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# **Tourist flows and inflows: on measuring instruments and the geomathematics of flows**

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## **Abstract**

The importance of tourism for France's economy and society means that proper knowledge of tourism flows is essential. But, designing a measuring system and periodic gathering of statistical data raise several difficulties. First, tourism is, by definition, based on movement and all phenomena involving movement are difficult to measure. Second, there are many different forms of tourism, including holidays and business trips, short and long stays etc. Third, the notion of tourism flows has different meanings for those in charge of road, rail or air traffic management, and for those in charge of tourist visits.

This paper first discusses the ambiguities of the notions used in tourism studies. It emphasizes the distinction between tourist flows along transportation routes and tourist inflows in specific places. This paper then reviews the proper calculation rules for each of the geographical objects used for measuring tourism phenomena, which are primarily lines and areas. It also addresses some of the problems raised by the failure to comply with these rules in published information.

Third, this paper presents the various systems used to measure tourist flows and inflows, and discusses their usefulness and limitations, before discussing some new developments in the field.

Finally, the paper examines the potential value of modern communication technologies for mobility studies. More specifically, it raises the issue of striking the right balance between statistical accuracy and individual freedom.



## **Introduction**

In December 2004, when a tsunami wreaked havoc on Asian coastlines that attract tourists from all over the world, the French government wanted to know how many French tourists were in the area in order to mobilize appropriate resources immediately. When a mosquito-borne disease spread on the island of Réunion; the government wanted to know what the usual tourist flows were for the period, how many tourists had cancelled their trips and what the shortfall was for local businesses and communities, in order to provide the necessary assistance for their survival. The same question comes up with each oil spill. The international body that examines applications for compensation demands estimates based on indisputable statistics. Therefore, the statistics required for these operations need to be provided. These statistics deal with tourist inflows measured over several years and the revenues generated by these inflows.

Notwithstanding these exceptional cases, the importance of tourism for France's economy and French society means that proper knowledge of tourist flows and the tourist industry is essential. Tourism plays a key role in France's economy and in French society. It concerns more than three quarters of the members of the French population who take a trip at least once a year. In economic terms, tourism accounts nearly 7% of GDP (Gross Domestic Product) and, more importantly; it provides the main positive contribution to France's foreign trade balance [Direction du Tourisme, 2007a, b]. This warrants an attempt to determine the pattern of tourist flows as accurately as possible. But the many different forms of tourism make it difficult to come up with a system for measuring tourist flows and to gather systematic data.

### **Who is a tourist?**

According to the international definitions used by the UN Statistics Commission, a tourist is anyone who takes a trip that involves spending at least one night away from home. This definition does not imply any specific activity. It covers business travel, holidays and journeys of discovery, even though tourists are most often thought of only as the sunburnt, camera-toting variety. The word tourist does not have a very positive connotation in France and many "travellers" reject the label of tourist that statisticians want to put on them when they are travelling "on business". This distinction may lead to major discrepancies between "tourism" statistics and statistics dealing with "holidays" or "leisure".

The definition requires that a tourist spend at least one night away from home. This minimum means that day trips are not considered to be tourism. This distinction may lead to major discrepancies between "tourism" statistics and "transport" statistics. Even within the tourism category, distinctions are drawn based on the length of the trip and the purpose of travel. More specifically, "holidays" only cover pleasure trips lasting at least four nights. Once again, tourist flows are often confused with flows of holidaymakers.

Tourism statistics always measure "nights" and not "days". It is presumed that travellers stop moving to spend the night in a given place. Therefore, travellers are not counted as being in a place unless they stop there to sleep. It is also easier to survey travellers in the places where they stop for the night.

Therefore, tourists are normal individuals who, at a given moment, are in a specific spatial and temporal context that involves taking a trip away from home and returning home after a minimum length of visit. A minimum stay is required to qualify travel as "tourism", but there is no minimum distance to be travelled. This means that people travelling to the other side of the world or just a few miles down the road are all qualified as tourists.

An "international tourist" is any person who is not resident in a country and who spends at least one night there during their trip. This final definition is an important one because it is used to measure international tourist flows.

If we consider that a tourist is someone who can come from anywhere and go anywhere else, it is easy to see why it is so hard to translate all these movements into statistics. It is always easier to count things that stay in one place than things on the move. The figures produced by counting these movements have to be processed using appropriate calculation rules, which vary according to the geographical object involved; hence the term geomathematics of flows. Major institutions do not always comply with these rules. Moreover, tourist flows and inflows are often estimated on the basis of the same surveys and measurements, which may lead to inaccuracies and even assessment errors that could be troublesome for the various players concerned with the development of tourism.

There are many such tourism players and their information needs are different. They can be split into two broad sectors, each of which covers several institutional or private players, and some players may be active in both sectors:

The “Transport” sector (transport operators, transport infrastructure producers and managers, along with various government agencies managing traffic) relates primarily to tourist travel and thus needs “flow” statistics measuring traffic of vehicles and people. A trip has a starting point and a destination and involves one or more modes of transport. Yet flows are not everything. If we want to know about traffic along a route, a measurement of flows is not enough; we need to know the date and time of travel: the same quantity of vehicles may move smoothly if the flow is regular, but may become congested during peak times. Tourist flows are not the only flows, even over long distances: they come on top of other flows of shorter duration, flows over shorter or longer distances, and flows of other types, such as flows of goods.

The “Inbound Tourism” sector (hotels, various forms of accommodation and catering, various levels of local government; tourism-related activities, such as sports and cultural activities, along with various types of trade, etc.) is concerned with the tourist’s “visit”. We use the term “inflow” (or visits) to measure tourists’ presence in France [Terrier et al., 2005a, b ; Terrier, 2006]. A visit implies the tourist’s presence in a given place. Once again, it is important to know the date and length of the visit. Then we look at the tourist’s activities and, naturally, their spending; but this last point is not of direct concern to us in this paper.

Therefore, the traffic advisory centre, transport network managers, mayors tourist towns, hotel managers, tourist site managers and leisure centre managers are all going to want to know about tourist flows, but this term will not have the same meaning for each of them and the same statistical system will not provide the answers to all of their questions.

The borderline between the private sector and the public sector is not always very clear-cut in the tourism sector. Local and central governments make great efforts to promote the attractions of their localities for domestic and international tourists. This means that the demands on the public statistics system exceed what would seem to be its legitimate mandate and, in any case, its capacities, given the resources dedicated to it. This paper deals with the public statistics system and does not attempt to define the ideal statistics system for tourism. Instead, it reviews the information sources available for measuring tourist flows, along with their contributions and limitations, and then considers some avenues for future development.

## **1. The geographical objects used: points, lines and areas**

When we speak of measurement instruments, we need to start by specifying which geographical objects are used as a basis for measurements. The geographical objects used may be lines (traffic routes) or areas (territories). Points may also be used as limits for lines (origin, destination) or as proxies for areas, as when one locality is used to represent an entire local area.

Traffic follows given routes (roads, railways, air corridors), which means that the natural geographical object for measuring flows should be a line, whereas an area should be used to measure inflows, or the presence of tourists in a given territory. In practice, we use areas most of the time, for the simple reason that all social and demographic statistics refer to areas. More specifically, these statistics do not refer explicitly to a geographical object, but to a political or administrative entity that has power over a clearly delineated physical territory. Most of the information derived from conventional statistics is therefore based on areas. This situation, as we shall see, calls for a number of precautions when measuring flows and making the related calculations.

### **1.1 Area-based measurements**

Several population surveys provide data on origins and destinations. These data are often specified at the level of municipalities (communes). The municipality of departure is known and the destination municipality is known in the information drawn from the population census, such as data on commuting, and it is also true of most surveys dealing with tourists.

Population surveys provide results by administrative entity, as we have said. Sometimes the main locality of an area is used as a proxy for the whole area. This is common practice when calculating distances travelled, with the distance from one main locality to another being used. These distances may be calculated “as the crow flies” or using commercially produced driving-distance tables.

#### *1.1.1 Area-based calculations*

The method of operation is always the same when the reference geographical object is an area. Any movement within the limits of the area counts for nothing, only movements that cross the limits of the area are counted. Such movements may be “inbound” or “outbound”, depending on whether the individual is entering or leaving the area. Flows in “transit” are not usually counted, unless there is a stop of a given length of time in the area, such as stay of one night or more in the case of tourism. Surveys generally provide information about the area of departure and the destination area, but no information about the itinerary, the areas crossed or even the route travelled.

The distinction between internal flows (stable), which are not counted, and external flows (“inbound” and “outbound”), which are the only flows counted, is the determining factor for measuring flows between areas. The data are biased because movements over short distances are counted if they cross the limits of an area, but movements over similar distances are not counted if they take place within the limits of the area. The smaller the areas used, the weaker

the bias. The impact of the bias is insignificant only if bulk of the movements measured involve distances that are greater than the diameter of the area. This means that the size of the reference areas used has a direct impact on the volume of flows measured. We would obtain different figures for the same volume of flows, depending on the size of the areas used. Furthermore, if the sizes of the areas vary significantly, the bias will not be uniform. Under these circumstances, it is not right to compare flows measured using areas of different sizes or levels. Yet, this is what often happens in international comparisons, where only the area of a whole country is taken into account. This results in comparisons between geographical entities in a single category that are as disproportionate as the United States as a whole and each European country on its own. This is a widespread problem in territorial analysis [Grasland *et alii*, 2000 ; Terrier, 2000], but it is especially significant when analysing tourist flows, particularly international tourist flows, as we shall show below.

### *1.1.2 Changes of scale*

The main problems in calculating flows based on areas come up when we want to change scale in order to transform data obtained at one level of areas into data about another level of areas. This operation is feasible, subject to certain conditions, when changing from smaller areas to larger areas (by aggregating smaller areas into a larger area), but it is impossible in the opposite direction.

#### a. a) Changing from a smaller area to a larger area

This change needs to be made, for example, when flow data between municipalities (NUTS 5 zones) are available and we want to calculate flows between Départements, or when data are available on flows between countries and we want to calculate flows between continents.

The new area must be made up of contiguous smaller areas in order to be valid. The calculation involves eliminating flows within the new larger area and recalculating inbound and outbound flows. In order to do so, we must consider flows between the smaller initial areas that make up the larger area to be internal flows that need to be eliminated. In our example of a change from the municipal level (NUTS 5 zone) to the Département (NUTS 3 zone) level, all of the flows measured between municipalities within the new larger area making up the Département become internal flows and are no longer counted. Then we add up the outbound flows from each of the initial areas to destinations outside of the new larger area. Finally, we add up the inbound flows to each of the initial areas from outside the new larger area.

We must have detailed information about flows between each of the initial smaller areas to carry out this operation. At the very least, we must be able to distinguish between the initially measured flows that become internal flows in the new larger area and those that remain external flows. If the only information we have for each smaller area is the sum of the inbound flows and the sum of the outbound flows, we will not be able to derive information about a larger area made up of these smaller areas.

Combining areas to make a larger area generally leads to a decrease in the flows measured since some of them become internal flows. Flows between Départements will always be less than the sum of flows between municipalities and flows between continents will always be less than the sum of flows between countries.

a. b) Changing from a larger area to a smaller area

A change to a smaller area is impossible to calculate. If we do not have any detailed information about the smaller area, we could attempt to model the flows by making assumptions based on information that may be available from other sources about the average distance travelled and the likely location of outbound flows, such as the population of places of residence, or inbound flows, such as the accommodation capacity of tourist areas. The accuracy of the figures obtained would depend on the quality of the supplementary information available and the assumptions used to build the model.

These problems relating to size and changes of size in areas give rise to a great deal of uncertainty in existing estimates of foreign tourists in a given country and, consequently, in estimates of international tourist flows around the world.

**How can we measure international tourist flows around the world?**

The number of foreign tourist arrivals in a country is measured each year. “Foreign” designates any person who does not reside in the country in question. Such a person is considered to be a tourist if they spend one or more nights in the country. If the person makes ten trips in the year and spends one or more nights each time, these trips are counted as ten foreign tourist arrivals. Each country provides this information to the UN World Tourism Organisation once a year. The UNWTO collects these statistics in order to analyse tourism around the world and publishes its findings annually [UNWTO, 2006].

First observation: countries are not at all uniform in terms of size. A resident of Brussels who makes a one-hour-and-twenty-minute trip on a high-speed train to spend a weekend in Paris will be counted as a foreign tourist, whereas a New Yorker who travels to San Francisco will not. This means that an area made up of little countries will generate a higher count of foreign tourist arrivals than a country as big as a continent.

Second observation: in addition to its size, the geographical position of a country relative to other countries also plays a role. Centrally located countries are much more likely to be crossed by tourists than border areas or peninsulas. This observation is especially germane for a country like France, which is located at the crossroads between Northern and Southern Europe and which is large enough to warrant an overnight stop when crossed by car.

Final observation: in view of the requirements set out above for changing from information about smaller areas (countries) to information about larger areas (continents), it is impossible, using the data that each country provides to the UNWTO, to calculate the inbound flows of foreign tourists to a continent. Such a calculation would only count people who are not residents of the continent and who spend one or more nights there. We may have information about the aggregate number of foreign tourist arrivals for each country, but we do not have detailed information about the origins of foreign tourists visiting a country, such as their country of residence or the countries visited previously in cases where travel involves stays in several different countries. And yet, world tourism analysts add up the figures provided by each country. This leads them to state, for example, that 52% of the tourist flows in the world have Europe as their destination. These figures count all tourists from other European countries as “foreign” tourists, whereas such tourists should not be counted when talking about foreign tourists in Europe. However, the UNWTO is unable to make such a calculation as things stand at present.

However, the statistics that Member States provide to Eurostat should make such a calculation possible, since each country is asked to distinguish between tourist flows arriving from Europe and tourist flows from the rest of the world.

But there is still another major problem regarding the treatment of tourists from another country who make a tour of Europe. At present, an American, Japanese or Chinese tourist who visits ten European capitals and spends one night in each country is counted as a foreign tourist arrival in each country visited. This means that when the figures for each of the European countries are added together to talk about tourism in Europe, these tourists will each be counted ten times. There is no practical way of

obtaining figures on tourism in Europe from the statistical systems of each country, since these systems record only the tourist's country of origin and not the country previously visited. A survey or a recording and monitoring system implemented at the European level would be the only way of obtaining information about such tourist flows without double counting.

This is only one of the many difficulties encountered when making international comparisons. We have already mentioned the first problem, which stems from the uneven size of the reference areas, which means that measurement data relating to international flows are not comparable.

The second problem is partially linked to the first and stems from the fact that we never count domestic tourism. This eliminates a good portion of the flows in France, where two-thirds of the tourists are French. The effect is even more pronounced in the USA because the country spans the whole continent.

## 1.2 Line-based measurements

The lines we are looking at here are transport routes. Measuring flows means counting the elements, or vehicles, that move along these routes. Yet, these elements have varying degrees of autonomy, depending on the type of route and the mode of transport. This leads us to distinguish between "closed" lines and "open" lines.

We say that a line is closed if an element moving along it has no autonomy with regard to its line of travel. A railway line is the purest form of such a line. It is materialised by two strips of steel that the vehicles must stay on. Travel along the railway line is very predictable from a departure point to an arrival point. But the line is only really closed from a single departure point to a single arrival point. A change of trains during a trip marks a break in the line and a train stopping at local stations, even though it stays on the railway line, should not be seen as travelling along a closed line, but along a succession of closed lines placed end to end.

Airline routes are defined by their departure point and arrival point in practice. Knowing the real flight path of an aircraft and the air corridors used is of no real use when measuring flows. This means we can consider airline routes to be closed lines.

Roads are an example of very open lines. The road network is very complex, making it possible to travel from one point to another along several different routes. Furthermore, the vehicles that use roads have a high degree of autonomy and are able to turn off, stop or turn around at any time. This means that there is no clear relationship between lines and trips. On the other hand, motorways can channel traffic over certain stretches between tollbooths or between on-ramps, and thus be seen more as closed lines.

Only closed lines really lend themselves to measuring flows. For one thing, travel along closed lines is usually managed and recorded, primarily through ticket sales, which means it is pointless to undertake other types of counts. In addition, the information is the same whether measured at the starting point, the destination or any point along the way. If we want to do more than simply measure flows, we can conduct a passenger survey. The best place for conducting surveys varies depending on the mode of transport. Air passenger surveys are generally conducted in the boarding lounge, whereas train passengers are usually surveyed once they are aboard, since there is no waiting before the train leaves.

There are fewer opportunities for measuring flows along open lines. Such lines are characterised by the freedom of movement of the vehicles that use them. Vehicles can enter,



exit, stop, turn and backtrack. We can measure flows past a given point, using automatic counters, tolls, or counts made by survey takers, but the flow measured at one point along the way does not enable us to make a direct estimate of the flow at another point. In practice, roads are broken up into segments where traffic is more or less uniform. The flows measured at one point along the segment are attributed to the segment as a whole. This system cannot be used for urban areas, where the lines are too open.

There are not really any calculations that can be used for lines other than simply adding up the flows measured successively along a single segment. However, we could attempt to extrapolate the flows measured at one point to a line or an area. As is the case with any extrapolation, this would require us to make assumptions about patterns, based on further information from other sources, whenever possible. As noted above with regard to such an approach, the accuracy of the results will depend on the accuracy of the information from other sources used to develop plausible assumptions about patterns.

## **2. Tourist survey methods**

One good way of measuring tourist flows and inflows is to conduct surveys of tourists. Such surveys may be conducted in the respondents' homes, at the places they are visiting or at points along the way when they are travelling. We shall not describe all of the tourism statistics systems here; readers can refer to more comprehensive papers on the subject [Bernadet, 2003]. We shall merely review the main principles of existing statistical systems and try to point out the contributions and limitations of each survey method when it comes to increasing our knowledge of tourism and measuring tourist flows and inflows.

### **2.1 Household surveys**

Two national tourism surveys in France are based on the principle of surveying respondents at home: the Tourism Demand Survey (SDT) and the Holiday Survey. The former is conducted once a month by TNS-Sofres for the Directorate of Tourism. It is based on a panel of 20,000 respondents who are surveyed monthly by mail. The latter is conducted by France's national statistics institute (INSEE) every five years and involves face-to-face interviews in respondents' homes.

The principle behind these surveys is simple. They take place after tourists return home, when they are no longer tourists, and they involve questions about travel during the reference period. The information sought can be complete, since the travel has been completed. On the other hand, some of the people in the sample are bound not to be tourists, since there is no way of knowing whether they have made a trip during the reference period before interviewing them. That being said, knowledge about respondents who stay home is considered important for social analysis [Rouquette, 2001; Chevalier, 2004].

The survey method used is the key to the level of detail in the information gathered, along with the quality of the sampling. Survey methods include telephone interviews, mailings or home visits. This type of survey encounters two main types of problems: memory problems and capturing the complexity of the trip. Memory problems are easy to understand; the longer the survey comes after the trip, the more uncertain memories are. This is not much of a

problem for major trips that leave big impressions, but little trips are often quickly forgotten. A face-to-face interview or a mail survey is less likely to encounter this problem since respondents can take their time to answer and even look at their diaries or other documents, in contrast to telephone surveys, which require off-the-cuff answers.

The complexity of a trip may vary depending on the succession of movements and visits. The simplest case is a trip that involves a single return journey to a single location. This is the case for 90% of the trips made by the French. The matter becomes more complicated when the trip involves several movements and locations.

The questionnaire for the Tourism Demand Survey, which covers overnight travel completed in the previous month, leaves room to describe three trips and two consecutive visits for each of the trips described, as well as the travel between locations. After that, there is a loss of detail about travel and visits. This means that information about the most nomadic tourists is incomplete; a long meandering trip with stays in different places each night cannot be fully described.

In the Holiday Survey, which covers the previous year, details are only required for holidays, meaning visits of four or more nights for pleasure. Respondents are also asked about visits of two or more nights, but in less detail. This information is gathered by survey takers, who make appointments to call on respondents in their home. This arrangement makes it possible to ask more complex questions.

The household surveys make it possible to cross-reference places of residence and holiday destinations. This provides us with an estimate of flows between French regions and between France and other countries. The Tourism Demand Survey also makes it possible to study absences and presences in an area on a given day simultaneously. Comparing the population present in a given area to its resident population makes a huge contribution and gave new impetus to inflow analysis.

#### **Tourist inflows : estimating the population present**

*(from [Terrier 2005] in «Le Tourisme en France » - INSEE-Références – December 2005)*

#### **Tourism leads to major variations in the population present in a place**

As mobility increases, particularly tourist mobility, people are not always where we expect them to be and the population “present” in a place at a given time may be significantly different from the “resident” population revealed by the general population census [Terrier et al., 2005a, b]. For example, tourism surveys show that, on 15 August, nearly 14 million French residents are away from home. If we count the 4 million foreign tourists in France on the same date, we get nearly 20 million people in France who are away from home.

Proper public management and planning calls for an estimate of the population present. Some amenities need to be calibrated according to the maximum population that may be present in a place at a given time. This means we need to be able to estimate the peak inflows. Other services need to be calibrated for the average population present, which also needs to be estimated.

The Tourism Directorate has calculated a day-by-day estimate of the population present in each Département in response to the public authorities’ concerns. The estimate starts with a day-by-day evaluation of absences, meaning the number of residents of the Département who are travelling outside of the Département. Then the presence in the Département of French and foreign tourists who do not live in the Département is estimated on the same day.

### **Another view of spatial planning**

This research has led to another view of spatial management and planning issues. It has also provided a basis for a new approach to local economics, called presence economics, based on the principle that consumption, and, consequently economic activity, stem from the presence of people in an area at a given time [Davezies and Lejoux, 2003].

The results show how important it is to distinguish between the population “present” and the “resident” population. Some Départements see their population double at certain times of the year, while in others, the population present is nearly always smaller than the resident population. If we wanted to have sufficient vaccine stocks in each Département to immunise the entire population present in an emergency, it is estimated that 71 million doses would be necessary, in view of the fluctuations in population present.

In 2003, which was the reference year for the survey, the Hautes Alpes Département set a record with a population present at the end of July that was 2.7 times greater than the resident population. The ratio in early November was only 0.96. Over the year, the population present in this Département, calculated in permanent resident equivalents, is one and a half times greater than the resident population. The Départements in the Ile-de-France region posted the highest absence rates. The population present in Paris ranges from 109% of the resident population at the beginning of December to 73% on 16 August. The record was set by the Hauts-de-Seine Département, where the population present on 15 August was only 56% of the resident population.

### **Variations in space and time**

The difference between the resident population and the population present varies over time and from place to place. This difference stems from the dual movements of outbound residents and inbound tourists. Tourist inflows nearly everywhere in France are at their highest in August. But the simultaneous resident departures and tourist arrivals mean that the highest population present figures are reached on different dates in different Départements: around 15 August in the Savoie and Morbihan Départements, early December for Paris and the Bas-Rhin Départements. Cities, and the largest cities in particular, post the highest number of departures, especially in the summer and during the school holidays. Cities have large populations and these populations travel more. On the other hand, tourist destinations each have their own seasons. For example, seaside resorts draw large crowds in the summer and the mountains attract skiers in the winter, and hikers and climbers in the summer.

Some highly urbanised areas are characterised by large flows of inbound and outbound tourists. This is obviously true of Paris, where the very large numbers of inbound French and foreign tourists are never greater than the numbers of absent Parisians travelling elsewhere at any time of the year. This phenomenon occurs in other Départements, but to a lesser degree, especially at the seaside or in the mountains, where there are cities that produce large flows of outbound tourists, but are also resorts that attract large inflows of tourists.

### **Inflows are relative**

People who worry about the 75 million foreign tourists overrunning our small country and its 65 million residents should note that these tourists do not all descend on France together. The peak day is reached in the summer, with slightly fewer than 4 million foreign tourists in metropolitan France. At the same time, some one million French residents are travelling abroad, which means that the excess population attributable to tourism is never more than 3 million.

The current prevalence of position determination technology opens up opportunities for new technologies that could supplement the contributions made by the household surveys. One example of using this technology is provided by BVA, which conducts telephone surveys for the outdoor advertising audience measuring firm Affimétrie using a high-performance geographical information system (GIS). Respondents are questioned about their movements on the previous day. The respondents tell the interviewers the addresses of their departure points (e.g. their homes) and the addresses of their destinations (e.g. their places of work). The interviewers then call up detailed maps on their computers that enable them to have the

respondents specify the exact routes travelled, street-by-street. In this case, we are measuring more than just the flow between the departure point and the destination; we have the exact route taken. When this information is supplemented by means of questions about the departure times and the arrival times, we obtain precise space and time information about the movements. If this system were added to existing household surveys on tourism it would greatly enhance the information about tourists' movements.

Surveys conducted in the respondents' homes are obviously good only for studying French residents, but they do not provide any information about foreign tourists. This limitation is particularly unfortunate for a country like France, in view of the numbers of foreign tourists visiting the country. Extending the scope of the survey would call for a representative sample of the entire population of the world, which is obviously inconceivable.

Some entities, such as IPK International, try to gather the findings of similar surveys of outbound tourists in as many countries as possible. These comparisons encounter problems because the surveys used are not all designed the same way. More specifically, these surveys do not all use the same definition of tourism. Many cover only stays of four or more nights, whereas the general trend is towards a greater number of shorter trips. Some of the surveys deal only with leisure travel, as in the case of the Holiday Survey. In some cases, the surveys only deal with the destination country and often ignore stays of one or two nights in countries crossed en route. These restrictions of survey fields, which are warranted because of the major cost savings involved, make it a delicate matter to compare the figures from surveys that do not cover the same field. This has even given rise to some pointless controversies [Terrier, 2003]. Nevertheless, such an approach may produce fairly good results for overall analysis and for measuring changes in major trends.

## **2.2 Other surveys of tourists**

Other types of surveys have been developed to enhance our knowledge of foreign tourists. Such surveys are often not as detailed as surveys conducted in respondents' homes and they raise many methodological issues. Nevertheless, subject to taking a number of precautions, they can be used to obtain data about foreign tourist flows and inflows. Proper knowledge of these flows and inflows is critical for France and its regions.

### *2.2.1 Accommodation surveys*

Based on the, sometimes theoretical, principle that a tourist stops for the night to sleep, we consider that the location of the overnight stay is the place of accommodation. In France, we rely mainly on the hotel and campground occupancy surveys conducted by the National Statistics Institute (INSEE) and the Directorate of Tourism. These surveys monitor occupancy from day to day, which means we can use them to estimate inflows, but not flows. They provide information about the geographical origin of tourists, thus enabling us to distinguish French tourists from international tourists.

The problem is that these surveys cover only two types of accommodation, which account for less than 20% of the stays in France by French tourists. Some other types of commercial accommodation (self-catering houses and flats) are surveyed in a few regions, but there is no

survey covering all types of tourist accommodation in the whole of metropolitan France, instead of just hotels and campgrounds. The other types of commercial accommodation, including self-catering houses and flats, tourist residences and holiday villages, and non-commercial accommodation (family, friends, holiday homes), cover such a wide variety of individual and collective establishments that it is very hard to design exhaustive surveys.

However, it is possible to use the findings of other surveys, such as the survey of foreign tourists conducted at border crossings in 1996, to establish correlations and to develop a model for estimating tourist inflows from the occupancy of hotels and campgrounds. But this approach would rely on extrapolations that would only be valid if the overall patterns have remained the same. In view of the age of the main 1996 survey to be used as a basis for the extrapolations and the fact that it cannot be reproduced (see below), the validity of the estimations would diminish over time.

### *2.2.2 Border surveys (cordon-line surveys)*

Cordon-line surveys, which are called border surveys when the limits of the survey area are national borders, are the surest way to determine the presence or inflow of tourists in an area on a given day. They are based on the principle of establishing a cordon line around the survey area. By questioning the people crossing the line into or out of the area, or a representative sample of them, we can determine the population present in the area at any time. If we question tourists leaving the area, at airports, at seaports, on trains or at border posts on the roads, we can gather comprehensive information about their visit to the area. But the elimination of road borders in Europe under the Schengen Agreements and the practical impossibility of using law enforcement officers to stop vehicles in order to survey the occupants mean that this type of survey is now unfeasible for tourists travelling by car. This is particularly unfortunate in France, where most tourist traffic enters and leaves by road [Christine and Vassille, 2004].

The most recent border survey providing detailed data on foreign tourists dates back to 1996. Several test surveys have been conducted since then, but none has produced useable findings. The methodology of such border surveys had to be adapted for tourists travelling by road. In the new Foreign Visitor Survey (EVE), foreign drivers are interviewed in motorway rest areas. This naturally raises major methodological issues about the validity of the sample [Direction du Tourisme, 2003].

Cordon-line surveys, called “flow” surveys, have also been used in France’s top tourist regions (PACA, Bretagne, Midi-Pyrénées, Rhône-Alpes, Aquitaine, Languedoc-Roussillon) for more than twenty years now. The quantitative findings are produced for each region or for each Département. These surveys provide helpful information on domestic tourism and they can be used to estimate the population present in different sub-national geographical units, and these estimates are more reliable than those produced by other surveys [Carreno and Marchand, 1999].

### *2.2.3 On-site surveys*

A new type of survey has emerged recently called a “shared-weight” survey. It follows major

research into methodology suited for measuring tourism and it holds out great hope [Deville et al., 2005a]. INSEE had already used this methodology for a survey of the homeless. This methodology surveys tourists in the different places they go, such as museums and beaches, as well as in bakeries, newsagents and hotels. This type of survey can be used to count tourists (including foreign tourists), as well as to gain more detailed knowledge about their behaviour. One of the problems involved in this type of survey, which is conducted at different sites, is to make a fair estimate of the actual number of tourists, since some tourists visit only one site, whereas other, more mobile, tourists can be encountered in more than one survey site. This calls for the implementation of methods to prevent weighting distortions caused by such differences in behaviour. The use of these “shared-weight” methods makes it possible to construct the probabilities of the breakdown of tourist numbers by site, without knowledge of the parent population.

This principle is being tested in Brittany for a visitor survey [Deville and Maumy, 2005b ; Morgoat, 2005]. It is still too early to obtain any concrete results, but this survey method does seem to hold out more promise for understanding tourism in a given area. If such surveys live up to expectations, public and private sector players in the survey area can use them to obtain high-quality information about the tourists who visit their region. The national systems are no longer able to provide such information with the requisite level of detail.

This rapid review enables us to state that the data provided by the various existing surveys at the national level can be used to produce fairly reliable estimates of tourist inflows and seasonal variations in such inflows for different geographical units. This means that the surveys provide measurements of the most relevant items for the various “inbound tourism” players. However, there is still substantial uncertainty about estimates of foreign tourist numbers. The major comprehensive survey that serves as a reference is the 1996 Border Survey. It is the foundation for the extrapolations and assumptions used to develop various models. The 1996 Border Survey is an old one, and it can no longer be reproduced.

Given the economic importance of foreign tourism in France, particularly in terms of the trade balance, very substantial resources are currently invested in the Foreign Visitor Survey. There is no denying that this type of survey raises some major methodological problems that we are striving to overcome. The preliminary results should be published soon and they have proven to be consistent with the results of the last border survey. However, it is critical for the future to be able to develop the new survey techniques currently being tested that seem to be capable of producing substantial improvements in the quality of tourism measurements.

As we can see, none of these surveys provides “real-time” knowledge of outbound tourism. Detailed surveys are conducted in retrospect, once the tourist has returned home. Furthermore, the sample may be large, with 20,000 people surveyed each month for the Tourism Demand Survey, but not all of the respondents have taken trips in France or abroad during the survey period. This means the Tourism Demand Survey is ill suited to obtaining detailed knowledge of flows by destination. Consequently, it is impossible, with any of the surveys, to know the exact number of French tourists present in a given place in the world at a given time.

However, we shall see that the development of techniques for locating and monitoring individuals and vehicles on the move opens up new possibilities.

### **3. Measuring flows without direct surveys: monitoring and measuring flows**

There have long been ways of locating and counting tourist flows that do not rely on conducting tourist surveys. The development of these systems is very closely linked to the various types of monitoring, such as the monitoring of the use of transport modes and infrastructures. The oldest system is the one based on ticket sales.

We are seeing the rapid development of possibilities for locating and tracking vehicles and people on the move, stemming from new passive and active position determination technologies, which can be used to record movements and measure the resulting flows in great detail. The development of the systems for making such measurements is clearly part of the trend towards closer tracking of individuals and vehicles (or certain vehicles) by governments. Using the data produced for statistical purposes in order to improve knowledge of tourist flows should at the very least result in the drafting of ethical rules to govern such use and measures to ensure compliance with these rules.

#### **3.1 Ticket sales and measuring flows: air and rail travel**

If there is a charge for the use of a transport mode or infrastructure, the operators concerned have to develop various practices to ensure that the user has actually paid. For a long time, the sole purpose of a ticket was to make it possible to ensure that a passenger had paid the fare. But the systems have changed over time and many of them can now be used to gather information about passenger flows and passenger characteristics. As the market grows more competitive between companies and modes of transport, operators have had to refine their management of passenger flows to avoid empty seats and to provide services that meet their customers' expectations and suit their habits.

Air travel occupies a special place in this respect because passengers are closely monitored. Individual passengers must provide proof of their identity, which means that airlines are able to know the exact number and types of passengers on a given flight. Comprehensive information about the flow of passengers on a flight is available, if the data gathering and processing system is properly organised. But for the purposes of understanding tourism, the passenger information that the airlines actually collect is incomplete. Unless a special survey is conducted, we cannot know the characteristics of the passengers (age, gender, nationality), or the purpose of their trip (business, holiday, etc.) Nor can we know how various trips by air or other modes of transport are combined in the tourists' overall itinerary. In the case of rail travel, there are several systems for recording and collecting data based on ticket sales. Some systems merely cancel the ticket, while others read the information contained in the magnetic stripe or the chip. Stand-alone readers check that the ticket is appropriate for the trip. Networked readers can feed an information system used to monitor the flow of passengers in real time or after the fact. Furthermore, a mandatory reservations systems and tickets that are valid only for a specific train provide a good proxy for measuring flows. Reservations are required for high-speed and intercity trains, but they are optional for other main line trains and no reservations are taken for travel on regional rail networks, which means that there is no way of automating the measurement of passenger flows. Some travel cards issued to individuals provide greater knowledge of passenger behaviour. The "Grand

Voyageur” card issued by the French railways (SNCF) is a prime example. Customers



holding the card obtain a few benefits and, in exchange, the railway obtains comprehensive information about the customer's rail travel.

Identification of individual transit pass holders is possible in some cases, such as that of the Navigo pass issued by the Paris transit authority (RATP). Such identification could be used, for example, to distinguish whether a flow of 100 trips was made by 100 different passengers or by 50 passengers making two trips each. It would also make it possible to quantify the chaining of different trips requiring connections between the Métro, trains and buses and it could be used to determine travel patterns. However, this type of system seems to be better suited for transport used for commuting rather than for tourism.

Collecting information is not the same as disseminating it. The major transport operators have implemented more and more sophisticated systems for closer monitoring of passenger flows and obtaining more detailed knowledge of their customers, but they guard these data jealously, deeming them to be strategic in an increasingly competitive market.

### **3.2 Road travel: tollbooths and radar**

The road network presents the greatest difficulties when it comes to determining flows. There is no way of monitoring traffic on surface roads or toll-free motorways. Toll systems provide partial and patchy information only. Some motorway routes are broken up into toll segments and motorists pay a few euros at each successive tollbooth, which entitles them to drive to the next tollbooth. This toll system does not provide any more information than a counting station. Other motorway routes use a ticket system, where motorists take a ticket upon entering the motorway and hand it in when they exit the motorway. This makes it possible to calculate the distance travelled and the corresponding toll. This system seems to provide a good measurement of flows, since the point of entry and the point of exit are known, as well as the dates and times, but, in practice, the stretches of motorway using the system are too dispersed to provide a basis for a complete flow measurement system. For example, the system would not make it possible to estimate the number of vehicles that drive straight through France from north to south when travelling from Germany to Spain.

Brief mention should also be made of traffic data measurements carried out by the technical staff of the Ministry of Public Works. The system is based on counting stations called SIREDO installed on publicly operated roads. There are currently 1,021 such counting stations installed along the 28,000 kilometres of the publicly-operated road network. The counting stations can be accessed remotely and batch processing of the data collected provides the basis for measuring road traffic. Real-time processing of the data provided by two-thirds of the counting stations is also carried out to regulate traffic. The data are gathered and imported by the MELODIE system and the main statistical processing to produce useable data for various agencies is carried out using the ARPEGES software. All of this musical-sounding system will change as part of the SICOT computerised traffic knowledge system project being carried out by the Road and Motorway Technical Research Unit (SETRA) to rebuild the entire system around a centralised architecture with decentralised management.

One method now being tested on foreign tourists counts the vehicles driving through motorway tollbooths and uses the credit cards used to pay the tolls to determine the nationality of the passengers [Provensal and Houée, 2003]. Credit card use varies from one

country to the next and depending on the type of toll. Therefore the information is supplemented by spot manual counts of foreign licence plates. This technique can be used to estimate flows along a route and to break them down by geographical origin. When the geographical circumstances permit, we can also attempt to derive estimates of tourist inflows in a region, but such extrapolations call for a great deal of caution. The counts are anonymous, which means that there is no way of distinguishing whether a car leaving the motorway at a given point is going to return to the motorway within the hour, or if it will stay in the region for a while, or even if it will continue on its way to another region using surface roads.

Optical recognition protocols have now achieved performances that open up the possibility of using cameras to read the licence plate numbers of moving cars. This technology was developed to back up the radars that check speeds, making it possible to automatically ticket the owner of a speeding car. As is often the case, the monitoring systems came before the measurement systems. However, it is conceivable that these expensive systems installed along roads and motorways could be used for non-law-enforcement purposes to monitor traffic flows. Such a system could be used, for example, for real-time measurement of the number of cars travelling from Germany or Belgium directly to Spain and their travel times. A network of cameras installed along major roads could also be used to distinguish through traffic from local traffic. This system would make it possible to conduct an advanced form of cordon-line surveys to determine how much time elapses between the arrival of a vehicle in an area and its exit. This would give us the length of stay and the licence plate would give us the geographical origin.

### **3.3 Tracking individuals' movements**

The new technologies for monitoring, recording and measuring flows of travellers mentioned above primarily involve what is known as passive positioning. This means the system does not transmit a signal to locate the vehicle or the passenger. The presence of an individual is recorded when they pass in front of a fixed sensor. Chips are increasingly replacing magnetic stripes in these systems, which are becoming more widespread, particularly in places of work, where each individual has to have their own access card that allows them to enter only the areas for which they have clearance. Credit cards are another passive positioning system, which, as we have seen, can be used at motorway tollbooths. Credit cards can also be used to keep a record of the holder's presence and, more importantly, the holder's spending, as long as the holder uses them to make payments.

Today, the development of active geographical position determination technology that provides accurate tracking of individuals' movements and their presence in a given place opens up new possibilities for measuring flows, as well as monitoring, since these two aspects are linked to each other. Active position determination systems can be used to locate the target individual or vehicle precisely, wherever they are. This requires both the system and the target to transmit signals.

The most common type of equipment found in this category is the mobile telephone. When it is switched on, it exchanges signals with nearby cells. Telephony operators have recently started marketing real-time telephone position tracking service. This service, which naturally requires the prior consent of the person being tracked, is primarily aimed at businesses that

wish to track their employees' movements on the road so as to optimise their ability to respond quickly to customer calls, for urgent on-site repairs, for example. This GSM positioning method is not very accurate (to the closest 700 metres or 20 kilometres, depending on the density of the cell network), but it requires little investment in equipment.

Another means of tracking tourists using their mobile telephones is offered by the geographical range of networks. In practice, users change networks when they change countries. The operators detect the change and the new operator takes over providing service in its own territory, under the terms of bilateral agreements between operators. If all of the operators agreed to provide this information, it could be used to estimate foreign tourist inflows. These measurements would have their limitations. They would only cover mobile telephone users with international calling plans. They would exclude tourists from countries where the telephone networks are not compatible with ours, such as Japan. They would also exclude tourists who change telephones when changing countries in order to save money by calling at local rates.

After the tsunami, there were suggestions that procedures for locating mobile telephones be used systematically in emergencies to locate individual travellers. The technical feasibility and legal issues involved in such a measure still needs to be established.

#### **Using mobile telephones to count the population present**

One example of the use of mobile telephones to measure tourist inflows is provided by an ongoing project by BET F. MARCHAND, which consists of quantifying the total population present in an area at a given time using mobile telephone data. The method is called Info-mobility and it can be used to estimate the various components of the population present (residents, visitors, transients), using information supplied by the different telephony operators concerned. The data are processed totally anonymously. The method counts the people present, but does not identify them. This method can be used as long as the area to be analysed is covered by a mobile telephone network. The results obtained for each area under study could then be aggregated to meet data needs at the level of the local community, the Département or the region.

Global Positioning Systems (GPS systems) have been available since 2000. They can give a position to within a few metres, which is much more precise than the GSM positioning methods based on mobile telephones. GPS units are not transmitters. If they are to be used for tracking, they need to be combined with a recording system for batch processing of positioning data, or with transmitters for real-time tracking. The latter solution would require substantial investment in equipment.

The various active position determination systems are increasingly used to track goods using transmitter tags. Road vehicles are sometimes equipped with onboard transmitters. These systems are also used to regulate bus systems and provide information for passengers. They are being made mandatory for heavy goods vehicles in Germany, which have to pay licence fees based on distances travelled. They are found in Argos beacons for use in rescues at sea. The technology is currently used for tracking people under specific circumstances (radio bracelets for prisoners, tracking elderly patients, tracking children in amusement parks, etc.) Widespread use of this technology would enhance the accuracy of statistics but is bound to stir controversy about its social impact.

This technology is evolving rapidly and the surge in the use of a new technology known by the generic name of RFID tags (Radio Frequency Identification) can no longer be ignored

[Culnaërt, 2006]. These tags were developed for the United States Army and they have bridged the gap between active and passive systems. The tags are passive components, but they can still be read at distances of about one hundred metres, which opens up some impressive possibilities. The starting price for such tags for civilian uses was about one euro in 2005. Tags were incorporated into the tickets sold to spectators at a major football match in Germany in order to monitor fans more closely. Tests were carried out in a California school, using the tags to track children and keep them safe. The United States requires that, in the future, people entering the country carry passports containing such tags. The tags are already widely used to track goods. In a field related to ours, RFID tags are being used in London to track the movements of a panel of drivers and, more specifically, to measure how often they drive by advertising hoardings.

## **Conclusion: striking the right balance between statistical accuracy and freedom**

Readers can see that movements are hard to translate into statistics. Accurate and comprehensive mobility measurement would require powerful and effective tracking systems. It would not be an exaggeration to say that good flow statistics cannot be obtained without a good policing system. The present trends in this matter are contradictory.

On the one hand, every effort is being made to facilitate free movement, without any constraints or checks. Under the terms of the Schengen Agreements, border controls have been eliminated inside Europe. In France, hotel guests are no longer required to fill out police forms. The elimination of border controls and police surveillance has obviously weakened our ability to establish good statistics on the movement of people. The french National Council for Statistical Information (CNIS) has recently upheld the principle that the use of law enforcement agencies to stop vehicles for the purpose of statistical surveys is inconsistent with individual freedom. The elimination of the traditional methods used for traffic surveys and border surveys have made life more difficult for statisticians dealing with these sectors.

On the other hand, and especially since the attacks of 11 September 2001, some countries, including the United States, have instituted more restrictive monitoring systems. The United States now require a level of information about travellers entering the country that violates individual rights previously recognised under French and European law.

For the time being, only animals are required to have an electronic tag inserted under their skin containing all of the information necessary to verify their identity and state of health. But our rapid review shows that all of the technology is available for real-time tracking of vehicles and persons. This technology is currently used primarily to provide services that users want [Belleil, 2004]. However, we should be careful to strike the right balance between the precision sought with regard to flow data and the protection of individual freedom, even if there is a price in terms of statistical accuracy.

Furthermore, improving the accuracy of measurements is not the answer to every problem, because the difficulty of establishing the numbers is compounded by the equally important problem of explaining them. One of the lessons of this all-too-brief review of instruments for measuring tourist flows is that we must always be prudent when interpreting the data. The measurement of tourist flows may make statistical methodologists and modellers happy by

giving them several interesting challenges, but it can also cause a great deal of confusion for those who need to use the data to carry out tourism development projects, or simply to enhance the management of their communities. Tourism industry professionals are often laymen when it comes to statistics. When they are faced with apparently contradictory figures, they are rarely able to distinguish between the discrepancies stemming from differences in survey fields and those caused by actual discrepancies between various measurement instruments. The effects of this complexity are compounded when the data are interpreted owing to the ambiguity of the terms used. For those of us in the business of measuring tourism, it is striking how nobody wants this word to stand for the same thing. Transport analysts see “passengers”, and, consequently, study trips, the purposes of these trips, how they are structured and how they are made, whereas experts analysing areas focus on the temporary residents of a place, the length of their visit, the reason for the visit and the circumstances. Then there is the use that is made of the figures in institutional communications about tourist flows. International bodies, such as the UNWTO, Eurostat and the OECD, have announced ambitious plans to improve and set global standards for the methods for measuring and analysing tourist flows as part of a new methodology for the tourism satellite accounts. But efforts still need to be made to prevent the communication of these figures from creating confusion.

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