Travel behaviour regarding demographical changes and GHG emissions in the Parisian region: Past trends and forecasts to 2030

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Abstract
This paper investigates the evolution of travel behaviour in the most densely populated region including Paris and departments, where the GDP per capita is the highest in France. Four household travel surveys available from 1976 up to 2001 allow us comparing travel time, travel distance and mode choice over years and also to forecast mobility up to 2030.

A large survey is regularly conducted on transportation behaviour of the households living in Paris region. It contains various survey instruments in order to describe the means of transport owned by the household, commuting habits, daily mobility, long distance trips, etc. Data collected in each of these instruments can be analyzed separately. The purpose of this survey is to describe the trips made by households and individuals who are living in Paris and the nearest departments, as well as their use of public and private transport means. The survey is conducted for a week day. We focus on internal trips as to say the trips which origin and destination are within the Parisian region (Ile de France).

This paper is focusing on local sustainable mobility in an urban context. We investigate on the one hand the understanding the evolution of travel behaviour in the most densely populated and wealthy region of France over years (past trends and forecasts), and on the other hand on the consequences of this urban mobility (travelled distance and modal choice) on the air pollutant emissions (GHG -CO2 eq- and local pollutants).

We have chosen to focus on the distinction between mandatory trips and non mandatory trips, mandatory trips being defined as trips which destination is work, university or school.

In a first part, we have studied travel behaviour related to demographic patterns but also socio-economic ones and geographical ones in order to identify some key elements determining travel time and choice, and urban mobility.

The analysis is developed at the trips' level and at the individuals' level. As a result, we observe that the mandatory trips do not increase recently in terms of time and distance, after a surge in the 1980s. In the same period, the overall mobility is hugely increasing. It appears that this increase is the result of the development of non mandatory trip.

We investigate the different evolution in travel time for mandatory and non mandatory trip by introducing
o firstly demographical patterns as age and gender; the evolution is mixed when introducing gender and age patterns. Indeed, from 1976 as mandatory trips (in terms of time and distance) decline for men they strikingly increase for women. The time travel dedicated to trip to work is also changing according to age class and huge difference appears between the 1970s and the 2000s.

o secondly geographical patterns as the housing location (Seven sub-regions more or less close to Paris) and taking into account the centralised organisation of the activities and thus of the mobility); in the recent years as mandatory trips has declined in Paris centre, they surge in the distant departments
where the housing price are lower.

Thirdly socio-economical patterns as income, car ownership, employment, labour force. From 1976, the travel time of multi-motorised household has increased on the opposite of household with no car.

After dedicating an important section to the analysis of past trends (since 1976 up to 2001) and the evolution of the characteristics of travel behaviour in the Paris region, we develop forecast for travel time, with a special focus on mandatory and non mandatory trips, up to 2030, mainly on the basis on demographic patterns within the age-cohort modelling approach.

In a second part, we are linking transport activities (passengers) and behaviour, urban frames to GHG emissions. The reduction of the greenhouse gases (GHG) emissions has become one of the major environmental issues of our time, due to the risks and consequences of global warming. France decided to take part in this reduction, since 1997 by signing the Kyoto protocol (stabilization of the emissions in 2010 on their level of 1990), and more vigorously while including in the 2005 Energy Law the aim to divide by 4 the levels of emission of GHG between 1990 and 2050. It is why it is so crucial to assess the exact impact of travel behaviour (travelled distance, and mode choice, type of vehicles). For this purpose, from a survey of local trips, we have defined a new approach enabling to relate the inventory of mobility-related energy consumption and pollutant emissions to individual behaviour.

The "Environment Energy Budget of Trips" is based on trips made by an individual on a casual weekday within his or her region of residence. It includes:
- on the one hand, a "Transport-related Energy Budget" (TEB), which is equivalent to the overall energy consumption resulting from his or her trips;
- on the other hand, several "Pollutant Emissions Budgets" (PEB), accounting for carbon dioxide and each of the four regulated pollutants (carbon monoxide, hydrocarbons, nitrogen oxides and particulate matters) the total volume of pollutants emitted during those trips.

As opposed to more traditional methods aimed at drawing up an inventory of pollutant emissions from transport activity as observed on the networks, the approach related to the Environment Energy Budget of Trips is not intended to determine the overall pollutant emissions generated by traffic. Its purpose is rather to simulate the variations of energy and environmental impacts of the population mobility within a given urban area as a result of the global change in individual behaviour. We have applied this method by the mean of a cross-sectional analysis for Paris Region in 1991 up to 2001 data, revealing the differentiations between the inhabitants living in the centre and those living the farthest way away. We have also found noticeable improvements in terms of CO2 emissions due to the switch form gasoline cars to diesel cars but the worsening of some local pollutants emissions. If possible, thanks to a projection up to 2030 on the technical characteristics of an average road vehicle, we will forecast trends in GHG emissions.

In the conclusion, we sketch a comparison between our results for Parisian region travel behaviour and related GHG emissions with those collected and computed for the Lille region, which is characterised by a cluster organisation of the activities and housing, and thus of the mobility.