Using national tourism demand surveys to assess greenhouse gas emissions from long distance passenger transport

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Abstract
Several recent studies on the regional, national and global levels show that tourism's contribution to greenhouse gas emissions is both significant (around or over its contribution to GDP) and growing fast. However, these studies do not examine individual tourists' consumption patterns which can lead to very different emission levels. Nor do they identify the drivers of tourist mobility; when tourism needs to be "unpacked" to elaborate adequate GHG reduction strategies.

This paper focuses on transport emissions from the origin to the destination, responsible for at least 75% of emissions by the tourism industry. The research is based on the panel "Suivi de la demande touristique (SDT)", a national tourism demand survey examining French residents' domestic and international tourism habits, i.e. French and foreign residents in metropolitan France. Each month, the SDT interviews a panel of 20,000 members on trips made in the previous month. Since 2004, they have also interviewed an 8 000 member panel on day trips of over 100km from the point of origin. Around 80 000 tourist trips are precisely described every year thanks to this survey, used as a basis for the extrapolation to national figures. This constitutes an excellent sample for monitoring national tourism demand. Using a bottom-up approach, the sample is used to calculate French GHG emissions by tourism transport. For each trip, the exact distance travelled by road, rail or air is measured (including for multi location trips), and individual emissions calculated through very precise emission ratios adapted to French specificities (car type, train type, aircraft, and different ratios according to economy or business classes, exact load factors or cars given by the survey…).

The figures obtained are excellent estimates of emissions by French tourists. They allow an in-depth analysis of emissions, their evolution and breakdown, the determination of ratios (emissions per overnight stays), some analysis of specific demand segments ('frequent flyers', impact of TGV on travel patterns...), as well as typologies and longitudinal analyses. Thanks to these data, household behaviour can be analysed, for instance, over a three year period (absolute departure rate, etc). One of the most interesting results is the identification of a small number of hypermobile travellers, responsible for most GHG emissions, while the majority of French residents only account for a very small share of total emissions.

1. Introduction

Tourism both affects global warming through its greenhouse gas emissions and is affected by climate change. (Ceron and Dubois 2003; UNWTO-UNEP-WMO 2008). However, until recently, tourism's contribution to global warming was given little attention. Tourism is an assembly of miscellaneous services, such as transport, accommodation, leisure activities, and agriculture. The conscious or unconscious view seems to be that an assessment of these activities' emissions is sufficient: tourism as such is never targeted in mitigation policies (see its conspicuous absence in the contribution of working group 3 on "mitigation" to the fourth assessment of the IPCC: IPCC 2007). Nonetheless, this overlooks the fact that tourism is an activity whose drivers are rooted in current societies and in their dynamics: a holistic view is indispensable to explain emissions and particularly their future.

Some assessments of emissions by the tourism industry have nevertheless been produced. Facts and figures first appeared in periodicals (Hoyer 2000; Becken, Frampton et al. 2001; Becken 2002; Gössling 2002), usually preceding research relying on databases and producing results at an international (UNWTO-UNEP-WMO 2008), regional (Peeters, van Egmond et al. 2004) and national level (IFEN 2000). At that stage, the first aim was to convince the scientific community and, quite strategically, institutions (governmental bodies, UNWTO, IPCC…) of the importance of considering emissions by the tourism industry. These assessments include both anecdotal case studies and calculations (e.g. Hoyer and Noess 2001; Gössling, Peeters et al. 2005) as well as overall assessments implying rather bold assumptions in their methods (Peeters, Szimba et al. 2005; Ceron and Dubois 2006; Scott, Amelung et al. 2007). Nevertheless all this work clearly met its goals: convincing the players of the importance of the issues and giving rough estimates, now widely recognised.

Tourism is responsible for about 5% of global CO_2 emissions, though its contribution in terms of effective global warming (radiative forcing) could be significantly higher if some specific features of aviation are taken into account (UNWTO-UNEP-WMO 2008). Over three quarters of the emissions (a conservative estimate) are caused by travel to the destination. The various studies also show that emissions vary tremendously according to the types of tourism (Gössling, Peeters et al. 2005; Becken, Simmons et al. 2006). This last appreciation is mainly derived from case studies which do not provide an overall view of the diverse emissions of tourist products and destinations. This constitutes a severe knowledge gap: tourism needs to be "unpacked" , or broken down into smaller components, if we want to provide guidance for adaptation and mitigation policies.

Tourism databases and national surveys contain extensive data which can be used to really "unpack" tourism. Their means are well beyond what can be obtained for specific research (e.g. on emissions by the tourism industry). They are, of course, dedicated to examining sectoral issues: where do tourists go, when, for what purposes, using what accommodation and which modes of transport. They also look into how tourist flows and expenses evolve. The point is that, when associated to a distance matrix and to the GHG emission coefficients of transport modes, they can be used to describe tourists' travel emissions.

The aim of our research is to examine tourist travel emissions in France and to contribute to filling the gap identified above. The French Ministry of Tourism possesses a relatively large panel survey on the travel patterns of French tourists (including same-day trips). While travel is responsible for most emissions generated by the tourism industry, we must stress that our research deals neither with the emissions generated by accommodation and the activities of French tourists at their destination, nor with the emissions of foreign visitors to France (travel, accommodation, activities).

2. Methods

2.1 The surveys

2.1.1 Description

The panel “Suivi des déplacements touristiques” (SDT) is a tourism travel survey concerning domestic and international tourism by residents in France. In other words, it deals with French and foreign residents in metropolitan France, thus excluding the tourism by foreign visitors to France, and French citizens living in foreign countries or in French territories overseas (Observatoire national du Tourisme ND). This survey is derived from the SOFRES “Metascope” panel, a major survey institute in France. Metascope includes 30,000 households and 53,000 individuals. Around 25% of panellists change each year so as to reduce professionalisation and weariness effects among the respondents. The response rate is around 75%. Representativity is ensured through stratification based on five criteria: the place of residence, the age of the family leader, his or her socio-professional category, the size of the household, and the size of the township. Biases of the panel such as the under-representation of the people under 30 or the over-representation of people over 65 and of single persons are corrected. Of the 30,000 households, 20,000 are sampled and one individual per household is questioned each month. Table 2 indicates some of the components of the survey.

Description of individuals	
Demographics	Age, gender, size of household, Number of children, family status (e.g. married…)
Geographical	Region of residence, size of township,
Sociological and economic	Profession, educational level, income, housing conditions (type of home, number of rooms), number of cars, second home
Description of trips and stays	
Trip characteristics	Number of trips which ended within the last month, and for three of them; departure and return date, main means of transport used, motives (19 choices)
Stay characteristics	Number of stays for each trip and for the two longer stays: length of stay, main reason, place (‘commune’ or ‘département’ for France, country if abroad), main accommodation used, if relevant, share of professional and non professional bed nights within the stay, number of persons accompanying, type of accommodation (17 choices), type of geographical space (seashore, mountain, countryside, urban), main activities (19 choices)

Table 1 Components of the Suivi des déplacements touristiques (SDT) survey

Around the end of the century, the results of the SDT showed a decrease in the number of trips which contrasted with the increase in mobility assessed by transport surveys and concerning all modes of transport. These results were not necessarily incompatible since the boundaries of the statistics differed and thus the figures could not be strictly compared. The diminishing number of tourists was not contradictory with the increase in the number of trips, since the latter resulted from an increase in day trips which are not accounted for by the SDT. This is why a survey of day trips was initiated in 2004. This survey deals with 8,000

individuals drawn from the SDT with the same criteria for representativity and periodicity, questioned on their trips of over 100km from home (Table 2).

Description of same-day trips
Date
Motive
Destination
Main means of transport
Number of persons travelling with…

Table 2 Components of the « Enquête des déplacements à la journée »

2.1.2 Limitations

The two surveys are large, and have been carried out over a long period of time on a monthly basis (some data has been monitored since 1990). However, they still suffer from a certain number of limitations.

- *An under-estimation of the number of tourists and bed-nights*. Apart from the fact that not all trips (only three) and stays (only two) per month are described, it is suspected that the proportion of persons that travel a lot (a characteristic that is not and cannot be directly checked) is lower in the panel than among the French population. Busy people might be reluctant to accept to fill in a large questionnaire every month and, if they do, might skip some trips to gain time. This is all the more problematic as these people are those who travel the most. Additionally, the surveys only include the trips of individuals under 15 when they travel with their parents, thus disregarding the autonomous travel of children. Also, before 2004, foreign residents were excluded from the panel which implies a slight discontinuity in volume; they are also currently under-represented in the sample.
- *Reliability and size of the samples*. Dealing with subcategories inside the panel – which is indispensable to "unpack" tourism – implies diminishing the reliability of the results. This means that analyses on an annual basis are more reliable than on a monthly basis; yet regarding the number of trips, of stays and bed-nights, monthly data are considered as reliable. This type of difficulty also arises on a geographical scale when dealing with minor destinations. This concerns destinations abroad (the panel does not seize a significant number of people going to New Zealand for example), which can be dealt with by aggregating destinations. It is also the case for some regions in France. For example, the SDT better captures the volume of travel to the Riviera and its characteristics than to less appealing regions.
- *Time related limitations.* The survey on same day trips only started in 2004, as did the inclusion of foreign residents in the SDT. Even though the SDT started in 1990, there were some important methodological changes in 1999 which would render comparisons with data prior to that date very complicated. Even within a shorter period, the possibility to track changes in individuals' behaviour is limited by the renewal of the sample; e.g. some people change residence or give up filling in the questionnaire. To these factors must be added the fact that the SDT is not a "true" panel as, within the household, the individual answering might change over time.

2.2 Adding a GHG calculation module

2.2.1 Associating distances to trips.

Since 1999, SOFRES associates a distance matrix (from commune to commune, and there are 36,000 communes in France) to the trips (both direct distance and road distance). However this leaves aside distances to foreign countries and to French territories overseas. For neighbouring countries, the data have been completed using as a starting point the

regional capital cities. For distant countries and French overseas territories, Paris has been considered as the starting point. For neighbouring destinations the capital city of the country has been retained insofar as it seems reasonable. For very long distance destinations the web site used considers the barycentre of the country. In addition, there are a certain number of trips for which the destination cannot be easily identified as a commune (e.g. a ski resort) in the answer to the questionnaire, although the small number of cases has meant that they have been dealt with on individually. Finally, another problem arises with trips that include multiple stays; here the database has been corrected to avoid counting them as two trips to separate destinations which would have over evaluated emissions.

2.2.2 Emissions coefficients

The almost unique source for French emission coefficients is Ademe (Ademe 2007), a French governmental source. The coefficients concern emissions from well to wheel, i.e. including indirect emissions but excluding a life cycle approach. For air transport emissions Ademe uses an uplift factor of twice the amount of CO_2 emissions, so as to account for non CO_2 effects (contrails, cirrus cloud formation…). A few coefficients reflect specific French situations (a highly electrified rail network fed by near to carbon neutral electricity). Some of the coefficients have been modified to take into account specificities linked to tourism travel such as the size of cars (larger than the average) or the occupancy coefficients.

3. Results

Some of the results are summarised below, so as to give examples of the questions that can be answered through this type of process.

3.1 An assessment of national tourism transport GHG emissions

The assessment provides a reliable picture of the contribution of leisure and 'visiting friends and relatives' tourism to national emissions. Domestic tourism transport (excluding professional trips) accounted for 3% of national GHG emissions in 2006, and 6% when international tourism by French citizens was added. Adding professional trips gives a total of 8%. Conversely, it does not provide business tourism figures that allow comparison of its contribution to that above, owing to the underestimation of business trips in the answers to the questionnaire.

3.2 A better understanding of the drivers of GHG emissions

A very precise light is shed on the influence of transport modes and of distance on emissions. In 2006, 7% of tourist trips used air transport while 75% used the car; the former are responsible for 62% of the impact on climate change related to origin/destination transport whereas the latter emit in the region of 10 million tonnes of CO2-e, i.e. 36% of emissions.

A tourist travelling by plane in business or first class (706,000 trips in 2006, 0.5% of the total trips for personal motives) emits 3.7t CO2-e for his transport. A person taking the high speed train (TGV) will emit on average 3kg CO2-e for his or her trip.

The contribution of long haul tourism to GHG emissions appears to be considerable. Trips within metropolitan France represent 36% of the emissions of French residents, and trips to Europe and the south Mediterranean 21%. Trips to the rest of the world (2% of the total and 5% of bed-nights) account for 43% of the emissions.

Furthermore, the processing of the database allows a link to be established between types of activities or accommodation and the emissions from transport associated with them. The tourists that stay in the most comfortable accommodation (3 stars and more) are those who emit the most during travel: 36% of total emissions. This is a consequence of a high share of trips abroad in that category. Conversely family tourism is associated with low transport

emissions: tourists that visit friends and relatives or stay in a second home emit less than 100kg CO-e per stay (although this group travels more frequently). Marine tourism (surfing, sailing, diving: Figure 1) is generally associated with high emissions (owing to the share of long distance destinations) as are visits to natural sites (three times the average). In contrast, winter sports activities are generally associated with low emissions: as the French stay in France and frequently use the high speed train.

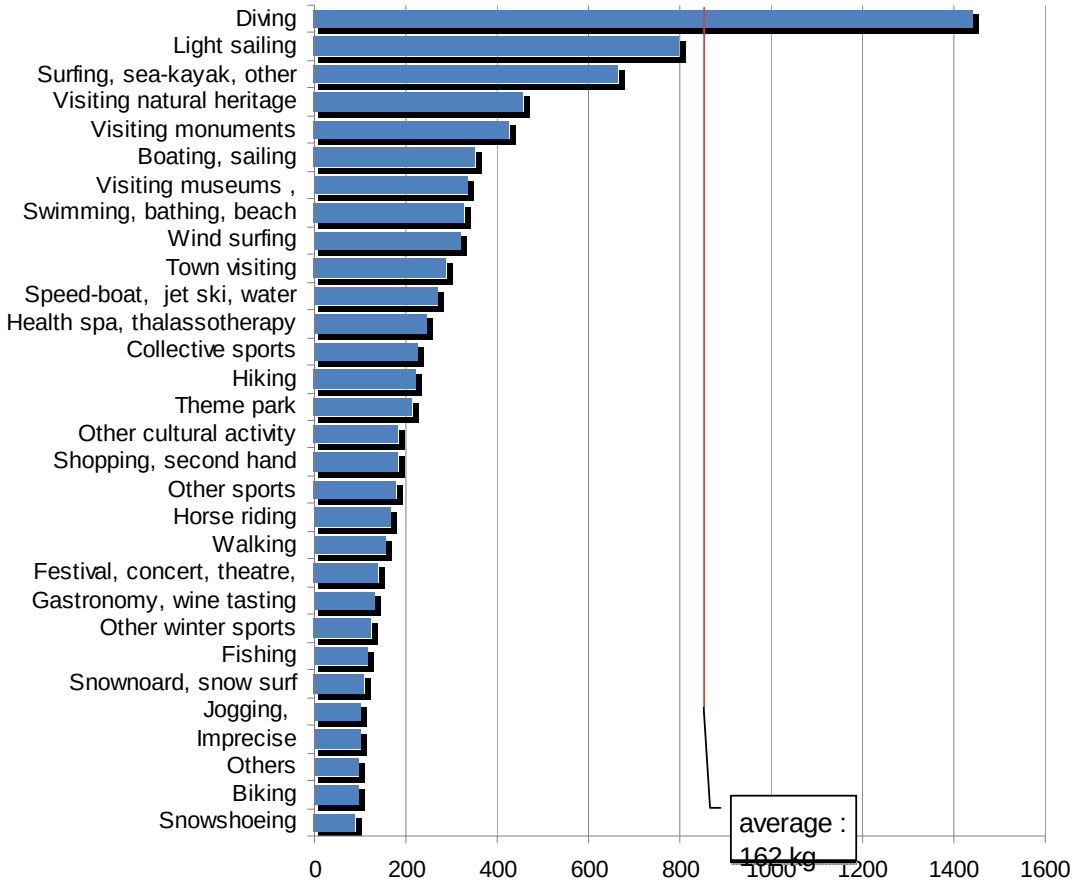

Figure 1 : Average CO2-e by trip and by activity

Finally the database provides for the mapping of emissions according to the different regions tourists originate from (Figure 2). The emissions are high in the north, the east and the Paris basin, which can be related to various factors such as climate, urban conditions, the proximity of a major airport or high income (which probably also explains the high emissions for the South East).

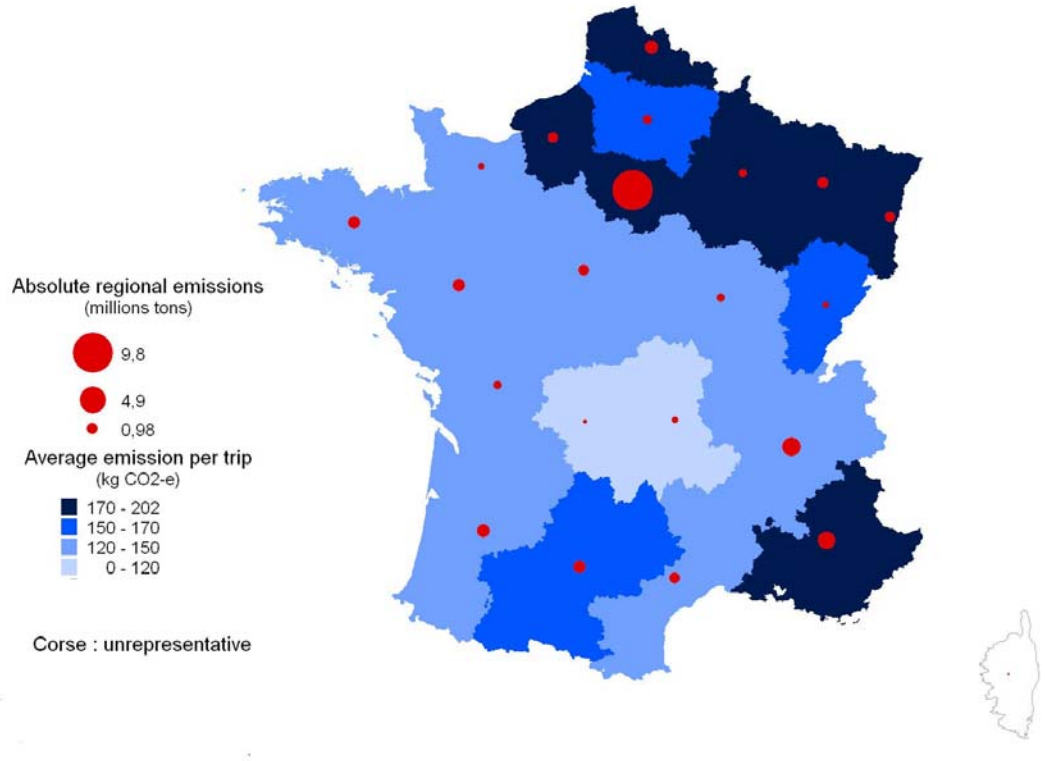

Figure 1: GHG emissions by tourism transport and average emissions per trip, according to the tourist's region of main residence

Read: Parisians emitted 9.8 MT CO2-e in 2006 for their tourist trips. The average emission of their trip was between 170 and 202 kg of CO2-e

3.3 Social stratification of emissions

Probably the main output of the research was that it allowed for emissions by different categories of individuals to be assessed. A small number of tourists are responsible for a large share of emissions: 5% of tourists generate 50% of emissions; slightly more than 3 million French residents emit 15 MT CO2-e, the same amount emitted by the remaining 60 million inhabitants (including those who do not travel).

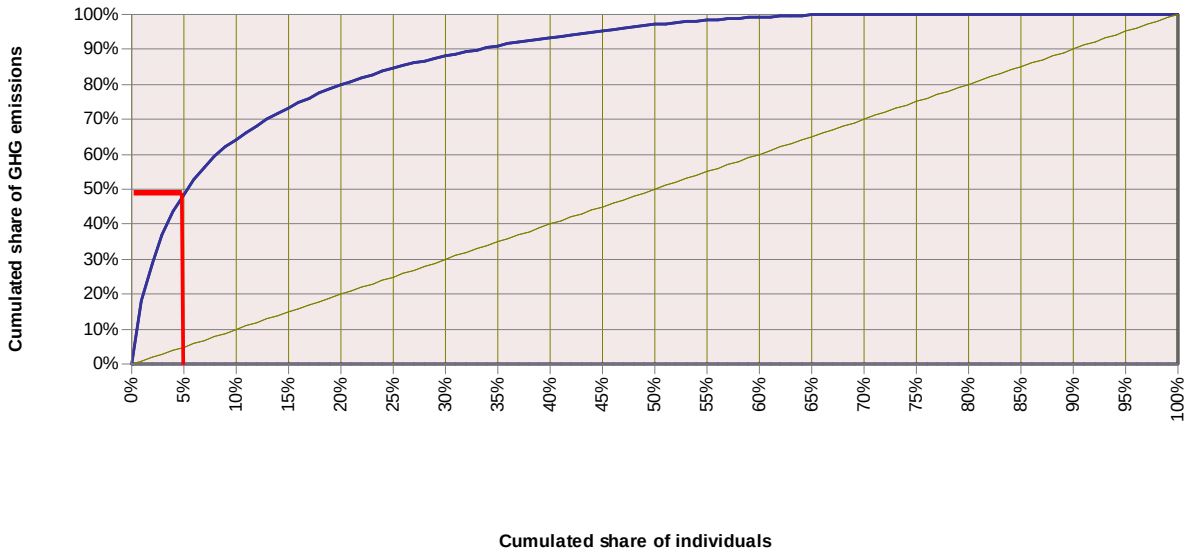

Figure 2: Cumulated share of tourism GHG emissions

3.4 Trends and pluri-annual analyses

For the same outputs as above, we have tried to analyse the dynamics from 2000 to 2007. Changes in survey procedure in 1999 do not allow comparisons with previous years and the inclusion of foreign residents or the beginning of same day trip surveying in 2004 complicate matters. Owing to the other limitations identified above and the margins of error they imply, in general it has not been possible to show significant trends.

The fact that the rules for the collection of data remain constant over several years (e.g. from 2004 to 2007) allows us:

- to collate the data for some subpopulations over that period so as to increase the size of the sample to be analysed for a specific purpose;
- to follow individuals that remain part of the sample throughout the entire period. It is then possible to analyse issues that only make sense over several years. For example, it is interesting to identify the people who only leave every two or three years: what are their socio-economic characteristics, how do they travel etc. They represent about half of the size of the sample of those who do not leave in 2007, quite a significant population.

3.5 Typologies

For 2006 we have applied a cluster analysis to the individuals common to the two databases; thus the working sample is limited to 4 510 individuals.

This sample is first dealt with through a principal component analysis followed by a hierarchical clustering. Six clusters are then obtained and can be described, prior to a more detailed analysis as:

- Cluster 1: frequent travellers that go for short or day trips
- Cluster 2: travellers who tend to use the train and privilege French destinations

- Cluster 3: travellers who tend to use their car and privilege French destinations
- Cluster 4: travellers who tend to use the plane and who favour French destinations not in their own region, as well as European destinations
- Cluster 5: frequent travellers who travel in France as well as to distant destinations and use all modes of transport
- Cluster 6: those who stay at home.

The interest of the automaticity of principal component analysis and hierarchical clustering is that it shows the proximity in terms of emissions by groups that can differ quite significantly for other criteria (culture, income etc.): e.g. the group of French citizens originating from Martinique and Guadeloupe, living and working in metropolitan France, (including a large proportion of medium and low rank civil servants), can be well represented in a cluster along with upper class travellers or retired people who benefit from high income. Conversely the process can show divides between groups that are fairly near in terms of social habits.

In Figure 3, each cluster is associated with the GHG emissions per individual.

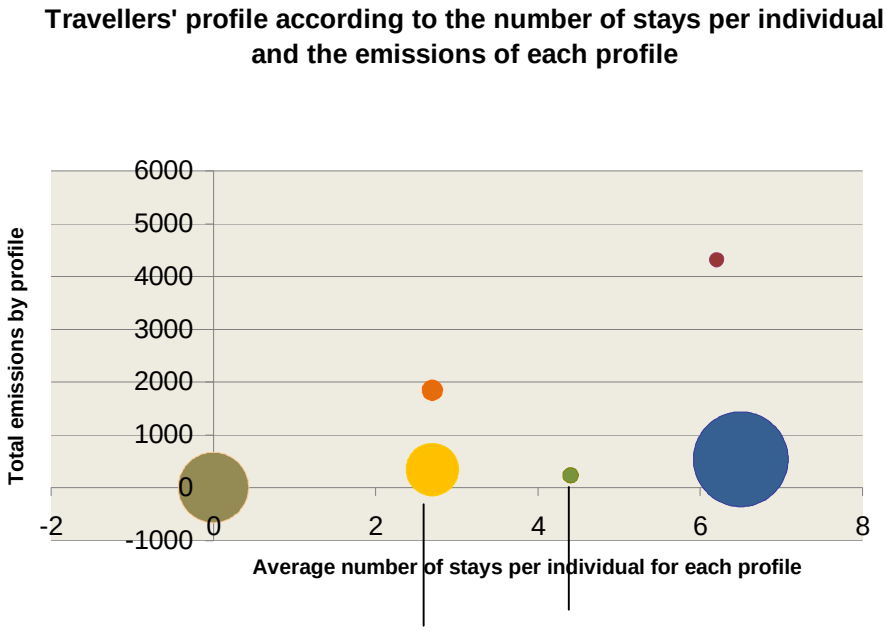

Figure 3: Typology of French travellers in terms of their emission profiles and behaviour

Interpreting the results and characterising the clusters in terms of social groups is not straightforward. Within a cluster, subgroups can be traced by looking at the state of variables that characterise them. These are mainly illustrative variables (profession etc.) but also the value of some active variables that can remind of the results of previous treatments of the database before the construction of the typology started should be considered.

Additionally, the relationship between a group of people and a cluster can be appreciated in terms of proximity (i.e. the group is over-represented in the cluster) and not in terms of belonging (the entire group is not included in the cluster).

4. Conclusion

The work we have done regarding the emissions from tourism transport suggests that tourism databases usually devoted to sectoral perspectives can yield excellent information to deal with research questions that refer to new or unusual perspectives on tourism (environmental, in this case). This implies combining tourism databases with others, built by institutions external to tourism, whose methods and categories might differ, which necessitates cautiousness and in the end an inevitable set of hypotheses or approximations. For instance, calculating tourism's contribution to France's overall GHG emissions requires a careful look at both the numerator and the denominator: are they comparable and with which precautions?

However large the tourist databases may be, they cannot be used to answer all questions: "unpacking" tourism rapidly leads to samples too small to deliver reliable answers. This kind of approach does not substitute for ad hoc surveys and issues (e.g. the travel behaviour of French tourists going to New Zealand cannot be explored through the SDT).The use of such databases can also be disappointing when used to shed light on trends, even when they have existed for a long period: access to heavy data, a decade old or more can prove difficult (outdated formats), the methods used to collect them and the questionnaires may have changed (in fact, because the fields of interest evolve).

Finally our work shows that applying techniques such as hierarchical clustering can deliver results that are not a priori obvious. Yet beyond the use of the technique, the capacity to interpret the results is decisive and requires being familiar both with tourism and with the insight at sake (environmental or other…).

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