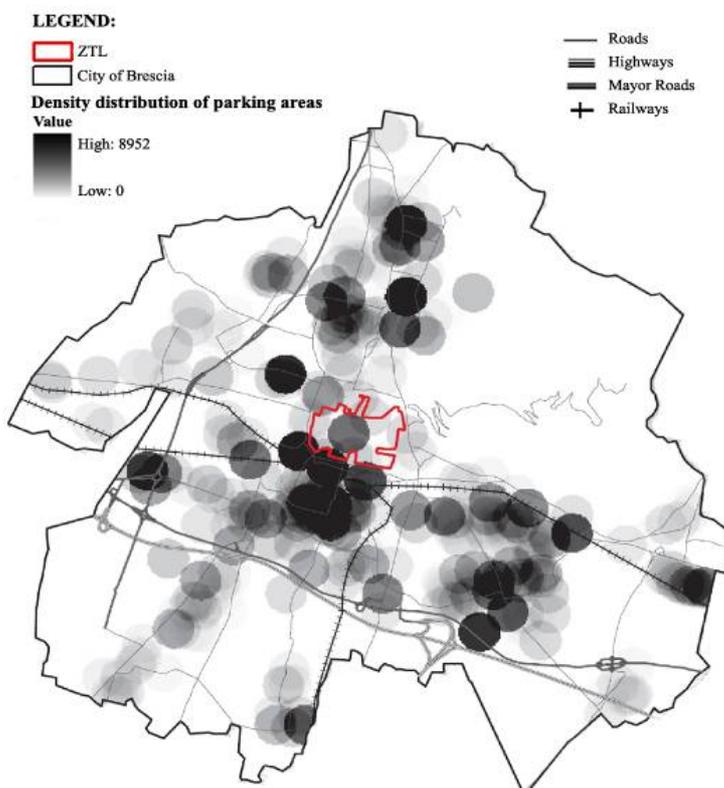


Fig. 2 Brescia and the density of parking spaces

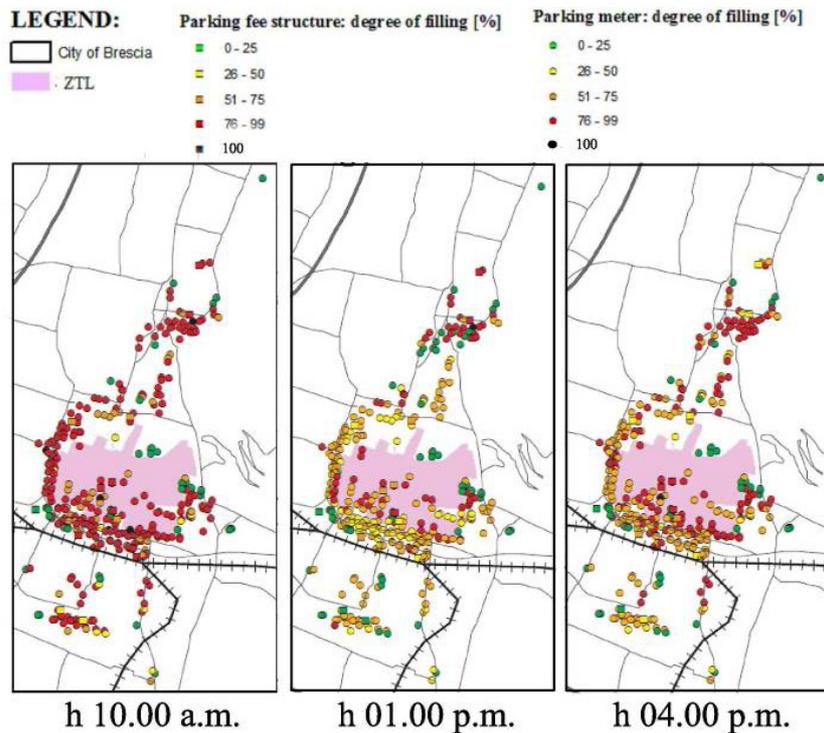


Fig. 3 Degree of use of the toll parking during three particular hours of the day (Data Source: Brescia Mobilità 2010)

### 5.3 INTERACTIONS BETWEEN CAR USAGE AND SERVICE LOCATION

Finally, according to accessibility theories, the availability of car parking should be linked with the location of the activities and opportunities located on the territory (see, i.a., Hansen, 1956; Litman, 2011b).

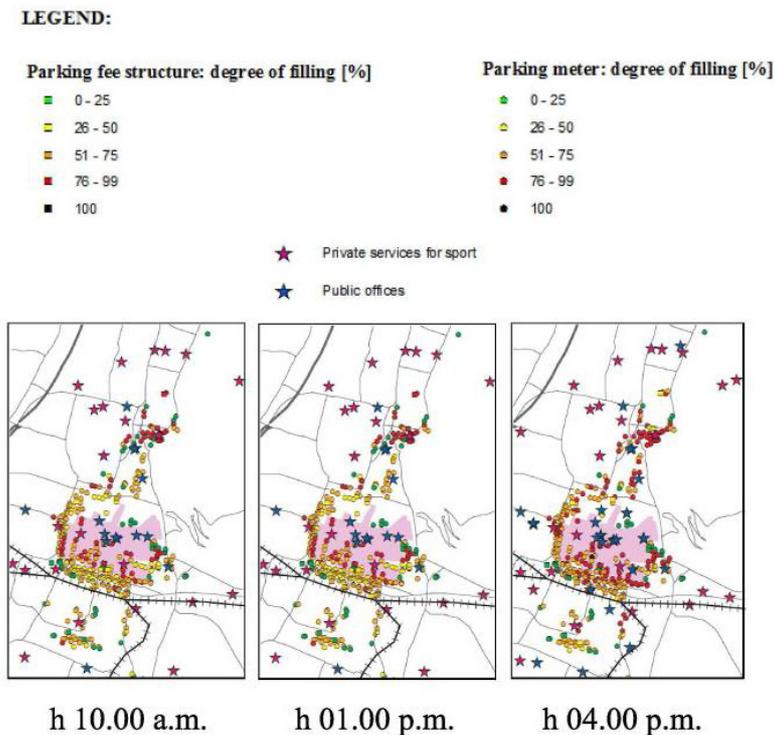


Fig. 4 The relationship between the degree of parking filling in time and public services opened at the same time

Processing available data, it is possible to evaluate the average number of parking lots available for each service and to what extent they are filled during the day. To give an example, this analysis is provided with reference to two kinds of facilities in Brescia: public offices and sport facilities.

Concerning the data available on the location and on the hours of operation for all the services in the municipality, some critical aspects can be highlighted, as some services are opened when the public transport system does not operate, or when number of parking spaces are not able to meet the demand that service requires (figure 4).

## 6 CONCLUSIONS

There is no doubt that the car has defined a new level of comfort for accessibility, and people expect easy access to city centres, housing and workplaces without long walking distances. Therefore, a fundamental dilemma arises when trying to make urban development less dependent on car: the inability of most alternatives to match the quality of accessibility provided by private motorised transport (Bertolini & Le Clercq, 2003). The assessment of the accessibility level provided by car parking areas and their use is therefore a first step towards the implementation of sustainable mobility policies, aimed at providing competitive alternatives to car use.

Within this framework, the paper showed that the location and the density of parking areas are strictly linked, but the daily use mostly unknown and influenced by the changing opening hours of services.

The results could be used to better place parking places, but also to dismiss them when a public transport means could be an efficient alternative. Also toll system can be assessed through the analysis, in order to coordinate the fees and the daily distribution of costs.

Further developments of the work include an analysis of how the demand and supply of parking areas changed after the entry in operation of the new light railway in the City of Brescia.

Car parking management policies and strategies can help in promoting alternative and more sustainable modes of transport.

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## IMAGES SOURCES

Figg. 1, 2, 3, 4: maps edited by the authors (2012).

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