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Metropolitan Mobility and Daily Activities Diversities and Constraints: The Grenoble Urban Area Case

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ABSTRACT

Inhabitants of metropolitan territories often have extensive daily living spaces in which they move around a lot to access their different activities. In a context where transition issues are at stake, initiatives encourage the reduction of individual mobility. In order to assess the potential of changing mobility practices, many analyses focus on understanding the modal shift's brakes and levers (economic and psychological dimensions, infrastructure assessment). We propose to study the drivers of metropolitan inhabitants' mobility by analysing the spatial and temporal organisation of their activities. Rooted in Time Geography, our approach consists in a statistical description of the variety of daily trajectories in the Grenoble metropolitan region before comparing it with a typology of living territories based on life qualities' characteristics.

KEYWORDS

Time Geography, Daily mobility, Activity programmes, Trajectories, Trip analysis

RÉSUMÉ

Les habitants des territoires métropolitains ont souvent des espaces de vie quotidiens étendus dans lesquels ils se déplacent beaucoup pour relier leurs différentes activités. Dans un contexte où les enjeux de transition des territoires se posent, les initiatives se multiplient pour réduire la mobilité quotidienne individuelle. Pour évaluer le potentiel du changement de pratiques de mobilité, de nombreuses analyses s'attachent à comprendre les freins et les leviers du report modal (dimensions économiques et psychologiques, évaluation des infrastructures). En complément de ces approches, nous proposons ici d'étudier les ressorts de la mobilité des métropolitains à travers l'analyse de l'organisation spatiale et temporelle de leurs activités. Ancrée dans la *time-geography*, notre approche consiste à décrire statistiquement la variété des trajectoires quotidiennes de la région métropolitaine de Grenoble avant de la confronter à une typologie des territoires de vie fondée sur leurs caractéristiques en termes de qualité de vie.

MOTS CLÉS

time-geography, mobilité quotidienne, programmes d'activités, analyse de trajectoires, territoires et qualité de vie.

INTRODUCTION

The geographies of our daily lives are becoming increasingly complex in metropolitan areas. Dealing with extended and scattered life-spaces and tight schedules is a matter of concern for people living in these areas. In this context, daily mobility plays a key role in holding together the spatial and time dimensions of the daily lives of individuals, who must mobilise resources and competencies to organise as best they can their activities and travels across their life spaces. At the same time, daily mobility clearly leads to car-use and fossil resource dependencies, congestion and air pollution increase as well as more sedentary lifestyles.

Considering these social and environmental issues and tensions that arise from the daily metropolitan ways of living, our contribution investigates the time-space activity and mobility patterns of the inhabitants of Grenoble Metropolitan Area (GMA). This leads us to describe the various conditions of living and moving in the different parts of the area (suburbs, central parts). Our approach is grounded in the conceptual framework of Time Geography which provides helpful theoretical tools to investigate the space-time dimensions of daily life (Hägerstrand, 1970; Ellegård, 2018). Most of its principles have been adapted to mobility studies through the "activity-based" approach, which seeks to incorporate information on activity programmes in the study of mobility behaviours (Vilhelmson, 1999; McNally *et al.*, 2007; Ellegård *et al.*, 2012). This study illustrates various ways to analyse information about daily mobility practices to better describe the constraints that

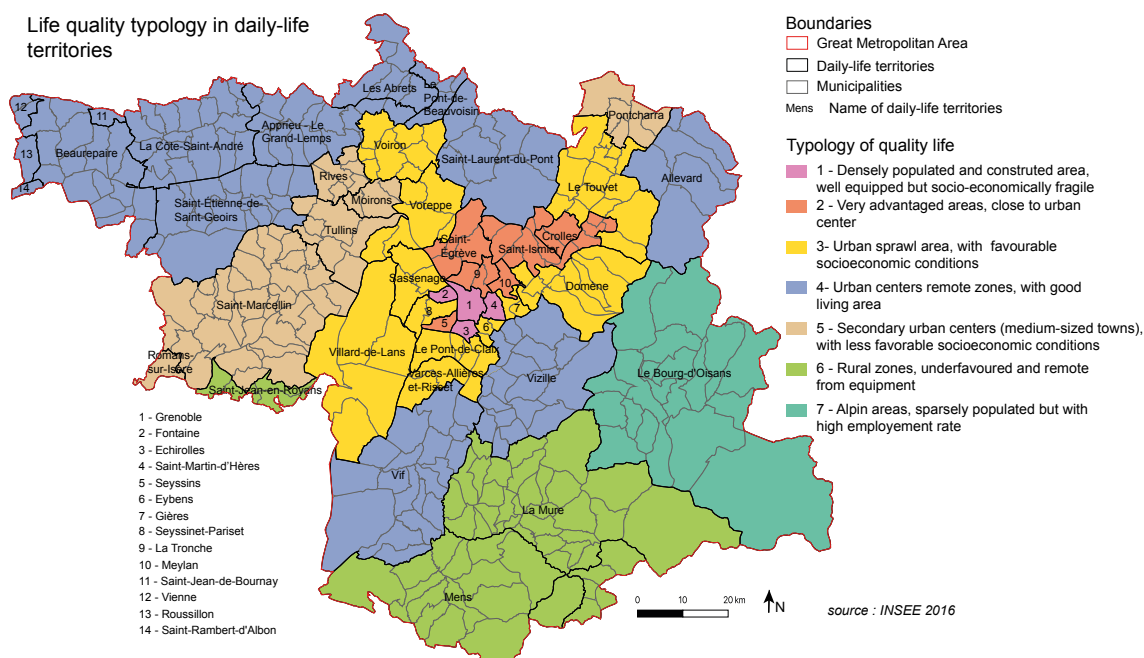
can weigh on households' mobility in a transition context in metropolitan areas. Based on Household Travel Survey data, our analysis aims at understanding to what extent daily activities and mobility patterns differ according to individuals' daily areas' spatial and temporal settings.

1. DATA AND METHODS

The data we use come from the 2010 Household Travel Survey¹ (HTS) conducted on the GMA. HTS provides an overview of a day in the life of the members of surveyed households. Members of each household (at least five years of age) selected for the survey are questioned about their trips of the previous day (times, modes, and purposes for each trip). Collected data focus on trips (with space-time attributes like hours, duration, origins and destinations, modes and purposes i.e. activities), and also provide information on individuals and households. The considered Grenoble HTS (2010) sampled 16,600 inhabitants (7,500 households) from 3,542 municipalities localised in the GMA (fig. 1), corresponding to 63,000 daily trips.

We also make use of two sets of data obtained from the French National Statistic and Economic Studies Institute, Insee (fig. 1). The first is a zoning that describes the spatial extension of inhabitant daily lives or *Daily-life territories*. The second characterises the quality of life, with subsequent typology classes attributed to the various zones.

Figure 1. Life-Quality typology in daily-life territories in Grenoble Metropolitan Area (according to Benard & Pichavant, 2016)



In order to grasp the mobility in the GMA, we present in Part 2 statistics about trip mode uses, and average length and duration of the trips made by the inhabitants of different daily-life Grenoble area zones.

Since it evidences some interesting differences in mobility and time-use according to the living localisation, we propose in Part 3 to deepen the subject by investigating the temporal sequencing of daily activities. A typology is obtained with the TraMineR tool (Commenges & Pistre, 2015): the R-programme package enables sequence analyses by clustering the time-slots organisations, mining, describing and visualising sequences of states or events (discrete sequence data).

In Part 4, we present the relationship between the daily activity patterns and the daily life zoning, as obtained from a Chi-square test, first for every activity-pattern class and daily life zone, and second for every activity-pattern class and every quality of life class (7-class typology).

These analyses, guided with a recently developed mobility-data dedicated tool, eventually lead to a comprehensive view of the variety of daily activity-patterns and mobility practices. The tool, called eSTime (Menin *et al.*, 2020), is based on Time Geography concepts, and enables to explore and visualise mobility data on individual and aggregate levels with original geovisualisations.

¹ In French: Enquête ménages déplacements (EMD) 2010 de la région urbaine de Grenoble, actually named EMC², Enquête mobilité certifiée CEREMA.

² It is important to note that the EMD 2010 area, GMA, is much bigger (354 municipalities) than the Grenoble Agglomeration Area (the administrative one), which only counts 49 municipalities.

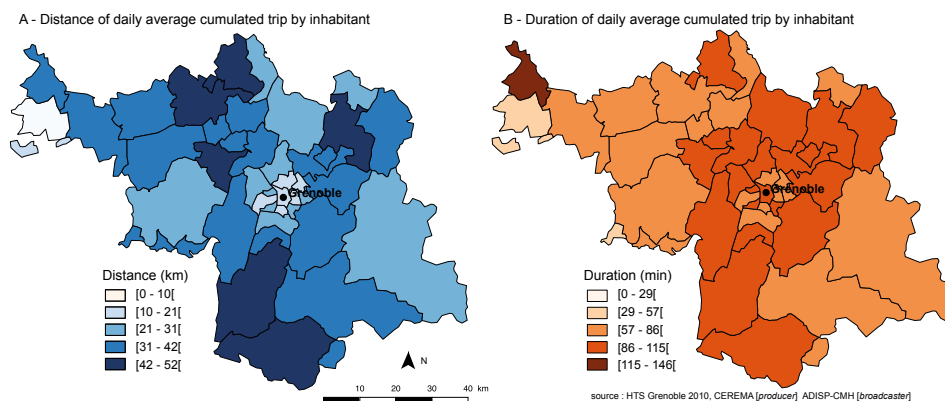
2. OVERVIEW OF DAILY MOBILITY IN GRENOBLE METROPOLITAN AREA (GMA)

The area surveyed by Grenoble 2010 HTS includes urban, peri-urban, rural and three mountain ranges (Vercors, Chartreuse, Belledonne) that constrain the transport infrastructure. Besides the road network, public transportation system relies on intercity trains or coaches at regional level, and on an effective public transit system comprising 45 bus lines and 5 tramway lines at the local level (Grenoble-city and the surrounding municipalities). The metropolitan area is strongly polarised, with Grenoble agglomeration concentrating the main employment opportunities, secondary and high-level education schools, shopping centres, sport and cultural leisure activities. Some secondary employment poles also exist with for instance the Grésivaudan “Alps Silicon Valley” and several smaller economic centres, like Voiron and Vizille, that attract local mobility (Chardonnel *et al.*, 2017; Tabaka, 2009).

The first general daily mobility overview includes data related to time, space, trip modes, and possibly other indicators related to personal and household characteristics. Looking at the cumulated inhabitants’ daily trip distances according to the residence area zone (fig. 2a), we observe that the closer the housing zone to the urban-heart, the better its quality-life class and the shorter the daily cumulated distances. However, even in some “well equipped” suburban areas (Vif for instance), the average cumulated distances can exceed 20 km, a value comparable to non-equipped areas.

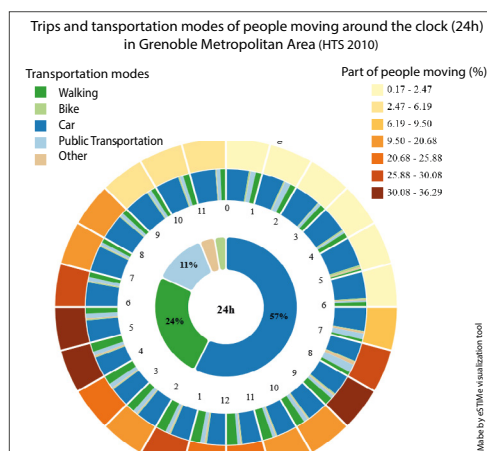
Concerning cumulated trip durations (fig. 2b), though the daily distances in Grenoble are shorter, the trip time-budgets are as important as in more distant suburbs areas (the so-called 2nd urban circle or “urban crown”), reaching 1.5 to 2 hours a day. This contrasts with the smaller trip-time budgets in the closest suburbs (1st urban circle: municipalities in Grenoble direct neighbourhood, except 2 municipalities in the west, and 3 in the south) and in the much more remote areas: between 0.5 and 1 hour per day.

Figure 2. The distribution of daily average cumulated trip distances (A) and durations (B) made by inhabitants of different GMA zones (HTS, 2010; Insee, 2016)



Looking at the trip-mode distribution in the whole GMA (fig. 3), we note that over half of the inhabitants use a car (57%). This is slightly less (45%) for Grenoble-city’s inhabitants, due to their use of public transportation (PT) and walking mode that are much higher than

Figure 3. The “Mobility wheel” (HTS Grenoble 2010, by eSTIME visualisation tool)



in the rest of the agglomeration (24% against 17% for PT, and 24% against 16% of people walking). In the remaining of the agglomeration area, the use of cars concerns 61% of the population. When looking at a specific area like the Grésivaudan Valley suburban area, almost three-fourth of inhabitants rely on this mode (72%), while 7% are PT users and 13% of people walking.

The common index that summarises the mobility intensity, called *daily mobility index*, gives the average number of trips per person³. This index is under 4 trips (3.63) for the whole GMA area. For Grenoble-city residents, it is higher (3.72 trips), and the highest value is obtained for the smaller Vizille agglomeration (4.09). It decreases for the rest of Grenoble-agglomeration excluding Grenoble and Voiron

3 It measures the average number of trips per person, by dividing the number of all collected trips with the number of all enquired persons aged over 5 (whether or not they made any trip during the day). In 2010, in the Grenoble HTS, almost 9 on 10 enquired persons made at least one trip in the study area: GMA (89%), the rest stayed at home (10%) or were absent in GMA (1%) during the enquired day.

agglomeration (for both: 3.63), in the rest of remote suburban and rural areas (3.56), and is the lowest in the Grésivaudan Valley suburban area (3.48).

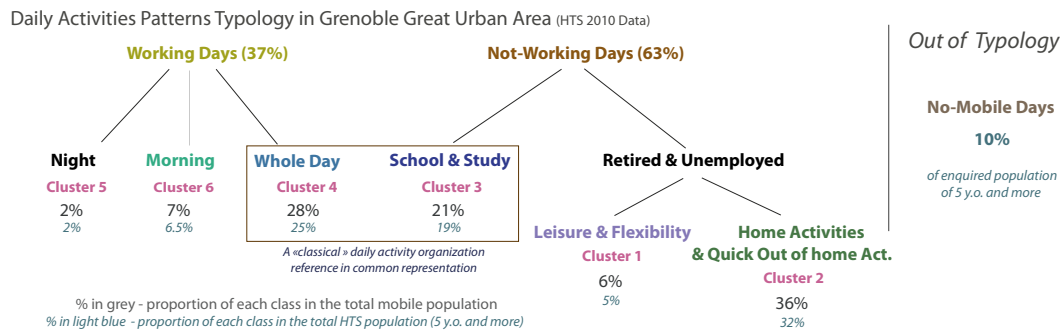
The outermost ring displays the estimated proportion of the surveyed population moving inner or towards GMA at each 1-hour period over 24 hours, while the innermost ring presents the part of these people per mode of transport. For example, between 8 and 9 am, over 30% of the population is on the move and more than half are using a car.

3. TYPOLOGY OF DAILY ACTIVITY PATTERNS

According to Time Geography, people are weaving daily trajectories in space and time, dealing with different kinds of opportunities and constraints in order to realise their projects. From this perspective, mobility is derived from the demand for activity participation and should be analysed through the sequences or patterns of activity behaviour (McNally & Rindt, 2007). For this reason, in order to better understand the outstanding standard mobility-index differences shown above, the method suggests to look inside the daily activity organisation forming a space-time trajectory of all enquired persons.

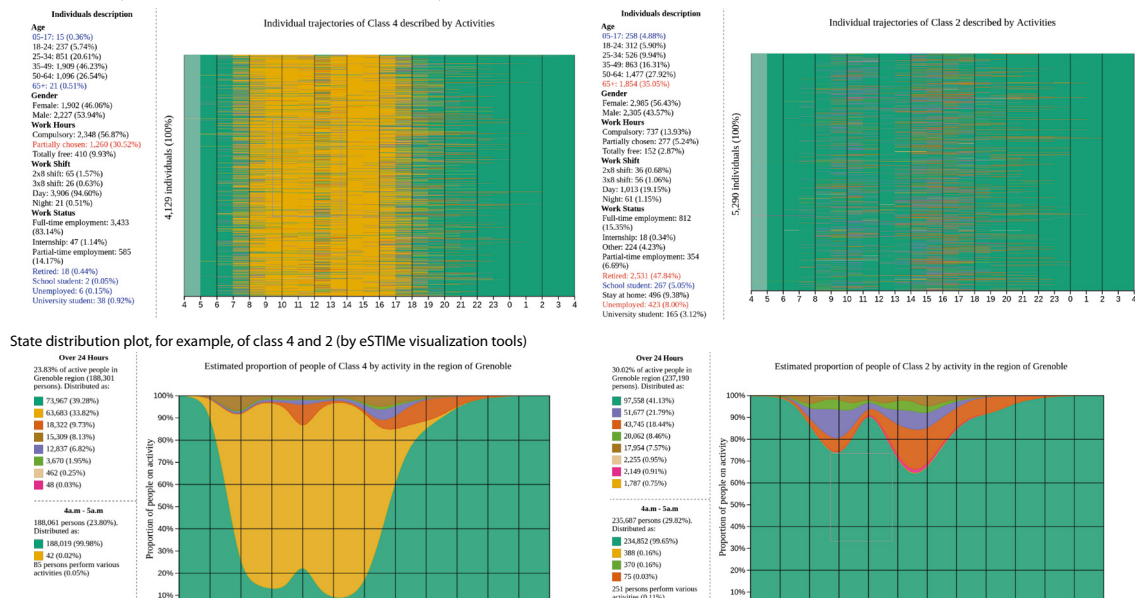
The clustering that we got by TraMineR tool analysis revealed six different daily activity patterns classes (fig. 4) based on daily activity sequences similitude, including children and adults, and excluding non-mobile individuals (10% of the sample).

Figure 4. General daily-activity pattern typology



Interpretation based on :

Sequences of daily activities pattern, for example, of class 4 and 2 (by eSTIME visualization tools)



The most numerous class, “Home-based & Quick out of home activities days” (class 2, 36% of the population) is mainly characterised by home activities, with the meridian (lunch) time spent at home, and no, or seldom, professional activities, some late evening and nocturnal activities, mostly leisure. 48% are retired people and 8% unemployed.

The second largest class (4), “Whole Day Working” (28% of mobiles), is organised around job activities, together with accompanying activities, especially in the morning and evening hours.

The 3rd class “School & Study days” (21%), corresponds to study activities structure almost all day, with possible additions, mostly leisure, after 4 or 5 pm, later in the evening or during lunch hours. These days

mostly concern school students (82%), university students (16%), and young adults (19% between 18 and 24 years old).

The three remaining classes show the realities of persons working and acting in shifted and no-standard hours. The work of people in “Morning Working Days” class (C6, 7%) starts mostly between 6 or 7 am and ends at the beginning of the afternoon (12 am to 3 pm). One-fifth of this population has part-time employment, over three-fourth work full time (77%), and the males are over-represented (56%). No clear activity pattern emerges for class 1, “Leisure & flexibility days” (6%): a single dominant –mostly leisure– out-of-home activity emerges between 10 am and 5 pm, with significant fluctuations (as early as 4 am and up to 8 pm). Persons aged 50 and above are largely represented in this class, 41% being retired, in addition to 15% unemployed or staying at home. A quarter (23%) are full-time employed, 8% part-time. The smallest class (2%), “Night Working & Leisure Days” (5), includes sequences with various daily activities (working, studying, leisure), and late leisure and working activities. Over half are full-time workers (55%), but it also includes school students (16%) and university students (12%), as well as individuals working part-time (8%). Males are clearly over-represented (62%).

4. RELATIONS BETWEEN ACTIVITY PATTERNS AND TERRITORIAL LIFE QUALITIES' CHARACTERISTICS

The first Chi-square test between the 6 activity patterns classes and the daily-life territories in GMA is highly significant ($p\text{-value} < 2.2 \cdot 10^{-16}$). The standardised residual results are reported in figure 5. It corresponds to the standardised difference between observed and expected number of HTS participants with one of the 6 activity patterns and living in one of the daily-life territories. For all classes of activity patterns, some territories are over-represented (red values) and others are under-represented (blue values). The second Chi-square test applied between the 6 classes of activity patterns and the 7 classes of life qualities typology (fig. 1), is also very significant (Chi-squared = 1,690, $df = 30$, $p\text{-value} < 2.2 \cdot 10^{-16}$), showing a relation between daily activity patterns and qualities of life in territories.

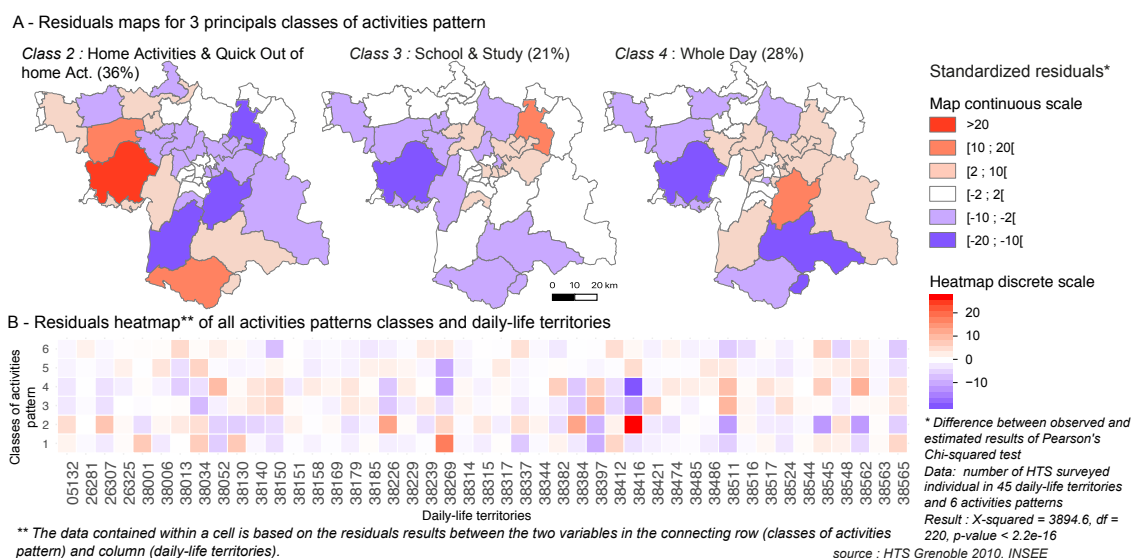
The territory of Saint-Marcellin (postcode 38416) is the most over-represented in the class 2 activity pattern (home activities and quick out-of-home activities). It is also over-represented for the class 2 activity pattern according to the second test that considers the quality of life typology, which means that people living in secondary urban centres, with less favourable socio-economic conditions, spend more time at home and do short distance trips. On the opposite, people who are living in territories around the Grenoble urban centre with good conditions of life are under-represented.

The 3rd class activity pattern, corresponding to students and scholars, is over-represented in the Grésivaudan Valley (East of Grenoble). The second test corroborates this result and shows more people of this class living in territories with the typology 1, 2 and 3 in terms of quality of life: urban centres (less favourable socio-economic conditions), close to urban centres (advantaged area), and in sprawl urban areas (good conditions).

People who organised their whole days around job activities and accompanying activities (class 4) are in territories around Grenoble urban centres and benefit from favourable socio-economic conditions. On the opposite, territories in secondary urban centres and rural areas are under-represented.

Activity pattern classes 1, 5 and 6 include fewer individuals. However, the results of class 1, characterised by leisure and flexibility, is typical of the Grenoble area with an over-representation in La Mure territory (postcode 38269) in the Alpine area.

Figure 5. Over- and under- representation of daily activities patterns in GMA daily life territories (results of Chi-square test)



CONCLUSION

While the mobility transition issue concerns metropolitan areas as a whole, inhabitants' daily-life spaces conditions are rather heterogeneous. In GMA, this leads to different activity patterns influencing mobility characteristics (distances, modes of transport). The present analysis evidences the importance of the relative situations of inhabitants when public policies encourage modal shift. If the cumulated trip distances of central-zones inhabitants are rather short, they can still access a myriad activities in a 2 to 5-km radius. Combining several activities and trips during a day increases trip-time budgets, but not significantly the distances. The range of accessible transportation modes is then more diversified, and better suits individual and family profiles. The daily time schedules of workers settled in suburban municipalities are more constrained: their mobility organisation and potential modal shift should be regarded in a weekly-scale perspective: distinguishing local activities possibilities (short distance) from regional ones (middle and long-distances). In this context, time flexibility (or non-flexibility) is a very sensitive point.

This analysis highlights the need to reconsider metropolitan mobility issues by analysing daily space-time organisations that the metropolitan areas enable (or not) thanks to different activities and transportation modes' opportunities offered to their inhabitants. Regional planning should, therefore, take into account the daily activity locations, their distances and accessibilities, in order to think over the diversity of the transportation infrastructures and choice for population in metropolitan areas.

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