INNOVATIVE DATA COLLECTION FOR MODELING GREEN TRANSPORT IN ISLANDS

Amalia Polydoropoulou, University of Aegean, 82100 Chios, Greece

Konstadinos G. Goulias, University of California Santa Barbara, Santa Barbara, CA 93106-4060, USA

Athena Tsirimpa, University of Aegean, 82100 Chios, Greece

Maria Kamargianni, University of Aegean, 82100 Chios, Greece

Ioanna Kourounioti, University of Aegean, 82100 Chios, Greece

Ioannis Tsouros, University of Aegean, 82100 Chios, Greece

ABSTRACT

Green development in island areas context is heavily dependent on transportation through the strong seasonality of transportation demand by residents and tourists exacerbating the impact of traffic on congestion, noise and pollution. This paper creates a comprehensive framework for innovative data collection, accounting for the unique characteristics of the area in its multiple dimensions. This is done through the fusion of ideas, data, and models in four pillars: “travel behavior of resident population”, “tourist preferences”, “environmental analysis”, and “economic and financial evaluation”. Data collection includes network and land use data that characterize living and traveling environments, surveys for residents and tourists, and atmospheric pollution data. GPS devices play a major role in data collection, contributing for easier, more efficient and less costly process. The methodology is tested, by a pilot survey conducted in Chios island, Greece, which fits the island context of seasonality effects and tourist behavior. The objective of the current study is to test that the proposed methodology can be applied in this context and yields desirable results. In a future full scale research task, with a larger sample and a longer period of data recording, better and more accurate results are expected.

Keywords: innovative data collection, gps devices, travel surveys, travel diary, gps aid in surveys, island context

1. INTRODUCTION

In order to create own place identity, their own competitive branding and export their image globally, island communities have to focus on their green (i.e. environmental) potential, both tangible and intangible. For this purpose, they need tools and methods to help them modify local resources into lucrative tourism product components, able to generate positive multiplier effects in the local economy. It is very common that policy makers on the islands try to link the local tourism potential with practices used in the past, which are often contradictory to the modern approaches applied today. They foresee tourism as a tool for development without planning thoroughly enough for its consequences on either the environment or the society. This paper proposes an action framework for the sustainable use of transport, which can guide local actors to identify, signify, valorize and manage their resources, in order to enter the global tourism market safely while guaranteeing (at the same time) viable long-term growth with strong behavioral support.

The state of the art in travel behaviour research has advanced rapidly in the past ten years to recognize and rectify many limitations of data collection, modelling, and simulation. The first important advancement is the stronger conceptualization of activity based approaches to travel demand forecasting (Bowman and Ben-Akiva, 2001; Ben-Akiva, 2007; Goulias et al, 2011). This advancement not only considers travel as a derived demand for the need to participate in activities but it also provides a wider theoretical framework of everyday life of the island residents and can be expanded to tourists. Within this advancement there are two major considerations that provide theoretical strengths and they are: a) all trips made by individuals are connected through an activity agenda and the choices made for each trip are strongly correlated to the choices made in many other trips; b) each person within a social network (with the strongest being the household) forms a daily agenda that is a function of the daily activity agendas of other persons (e.g., in a household with children the parents make explicit arrangements to chauffer children to activities); and c) the urban landscape within which all these daily agendas take place is a dynamically changing environment that offers opportunities and places barriers to the execution of activity schedules and therefore trip choices are strongly conditional on this. These theoretical and methodological advancements require more sophisticated data collection methods (Goulias et al., 2013).

In data collection many new technological and data fusion advancements allow us to establish a closer communication to the respondents in surveys, decrease respondent burden, and increase the amount and quality of information. For example, when we collect data employing GPS enabled devices and internet communication we avoid asking repetitive questions about timing of travel and location and can ask strategically with high value (e.g., type of activity engaged and the presence of other persons at activity locations). In this way one can ask questions about revealed behaviour in more detail and verify answers using secondary data. They also allow the creation of “experiments” in the form of hypothetical questions comparing different options that are called stated preference studies. These studies allow to examine potential actions from policies that cannot be tested in the real world. Moreover, merging of data from revealed preference data and stated preference enrich behavioural models in a way that can help us answer policy questions with increased flexibility. In simulation, when data are available the day in the life of an entire country can be represented with extreme detail in time (second by second) to represent the execution of activity agendas of persons and at the level of longitude and latitude (point to point). These advancements are heavily based on observations of residents in large metropolitan areas and their subject is the daily life of these residents. We did not experience similar advancement in the area known as “long distance travel’ that includes travelling for tourism (either as a purely leisure travel or a combination of business and leisure). There are examples of research activities dedicated to first collect data of this behaviour. The data can be used to inform an activity based approach that is tailored to this type of behaviour.

Of course all these advancements increase the need for higher quality data, computational power, and familiarity with more sophisticated data analysis and visualization techniques. This is often influenced by the tour operators’ marketing campaigns which steer the tourism flows to specific island destinations. On the other hand though, a rising number of “active” and “aware” travellers seek destinations which meet their criteria on environment protection and management, similar to practices applied at their home town or country. The implementation of similar practices at the island destination is very likely to attract tourists keen to visit a destination with a high environmental awareness.

The quantification of environmental impacts entailed by leisure-related activities as well as their contribution to the overall levels of local (destination) and global pollution have been two of the main research areas of tourism studies over the last decade. Issues of concern include primarily energy consumption (fossil fuels) and greenhouse gas emissions (carbon dioxide or carbon dioxide equivalents), that affect the eco-efficiency of the sector and the environmental life cycle of tourism and tourism-related industries (journey, transport, accommodation and other activities at the destination). Tourism should not become a victim of its own success hence there is an acute need to reduce its environmental footprint, particularly of the transport sector, and direct the tourism industry towards more sustainable practices.

Regarding the environmental analysis, there are many recent efforts to estimate the air pollution caused by transport using transport activity (e.g., vehicle-kilometres-travelled coupled with emission factors) in air quality – transportation models. This approach is very useful to predict the changes in the pollutant emissions that will result in different measures/policies/changes in people’s attitude. However there is considerable uncertainty of the outcomes of the activity models due to uncertainties in the characteristics of the fleet. Another approach is the direct point or line measurements of air pollutants and the application of dispersion models for the estimation of spatial distribution of pollution. The outcomes of the spatial models for certain pollutants such as particulate matter are related and could be validated by satellite images.

In the remained of the paper the particularities of island areas and the research context is described first. This is followed by the data collection methodology. Emphasis is given to the pilot research conducted in the island of Chios, Greece, and the methodological context. The pilot focuses on the use of GPS devices for data collection purposes and analyzes the data elements that can be collected using these devices. The pilot results are then presented and discussed. In the final chapter conclusions and thoughts for future research are offered.

2. INNOVATIVE DATA COLLECTION METHODOLOGY

2.1 Data collection methodology for island residents (travel behavior)

Figure 1 presents the overall scheme and components of the survey design for households residing on the islands. Key differences with many existing surveys are: a) a satellite design to collect more in depth data at a reasonable expenditure, b) data collection that spans longer periods extending to one week for a portion of the sample; c) the incorporation of a panel component to capture additional behavioural dynamics; and d) a set of complementary survey components that provide data for more detailed behavioural models and verification and validation.

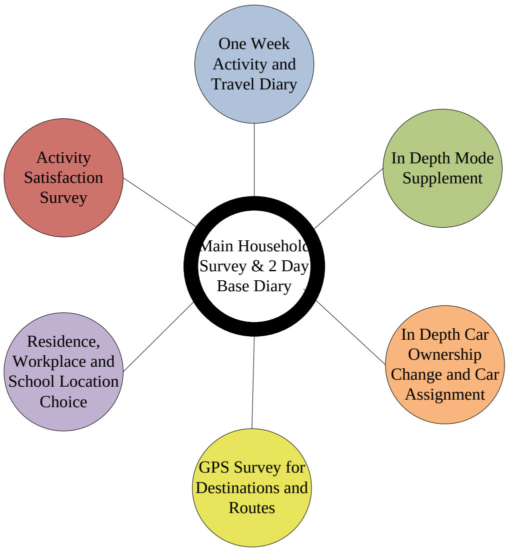

Figure 1 Data Collection Overall Scheme for Households/Residents Survey

At the very centre of Figure 1 is a household survey that collects a selection of social and demographic information for every person in each household selected. The households will be interviewed to obtain detailed information on the socio-economic characteristics and a two-consecutive day activity participation and travel behaviour diary of all persons residing in these households. This sample of households can be stratified by geography to ensure sufficient segments of the population for model estimation and for this reason a strategy for minimum number of households for locations within the study area is needed in model development that requires spatial detail (e.g., a destination choice model).

The data elements required are household composition, demographics, individual characteristics (age, gender, education, employment, drivers license, marital status), and vehicle data. The base two-day activity-travel diary includes a complete record of each person's daily schedules including all activities engaged and all trips made, locations visited, with whom each activity and trip were made and activities carried out at home and at other places. This diary will be for a pre-specified pair of days for all persons in the household and will spread over a 12–month period with a uniform distribution of interviews throughout the survey period.

One Week Activity and Travel Diary: Approximately 50% of the main survey households will be recruited to participate in an entire week diary. This will enable the creation of models that account for day-to-day variation in activity scheduling and travel. Timing of this component should maximize response rate, completion rate, and minimize any biases.

In Depth Car ownership Change and Car Assignment: This is an in-depth survey to identify the determinants for each of the car ownership, car type (e.g., new/used, model, make, and fuel type), and car assignment. In the car assignment data collection both the primary and secondary drivers shall be identified. Questions should also be created to identify determinants of change in car ownership, type, and assignment of cars to household members. Particular emphasis should be given to policy controlled determinants (e.g., taxation, incentives, insurance).

In-Depth Mode Supplement: This is an add-on survey that collects information about detailed reasons for not using specific modes. The survey objective is to identify situational constraints, attitudes, and predispositions in favour or against modes such as walk and bike and public transportation. The data collected will enable the creation of models to study policy actions that go beyond the time-cost-comfort analysis.

GPS Survey for Destinations and Routes: This is a GPS household member tracking component to develop a) a database to correlate destinations to routes and identify a typology of different types of routes and stop making patterns; b) develop a route choice model; and c) estimate the level and nature of misreported trips by different modes of the main two-day activity diary.

Residence, Workplace, and School Location Choice: This is an in-depth survey to identify the determinants for each of the residential, workplace, and school choices. Both primary locations and secondary locations shall be examined in more detail than typical household surveys and data collected to estimate choice models for each dimension. Questions should also be created to identify determinants of change for each location examining behaviour retrospectively and prospectively. Particular emphasis should be given to policy controlled determinants and the life course changes/turning points as well as sense of place questions.

Activity Satisfaction Survey: This is a small scale survey following the day reconstruction method (DRM) that records activities and satisfaction for each activity. There are two key objectives for this component: a) provide a benchmark for the diary instrument; and b) create an assessment of activities (including trips) and subjective experiences. This second objective will enable estimation of choice models with latent variables and classes that are by far richer and more informative than their counterpart observed variable discrete choice models. This survey may be particularly useful for the assessment of happiness to compare with utility-based happiness measurement.

2.2 Data collection methodology for tourists

Figure 2 presents the overall scheme and components of the survey design for tourists.

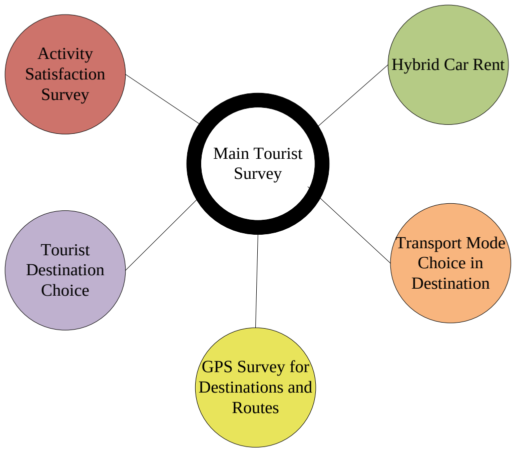

Figure 2 Data Collection Overall Scheme for Tourists' Survey

At the very centre of Figure 2 is a tourist survey that will take place in the islands of Chios and Lesvos. During this survey the respondents' will have to complete a trip diary and record all the trips and activities they undertake during their stay (maximum 7 days).

Hybrid Car Rent: This is an in-depth survey to identify the determinants for renting a hybrid vehicle instead of a conventional car. Approximately 10% of the main survey will be recruited.

Transport Mode Choice in Destination: This is an add-on survey that collects information about detailed reasons for not using specific modes. The survey objective is to identify situational constraints, attitudes, and predispositions in favour or against modes such as walk and bike and public transportation. The data collected shall enable the creation of models to study policy actions that go beyond the time-cost-comfort analysis. Approximately 20% of the main survey sample will be involved in this survey.

GPS Survey for Destinations and Routes: This is a GPS tourist tracking component to develop a database to correlate destinations to routes and identify a typology of different types of routes and stop making patterns.

Tourist Destination Choice: This is an in-depth survey to identify the determinants for choosing a tourist destination. Questions should also be created to identify determinants of repeated destination choice.

Activity Satisfaction Survey: This is a small scale survey (10% of the overall sample) that will provide insight on tourists subjective experiences and the level of satisfaction with the activities that were engaged.

2.3 Data collection methodology for the environmental analysis

The measurements of the gaseous pollutants will be conducted using automated gas analyzers. A range of instruments will be used to determine the properties (concentration, size, and composition) of Particulate Matter (PM) including an optical particle counter for measuring the concentration of particles in the air, a scanning mobility particles sizer for determining the size of the particles, as well a particle sampler for collecting samples for further chemical analysis.

We will therefore perform point measurements of the concentrations of gaseous species such as NO_x, SO_2, and O_3, as well as the concentrations and size distributions of PM in the cities of Chios and Mytilini. Analysis of the temporal variation of the concentrations of the gaseous pollutants and the PM will be used to identify the most important sources of air pollution in the region. Analysis of the variation of the properties of PM (i.e., size and chemical composition) will further assist towards quantifying the contribution of the various sources to the quality of the atmosphere in the region.

Point measurements in combination with air transport models will be used to evaluate the quality of the atmospheric environment in the region, as shown in Figure 3. The predictions from the models will be compared with satellite observations for validation. Finally, the air quality assessments will be compared with predictions of air quality parameters from Air Quality-Transportation models.

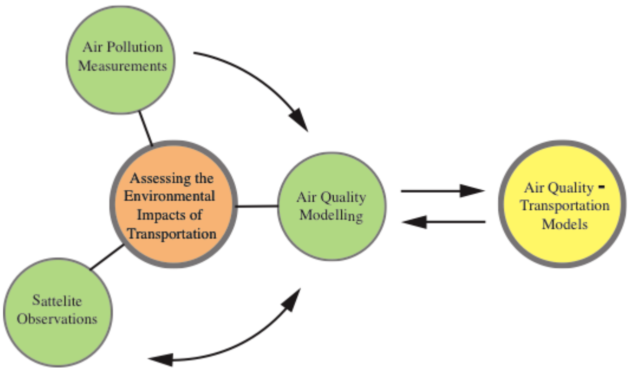

Figure 3 Process for assessing the quality the atmospheric environment in the region, and the selection/validation of the most appropriate Air Quality-Transportation models

3. PILOT APPLICATION IN CHIOS ISLAND

In order to develop a transportation model it is necessary to develop a network (in essence a graph with links and nodes) of different modes, assign speed on each link, and identify points where vehicles and their travelers experience delays (e.g., a traffic signal). Another need in transport models is the identification of route choices of respondents. In diary data collection, we also need to verify that respondents recorded their trips accurately. All this can be done through the use of Geographic Positioning System (GPS) devices.

This pilot application has three objectives:

1. To review the present literature on the GPS tracking devices use in travel surveys and in data collection process;
2. To present a methodology for data collection, not only considering the travel diary aid but also the use of the devices to collect data about the road network, the effect of seasonality in travel times and speed and the evaluation of a public transit system;
3. To test the stated methodology in a pilot study in an island area context, in Chios, Greece.

The survey took place in Chios island, Greece, in different periods of time. 4 GPS devices were used, 3 of which were QStarz BT-1000-XT (travel logger) and the remaining was an AMOD traveler. The devices were given to 2 taxi drivers and to 4 students during the periods 5-12/8/2012, 20/8-12/9/2012 and 1-5/10/2012 (the last and short period in order to collect data used for seasonality comparison). These traffic counts took place from late July to August 2012 in the main junctions of Chios island road network.

3.1 How gps devices are used so far

It is now evident that response rates in household travel surveys are dropping (Stopher and Greaves, 2007; Wilson, 2004). In fact the households that are hard to contact (and because of that they represent the highest non-response rates) are the ones that travel the most. In these cases the travel survey or the travel diary are considered an extra burden on the already stretched household schedule. An additional issue is the tendency of the respondents to omit trips in the travel diaries, either when contacted by phone surveys (Wolf et al., 2003) or even in face to face interviews (Stopher et al., 2005).

The present paper reviews literature regarding the use of GPS devices (or other tracking devices, such as smartphones), in the process of data collection in travel related surveys. A missing link in the reviewed literature is the absence of in depth data used when conducting surveys as described in Section 2. This section aims to present a methodology that links data needs and extracts the whole amount of data, taking advantage of the full potential of the GPS devices. For example, while the data of the devices is used to confirm the travel diary entries, there is much more data regarding the device's memory such as speed, travel times, waiting times at traffic lights, route choice and so on. The methodology is tested, in an island area context.

One of the first references on GPS based methods is the survey of Murakami and Wagner, 1999, which studied the reliability of GPS devices to verify the number of trips reported by the respondent, the actual trip times and any other characteristic that may be recorded wrong in the trip diary of the survey. This research, being published over 13 years ago, used mobile devices much larger and more expensive ($1350 of a GPS device) than the ones used today. The findings verified that the research participants tend to forget or to over-estimate the number of daily trips, and a GPS device can actually contribute to the correct trip data collection and correction of possible mistakes.

Stopher and Greaves, 2007 suggested the elimination of travel diaries along with data fusion techniques, panel surveys and continuous measurement as an answer to the gradually dropping response rates, and increasing costs of surveys. However, it is noted that these fusion techniques depend highly on the acceptance of the respondents to carry a GPS device with them all day. This fact may raise concerns on personal security or even fear. An answer to this may be the use of smartphones with integrated GPS function, which even solves the problem of reaching young people and busy professionals (which have always been the most difficult to reach). Another issue identified by Wolf et al, 2001 was that this survey design lacks the ability to precisely determine the means of transport (raw GPS speed data from a motorbike and a car is much alike) and does not actively engage the respondent in the survey procedure. Moreover, activities of participants are not recorded and need to be predicted using other methods.

Bhat et al., 2012 presented an analysis of the factors that influence the differences between what is written down in the trip diaries and the actual trips verified by the GPS devices. They point out the different nature of these two methods of data collection, especially when a survey is conducted solely by GPS devices, without a trip diary present. Some interesting results of this survey were the following:

- Home based work trips is the trip purpose that participants tend to record with the higher consistency. 63% of the survey participants recorded in the trip diary the same number of W-H trips with the number recorded by the GPS device, while only 42% recorded the same number for non home based work trips;
- In cases of elderly people, or people with certain disabilities or even households that people do not have so many work based trips, the use of the GPS device was crucial in recording the correct number of trips.

Doherty and Papinski, 2004 used a GPS aided data collection methodology combined with travel diary and activity diary data, and attempted to identify spontaneous (on the spur of a moment) activities. Papinski et al., 2009 attempted to explore the route choice decision-making process, actually by comparing the planned routes (stated in a travel diary) and the observed ones, revealing that the GPS devices can be used in studies containing qualitative factors.

Stopher and Collins, 2008 suggested a probability matrix to determine mode choice. Average travel times and speeds provided by GPS devices for every mode were recorded in a matrix and other factors (such as bicycle ownership) determined the probability of a certain mode choice. This study used GIS maps in order to calibrate the matrices, in the same way that Tsui and Shalaby, 2006 did.

Cortes et al. 2011 attempted the evaluation and verification of travel times of public transportation (mainly bus) by using GPS devices. The research recorded the bus's speed by using mobile devices and with the aid of geo-coding and GIS software defined the location of the areas in the network that suffer more from traffic congestion, or categorized the bus lines according to their efficiency, speed and time accuracy. These data were then used to locate the bus stops that cause more traffic congestion problems. It was concluded that this methodology is not limited in bus lines with fixed schedule, but can also used in hop on – hop off bus lines or in cases of taxis and mini buses making stops at the passenger's demand.

Şimşek et al., 2013 used the data collected by mobile GPS devices to evaluate drivers performance and behavior. The methodology of the research, apart from defining the correct (or the socially expected) driving behavior, used the GPS tracks, to measure speed and route choice, and then compared the data with the legal speed limits. This step was the basis for the construction of matrices that presented the weekly trip pattern for each driver and located the days and hours that the driving speed or the route choice may be dangerous. Finally, three quantitative factors were evaluated: driving speed off the legal limits, waiting times in traffic lights and fuel use in every trip (depending on the vehicle).

Du and Aultman-Hall, 2007 focused on the correct identification of trips ends using GPS devises, and presented a methodology for data analysis when arranging a lot of logging data. They found out that after an automatic identification of trips ends, 94% of the trips were correctly identified (on a passive stream of GPS data).

Herrera et al., 2010 attempted traffic monitoring using GPS enabled cell phones. Exploiting the “extensive coverage provided by mobile phones and the high accuracy in position and velocity measurements provided by GPS units” the prototype demonstrated a successful way to monitor traffic.

Quiroga and Bullock, 1998 proposed an integrated methodology considering travel time and speed using the combination of GIS and GPS technologies. They used a spatial and mathematical model in order to arrange and to exploit large amount of raw data, although the GPS devices available at that time were large and not very reliable in a contemporary sense.

Asensio et al., 2009 used the GPS devices to collect speed data for road traffic noise mapping. This is another case of expensive and difficult data collection that GPS technologies may make it cheaper and easier to collect.

Finally, GPS devices have been recently used in studies constructing a pedestrian network algorithm derived from multiple GPS traces Kasemsuppakom and Karimi, 2013; and in route choice models developed with Revealed Preferences data from the devices studying cyclists’ behavior (Broach et al., 2012). Both studies show that the use of such devices can be instrumental when trying to evaluate green modes of transport.

3.2 Pilot Application

This section presents the results of a pilot GPS application in the island of Chios, as part of the Green Transport in Islands project.

3.2.1 Travel speed and time and route choice

The main use of the GPS devices is exploiting the device’s ability to log the position and the moving speed (in a frequency set by the user) for a given time. With compatible GIS software (most of the contemporary devices are compatible with all the freeware (free of charge software) GIS software available, i.e. Google Earth), live tracing (speed, time and location) and playback of the whole route is easy. Figure 4 presents a trip speed variation.

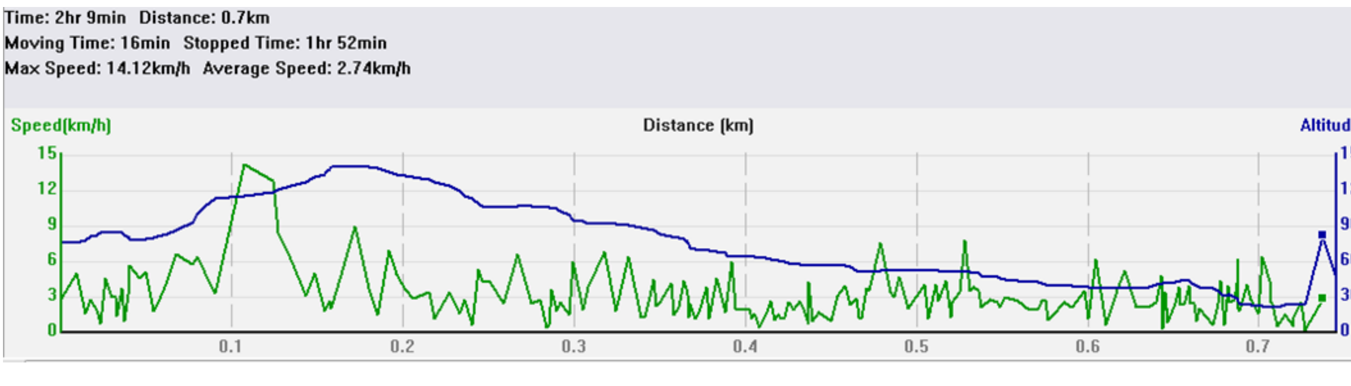

Figure 4 Trip speed variation

Proportional stopped time (PST) is a measure of traffic congestion (or journey quality). It is the ratio of the time the vehicle was not moving to the total journey time: $\mathrm{PST} = T_s / T.$

The GPS logs can be used to "fit" this equation in a single link of interest, or a group of links. The comparison between the data from high season and the low one can result in interesting conclusions for the seasonality effect.

The airport route is presented as an example. This is a 2.14 km route passing around the island's airport. It is one of the main routes connecting Chios town (the islands main town) with the south part of the island. In table 1 data from two period (one in August and one in October) of recording is shown:

Table 1 Data from airport route

Sample	25	Sample	22
Average speed	48,032 km/jour	Average speed	45,5 km/hour
Legal driving speed	40 km/hour	Legal driving speed	40 km/hour
Travel time	2,8 minutes	Travel time	2,95 minutes
Indication of traffic congestion	No	Indication of traffic congestion	No

As already stated, a GPS device can be used to develop a choice set of routes and their attributes. The following example is a route choice from Chios city to the northern town of Vrontados (4km to the north). The route choice is between the coastal road and the interior one.

Attribute	Coastal route (car)	Interior route
Average speed (km/h)	46,8	44,6
Travel time (minutes: seconds)	4:12	4:39
PST	0.027	0,031

This procedure leads to a mean speed and a mean travel time for a certain route or link. The latter may be used to calibrate a model, or a simulation of a network.

3.2.2 Average waiting time and delays in traffic lights

An additional use of the GPS devices is the capability of recording the waiting time in traffic lights or in interchanges that require long stops.

3.2.2.1 Traffic light in Chios town – Vrontados road and Kampos road

Table 2 Traffic lights data Vrontados and Kampos

Direction	To Vrontados	To Chios town	To Kampos	To Chios town
Sample	59	59	40	34
Average waiting time (seconds)	3,3	9,8	15,8	14,2
Number of vehicles that didn't stop (Green light)	23	14	9	1

Table 3 Positions of traffic lights

Figure 5 Traffic lights Chios-Vrontados

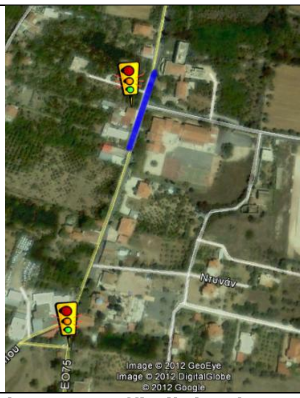

Figure6 Traffic lights in Kampos

Cars that did not stop are counted when the speed graph does not indicate a significant variation in speed. Another interesting result is that in these specific traffic lights longer delays were observed, compared to the other intersections. In the table below the highest of them are presented along with the time they occurred:

Table 4 Delays and time

Delay (seconds)	Time
48	13:45
44	12:55
39	11:00
36	20:45
35	14:30
31	14:05

The next chart presents the results of traffic counts in the area, especially the lane in which the delay counts were made:

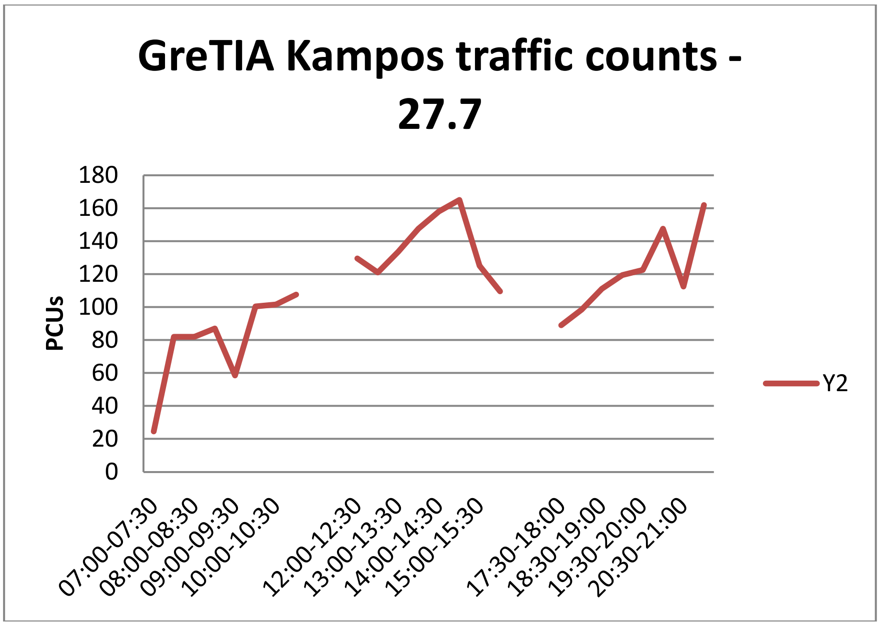

Figure 5 GreTIA traffic counts Kampos

There seems to be a correlation between the hours with high traffic counts and the hours with long delays in the traffic lights.

3.2.3 Public transit

Data regarding public transit services collected by GPS include: Average waiting time on a stop, travel time, route time, route accuracy, timetable accuracy, accessibility, etc. In the pilot survey a bus line connecting Chios town with the northern town of Vrontados (almost a suburb of Chios town) is evaluated. In Chios the bus service does not have regular bus stop areas and the bus stops on passengers' demand.
In figure11 the regular bus route is shown, with the stops of the certain observation marked in a red circle.

Table 5 below presents the data for all the observations:

Table 5 Bus line data

Bus to	Vrontados	Chios town
Average speed	32.9km/hour	34.3 km/hour
Average travel time	16 minutes 18 seconds	15 minutes 50 seconds
Average stops	6	4

The non existence of fixed bus stops, leads to continuous stops, deteriorating the overall quality of the service... In figure 8, if the terminal stops are excluded, 3 stops are made during the trip, which are very close to each other (shorter than 50 meters). This is shown better in figure 9 which shows the stops made for all the observations. The results demonstrating the actual areas that people prefer to stop the bus may help the route planning and design of the bus stops.

Figure 6 Stops in a two-way trip

Figure 9 Bus stops for all observations

4. CONCLUSIONS AND FURTHER RESEARCH

In terms of planning green transportation policies the review of best practices and case studies as well as the collection of accurate date is of critical importance. New generation activity-based models are gaining ground in transportation modeling. The most important attribute of these models is the incorporation of intra-household interactions. They are based on the detailed classification of activities and travel segmentation. The main features of these new travel demand models include the long-term decisions, tour and trip dairies. In person interviews remain the key for disaggregate information and given that data these models aim at identifying household members interactions survey data must be collected with more attention to assure completeness and accuracy.

The use of GPS devices by respondents, over a two day period for the pilot experiments, provided a useful amount of data, regarding travel speeds and travel times. The fact that these data is used to confirm the travel diary entries of the respondent was a major objective of the study. Furthermore, with the full data collection the network speeds and travel times will be used be used to calibrate models or traffic simulators running for the area.

The part of the research that counts the waiting time in traffic lights provided a lot of insights. There is the limitation of the GPS device logging and battery capacity that were identified. The fact that some of the longer waiting times were logged in the peak of the traffic counts in the area is an indicator that there may be a higher correlation between the data collection for these two measures.

Considering the part of the public transport (urban buses) evaluation, the study revealed that the use of GPS devices in the buses can lead to a large amount of data that can be used to construct an instrument of evaluation of the lines or the overall public transit system. The findings from this survey revealed that there may be a rational bus stop system, practically designed by the passengers' demand.

Finally, when addressing seasonality issues, the research concluded that if the GPS surveys were running all-year around, or even during two different seasons, big differences in all statistics were to be logged.

A full scale survey, addressed to 1000 households of the Chios island, will be conducted during two different seasons of the year April 2013 and July 2013, in order to capture seasonality effects of transportation on the environment.

Acknowledgements: This research is part of the Project Green Transport in Islands (GreTIA), Thales Program "Education and Long Life Learning" co-funded by the European Union and Greek National Sources.

REFERENCES

1. Abou-Zeid, M. and Ben-Akiva, M. (2010) "A Model of Travel Happiness and Mode Switching", in Choice Modelling: the state-of-the-art and the state-of-practice; Proceedings from the Inaugural International Choice Modelling Conference, Hess, S. and Daly, A. (eds.), pp. 289-305.
2. Almeida, A.M., M. Ben-Akiva, F. C. Pereira, A. Ghauche, C. A. Guevara, S Niza and C. Zegras (2009) "A Framework for Integrated Modeling of Urban Systems", Integrated Modeling, 45 ISOCARP Congress.
3. Asensio, C., J.M. López, R. Pagán, I. Pavón, and M. Ausejo. "GPS-based speed collection method for road traffic noise mapping." *Transportation Research Part D: Transport and Environment*, 2009.
4. Bhat, Paleti, Sen, and Bricka. "An analysis of the factors influencing differences in survey-reported and GPS-recorded trips." *Transportation Research Part C*, 2012: 67–88.
5. Bowman, J.L. and Ben-Akiva, M. (2001), 'Activity-Based Disaggregate Travel Demand Model System with Activity Schedules,' Transportation Research Part A, vol.35, pp. 1-28

6. Broach, Dill, and Gliebe. "Where do cyclists ride? A route choice model developed with revealed preference GPS data." *Transportation Research Part A: Policy and Practice, Volume 46*, 2012.
7. Doherty, S. T., and D. Papinski. "Is it possible to automatically trace activity scheduling decisions." *it possible to automatically trace activity scheduling decisions.* Maastricht, The Netherlands, 2004.
8. Du, J, and L Aultman-Hall. "Increasing the accuracy of trip rate information from passive multi-day GPS travel datasets: Automatic trip end identification issues." *Transportation Research Part A 41*, 2007: 230.
9. Duarte, A., Garcia, C., Giannarakis, G., Limão, S., Polydoropoulou, A. and Litinas, N., 2009a. New Approaches in Transportation Planning: Happiness and Transport Economics. NETNOMICS:Economic Research and Electronic Networking(Special Issue on 'Design and Evaluation of Transportation Networks'), 1–28.
10. Duarte, A., Garcia, C., Limão, S. and Polydoropoulou, A., 2009b. Experienced and Expected Happiness in Transport Mode Decision Making Process. In: 88th Annual Meeting of theTransportation Research Board. January 11-15, 2009, Report of a Conference, Conference Proceedings, Washington DC.
11. Goulias K. G. (2011) Transportation Planning and Modeling, Chapter 10 in Handbook of Transportation Engineering, Volume I: Systems and Operations, 2nd Edition, (eds Myer Kutz), McGraw-Hill, New York, NY. Pages 10-3 to 10-27.
12. Goulias K.G., C. R. Bhat, R. M. Pendyala, Y. Chen, R. Paleti, K. C. Konduri, G. Huang, and H. Hu (2011) Simulator of Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT) in Southern California: Design, Implementation, Preliminary Findings, and Integration Plans. Paper prepared for presentation at the IEEE Forum on Integrated and Sustainable Transportation System, Vienna, Austria, June 29 to July 1, 2011.
13. Goulias K.G., R.M. Pendyala, and C. R. Bhat (2013) Chapter 2: Keynote - Total Design Data Needs for the New Generation Large-Scale Activity Microsimulation Models. In *Transport Survey Methods: Best Practice for Decision Making* (eds J. Zmud, M. Lee-Gosselin, M. Munizaga, and J. A. Carasco). Emerald Group Publishing, Bingley, UK
14. Henson K., K.G. Goulias, and R. Golledge (2009) An Assessment of Activity-based Modeling and Simulation for Applications in Operational Studies, Disaster Preparedness, and Homeland Security. Transportation Letters,1(1), pp.19-39.
15. Herrera, J, D Work, Xuegang,B Herring R, and Jacobson Q. "Evaluation of traffic data obtained via GPS-enabled mobile phones." *Transportation Research Part C 18*, 2010.
16. Kasemsuppakorn, P, and H Karimi. "A pedestrian network construction algorithm based on multiple GPS traces." *Transportation Research Part C*, 2013.
17. Koutoura, C. *Mode of transport choice in the city of Chios.* MsC thesis, Chios: University of the Aegean, 2009.
18. Moshe Ben-Akiva, Joan Walker, Adriana T. Bernardino, Dinesh A. Gopinath, Taka Morikawa, and Amalia Polydoropoulou (2002). "Integration of Choice and Latent Variable Models." In Perpetual Motion: Travel Behaviour Research Opportunities and Application Challenges. Editor: Hani Mahmassani. Publisher: Elsevier Science, May 2002.
19. Papinski, Scott, and Doherty. " Exploring the route choice decision-making process: A comparison of planned and observed routes obtained using person-based GPS." *Transportation Research Part F: Traffic Psychology and Behaviour*, 2009.

20. Polydoropoulou A. and M. Ben-Akiva (2000). "Combined RP/SP Nested Logit Access/Mode Choice Model for Multiple Mass Transit Technologies." Transportation Research Record 1771
21. Polydoropoulou, A. and A. Tsirimpa (2010a). Stated Preference Applied to Market Research for Travel Information Systems: A Case Study for Athens Urban Area. 13th International IEEE Conference on Intelligent Transportation Systems - ITSC 2010, Madeira Island, Portugal, September 19 – 22, 2010.
22. Polydoropoulou, A. and Tsirimpa, A. (2010b). Green Transport in Island Areas. 3rd International Scientific Conference on Energy and Climate Change, 7-8 October, Athens, Greece
23. Quiroga, C, and D Bullock. "Travel time studies with global positioning and geographic information systems: an integrated methodology." *Transportation Research Part C 6*, 1998.
24. Stopher, P.R., and A., Collins. "Conducting a GPS prompted recall survey over the internet." *Paper Presented at 84th Annual Meeting of the Transportation.* Washington, DC., 2008.
25. Stopher, P.R., and S Greaves. "Household travel surveys: Where are we going?" *Transportation Research Part A 41*, 2007: 362.
26. Stopher, P.R., M. Xu, FitzGerald, and C. "Assessing the accuracy of the Sydney household travel survey with GPS." *28th Australasian Transport Research Forum.* Sydney, 2005.
27. Tsirimpa A. and Polydoropoulou, A. (2009) "Modeling Intention and Acquisition of ATIS" 12th International Conference on Travel Behaviour Research, Jaipur
28. Tsirimpa, A., Polydoropoulou, A., and Antoniou, C. (2007b) "Development of a Latent Variable Model to Capture the Impact of Risk Aversion on Travelers' Switching Behaviour" 11th World Conference in Transportation Research, Berkeley, CA, 24-28 June 2007
29. Tsui, A., and A., Shalaby. "Enhanced system for link and mode identification for personal travel surveys based on Global Positioning Systems." *Transportation*, 2006.
30. Wilson, J. "Measuring Personal Travel and Goods Movement." *Transportation Research Board Special Report 277*, 2004.
31. Wolf, J., M. Loechl, M. Thompson, and C. Arce. "Trip rate analysis in GPS-enhanced personal travel surveys." *Transport Survey Quality and Innovation*, 2003.
32. Wolf, J., R. Guensler, and W., Bachman. "Elimination of the Travel Diary: An Experiment to Derive Trip Purpose from GPS Travel." *Transportation Research Record*, 2001: 127-129.

33. Yoon S.Y. and K.G. Goulias (2010) An Intra-Household Assessment of Land Use and Activity- Travel Behavior Patterns in California. Presentation at the World Conference on Transport Research, July 11-15, Lisbon Portugal