



GREen Transport in Island Areas – GREtIA

Deliverable D2: Current Situation Analysis

Το έργο υλοποιείται στο πλαίσιο του Επιχειρησιακού Προγράμματος: «Εκπαίδευση και Δια Βίου Μάθηση» και συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ευρωπαϊκό κοινωνικό ταμείο – ΕΚΤ) και από εθνικούς πόρους.

The project is funded in the framework of the Operational Programme “Education and Life-Long Learning” and is co-funded by the European Union (European Cohesion Fund – ECF) and national funds.

Chios, July 2012



EXECUTIVE SUMMARY

Green development 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 project creates a comprehensive green transport policy, research and development action plan for Aegean island areas, accounting for the unique characteristics and growth prospects of the area in its multiple dimensions. This report presents the current situation analysis.

Initially the evolution of the air pollution modeling is reviewed. These models are classified into groups according to their physical or mathematical principles and their level of complexity. Furthermore air quality (photochemical models) and dispersion models are presented, with their input requirements and the decision support systems that each of them uses. The section ends with the further research needs on the topic, such as evaluation of hot spot air quality models or the development of emissions models.

The next task is intended to review best practices and policies implemented internationally for the promotion of green transport alternatives, as well as to identify those policies that will fit better the needs and particularities of island areas. Best practices of eight European cities that portray best practice in terms of continuous and integral transport policy, modal split for all journeys, especially bicycle mode share, and car free initiatives are presented. In addition, the current situation regarding the transportation system of the study area is analyzed (including available infrastructure, supplied services, road network flaws and flows, particularities of the islands etc.). There is also an extended literature review on the subject and some conclusions regarding the experience to date with activity-based models in practice.

Following the transportation literature and best practices review along with the situation analysis in the islands, is the environmental practices analysis. The section starts with a review of sustainability issues in the transport literature, and continues with the review of sustainable transport policies. It then covers sustainability indicators (such as the ecological footprint) and presents case studies including ecological footprint analysis. Finally it recaps the findings of the literature review and presents recommendations for the rest of the project

The report continues with the tourism section, comparing the complex tourist activity with the transport activity, based on the fact that both are activities involving mobility. The difficulty of distinguishing what comes first between these two and how these two interact is a subject of the present report. The report is concerned with the Greek geographical and transport peculiarities that directly affect the tourism of the country and the study areas. Tourist activities and the ideas of sustainable tourism are presented. Finally some green tourist certificates are being examined with their drawbacks being pointed out.

The last section of the report concentrates on the consultation process which includes interviews with the key decision makers to identify the factors influencing the promotion and the development of green initiatives in the islands, and with the stakeholders of tourism industry and local government officials to record their views on the project scope and the islands particularities. The task aims to depict in detail all attributes



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composing the modern internal and external business environment of the North Aegean islands.



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1 INTRODUCTION

1.1 Scope and Objectives

Green development 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 project creates a comprehensive green transport policy, research and development action plan for Aegean island areas, accounting for the unique characteristics and growth prospects 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”. The project identifies the factors that affect the study area development by: a) defining the requirements of decision makers; b) investigating individual activity and travel patterns; and c) exploring island destination choice for tourists. Data collection includes network and land use data that characterize living and traveling environments, surveys for residents and tourists, and atmospheric pollution data. Based on this information we develop advanced integrated discrete and latent variable choice models for both tourists and residents to simulate their travel behavior. We also develop environmental and economic models to analyze and evaluate the impact of green transport policies. The final product is a policy platform which includes environmental analysis, travel simulation, and economic analysis. In this way our project uses approaches that are multidisciplinary (e.g., data collection informed by geography, engineering, and environmental science) and based on interdisciplinary research (e.g., discrete choice travel models from economics and engineering) moving one step further in research. Fusion of these ideas, data, and models lead to novel (transdisciplinary) research directions and methods that function as gateways of many other research directions in transportation and environmental science and engineering.

1.2 Project's Tasks

The GRETIA project consists of four pillars and is organised in the form of work packages (WP). The four pillars are:

- (a) Travel Behaviour of Island Residents;
- (b) Tourist Preferences;
- (c) Environmental Analysis; and
- (d) Economic Evaluation.

For each of the pillars the corresponding work packages have been developed – those that have overlapping periods are represented in white colour.

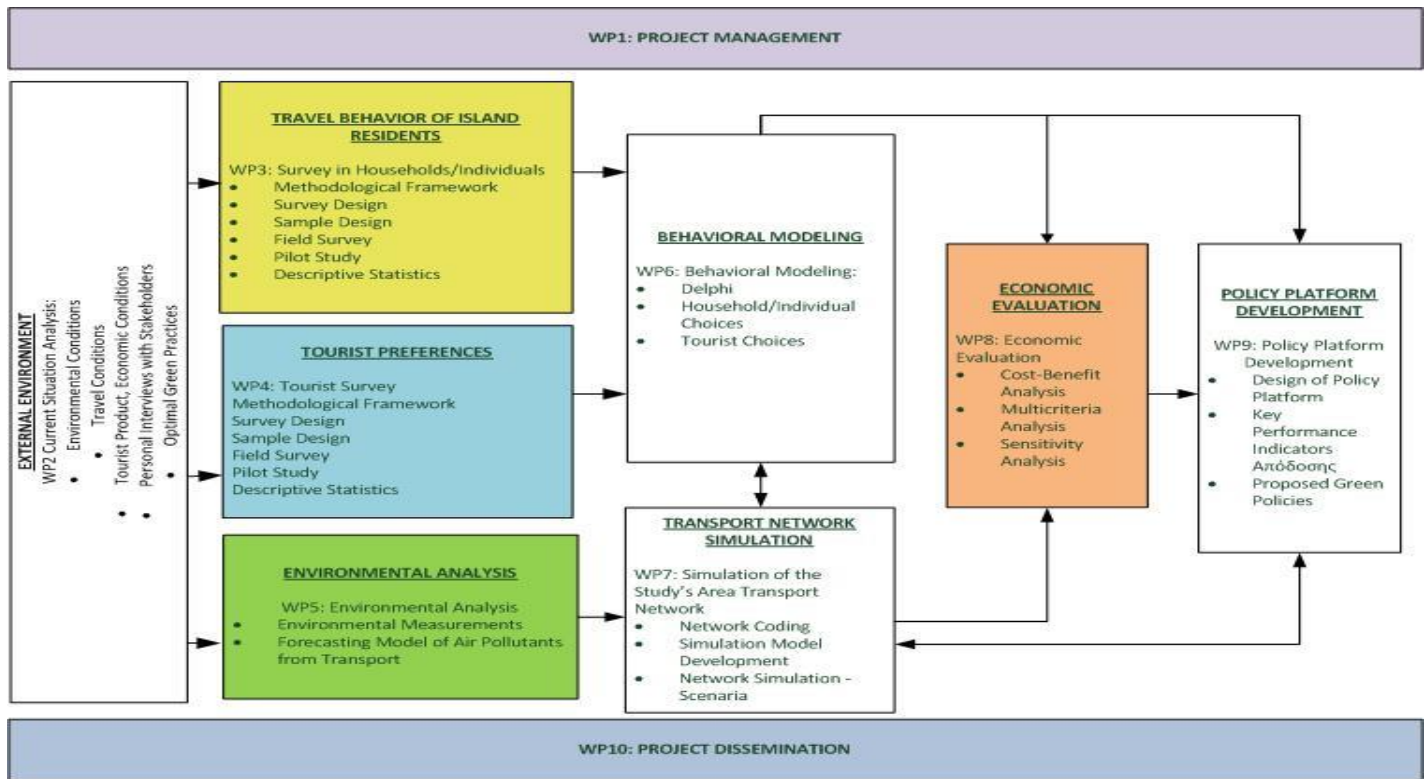


Figure 0.1. Workpackages

1.3 Scope of the Project

This report is the first deliverable of the GreTIA project. It is composed of 8 sections. In Section 2 the environmental practices are presented. The best practices in travel behaviour research are highlighted in section 3. In addition, the transport conditions in the study area are analysed in Section 4. The environmental impact of transportation systems and the tourism product are thoroughly investigated in sections 5 and 6 respectively. In Section 7 the findings of the consultation event in Chios are presented. Section 8 concludes the report.



2 ENVIRONMENTAL PRACTICES – MODELING OF MOBILE SOURCE ATMOSPHERIC POLLUTION

The objective of this task is to review the international academic literature on the environmental modeling of air pollutants and its use in assessing, quantifying and understanding air pollution with emphasis to roadway traffic air pollution. The results of the study could be used in order to assess their applicability in the study area, but also to identify potential fields that can stimulate innovation in the current project.

2.1 Introduction

Historically, air pollution was coincided with Industrial Revolution of 1750-1880 in Europe and it was associated with coal burning for manufacturing, transportation, and urban heating (Jacobson, 2002). In 1905 the term smog was introduced to describe the combination of smoke and fog that was visible in several cities through Great Britain, which significantly reduced visibility and caused severe health problems to the residents. This smog contained soot particulates from smoke, carbon monoxide, sulfur dioxide and other components. Today, pollution resulting from coal and chemical combustion smoke in the presence of fog or a low-lying temperature inversion is referred to as London-type smog. Several London-type smog events were recorded in the nineteenth and twentieth centuries, the worst being in London, in 1952, when 4.000 excess deaths occurred. Today the term smog is used to describe pollution conditions characterized by significant reduction in visibility. The term is applied without consideration to pollutant types, sources or smog forming processes (Godish, 1991).

Persistent pollution problems in sunny regions that have been associated with photochemically driven reactions have received great attention in the twentieth century. The most prominent cases were observed in the city of Los Angeles (Godish, 1991; Jacobson, 2002). Photochemical smog does not require smoke or fog for its production but involves reactions among nitrogen oxides [$\text{NO}_x(\text{g}) = \text{NO}(\text{g}) + \text{NO}_2(\text{g})$] and reactive organic gases (ROGs, total organic gases minus methane¹) in the presence of sunlight. The major source of pollutants is the automobiles which release exhaust gas into the atmosphere (Godish, 1991). These motor vehicle emissions, along with poor dispersion resulting from temperature inversions and topographical barriers and abundant sunshine, provide conditions of the formation of smog of considerable complexity. Because of the presence of NO_2 , the photochemical smog is brown in color. The most recognized gas-phase by-product of photochemical smog reactions is ozone, which can cause adverse health effects (HEI, 2010).

Apart from the relatively localized smog, there are also regional air pollution problems such as the acidic deposition (acid rain) that was first recognized in Sweden in the mid-1960s and later in the USA in the mid-1970s (Godish, 1991). The increased

¹ Methane is a fairly unreactive hydrocarbon



acidity in precipitation is the result of the presence of sulfuric and nitric acids. The major sources of precursors for these strong acids include fossil-fuel-fired power plants, industrial boilers, metal smelters and automobiles that emit SO_2 and NO_x . It is apparent that long-range transport of acid precursors has a profound effect on acidic deposition hundreds of kilometers downwind of sources. It has for example been estimated that 50% of the acid forming pollution burden in Canada originates in the United States (Godish, 1991). The effects of the acidification include extensive periodic kills of fish in surface waters as well as leaf damage and decreased productivity in terrestrial ecosystems.

During the 20th century, two well known global scale phenomena, the greenhouse effect and the depletion of the stratospheric ozone layer came to the forefront of environmental problems. The depletion of ozone layer was successfully addressed by the prohibition of chlorofluorocarbons (CFCs) (Montréal Protocol, 1987) the compounds that play the most important role in reducing stratospheric ozone (Jacobson, 2002). In 2000, reported CFC emissions were less than one-tenth those in 1976 and global stratospheric ozone levels are expected to be replenished to their original levels by the year 2050. The greenhouse effect is mainly the result of fossil fuel burning and the increase in concentration of heat trapping gases (e.g., CO_2 and CH_4 , and N_2O) that cause the rise of ambient temperature. Climate change is probably the most serious environmental threat that the world faces and a radically different pattern in energy consumption is needed to address it.

2.2 Air pollution modeling evolution

Air pollution measurements give important quantitative information about ambient concentrations of air pollutants, but they can only describe air quality at specific locations and times, without giving clear picture of the potential sources and transportation in the atmosphere. Air pollution modeling is a numerical tool used to describe the causal relationship between air pollutant emissions, meteorology, atmospheric concentrations, deposition, and other factors. Air pollution models play an important role in science, because of their capability to assess the relative importance of the relevant processes. Air pollution models are the only method that quantifies the deterministic relationship between emissions and concentrations/depositions, including the consequences of past and future scenarios and the determination of the effectiveness of abatement strategies. This makes air pollution models indispensable in regulatory, research, and forensic applications (Daly and Zanneti, 2007).

One of the first challenges in the history of air pollution modeling during the 1930s was the understanding of the diffusion properties of plumes emitted from large industrial stacks (point sources). For this purpose, a very successful, yet simple model was developed – the Gaussian Plume Model. This model was applied for the main purpose of calculating the maximum ground level impact of plumes and the distance of maximum impact from the source (Daly and Zanneti, 2007).

The model uses the Gaussian equation, which treats inert pollutant emissions (such as CO and certain types of PM) that disperse from a given source as a plume, travel downwind and spread horizontally and vertically according to the release height and wind speed/direction (Jungers et al, 2006) (cf. Figure 2.2.1). It is assumed that the concentrations from a continuously emitting source are proportional to the emission rate, inversely proportional to the wind speed, and that the time averaged pollutant

concentrations horizontally and vertically are well described by Gaussian (i.e. bell-shaped) distributions (Boubel et al., 1994). In its simplest form, the Gaussian plume model assumes that there are no chemical or removal processes taking place and that pollutant material reaching the ground or the top of the mixing layer as the plume grows is reflected back towards the plume centerline (Vardoulakis et al, 2003).

In the 1960s, the studies concerning dispersion from a point source continued and were broadening in scope (Daly and Zanneti, 2007): The use and application of the Gaussian plume model spread over the whole globe, and became a standard technique in every industrial country to calculate the stack height required for permits. Gradually, the importance of the mixing height was realized and its major influence on the magnitude of ground level concentrations was studied.

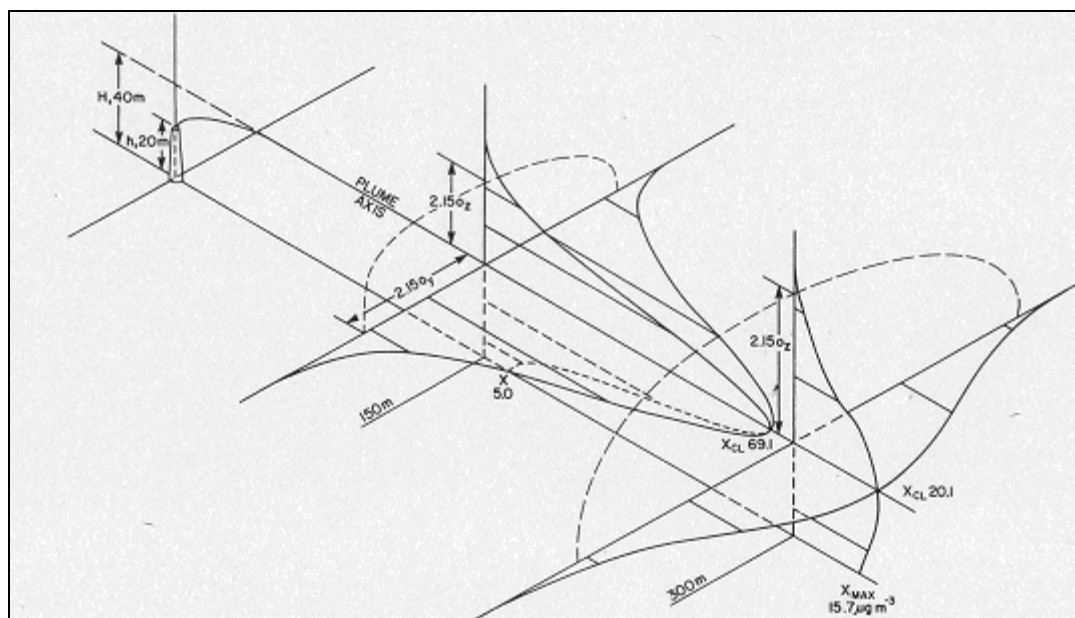


Figure 2.2.1 Two cross sections through a Gaussian plume (Source: Boubel et al., 1994)

Apart from industrial applications (i.e. point sources), specially designed Gaussian plume models can be used to calculate pollutant concentrations in the vicinity of highways (i.e. line sources) and over urban agglomerations (i.e. area sources) (Vardoulakis et al, 2003). Gaussian models are not directly applicable to small-scale dispersion within the urban canopy, since they treat buildings and other obstacles only via a surface roughness parameterization. In some cases, they include specialized modules for street canyons (Vardoulakis et al, 2003). Gaussian diffusion models have limited applicability for relatively flat and homogenous surfaces, reasonably steady and moderate to strong winds neutrally buoyant or slightly buoyant conditions and relatively short distances (<50km) from simple source configurations. These limitations arise from the simplified assumptions implied in their formulation and physics (Pal Arya, 1999).

Shortly after 1970, scientists began to realize that air pollution was not only a local phenomenon (Daly and Zanneti, 2007). It became clear - firstly in Europe - that the

SO₂ and NO_x emissions from tall stacks could lead to acidification at large distances from the sources. It also became clear - firstly in the US - that ozone was a problem in urbanized and industrialized areas. And so it was obvious that these situations could not be tackled by simple Gaussian-plume type modeling.

Two different modeling approaches were followed, Lagrangian modeling and Eulerian modeling (Daly and Zanneti, 2007). The two systems use different reference systems (Mousiopoulos, 1997): in Eulerian modeling, the pollutants are reported on a fixed (e.g. with respect to earth) frame of reference whereas in Lagrangian modeling the frame of reference is moving with the average velocity of the air mass. In Lagrangian modeling, an air parcel is followed along a trajectory, and is assumed to keep its identity during its path (Daly and Zanneti, 2007). In Eulerian modeling, the area under investigation is divided into grid cells, both in vertical and horizontal directions (Daly and Zanneti, 2007). In general, Lagrangian modeling was mostly performed in Europe, over large distances and longer time-periods, and focused primarily on SO₂ (e.g. the well-known EMEP-trajectory model). Eulerian grid modeling was predominantly applied in the US, over urban areas and restricted to episodic conditions, and focused primarily on O₃ (the Urban Airshed Model-UAM originated for photochemical simulations on the Los Angeles basin). Also hybrid approaches were studied, as well as particle-in-cell methods (Daly and Zanneti, 2007).

It can be stated that, since approximately 1980, the basic modeling concepts and tools were available to the scientific community. Developments after 1980 concerned the fine-tuning of these basic concepts (Daly and Zanneti, 2007).

2.3 Model Classifications

Although there are no clear-cut distinctions between different categories, models might be classified into, often overlapping, groups according to their physical or mathematical principles (e.g. reduced-scale, box, Gaussian), their level of complexity (e.g. screening, statistical or numerical) etc (Vardoulakis et al, 2003).

Some of the classifications are presented below:

2.3.1 Steady-state and non steady-state models (EPA, 2004):

This is one of the major categories. Steady-state models are models that assume no time-varying processes occurring over the period of interest. Hence, material released travels infinitely in only one direction over the time period (e.g. one hour). Often, these models assume that the pollutants are distributed normally and are thus called Gaussian plume models (Figure 1). The steady-state model typically uses meteorological information obtained near the source and assumes it holds true throughout the modeling region (e.g. a 50 kilometer radius). Wind direction, wind speed and atmospheric stability are used to predict concentrations. This type of models is most widely used for stationary sources and for non-reactive pollutants, but they can take into account deposition and simple linear decay. The models are least applicable in areas with rapid time-varying conditions, over spatially varying terrain and land use, over large spatial scales (> 50 km), and where complex atmospheric chemistry takes place.

Non-steady state models are models that can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. The modeling region is typically divided into grid cells, and the model

simulates movement of pollutants between cells by taking into account advection, degradation, and other physical and chemical processes. These models are often used for chemically reactive pollutants (photochemical models) and/or in cases of complex topography or meteorology (e.g., complex sea breeze circulation). They require complex wind flow characterization and other detailed meteorological information for dispersion. For chemical transformation, they require information on the important chemical compounds as well as chemical kinetics to properly characterize the transformation and removal of air toxics. These models often take the form of grid models with the calculation of the physical and chemical processes taking place at each grid location.

2.3.2 Screening and Refined Analysis Models (EPA, 2004):

The overall accuracy and precision of results determined by a model is generally proportional to the complexity of the model, which in turn affects input data requirements and overall resources. Screening-level models are designed to provide conservative (i.e., high) estimates, and are useful for applications such as identifying sources and/or air toxic pollutants that appear likely to contribute the greatest risk among a group of sources and chemicals released. Data requirements are generally low (e.g., emission rates, some stack parameters), and running the models is generally easy and requires few resources.

Refined models take into account more complex chemical behavior and a greater degree of site-specific information, generally producing more accurate results. Data requirements are higher (e.g., site-specific meteorology, terrain, chemistry data), and application of more refined models may require expert judgment in developing model inputs and setting model options. Some models can be used both as a screening model and refined model if additional site-specific information is used in the application.

2.3.3 Numerical and Statistical Models (Zanneti, 1990; Melas, 2007)

Numerical models use a system of equations based on the basic principles of conservation of momentum, energy and mass. In order to solve these equations, numerical methods are used. Numerical models are more suitable to be used in complex conditions (area sources in urban areas, areas with intense relief, complex meteorological conditions) but they have greater demands on input data and computational power. They are very useful tools for research activities but their use on an operational basis is very limited.

Statistical models of air pollution have been developed primarily to provide a simpler and less data-demanding approach for estimating atmospheric concentrations, either for the purpose of air quality management (e.g. as screening models) or for exposure assessment in epidemiological studies. These models are not deterministic, in the sense that they do not establish nor simulate a cause-effect, physical relationship between emissions and ambient concentrations. Statistical models largely ignore the intervening processes, but represent the relationship between the source and concentrations at the receptor in the form of (empirically-informed) formulae or statistical functions.

2.3.4 Source specific and grid-based models (Seigneur and Dennis, 2011).

Contemporary air quality models can be grouped into two major categories: (1) models that calculate the concentrations of air pollutants near a source (source-specific models) and (2) models that calculate concentrations of air pollutants over large areas ranging from an urban, regional, continental, and the global scales (grid-based models). Source-specific models are Lagrangian, which treat atmospheric dispersion as a source specific process (i.e. the dispersion coefficients are a function of distance from the sources), whereas grid-based models are Eulerian, which treat atmospheric dispersion as a characteristic of the ambient environment (i.e., dispersion coefficients are not related to any source characteristics). Source-specific Lagrangian models include steady-state Gaussian plume models such as AERMOD and non-steady-state puff dispersion models such as CALPUFF and SCICHEM.

Some discussion on specific air pollution models that are particularly important and are used by a large community of scientists is presented below. Also, a comprehensive but not exhaustive list of the most important air pollution models and their main attributes is presented in Table 1.

2.3.5 Dispersion Models

Dispersion models do not contain an advanced chemical transformation module therefore they are appropriate for modelling the micro-scale dispersion of inert pollutants such as CO and SO₂ because of the simple manner in which their chemical reactions can be represented (Godish, 1991).

The input requirements of dispersion models are (Vardoulakis et al, 2003):

- Traffic data
- Emissions
- Meteorological data
- Street geometry
- Background concentrations

There exists a large variety of models for describing atmospheric dispersion of pollutants. The US-EPA today recommends the following two computer packages for simulation of non-reactive chemicals such as SO₂ (EPA, 2005; EPA, 2012):

- AERMOD:

AERMOD is a multi-source, steady-state Gaussian plume model, developed by EPA and American Meteorological Society. AERMOD is currently one of the most sophisticated dispersion models available, and it is the EPA-recommended model for evaluating the dispersion of inert pollutants from point, area and line sources under short range, steady-state conditions (Jungers, 2006). It uses a single wind field to transport emitted species. The wind field is derived from surface, upper-air, and onsite meteorological observations. AERMOD also combines geophysical data such as terrain elevations and land use with the meteorological data to derive boundary layer parameters such as Monin-Obukhov length, mixing height, stability class, turbulence, etc. AERMOD contains a photochemical option for nitrogen dioxide (NO₂) that accounts for the transformation of NO₂ to nitric oxide (NO) in the presence of

ozone, as well as dry and wet deposition options (EPA, 2008). Like ISC3, AERMOD was developed more with stationary-source applications (such as industrial smoke stack type sources) in mind, but it can be applied to mobile source emissions from roadways by combining multiple volume or area sources joined consecutive (Jungers et al, 2006). However, AERMOD contains a significant amount of modelling capability that is specific only to stationary source modelling, which may be cumbersome for practitioners who only wish to perform analyses for mobile source emissions (Jungers et al, 2006). AERMOD is today replacing the ISC models for most regulatory applications in the US (Daly and Zanneti, 2007). For long-range (> 100 m) and/or non-steady-state conditions, the EPA recommends the use of *CALPUFF* (Jungers, 2006).

- *CALPUFF* (Daly and Zanneti, 2007; EPA, 2012):

CALPUFF is a non-steady state Lagrangian puff dispersion model. The advantage of this model over a Gaussian-based model is that it can realistically simulate the transport of substances in calm, stagnant conditions, complex terrain, and coastal regions with sea/land breezes. *CALPUFF* is particularly recommended for long-range simulations (e.g., more than 50 miles) and studies involving the assessment of the visual impact of plumes. With the development of the *VISTAS* Version 6 model2, *CALPUFF* can use sub-hourly meteorological data and run with sub-hourly time steps. This version of *CALPUFF* is appropriate for both long-range and short-range simulations.

- *DIPCOT* (DIsPersion over COmplex Terrain (Davakis et al, 2004)

DIPCOT is a model developed in the National Centre of Scientific Research *DEMOKRITOS* of Greece that simulates dispersion of buoyant plumes from multiple point sources over complex terrain on a local to regional scale. It does not include wet deposition or chemical reactions.

- *OCD* - Offshore and Coastal Dispersion Model Version 5 (EPA, 2012)

OCD is a straight line Gaussian model developed to determine the impact of offshore emissions (e.g. oil platforms, tankers) from point, area or line sources on the air quality of coastal regions. *OCD* incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline. Hourly meteorological data are needed from both offshore and onshore locations.

For the simulation of the air pollution specifically from road traffic, there are about 25 available models in the literature. Some of the most important, are:

- *CALINE3* (CALifornia LINE Source Dispersion Model, version 3).

CALINE3 is a steady-state Gaussian dispersion model designed to determine non-reactive pollution concentrations at receptor locations downwind of highways located in relatively uncomplicated terrain (Jungers, 2006; EPA, 2012). *CALINE3* was designed to predict emissions from vehicles under free flow conditions but does not account for emissions from idling vehicles (Jungers, 2006). It has been used for many years to model emissions from roadway sources; its line source algorithm has been well refined and its accuracy has been verified (Jungers, 2006). The model does not contain an emissions component, but requires inputs from a mobile source emission factor model, such as the *MOBILE* model (EPA, 2001). *CALINE3* is incorporated into the more refined *CAL3QHC* and *CAL3QHCR* models (EPA, 2012).



CAL3QHC and CAL3QHCR are two models based on the CALINE3 dispersion algorithm, but also include additional calculations for approximating emissions near roadway intersections (Jungers et al, 2006). CAL3QHC is a multi-source Gaussian dispersion model developed by the U.S. EPA in 1990, intended to be used for estimating vehicle emissions near roadway intersections. The U.S. EPA recommends that *CAL3QHC* be used as a screening tool for estimating the worst-case CO concentrations at receptor sites near the intersection. The model is relatively insensitive to traffic speed, reducing the need for extensive on-site data collection. CAL3QHCR is a refine tool that requires specific meteorological and traffic data.

- CALINE4 (California LINE Source Dispersion Model), version 4)

CALINE4, the latest version of the CALINE series of pollutant dispersion models, is one of the most validated models available for predicting air pollutant levels near highways and arterial streets (Benson, 1984). It was developed by the California Department of Transportation (CalTrans) and it has been widely used in scientific and engineering applications mainly concerning highway development and management (Jones et al., 2000). This version updates CALINE-3, specifically by fine-tuning the Gaussian method and the mixing zone model (EPA, 2008). An option for modeling intersections was added (Benson, 1992). It is similar to CAL3QHC, but has an advanced method for calculating NO₂ concentrations using the Discrete Parcel Method.

The model uses Gaussian plume theory to simulate the dispersion of pollutants emitted from a line source. This is divided in a series of elements, which are modeled as equivalent finite line sources located normal to the wind direction. The region directly over the road, called the mixing zone, is treated as a zone of uniform emission and turbulence. Within the mixing zone, vehicle induced turbulence (both mechanical and thermal) is taken into account (Benson, 1992).

- HYROAD (Hybrid Roadway Intersection Model) (Jungers, 2006).

HYROAD is an advanced, relatively new emissions model that was also developed specifically to monitor pollutant dispersion, especially CO, near roadway intersections. *HYROAD* addresses the three key aspects controlling the magnitude of CO concentrations: traffic operations at intersections; vehicle emissions; and atmospheric transport and dispersion. *HYROAD*'s dispersion module uses a Gaussian puff approach, with dispersion induced by traffic flow and wind characteristics, and also uses either MOBILE5 or MOBILE6 emissions factors (as specified by the user). Each module can be used as a stand-alone program and is not dependent upon the functionality of the other two modules. HYROAD also has the capability to function both as a screening and as a refined model for analyzing CO dispersion. HYROAD requires simplified meteorological inputs: wind speed and direction, standard deviation of the horizontal wind speed, Pasquill-Gifford stability class, a mixing height, and ambient temperature (EPA, 2008). An ambient background concentration also can be entered (EPA, 2008). The limitation of the model is that since it is a very new model, not much is yet known about its accuracy under varying conditions over time.

There are models that treat both stationary and mobile sources: The Industrial Source Complex (ISC3) is capable of modeling the dispersion of both stationary and mobile source emissions. ISC3 has a screening version called SCREEN3 that uses a worst case scenario approach for modeling emissions (Jungers et al, 2006) to check

if the worst-case air quality scenario is likely to exceed some threshold value, or a target emissions level.

PROKAS-V (Lohmeyer, 2000) is a Gaussian dispersion model for evaluating the atmospheric dispersion of air pollutants emitted from vehicular traffic on a road network of line sources on a local scale.

The Point Area Line (PAL) model is capable of analyzing those three source types and was developed for modeling many different source locations simultaneously (Petersen and Rumsey, 1987; Jungers et al, 2006).

In urban areas, dispersion is affected by atmospheric flow changes, produced by building street geometry and aerodynamic effects. Microscale air pollution simulations are a complex task since the time scales are comparable to the spatial scales. Initial and boundary conditions are also vital. Microscale Computational Fluid Dynamics (CFD) models, are playing an increasing role in air quality studies. CFD modeling is based on the numerical solution of the fluid flow and dispersion equations which are derived from the basic energy, mass, and momentum conservation laws. Popular CFD codes include PHOENICS, FLUENT and STAR-CD (Vardoulakis et al, 2003; Boulter and McCrae, 2007).

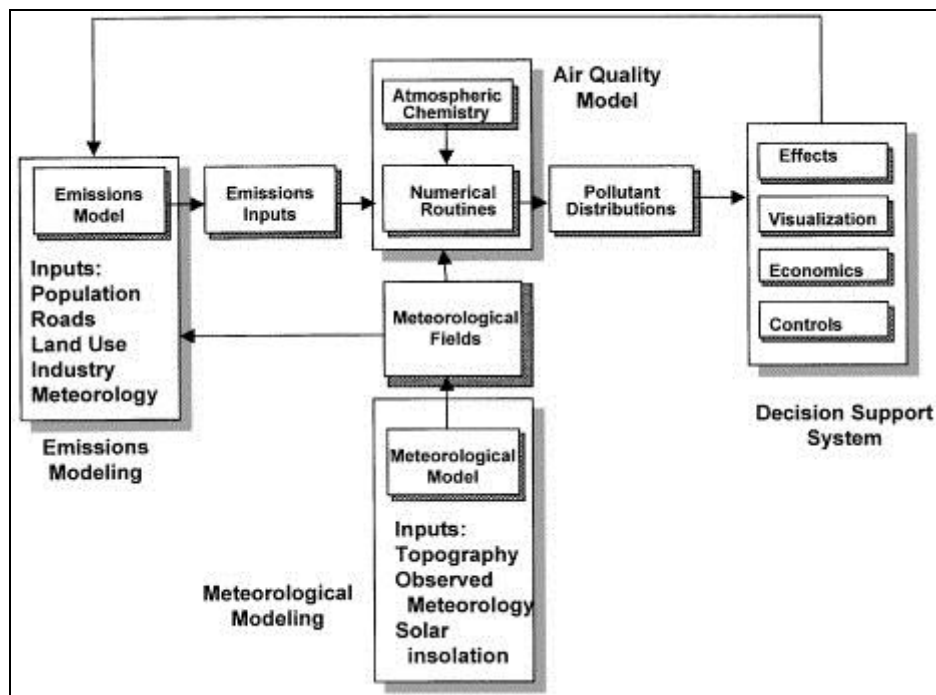


Figure 2.3.1 Inputs and outputs of photochemical air quality models and related modeling tools, and how the models interact. The meteorology impacts emissions (e.g., higher temperatures increase biogenic emissions and evaporation), as well as transport and chemistry of pollutants (Source: Russel and Dennis, 2000).



2.3.6 Air Quality (Photochemical Models)

Some pollutants result from precursor pollutants undergoing chemical reactions in the atmosphere, such as the formation of ozone from hydrocarbons and oxides of nitrogen. These atmospheric reactions typically require time scales of the order of hours to days to occur, and therefore the air mass will be transported away from the original source before the pollutant of concern has formed. The evolution of the concentration of such pollutants is assessed by looking at all of the emissions in an air basin rather than to source-by-source contributions (Jungers et al, 2006). Chemical reactions are also included in the analysis and these complex phenomena are modeled by the photochemical (or air quality) models.

Air quality models (also referred to as atmospheric chemical transport models and, in the case of ozone and PM, photochemical models) simulate the atmospheric concentrations and deposition fluxes to the Earth's surface of air pollutants by solving the mass conservation equations that represent the emissions, transport, dispersion, transformations and removal of those air pollutants and associated chemical species (Seigneur and Dennis, 2011). These models are applied at multiple spatial scales from local, regional, national, and global. In Figure 2.3.1, the inputs and outputs of photochemical air quality models and related modeling tools, and how the models interact is presented.

Some examples of photochemical models are following (Daly and Zanneti, 2007):

- CMAQ: <http://www.epa.gov/asmdnerl/CMAQ/index.html>

The primary goals for the Models-3/Community Multiscale Air Quality (CMAQ) modeling system are to improve 1) the environmental management community's ability to evaluate the impact of air quality management practices for multiple pollutants at multiple scales and 2) the scientist's ability to better probe, understand, and simulate chemical and physical interactions in the atmosphere. The newest Models-3/CMAQ version 4.5 is now available for download from the CMAS Website:

http://www.cmascenter.org/download/release_calendar.cfm?temp_id=99999

- CAMx: <http://www.camx.com/>

The Comprehensive Air quality Model with extensions is a publicly available open-source computer modeling system for the integrated assessment of gaseous and particulate air pollution. Built on today's understanding that air quality issues are complex, interrelated, and reach beyond the urban scale, CAMx is designed to:

- Simulate air quality over many geographic scales
- Treat a wide variety of inert and chemically active pollutants:
 - Ozone
 - Inorganic and organic PM_{2.5}/PM₁₀
 - Mercury and toxics
- Provide source-receptor, sensitivity, and process analyses
- Be computationally efficient and easy to use



The U.S. EPA has approved the use of CAMx for numerous ozone and PM State Implementation Plans throughout the U.S, and has used this model to evaluate regional mitigation strategies.

- UAM: <http://uamv.saintl.com/>

The Urban Airshed Model® (UAM®) modelling system developed and maintained by Systems Applications International (SAI), is the most widely used photochemical air quality model in the world today. Since SAI's pioneering efforts in photochemical air quality modelling in the early 1970s, the model has undergone nearly continuous cycles of application, performance evaluation, update, extension, and improvement. Other photochemical models have been developed during this long period, but no model today is more reliable or technically superior.

- MUSE (Moussiopoulos et al, 1997)

MUSE is a photochemical atmospheric dispersion model developed at the Aristotle University of Thessaloniki (Greece). It is intended for the study of photochemical smog formation in urban areas and assessment of control strategies on a local to regional scale. It can simulate dry deposition and transformation of pollutants can be treated using any suitable chemical reaction mechanism. As a new constituent of the EUMAC Zooming Model (EZM) system, the multilayer model MUSE allows efficiently simulating the formation of photo- chemical smog on smaller computers (e.g. workstations).



Table 2.3.1 Summary of the attributes of some important models simulating air pollution

Model/References	Model type	Chemical /removal mechanism	Grid size/features/comments	Typical applications (location/pollutant/research and/or policy focus)
AERMOD (EPA, 2012)	Steady-state Gaussian plume dispersion model	Transformation of NO ₂ to NO in the presence of ozone. Dry and wet deposition.		The model currently recommended by EPA for local impacts of point sources/ Policy focus
CALPUF (EPA, 2012)	Non-steady-state Gaussian puff dispersion model	Linear chemical transformation of SO ₂ and NO _x /wet and dry deposition		Inert pollutants transportation and dispersion/policy focus
Point Area Line (PAL) model (Petersen and Rumsey, 1987)	Steady-state Gaussian plume dispersion model	Dry deposition		Capable of analyzing those three source types and was developed for modeling many different source locations simultaneously/non reactive pollutants/
CALINE3 (EPA, 2012)	Steady-state Gaussian dispersion model	-	It assumes flowing traffic – It does not include queuing	CO, NO ₂ and particulate mater/Policy focus. The model is currently recommended by EPA for Predicting Air Pollutant Levels Near Highways and Arterial Streets



Deliverable 2: Current Situation Analysis

Model/References	Model type	Chemical /removal mechanism	Grid size/features/comments	Typical applications (location/pollutant/research and/or policy focus)
CAL3QHC and CAL3QHCR (EPA, 2012)	Steady-state Gaussian dispersion model	-	CAL3QHCR is a more refined tool compared to CAL3QHC. Both approximate emissions near roadway intersections	CO, NO ₂ and particulate mater/Policy focus. The model is currently recommended by EPA for Predicting Air Pollutant Levels Near Highways and Arterial Streets
CALINE4 (Benson, 1992)	Steady-state Gaussian dispersion model	Discrete Parcel Method for NOx chemistry	Similar to CAL3QHC	CO, NO ₂ and particulate mater/Policy focus. Predicts Air Pollutant Levels Near Highways and Arterial Streets
HYROAD (Jungers, 2006)	Gaussian puff model	-	Addresses: traffic operations at intersections; vehicle emissions; and atmospheric transport and dispersion	Monitors pollutant dispersion, especially CO, near roadway intersections.
CMAQ EPA Community Multiscale Air Quality (Russell)	Eulerian, multilayer, nested grid photochemical	CB-IV, RADM2, SAPRC, dry and wet deposition	Grid sizes from 4-36 (and 108) km, Plume in-Grid, cloud processes, aerosol dynamics, wet	North America/acid deposition and ozone and PM/research and policy



Deliverable 2: Current Situation Analysis

Model/ References	Model type	Chemical /removal mechanism	Grid size/features/comments	Typical applications (location/pollutant/research and/or policy focus)
and Dennis, 2000).	model		and dry deposition	
CAMx Comprehensive Air Quality Model with extensions.	Eulerian, multilayer, nested grid photochemical model	CB05 , CB6, SAPRC99 gas-phase mechanism, dry and wet deposition	10-50km	USA, Europe/Ozone, PM, toxics/research and policy

2.4 Conclusions

In conclusion, air pollution modeling research was evolved between the 1930s and the 1980s from simpler to more sophisticated approaches, following and explaining the transition from SO₂ smog to the photochemical air pollution in modern cities. At the beginning, air pollution from point sources like large industrial stacks was estimated using the Gaussian Plume Model. Later on, modeling research mostly performed in Europe, tried to explain the acid rain formation and it was focused primarily on long range transport of SO₂ using Lagrangian modeling. Eulerian grid modeling was predominantly applied in the US, over urban areas and focused primarily on O₃. It can be stated that, since approximately 1980, the basic modeling concepts and tools were available to the scientific community and only a fine-tuning was performed thereafter.

The modeling of mobile source atmospheric pollution followed the same pattern and used the same concepts and tools as the general air pollution modeling research. However, the allocation of emissions to grid cells by using the Eulerian grid models runs the risk of underestimating pollution density and pollutant concentrations along and in the vicinity of roadways. Therefore alternative methods in reduced scale were developed including the estimation of street canyon effect or the use of Microscale Computational Fluid Dynamics (CFD) models.

Other specific issues to the modeling of air pollution by transport include the accurate estimation of emissions of the vehicles, which is used as an input to the models. This estimation is usually performed by separate models but there is recently a trend for the integration of emission, dispersion, photochemical reactions and deposition under the same platform. The accurate and detailed emission estimation during the day or the estimation of emission's seasonality is important to identify the daily and seasonal peaks in pollution due to transport. The allocation of transport emissions in space, within major roadways, facilitates the identification of hot spots where the pollution and the exposure of the population is higher than the surroundings.

2.5 Further research needs

There is a need to further understand the atmospheric transport and dispersion of emissions within the first few hundred meters of the roadway, a region often characterized by complex flow (e.g. sound barriers, road cuts, buildings and vegetation). Therefore, new studies of near-road emissions and field and laboratory measurements of concentration distributions are necessary.

According to EPA (2008), in order to advance the application of near-road emission and air quality models, it is necessary (1) to evaluate hot spot air quality models and (2) to develop and to evaluate emissions models. The trend is towards non-steady-state models that will more accurately emulate dispersion in complex situations such as within complex terrain or street canyons.



3 BEST PRACTICES AND TRAVEL BEHAVIOUR RESEARCH

This task is intended to review best practices and policies implemented internationally for the promotion of green transport alternatives, as well as to identify those policies that will fit better the needs and particularities of island areas. In addition, the current situation regarding the transportation system of the study area will be analyzed (including available infrastructure, supplied services, etc.).

3.1 Best Practices Review

Transport plays an essential role in the social and economic life of every European. It also accounts for about 20% of Europe's primary energy consumption. About 98% of the energy used by the transport sector comes from fossil fuels (EU, 2006a), which makes it a major source of greenhouse gas emissions and air pollution.

While efficient and reliable transport is vital to every city's competitiveness and quality of life, increasing demand has generated significant negative impacts on the economy and environment. In addition, transport is the fastest growing sector in EU in terms of energy use: forecasts estimate an increase in demand of 50% for freight transport and 35% for passenger transport by 2020 (EU, 2006b). The EU is determined to do something about this situation.

By 2020, the EU is committed to achieving at least a 20% reduction in greenhouse gas emissions across the entire economy, compared to 1990 levels. Transport has its part to play in meeting these goals. According to the European Commission's Action Plan for Energy Efficiency (2006), the transport sector has the potential to cut its energy use by about 26%. To achieve this, Europe cannot simply rely on developing green technologies and improvements in infrastructure. Shifting to greener modes of transport and soft measures – such as transport demand management schemes, awareness-raising, and education and training – can play a significant role, as underlined in the Commission's Green Paper for Urban Transport (EU, 2007).

Europe's mobility culture and travel habits have to change and embrace more sustainable transport choices. Making people aware of the environmental and social impacts of unsustainable travel choices and educating consumers in order to create a larger market for tried and tested energy-efficient vehicles is the key to success for any sustainable mobility policy.

A key driver of environmentally friendly transportation is visionary urban leadership that advances better ways to manage traffic and street space. Innovative leaders often get their inspiration by seeing what other cities are doing to advance best practices. Global challenges of rapid urbanization, environmental degradation, and demands for economic vitality and livable communities are common themes driving global green growth initiatives. These are also key to reducing greenhouse gases. This section provides an overview of the best practices on experiences gained, policies and directions taken by selected European cities that have sought cost-effective transportation solutions and achieved measurable results, improving the environment and quality of urban life and economies.

Best practices of eight European cities that portray best practice in terms of continuous and integral transport policy, modal split for all journeys, especially bicycle mode share,

and car free initiatives are presented. The cities are:

1. Malmö (Sweden)
2. Copenhagen (Denmark)
3. Odense (Denmark)
4. Croningen (the Netherlands)
5. Delft (the Netherlands)
6. Freiburg (Germany)
7. Vitoria-Gasteiz (Spain)
8. Stockholm (Sweden)

3.1.1 Malmö

Malmö is Sweden's third largest city with a population of 293,909 as of the 1st of January 2010 (Wikipedia, 2012a). Malmö City actively works to facilitate the city's traffic, with a strong focus on public transport and non-motorized transport, especially bicycle. Malmö's public transportation strategy began with the idea that public transportation should be so attractive that it is just as efficient, or better than, travelling by car. Aspect of this strategy could possibly be used in Chios.

The City of Malmö (City of Malmö, 2010a) carries out a large-scale travel habits survey every five years, with the most recent survey having been carried out in 2008. In addition, the traffic is counted yearly at 140 traffic measure points across the city. The city's monitoring of the changes in the travel habits of its people has so far conveyed that cars are being used for shorter journeys less often (City of Malmö, 2009a). In addition, the number of journeys per person for 2008 and 2003 is on average the same. However, the number of car journeys fell from 52% of all journeys in 2003 to 41% in 2008. Conversely, the number of shorter journeys on foot and by bicycle increased, and for longer distances the number of train journeys also increased. This is in line with the increases in rail and bicycle traffic recorded in the entire region. Overall, the percentage of bicycle journeys rose from 20% to 23%, with the number of journeys on foot increasing from 14% to 20%. In 2008 Cycling in Malmö increased by 11%; with approximately 30% of all transport journeys occurring on a bicycle. As much as 40% of all work-related activities are undertaken by bicycle. Malmö's high cycling rates can be attributed to its continuous investment in providing well-connected and integrated cycle routes (City of Malmö, 2009b).

Cycling

Malmö city continuously invests in improving its cycle routes and its already impressive percentage of bicycle mode share. At present a variety of solutions are being tested along this stretch of cycle network, which runs through Malmö from the southern part of the inner city to the northern part. Malmö city's aim is to make cycling faster, safer and more enjoyable.

The innovations introduced along this route include (City of Malmö, 2011):

- Rails at traffic lights, which cyclists can rest against so that they do not need to put their feet down.
- Large mirrors at crossings allowing cyclists to see around corners where visibility would otherwise be poor.
- Different types of lighting along the route to improve visibility in the dark.
- Air pumps at six locations around the city for cyclists who need to top up their air. (Similar pumps can be found in Odense in Denmark). The pumps can also be used



for prams and wheelchairs. Tools have been added to the three air pumps along the cycle route, turning them into mini-service stations where cyclists can carry out basic repairs.

- Cycling barometers at different locations in the city automatically count and display passing cyclists which provide a visual indication of cycling levels in Malmö; showing how many people cycle in Malmö, encouraging and reminding cyclists that they are appreciated.
- Radar sensors have been fitted at 28 intersections to detect approaching cyclists and automatically give them a green light at intersections, which are not already crowded by car traffic. At the junctions the lights turn green quickly in favour of the oncoming cyclists allowing cyclists to flow more smoothly in traffic. A free map is also available which portrays all of Malmö's cycle paths.
- Skånetrafiken's (regional public transportation authority) website includes an online bicycle journey planner which suggests the best route to take when cycling in Malmö. You also get a time comparison for the same journey by bike, bus, and car with cycling often coming out on top.

Public Transport

Within the city, green city buses run frequently along lines and are entirely powered by biogas (Skånetrafiken, 2012). Malmö Stad (City of Malmö, 2010a; SIK, 2004) claims that a focus on modern, environmentally-friendly public transport means that passengers can find out departure times using their mobile phones and public transport is given priority at crossings, ensuring green, clean travel.

Approximately 29 million journeys are made on city buses in Malmö each year (Skånetrafiken, 2012). Several policies and programs have attempted to make city buses an even more attractive choice. Such efforts include increasing the frequency of bus transportation, as well as providing for bus traffic lanes. Additionally, Skånetrafiken has installed digital real-time signs at almost 100 bus stops so that travellers can see when exactly buses will arrive. One can also get real-time information via mobile phones using either mobile internet or a downloadable program. Having a mobile journey planner allows travellers to plan their journey while on the go.

Skånetrafiken has also drawn up a safety policy and installed cameras on all city buses for greater security onboard. Bus travellers take priority in purely practical terms, the city's buses communicate electronically with traffic lights so that they get a green light more quickly than cars. And if the traffic light is about to turn red, buses are given a green light for a few moments longer.

Environmental Friendly Cars

The City of Malmö and many of the city's organizations and businesses are investing in environmental friendly cars (City of Malmö, 2010b). Employees working for Malmö's city council receive the opportunity to join eco-driving training. The city councils own fleet of vehicles already consists almost exclusively of environmental friendly cars and a large number of private companies have followed the councils' lead. The city councils company vehicles are almost exclusively classified as environmental friendly cars, with many those using renewable fuels such as biogas and ethanol. A few are electric, and one even runs on hydrogen gas from wind power. In Malmö, driving an environmental



friendly vehicle is both easier and cheaper. Malmö city has a low-emissions zone for Heavy Goods Vehicles (HGVs). Within this zone only HGVs with modern engines are permitted. Those who drive environmental friendly cars made within the last three years can also apply for a special parking permit from the city council, which entitles them to one hour's free parking.

Malmö Lastbilscentral (Malmö Lorry Centre) has invested heavily in heavy eco-driving – economical driving for HGVs – enabling it to make an approximate saving of 15% on its fuel consumption (ELTIS, 2009). Some vehicles have also been fitted with onboard computers, which can work out the fastest route and how much fuel will be used. In addition the company has seen a significant reduction in damaged goods since introducing these measures. The city council has also helped to set up an ordering system which connects food producers with restaurants and caterers via a website. Farmers can upload details of seasonal produce and restaurants can log on to order locally-grown, organic food which is then delivered on a pooled basis by biogas-powered lorries. Shorter journeys and less empty mileage help save both money and the environment

Changing Travel Attitudes and Perceptions

Since 2001, the Malmö's city council has been working continuously on changing travel attitudes and behaviors. The ultimate goal is for more people choosing to walk, cycle, or use public transport, instead of using their cars (City of Malmö, 2009a). The fact that so many parents regularly drive their children to school has become a major problem. The Friendly Road to School project aims to encourage parents of children attending the first few years of school to walk or cycle to school with them instead of driving them by car (Jönsson, 2010).

Each meter walked by pupils on their way to school is converted into a footstep on a giant map of Europe at each of the participating schools. In this way, the project can be integrated into teaching and the children learn about the cities and countries, which they pass through.

Persuading companies to take more responsibility for business travel and employees' journeys to and from work is part of the work involved in changing travelling habits. Having held seminars and breakfast meetings on the subject, Malmö started to work with companies by offering help and advice in drawing up mobility plans including measures to change travelling habits. In the Businesses on Bikes project 53 companies replace ridiculously short car journeys with bicycle journeys.

Malmö's success has been down to the fact that the municipality, different businesses and people are willing and happy to work together to help make a better future for the city. In the Western Harbour, the municipality led the way and brought together house builders and the local energy company. They also involved people, asking them what they would want the Western Harbour to look like. The result of the public consultation is a place great for the city, great for the businesses that took part and great for the people. Furthermore, it appears that Malmö city's success is also down to its strong and continuous integration with public transport.



3.1.2 Copenhagen

The Greater Copenhagen Region is a metropolitan area of 1.8 million inhabitants (Wikipedia, 2012b). Copenhagen is often seen as leading best practice in the implementation of transport policy. It is known internationally as a model bicycle friendly city. In Copenhagen bicycles and public transportation are prioritized over cars in planning. Effort is put into continually improving the efficiency of public transport. Bicycles and public transport also receive greater funding (City of Copenhagen, 2009a). Copenhagen is eliminating car parking spaces at a rate of 2-3% per year including minimal parking even out of the city center. For example DR Byen (DR Town) is the headquarters of the Danish national broadcasting corporation (DR) and employs approximately 2,700 employees but only provides 500 parking spaces. 47% of Copenhageners do not own a car, 58% use a bicycle everyday, 26% use a car everyday and 25% use a bus every day (City of Copenhagen, 2012).

Cycling

Copenhagen city council carries out a Bicycle Account bi-annually. This account is an assessment of cycling development in Copenhagen, dealing with city cycling conditions, new initiatives as well as the way in which the Copenhageners themselves perceive cycling facilities (City of Copenhagen, 2002; 2000). The most recent account is based on 2010 statistics and includes telephone interviews with 1,025 randomly selected Copenhagen residents (City of Copenhagen, 2011; 2010b). The bicycle account also includes data from Denmark's Department of Transport's Transport Survey of Transport Behavior – research carried out by the department involving the continuous collection of information on the transport behavior.

Copenhagen has the longest pedestrianised street in the World (Stroget), it has been called the most liveable city in the World, and it has a realistic vision to become the World's best cycling city. Cyclists in Copenhagen travel a total of 1.21 million kilometers by bike every day (City of Copenhagen, 2012), the equivalent of cycling to the moon and back twice. Copenhagen however is not a natural bicycling city. In the early 1960's it was a city renowned for cars, traffic jams, and pollution. In 1962 the city created its first pedestrian street, the Stroget, and every year since then Copenhagen has allocated more and more of its public space to bicycles, pedestrians and people who just want to sit and take a load off. 34% of Copenhageners commute by bicycle. 96 % of Copenhagen school children have a bicycle. Around 55 % of all school children cycle to school on a regular basis either alone or with a parent (City of Copenhagen, 2011). When children's route to school is between one and two kilometers they tend to cycle, if the route is shorter they walk, and if it is longer they are either driven or use public transport.

Copenhagen's city government, along with Jan Gehl's public space research institute, is constantly measuring and analyzing street usage (City of Copenhagen, 2010a). After finding that the majority of the city's bike accidents were taking place at busy intersections they began striping them in blue. They are now studying whether these blue paths are doing anything to reduce casualties.

The people of Copenhagen follow and respect the rules of the road. The vast majority of Copenhageners will get off their bicycles and walk when they come to a pedestrianised street. People stop at traffic signals. They stay in their lanes. Cyclists follow the rules of the road because they are a legitimate mode of transportation and



they have their own infrastructure. It is possible to bike across the entire city in 45 minutes (City of Copenhagen, 2009a).

Bicycle planning has the same status as public transport planning. In 2002 one third of its road construction budget went towards cycling improvement. Fees and taxes for vehicular purchase, use, and parking have increased and continue to increase. As a result in Copenhagen there are over one million bicycles, one for every resident (City of Copenhagen, 2012).

The Copenhagen bicycle network consists of over 180 miles and was built over the course of almost a century. Bicycle traffic is considered a distinct traffic category with its own separate road area, on par with motor and pedestrian traffic.

Copenhagen's larger streets feature travel lanes for cars, then sometimes a semi-separated bus lane, a stone kerb, then a slightly elevated cycle lane, then a pedestrian area. At most intersections cycle lanes are clearly marked in blue paint and separated from pedestrian walkways. At intersections bicycles have the right of way.

Copenhagen has set up 125 parking areas and stocked them with 1,300 specially designed bicycles with spoke-less wheels and puncture-proof tyres. A 20-kroner coin releases the key and one is free to ride anywhere with the bicycle.

Public Transport

Public Transport in Copenhagen includes buses (including boat buses), trains and a metro. Copenhagen operates one public transport system, which comprises same fares, tickets and the ability to transfer freely between different modes (City of Copenhagen, 2009b). Transport planning emphasizes public transport making buses more convenient than trains. Certain streets have limited or no access to cars.

Today 37% of Copenhagen's commuters cycle to work or education (City of Copenhagen, 2012). By 2015 the city aims to raise this to 50%. The city is committed to further improving bicycle infrastructure and developing campaigns and to promote urban development in ways that consistently incorporate and give high priority to cycling. Copenhagen's most recent bicycle account portrays that cyclists and non-cyclists prime motivation for more cycling would be more and wider cycle tracks and fewer cars. The city also aims to reduce motor traffic by introducing road pricing.

Copenhagen operates following the idea of thinking mobility rather than traffic control, prioritizing bicycles and public transportation over cars. The city strives for a flexible multi-modal mass transit system. It is clear that efficient, reliable, safe public transportation can entice people to reduce car use. Copenhagen has made undesirable travel behaviors inconvenient and expensive, a good tactic that Aegean Islands could adopt.

3.1.3 Odense

Odense is the third largest city in Denmark and the main city of the island of Funen. As of the 1st of January 2012 the population of Odense was 168,798 (Wikipedia, 2012c). More than 150 different nationalities live in Odense among them are several



international students. All in all 16,320 students attend higher education in Odense. 21,928 children live in Odense and they have more than 250 playgrounds to play in.

Since the 1980s, Odense has created an extensive cycling network comprising in excess of 350km of cycle paths and lanes. In the 1990s attention focused on improvement of traffic safety and comfort and to bicycle use promotion. Consequently, Odense experienced a growth in bicycle trips of approximately 50%, with a simultaneous drop in accidents of approximately 20% in the 1990s (EU, 2004).

Cycling

The Odense's plan concerned not only with building more cycle infrastructure, but also safety, leisure cycling, legal issues, accessibility, service, maintenance and quality (City of Odense, 2010). Odense's cycling promotion plan gives cyclists more rights: for instance, cyclists are allowed to cycle both ways along one-way streets, and they are given more space, for example through the construction of new cycle paths.

Below are presented various sub-projects considered as good examples of action planning for more cyclists in Odense.

Highest Quality for Cyclists: At Odense Central Station, a new underground parking lot for bicycles was opened, featuring video surveillance, music, special locking arrangements, water fountain, lockers, and showcases for bicycle equipment (City of Odense, 2011). This parking lot expresses a standard that even the finest car parking lots can hardly live up to. Quality also extends to the upkeep of all bicycle paths in Odense. This means that tasks like putting down even surfaces, keeping the paths free from dirt, garbage, broken glass and so on, and snow clearing are carried out at the same high level as on the largest roads in the municipality. The municipal road inspectors must inspect all bike paths regularly (on bike, of course).

Cycle Trailers for Children: Trailers for children are well-known in Denmark, although only few have yet tried it themselves. Trailers give good training for the parents and show a good role model for the children to become cyclists too (CIVITAS, 2008). So the trailer is a healthy and a safe offer for new parents. An extra advantage is that you can carry two children plus some luggage without major problems. These were the reason why all parents with children in kindergartens were offered to borrow a trailer for free for one week. This campaign involved in total 7500 parents. 10 trailers were sponsored by the manufacturers and each trailer went to a kindergarten for 2-3 months in turn. One employee was responsible for instructing the parents. All work concerning moving the trailers from one kindergarten to another and repairs were taken care of by a team of young people from a job creation project. Parents were also given the option of buying a trailer afterwards.

Campaigns for School Children: During the period 1955-1971, Denmark had the highest rate of child mortality due to road accidents in Western Europe (Barsi et al., 2010). In Odense the police only experience about 41% of pedestrian and 35% of cyclist accidents. Only one out of six accidents occurs on trips to and from school. Cycling is the most common mode of children's transport and the use of bicycles increases with age. The project in Odense started more than 20 years ago and includes all 45 schools (City of Odense, 2010). The study includes also routes to and from organized activities. Aerial photographs were used for mapping each child's routes. For each school, maps of the area have been drawn, showing where the children actually move around and the places, which they consider dangerous. Based on the study, proposals to improve the traffic environment for children were worked out.



All results and proposals for each school were included in a report. Since 1981, a total of around 200 projects have been implemented. The most common measures have been slow-speed areas, traffic islands and separate foot and bicycle paths. New techniques have been developed, e.g. to get the acceptance of speed humps on roads with city buses.

Speed registration on twelve 30-km/h roads showed a decrease in speeds from 45 to 31 km/h. The effect on the total number of accidents has been a reduction of 82 % (Barsi et al., 2010). Furthermore the accidents are now less serious. A new national pilot project permits automatic speed control in Odense. Control is used on school roads with heavy traffic, where road humps cannot be accepted. Looking at the traffic accidents involving children there has been a drop of 24% from 1994 to 1999, even though that there has been some fluctuation in the meanwhile. Adding data from the hospital to double the number of accidents doesn't affect this conclusion. New statistics show that the percentage of children cycling to school in Odense today varies between 24 and 73 % at different schools .

Green Wave for Cyclists: It is possible to arrive at green light every time in a specific traffic light in Odense. To guide the cyclists, Odense has developed a 'running light' that makes a green wave (City of Odense, 2011). It is the first of its kind. If you don't cycle in the green wave you have to speed up or slow down to avoid the red light. The idea behind the green wave is to give the cyclist some priority in traffic and to make travelling more comfortable.

Many campaigns were led to make people sensitive and interested in the daily use of bicycle, and as a result of this transport policy and bike promotion, the modal split changed during a 10 year period in favour of cycling: +50% cyclists (1990-2000). The four-year promotion program (1999-2002) in Odense was assessed in detail (EU, 2004). During an extensive survey conducted among citizens, about half of them appeared to be informed about the initiatives that had been taken during the four 'National Cycling City' years.

The assessment also proved that development in traffic safety had been positive during the four years the program lasted, but equally positive as in preceding years: 20% fewer cycling victims in four years. To illustrate the development in bicycle use, the assessment compared the period 1999- 2002 with 1994-1997 (EU, 2004). The share taken up by bicycles in all trips by citizens of Odense aged between 16 and 74 rose from 22.5 to 24.6%. There was a simultaneous, notable decline in public transport (8.2 to 6.6%). The increase in bicycle use remained within the fluctuations appearing in the time sequence from 1993 onwards. The bicycle share largely fluctuated around 25%. This was the case in 1993, later (1996) it fell until slightly over 20% and it has since been fluctuating between 23% and 27% - with 2000 as top year.

To summarise:

- The number of cyclists in Odense rose by 20% in three years (1999-2000);
- During the same period, the number of accidents declined by 20%;
- 25% of Odense's citizens choose the bicycle as their mode of transport for getting to work or their place of study and for other errands; and
- 80% of Odense's children walk or ride a bicycle to school.



3.1.4 Groningen

Groningen is a medium sized city located in the northeast of the Netherlands, approximately 200 km from Amsterdam. The city has a population of approximately 190,000 inhabitants (Wikipedia, 2012d). Groningen as well as being an important economic center, is a university city catering for over 30,000 students and the average age of the citizens is 33 years.

In the past 25 years Groningen has had a consistent transport policy aiming at encouraging the use of the bicycle and discouraging the use of the car for short distances (Dutch Bicycling Council, 2008; 2009). Given the historic structure of the city, Groningen has limited possibilities in terms of extending car infrastructure, which consequently encourages the transfer of mode share to bicycle use. In terms of bicycle use the city has held the top ranking amongst Dutch cities for many years with a bicycle use share of approximately 40% (all trips). Policy, coherence, and continuity are the contributing factors to this success. Successions of policies have viewed cycling as an integral part of urban renewal, planning and transport strategy. Through the provision of proper infrastructure and amenities cycling has increased over time and today the main 46 routes of Groningen's cycling network is used daily by approximately 216,000 citizens (Dutch Bicycling Council, 2009). Cycle traffic has received priority over traffic and through the promoting of cycling as the main mode of transportation, city planners, local authorities, and cycling advocates have played an important part in establishing the city's reputation as city which provides sustainable urban living.

Office buildings, services and mixed use developments have all been developed in the vicinity of public transport interchanges and are highly accessible by bicycle. There has been an extensive program of urban renewal with high quality accommodation located within the city (City of Odense, 2010). Strict parking policy has been implemented and the distribution of shopping facilities has been designed so that people can do their daily shopping in neighborhoods with the City Centre the main center for shopping. In addition, supermarkets are not permitted adjacent to motorways or within industrial sites. It is reported that initially these measures were regarded as severe and there was hostility to the plans, particularly by retailers, who thought their premises would become inaccessible with a subsequent drop in turnover. However, 20 years on and visitors to the city have increased. More people have moved back to the city, increases in retail trade and a high quality environment entirely dominated by pedestrians and cyclists and not motor traffic has been created. The spatial policy of Groningen continues to focus strongly on a compact city. Within a 3 km radius from the heart of the city 8% of all inhabitants and 90% of all jobs can be located.

Groningen City offers the following:

- A reclaimed Grote Markt which was once a traffic roundabout and today is the city square-a centerpiece with markets and street cafe's;
- A city divided into four sectors within the ring road which cannot be crossed by motor traffic (i.e. it is impossible to get directly from one sector to the other by car and requires use of the ring road);
- 11 Park and Ride sites provided on the outskirts of the city for visitors to the city center;
- Shuttle services for employees living on the outskirts of the city and in rural areas;
- Cycle lockers located at rural bus interchanges to allow those in suburban areas to bike and ride;



- An extensive cycle network with direct radial routes into the city center from the suburbs to the city center with journey times of 20 minutes;
- Maximum accessibility by bicycle such as permission for cyclists to travel in the opposite direction of one way streets and permission to turn right on a red traffic signal when the road is clear and it is safe to do so;
- Integration of bike and rail at the central rail station through the provision of guarded bike shelters for up to 5,000 bicycles;
- free public transport to all conference delegates, and
- Newly built neighborhoods are no more than 6 km from the city center and along major bicycle and scooter 'roadways'.

3.1.5 Delft

Delft is a town of approximately 96,000 inhabitants (Wikipedia, 2012e). Delft has an historical center and a dense residential area. Since the early 1980s Delft designed and realized a cycle network in the city. A slogan: Delft fietst - Delft cycles was put in place to encourage cycling across all ages. Delft is connected to Rotterdam via a cycle free way.

A new bicycle plan was made in 1999. Priority was given to cycling areas that experience bottle- necks, and a study was done to identify these areas (van Goeverden, 2010). Second, further facilities, and accommodations were made for bicycle parking and storage to make cycling a more comfortable option. Funding was received to accomplish these measures. Local operators including The Delft Entrepreneurs Federation, the first Dutch Cycling Federation (ENFB), the University and the Priority to Children organization, had a large influence on the plan's contents. The following outlines the objectives of the plan to (Pucher and Buehler, 2008):

- encourage the use of the bicycle as an alternative means of transport to the car for distances up to 7.5 km by creating new cycle tracks, linked to the existing network and limiting problems engendered by other forms of traffic;
- increase the modal share of bicycles even further;
- reduce the number of accidents to cyclists by improving infrastructures;
- reduce the number of accidents involving schoolchildren through traffic education;
- increase the parking facilities for bicycles in the neighborhood of the original sites and destinations by providing cycle garages, particularly in residential areas, and by converting car parks into cycle parks; and
- reduce the number of cycle thefts by creating more guarded cycle garages and installing deposit services for bicycles (particularly close to the two railway stations, schools and businesses) and by equipping cycle parks with efficient anti-theft devices.

So far, the Delft bicycle network consists of:

- building of two tunnels;
- construction of three bicycle bridges;
- reconstruction of seven intersections;
- creation of space to wait in front of cars at 14 traffic lights;
- 3.3 km of new connecting bicycle tracks;
- 2.6 km of streets that are bi-directional for cycles, but one-way for cars;

- 8.5 km of bicycle lanes and tracks parallel to roads; and
- repaving of 10 km bicycle path with asphalt.

Through the policy implemented, the average number of daily trips made by bicycle has increased by 12%, rising from 25 000 to 28 000, and the total distance covered by 6 to 8% depending on the type of trip (Dutch Bicycle Council, 2009). The increase in the number of trips is mainly attributed to men, using their bicycle more often to go to work or study. The average distance of a trip has risen from 3.7 to 3.9 km, which seems to reflect an increasing interest in cycling among the inhabitants of the town's peripheral districts. Note that this increase has not occurred to the detriment of the time needed to make the trips, which has remained the same, and therefore tends to demonstrate the effectiveness of the network. An evaluation study has shown that these results are mainly due to a change in use of the network (van Goeverden, 2010). The following factors have contributed towards this improvement:

- the hierarchical structure is an important part of town planning because it gives priority to urban centers and links between the various levels described;
- 60% of the kms covered by bicycle were at town level, which only represents 30% of the total length of the network; and
- the use of cycle tracks has increased, rising from 30 to 35%, while at the same time, the use of roads for cycling has fallen from 45 to 40%.

Improved comfort and safety therefore seem to encourage residents to choose the bicycle as a means of transport. The number of cars travelling into the town center has fallen, which is good for its attraction and creates a pleasant atmosphere. Modal distribution has risen from 40 to 43% for the bicycle. Cars and walking have remained stable at 26% while public transport has fallen from 6% to 4%, although the number of passengers carried has not changed. Delft transport plan is another good example of green transport that Lesvos and Chios Municipalities could take advantage of.

3.1.6 Freiburg

Since the 1970s Freiburg, a city with a population of about 230,000 people (Wikipedia, 2012f), has been developing this reputation as Germany's ecological capital. By 1986 the City had a vision for a sustainable city reliant on an ecologically-oriented energy supply, today its solar, energy efficiency and transport programs are among the best in the world (EU, 2007). Over 10 years CO₂ emissions have been reduced by more than 10% per capita, there has been a 100% increase in public transport use – with up to 35% of residents choosing to live without a car Freiburg is living proof that solar can work in the Northern Hemisphere (Buehler and Pucher, 2011). Freiburg is a sustainable city driving down CO₂ emissions by regulation, incentives, design, long-term commitment, and policy reform.

Commuter car journeys have fallen from 60% in 1970 to 43% in 2009, taking 4,000 cars per day away from the city center (City of Freiburg, 2009a). The main points of this traffic policy in Freiburg have always been: expanding the public transport network, completing the cycling network, realizing 30 km/h zones in staying areas, limiting the number of lanes on some main roads or narrowing them down, and applying a controlling car parking policy (City of Freiburg, 2010).

The focus of inner-city traffic policy was placed on public transport due to the

preservation of the historic city center (also Lesbos and Chios have historic areas in their city centers). A highly innovative urban transport policy lies at the core of Freiburg's transformation. The medieval city center has been progressively pedestrianized, revitalizing its use (City of Freiburg, 2009b). In 1972 the decision for the maintenance of the light rail system was made. As a consequence, the city center was pedestrianized in 1973 and in 1983 the first new tram route was opened. In 1990, a 30 kph zone was introduced for almost all residential streets, except main roads. The public transport system is reliable, frequent, and convenient. In addition with a monthly pass for 45 Euros, which covers the whole region and multiple modes, the system is also affordable. Almost a third of daily commuters use public transport (City of Freiburg, 2009b).

Cycling

A cycling plan was drawn up in 1970, and the city now has over 500 km of bicycle paths, and a third of all journeys are by bicycle. There are more than 5,000 bicycle parking spaces in the city, with more at tram stops for bike and ride commuters. The main railway station has parking and other cyclist facilities for 1,000 bicycles (City of Freiburg, 2010).

Since 1976 Freiburg has been conducting an active cycling policy at an annual investment of €836,000. In the past ten years a considerable effort has been put in towards further expansion of the cycling network. This has resulted in a coherent, fine-mesh cycling network, connecting all quarters with the city center and with each other.

This cycling network now has a total length of 500 km, of which 160 km are cycle paths (114 km along main roads, 46 km autonomous), 130 km through 30 km/h areas (of which 90 km are cycle lanes) and 210 km on country roads. It is now possible to traverse the city by bicycle without any interruption in an east-west direction, using the car-free bicycle route known as Dreisam, a wide road lining the bank.

Another detailed study was performed in 2002 (City of Freiburg, 2009a). It concerned mapping the time each mode of transport took to travel from certain city locations to the Bertoldsbrunnen, a tram-and-bus node in the heart of the city. This map shows that bicycles are the quickest mode of transport for distances up to 3 km. Public transport is quicker than the bicycle only when you start from a few immediate station surroundings in the remotest western quarters. It is not likely that there will be many cities that would even realize the value of such knowledge about competitive positions of different modes of transport.

The active cycling policy of Freiburg most certainly contributed to the fact that bicycle use has almost doubled in size since the early '80s as regards local trips. In 1999 Freiburg inhabitants took their bicycles for 28% of their local trips. This is 22% of all trips. At the same time, car use for local trips dropped heavily: from 38% to 29%. All of them together, the environment-friendly modes of transport (public transport, bicycle, walking) cover 70% of all local trips (City of Freiburg, 2009a).

3.1.7 Vitoria-Gasteiz

Vitoria-Gasteiz announced the European Green Capital of 2012. It is a medium-sized city: the municipality comprises the urban area, with a population of 235,445, plus 64 small, rural hamlets in the surrounding countryside (EU, 2012).



From a town of just 50000 people in 1950, the population of Vitoria-Gasteiz surged during the 1960s, as job opportunities in the strong mechanical and metallurgy industries attracted more and more people from all over Spain. Careful urban planning has, however, limited the environmental impact of this rapid growth (EU, 2012).

The Sustainable Mobility and Public Space Plan of Vitoria-Gasteiz City (EU, 2012) aims to reverse the upward trend in private car use and improve other means of transport such as bus and tram networks, bicycles and space for pedestrians. In 2008, the city introduced a new tramline, followed a year later by revised bus routes, coupled with new parking regulations. As a result, journeys by public transport rocketed by 45%. All the vehicles are accessible to people with disabilities.

With four out of five residents employed within municipal boundaries, walking is the most popular way of getting around. The latest mobility survey revealed that nearly 50% of all journeys are on foot. As much as 25% of the city is reserved for pedestrians, with 33 km of pathways within the city and 91 km across the Green Belt.

As well as its pedestrian network, Vitoria-Gasteiz is actively promoting cycling, planning to invest €22 million in its Bicycle Master Plan. A public bike system was created in 2006 with a network of pick-up and drop-off points across the city. By 2011, there were 17 pick-up points offering 350 bicycles free of charge. The service has also taken into account the needs of people with disabilities by providing, for example, tandems for the sight impaired or tricycles for people with reduced mobility.

The roll-out of electric vehicles is key to the city's strategy, supported by technological innovation, tax incentives and communication campaigns. Since 2008, the city council has participated in the European Civitas MODERN project (2012), which funds sustainable mobility demonstration projects. Vitoria-Gasteiz plans to develop a pilot scheme with four electric vehicles available on a car-sharing basis, and a control group of citizens who will evaluate the vehicles, the recharging points and management of the car-sharing scheme itself (Civitas MODERN, 2012).

3.1.8 Stockholm

The City of Stockholm has 795,163 residents spread across 14 islands (Wikipedia, 2012g) and it was the European Green Capital of 2010. Stockholm has an extensive and well-developed public transport system. Some 90% of Stockholm residents live within 300 meters of public transport with an hourly or more frequent service. Travel by public transport to the city center during morning peak hours is constantly increasing, while the number of car trips is declining. Interestingly, 68% of all trips within the city center are made on foot or by bicycle. During peak hours, 78% of all trips to the inner city are made by public transport (City of Stockholm, 2010).

Since August 2007, Stockholm has levied a congestion tax on all Swedish-registered vehicles driving in and out of the city center on weekdays between 6.30 am and 6.29 pm (City of Stockholm, 2008). Toll stations are 100% automatic. Traffic is monitored on-camera and bills are sent out to car owners electronically, where possible. The charges have cut traffic and emissions by 10-15%

40% of cars sold in Stockholm are clean vehicles. Clean energy fuels much of Stockholm's public transport system. All rail services are operated with certified renewable electricity, and all city buses run on renewables.



In the coming years, Stockholm foresees increasing the number of buses fuelled by biogas from 129 in 2009 to 500. Stockholm Transport also uses some 400 ethanol buses and a handful of ethanol-hybrid buses, comprising the world's largest ethanol fleet. In 2008, one-quarter of buses in the region ran on renewable energy, while by 2025, all public transport will be fossil-fuel free.

Cycling

Over the last decade, the number of bicycle trips by Stockholm residents has jumped 75%, owing in large part to the expansion of cycling paths and lanes, together with Stockholmers' growing interest in health and physical exercise (City of Stockholm, 2010). In addition to these separate lanes, more and more cyclists travel on local streets, made safer by 30 km per hour speed limits. Those without their own bikes can always rent one cheaply from several stations throughout the city. There are also nine official bicycle-pump points where cyclists can inflate their tyres. The City of Stockholm is connected by over 760km of bike lanes. There is also an internet-based travel planner for bikers, covering both the inner city and neighboring municipalities: <http://cykla.stockholm.se/>

Environmental Friendly Vehicles

Since 1994, Stockholm has actively campaigned for clean vehicles to be introduced on the market as well as providing adequate infrastructure for fuelling them. In 2000-2005 companies are offered the opportunity to test drive clean vehicles for one week at no cost, enabling drivers to become more accustomed to clean vehicles and helping companies determine whether or not clean vehicles meet their demands for functionality, performance, security and price (EU, 2012; 2009; ZEUS, 2000). Test-driving was offered to a target group of fleet managers and CEOs in a selected group of companies.

The effort is paying off: clean vehicles make up an impressive 40% of sales (City of Stockholm, 2010). Of the total fleet in early 2009, 14% were ethanol or biogas-fuelled, hybrid-electric or ultra-low emission vehicles, and the trend is positive. All inner-city buses operate on biogas or ethanol; 50% of refuse trucks and 40% of taxis either consume biofuels or are hybrids.

3.2 State of the Art in Travel Behaviour Research

Activity engagement constitutes the backbone of human behavior (Devilleine et al., 2012). Activity-based approaches explicitly recognize the fact that individuals travel in order to fulfill their need to engage in activities. An activity-based model should predict activity participation and time allocation, with explicit consideration given to spatial, temporal and social constraints, while accounting for inter-dependency among individuals in a household and among trips (Goulias and Kim, 2001).

The development of activity-based models as a tool to analyze travel behavior and forecast transport demand has been motivated by the growing complexity in activity patterns resulting from socio-economic changes, growing congestion, and negative externalities, as well as the need to estimate changes in travel behavior in response to innovative policies designed to achieve sustainability (Shiftan and Ben-Akiva, 2011).



Several successful implementations of the activity-based models have already demonstrated that the activity-based concept is workable. Operational modeling systems at the regional level can be constructed that are both practical (reasonable running time, reasonable size and scope of the travel/activity surveys required to support the model estimation), and that also incorporate the best components from the frontier-line research on activity and travel behavior (Davidson et al., 2007). Overall, when describing the new generation of regional travel demand models, three basic features should be highlighted:

1. An activity-based platform that implies that modeled travel is derived within a general framework of the daily activities undertaken by households and persons.
2. A tour-based structure of travel where the tour is used as the unit of modeling travel instead of the elemental trip; this structure preserves a consistency across trips included into the same tour, by such travel dimensions as destination, mode, and time of day.
3. Micro-simulation modeling techniques that are applied at the fully-disaggregate level of persons and households, which convert activity and travel related choices from fractional-probability model outcomes into a series of crisp decisions among the discrete choices.

While complimentary, these features are essentially independent, and having one of them in place in the modeling system does not automatically require the others. Recognition of the activity-based nature of travel and attempts to derive travel from the comprehensive analysis of the individual daily activity agenda started long ago without any explicit linkage to a tour-based technique or to micro-simulation (see (Bhat and Koppelman, 2000).

Similarly, the tour-based concept of modeling travel is rooted in trip-chaining models that were first developed independently of the activity-based paradigm, until it was recognized after the works of Bowman and Ben-Akiva, (1999; 2001) that the tour may serve as an effective unit to construct daily activity patterns.

Micro-simulation techniques first opened the way to effectively apply activity-based and tour-based constructs in a practical regional modeling setting (Bradley et al., 1999; Vovsha et al., 2002; Bradley et al., 2001; Jonnalagadda et al., 2001). Several activity based models, incorporating all three of these salient features of the new activity-based models, are summarized and presented below.

Goulias et al. (2012) developed a large scale spatio-temporal simulator of activities Greenhouse Emissions, Networks, and Travel (SimAGENT) for Southern California. The simulator includes population synthesis that recreates the entire resident population of this region, provides locations for residences, workplaces, and schools for each person, estimates car ownership and type as well as main driver for each vehicle, and provides other key personal and household characteristics. Then, a synthetic schedule generator recreates for each resident person in the simulated region a schedule of activities and travel that reflects intra- household activity coordination for a day. These synthetic activity and travel daily schedules are then converted to multiple Origin Destination (OD) matrices at different times in a day. These are in turn combined with other OD matrices (representing truck travel, travel from and to ports and airports, and travel generated outside the region) and assigned to the network in multiple periods in a day. The assignment output is then used in another software to produce estimates of fuel consumed and pollutants emitted (including CO₂) by different classes



of vehicles. The overall model system also includes provision for finer spatial and temporal resolutions.

Auld (2012) developed the Agent-based Dynamic Activity Planning and Travel Scheduling (ADAPTS) model, which implemented for the Chicago region for validation. ADAPTS is a new activity-based travel demand model which has been developed (Auld, 2011) to demonstrate the direct integration of travel demand modeling with traffic assignment. The fundamental concept underlying the development of the ADAPTS is to treat activity planning and scheduling events as individual discrete events within the overall simulation framework. Consequently, an activity is created and modified over time and eventually executed (i.e. assigned to the network) in one unified simulation. The model is dynamic in the sense that activities are generated and passed to the network assignment as they are scheduled, rather than pre-defining daily activity schedules for agents to assign at one time. This allows for dynamic interaction effects within the demand model and network simulator, including such things as opportunistic scheduling, en-route replanning, etc.

Pendyala et al. (2010; 2012) designed an integrated model system, SimTRAVEL, which involves the microsimulation of location choices within the land use domain, of activity-travel choices within the travel demand domain, and of individual vehicles on networks within the network supply modeling domain with a view to more tightly tie together component model systems in a behaviorally consistent fashion. The proposed alternate design adopts an event-based paradigm in which every activity-travel episode is an event that is simulated along a continuous time axis. The land use microsimulation model is run first to simulate the locations of households and businesses. In the activity-based model system, time-space prism constraints are identified based on the scheduling of mandatory activities of the individual as well as of those household members who may be dependent on the individual for transportation. In any unconstrained time period, activities (and travel to the activities) may be undertaken. The choice of mode and destination for any activity is determined using a joint mode/destination choice model. The mode choice set includes only those modes that are available to the individual at the time that an activity is going to be undertaken, and the destination choice set includes only those destinations that can be reached by the fastest mode possible without violating time-space prism constraints. Therefore the joint mode/destination choice model requires an initial set of network level of service attributes to simulate these choices. The set of initial network level of service attributes may be obtained from a validated four-step model or by applying a bootstrapping procedure. A prototype has been developed and tested on a three city subarea in the southeast region of the Phoenix metropolitan area.

Bowman et al. (2006) developed a regional travel forecasting model system called SacSim (developed in 2005 and being implemented in 2006) for the Sacramento (California) Area Council of Governments. The system includes an integrated econometric microsimulation of personal activities and travel (DaySim) with a highly disaggregate treatment of the purpose, time of day and location dimensions of the modeled outcomes. Initially, the Population Synthesizer creates a synthetic population, comprised of households drawn from the region's U.S. Census Public Use Microdata Sample (PUMS) and allocated to parcels. Long-term choices (work location, school location and auto ownership) are simulated for all members of the population. The Person Day Activity and Travel Simulator then creates a one-day activity and travel schedule for each person in the population, including a list of their tours and the trips on each tour. These components, comprising DaySim and implemented jointly in a



single software program, consist of a hierarchy of multinomial logit and nested logit models. The models within DaySim are connected by adherence to an assumed conditional hierarchy, and by the use of accessibility logsums. The trips predicted by DaySim are aggregated into trip matrices and combined with predicted trips for special generators, external trips and commercial traffic into time- and mode-specific trip matrices. The network traffic assignment models load the trips onto the network. Traffic assignment is iteratively equilibrated with DaySim and the other demand models. SACSIM was calibrated and tested for a base year of 2000 and for forecasts to the years 2005 and 2035 (Bradley et al., 2010). It was used to provide forecasts for the Regional Transportation Plan (RTP) and continues to be used for various policy analyses.

With regards non-motorized trips, Sacramento's SacSim activity-based model uses parcel/point level land use data (Bradley et al., 2010), potentially providing the finer resolution needed for more accurate non-motorized modeling (Liu et al., 2012). Parcel/point data also allows more accurate representation of transit proximity as distance from each parcel/point to the nearest transit station or stop, and more accurate measurement of intra-zonal walk time and drive time. These continuous, micro-level representations of land use and walk accessibility, and intra-zonal accessibility permit improved modeling of non-motorized travel. Walk and bike are modeled in the tour and trip mode choice models, which include two land use variables – mixed use density and intersection density. The former is defined as the geometric average of retail and service employment and households within a half mile of the origin or destination parcel, while the latter is measured as the number of 4-way intersections plus one half the number of 3-way intersections minus the number of 1-way intersections (dead ends and culs de sac) within a half mile of the origin or destination parcel. Other models in SACSIM, such as the destination choice models, also include land use and urban form variables defined within a given distance of a parcel/point, such as density variables and street pattern variables.

The San Francisco County Chained Activity Modeling Process (SF-CHAMP) was developed for the San Francisco County Transportation Authority (SFCTA) to provide detailed forecasts of travel demand for various planning applications (Outwater and Charlton, 2006). These applications includes developing countywide plans, providing input to microsimulation modeling for corridor and project-level evaluations, transit planning, and neighborhood planning. The objective is to accurately represent the complexity of the destination, temporal and modal options and provide detailed information on travelers making discrete choices. These objectives led to the development of a tour-based model that uses synthesized population as the basis for decision-making rather than zonal-level aggregate data sources. The tour-based model has nine primary components (Outwater and Charlton, 2008). Most of the model components were estimated using household survey data for San Francisco residents only, collected by the Metropolitan Transportation Commission (MTC). Each model component was calibrated using various observed data sources, and then the full model was validated using traffic count and transit ridership data for each time period. However, over the years, improvements to SF- CHAMP have been primarily shaped by the questions confronting decision makers. Model improvements have addressed issues such as road pricing, parking availability and pricing, transit treatments, non-motorized infrastructure, land use decisions and the quality of the built environment (Erhardt et al., 2008; Zorn et al., 2011; Hood et al., 2011; Zorn et al., 2012). For instance, SF-CHAMP is unable to capture any benefit related to capacity expansion,



crowding's effect on travel time nor on any of the real-life true capacity limitations.

Pendyala et al. (2005) developed a multimodal comprehensive activity-based travel demand forecasting system for the State of Florida, FAMOS, which consists of two main modules that together comprise a microsimulation model system for modeling activity-travel patterns of individuals: 1. Household Attributes Generation System and 2. Prism-Constrained Activity Travel Simulator (PCATS). FAMOS simulates activity-travel patterns at the level of the individual decision-maker. Thus, not only is it an activity-based model system, but it is also a microsimulation model system. This is because activity-travel patterns are simulated at the micro level, i.e., at the most disaggregate level possible. By simulating activity-travel patterns at the level of the individual decision-maker, the model provides a strong platform for modeling travel demand in a region along a continuous time axis. The output of FAMOS is essentially a series of activity-travel records for all people in the simulation. These activity-travel records can be aggregated both spatially and temporally to obtain zone-level origin-destination (O-D) matrices by trip purpose, mode, and time of day. These O-D matrices then are fed into any static or dynamic traffic assignment routines for obtaining link volumes by time of day. The model system has been developed and estimated using household activity and travel data collected in the Southeast Florida region of Florida in 1999.

The New York activity-based model (Vovsha and Chiao, 2008) is the first comprehensive multimodal model developed for the New York Metropolitan Region, which encompasses an entire 28-county, three-state region that includes portions of Connecticut and New Jersey, with a total population of 20 million residents. The NYMTC model's success has proven that the concept of a microsimulation activity- and tour-based model can be applied for a large metropolitan area with a unique level of complexity for the transportation system. The NYMTC model has four major consecutive modules: (1) Tour generation, which includes household synthesis, automobile ownership, and journey frequency choice models; (2) Tour mode and destination choice, which includes pre-mode choice, primary destination choice, entire-tour mode combination choice, stop-frequency choice, and stop-location choice; (3) Time-of-day choice and pre-assignment processor, which includes tour time-of-day choice for outbound and inbound directions, trip mode choice, and construction of mode-specific and time-of-day period-specific trip tables; and (4) Traffic and transit simulation, which is implemented by time-of-day periods.

Roorda et al. (2009) based on the Travel Activity Scheduler for Household Agents (TASHA) (Miller and Roorda, 2003; Roorda, 2005) microsimulation framework propose an integrated model of vehicle transactions, activity scheduling and mode choice with the help of the concept of stress, which is expected to "occur when one's current state deviates from some alternative desired/expected/optimal state (Miller, 2005). The importance of introducing the stress can be justified by the existence of irreversibility and uncertainty, especially in long-term decision, where transaction costs might be significant. The stress could come from both a household member him/herself under study and other member(s). The authors operationalize the concept of the stress, as a measure of potential improvement in behavioral change, based on the utility loss due to the unavailability of household vehicles and the occurrence of conflicts over the use of household vehicles. In the integrated model, the stress is used as feed-back into the model of vehicle transactions and type choice. Furthermore, the integrated model explicitly represents intra-household interaction in joint activity participation, vehicle allocation, and ridesharing, chauffeuring and conflict resolution. For the model estimation were used two sources of data. The automobile transactions model is based



on the Toronto Area Car Ownership Survey (TACOS), a retrospective survey of 935 households (Roorda et al., 2000). The TASHA model of activity scheduling and mode choice is based on data from the 1-day trip diary Transportation Tomorrow Survey conducted in 1996 (DMG, 1997). The most conflicts occur over the vehicle in one-vehicle households. By buying a vehicle, a one-vehicle household reduces the number of conflicts it experiences by 0.19, on average, which is virtually all of the conflicts it experiences. Similarly, a two-vehicle household can eliminate almost all of the conflicts it experiences by purchasing a third vehicle. When a two-vehicle household disposes of one of its vehicles, almost 2.5 times the number of conflicts is generated as the one-vehicle households would eliminate if it purchased a vehicle.

Bhat et al. (2004) designed the Comprehensive Econometric Microsimulator for Daily Activity-Travel Patterns (CEMDAP) to model the daily activity-travel patterns of individuals, which uses census tract-block group-block level summary tables as control totals for synthesizing households and individuals from the 2000 Public Use Microdata Samples (PUMS) data. Some of the summary tables contain the distribution of a single variable, while other tables describe the joint distribution of multiple variables. These tables are used to construct a full multiway distribution by using a recursive merge procedure and the iterative proportional-fitting procedure. For the Dallas-Fort Worth (DFW) application, four household-level variables and three individual-level variables, are used as controls. The household-level variables are household type (six categories), household size (seven categories), presence of children (two categories), and age of householder (two categories). The individual-level variables are gender (two categories), race (seven categories), and age (10 categories). All other variables in the PUMS data that are required for the activity travel pattern simulator, but not controlled during the population synthesis, are not directly used. Instead, their values are simulated on the basis of a suite of models estimated by using PUMS and other sources of data (Guo et al., 2005).

In 2006, Pinjary et al. presented CEMDAP II, a new modeling system that enhances CEMDAP in several ways. First, the new system is developed at a finer spatial resolution and applied to a 4,874-zone system for the DFW area in Texas. Second, the activity-travel patterns of children (persons under 16 years of age) are now explicitly modeled and forecasted. Third, the interdependencies between the travel patterns of children and their parents (such as escort to and from school and joint participation in discretionary activities) are explicitly accommodated. Finally, for estimation of the models, the raw survey data obtained for the DFW area were reprocessed to create a larger sample and all the model components (over fifty in all) were re-estimated. The overall modeling system is broadly subdivided into the following five categories: (1) the generation-allocation model system, (2) the worker scheduling model system, (3) the non-worker scheduling model system, (4) the joint discretionary tour scheduling model system and (5) the children scheduling model system. The data used in the estimation of all the model components were obtained from three main sources: (1) the 1996 DFW household activity survey, (2) the DFW zonal land-use database, and (3) the DFW interzonal transportation level of service data. The final estimation data set comprised about 23,000 activity-travel records for 6,166 persons from 2,750 households.

PB Consult Inc. (2005) designed the Mid-Ohio Regional Planning Commission (MORPC) model, which is a disaggregate tour-based model applied with the micro-simulation of each individual household, person or tour. The MORPC model consists of the following eight core components: 1. Household car ownership choice, 2. Coordinated choice of individual daily activity pattern type and number of tours for

mandatory purposes (work, school, university), 3. Household generation of fully joint tours for non-mandatory purposes (shopping, other maintenance, eating out, other discretionary) and person participation in them, 4. Household generation of individual tours for maintenance purposes (escorting, shopping, other maintenance) and allocation to persons; individual generation of tours for discretionary purposes (eating out, other discretionary) and at-work sub-tours, 5. Primary tour destination choice, 6. Tour time-of-day choice, 7. Entire-tour mode combination choice, 8. Stop frequency, stop location, and trip mode choice. All eight model sets were validated against the surveyed population (5,555 households) with very good results. Then the model was applied for the base year synthetic population (610,000 households) and validated against the traffic counts, transit counts and on-board survey. The model area is divided into 1805 internal and 72 external zones. The primary inputs to the model are transportation networks and zonal data, where each zone has the standard socioeconomic characteristics.

Shiftan et al. (2003) developed an advanced activity-based model system for the City of Tel-Aviv in Israel. The model system is developed as a system of logit and nested logit models assuming a hierarchy of the model components. At the highest level of the model system there is an auto availability model predicting the probability of having various number of autos available to the household. In addition, an aggregated auto ownership model was prepared to produce control values at the aggregated level in order to validate the Auto Availability Model. Following this model, the primary activity model determines a person's primary activity. The alternatives include work, education, shopping, other types of activity out of home, and staying at home. For activities outside the home, the model determines the destination of the primary activity and the main mode of the tour. In developing the model, emphasis was put on evaluating the response to different transportation policies such as parking restrictions and pricing in addition to improved and new infrastructures and transit services. Some of the innovative aspects in this model system was based on a combination of data sources including a tour-based stated-preference survey, a three-day trip diary database enriched in communities adjacent to a rail corridor, and a detailed parking survey that includes information on parking demand and supply.

Srinivasan and Bhat (2008) in their descriptive study of activity patterns explored joint participation with both household and non-household members, and examined the generation, location, and scheduling of joint activity episodes. Such an exploratory analysis is a necessary first step in informing the development of activity-based travel demand models that adequately capture joint participation in activity and travel episodes. By using data from the American Time Use Survey (2003-2004) in which participated 34,693 persons, they found that about 30% of individuals undertake one or more out-of-home (OH) activity episodes with household members on weekdays, and about 50% pursue OH activity episodes with non-household companions on weekdays. The results of this analysis highlighted the high levels of joint activity-travel participation by individuals. Further, independent activities are found to be different from joint activities in systematic ways. Specifically, joint episodes are of longer durations, significantly likely to take place at the residence of other people, and often confined to certain time periods of the weekday. In addition, within the class of joint episodes, important differences are also observed based on activity type, companion type, and the day of the week. Finally, they also found strong influence of socioeconomic characteristics (such as gender, employment characteristics, household structure, presence of children, and income) on how individuals spend time with

different types of companions.

Kato and Matsumoto (2008) propose a Tobit-type joint time allocation model in the context of a nuclear family with a child (a representative child). The model adopts a special case of the multi-linear and iso-elastic household utility, i.e., the additive type of household utility (Zhang et al., 2002; Zhang and Fujiwara, 2006). It refines the aforementioned studies in three ways (Timmermans and Zhang, 2009). First, a child is explicitly introduced into the model. Even though the multi-linear and iso-elastic models can be theoretically used to represent the influence of children. Second, the newly developed model incorporates not only the constraint of available time, but also that of monetary budget. Third, the new model explicitly represents the occurrence of activity (i.e., whether an activity is performed or not) by using a non-linear Tobit-type modeling approach. For the model estimation Kato and Matsumoto used data from a paper-based household survey that they conducted in Tokyo and Toyoma in 2003 with a total sample of 1432 participants. The empirical analysis of the model reveals the common characteristics between the two cities – with respect to the child’s gender; the husband’s weekly non-working days, allowance, and job; and the wife’s age and job – that significantly influence the household’s welfare. The analysis also reveals different characteristics between the two cities. First, the greater the number of children in a household, the higher is the significance of the husband and wife’s joint out-of-home leisure activity on a weekday for household welfare in Tokyo (mega city), and the lower is the same in Toyama (local city). Second, the greater the non-working days of the husbands, the lower is the significance of their individual out-of-home leisure activities on a weekday for household welfare in Tokyo and the higher is the same in Toyama.

Wang and Li (2008) present a model of household time allocation with the consideration of hiring domestic helpers. The modeling methodology adopted is similar to the one proposed by Kato and Matsumoto (2008), but it is unique in the sense that it deals with the influence of domestic helpers on household time allocation behavior. The model assumes that the utility of hiring a domestic helper is inherently related to the time allocation behavior of household members. Such modeling approach reflects the fact that domestic helpers impose a continuing influence on the household across a given period of time. In order to estimate their model they used trip diary data from the Hong Kong Travel Characteristics Survey conducted in 2002. The final sample used for this study involves 10,381 households, of which about 11.7% or 1210 households have live-in maids or full-time domestic helpers. Even though hiring domestic helpers is a common practice in some limited Asian countries and regions such as Singapore, Hong Kong and the mainland of China, it could also have its specific policy implications with the increase of women (especially the married women) participating in the labor market in the context of other countries and regions. The paper provides a logical and operational method to represent the influence of some specific persons on household time allocation behavior. These persons could include not only the domestic helpers, but also the extended family members such as parents of household heads (Timmermans and Zhang, 2009).

Zhang et al. (2008) develop a new type of household discrete choice model by integrating different types of household choice models based on latent class modeling approach under the principle of random utility maximization, where household utility function at each model is defined to theoretically reflect its members’ preferences and intra-household interaction. A latent class corresponds to a particular group decision-making mechanism. The proposed model can deal with not only the choice situations where multiple household members involved in joint decision are known a priori, but

also the situations where the involved members are unknown. As a case study, three types of household utility functions are dealt with: multi-linear, maximum and minimum types, in the context of couples' car ownership behaviors. Using the data collected from household members over 15 years old in two Japanese cities (Hiroshima City and one of its satellite cities, Higashi-Hiroshima City) in 2004, they found that changes of utility combinations result in very complicated variations in both signs and values of the model parameters and choice probabilities by multi-linear utility show small variations across different combinations.

Arentze and Timmermans (2008) describe the household behavior based on the concept of need in the context of multi-day, multi-person activity participation. The need of household or its member is the source of motivations to perform various activities and the change of need consequently generates the utility. The authors introduce the concept of potential to illustrate how and how much an activity could satisfy certain need of a household and/or its member(s). Intra-household interaction is represented in several ways. First, it is proposed to use a weight that a household assigns to the household needs relative to the weight that a household member assigns to his/her personal needs. Accordingly, altruism-selfishness is implicitly incorporated. Then, an exchange procedure is further proposed to reflect the fact that the household members "use joint decision rules first to make their agendas consistent and next to see whether personal re-allocations could improve the group result. The joint decision rules are introduced to properly evaluate the influence of disagreement between household members on the selection of household activities and the allocation to members. Since the need may vary over time, a dynamic micro-simulation approach is proposed.

Spissu et al. (2008) presented an analysis and modeling of weekly activity-travel behavior using a multi-week activity-travel behavior data set with 5,561 discretionary activities on 5,936 days, collected in and around Zurich, Switzerland. Her survey focuses on six categories of discretionary activity participation (namely: 1. OH social, 2. OH meals, 3. OH sports, 4. OH cultural, 5. OH leisure, 6. OH personal business, and 7. Other) to understand the determinants of, and the inter-personal and intra-personal variability in weekly activity engagement at a detailed level. A panel version of the Mixed Multiple Discrete Continuous Extreme Value model (MMDCEV) that explicitly accounts for the panel (or repeated-observations) nature of the multi-week activity-travel behavior data set was developed and estimated on the data set. The panel MMDCEV model allowed the researchers to quantify and assess the relative magnitudes of within-individual week-to-week variation and between individual variation in the preference for discretionary activities. The analysis revealed that week-to-week intra-individual variation is greater than inter-individual variation in discretionary activity participation for virtually all activity categories, suggesting the importance of collecting and analyzing multi-period activity-travel data in the context of discretionary activity participation. The greatest inter-individual variance occurred in sports activity participation.

A unified model of activity type choice (generation), time of day choice, mode choice, destination choice, and time use allocation (duration) was proposed by Eluru et al. (2010) and estimated on a survey sample data set drawn from the 2000 San Francisco Bay Area Travel Survey (BATS). The model system constitutes a joint multiple discrete continuous extreme value (MDCEV) - multinomial logit (MNL) model, in which all discrete choices, except for destination choice, and the continuous duration dimension are modeled using the MDCEV, and destination choice is modeled as a MNL (with sampling of alternatives) nested and therefore integrated with the MDCEV model

component. The parameter estimates of the joint model offer behaviorally intuitive results that support the integrated treatment of these choice dimensions as a choice bundle.

Ferdous et al. (2010) proposed a multivariate ordered-response system framework to model the interactions in non-work activity episode decisions across household and non-household members at the level of activity generation. Such interactions in activity decisions across household and non-household members are important to consider for accurate activity- travel pattern modeling and policy evaluation. They address this estimation problem by resorting to the technique of composite marginal likelihood (CML) that is based on the classical frequentist approach. The empirical analysis uses data drawn from the 2007 American Time Use Survey (ATUS). The results underscore the substantial linkages in the activity episode generation of adults based on activity purpose and accompaniment type. More specific, the results indicate the presence of distinct gender effects in activity type participation and accompaniment. Men are less likely than women to participate, across all companion types, in family care activities, maintenance activities and non-maintenance shopping activities. The extent of this linkage varies by individual demographics, household demographics, day of the week, and season of the year. The results also highlight the flexibility of the CML approach to specify and estimate behaviorally rich structures to analyze inter-individual interactions in activity episode generation.

Pattabhiraman et al. (2012) presented an analytical model to describe the choice of activity location, duration, and requery. A theoretical model based on the theory of needs and utility maximization is developed. The model assumes that there is a psychological inventory associated with a need that gets consumed with time to satisfy the need. Each time an activity is performed, this inventory is replenished by a quantity called the activity output, which is a function of activity location attractiveness and duration. Using a saw-toothed inventory model, the choice of activity location, duration, and frequency is formulated as an optimization problem that seeks to maximize the average level of psychological inventory subject to time and budget constraints, under steady-state conditions. The problem is solved in two stages, for discrete and continuous decision variables. In the first stage, given a location, the optimal duration for that location is found. In the second stage, the optimal location is found by selecting the location which maximizes the average level of inventory. Then the optimal frequency for that location is determined. The properties of the general solution are studied, and then explored for a translog functional form of the activity output. Finally, an empirical model is developed for the location, duration, and frequency choices based on the theoretical model, and an estimation procedure is proposed that can be applied to single day travel diary data.

Bhat et al. (2012) developed and estimated a Multiple Discrete Continuous Extreme Value (MDCEV) model of household activity generation that jointly predicts the activity participation decisions of all individuals in a household by activity purpose and the precise combination of individuals participating. In their empirical analysis, the baseline preference utility of the independent (single person participating) activity alternatives for any household is specified as a function of household, individual characteristics, and residential neighborhood accessibility, while the utility of joint activity alternatives is specified as a function of household, combination of individual characteristics constituting the alternative and residential variables. The model was estimated on a sample of 8900 households obtained from the Post Census Regional Household Travel Survey conducted by the South California Association of Governments (SCAG) in the

year 2000. The results indicate that households with many children (aged less than or equal to 15 years) are most likely to participate in child care, school care, and after school care activities. Also, work duration also has an influence on the preferences for activity alternatives.

In another survey, Choo et al. (2012) focused on weekend trips and compared travel characteristics on weekends with weekday. Their study explored characteristics of travel behavior on weekends through descriptive analyses such as t-tests and ANOVA tests with respect to socio-demographic variables. In addition, they developed three Tobit models for trip frequencies (number of daily trips) of weekday and weekends to identify key factors that significantly affect travel behavior. Data for this study came from a 24-hour household travel diary survey conducted in the Seoul Metropolitan region through face-to-face interviews in 2006. The sample size of the survey is 230,900 households, while the survey for weekend travel was conducted on 11,545 households in the same week. It was found that travel characteristics are significantly different between weekday and weekends. Youngers have more trips on weekdays and Saturday but less trips on Sunday. Also, they found that weekend travel is affected by various household (household size, number of cars in a household, household income, residence area, type of house, and presence of preschoolers) and personal (gender, age, occupation, employment status, workweek type, and presence of a driver's license) attributes. Finally, they found that weekend travel behavior is more strongly affected by geographical and cultural characteristics of the country or the city than socio-economics and demographics and they suggested that travel demand models for weekends need to be different from weekday as well as by region or country.

Liu and Deng (2008) presented an on-going effort undertaken by New Jersey Department of Transportation (NJDOT) to develop statewide weekend travel demand forecast and mode choice models for New Jersey by balancing state of the art research and practical modeling applications for multiple agencies. They examined the unique characteristics of weekend travel with several travel survey data sources (e.g. RT-HIS, NPTA and NHTS); reviewed existing travel demand forecast models by various organizations in New Jersey (e.g. NJTPA, SJTPO, DVRPC, NYMTC, NJ Transit and NJ DOT); and developed a statewide weekend travel demand forecast model that can be incorporated into the existing long range transportation planning process at both metropolitan and state levels.

Bhat and Misra (1999) studied a utility-maximizing resource allocation problem for the allocation of total weekly discretionary time of individuals between in-home and out-of-home locations and between weekdays and weekends. A model was formulated and applied to an empirical analysis using 1985 time-use survey results conducted in the Netherlands. The analysis considered household socio-demographics, individual socio-demographics, and work-related characteristics as the explanatory variables. The age of the individual was regarded as the most important factor determining discretionary time split with older people having a strong in-home orientation. Other factors such as the number of young children, adults and autos in the household, gender, work duration on weekends and travel time to work also affected discretionary time split.

Sall and Bhat (2007) developed a model to examine the spatial and temporal characteristics of weekend work episodes. Empirical analyses were conducted using 2000 San Francisco Bay Area Travel Survey data. The results indicate the important effects of day of week, individual demographics, work-related variables, household

characteristics, and location variables on weekend work participation characteristics. Females were less likely to work over the weekend compared to males, avoiding starting work early in the morning or late in the evening. Self-employed individuals were more likely to work at home and individuals working with a flexible work schedule showed less preference to work on weekends. Individuals who worked at home were likely to work shorter durations, and start their work activity later in the day. The seasonal and location effects were not statistically significant.

Bhat and Srinivasan (2005) analyzed the frequency of participation of individuals in out-of-home non-work and non-school episodes over the weekends. A multivariate mixed ordered response model accommodating the effects of explanatory variables and capturing the dependence among the propensity to participate in different activity types was developed and applied to the 2000 San Francisco Bay Area Travel Survey data. Single parents and adults in households were more likely to participate in physically active recreational episodes. Individuals who lived alone and adults in couple families were more likely to participate in recreational activities than other non-single parent. Adults in households with children participated less in maintenance shopping and personal business activities on weekends and more in community and pick-up/drop-off activities.

Ashish (2004) provided a comprehensive analysis between weekday and weekend travel patterns, utilizing the 2001 NHTS data. Differences and similarities between the two patterns were identified by urban area size. Weekend and weekday travel behavior models were developed to capture the relationships of socio-demographics, activity durations and travel duration, based on the structural equations modeling that provides various direct and indirect effects inhibited in the relationships among them. Females were found to make more trips and activities than males on weekdays, while a reverse trend was shown on weekends. High income led to less time on weekend subsistence activities and the number of children had a positive effect on the social activity duration. Slightly more person miles occurred on weekends than weekdays. However, the total vehicles miles traveled by household were longer on weekdays because higher occupancy vehicles (SOVs) were preferred for longer trips on weekends.

Kim et al. (2004) analyzed the weekend travel behavior changes due to a 5-day workweek instead of a 6-day one. Activity participation and travel behavior were compared between two population groups, those currently working 5 days and 6 days a week. Multilevel structural equation models were developed using the 2002 Seoul Metropolitan Area Transportation Survey. The relationships among socio-demographics, activity participation, and travel behavior within households as well as between household models were found. The effects of variables were significantly different between two groups. In the within-household model, single women and those with a high level of education spent more time on leisure activities on Saturday. In the between-household model, households having more students participated in fewer leisure activities, while household income growth resulted in leisure activity and travel time increases.

A few modeling approaches were attempted using the 2000 San Francisco Bay Area Travel Survey data. Bhat and Gossen (2004) formulated a mixed multinomial logit model for the type of recreational activity episodes of individuals on weekends. The choices include in-home, out-of-home, and pure recreational episodes. The effects of household and individual socio-demographics, land-use and density variables, and episode participation attributes were analyzed in detail. Individuals in households with

several other adults and high-income households were more likely to participate in in-home recreation and single parents had less recreation. Individuals preferred to have recreational episodes in the morning and pursue in-home recreation on Sundays. Land-use and density' impacts on weekend recreation choice were not substantial.

With regard the activities and mode choice, Guojun Jiang et al. (2012) investigated the interdependency between bicycle usage and activity patterns, and capture the decision order between them. To achieve the research objective, data was extracted from the household travel survey in urban area of Bengbu, China. The final sample contains 5632 valid cases. The co-evolutionary approach combined with MNL model was used to capture the interrelationship between bicycle usage and activity patterns. The analytical procedure included five steps: sort of bicycle usage and activity patterns, statistical analysis, MNL model specification, co-evolutionary modeling process and the final model evaluation. It turned out that on average 4.25 cycles were needed to reach a final decision for both bicycle usage and activity pattern choice facets. The model estimation results showed that in the majority of the cases, activity pattern is made in prior to mode choice. In other words, travelers made the decision on bicycling or not according to the pattern of their daily activities. Furthermore, this study also found that the patterns of subsistence activities had larger impacts on the choice of bicycle compared to the maintenance and recreational activities. The coefficient of gender indicates that compared to women, the probability of bicycling among men is higher. People with the age of 20 to 60 seem to be the most frequent bicyclists. Compared with employees and students, self-employed or retired people are less likely to bicycle. The probability of bicycling also decreases if an individual holds a public transport card. Annual household income and car ownership are negatively related to bicycle usage. It implies that maintenance or recreational activities would be more determined or influenced by bicycle choice than work related activities.

Ye *et al.* (2007) considered three different causal structures for links between trip chaining and mode choice. The first structure assumed that trip chaining pattern was determined first and influenced mode choice while the second structure was the either. In the third structure, both trip chaining and mode choice were determined simultaneously. The first two structures are estimated within a recursive bivariate probit modeling framework that accommodates error covariance. The simultaneous logit model is estimated for the third structure that allows a bidirectional simultaneous causality. The analysis and model estimation are performed separately for work tour and non-work tour samples drawn from the 2000 Swiss Microcensus travel survey, which trip dataset includes 103,376 trips reported by 29,407 interviewed persons. Model estimation results showed that the need to make a complex tour increases dependency on the auto mode. In addition, it was found that demographic and socio-economic characteristics, the tour's primary purpose, and time-of-day significantly influence mode choice and tour complexity. Generally, it was found that the causal structure in which trip chain complexity precedes mode choice performs best for both work and non-work tour samples.

Ben-Akiva (2007) gave a new extension to activity based modeling by investigating the happiness of the travellers. The overriding hypothesis is that activities are planned and undertaken to satisfy needs so as to maintain or enhance subjective well-being (Abou-Zeid and Ben-Akiva, 2009). In 2012, Abou-Zeid and Ben-Akiva (2012a; 2012b) presented an empirical analysis and a theoretical analysis of the relationship between well-being and activities. The empirical analysis consisted of an exploratory model of the effects of activity and travel well-being on the propensity to participate in activities.

Using a convenience universal sample of highly-educated commuters, they found significant correlations between activity/travel well-being and activity participation for a number of different activity types: the greater the happiness while performing an activity and the greater the satisfaction with travel to the activity, the more frequently an activity is conducted. The theoretical analysis consisted of developing a model framework for the extension of activity pattern models based on the activity-schedule approach (Ben-Akiva et al., 1996) which structures the day into an overarching activity pattern and then determines the timing, destination, and modes of tours and trips comprising the pattern. They presented two extensions to these models. The first extension was econometric and attempted to better estimate the utility of an activity pattern by adding a measurement equation where satisfaction with a pattern was used as an indicator of its utility. The second extension was behavioral and attempted to formulate the activity pattern utility so as to account for the behavioral process of activity generation, based on the idea that activities are conducted to satisfy needs.

3.2.1 Conclusions

Concluding, sustainable transportation is often considered a big city issue. But in order to maintain economic and environmental health, and ensure equitable access to key services such as employment, educational institutions and medical services, smaller, rural and insular communities also need to find solutions to increase mobility options for their citizens. The case studies in this section presented the best practices of some capital cities, but more attention was paid in the best practices of medium and small-sized European cities, which in the past faced similar transport situations with Lesbos and Chios islands and through simple transport planning, policies and campaigns managed to become sustainable and green.

The review of the best practices indicates that the planning of green transportation policies, begin by conducting a review of relevant existing facilities and a survey for collecting accurate data about citizens' transport needs. The data analysis could provide to local authorities a valuable source of information in order to develop their policies. Once the policies are developed and applied the establishment of monitoring and evaluation procedures are necessary. In this context, a green transportation plan and system should:

- Encourage the modal shift from private cars towards public transport and non-motorized.
- Increase the share of non-motorized transport (walking and cycling).
- Avoid or reduce unnecessary or undesired mobility.
- Facilitate access to a regular, frequent, comfortable, modern, competitively priced, well-linked network of public transportation.
- Promote selective and rational use of private cars with a preference for clean, quiet, energy-efficient vehicles powered by renewable or alternative fuels.
- Provide an accessible environment suitable for everyone. Accessibility does not only mean easy to reach, but also easy to use. When talking about accessibility, every citizen is concerned not only disabled and older people. Also children, an often forgotten target group, need to be considered, as they still need to learn how to move around independently and safely.



- Provide safe routes to all road users (pedestrians, cyclists, drivers).
- Provide accurate and real-time information and orientation to all road users.
- Consistently educate and train the road users of all ages about green transportation issues.
- Make the most efficient use of land.
- Be actively managed in an integrated manner with the participation of all the stakeholders and public consultation.
- Have short, medium and long-term objectives with an effective monitoring system.

Several conclusions regarding the experience to date with activity-based modeling can be drawn:

- There is a growing interest and an increasing number of applications of travel demand models of the new generation. These important properties of the new models include an activity-based conceptual platform, the focus on the tour as the base unit for the modeling of travel, and the use of a micro-simulation technique that operates on households and persons at the fully-disaggregate level. The new generation of models brings much stronger behavioral realism to the travel demand forecasting process, by ensuring an internal logical consistency among the various activity/travel components for each household, person, and tour.
- Although these new modeling structures are evolving rapidly, following somewhat different specific paths of developments, it is already possible to summarize the important new structural features of these models. Among them is the explicit incorporation of intra-household interactions, a significant and important new component that has been entirely missing in the conventional travel demand models (Davidson et al., 2007).
- The new generation of models is based on the detailed classification of activities and travel segmentation. In particular, activities are grouped by type (mandatory, maintenance, discretionary) and setting (individual, allocated, joint) where a special modeling technique is applied for each particular type and setting.
- The skeleton of the new travel demand model can be outlined as a sequence of conditional choices that include long-term level decisions, daily pattern/schedule level, tour level, and trip level.
- The disaggregate travel diary information obtained through home interview surveys remains the empirical foundation for the estimation of the travel demand model, including activity-based models. However, given the increased emphasis on activities themselves, and the need for the data to clearly identify household interactions, certain aspects of the home interview survey data collection deserve more attention to assure completeness and accuracy. This is especially relevant for activities undertaken jointly by several household members and also in-home activities.
- The analytical structure of the new generation of activity-based tour-based models in application is fundamentally different from the conventional aggregate models. Instead of fractional-probability calculations at the level of origin–destination pairs of zones, the model is applied at the level of individual



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households, persons, and tours with no explicit restrictions on the number of variables or population/travel segments.

- It is important to effectively promote the development and application of activity-based models and demonstrate their clear advantages to practical planners in a meaningful way. Demonstrating clearly their practical advantages for planners and decision-makers, seems to be the best strategy for the promotion and eventual widespread acceptance of the new generation of travel demand models.



4 TRANSPORT CONDITIONS IN THE STUDY AREA

This section reviews the main land use, socioeconomic and transport related characteristics of the Islands of Chios and Lesvos.

4.1 The Island of Chios

Chios Island is located in the Aegean Sea, seven miles from the coast of Asia Minor. It is the fifth largest of the Greek islands, 51320² people live in the main city or the villages and the towns of Chios. The port of Chios is the main freight and passenger hub, connecting the island with the neighboring islands of Samos, Lesvos and Limnos (itineraries vary, especially in the summer), the cities of Kavala and Thessaloniki and Greece's main port, the port of Piraeus. There is also a daily connection between Chios and Cesme, mainly for tourist purpose (recently also for freight transport).

Chios airport connects the island with the islands of Lesvos, Samos and Rhodes, and the cities of Athens and Thessaloniki. Connection with Athens is daily, with Thessaloniki most days of the week and weekly for the islands. In the summer months, there are some charter flights connecting Chios with some (mostly northern European) cities.

Chios attracts tourists mainly during the summer season, when a lot of Greek Americans visit their homes. This is an added burden on the islands road network, considering that many of them bring their cars together.

4.1.1 Particularities of Chios

Chios Island has some particularities worth mentioning in this study. Chios town, the capital of the island (also called Chora, mostly by natives) is the center of the islands transport flows, commercial activity and has a population of approx. 30.000 people. There is not a second large population concentration in Chios (contrary to what happens in other islands), and the second most populous town is the neighboring Vrontados with 5000 population, which is becoming almost a suburb of Chios town, as a result of the recent intense urbanization of both areas and their local proximity. Chios town is situated in the middle of a north – south axis which is a prominent geographical separation of the island areas. As a result, the traffic flowing from north to south or backwards (transit) also flows through Chios town (there is a longer alternative, with much worse road condition).

Chios town has developed around the main core of Chios port and along the main road arteries. The center of the town is developing mainly around the municipal garden and some traditional commercial roads. (Usual land use is for commercial, governmental and entertainment reasons). Another special condition about Chios is the large number of car ownership per capita. As it can be seen in Figure 4.1.1 below, approximately 2500 new vehicles appear each year on the island. Considering the island population, this is a large number (5% of the total population).

² 2011 temporary census results

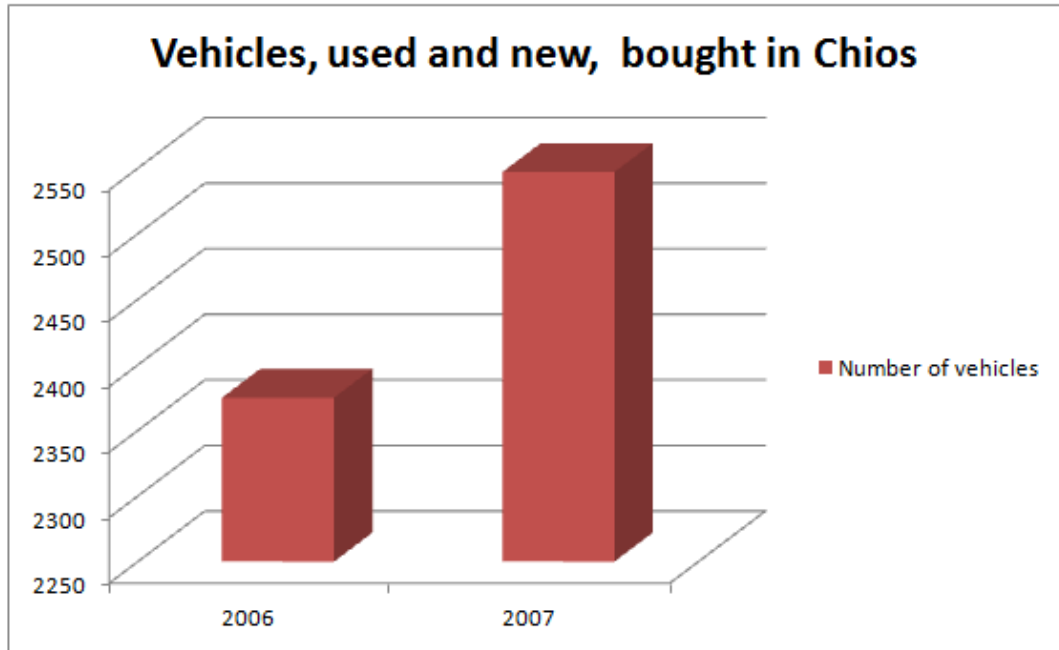


Figure 4.1.1 Vehicles, used and new, bought in Chios

4.1.2 Study Area

The study area is the whole island. It must be understood, though, that Chios town plays a leading role in the transport flows of the island. Figure 4.1.2 presents the center of Chios town. A big portion of the road next to the port is a part of the center. This fact leads to traffic congestion, whenever a ship unloads passengers and cars in the island, the situation being worse during summer months. Considering the central square and the municipal garden as the city center, the circular road around them is almost always congested during summer months, especially the days and hours when the local stores are open.

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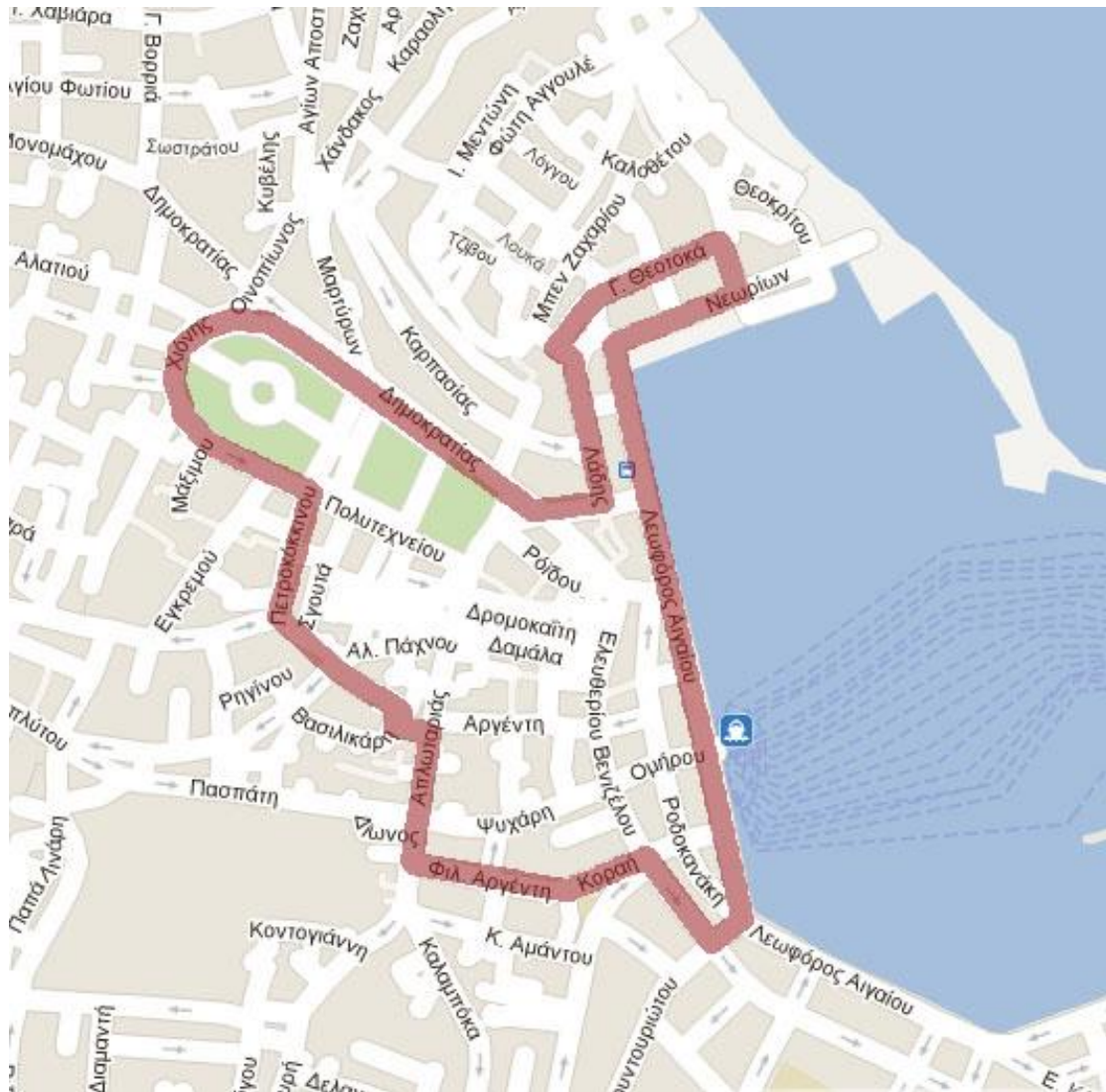


Figure 4.1.2 Chios town center (Source: Mendonidi, 2009)



Figure 4.1.3 Alternative Chios town center (Source: Mendonidi, 2009)

4.1.3 Socioeconomic Characteristics

In this section the main socioeconomic characteristics of Chios Island are presented. In Table 4.1.1 the main well being indicators are presented. In 2009, Chios was the 4th prefecture in Greece in bank savings (Lyviakis 2009), while back in 2007 it was in the 2nd place, right after Athens. It should be pointed out that the income of Chios inhabitants is ranked 7th among the 57 Greek prefectures. Furthermore, the unemployment rate in Chios is rather low compared with the rest of Greek prefectures. Chios has a fair amount of high school students per 1000 people (ranked 17th in Greece), and in addition it ranks first at the university entries per population for 5 consecutive years.

Table 4.1.1 GDP (pp), bank accounts of local population (Source: Nomoi, 2010)

Well-being indicator	Reference Year	Chios	Country average	Ranking in Greece (52 prefectures)
Savings accounts	2009	23,200 €	18,800 €	2
Income (pp)	2008	16,100 €	16,700 €	7
Taxes paid (pp)	2008	1,200 €	1,600 €	11
Population growth/1000 people	2008	0	0.9	19
High school students / 1000 people	2009	66	62	17
Unemployment rate	2009	3.7%	9.5%	45

In the table below there is a comparison with other island areas (both island states of the EU and Sicily as a big island part of an EU country).

Table 4.1.2 Comparison with other island areas

Indicator	Chios	Malta	Cyprus	Sicily
Population Density (/km ²)	57.5	1240	82	200
Area (km ²)	904	316	9252	25711
Cars per 1000 people (2009)	420	566	529	583
Total road fatalities per 100,000 population (2009)	50	3.4	10.4	-

In Figure 4.1.4 the population of the island during the last 40 years is presented. As it can be seen there from both Figure 4.1.4 and Figure 4.1.5 there is a decline in the population in the past 10 years. This decline should be attributed to the tendency of young people to leave the island searching for better work opportunities in larger national or international cities.

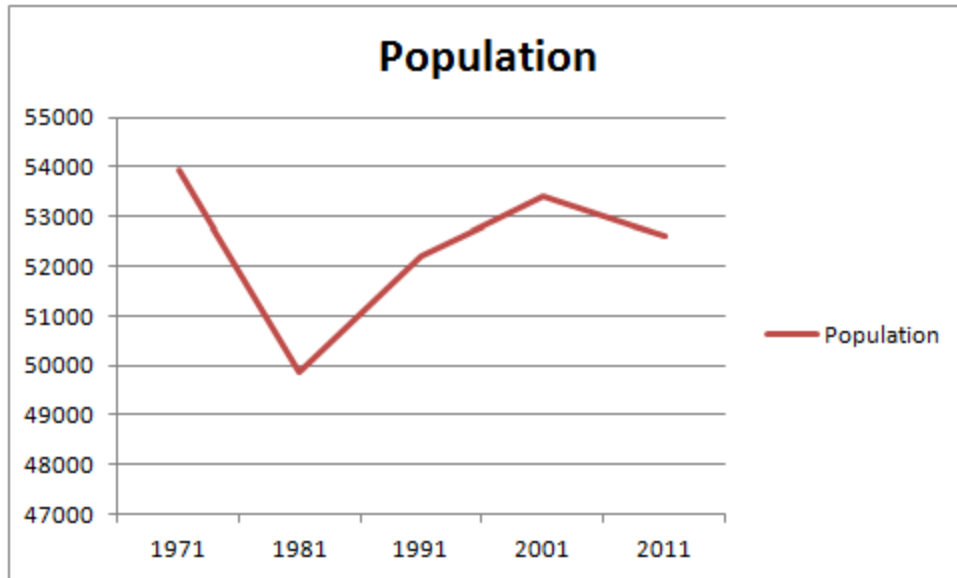


Figure 4.1.4 Chios population 1971-2011

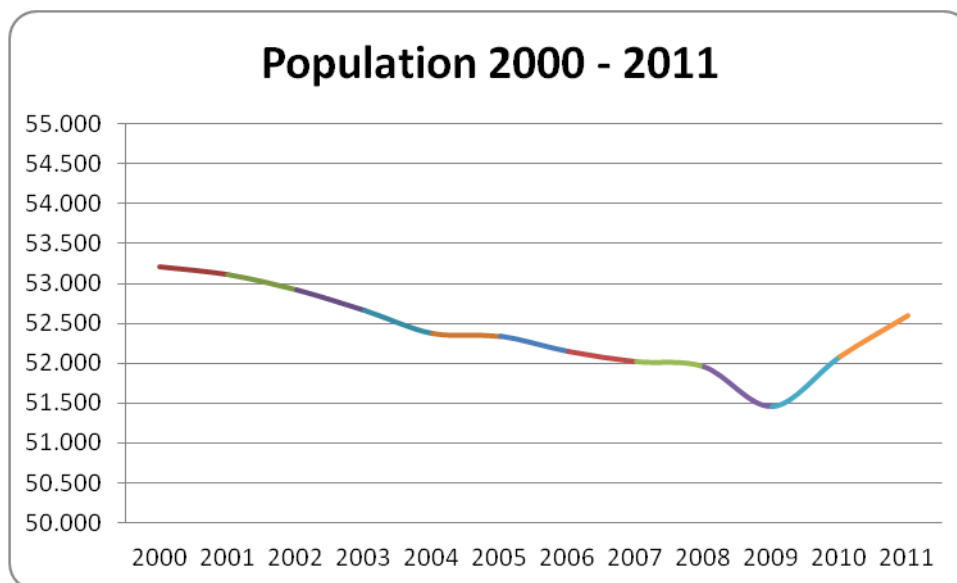


Figure 4.1.5 Chios population 2000-2011

Figure 4.1.6 presents the unemployment rates in the Chios Island. As shown in the figure below there is a small decline in the unemployment in Chios. This change is in the opposite direction of the national trend, (unemployment rise – consequence of the economical crisis and the austerity measures). The national rise can be explained by the national economic crisis that started in 2009 and the consequences are starting to show up in the unemployment statistics for 2010 (17.47% in Greece, 13,4% in Chios).

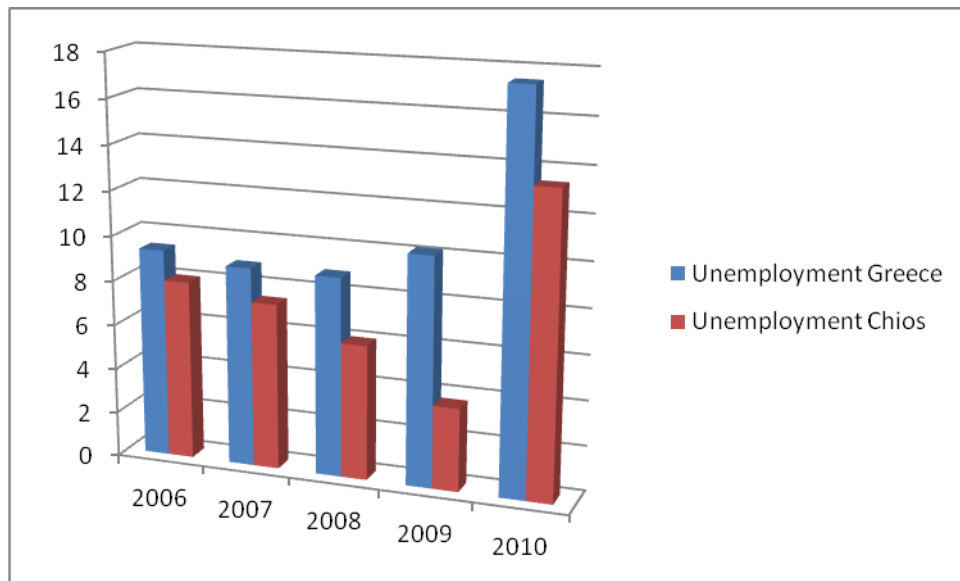


Figure 4.1.6 Unemployment in Chios in comparison with the national percentage

4.1.4 Transportation System Characteristics

4.1.4.1 Intra-Island Transportation System Characteristics

As already stated, Chios has a large number of vehicles for its population. In Figure 4.1.7 a steady increase in the car ownership, from 2000 until 2009, can be noted. Back in 2007 there were 38.78 cars for every 100 people on the island (3rd place in Greek prefectures, with Athens and Thessaloniki metropolitan areas being the 2 first). In 2009, this number rises to 42 cars per 100 people.

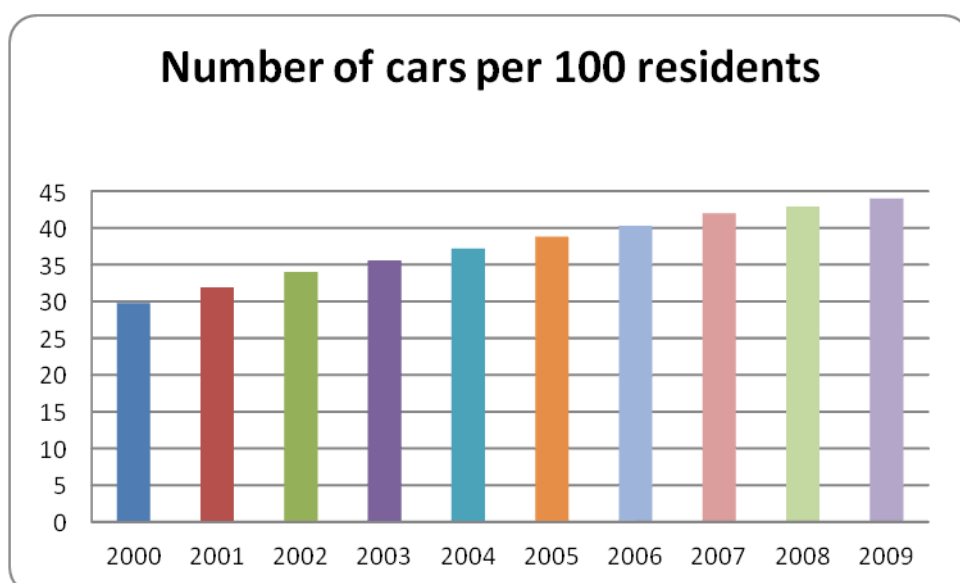


Figure 4.1.7 Number of cars per 100 residents Chios

The vast majority of vehicles in the island of Chios can be grouped in the following categories:

- Motorcycles (motorbikes<50cc and motorcycles over 50 cc)
- Passenger cars
- Taxis
- Buses
- Trucks

Motorcycles are used mostly in Chios town and their use is popular especially among young people and teenagers, the majority of which tend to drive without having a driving license. Due to the island's rough and badly maintained road network small motorcycles are rarely used for big distances. However there is a rising trend of motorcycle use on the island, as presented in Figure 4.1.7.

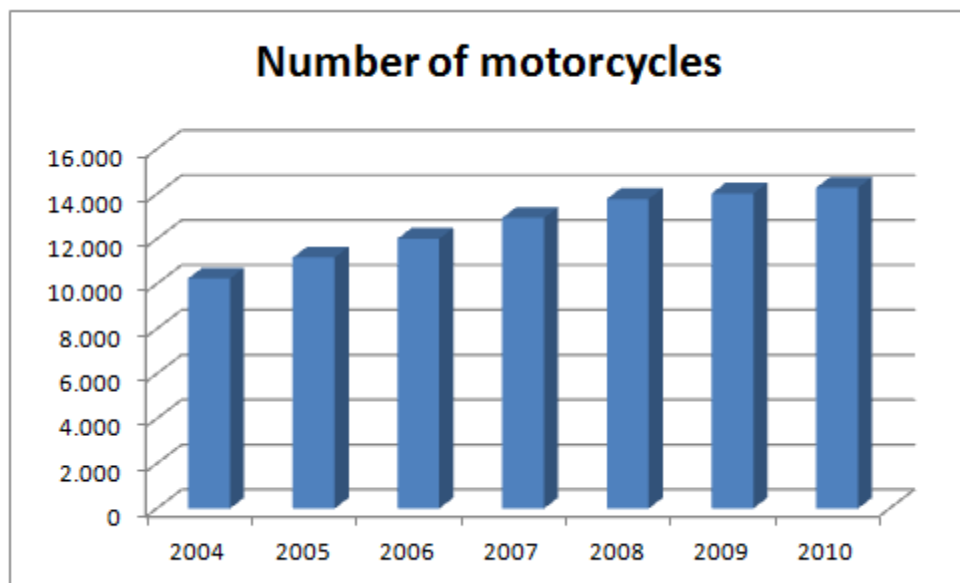


Figure 4.1.8 Number of motorcycles in Chios

Road accidents are a major problem of the transportation system characteristics. As shown in the Figure 4.1.9 below, the number of road accidents remains in an elevated level (above 30 per year) for the last 6 years.

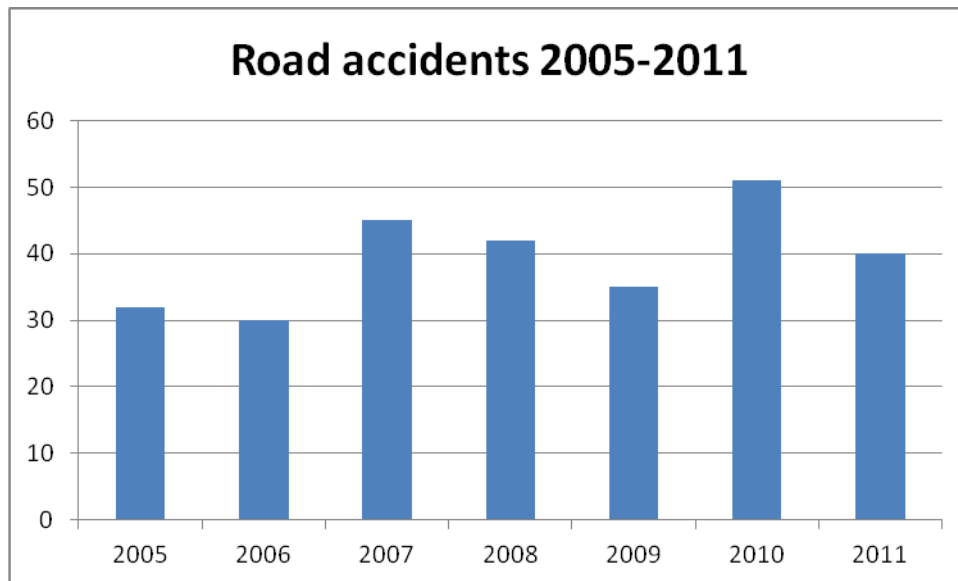


Figure 4.1.9 Road accidents in Chios

An even more disappointing fact is the age of the road accidents victims. As shown in the figure below, over 25% of the fatalities are aged 18 to 23 years old.

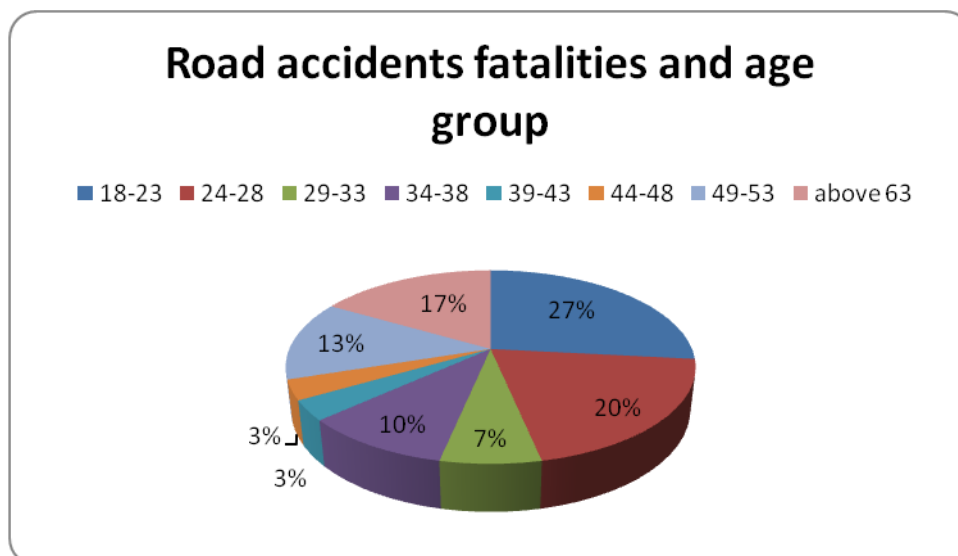


Figure 4.1.10. Fatalities per age group

Suburban public transport in Chios (between Chios town and the villages), is organized in a simple network of stops. A fleet of 16 (privately owned) buses and 17 drivers is used. The age of the fleet is relatively young, as the old buses were recently (ktelchios.gr 2010) replaced by new ones of 40-50 seats.

Urban public transport has also been upgraded recently with the scheduling of frequent mini buses, from and to parking areas outside the center of Chios town, in an effort to improve the traffic congestion in the center. The main bus line connects areas around Chios town (from northern suburbs – Vrontados to Kampos and Nechori in the south).



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These urban bus lines pass through the main roads in the center adding stress to the already elevated traffic burden.

Figure 4.1.11 (left) shows a typical bus route passing through the center of Chios town, with the line origin in Vrontados and destination somewhere south of the town (Karfas, Agia Foteini, or southern villages). Areas covered in blue are the areas considered as the center of Chios town, so the possibility of traffic congestion in these areas is elevated. Figure 4.1.11 (right) reveals an alternative to this bus route that, although longer, avoids the center of the town.

Deliverable 2: Current Situation Analysis

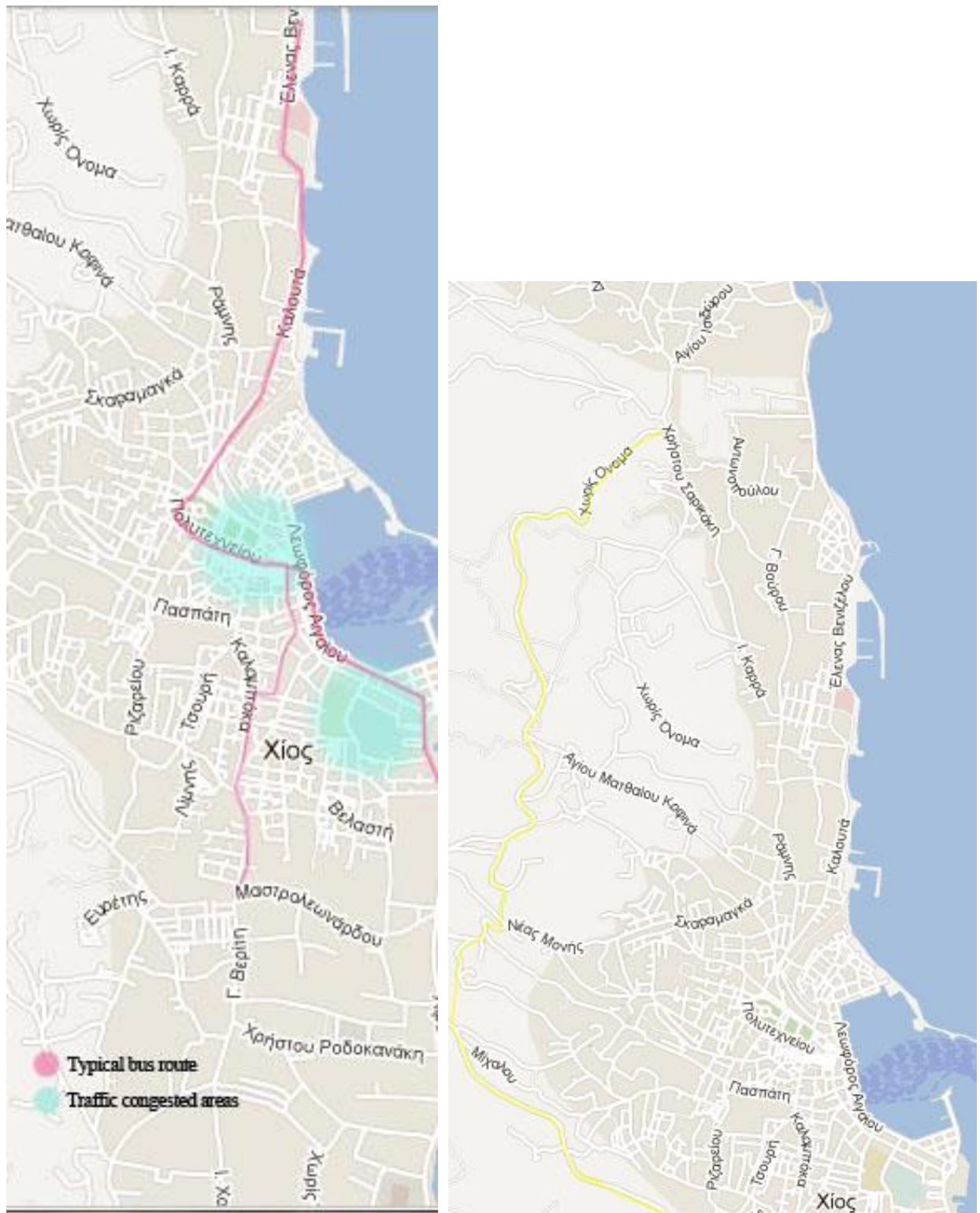


Figure 4.1.11 Typical bus route through Chios town (left) and ring road in Chios (right)

There is a growing trend in favor of bicycles in Chios. While there is not much official evidence, only the observation of bicycle sales growth during the last 5 years, (to support this fact, the daily local experience shows that more people (mainly those that live in or near Chios town) chose bicycle as their main transport means. Road surface condition is not the ideal for bicycle use, and there has not been any recent planning for bicycle lanes.

4.1.4.2 Inter-Island Transportation System Characteristics

The passenger market structure is depicted in the following figure. A passenger has the choice of airplane or ship to move to Athens or another city. The main transport hub in and out of Chios is Chios town (airport and port) but there is the alternative of Mesta port, located in the southwest of the island (mainly preferred by southern Chios locals).

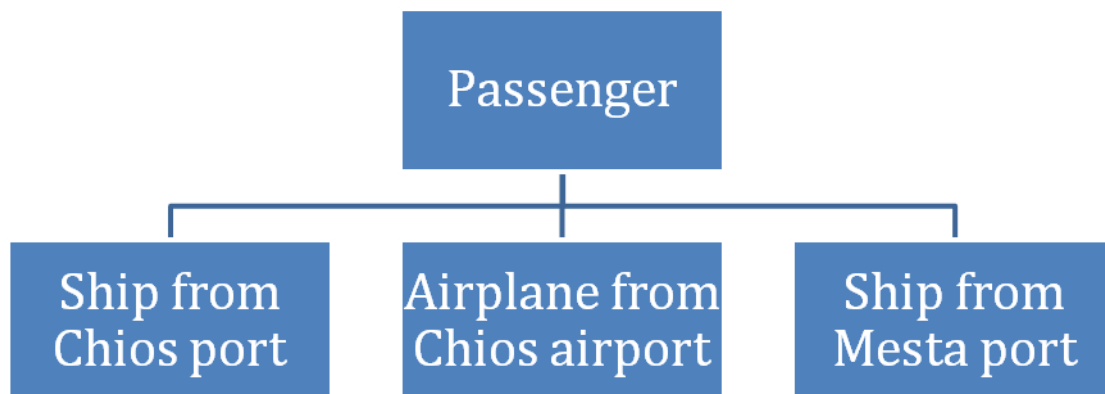


Figure 4.1.12 Passenger market structure in Chios

In the freight market case, the shipper (receiver) has the choice of airplane and plane again, but the airplane is used mostly for light and valuable cargo as well as for printed press arriving early in the morning with the first plane landing from Athens. A big majority of truck owners chose the Mesta port alternative for cost reasons.

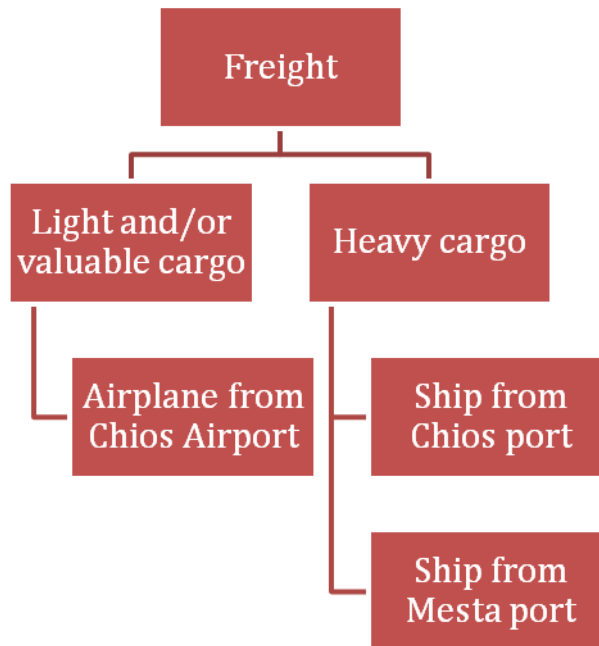


Figure 4.1.13 Freight market structure in Chios

Figure 4.1.14 presents the seasonality observed in the passenger movement of Chios port. While during the winter months passenger movement is limited to around 10.000 passengers arriving at Chios port every month, in July the island was visited by as many as 34.000 passengers. The small peak during April is explained by the tourists and local students visiting the island for the Easter. Figure 4.1.15 presents the demand of Mesta port, which also confirms that the same rules also apply, in a smaller but proportionate scale.

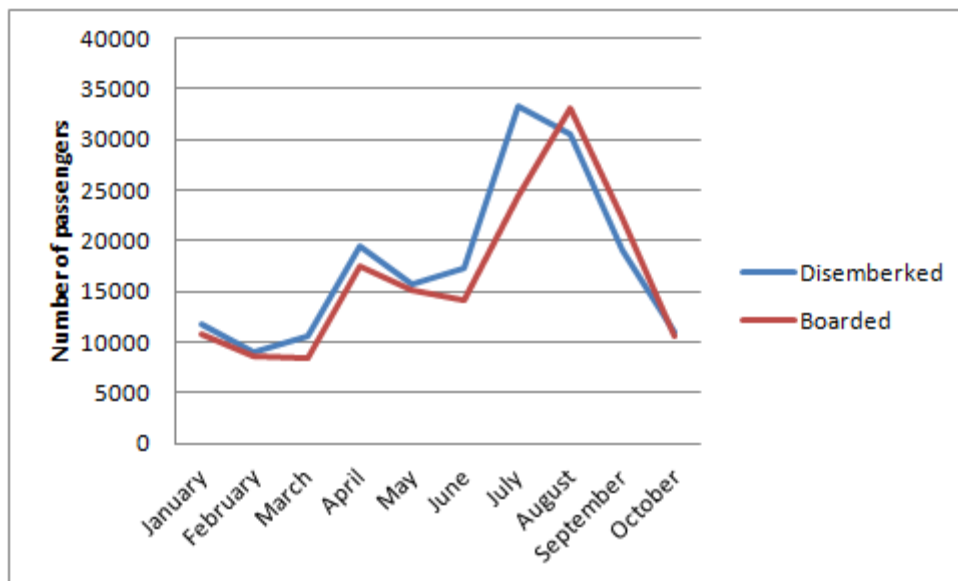


Figure 4.1.14 Chios port passenger's movement 2011 (Source: Chios Port Authority)

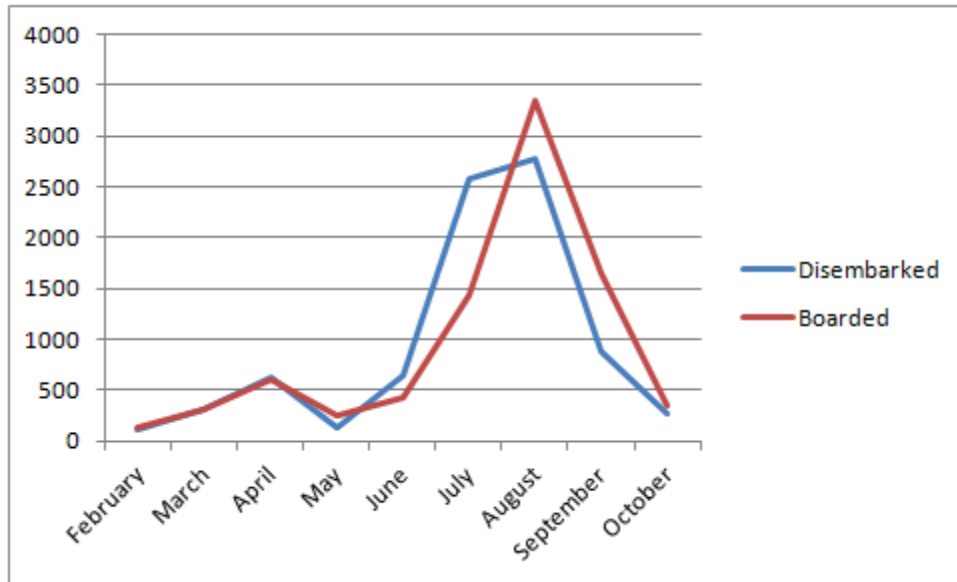


Figure 4.1.15 Mesta port passenger movement 2011 (Source: Chios Port Authority).

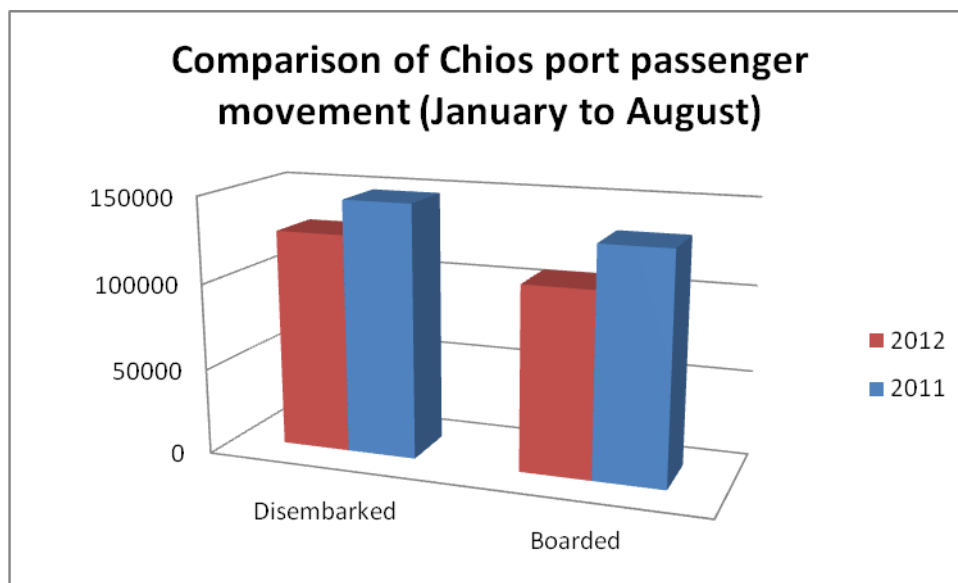


Figure 4.1.16 Chios port passenger movement 2011 – 2012 (Source: Chios Port Authority)

4.1.5 Land Use Characteristics

Table 4.1.3 presents the changes of land use in Chios from 1991 to 2001. The most rapid change is observed in the growth of land used for residential purposes. Private pastures shrink while there is a small rise in public ones. Forest land is decreased mainly due to the big fires (mainly during the summer season).

Table 4.1.3: Land use in Chios

	Pasture :	Private	Public	Crops	Forest	Residential	Other
1991		14610	42980	16530	9700	4530	2070
2001			13820	44150	16540	9550	5024
1316							
Change		-5,41	+2,65	+0,06	-1,55	+9,83	-
36,43							

Figure 4.1.17 is based on el-stat (Greek national statistics service – 2001 census) data for the land use in Chios, the island area is 90.400 hectares and the distribution of the land use is the following:

- Forests 9,550 hectares
- Public pasture – Bushes – 44,150 hectares
- Private pasture – grass lands - 13,820 hectares
- Arid land (rocks) – 1,316 hectares
- Agricultural crops – 16,540 hectares
- Residential areas – 5,024 hectares

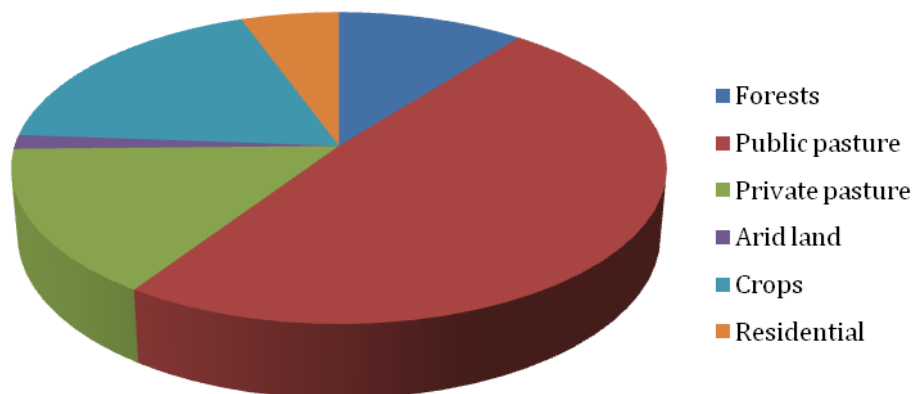


Figure 4.1.9 Land use in Chios

Chios commercial chamber splits the 3.790 businesses on the island in the following categories:

- Commercial

- Small industry
- Professionals
- Tourism

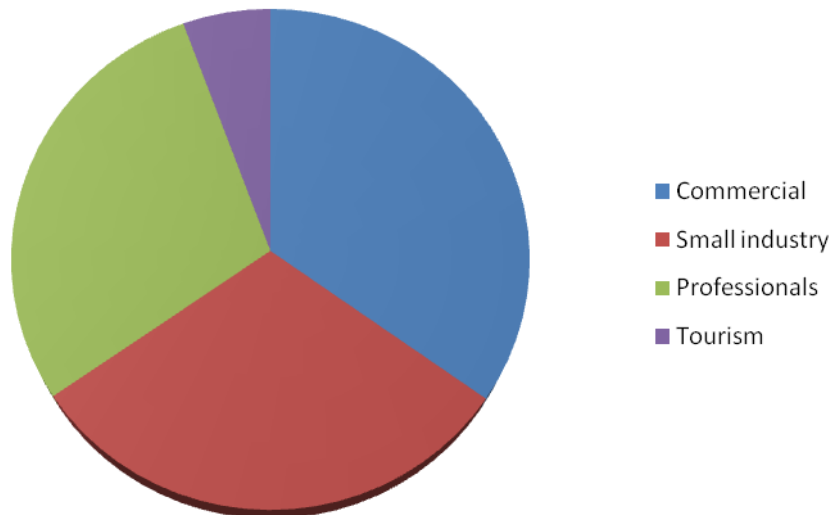


Figure 4.1.10 Commercial activity

4.2 The island of Lesbos

Lesvos Island is located in the northeastern Aegean Sea. It is separated from Turkey by the narrow Mytilene Strait. It has an area of 1,632 km² making it the third largest Greek island. Its population is approximately 85,410 (census 2011), a third of which (34,549) lives in its capital, Mytilene, in the southeastern part of the island. The remaining population is distributed in small towns and villages, the largest of which are Kalloni, the Gera Villages, Plomari, Agiasos, Eresos, Polichnitos and Molyvos (the ancient Mythymna).

The economy of Lesbos is essentially agricultural in nature, with olive oil being the main source of income. Tourism in Mytilene, encouraged by its international airport and the coastal towns of Petra, Plomari, Molyvos and Eresos, contribute substantially to the economy of the island. Fishing (the city exports sardines harvested from the Bay of Kalloni) and the manufacture of soap, cheese, yoghurt and ouzo (the Greek national liqueur) are the remaining sources of income.

The port of Lesbos is the main freight and passenger hub, connecting the island with the neighboring islands of Limnos, Chios, Samos and Ikaria (itineraries vary, especially in the summer), the cities of Kavala and Thessaloniki and Greece's main port, the port of Piraeus. There is also a daily connection in summer between Lesbos and Ayvalik and one to three days a week between Lesbos and Dikili, mainly for tourist purpose.

Lesvos airport connects the island with the islands of Limnos, Chios, Samos, Rhodes and Crete, and the cities of Athens and Thessaloniki. Connection with Athens and Thessaloniki is daily and several days of the week for the islands. In the summer

months, there are some charter flights connecting Lesvos with some (mostly northern European) cities.

Lesvos attracts tourists mainly during the summer season, when people in their vast majority from north European countries visit the island. The most popular destinations on the island are Molyvos, Eresos, Vatera, Plomari and Petra. There is also domestic tourism in Lesvos Island. The island is famous for its religious tourism. Many people from all over Greece come to the island all year round, in order to visit for example the monastery of St. Raphael at Thermi, the monastery of Taxiarches at Mandamados or the church of Virgin Mary (Panagia) at Agiasos and Petra. Petrified Forest at Sigri and the popular hot springs in many places of the island are also a source of tourism and many visitors come to admire this unique natural monument and natural phenomenon correspondingly. An alternative form of tourism for the island is birdwatching, which attracts many visitors in several popular for this reason places (like Kalloni Saltpans) especially in winter and spring seasons, in order to admire a wide range of rare birds. All these trips are an added burden on the island's road network, considering the fact that many of the visitors use private modes of transport.

4.2.1 Particularities of Lesvos

Lesvos Island has some particularities worth mentioning in this study. Two unequal gulfs, Kalloni in the southwest and Gera in the southeast, divide the island into three parts. The town of Mytilene is the capital of Lesvos Island, with a population of approximately 35,000 people. It is located in the southeastern part of the island, north and east of the Gulf of Gera. It is the center of the island's transport flows and commercial activity. It is true that the town's international airport is 8 km south away and there is no road connection with the rest of the island apart from Mytilene, which makes the pass through the town unavoidable. Moreover, in the waterfront of the town there is a conflict between the land used for the port purposes and the land used from the administrative services. All these facts undoubtedly deteriorate the traffic flows in the center of the town. The second largest town of the island is called Kalloni. By geographical option it is located in the center of the island, mostly serving the locals from western villages, and it also plays an important role in the commercial transactions of the island, with a population of 8,500 people.

Mytilene has been developed around the main core of Lesvos port and along the main road arteries. The center of the town is developing mainly around the Ermou Street, where the market is located, and some traditional commercial roads. There is an antithesis revealed in the town of Mytilene. The main core of the town was built in the same way as the old town and is connected with its historical past. Narrow and old streets appear in the center of the town, which do not allow many interventions for improvement. As a result, normal traffic flows are often not favored. On the other hand, the newer expansions of the town (like Chrysomallousa area) are densely populated, as a result of city growth, but in many cases it happened in an anarchic building way. The usual land use in the town is for commercial, governmental and entertainment reasons.

4.2.2 The natural environment of Lesvos

Lesvos has a great biodiversity mainly because of the variety of ecosystems on the island, the particularity of its rock formations, the long-term effect of man's activity on

nature, its proximity to Asia Minor as well as the recent, from a geological point of view, detachment of the East Aegean from the coasts of Minor Asia (Bazos, 2005).

In the eastern and central part of the island there are huge olive groves and pine tree forests, whereas the western part, which is dryer, is dominated by chestnut groves and Mediterranean frigana and maquis type biotopes. There are also natural and technical wetlands (The Petrified Forest Museum, 2012). *Alyssum lesbiacum* is perhaps the only endemic plant species of the island. However, some plants of the East such as *Rhododendron luteum* and *Haplophyllum megalanthum* are only found on Lesbos, while others are found very rarely and dispersed all over Greece, e.g. *Osmunda regalis*, *Datisca cannabina*, *Comperia comperiana*, *Dianthus anaticus*, *Elatine alsinastrium*, *Corydalis integra*, *Ranunculus isthmicus*, *Silene urvillei* and others (Bazos, 2005).

The fauna of the island is very interesting (Vrisa National History Collection, 2012). It is composed by European as well as Asian species because of the neighbouring with Asia Minor. Mammal species like the Persian Squirrel *Sciurus anomalus*, reptiles like the Coastal Viper *Montivipera xanthina*, and birds like the Kruper's Nuthatch *Sitta krueperi* belong to the fauna of Asia Minor peninsula and their distribution in Greece is restricted only in Lesbos.

The uncontrollable tourist development during the last years, the new roads, the drainage of wetlands, the fires, the overgrazing of some places, and the illegal hunting are the major threats for the rich fauna and flora of Lesbos. There are some threatened species, for example *Pancretium maritimum* (lily of the sea) has almost disappeared from the sandy beaches of the island. The need for protection is urgent, in order to secure the conservation of the natural heritage.

Lesbos has three major protected areas of the Natura 2000 Network (Table 4.2.1, Figures 4.2.1 and 4.2.2). The Natura 2000 Network is a European Ecological Network of areas, with natural habitat types and native plant and animal species which are important at the European level. It is composed of two categories of areas: the "Special Protection Areas – SPA" for avifauna, as defined in the Directive 79/409/ EC and the "Sites of Community Importance – SCI", as defined in the Directive 92/43/EC. Kaloni Gulf is one of Lesbos' Natura 2000n sites, with a rich avifauna. There, 68 bird species of the Annex I of Council directive 79/409/EEC are found. The second area is Gera Gulf, Dipi marsh and mount Olympos. The third area is the western peninsula that includes the petrified forest of Lesbos in Sigri.

Table 4.2.1: The Natura 2000 areas of Lesbos (Source: YPEKA, 2012)

SITE CODE	SITE NAME	AREA (ha)
	LESVOS ISLAND	
GR4110003	WESTERN PENINSULA – PETRIFIED FOREST	20974,07
GR4110004	KALLONI GULF AND LAND COASTAL ZONE	18297,82
GR4110005	GERA GULF, NTIPI MARSH AND OLIMPOS MOUNTAIN	11200,41

GR4110007	COASTAL WETLANDS OF THE KALLONI GULF	6461,00
GR4110009	ISLETS OF LESVOS (CLUSTER OF TOMARONISION, KIDONAS, AGIOS GEORGIOS, GLARONISI)	103,00

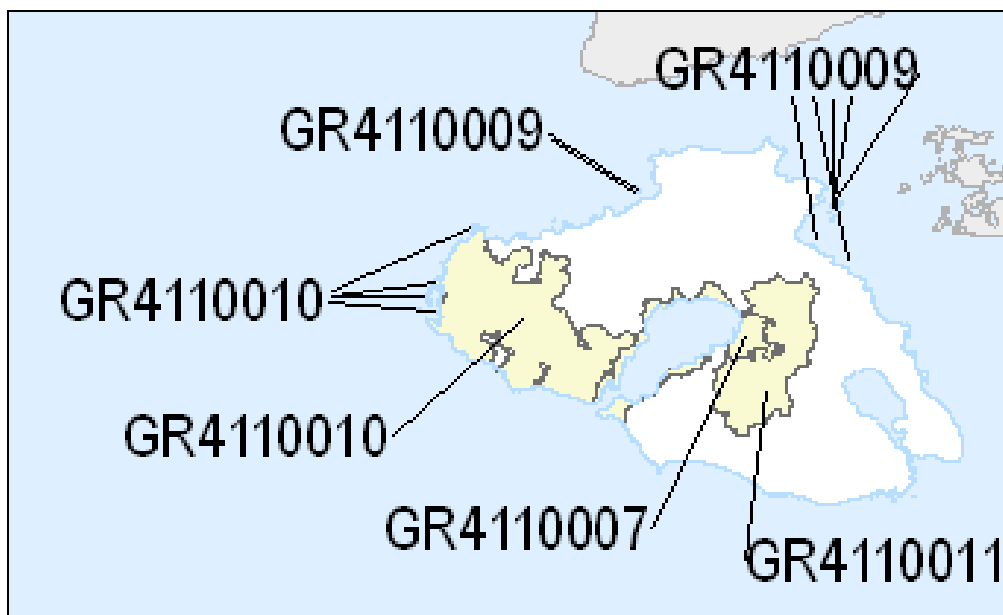


Figure 4.2.1 Special Protection Areas for avifauna in Lesvos Island (source: YPEKA, 2010)

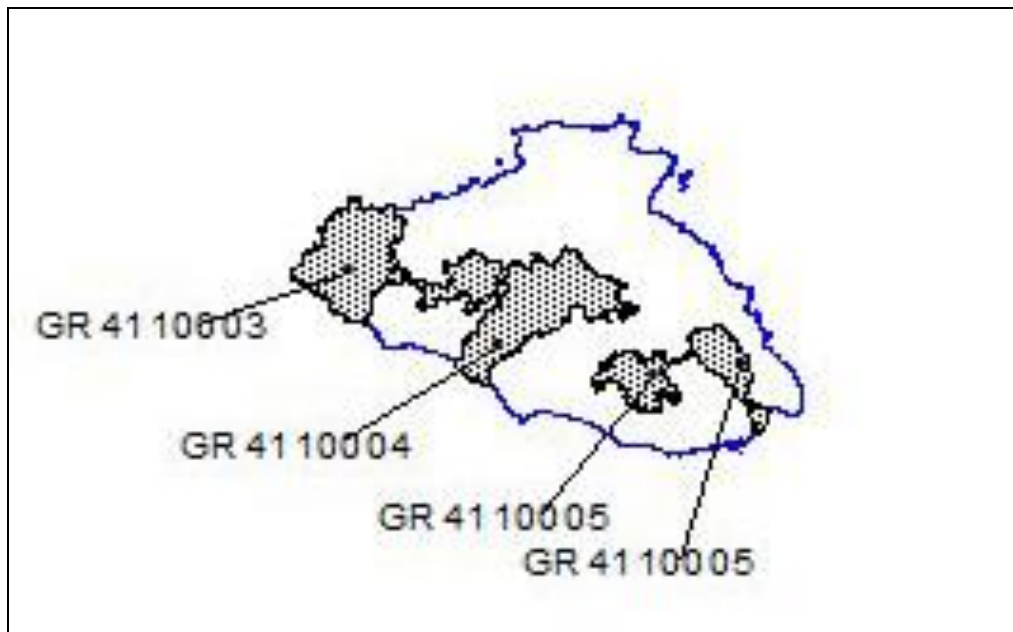


Figure 4.2.2 Sites of Community Importance in Lesvos Island (source: YPEKA, 2012)

4.2.3 Study Area

The study area is the Lesvos Island. It must be understood, though, that Mytilene plays a leading role in the transport flows of the island. After the unification of the municipalities in accordance with the administrative system of Kallikratis, Mytilene's role as the capital and center of the island's transaction flows is empowered, with the previous municipalities losing their advantage of being self-governed.

Figure 4.2.3 shows the center of Mytilene. A big portion of the road next to the port is a part of the center. This fact leads to traffic congestion, whenever a ship unloads passengers and cars in the island, with the situation being worse during summer months. Considering the central square (Sappho Square) as the city center, the circular roads around it is almost always congested during the summer months, especially the days and hours when the local stores are open.



Figure 4.2.3 Mytilene center

Figure 4.2.4 presents the southern center of Mytilene, which consists of the main roads around St. Eirini Park and St. Constantine Park, such as Kavetsou Street, Vostani Street, Eleftheriou Venizelou Street and Odysseas Elytis Street. These roads are observed to be congested especially during the summer season and at peak hours of the day.



Figure 4.2.4 Southern center of Mytilene

Deliverable 2: Current Situation Analysis

In general, there are four main exits from the town of Mytilene. As shown in Figure 4.2.5, the first exit of the town (the northern one) passes through the 8th November Street, the Minor Asia Street and the Navmachias Ellis Street and leads to northeastern villages of the island, like Moria, Thermi, Pamfila and Mantamados. In the same figure it can be seen the second exit of the town (the central one) that passes through the Vournazon Street and Zoodochou Pigis Street and leads to destinations such as Kalloni, Molyvos, Eressos and Polichnitos.

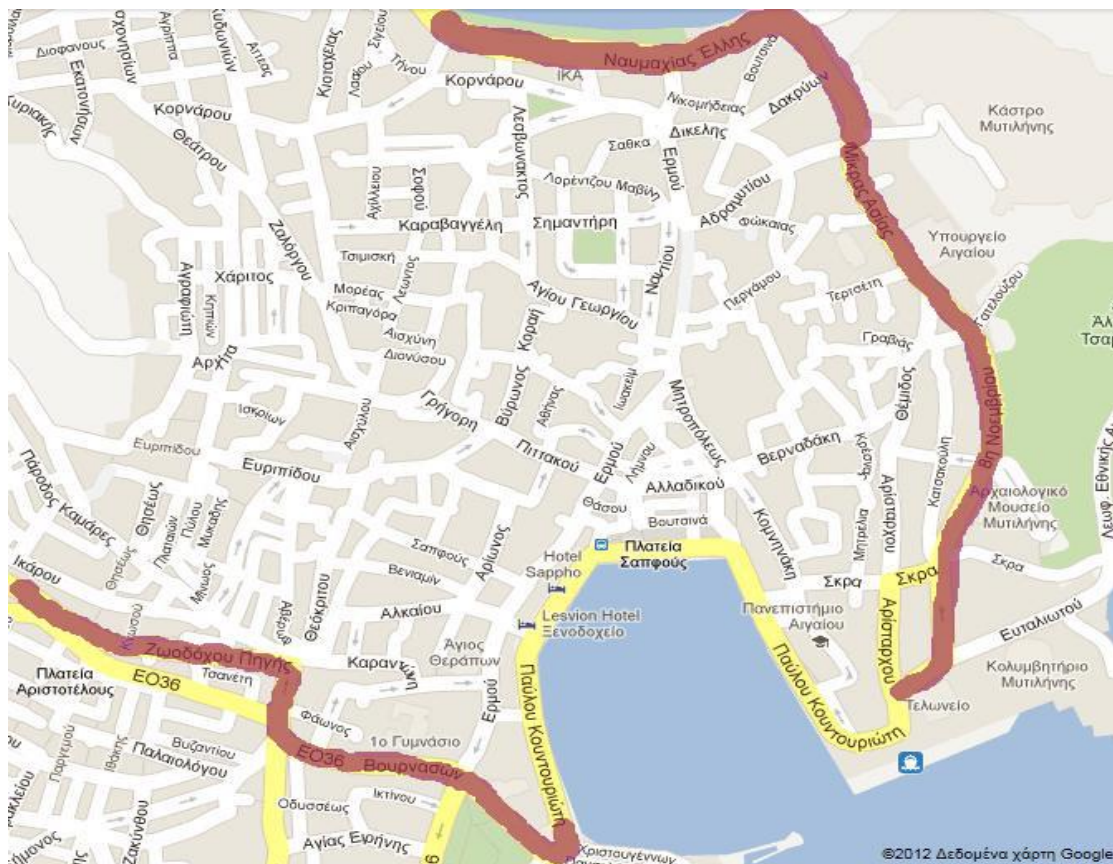


Figure 4.2.5 The north and central exits of Mytilene

Deliverable 2: Current Situation Analysis

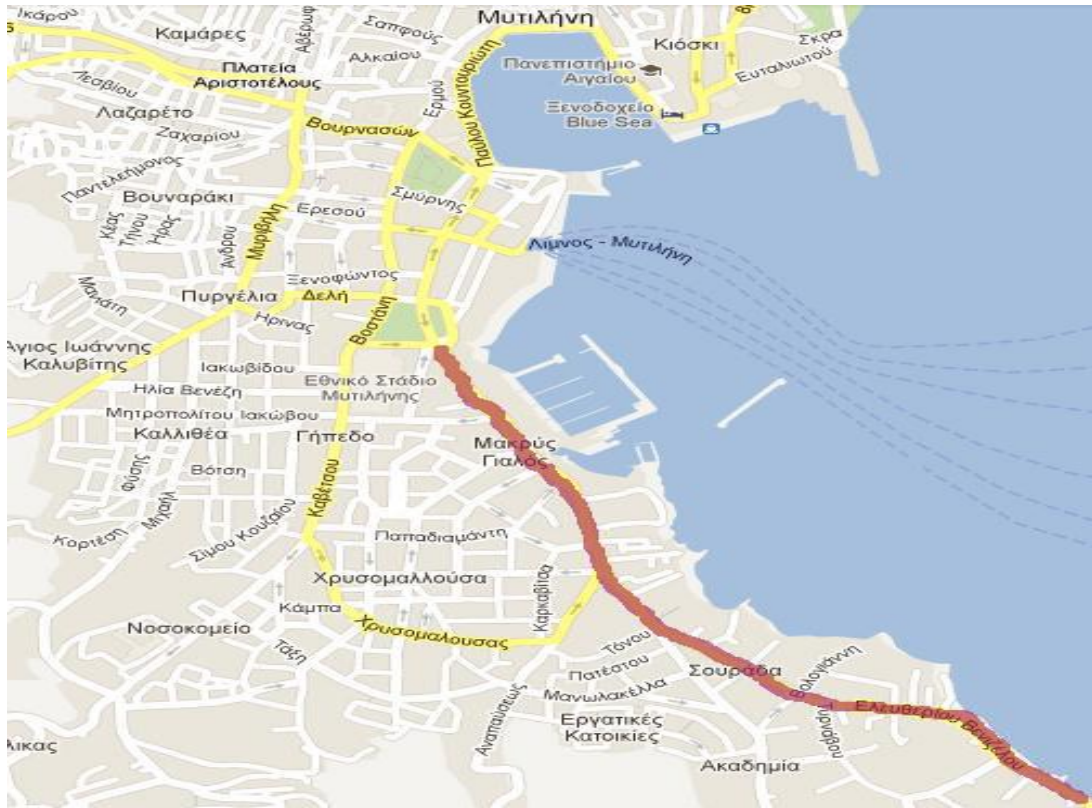


Figure 4.2.6 The south exit of Mytilene

Figure 4.2.6 shows the third exit of Mytilene (the south one), which passes through Eleftheriou Venizelou Street and leads to the Airport area and to areas such as Pligoni, Vareia and Neapoli. The fourth exit of the town is presented in Figure 4.2.7. This exit passes through Myrivilli Street and Kykladon Street and leads to areas southern to Mytilene, such as Loutra and Charamida.

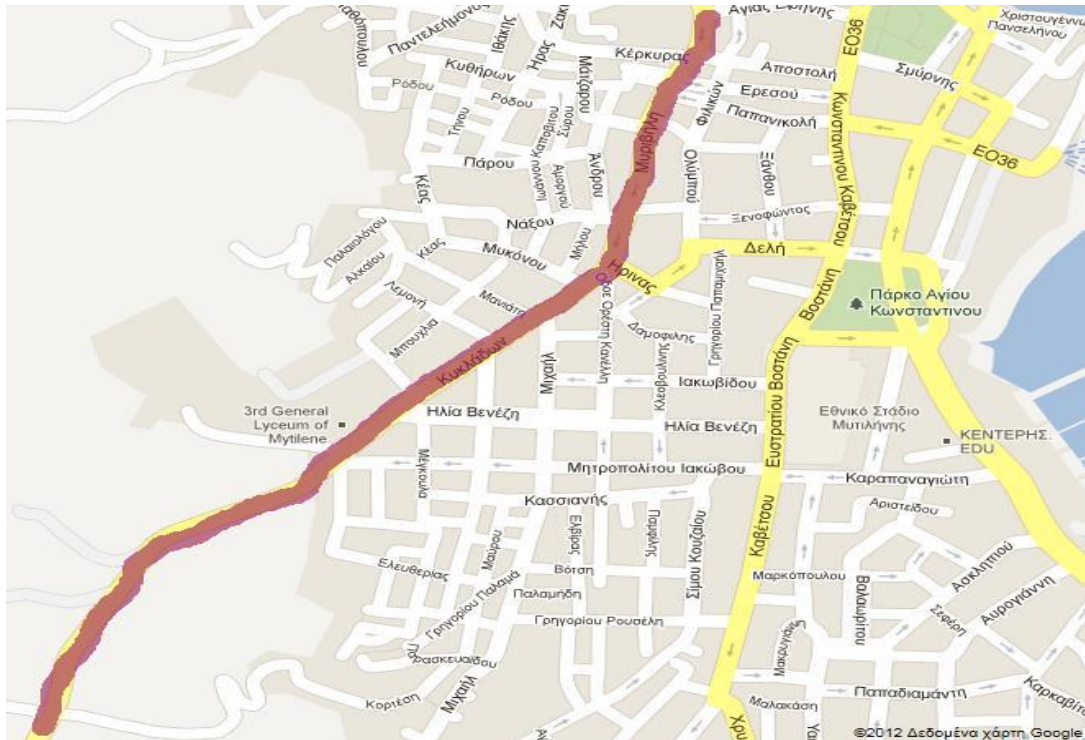


Figure 4.2.7 The fourth exit of Mytilene town

4.2.4 Socioeconomic Characteristics

In this section the main socioeconomic data of Lesvos are presented.

Figure 4.2.8 presents the fluctuation of population in Lesvos Island during the past 50 years. Specifically, it reaches a peak of almost 120000 inhabitants in 1961 and then it declines steadily to nearly 97000 in 1971. From 1971 until 1981 there is a further reduction to 88000 people and then it falls to nearly 87000 in 1991. It is obvious that the population of the island increases to more than 90000 in 2001 and then it falls again to its lowest point ever, reaching the number of nearly 85000 inhabitants.

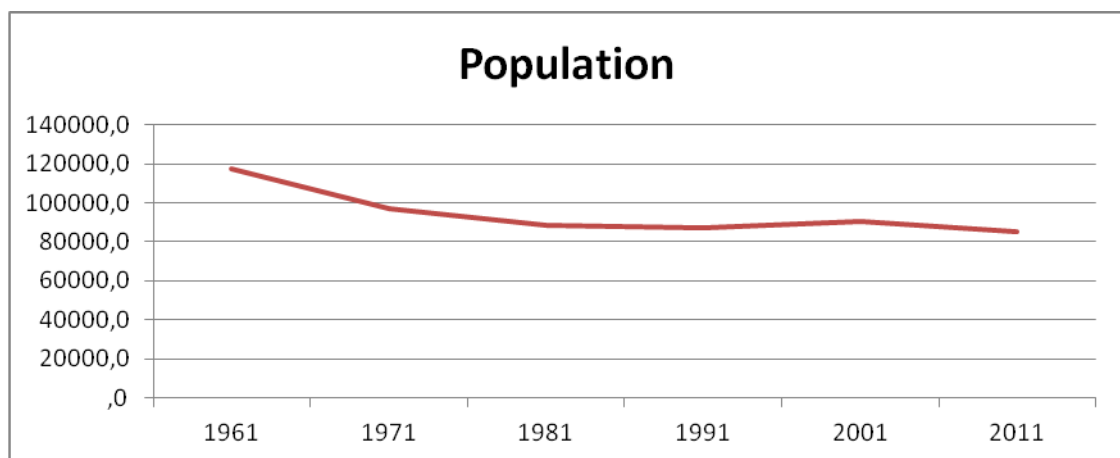


Figure 4.2.8 Lesvos population 1961-2011 (source: Hellenic Statistical Authority)

Figure 4.2.9 presents the unemployment rate in Lesvos Island. As it can be seen, there is a decline in the unemployment in Lesvos from 2005 until 2008. On the contrary, this decline was followed by a worth mentioned increase in unemployment from 2008 until 2011. This change can be explained by the national economic crisis that started in 2009 and the austerity measures.

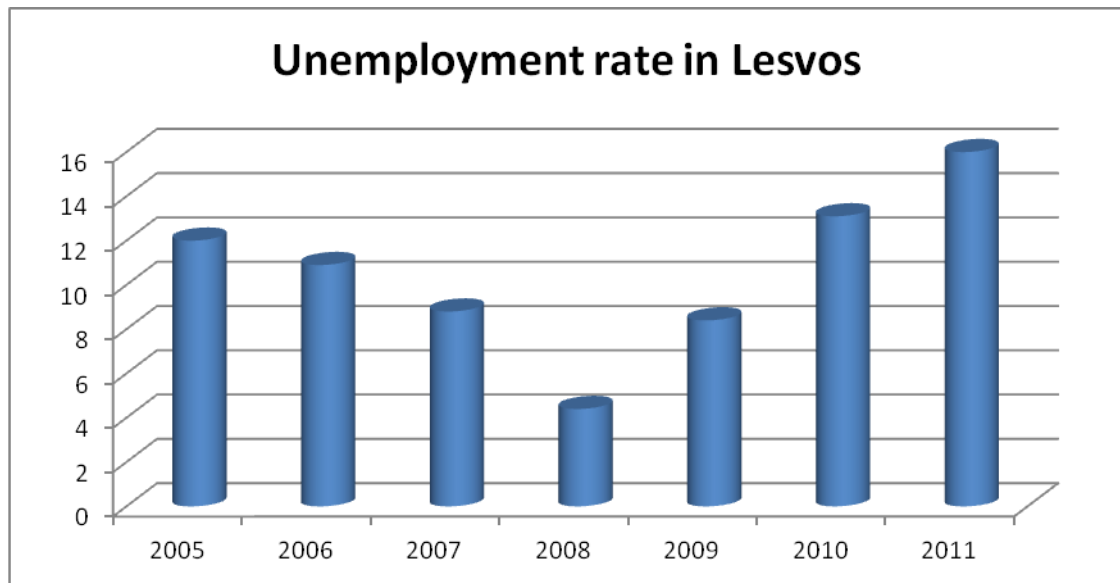


Figure 4.2.9 Unemployment rate in Lesvos (source: Hellenic Statistical Authority)

In Table 4.2.2 below the main well being indicators are presented. In 2009, Lesvos was the 9th prefecture in Greece in bank savings. It should be pointed out that the income of Lesvos inhabitants is ranked 26th among the 57 Greek prefectures. It is worth mentioning that there was an important decline in the population growth in 2008 (ranked 37th Greek prefectures). Furthermore, the unemployment rate in Lesvos is at the level of 8.4%, which gives to the island the 31st place among the Greek prefectures. Lesvos has the amount of 62 high school students per 1000 people (ranked 17th in Greece).

Table 4.2.2 Well-being indicators of local population (Nomoi 2010, annual report)

Well-being indicator	Reference Year	Lesvos	Country average	Ranking in Greece (52 prefectures)
Savings accounts	2009	15,800 €	18,800 €	9
Income (pp)	2008	14,200 €	16,700 €	26
Taxes paid (pp)	2008	1,040 €	1,600 €	21
Population growth/1000 people	2008	-2.3	0.9	37
High school students / 1000 people	2009	62	62	32
Unemployment rate	2009	8.4%	9.5%	31

4.2.5 Lesvos Transportation System Characteristics

4.2.5.1 Intra-Island Transportation System Characteristics

The vast majority of vehicles in the island of Lesvos can be grouped in the following categories:

- Motorcycles (motorbikes < 50cc and motorcycles over 50 cc)
- Passenger cars
- Taxis
- Buses
- Trucks

As shown in Figure 4.2.10 below, approximately 3,300 new vehicles appear each year on the island. Considering the population of the island, this is a large number (9% of the total population).

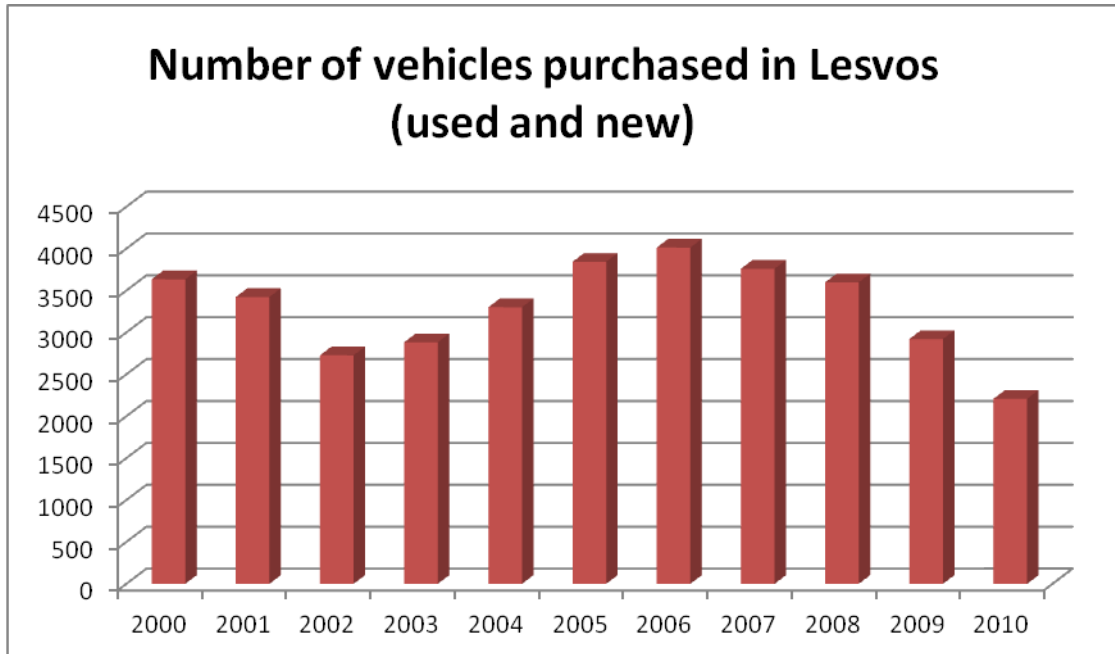


Figure 4.2.10 Number of vehicles purchased in Lesvos (source: Hellenic Statistical Authority)

Figure 4.2.11 presents the car ownership rates in the Lesvos Island. As it can be seen there is a steady increase in the car ownership, from 2000 until 2009. More specifically, in 2000 there were 16.5 cars per 100 inhabitants, while in 2009 this number rose to 25.8 cars per 100 inhabitants.

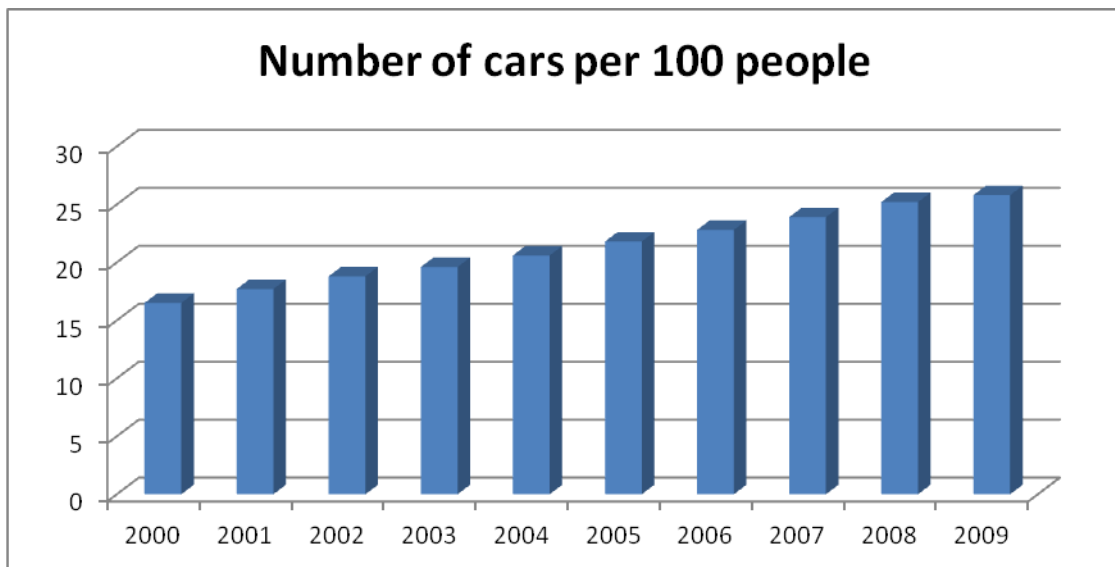


Figure 4.2.11 Number of cars per 100 people in Lesvos (source: Nomoi 2010, annual edition)

Motorcycles are used mostly in Mytilene and their use is popular among young people (even children of small age use them, illegally). Due to the island's rough road network and long distances, small motorcycles are rarely used for travelling outside the town. However, there is a rising trend of motorcycle use on the island, as presented in Figure 4.2.12.

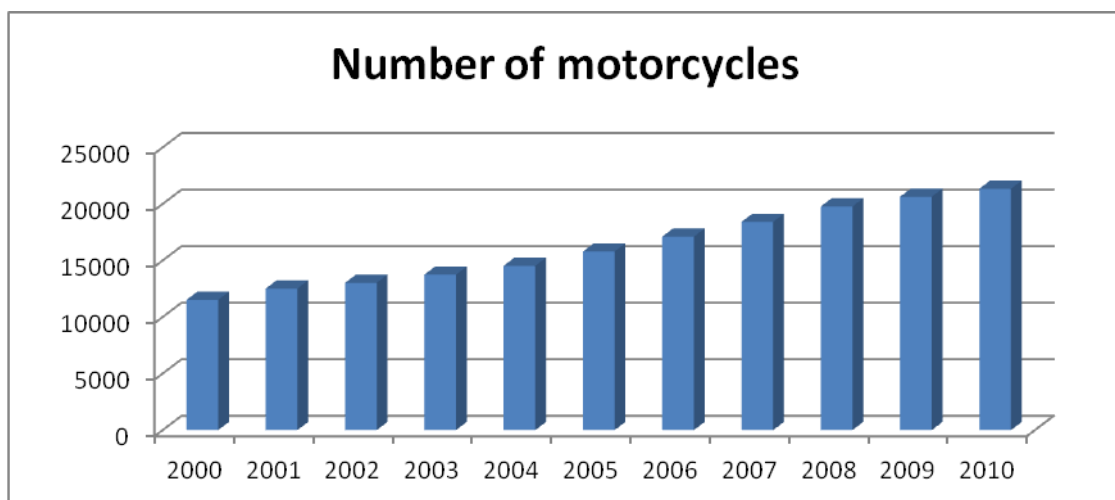


Figure 4.2.12 Number of motorcycles in Lesvos (source: Hellenic Statistical Authority).

The bad condition of the road network in the island is one of the reasons that traffic accidents happen. As shown in the Figure 4.2.13, there are many accidents occurring each year in Lesvos Island, while the vast majority of vehicles involved are privately owned cars and motorcycles. Nevertheless, there has been an effort in recent years in order to improve the condition of the road network, like Mytilene-Kalloni road and Mytilene-Polichnitos road that connect major destinations on the island.

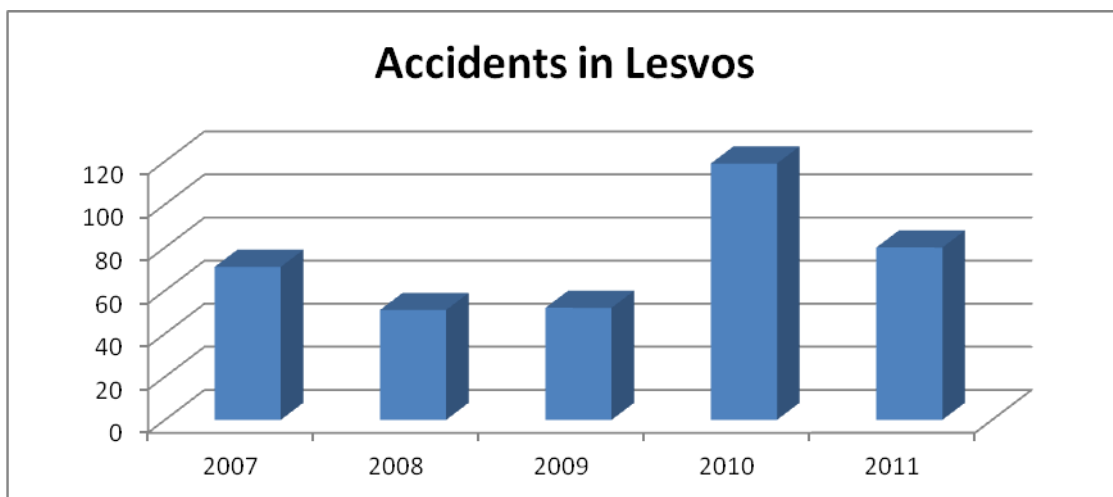


Figure 4.2.13 Accidents in Lesvos Island (source: Police Authority of Mytilene).

Figure 4.2.14 presents the percentage of dangerous infringements occurred in Lesvos Island in 2009. As we can see, in the first place are infringements related to no use of safety belt (23,9%) and then follow speed infringements (21,8%), leaving infringements related to no use of helmet in the third place (19%).

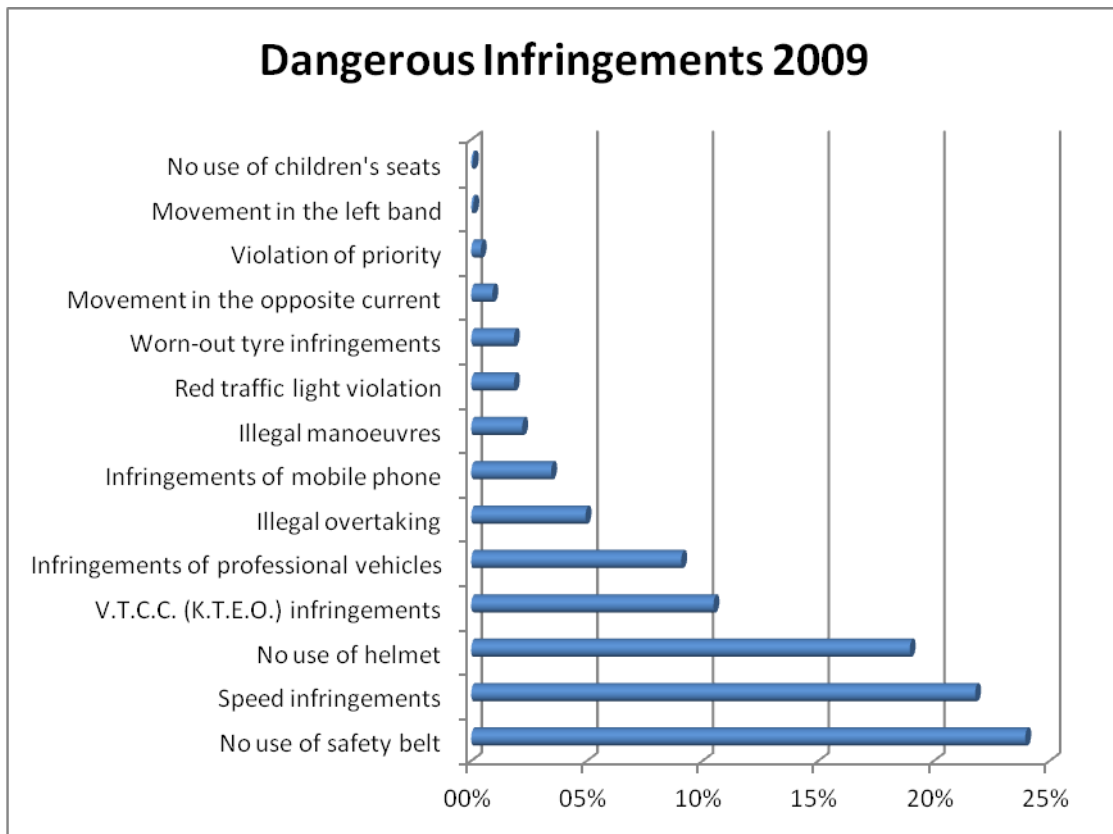


Figure 4.2.14 Dangerous infringements in Lesvos Island 2009 (source: Ministry Of Public Order & Citizen Protection, data processed by National Technical University).

In the Table 4.2.3 below the number of dangerous infringements in Lesvos Island 2009 and the change compared to the 2008's corresponding data are presented. As it can be easily concluded, there is an enormous reduction in infringements related to no use of children's seats (-76,5%), movement in the opposite current (-72,1%) and movement in the left band (-64,3%). On the other hand, there is an important increase in infringements related to violation of priority (27,8%) and red traffic light violation (9,6%).

Table 4.2.3 Dangerous infringements in Lesvos

Dangerous Infringements	2009	Change compared to 2008
No use of safety belt	1.338	5,5%
Speed infringements	1.217	-25,2%
No use of helmet	1.059	-23,0%
V.T.C.C. (K.T.E.O.) infringements	585	-29,9%
Infringements of professional vehicles	507	-10,9%
Illegal overtaking	276	-25,6%
Infringements of mobile phone	193	-
Illegal manoeuvres	123	4,2%
Red traffic light violation	103	9,6%
Worn-out tyre infringements	103	-
Movement in the opposite current	51	-72,1%
Violation of priority	23	27,8%
Movement in the left band	5	-64,3%
No use of children's seats	4	-76,5%

Interurban public transport in Lesvos (between Mytilene and the villages), is organized in a simple network of stops. A fleet of 31 (privately owned) buses and 31 drivers is used. The age of the fleet is on average 17 years and almost all buses have 50 seats. Figure 4.2.15 presents all the routes that connect Mytilene with the rest of the island. It is true though, those itineraries are reduced during the winter period. As a result, many people use their own mean of transport, because the routes are not convenient.

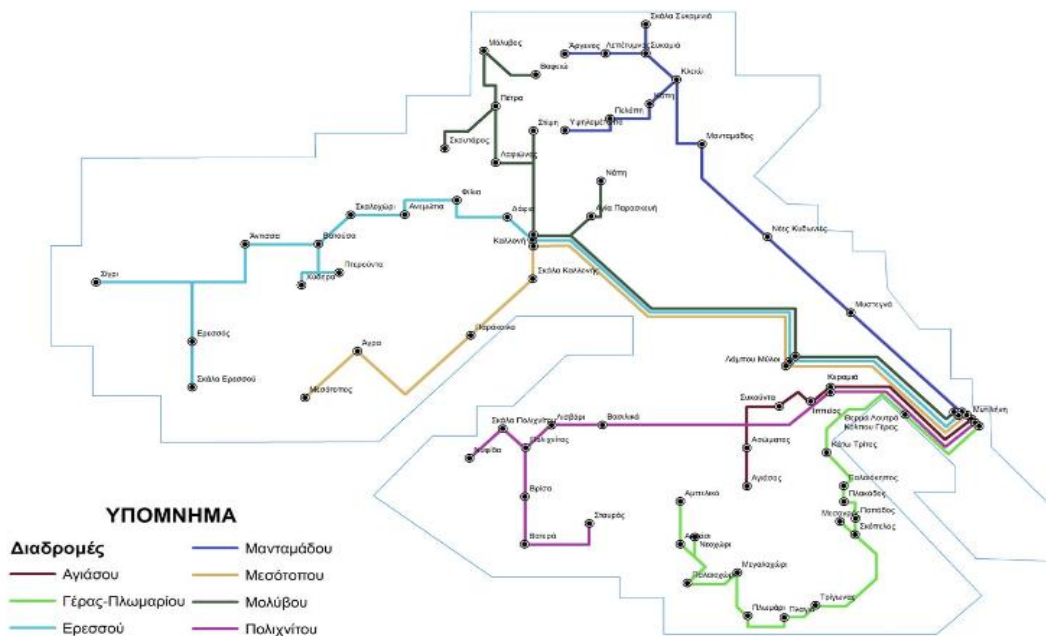


Figure 4.2.15 Suburban public transport routes in Lesvos (source: Interurban Transport Station of Lesvos)

Deliverable 2: Current Situation Analysis

Urban public transport has also been upgraded recently with the scheduling of frequent mini buses, in an effort to improve the traffic congestion in the centre. The main bus lines connect areas around Mytilene (from northern suburbs and regions such as Moria, Pamfila, Thermi, St. Raphael Monastery, Panagiouda to southern suburbs and nearby regions such as Chalikas, Neapoli, Kagianni, St. Marina, Pligoni, Loutra). These urban bus lines pass through the main roads in the centre of the town, adding stress to the already elevated traffic burden. The fleet of urban public transport consists of 17 buses (privately owned) and 16 drivers are used. It has an average age of 22 years and each bus has 30-40 seats.

Figure 4.2.16 shows a typical bus route passing through the center of Mytilene, with the line origin in Panagiouda and destination somewhere south of the town (Airport area, Neapoli, Pligoni, or southern areas). Areas covered in blue are the areas considered as the center of Mytilene, so the possibility of traffic congestion in these areas is elevated.

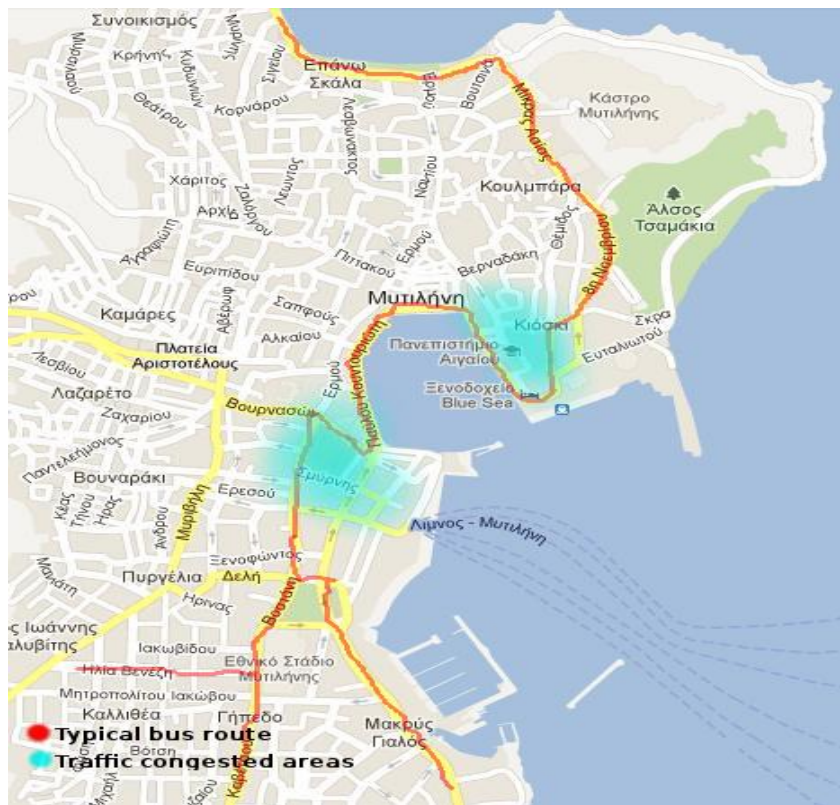


Figure 4.2.16 Typical bus route through Mytilene

Deliverable 2: Current Situation Analysis

Figure 4.2.17 reveals an alternative to the previous bus route that, although longer, avoids the center of the town. This is a ring road that surrounds the city center and helps in improving the traffic condition in the town.

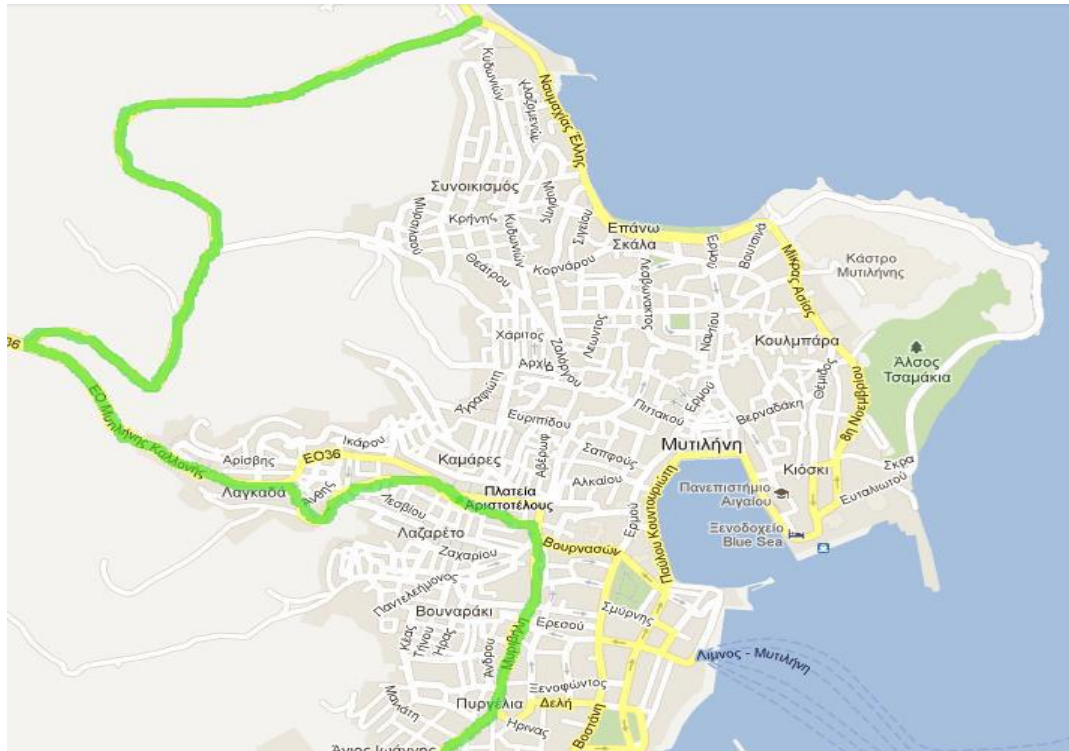


Figure 4.2.17. Alternative bus route

There is a growing trend in favor of bicycles in Lesvos. While there is not much official evidence, the daily local experience shows that more people (mainly those who live in or near Mytilene) choose bicycle as their main transport mean. Moreover, cycling races that pass through main road arteries of the town are organized each year. Road surface condition though is not ideal for bicycle use, but there has been recent planning for bicycle lanes (through a study made from the National Technical University), which would not only make it easier and safer for riders to cycle, but also would improve the traffic congestions (especially in the center of the town). In the Figure 4.2.18 the primary and secondary bicycle lines are presented, as they were proposed to the study made from the National Technical University.

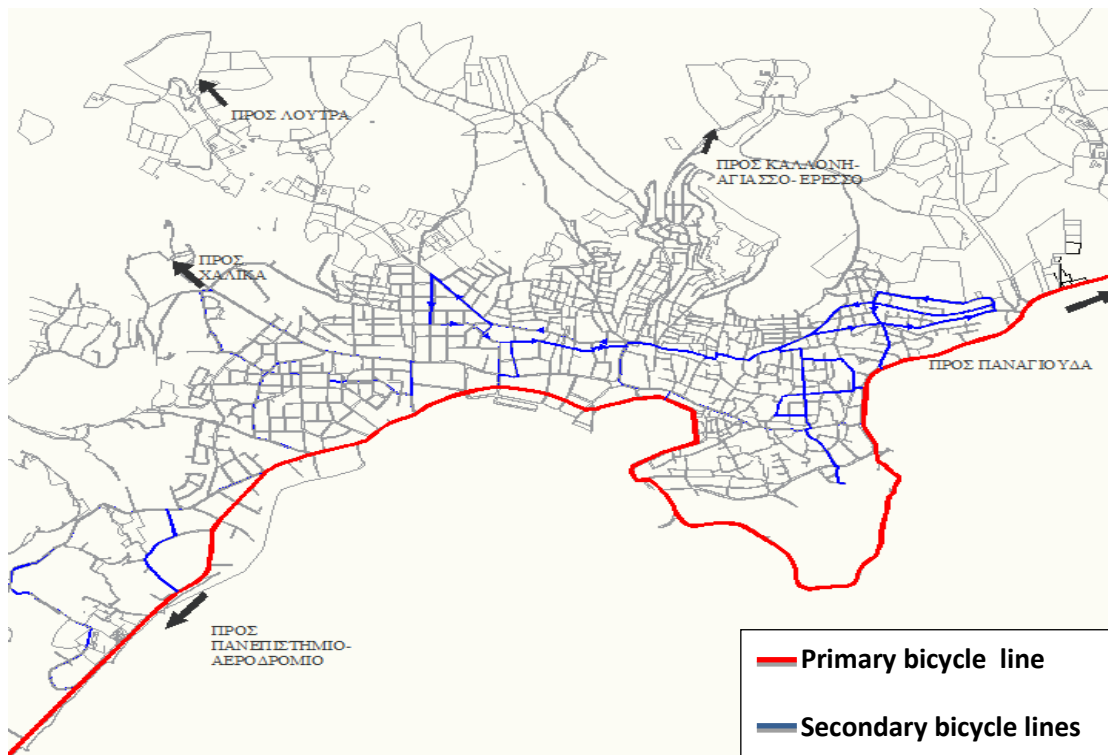


Figure 4.2.18 Network of cycling routes in Mytilene (source: Strategic plan for creating viable movability conditions emphasizing on bicycle in Mytilene town, National Technical University, 2009)

4.2.6 Inter-Island Transportation System Characteristics

The passenger market structure is depicted in the following figure. A passenger has the choice of airplane or ship to move to Athens or another city. The main transport hub in and out of Lesbos is Mytilene (airport and port) but there is the alternative of Sigri port, which is located in the west of the island (mainly preferred by inhabitants who live in the western villages of Lesbos) and is occasionally used. The port of Sigri connects Lesbos Island with Lavrio, Thessaloniki, Limnos and St. Efstratios.

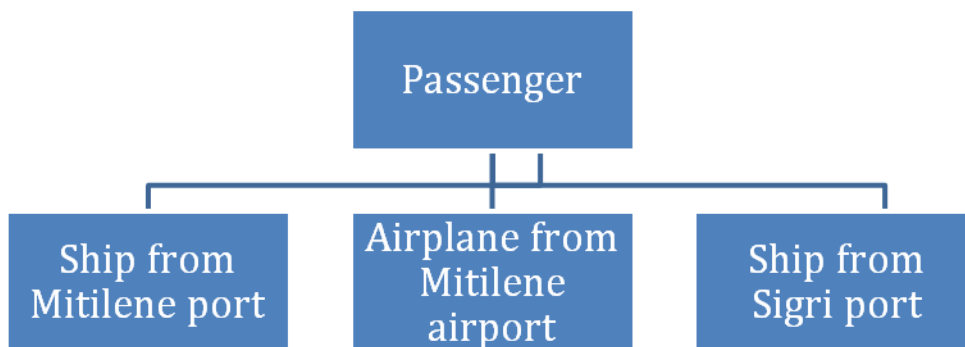


Figure 4.2.19 Passenger market structure in Lesbos

In the freight market case, as shown in Figure 4.2.20, the shipper (receiver) has the choice of airplane and ship again, but the airplane is used mostly for light and valuable cargo as well as for printed press arriving early in the morning with the first plane landing from Athens. Sometimes it is chosen the Sigri port alternative for cost reasons.

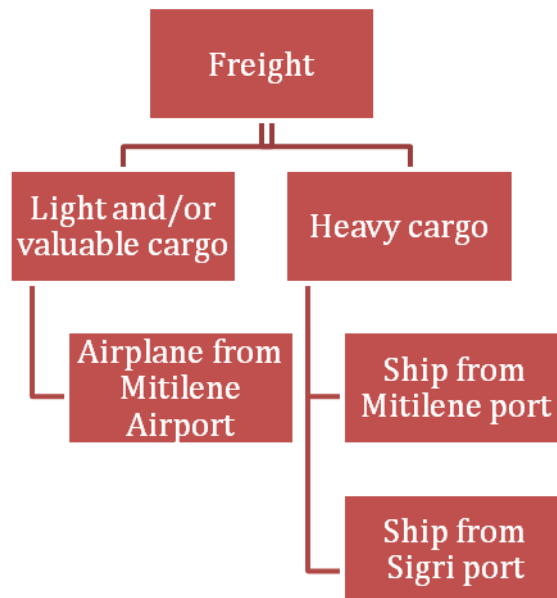


Figure 4.2.20 Freight market structure in Lesbos

Figure 4.2.21 presents the passenger movement of Mytilene airport for the previous year. As it can be easily conducted, passenger movement comes to a peak during the summer season.

Figure 4.2.22 clearly shows the seasonality observed in the passenger movement of Mytilene port in year 2011. While during the winter months passenger movement is limited to around 10,000 passengers arriving at Mytilene port every month, in July the island was visited by as many as 40,000 passengers. The small peak during April is explained by the tourists and local students visiting the island for the Easter. In Figure 4.2.23 is presented the annual passenger's movement at Mytilene port for years 2007-2011. It is obvious that there is a steady decline that begins in 2009, when the financial crisis started.

Figure 4.2.24 confirms that the same rules as in Mytilene port also apply for the Sigrí port, in a much smaller but proportionate scale. In contrast to Figure 4.2.23, Figure 4.2.25 clearly shows that the low passenger's movement in 2008 at Sigrí port is followed by a worth mentioned rise in 2009, which ends up in a decline in 2010.

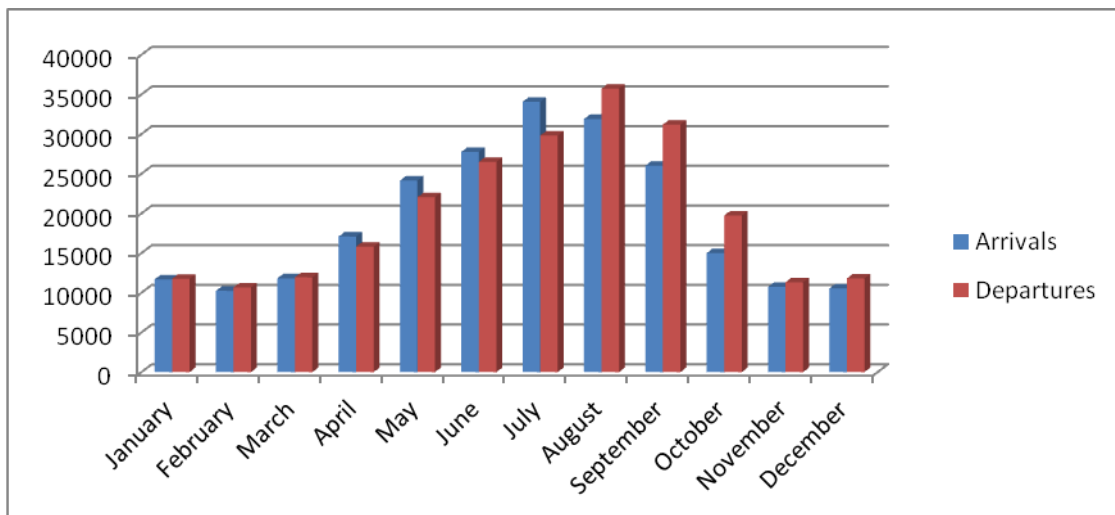


Figure 4.2.21 Mytilene airport passenger's movement 2011 (source: Civil Aviation Authority)

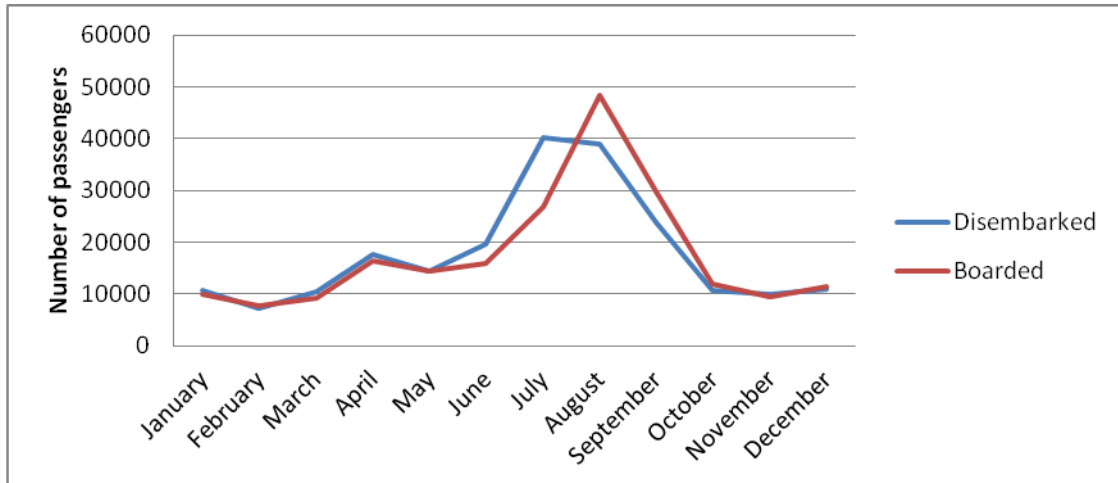


Figure 4.2.22 Mytilene port passenger's movement 2011 (source: Mytilene Port Authorities)

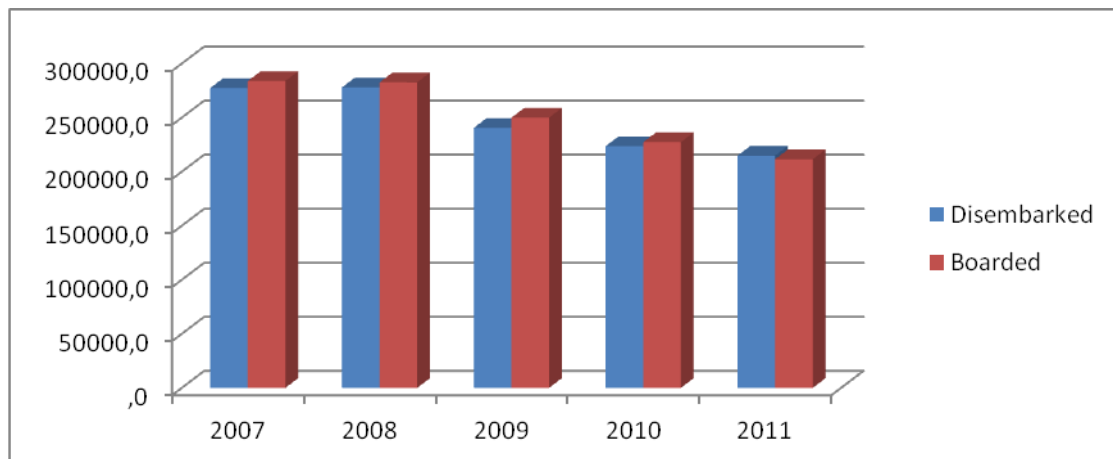


Figure 4.2.23 Mytilene port passenger's annual movement for years 2007-2011 (source: Mytilene Port Authorities)

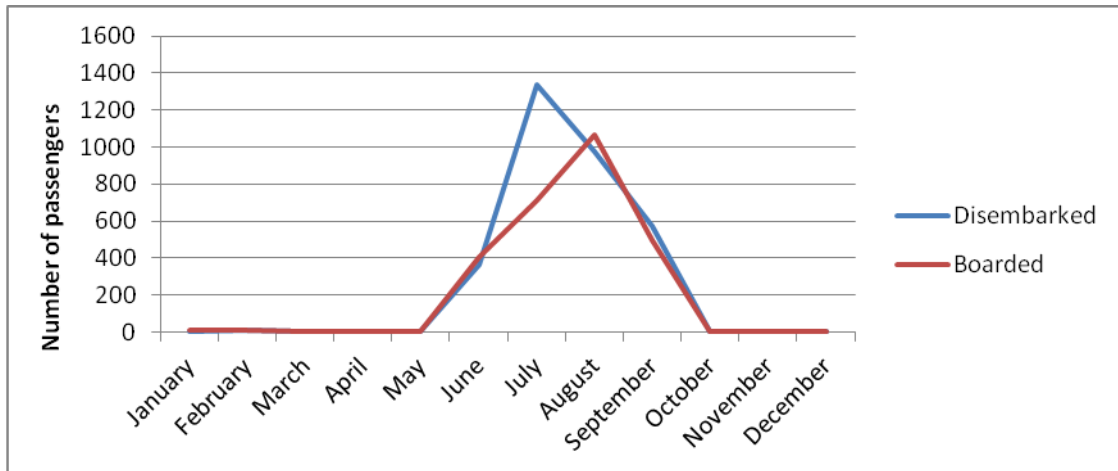


Figure 4.2.24 Sigrí port passenger’s movement 2010 (source: Sigrí Port Authorities)

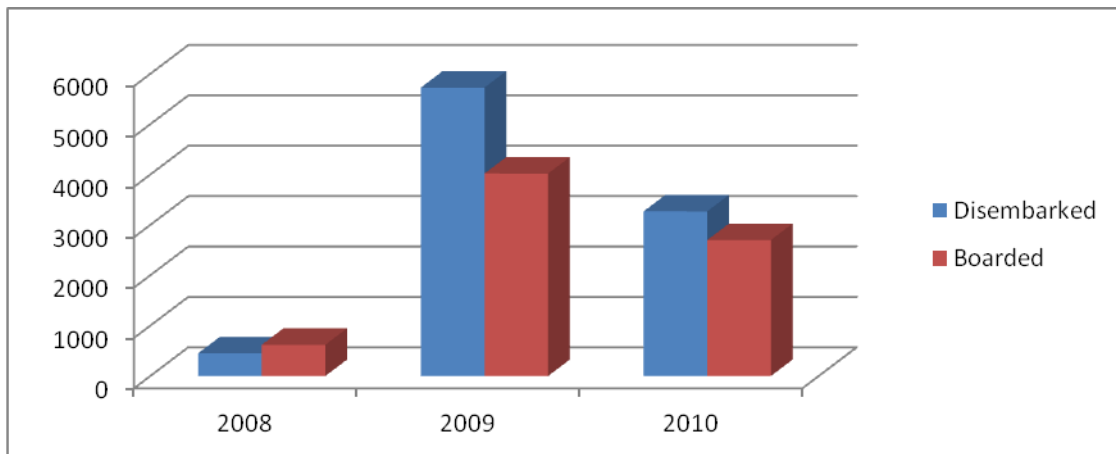


Figure 4.2.25 Sigrí port passenger’s annual movement for years 2008-2010 (source: Sigrí Port Authorities)

The leisure port (Marina) of Mytilene is in the same area as the main port of the town of Mytilene, in the southern east area of the island of Lesvos. The marina has a land and a marine area. The maritime area includes an internal and an external port, while the storage area has a surface of more or less 37.500 m². The capacity of the marina is 252 places, which includes 222 places in the marine area, the floating docks and platforms and 30 places on the land area. It is a new marina operating since 2010, while recently (July 2012) a contract was signed between Folli Follie Group and Setur Servis Turistik A.Ş., which confirms this joint venture and the two companies take over the hiring and management of the marina for 40 years. It is situated in the region of the Makri Gialo, part of the municipality of Mytilene. The distance from the marina to the center of the town is about 1km, while the distance to the airport is less than 7km. Marina contributes to the increase of tourism in the island, while it is scheduled to offer several facilities/amenities available to boat owners and there will be a mini van transporting boat owners to the center of the town or for sightseeing.



Figure 4.2.26 Marina of Mytilene

In the figure 4.2.27 the boat movement in Mytilene's Marina for the year 2011 is presented. As it is shown, there is a peak to the number of boats arriving at the island during the summer months, so traffic in and out of Marina area is increased during this period. As it can be conducted though, Marina's boat movement is much under its capacity even at peak season.

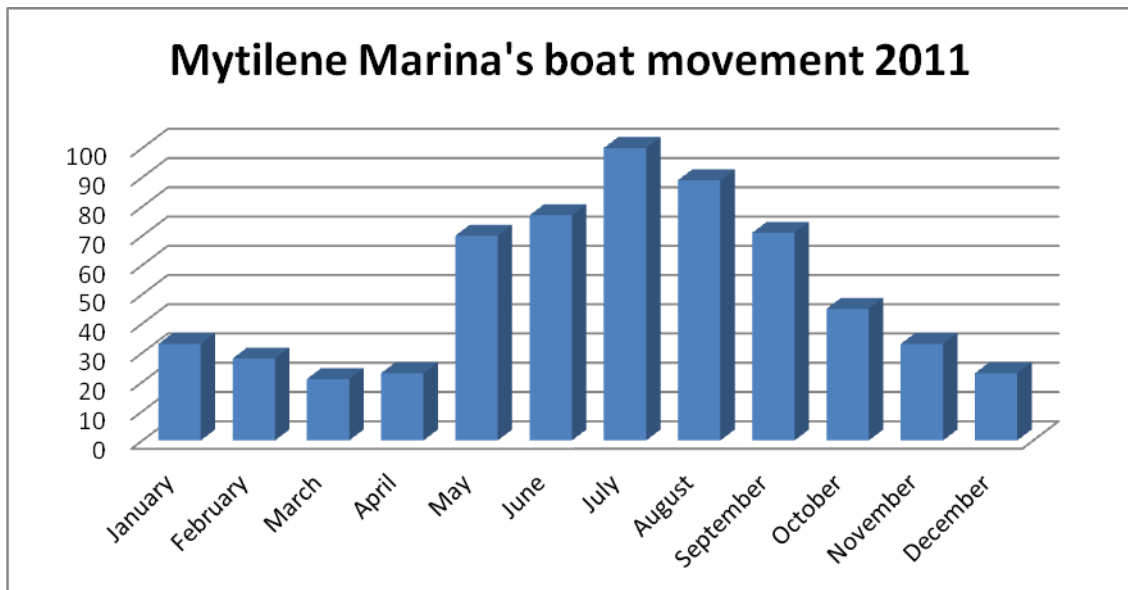


Figure 4.2.27 Mytilene Marina's boat movement 2011 (source: Marina of Mytilene)

4.2.7 Land Use Characteristics

In the figure below the land use in Lesvos in 1991 is presented. As it can be seen, the largest part of the land was covered from crops (793 thousand stremmas) and private pastures (761.6 thousand stremmas) and then follow the areas of forests (313.8 thousand stremmas), public pastures (141,9 thousand stremmas), areas covered by buildings and roads (71.7 thousand stremmas), areas under water (33.2 thousand stremmas) and other areas (38.5 thousand stremmas)

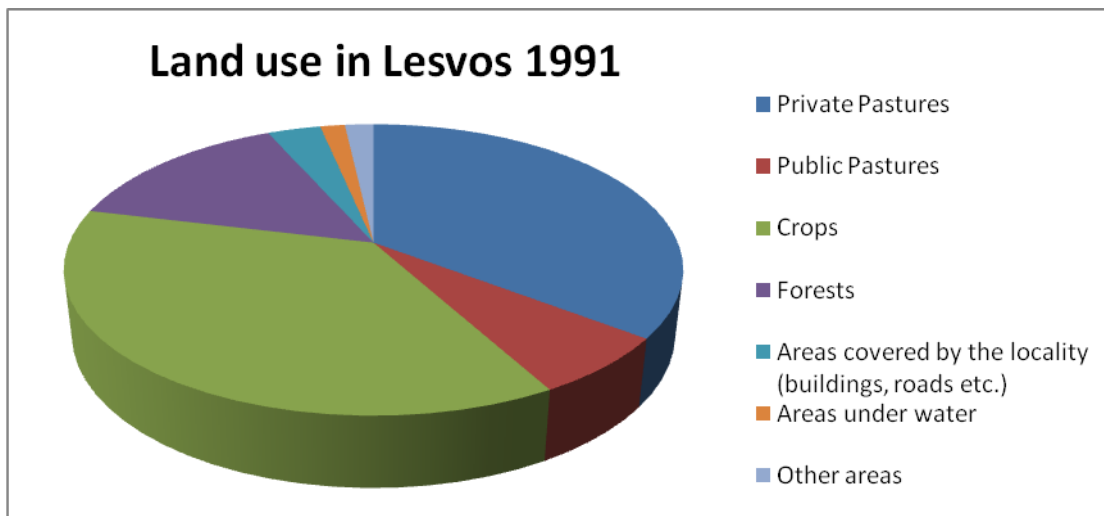


Figure 4.2.28 Land use in Lesvos (source: Hellenic Statistical Authority)

Figure 4.2.29 shows the distribution of land use in Lesvos in 2000 (pre-census data). According to the Hellenic Statistical Authority, the island area is 2.151,4 thousand stremmas, from which 1419,6 thousand stremmas consist of agricultural areas (arable land, permanent crops, pastures), 684,5 thousand stremmas consist of forests and seminatural areas, 21,1 thousand stremmas consist of surfaces under water and 2,6 thousand stremmas consist of artificial surfaces (industrial and commercial units, transport units).

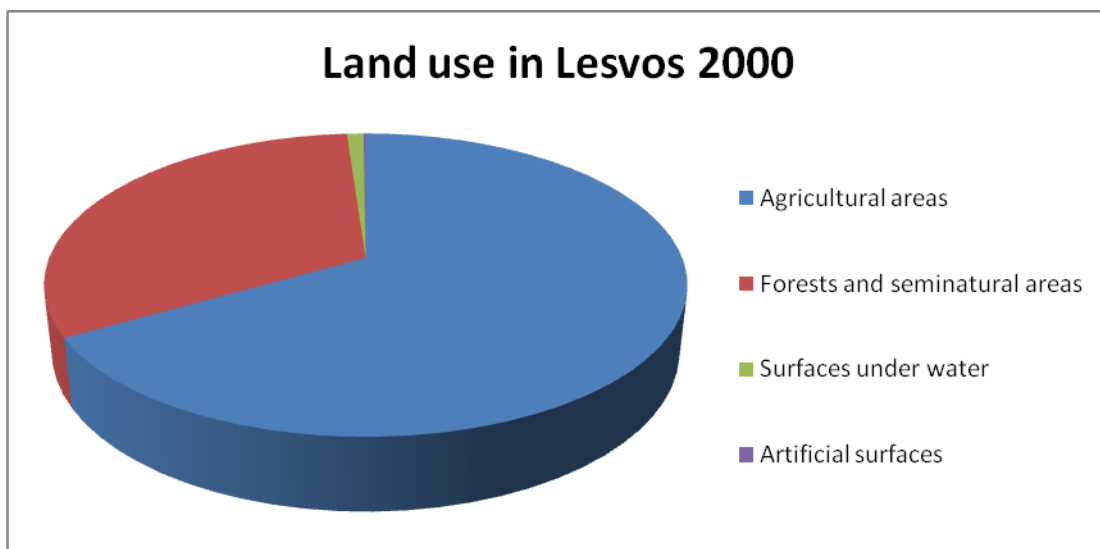


Figure 4.2.29 Land use in Lesvos (source: Hellenic Statistical Authority)

4.3 Conclusions

4.3.1 Chios Island

Chios town plays a crucial role in the transport situation of the island. Both geographically and socially it is the center of the island and most of the traffic flows origin or end up there. The center of Chios town faced traffic congestion problems during rush hour, which are deteriorated during the summer months, due to the mass arrival of tourists and Greek-Americans who visit the island.

The population of the island remains almost the same for the past 20 years, but there is a steady increase in the number of cars. As shown in the figures, Chios is among the first places in Greece regarding the number of cars per capita. This is the main reason for the traffic congestion, with the small and unplanned road network adding to this fact.

Regardless of the Chios town road network, the island's roads are generally in a bad condition. Excluding the new Mesta-Chios road, roads connecting the capital with big villages (like Kardamyla) are in a bad condition. Most of the roads are built on existing trails and dirt roads, leading to the fact that they are full of sharp turns and run through villages.

The condition of the road network is a key factor influencing the many road accidents happening on the island. Another factor is the mass usage of motorcycles, many of them driven by under-age people (some not even of age for a driving license).



Nevertheless there is a bicycle trend growing the recent years, which should be encouraged by policy measures and new infrastructure.

4.3.2 Lesvos Island

Mytilene town plays a crucial role in the transport situation of the Lesvos Island. Although geographically it is located at the southeastern part of the island, it is the center of the economical transactions of the island and most of traffic flows origin or end up there. The center of Mytilene faces traffic congestion problems during rush hours, which are deteriorated during the summer months, due to the mass arrival of tourists and North Europeans who visit the island. Kalloni, the second largest town, also plays an important role in the island's economy and transportation system, as it is located in the center of the island.

The population of the island remains almost the same for the past 20 years, but there is a steady decrease in the number of cars. As shown in the figures, Lesvos has a large number of cars per capita. This is the main reason for the traffic congestion observed in the center of the town.

Regardless of the Mytilene's road network, the island's roads are generally in a good condition. Recently, there have been made important improvements in many roads on the island, such as the new Mytilene-Kalloni road and the new Mytilene-Polichnitos road. Undoubtly, many of the roads that connect villages and pass through them are in a bad condition, as they are built on existing trails and dirt roads, leading to the fact that they are full of sharp turns.

The condition of the road network is a key factor influencing the many road accidents (which tend to decrease) happening on the island. Another factor is the mass usage of motorcycles, many of them driven by under-age people (some not even of age for a driving license). Nevertheless, there is a bicycle trend growing the recent years, which should be encouraged by policy measures and new infrastructure.

5 ENVIRONMENTAL IMPACTS OF THE TRANSPORTATION SYSTEMS

This section presents a review of the global academic literature on the environmental consequences of transport, sustainable transport policies and ecological indicators (i.e. indicators of environmental quality), all geared towards insular tourism transport. In addition, a synthesis of its findings into conclusions and recommendations for other WPs is presented. It is understood that we are especially interested in best management practices and measures that are applicable and may stimulate innovation in the GreTIA study area.

5.1 Background

As regards our methodology, we located the academic literature that is reviewed in this section by using keywords such as: sustainable/green transport; (small) islands; sustainable transport policies; green accounting; sustainable transport indicators; Ecological Footprint Analysis (EFA); Quality of Life (QoL); and socioeconomic barriers. The bulk of the literature collected included journal papers and technical publications of sundry nature (including some of the Global Footprint Network, GFN).

As Goldman & Gorham (2006) put it aptly, transportation is a complex and porous social, technical, and economic system that is difficult to address comprehensively, especially against the background of increasing global demand for motorization and mobility. How are tourism, transport and the environment linked? Tourism, the world's largest industry, is viewed as a high consumption industry, with tourists consuming more than the per capita host community, and many destinations operating at sustainability lower than the global average (Patterson, Niccolucci & Bastianoni, 2007). Transport in particular contributes 94% of the energy used in tourism. Road transport and aviation in particular are popular, most developing and most polluting transport sectors (Woodcock, Banister, Edwards, Prentice & Roberts, 2007; Chapman, 2007). While road transport accounts for 81% of energy consumed locally, it should be kept in mind that most energy consumption and greenhouse gas emissions of tourism, are due to air travel. Therefore, limiting air travel (e.g. by attracting tourists from nearby areas) is an astonishingly simple measure to prescribe (albeit difficult to achieve) that may, in one swoop, reduce energy consumption and greenhouse gas emissions dramatically.

How should we approach the term green transport? First off, green transport is an alternative term for sustainable transport. Of the numerous definitions of sustainability, we prefer to think of it as economic development in qualitative rather than quantitative terms: development that secures a satisfactory Quality of Life (QoL) for the current generation within the carrying capacity of the environment. By respecting the constraints imposed by the limited availability of natural resources, future generations are assured of equivalent (if not equal) development opportunities. Therefore, sustainable (or green) transport refers to transportation systems that are built and operate in a sustainable manner. Further deliberation on the services provided by transport, indicates that sustainable transportation essentially means sustainable mobility (Black, 1996) or, more accurately, access to transport services that enable mobility (Gudmundsson & Höjer, 1996).

What are the specifics of island transport? Compared to the general transport picture, islands are geographically isolated, lack of capital is an issue for many islanders (Enoch & Waren, 2008), and tourism is both an important component of insular transport as well as an important source of income for local societies. In turn, income is an important determinant of car mobility, so tourism boosts transport demand both directly and indirectly (by increasing the income of islanders).

While much of sustainability depends on energy consumption and greenhouse gas emissions, there exist many more environmental impacts of transport that must be addressed in GreTIA. These are presented in the next subsection.

5.2 Transport sustainability

For quite some time (e.g. Black, 1996), it has been believed that current transportation systems are not sustainable because: oil reserves are finite; traffic emissions impact both urban air quality and the global environment; motor vehicle (air conditioning) coolants degrade the ozone shield; motor vehicle accidents result in injuries and fatalities; transport facilities are congested; and motor vehicles stimulate urban sprawl (creating a negative feedback loop). The transportation sector does indeed consume non renewable resources such as: energy, human and ecological habitats and atmospheric carbon loading capacity (Goldman & Gorham, 2006).

In this subsection we propose that a holistic view of environmental impacts be taken, incorporating all effects of transportation systems on the atmosphere, the hydrosphere, the geosphere and the biosphere. These may be classified as follows:

- *Air pollution*: urban air pollution (local problem, to be tackled in WP5); greenhouse gas emissions, i.e. mainly CO₂ contributions (global problem, tackled here and in WP9).
- *Noise*: noise pollution (a form of energy emissions).
- *Water pollution*: water and groundwater pollution via street runoff, which carries diffuse surface pollution emitted by vehicles as they travel on streets and highways; marine pollution caused by oil spills (an indirect effect caused by fuel demanded by transport).
- *Soil erosion and pollution*: soil erosion (mainly by construction of new infrastructure); degradation and loss of open spaces and wetlands; solid waste issues, i.e. municipal garbage and hazardous material transportation.
- *Impacts on ecosystems*: impacts on ecosystems (flora and fauna, especially endangered species) such as degradation, encroachment and separation.
- *Use and depletion of resources*: energy consumption (very important in light of the era of peak oil and global climate change, thus the notion that ecological footprint indicator is a particularly good tool to show the overall impact of transport and its relevance to tourism); increased consumption of various other resources that are inputs required by transportation technologies (e.g. rare minerals required by catalytic converted of vehicle cars).
- *Socioeconomic impacts*: land use changes and decreased property values; increased demand on public services (e.g. electrical grid) and emergency response services; structural problems, mainly vibration damage; population health effects; productivity losses caused by accidents; and various effects on employment and other economic activities including tourism.
- *Impacts on the historic and cultural environment*: loss of historic buildings and monuments.

- *Political impacts*: national security concerns.

With the above environmental profile of transport in mind, in the next subsection we present literature findings on transport policies that are intended to enhance sustainability.

5.3 Policies

As point out by Goldman & Gorham (2006), transportation decisions tend to be made in the service of larger policy goals such as: economic growth, job creation, land use management, and geographic transfers of wealth. What would be an appropriate conceptual framework for the consideration of sustainable transport policies? Black (1996) site professional sources that see transport policies falling into the following broad classes: (1) regulatory mechanisms to control emissions; (2) tax increases that favor energy-efficient transport modes, (3) support for new technologies and alternative fuels; and (4) planning approaches that decrease travel demand. To these one may add telecommuting solutions and options offered by Intelligent Transport Systems (ITS). Of interest (although dated) is the following 12-point plan for sustainable emissions by Hughes (1993), as presented by Black (1996):

1. motor vehicle fuel economy labeling (e.g. in miles per gallon or kilometers per liter), a practice that has become quite widespread but has failed to secure a move towards more energy efficient vehicles;
2. fuel economy feebates or rebates;
3. programs for the development of alternative fuels;
4. speed limits for motor vehicles;
5. employee travel schemes;
6. environmental impact assessment of transport projects;
7. increased spending on transit;
8. redistribution of transport taxes to more energy-efficient modes;
9. infrastructure accessibility taxes;
10. area licensing or road fees;
11. land use planning;
12. and carbon taxes aimed to lessen vehicle use, fuel consumption and carbon dioxide (CO₂) emissions.

Directing our attention to specific studies, most sustainable transport policies concern the passenger car. On car ownership in developed countries, it is noted that while income levels affects the number of cars (which are usually expressed in number of cars per 100 or 1000 people), it is gasoline prices that affect the size of cars (Enoch & Warren, 2008). Levels of car ownership are affected by: the availability of infrastructure; income distribution within a country (or a region); the quality, affordability and availability of public transport services; state policies; and cultural, social and religious values. Car use is affected by: income; gender; age; occupation; and educational level. Regarding car policies in less developed countries, it has long been established that there exists a strong relationship between car ownership and the rate of economic growth (Button,1993). Overall, fuel price and income were found to be important influences in the short term (Enoch & Warren, 2008) with neither fuel price nor degree of isolation (remoteness) playing an important role.

Boyle (1990) argues that a combination of mandatory efficiency standards, increasing fuel prices through carbon taxes (something that is destined to happen in the post peak oil era), and an appropriate grant/tax regime, will likely to be an effective strategy in

achieving improvements in car fuel efficiency. Unfortunately, as average car mileage and car ownership keep increasing, and average car velocities keep decreasing, only aggressive measures could reduce fuel consumption. Boyle also suggests that a transition away from oil-based transport (such as biomass-derived ethanol/methanol or electric vehicles) is one of the few longer term options to control greenhouse gas emissions and urban traffic pollution. Boyle is reserved on the viability of hydrogen as an automobile fuel, a thesis with which we wholeheartedly agree (Zubrin, 2007).

Vieira et al. (2007) discern two major technological strategies to overcome the burden of fossil fuels in transportation: increase fuel economy of vehicles as well as introduce end-of-pipe technologies to reduce traffic emissions; and introduce alternative fuels, such as biofuels. They also emphasize the importance of eco-driving (i.e. driving in a manner friendly to the environment), as it affects favorably energy use and vehicle maintenance e.g. by reducing accelerations and decelerations in driving behavior. Their work brings forth the importance of driver education. In the second part of a lengthy study, Santos, et al. (2010) argue for the promotion of an energy-efficient driving style and the stimulation of purchases of more energy-efficient cars (with education, even at the school level, and tax benefits as motives).

The use of bicycles is of particular interest in this project, because (a) cycling is well suited to ecotourism and (b) the study area enjoys good weather for a large part of the year. It has been found (Santos et al., 2010; Pucher et al., 2011) that:

- Cycling is promoted by: expansion and improvement of bicycle lanes and paths; traffic calming; sheltered and secure parking; bike-transit interaction and integration; bike sharing programs; education and training programs; and promotional events (such as rides, races, festivals, and special cycling events, that take advantage of the Internet).
- Cycling is concentrated in central cities and near universities; to this end, the existence of university campuses in our study area offer additional potential to our endeavors.
- Finally, there is spatial variation and socioeconomic inequality in cycling trends; to this end, it would be interesting to find out what the cycling trends are in our study area.

Coleman (2000) suggests that local authorities need to continue with awareness efforts, although he points out that this is likely to be a lengthy process with a slow return. On a pessimistic note, he argues that the widespread implementation of green commuter plans is unlikely unless national legislation requires it. Interestingly, he suggests that targeting (large) businesses in urban and suburban locations may be a sensible short term way forward – this constitutes an interesting possibility for our study. Attard (2005) argues in favor of integrated transport systems using the best available technology.

Implementing sustainable transport policies is not easy. The European Conference of Ministers of Transport's (ECMT) Sustainable Urban Travel (SUT) program (1997–2001) sponsored a series of workshops aimed at addressing why implementation of integrated sustainable policies has proven to be so difficult (Goldman & Gorham, 2006). As (Woodcock et al., 2007; Chapman, 2007) point out, good sustainable solutions, such as walking and cycling, are at the same time the least preferred. Some of the barriers to the implementation of sustainable transport have been pointed out by Attard (2005):

- high status associated with the car; this may be of particular concern for the study area, which is reputed to have high car ownership levels;
- lack of infrastructural and professional investment in public transport operations;
- lack of professionals in the field of land transport planning;
- organizational fragmentation;
- lack of proper and accurate information;
- political issues;
- and funding problems.

Also, as Steg & Gifford (2005) point out, policy makers should take into account how policies may affect QoL, e.g. restrictions in freedom of choice may be ill received and psychologically resisted.

All in all, there are indeed significant political, economic, social, institutional, and technological challenges to the implementation of sustainable transport systems. Therefore, of particular interest to GreTIA is the development of innovative measures for sustainable transport. Goldman & Gorham (2006) sketch out four types of innovative measures in sustainable transport:

- a) *New Mobility*, referring to more flexible, convenient and competitive travel options (than the passenger vehicle). These include distributed travel information (real time and making use of the Internet via mobile devices), fare integration (via e.g. smart cards), car sharing (with fuel efficient models, assured reserved parking and other perks), bike sharing (unlocked by telephone, charged on credit cards and equipped with sensors for better damage and maintenance control), auto-free housing (in coveted areas, with parking exceptions provided as bonuses), and other new service paradigms (such as integrated origin to destination planning).
- b) *City Logistics*, referring to urban freight traffic.
- c) *Intelligent System Management*, referring to tools such as congestion charging, comprehensive bus management systems (with smart bus routes that provide enhanced passenger information, real time arrival displays, low floor buses, more regular cleaning, better bus shelters, transit priority signals, automatic vehicle location and driver instruction systems), automated traffic enforcement, and full business plans and business case presentation for new proposals.
- d) *Livability*, i.e. accessibility, public spaces, social engagement and recreation, and the overall health and economic welfare of city residents. Related measures include pedestrian realms (e.g. streets exclusively for the use of bicycles and pedestrians, banned parking on sidewalks), breaking the driving routine (e.g. with car free days or rationed access to the city during peak hours), rapid bus transit and zones of shared neighborhood space.

With green transport policies aiming to improve the sustainability of transport systems, it is important to be capable of assessing sustainability levels on a quantitative basis. This is the subject of the next subsection.

5.4 Indicators

Concepts that have been suggested to evaluate the environmental consequences of tourism include the process of Environmental Impact Assessment (EIA), the Concept of Carrying Capacity (CCC), and the method of Limits of Acceptable Change (LAC) (Gössling et al., 2002). While all these may easily focus on changes occurring in the

local environment, EIA and LAC cannot assess sustainability from a more comprehensive (global) point of view. This is of special importance in the case of tourism that is an activity that seems to draw on extensive hinterlands.

While environmental economics strive to solve environmental problems largely by attempting to internalize pollution externalities to the market system, ecological economics challenges the neoclassical growth theory assertion that utility increases with consumption (Patterson et al., 2007). Most sustainability indexes fall within the domain of ecological economics.

Green accounting attempts to internalize environmental damages into financial calculations, and is related to the use of various quantitative sustainability indicators, that allow the use of such arithmetic computations. Of the many such indicators, Ecological Footprint (EF) is a prominent sustainability indicator that falls within the domain of Ecological Economics and green accounting (Wackernagel & Rees, 1995). EF is described in detail in the next subsection, where it is also shown that is a tool particularly applicable to studies of tourism.

5.4.1 Ecological Footprint (EF)

EF is an indicator of energy consumption, material consumption and waste generation, and it is cited as a key environmental indicator in the case of sustainable tourism assessment (Patterson et al., 2007). EF is the inverse of CCC: instead of comparing the demands exerted on an ecosystem to its carrying capacity, it estimates the land required to satisfy these demands (Wackernagel & Rees, 1995; Chambers et al., 2001), allowing the comparison of the area required to support a certain lifestyle with the area available (Gössling et al., 2002). In other words, EFA offers a quantitative tool to assess if total consumption is ecologically sustainable.

EFA classifies land (i.e. ecologically productive areas that provide resources and assimilate wastes) into 6 categories: (1) fossil energy land, (2) cropland, (3) grazing land, (4) forests, (5) built-up land and (6) fishing ground. Fossil energy land is the (hypothetical) equivalent planted forest area that is necessary in order to absorb CO₂ emissions. In order to get a feeling, one hectare of fossil energy land can annually sequester the CO₂ derived from 56 GJ of coal, 73 GJ of liquid fuels (e.g. gasoline), or 96 GJ of natural gas (Gössling et al., 2002). EF results are reported in global hectares (gha), which are weighted (rather than actual) ecological surfaces (one hectare is equal to 10000 m²). Some of these facts are depicted in Figures 5.4.1 and 5.4.2.



Figure 5.4.1 Ecological Footprint schematic (Wackernagel & Rees, 1995)



Figure 5.4.2 Ecological Footprint area and sea land types (<http://www.stepsforward.org.uk/tech/footprint.htm>)

On top of its value as a sustainability indicator, EF is a great communication tool. Figure 5.4.3 shows a world map in which countries are stretched to indicate their effective consumption, estimated by EFA. As an example of the results that may be obtained, it has been estimated that the island of Taiwan requires an area 42 times the size of the island in order to sustain its 2007 consumption (Wang et al., 2012).

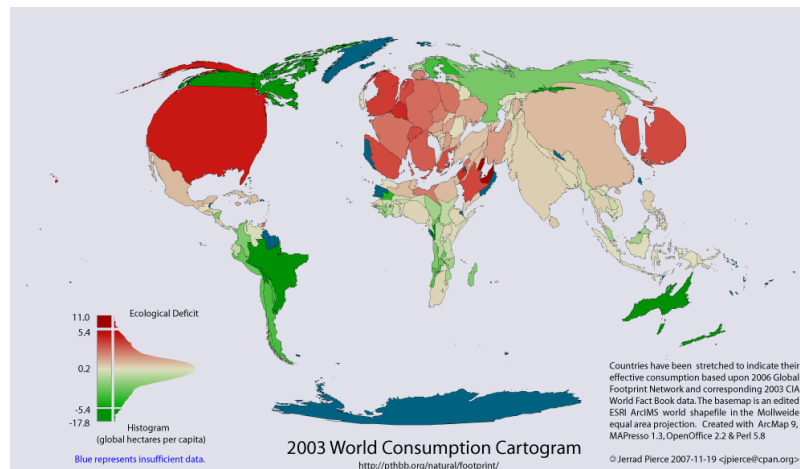


Figure 5.4.3 World cartogram showing effective consumption

Ecological Footprint Analysis may be used for the estimation of the global impact of tourism, especially (road and air) transport. What is great about EFA, is that suggested policy measures and future scenarios may be translated to Ecological Footprint changes. And, like other sustainability indexes, EF provides a quantified means to assess whether environmental commitments are met (Patterson et al., 2007).

Different studies attribute different percentages to transport, as a part of total EF. For example, in Victoria, Australia, the transport EF is reported to be 10% of the total EF (<http://www.epa.vic.gov.au/ecologicalfootprint/ausFootprint/default.asp>). Carnegie Mellon University reported 13% of its total EF to be attributed to transport (Carnegie Mellon University, 2008). We expect these percentages to be much higher in tourism studies, mainly due to the gigantic ecological footprint of air travel.

While EFA is relevant to our study (GreTIA being a tourism transport project), there are a couple of shortcomings to keep in mind. Firstly, for tourists flying from overseas, their air travel EF is expected to dwarf local EF, thus it is important that air and local transport EF be estimated separately. In addition, it appears that opportunities to compare EF calculations against tourist EFs in the literature are constrained by: differences in methodology; differences in the composition of impact categories; and limitations in the availability of data (Patterson, Niccolucci & Bastianoni, 2007). As long as local EF is estimated separately, we expect it to confirm that road transport may become critical in future tourist development scenarios that rely excessively on private transport.

Important inputs to the EF of transport include road network data, such as traffic volumes, vehicle types, vehicle fuel efficiencies and the physical dimensions of road network. In the case of tourism studies, energy consumption by road transport is usually estimated both for total trips (i.e. by residents and tourists) as well as tourists only. It is then interesting to assess the contribution of tourism transport to the total energy consumption. An important factor in this, is how massively tourist routes are used. Therefore, tourist trip matrix data will be required for the estimation of the EF of tourism transport – it is expected that these will be obtained from Task 6.3 (Modeling of Tourist Choices) of WP6 (Behavioral Modeling).

Having completed a general look at the Ecological Footprint, the sustainability indicator best fitted to our project, we now direct our attention to case studies of green transport worldwide.

5.5 Case studies

We examine (a) general case studies on green transport policies, (b) case studies on various EF analyses, and (c) case studies on the EF of tourism and transport.

5.5.1 Cases: policy

We start with a few cases on (sustainable) transport policies.

In case study on public transport in *Malta*, an important tourist destination in the Mediterranean, Attard (2005) points out that the public transport service relies solely on buses and operates in a radial fashion across the main island being a remnant of that adopted when buses were first introduced in the beginning of the 20th century. The city is a major destination as well as a major interchange hub for passengers wishing to reach various destinations around the island. The Maltese experience showed that bus service was very successful because car ownership was low. As private mobility increased though, the modal choice shifted from public to private transport.

In a case study of *Xiamen Island, China*, Zhou et al. (2012) consider policies that target energy consumption by urban transport, and have been applied successfully in developing countries. Among these, they consider giving priority to the development of public transportation, the performance of which is measured by indicators such as: coverage rate of public traffic network (more than 78%), service radius of transit stops (at least as low as 500 m), and average waiting time (less than 5 min). They also examine the construction of walkways and bicycle roads. Land use policies they examine, include: banning new industrial zones on the island and reducing their number of currently existing ones; and converting industrial land to commercial mixed use land. These are all coupled with economic policies aimed to: increase private car costs by fuel taxes and increase in parking costs; and reduce bus costs with fiscal subsidies for bus operators. Their work illustrates the importance of coupling technological measures with fiscal control.

In a study of the island of *Mauritius, Indian Ocean*, Enoch (2003) points out several areas that are appropriate targets for policy improvements. These include: (a) managing road use (e.g. smoothen traffic flow, cut accidents, manage parking, and reduce pollution); (b) managing the vehicle stock (e.g. new regulations, improved enforcement, better quality fuels, price incentives for greener vehicles; and (c) improving public transport (with measures such as incentives for bus operators to improve vehicle and service quality, more competition, possible consolidation of individual operators into companies or co-operatives and privatization, and reform of the taxi industry). All of these, properly attuned to the realities of our study area, are appropriate directions for GreTIA.

In a study of electric scooters in *Taiwan*, Hwang (2010) argues that electric-scooter promotional program fail due to challenges related to battery prices and safety. Taiwan's Statute for Renewable Energy Development, which increases electricity produced from non-carbon sources, capitalizes on the benefits of electric scooters.

5.5.2 Cases: Ecological Footprint of tourism and transport

In this subsection, we examine two key EF studies that specifically address tourism, and focus on the transportation components of such studies.

Patterson et al. (2007) present an EFA application in the area of *Val di Merse, near Siena, Italy*. The Merse watershed valley spans an area of 508 km². An Agenda 21 report drew attention to the following 3 challenges for Siena: congestion in the province's historical center, lack of rural employment opportunities, and inefficient resource use. Most tourists were drawn to the study area by artistic attractions (54%) and thermal spas (29%), with destinations slightly off the beaten path, such as Val di Merse (50 km away from Sienna) attracting smaller a small 3.5% of total tourists in the area. Business travelers and day tourists were infrequent.

The EF of the entire area included tourists as well as the resident population. EFA accounted for: consumption of energy (including transport); use of raw materials; use of water; foodstuff use; generation of wastes (including CO₂ emissions from the use of fossil fuels); and loss of productive land associated with the built environment, e.g. buildings, roads. Specific tourist consumption categories included: arrival transport; local transport; accommodation (including land, energy, and water and heating fuel use); food and fiber consumption; waste production; and activities including entertainment. Resident consumption adhered to standard categories: food and fiber consumption; housing; local transport; civil services; and other consumed goods and waste production. The study used the concept of equivalent residents, i.e. tourists represented as an additional percentage over the resident population (estimated via bed-nights as a percentage of total days in a year).

EF data were collected from civic assessment sources, and included: land cover data (obtained from CORINE); data for resident food consumption; electricity; heating oil; resident automobile fuel (i.e. gasoline and diesel); waste generation; water consumption; and consumer prices. All data were cited as close to a reference year 2003 as possible.

Regarding arrival transport, the principal modes of transport used were: car, train, coach and air. Airline fuel usage and emissions were determined with the aid of an online emissions calculator, using the assumptions of a round trip economy class ticket, a Jumbo 747, and 80% occupancy. Total airline distance traveled was multiplied by a 2.7 CO₂ emission conversion factor (to account for additional radioactive forcing resulting from airline emissions at altitude). Conversion factors for transport modes were provide by the literature and are shown in

Table 5.5.1 Transport conversion factors for Val di Merse, Italy (Patterson, Niccolucci & Bastianoni, 2007)

	Conversion factor ha/year per 1000 km/person	Radiative forcing factor	Occupancy assumption
Car	0.06		2.5 persons
Train or coach	0.03		–
Air			
Long haul (>2000 km)	0.09	2.7	80%
Short haul (<2000 km)	0.06	2.7	70%

A tourist survey, similar to the one we plan to carry out in WP4, interviewed 220 tourists and 20 lodging providers. Questions established: age, country or origin, group size, mode of arrival transport, daily travel distance, accommodation site, daily meal provision (i.e. bag lunch, bar or restaurant), and purchases. The average respondent was 46 years of age, married with one child, traveling in a group of 3. Country of origin is showed in Table 5.5.2, and it a piece of information necessary in order to compute air travel EF.

Table 5.5.2 Country of origin of tourists in Val di Merse, Italy (Patterson, Niccolucci & Bastianoni, 2007)

Country of origin	Number of arrivals	Percent of total	Bed nights	Equivalent Residents
Italy	14,716	31	45,151	124
Germany	10,467	22	75,044	206
United Kingdom	5231	11	27,146	74
Netherlands	4666	10	34,130	94
United States	2226	5	12,838	35
Other	8065	17	50,216	138
European				
Rest of the world	1420	3	25,515	15
Total	46,791	100	250,113	685

Local travel was the principal form of entertainment for tourists. During the tourist survey, respondents were presented with a map and asked to indicate day-trip destinations, itineraries, driving distance and activities by day; this information was compared with responses from car rental companies. Data on energy, water use and waste generation were estimated based on lodgings near the interview site distance

assumption (15 km from the site). Reported average daily travel distance for tourists was 75 km/day, although interviews with car rental companies and responses to other queries suggested that 100 km/day was more realistic as a conservative estimate. The fact that tourists may be underreporting their travel distance must be taken into account in GreTIA. Finally, conversion coefficients for car travel were weighted by 2.5 to reflect the respondent's average car load.

Apart from transport, more consumption categories were examined in the Val di Merse study. Activity energy values were assigned from the literature as follows: museum visits consumed 10 mJ/tourist (60% electric, 40% gas); farm visits consumed 7 mJ/tourist (70% electric, 25% petrol, 5% gas); tourist shopping consumed 0.8 mJ/tourist (60% electric, 40% gas); and horse-riding consumed 0.6 mJ/tourist (15% electric, 80% petrol, 5% gas). Conversion factors assigned to electricity, petrol and gas were 0.05, 0.016 and 0.011 ha/GJ respectively. Regarding food (which generates additional travel demand), although the results of a Himalayan EFA suggest that tourists and residents may EF have very different consumption patterns (Cole & Sinclair, 2002), , tourists in the Val di Merse area were found to eat typically in the Tuscan (i.e. local) style. All in all, tourists ate out more often than residents: breakfast was most frequently reported at the place of lodging (83%) with the remainder at a cafe; lunch was nearly evenly distributed between cafe (36%) restaurant (25%), and bag lunch (39%); finally, dinner was taken more commonly at restaurant (74%) than place of lodging (26%). All in all, food and fiber consumption contributed 6% to the total tourist equivalent resident EF, or 2.22 gha/year/capita.

Tourists in Val di Merse were found to have a high average length of stay (5.3 days) with respect to other Italian destinations. A total of 250115 bed nights amounted to 685 equivalent residents, and represented an additional 5% over the registered population. Tourist accommodation contributed to the EF via: the built-up area required for rooms, apartments, activities, roads; as well as the energy land to account for energy use (electricity and heating), water consumption and waste generation. In Val di Merse, 20% of lodgings were categorized as hotels; 80% as home stays or agrotourism (where estimates for lodgings were based on the aforementioned responses from providers within 15 km of the interview site). Lodging EF for tourists consisted of: per capita consumption of electricity, municipal water consumption and generation of wastes. To reduce EF, measures such as collecting linens on a weekly, (rather than daily) basis, and forms of energy conservation such as pay-per-unit heating, were reported.

Waste was the final consumption (or rather generation) category examined in the Val di Merse study. It was found that waste EF totaled 1% of the total tourist footprint, or 0.045 gha/year per tourist equivalent resident. It is worth reporting that, although tourists are typically estimated to generate less daily waste than residents (with a waste generation peak on checkout day), the Val di Merse study failed to determine that Siena's tourists produce waste in different quantities than residents.

Wrapping up the analysis, it was found that tourist ecological footprint (5.28 gha or global hectares) was approximately equal to that of residents (5.47 gha), with the exclusion of air transport. It was found that 34% (i.e. one out of three) of foreign tourists arrived by air travel, traveling an average estimated distance of 7315 km, emitting 2.6 tons of CO₂ per trip. The EF for arrival transport summed up to 0.48 gha per arrival, which translated to 32.8 gha per equivalent resident (or 86% of the total impact). As pointed out in a previous subsection, the inclusion of air transport added a huge cap on the total tourism impact, as shown in Figure 5.5.1.

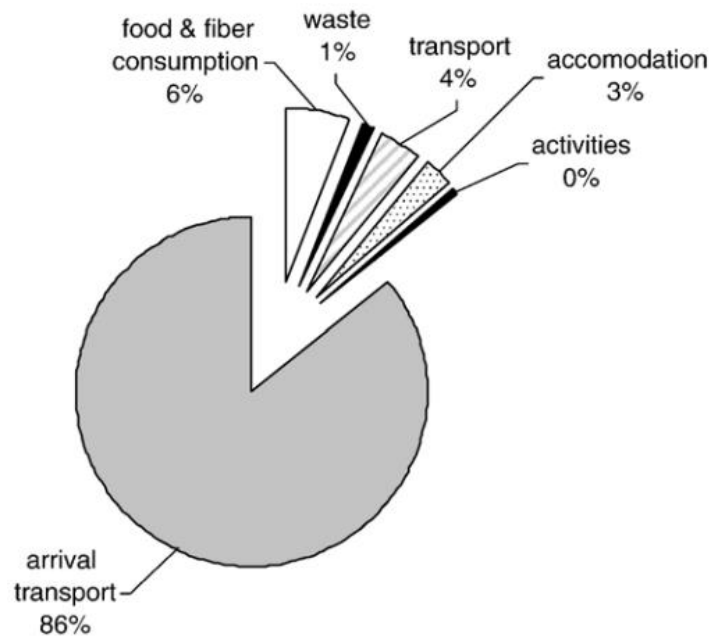


Figure 5.5.1 Components of tourist EF in Val di Merse, Italy (Patterson, Niccolucci & Bastianoni, 2007)

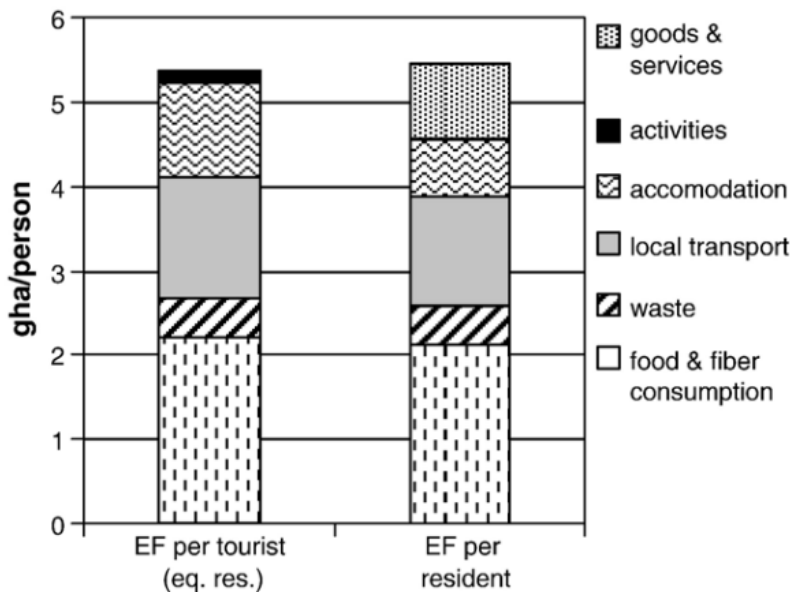


Figure 5.5.2 EF composition of tourists and residents in Val di Merse, Italy (Patterson, Niccolucci & Bastianoni, 2007)

A few interesting policy conclusions may be drawn from the Val di Merse study. Tourism amounts to an invisible population, which must be taken into account in civil planning efforts. Approaches that may be employed to reduce the energy and material throughput of tourism include: transportation options; solid waste management; renewable energy options; recreation management; green-space protection options; and local product development. The Province of Siena has made an effort to increase



itineraries, structures, and activities of low energy and environmental impact such as: walking, biking, agricultural tours and horseback riding.

The Val di Merse study closes by pointing out ways in which an EF study may be useful. For one, municipal planners may employ EFA to anticipate civil needs for water, energy, and waste for the growing tourism population as well as measure tourism sector progress against the Agenda 21 goals in effect for the region. In addition, the use of environmental indicators such as the EF can assist in testing the assumptions we make of environmental impact, provide a common denomination for comparisons among populations and help to establish benchmarks against which to improve.

In an insular tourism EF study, Gössling et al. (2002) apply the EF methodology in *Seychelles* and underscore statistical issues that hinder the calculation of EF for leisure tourism. The Seychelles is a republic of 115 islands in the south-western Indian Ocean (off the coast of Mozambique in South East Africa), a high-value destination attracting a global wealthy clientele. The Seychelles is a pristine eco-destination that makes an attempt to integrate environmental conservation and development. As with other tropical developing countries, tourism began in the late 1960s with the rise of civil aviation. The authors report that Seychelles has several tourism advantages:

- Crime is virtually absent.
- There is no begging. Tourists are neither confronted with extremely poor people nor with hassling in shops or on the beaches.
- Tropical diseases like malaria do not exist.
- The climate is stable and seasonality is low.
- There are no tropical storms.
- The great number of small bays and beaches makes it possible to distribute the tourists in a multitude of locations.
- The economy is diversified, building on a strong fisheries industry.
- The culture seems resistant to the touristic influences.

Prices per bed-night in the Seychelles reach from US\$40 in guesthouses to US\$ 1955 per bungalow in Frégate Island, reported to be the most expensive resort hotel in the world . In addition, a major program is currently underway to upgrade hotels and guesthouses with the aim of turning the Seychelles into a three to five star destination. Tourism has contributed to make the Seychelles one of the wealthiest nations in Africa with a per capita GDP of US\$ 10600 (in 1998 US\$ corrected for purchasing power parity), ranking 53rd in the United Nations' Human Development Index.

The Seychelles is a destination of environmental importance. The authors report that half of the terrestrial surface of the islands is preserved in protected areas, more than in any other country in the world (although doubts have been expressed about the effectiveness of conservation efforts, as in Greece). The Environment Management Plan of Seychelles 2000~2010 (a comprehensive document) outlines the continuation and extension of environmental conservation towards sustainable development.

The Seychelles study confirms previous findings, arguing that typically, more than 90% of a typical tourist trip's contribution to climate change results from air transport. The same holds for long-distance ecotourism, characterized by the involvement of local communities, i.e. ecotourism may be sustainable on the local level (in the sense that it respects local ecosystems) but it may not be sustainable from a global point of view. Roughly 117690 international leisure tourists who visited the Seychelles in the year



2000. The country of origin for tourists in Seychelles is shown in Table 5.5.3 and it is confirmed that the majority of tourism originates from distant overseas destinations.

Table 5.5.3 Countries of tourist origin, Seychelles (Gössling, Borgström Hansson, Hörstmeier & Saggel, 2002)

Country of origin	Number of arrivals	Total (%)
France	28,282	22
Italy	19,951	15
Germany	17,720	14
UK and Eire	16,458	13
Switzerland	5001	4
USA	4746	4
Scandinavia	4329	3
		74

On arrival transport, the Seychelles study mentions that aircraft emissions are released in a height of 10 to 12 km height, where they have additional warming potential they do at the Earth's surface, thus they need to be weighted with a factor of 2.5 to 3.0. A value of 2.7 was used in the Seychelles study. Airport EF computations have to account for the fact that infrastructure is not used by tourists only. As an example, the international airport in the Seychelles is built on about 110 ha (including parking sites, etc.). However, only 74% of the arrivals at the airport are by leisure tourists. Thus, the area use amounts to 81.4 ha or 6.92 m² per tourist (based on the 117690 leisure tourist arrivals). Limited data were available for international flights, so average distances flown per tourist were calculated based on what flight data were known. Given flight distances, energy use was computed by applying a conversion factor of 2.0 MJ/pkm (passenger km). The authors point out that their results may be conservative, because a certain percentage of the unknown flights may have been private aircraft by Russian or Arab tourists (arriving with small, relatively energy-intensive aircraft). Finally, as pointed out in similar studies, EFA revealed that the major environmental impact of travel is a result of transportation to and from the destination: more than 97% of the energy footprint is a result of air travel. This implies that in a sense, any tourism based on air traffic essentially is unsustainable, and there can be no ecotourism based on long-distance travel. Small, regional tourism involving only short transport distances may be a true sustainable tourism option.

As in all EF studies, EF relates human consumption and waste generation to six major components of productive space: arable land, pasture, forest, sea space, built-up land and fossil energy land. Built-up land refers to spaces where the biological productivity is not used or usable because these areas have been covered with roads, buildings etc. In a sense, built-up land is equivalent to destroyed biomass capacity. Fossil energy land represents the area of newly planted forest that one would need to set aside in order to store the CO₂ released into the atmosphere by human activities. In order to aggregate the different categories of space to a total footprint, the areas are multiplied by equivalence factors that account for the category's relative yield compared with world-average space (which is given the equivalence factor of 1). Average arable land,

for example, is 3.2 times more biologically productive than world-average space, and is therefore multiplied with a factor 3.2. A full set of equivalence factors used in the Seychelles study is shown in Table 5.5.4.

Table 5.5.4 Equivalence factors, Seychelles (Gössling, Borgström Hansson, Hörstmeier & Saggel, 2002)

Equivalence factors (based on relative biomass yield)	
World average space	1.0
Fossil energy land (newly planted forest area needed to absorb emitted CO ₂)	1.8
Built up land (required for roads, houses, playgrounds, golf courses, etc.)	3.2
Arable land (for growing crops)	3.2
Pasture (for grazing animals)	0.4
Sea space (for harvesting fish and other sea food)	0.1
Forest area (for producing wood for furniture, paper etc.)	1.8

Regarding land transport, distances travelled within Seychelles (shown in Figure 5.5.1) were calculated taking into account the use of, rented cars, taxis, bus or coach, public transport, helicopter, aircraft and boat.

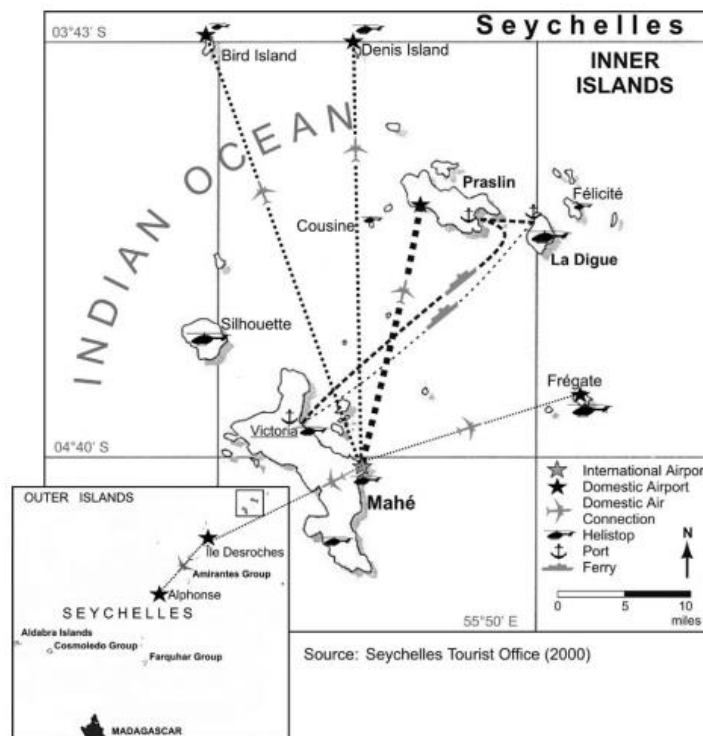


Figure 5.5.3 Map of land transport, Seychelles (Gössling, Borgström Hansson, Hörstmeier & Saggel, 2002)

What generated local travel demand by Tourists in the Seychelles? Tourist recreational activities were classified into: attractions such as museums, visitor centers and

botanical gardens; entertainment such as cinema, bar and shopping; and sport activities such as diving, jet boating and golf. Specific activities included: diving, deep-sea fishing, excursions by boat, museums and visitor centers (e.g. national parks, tea plantations), the Botanical Garden, and the Artist Village Creole.

As shown in Table 5.5.5, the land used for tourist infrastructure (roads, airports, accommodation establishments, etc.) in the Seychelles is surprisingly small (105 m² per tourist in equivalent world average space). This can be explained by the fact that such built-up land is used by a great number of tourists per year, leading to a rather small per capita built-up area demand.

Table 5.5.5 Built-up land footprint, Seychelles (Gössling, Borgström Hansson, Hörstmeier & Saggel, 2002)

Built-up land footprint

Category	ha per cap per year
Roads	0.0002
Airports	0.0009
Accommodation	0.0015
Activities (golf courses)	0.0008
Total footprint on built up land	0.0033
Equivalent area in world average space	0.0105

Turning to the accommodation footprint, built-up land requirements per bed amounted to: 2000 m² in five star hotels; 300 m² in three to four star hotels; 300 m² in self-catering apartments; 200 m² in luxury guesthouses; 100 m² in one to two star hotels; 60 m² in simple guesthouses; 50 m² in private houses; and 15 m² in boats (including harbor area). Energy requirements per bed night amounted to: 110 MJ for five star hotels; 70 MJ for three to four star hotels; 50 MJ for self-catering; 40 MJ for one to two star hotels; 40 MJ for luxury guesthouses; 30 MJ for simple *guesthouses*; 30 MJ for private; and 40 MJ for boat. These values account for: rooms; apartments; gardens; restaurants; and fossil energy land to account for energy use in heating/cooling, air conditioning, cooking, illumination, cleaning, and the desalination of seawater. The authors note that upper class hotels had a substantially larger ecological footprint than guesthouses. In particular, the Lemuria Resort, a new five-star hotel with 240 beds and 410 employees, spread over an area of 110 ha (including a golf course), amounted to more than 4580 m² per bed (or approximately 2290 m² excluding the golf course). The authors explain that resort uses more energy than the entire rest of the island with its 6500 inhabitants and its more than 1500 beds in hotels and guesthouses.

Food and fiber EF was based on cropland, productive sea space, forest and pasture. The authors of the Seychelles study note that the estimation of the EF was difficult due to the poor official statistical database and the unwillingness of the tourist industry to provide data. They also note that energy requirements for the following activities were not included in EF calculations: producing and transporting food and fibers to the Seychelles; spatial implications of solid waste or nutrient loads to the sea.

Concluding the analysis, total ecological tourist footprint (for an average length of stay of 10.4 days) is shown in Table 5.5.6, broken down by land categories

Table 5.5.6 Total tourist EF, Seychelles (Gössling, Borgström Hansson, Hörstmeier & Saggel, 2002)

Total ecological footprint	
Areas expressed in world average space equivalent	ha per cap per year
Fossil energy land	1.7373
Built up land	0.0105
Arable land	0.0632
Pasture	0.0277
Sea space	0.0032
Forest	0.0145
Aggregated footprint per tourist	1.8564
Aggregated footprint of all tourists	218,482
Extrapolated vacation footprint (1 year)	65015

How does the total footprint compare to the rest of the world? Extrapolating the EF of a typical journey to the Seychelles (10.4 days) to 1 year, results in an area of more than 65 ha of global average space. This may be compared with the average EF of citizens of industrialized nations, which amounts to between 5 and 11 ha of world average space (excluding air travel). In other words, an average holiday in the Seychelles corresponds to 17 to 37% of the annual footprint of a citizen of an industrialized country. This certainly seems like a heavy environmental price to pay for holiday tourism.

5.6 Conclusions

We have nearly concluded our report on Task 2.1 of WP2 of GreTIA and we are now ready to synthesize our literature review into conclusions and recommendations for the rest of the project.

Based on the findings located in the literature, we recognize an interesting game theoretic interchange that operates in the field of long distance tourism, which we name the *Sustainable Tourism Dilemma (STD)* and explain as follows. A substantial share of international tourist arrivals takes place via air transport. In the case of pristine destinations like Seychelles, environmental conservation contributes to their green image, but it is based on a continuous flow of funds that originate from income derived from tourism. Such remote green destinations depend on a large ecological hinterland to maintain the tourist system: as shown by EFA in the Seychelles study, comparing the terrestrial protected area (about 230 km²) with the almost 10 times larger ecological hinterland (2184 km²) gives an idea of the magnitude of this trade-off. In other words, green touristic destinations such as the Seychelles derive their income from overseas tourists at the expense of the rest of the world that pays an exorbitant price in

greenhouse gas emissions. A similar puzzle will, no doubt, be faced by the GreTIA study area.

A number of questions have been derived from the studies reviewed, that must be answered in GreTIA:

- *Environment*: What is the state of the natural and man-made environment of the study area? Are there any Agenda 21 or State of the Environment reports for our study area? What Environmental Impact Statements have been carried out in the past? What were their findings? What percentage of the island's terrestrial area is (environmentally) protected?
- *Transport*: What percentage of land cover in the study area is covered by roads? What are the major road routes and what is their geographical dispersion? What are the traffic flows on each route? At what saturation level do these routes operate? What seasonality do they exhibit? Is traffic congestion a problem? How is the public transport supply? Which mass transportation modes are offered, e.g. public buses? How many buses are there per people and how do they compare to other tourist destinations in Greece? How many stops are there per kilometer? What are the levels of car ownership? How do they compare to the national average, i.e. about 35 to 40 cars per 100 people (e.g. Paravantis & Georgakellos, 2007)? What is the average car occupancy?
- *Tourism*: How many tourists visit annually? What is the ratio of tourists to the resident population? How are their arrivals distributed through the year? Which are the countries of origin and the modes of arrival transport? What are the typical characteristics of an arrival or departure flight (e.g. round trip economy class ticket, twin propeller plane, 80% occupancy – this will also determine the appropriate weighting factor for the additional warming potential of air traffic)? What is the average length of stay (e.g. 5.3 days)? What is the average expenditure per tourist (e.g. €40 per day)? Which are the major tourist destinations and attractions, and where are they located? What are typical tourist recreational activities? What percentage of tourists are one day tourists? What are the typical distances traveled by tourists? How are these reported by tourists and car rental companies? What percentage of the total traffic is touristic? Are there alternative tourism activities, e.g. nature, ecotourism, agrotourism? How many hotels, motels and homes or rooms for rent are there and where are they located? What is the total bed supply? Are linens collected on a weekly (rather than daily) basis? Are there any other forms of energy conservation, such as pay-per-unit heating? At what rate do tourists generate waste and how is this compared to residents? How do tourists eat, compared to local residents?
- *Local economy*: What percentage of jobs is related to the tourist sector? What is the attitude of the local government towards tourists?

To these we add a few methodological issues that need to be considered and resolved by other WPs:

- Should GreTIA look into EF beyond transport? There are two approaches to the scope of our study: On the one hand, GreTIA only examines tourism and sustainable transport, i.e. looking at food consumption would be beyond the scope of our project. On the other hand, estimating total EF would allow us to express tourism transport EF as a percentage of total EF; this would also allow us to quantify qualitative changes, resulting from alternative policy scenarios.



- Whatever approach we choose, we must also look into incorporating vehicle air pollution measures into EF. In other words, the calculation of EF that will take place in Task 9.2 (Calculation of Key Performance Indicators) of WP9 (Policy Platform Development), must somehow incorporate the results of WP5 (Environmental Analysis).
- What are the advantages of tourism in our study area, and what kinds of tourists do they attract? Tourism responses should be cluster analyzed and tourist types linked to study area characteristics.
- Since most of the tourist EF is due to air travel, what realistic options do we have for reducing the total tourism EF in our study? Perhaps we could provide incentives for tourists from nearby countries to visit. We could also provide incentives for visiting the study area by ship.

Finally, we outline some policy directions that must be examined by the rest of the project:

- Since road transport is reported to contribute a large percentage of local energy use by tourists, and most of road transport is with private vehicles, the most obvious policy is to reduce private vehicle use. How may this be done?
- Local authorities should consider boosting itineraries, structures, and activities of low energy and environmental impact such as walking, biking, agricultural tours and horseback riding.
- Is there any planning in effect for our study area regarding upgrading hotels and guesthouses? If so, it should be taken into consideration in this project, and the output of this project should in turn be fed into such planning.

In closing this Task 2.1 section, we mention that we are looking for the improbable (Goldman & Gorham, 2006), i.e. measures that are inexpensive, quickly implemented, politically popular, and effective sustainable tourism transport strategies.

6 TOURISM PRODUCT

6.1 Introduction

Tourism like transport, are complex activities involving mobility (Duval, 2007). Air transport is almost directly responsible for the global growth in international tourism arrivals, as air transport is a global phenomenon. The evolution of tourism is greatly influenced by and is a function of the development of means of transport (Prideaux, 2000, Duval 2007). Culpan (1987, p 546) identified transportation modes and management as the important ingredients of the international tourism system, acknowledging that linkage by air, sea and land modes is essential for the operations as well as the availability of support services such as fuel stations, auto repair, motels and rest facilities for land travel.

It is difficult to distinguish what comes first, tourism or transport, it is a fact though that transport facilities are an initial and integral need for tourism; the quality of transport services offered also influences the type of tourist flows. Transport within the tourism system, demonstrates how transport modes, nodes and networks interact to facilitate tourism (Page, 1999). The transport networks to any destination are primarily used by tourists as tourist is the one who travels to a country other than that in which he/she has the usual residence for at least one night but no more than a year and whose main purpose of visit is other than the exercise of an activity remunerated from within the country visited (UNWTO, 1991). Transport while at destination though is not used solely by tourists.

Transportation is an integral part of modern societies while together with the accommodation and the catering sector are the fundamental elements of the tourism industry. Tourism cannot thrive without the services of one or more means of transport. It is largely due to the upgrading and advancement of the transport industry's elements that tourism sector has witnessed steady and continuous expansion. If the tourists are not able to reach effortlessly and get around a destination because of transport network inadequacies then it is almost certain that they will seek to include alternative destinations in their itineraries. An efficient transport system helps leisure visitors reach and get pleasure from a destination faster and inexpensively enjoying comfort and safety at the same time.

As far as the Greek transport network is concerned and given the geographical peculiarities of the country's mainland, significant efforts of infrastructure development were realized during the last decades aiming at a secure and trustworthy passenger mobility across the Greek territory. The transformation and upgrading of the transport network is expected to generate positive income results through the multiplier-accelerator process (Stabler et al, 2010). The accessibility advancement across the territory would be fundamentally important and give impulse to the alternative forms of tourism through the dynamics upon which the regional/peripheral economic activity is based. Typical examples that could be included in the efforts concerning the improvement and modernization of the transport infrastructure dimensions are the Rio-Antirio cable bridge, the Egnatia Motorway, the PATHE road axis, the Attica Tollway, the upgrading works in the harbours of Piraeus and Rafina, the new International Airport of Athens, the redevelopment of regional airports and the technological improvement of Greek railways. Comparatively disadvantaged, despite the efforts for a spatial and technological growth and a network expansion, is the Greek railway

network which mostly covers the north-south axis because of the land restrictions imposed by the mountainous peculiarities of the Greek mainland.

The significance of transport services as a key parameter in destination development, even when it is widely acknowledged, is usually downgraded to a less important level compared to more specific and income generating tourism industry's sectors such as accommodation and catering. The aggregate transport infrastructure base of a country or a single destination as a potential determinant of its attractiveness is being explored by a number of authors (Van Doren and Lollar, 1985, Gunn, 1988, Inskip, 1991) since it enhances the level and the easiness of tourists' and visitors' access to different parts of the region selected for leisure and tourism recreation activities.

Transport networks and their respective trustworthiness, at a micro spatial level, is of great importance since they facilitate visitors' mobility and ease the access to remote resorts and attractions contributing to the effort for even development and less congestion and pollution phenomena. High quality performance of the means of transport is really important for a destination whose economy is strongly and directly related to the tourism industry activities. Tourism is considered to be both a mass phenomenon and an individual activity hence its unhindered existence and development requires modern, reliable, safe and value-for-money transport services. The services in question and their successful application that concerns the vital dimension of connectivity between places could influence, either in a positive or a negative way, the volume and the nature of the tourism flows. In what follows, section two deals with the relationship between transport and tourism at both macro and micro levels. Then, section three examines issues of sustainable tourism development focusing on the role of transport. Section four discusses the importance of green tourism certificates in the context of specific tourism subsectors with primary emphasis on transport and accommodation, while it also evaluates the evolution of such certificates at a destination level.

6.2 Transport and Tourism: A Complex Relationship

From a spatial perspective, air transport can be used to travel from an origin to a destination; air, rail, coach, sea transport can be used to cover longer distances from the point of entry to the final destination and taxis, public transport (metro, bus, tram, light rail) and car (rented or private) can be used while being at the destination. The time budget and the cost effectiveness are the two main factors affecting the transport mode used by tourists while at the destination.

6.3 Transport and Tourism at a Macro Level

The tourism industry is subject to horizontal and vertical integration on a global scale. Such processes can cause large leakages of income and result in low values of the tourism multiplier (Stabler et al., 2010). Airlines serve gateway cities in alliance with international tour companies, hotel chains and car-hire firms suggesting that the main profit is likely to accrue to the developed countries from which international tourists originate (Graham, 1995).

In many ways, the interdependence of tourism and transport is not always apparent. There are three reasons for this, according to Duval. First, a particular mode of transport can be both a facilitator of mobility, as well as an attraction (Lumsdon and Page, 2004). Second, the provision of transport solely for tourist use is rare with some exceptions like cruising at a lake or using a steam train to reach a destination instead

of driving. Third, the extent to which transport plays a role in tourism development is not often entirely clear. In some cases transport facilitates travel while in others transport is deliberately part of the experience (cruising on a sailing boat for example). The use of rail, road or urban transport systems is not designed for entirely tourist use. It is also difficult to measure the level of tourist use of these modes as they can be used by residents, domestic and international tourists.

6.4 Air Transport

Air transport is one of the higher regulated transport industries (Graham, 1995). Today there are three distinct types of carriers, legacy or network carriers, charter and low cost carriers (LCC). Charter airlines have been called the original LCC (Buck and Lei, 2004) as they introduced the seat only market while being vertically integrated with tour operators. Papatheodorou (2002) states that vertical integration is advantageous as the cost of marketing and promotion and commercial risk is generally borne by tour operators. Over the last decade though, many charter operations in Europe have been replaced by LCC (Bieger & Wittmer, 2006).

Table 6.4.1 Carrier Typology and Impact on Travel Flows (Source: Bieger and Wittmer, 2006)

	Network carriers	LCC	Charter carriers
Target Market	Extensive coverage and attempt to increase market share; impact of formal alliances often critical in maintaining market share	Smaller than network carriers, often serve to feed larger networks; serving geographically niche markets	Mass tourism flows to holiday destinations
Critical success factor	Market share	Share of niche market	Relationship with tour operators; seasonal loadings
Network type	Hub and spoke	Several smaller hubs; point to point routes	Point to point mostly

As illustrated in the table above, it is clear that there is an overlap between charter carriers and LCC. In Europe a large number of charter carriers have been forced out of the market as LCC have dominated on the routes they were serving. LCC also operate to popular tourist destinations on a year round basis unlike charter carriers which shift their operations from summer to winter destinations. LCC though, follow a similar pattern, diverting services to popular winter destinations and increase the frequency of services to the summer ones. Network carriers on the other hand use their expanded network as a competitive advantage to those travelling long distances offering ease of connecting flights and destinations, particularly when members of an airline alliance.

The expansion of air networks has enhanced the development of tourism to many remote countries, particularly in Africa and Asia. The Caribbean was a cruise destination as tourist flows were travelling to Miami to board a cruise ship. Aviation development has contributed to the development of the Caribbean as a leading tourism destination, as direct air services from Europe and the United States are offered to the area. China also experiences high tourism flows, both incoming and outgoing, due to the development of air services between origin and destination.

Accessibility can make or break a destination. There are two streams of argument here: one involves the number of visitors and the other involves number of visitors per capita. The first contends that too much access brings in a larger number of people that can increase the level of degradation, decrease the experience, and impact the natural state of the resources. The second argument takes into consideration the ratio of visitors to the host population and the level and type of impacts created. On the issue of carrying capacity, Inskeep (1987) acknowledges the fact that areas such as small islands, arid and coastal lands, reefs, mountains and lakes are vulnerable to tourist overuse and overdevelopment and proposes that carrying capacity should be a part of the comprehensive regional and site-specific analysis and planning process. And it is important to distinguish between capacity based on tourist acceptability and that predicated on environmental deterioration because the two may not be the same (Inskeep, 1987, p 121).

The modes we choose and how we travel are indicators of our level of awareness. Some tour operators give options to their clients while others just group them together to get the best out of a deal. Access to places would rather be organically developed or planned with the conservation of nature in mind. And the impacts of transportation on the environment have been an issue through the years. The Kyoto Protocol is seen as the instrument to force industrialized countries to reduce emissions, yet still has to prove its worth.

The sustainability issue between tourism and transportation is perceived differently by the local government, the operators, and the various organizations. It is important and essential to the success of a plan that a tourism strategy takes into consideration the various roles of the stakeholders in making the practice more sustainable. Brohman (1996) believes that the state and the market should establish the parameters wherein tourism development will serve both the interests of the state and the public. The importance of the role of non-government organizations (NGOs), community groups, and the local government in the planning of the destination areas is stressed.

6.5 Transport and Tourism Relation in a Micro Spatial Level

Transport at the destination level can be divided into two main categories.

1. Destination level which can be a region, resort, city etc. In that case, transport should be integrated into destination development, planning and marketing decisions. Transport can be used both as a facilitator or an attraction (scenic route, cruise at the canal or lake, etc).
2. Attraction level which has an even smaller scale, and can be seasonal too. Man-made attractions like theme parks or monuments receive a high volume of visitors. The operator of the attraction would be interested in participating in the transport operation and development plans which are related with access to the attraction itself.

In several cities, islands or mixed areas that are dependent to a significant extent upon the revenues accruing from tourism, local authorities and bodies in charge have dynamically supported tourism activity. Unobstructed and reliable mobility is considered to be of high importance for visiting tourists since it directly influences the expected level of satisfaction they originally had in mind when they designed their itineraries and booked their holidays. Several destinations face increasing numbers of visitors, a phenomenon that creates the necessary conditions for the local governments to develop policies and mechanisms that could efficiently deal with the pressure that derives from the augmented inbound tourist activity.

a. Rental Services

The vast majority of visitors arriving at a destination require mobility services, a need that has to be satisfied either by the existing public transport network or the private transport rental services. In high peak tourist periods increased demand pressure is placed upon the whole transportation network. Both public and private transportation must adapt and manage the seasonal demand pressure originating from tourism and leisure direct and indirect activities. In most of the cases a destination's existing transport infrastructure can meet the increased number of arrivals thanks to targeted optimizing modifications and services' rescheduling of the operating fleets so as to achieve a high quality, sufficiently trustworthy and punctual transport service.

The most common transfer from one to place to another involves people walking between places that are not far from each other. Walking short distances is simple, inexpensive and eco-friendly but this basic transportation dimension cannot satisfy modern tourism industry's demanding requirements. Large scale modes of transportation are necessary for a destination to be accessed from remote tourism generating regions. In most of the cases, reaching a destination does not mean that there would be no further transportation demand until the departure since exploring a place requires some kind of medium distance transportation modes usually described as local transport solutions. The most popular and broadly used modes of transportation are usually land-based ones such as buses, both scheduled and tourist ones, hired cars, bicycles, tricycles, motorcycles and taxis. There are numerous destinations, mainly island ones, such as Hydra and Spetses where local transport services are mostly realized by small taxi boats.

In recent years, individual non-package holidays become more and more popular while the majority of tourists seem to choose shorter breaks to longer ones which in turn lead to increased need for mobility services. In occasions where short distances and small loads are involved the land-based modes of transportation are considered to be the most cost-effective and appropriate ones since collection and distribution functions can be easily realized in a convenient and affordable way. Furthermore, a leisure destination cannot be easily discovered if there is no trustworthy means of transport to encourage and facilitate the access to the local attractions.

Apart from the car hire, there is an increasing number of tourists that choose motorcycle tourism or various motorcycle related activities during their holidays. The number of those that decide to include a motorcycle experience in their itineraries is significant enough to make several rental and tourism agencies to take an active interest in this market segment and include motorbikes in their rental fleets. Even when motorcycle activities are only a part of the whole leisure experience, they can be rather income-generating investments both for rental companies and the local economies of remote regions that cannot be easily reached with other means of transport. Scotland



and New Zealand are two typical examples of motorcycle tourism destinations, since they have developed initiatives specifically planned to attract and accommodate this money-spinning market.

Hoyer (2000) highlights that sustainable tourism should be directly connected to the perception of sustainable mobility. A decrease in the aggregate levels of mobility in tourism destinations could lead to greener modes of transport. However, this aim is not effortlessly possible since the majority of the current leisure activities is regularly based upon private means of transportation such as cars and motorcycles. The increased use of hire cars is directly linked to intense congestion phenomena and atmospheric & noise pollution (Nellthorp et al., 2001; Schreyer et al., 2004). It is often suggested that leisure mobility's demand management measures designed to make public transport more attractive have little impact upon car and motorcycle hire and use. Efforts for a significant reduction in the car use, both private and rented ones, have intensified in the last years in several tourism destinations as congestion and pollution phenomena caused by an augmented volume of traffic deteriorated the destination's attractiveness and quality of life. There is raising acknowledgment that congestion phenomena considerably degrade the destination's prettiness that both tourists and residents desire (Hall 1998).

b. Bus Services

Several leisure destinations, both tourism and plain urban ones, have explored ways that could help them stabilize or even trim down the level of car use while at the same time promote more sustainable form of transportation such as bus services, cycling mobility even walking. The degree to which transport services are a significant part of the overall leisure experience is an area under continuous discussion and research but still not much published research explains the connection between the type of transport service chosen and the overall experience gained as a result of this choice (Lumsdon and Page, 2004).

Bus services, both scheduled and tour ones, are considered to be the main substitute mode of transport to the car for many regional tourism destinations. In many countries like Greece, the provision of scheduled bus services is governed by national legislation. Several private bus companies though operate services on a commercial basis in destinations where local government is not willing to provide long-distance, low income generating bus services. It is quite common for leisure resorts and accommodation organizations in remote regions to buy in private bus services from licensed bus companies so as to meet their visitors and customers' needs for frequent and trustworthy transportation.

Privately-owned coach services usually emerge since the responsibility for the design and implementation of bus services at rural destinations tends to fall to a local government's transport department with limited budget and access to sound data to design and implement profitable single or interconnected routes resulting to a reliable bus network. It has to be recognized that the design of an effective bus network requires deep and thorough knowledge concerning the volumes and the types of visitors, traffic management techniques, design standards and partnership's potentials and legislation. An effective traffic management policy alone could be enough to lead to a significant modal shift from car and motorcycle utilization to public transport media encouraging people to experience a tourism destination without using private modes of transport. As far as design standards are concerned, bus services that guarantee

passengers' comfort, security and entertainment constitute the key determinant for a profitable and trustworthy transport network (Friman and Edvardsson, 2003).

The bus service frequency is considered to be of high importance since bus networks should be designed to ease a variety of leisure activities all the way through the visiting period. The variance though between those who require high frequency bus services and those who decide to use the public transport media for simple leisure activities could impose further issues that should be included in the schedule design process. A typical example of the latter situation is a bus service that connects a popular leisure destination with the local airport or the harbour, i.e. a service that should be quite frequent, and an alternative route that connects the sites mentioned above but continues the journey to remoter regions. A round trip of the former route could be realized in a shorter period allowing for more round services and higher frequency throughout the day while the round trip that refers to a longer distance route could lead to less frequent bus services.

Seasonality phenomena could impose further implementation problems upon the design of a bus network system since reliability issues could come up during a low demand period. It is quite common for tourism destinations facing seasonality phenomena to experience volatility in the network performance during the low season. The development and implementation of a hub-and-spokes operating system could be the solution for a successful supply of viable and continuous services. Seasonality though requires more radical measures for the tour bus companies since the demand for their services during the low seasons faces vertical decline leading to a lack of income generating performance on a continuing and regular basis.

Another core dimension of the transport sector is the service delivery. The prerequisites of the tourists concerning a premium service delivery are directly related to reliability and quality issues. As far as bus services are concerned the characteristics that most commonly constitute good service delivery concern modern and secure vehicles and cleanness of facilities while the bus drivers are expected to be friendly, good talkers, cooperative, have superior driving skills, speak foreign languages and be aware of connections, fares and tourism attractions' information. Overall, the core service delivery factors of consistency and drivers' excellence are appraised as critical to accomplishment in winning over tourists and hence in accomplishing modal shift (Downward and Lumsdon, 1999).

c. Cycle Tourism

Several rising movements are pointing to the coming out of the bicycle as an alternative leisure and entertaining transportation mode. Cycle tourism has been defined as recreational cycling activity ranging from a day or part-day casual outing to a long distance touring holiday (Lumsdon, 1996). The main point of the bicycle tourism activity is that it is usually recognized by the tourist or the excursionist as an integral part of his holiday. Yet there is no extensive research concerning cycling within a tourism context. Bicycle touring is a leisure activity that becomes more and more popular as an inseparable part of a holiday experience. There are numerous tourism related cycle routes that are currently designed and put into practice throughout Australia, New Zealand, Europe and Asia. There are three main types of cycle tourism and numerous different activities undertaken by cycle tourists. These cycle types and activities are set out in Table 6.4.1 and Table 6.4.2 respectively.

Table 6.5.1 Types of Cycle Tourism (Source: Sustrans – Routes for People (1999))

Cycling Holidays	Holiday Cycling	Cycling Day Visits
These are defined as holidays, by both domestic and non-domestic visitors, where cycling is the main purpose of the holiday. Participants are sometimes referred as dedicated cyclists.	This means cycling whilst on holiday, and consists of day cycle rides taken by both domestic and non-domestic visitors, while on holiday away from home, cycling being one of a number of activities undertaken during the holiday.	These are defined as trips from home, to places outside a person's usual place of residence. These trips may involve setting out from home by bike, or taking the bike by car or train, for a day or half-day cycle ride.

Table 6.5.2 Activities Undertaken by Cycle Tourists (Source: Sustrans – Routes for People (1999))

Activities Undertaken by cycle tourists		
Cycling Holidays	Holiday Cycling / Cycling Day Visits	Other
Centre-based Cycling Short Breaks	Traffic-free Cycling	Offroad Cycling / Mountain Biking
		Club Cycling
Independent Cycle Touring Holidays and Short Breaks		Organised Cycle Rides
Packaged Cycling Holidays and Short Breaks	Circular Cay Cycle Rides	Sponsored Charity Rides
		Schools / Youth Group Cycling
		Cycle Racing

Cycling-related tourism is considered to be a subsection of adventure tourism experiencing signs of augmentation in terms of tourist demand (Jackson & Morpeth, 1999 & Ritchie, 1998). Cycle tourists tend to travel for a longer period than other tourists while they often stay overnight in remote destinations so as to better explore the destination area rather than stay around rural and over-congested regions (Ritchie & Hall, 1999). Local government policy makers should recognize the need for development and construction of both main and secondary cycle routes because they play a major role in catching the attention of bicycle tourists. As Lamont (2009) has noted, planning initiatives should focus on meeting the expectations of this type of tourism activity in terms of cycling route surface quality, terrain attractiveness, safety and supporting infrastructure (such as signage, rest areas, toilets and drinking water).

There are many ways of segmenting the cycle tourism market. The following table provides an assessment of the main interests and product requirements of each cycling tourist market segment (Sustrans, 1999).

Table 6.5.3 Cycling Tourist Market Segments – Key Interests and Products

MARKET SEGMENT	TYPES OF CYCLING TOURISM INTERESTED IN:	PRODUCT REQUIREMENTS
Infrequent Leisure Cyclists	Traffic-free Cycling Packaged Cycle Touring Holidays	Traffic-free cycle paths Cycle Hire Packaged cycling holidays
Occasional Leisure Cyclists	Day Cycle Rides (20-25 miles on quiet country roads and traffic-free paths) Centre-based Cycling Short Breaks Access to countryside from town and home	Circular day cycle routes with maps and information Traffic-free cycle paths Safe places to leave the car while cycling Ideas for cycling short breaks Cycle friendly accommodation Cycle parking and storage Cycle repair rescue
Frequent Leisure Cyclists	Day Cycle Rides (30-35 miles on quiet country roads and traffic-free paths) Centre-based Cycling Short Breaks Access to countryside from town and home	Circular day cycle routes with maps Traffic-free cycle paths Safe places to leave the car while cycling Ideas for cycling short breaks Cycle friendly accommodation Cycle parking and storage Cycle repair rescue
Cycling Enthusiasts	Day Cycle Rides (40-50 miles primarily on quiet country roads) Independent Cycle Touring Holidays and Short Breaks Access to countryside from town and home	Ideas for day cycle rides - Cycling Enthusiasts will tend to plan their own rides, using cycle route leaflets for ideas and information Cycle access by train (generally more important for Cycling Enthusiasts than other market segments) Cycle friendly accommodation



		Cycle parking, storage and repair
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6.6 Tourism and Sustainability

Despite the timeless recognition of its economic importance, tourism industry was only briefly considered in reference to the concept of Sustainability during its first introduction in the Rio Summit of 1992. The specific Agenda 21 for the Travel and Tourism Industry was developed later on in 1996 by the UN World Tourism Organisation (UNWTO), the World Travel and Tourism Council (WTTC) and Earth Council, in order to address the economic, environmental, and socio-cultural aspects of tourism development and to promote a suitable balance between the three dimensions that guarantee the long-term sustainability of the sector (UNWTO, 2012).

6.6.1 Sustainable Tourism

The most accepted definition of Sustainable Tourism is the one provided by UNWTO, referring to the activity that leads to the management of all resources in such a way that economic, social and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity and life support systems. Building on the definition of sustainability, it's both an environmentally and a culturally (local) responsible notion that on the same time ensures (UNEP, 2012):

- a. optimal use of environmental resources that constitute a key element in tourism development, maintaining essential ecological processes and helping to conserve natural heritage and biodiversity;
- b. socio-cultural authenticity of host communities, conservation of their built and living cultural heritage and traditional values, and contribution to the inter-cultural understanding and tolerance; and
- c. viability of long-term economic operations, provision for socio-economic benefits to all stakeholders, including stable employment and income-earning opportunities and social services to host communities, and contribution to poverty alleviation.

In this regard, major principles of sustainable tourism are adapting, planning and managing in an integrated way to achieve a balance between destination's carrying capacity and usage/development of all tourism and tourism-related activities (accommodation, transportation, land use, safety etc.), as well as the active participation of all involved stakeholders (indigenous people, local communities, visitors, industry and government). Originated to sustainable tourism, a number of related concepts and definitions have been developed. Among the most prominent ones are (The Sustainable Tourism Gateway, 2012):

Responsible Tourism

For a number of destinations and tourism operations, responsible tourism is the pathway towards sustainability. Considering all three dimensions of sustainability, responsible tourism is developed to assist the insufficient progress made since the Earth Summit of Rio towards sustainable tourism, by engaging everyone involved in tourism (government, product owners and operators, transport operators, community services, NGO's, tourists, local communities, industry associations etc.) to take full



responsibility for their actions and their actions' impacts and to commit personally to the goals of sustainability (e.g. Corporate Social Responsibility activities). Responsible Tourism is considered as a way of behaving rather than a form of tourism and it can be easily realized in different originating markets and diverse destinations (Goodwin, 2002), as long as there exists a shared understanding among stakeholders of the kind of tourism they develop or engage in.

Ecotourism

Even though not necessarily identical, ecotourism is also referred in literature as nature tourism, low impact tourism, green tourism, bio-tourism or ecologically responsible tourism, to describe the critical endeavour of environmentalists since the 1980s, to preserve destinations rather intact from human intervention for the future generations. According to the official definition and principles of ecotourism established by The International Ecotourism Society (TIES) in 1990, ecotourism refers to Responsible travel to natural areas that conserves the environment and improves the well-being of local people (TIES, 2012). Honey (2008), expands on the TIES definition by describing the seven characteristics of ecotourism:

- Involves travel to natural destinations,
- Minimizes impact,
- Builds environmental awareness,
- Provides direct financial benefits for conservation,
- Provides financial benefits and empowerment for local people,
- Respects local culture,
- Supports human rights and democratic movements.

As such, ecotourism's main principles are socially responsible travel, personal growth, and environmental sustainability. Ecotourists visit destinations where natural (flora, fauna) and cultural heritage are the primary attractions, and consider their experience as a direct benefit to the economic development and political empowerment of local communities, or as fostering respect for different cultures and human rights. Today, according to the UN World Tourism Organization, ecotourism is the fastest growing market in the tourism industry, growing at a rate of 5% worldwide and representing over 11% of all consumers' spending (TIES, 2012).

Green Tourism

Initially, the definition of this term included environmentally friendly travel that in general did not concern itself with cultural or economic dimensions of the destination. Current tendencies in the tourism sector however, require for the notion to expand in a way to incorporate full sustainable tourism principles and to include programs that minimize the negative aspects of conventional tourism on the environment and enhance the cultural integrity of local people (The Sustainable Tourism Gateway, 2012). Nevertheless, integral element of green tourism consists of the promotion of activities related to: 3R (reduce, recycle and reuse), energy efficiency, resources conservation, and reduction of effluents. <http://en.wikipedia.org/wiki/Ecotourism> - cite note-Randall-2 For these reasons, green tourism often appeals to advocate of environmental and social responsibility.

6.6.2 Sustainable Tourism and the Profile of Tourists

Tourists can be categorized in a number of typologies depending on the type of tourism product they pursue (e.g. health, niche, winter, pilgrimage, fishing), but mainly on the purpose of their visit. The latest is the basic typology used by international organizations as EUROSTAT for statistics purposes, which differentiates among leisure, business or visiting friends and relatives (VFR) travellers (EC, 1998). Leisure tourists travel for purposes of leisure, so they are likely to be on holiday or taking a short break. Business tourists are travelling in the context of their job to attend an associated meeting, conference or event. Both categories could demonstrate potentially elements of sustainable, green and responsible behaviour, in the same way that related products could be developed in respect to sustainability and green certification principles (EC, 1998).

The last category of VFR tourists, accounts for travellers visiting persons related by close family ties who on the same time combine vacation-type activities. These tourists present a longer average length of stay since they are unlikely to have high expenditures due to the usage of non-convention tourism accommodation facilities (Backer, 2007). With the exception of immigrants returning to their home places for summer vacations, this kind of tourism was not very common until recently. New economic circumstances though, are expected to give a great boost in the numbers of VFR tourists who seek a way to obtain high quality product in minimized cost. The problem with this category, though, is that green profile can only be related to the sole responsibility of the individual both tourist and host, to behave in an environmentally and sustainably sole way. Being already the most neglected area in tourism research (Backer, 2009) in terms of data collecting and tracking, it is very difficult to define the exact profile of VFR tourism and to detect green behaviours.

With the exception of eco- and nature-based products, little information exists in the international literature about the profile of green tourists that pursue them. Ottman defined Green Consumer as an individual looking to protect themselves and their world through the power of purchasing green decisions (Ottman, 1992). However, as the existence of green consumer is questioned so is the existence of the green tourist (Swarbrooke & Horner, 2007), as a result of the complexity surrounding consumer behaviour, the range of consumers' influences and the way these affect individuals over time (Sharpley in Font, 2001). After all, green consumerism is driven by a number of factors such as encompassing cost, weather, destinations' features, quality of facilities, availability and alternative options (Harris, 2007).

In a broader sense, green tourists may be potentially concerned by a range of issues, which Swarbrooke and Horner, summarize in Figure 6.5.1.

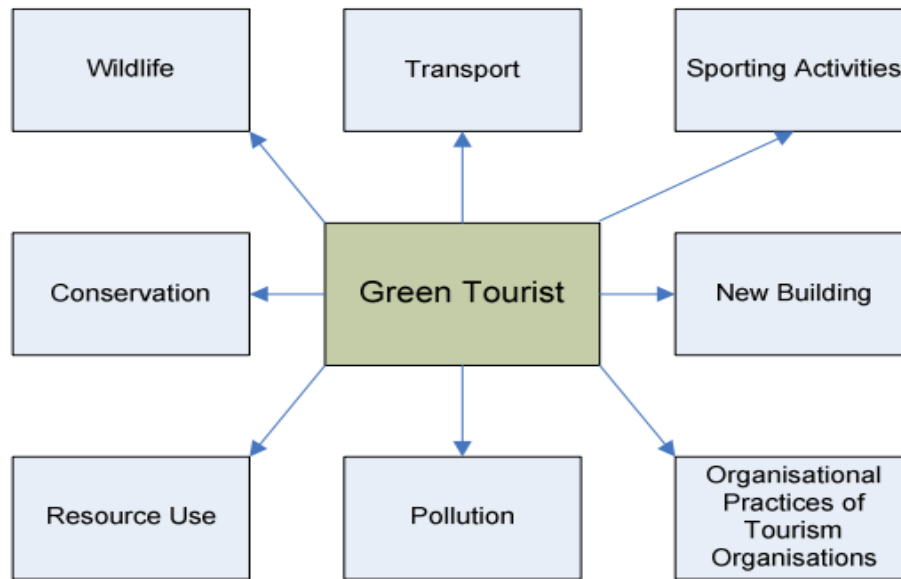


Figure 6.6.1 Issues that may concern a Green Tourist (Source: Swarbrooke and Horner (2007))

However, the actual extent of consumer demand for green tourism remains an area of considerable uncertainty and debate among experts. On one hand, a report published by the Centre on Ecotourism and Sustainable Development (CESD) and International Ecotourism Society (IES) in 2004 (Bien, 2004), observed a strong support for responsible/ sustainable tourism from both tourists and travel companies that was expressed as willingness to pay more for ethical practices, to contribute to community projects, and to support certification standards and eco-labels. More studies in the last years (Bricker, Sarnoff, & Schultz, 2009) show an increasing awareness from tourists for sustainability practices which they claim to consider during the planning process of their trip. Tierney, Hunt and Latkova in 2011 approach travellers' support for green or eco-friendly practices and sustainability in the travel/tourism industry through their responses in 18 statements of green practices presented in Table 6.5.1.

Table 6.6.1 (Source: Tierney, P., Hunt, M. & Latkova, P. (2011). Do Travelers Support Green Practices and Sustainable Development, Journal of Tourist Insights, 2(2):5.)

Attitudes Towards Green Practices	n	Don't know	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Mean
		%	%	%	%	%	%	
Imperative travel industry become more green	250	.4	.0	3.6	12.8	35.2	48.0	4.26



Deliverable 2: Current Situation Analysis

Children's future depends on more green practices	243	2.1	2.5	6.2	132	29.6	46.5	4.05
I am personally committed to supporting green practices	247	2.8	2.8	8.9	20.6	36.0	28.7	3.70
My friends or family encourage me to support green practices	246	2.8	2.4	12.2	28.5	32.9	21.1	3.50
Travel companies should contribute cash to local non-profit NGOs supporting green practices	240	5.4	2.5	10.8	27.9	38.3	15.0	3.36
Some green practices can save me money while traveling	245	8.2	4.5	9.8	24.1	37.6	15.9	3.26
Major factor holding me back from supporting green travel companies is not knowing which company undertake green practices	248	4.4	6.0	13.7	30.2	35.1	10.5	3.17
Attitudes Towards Green Practices	n	Don't know	Disagree	Disagree	Neither	Agree	Strongly agree	Mean
I would be willing to pay additional 10% for green travel services	239	5.0	6.3	17.2	22.6	36.8	12.1	3.16
I specifically seek out green service providers when planning travel	242	3.7	4.1	15.7	38.8	24.4	13.2	3.16
Prime reason travel companies do green practices is government forcing them	244	8.2	4.5	18.0	30.3	27.5	11.5	2.99
I am not familiar with green practices	246	3.3	13.4	24.0	25.6	25.2	8.5	2.82
Most green practices are just for public relations and have no real substance	248	2.8	15.3	28.6	21.8	19.4	12.1	2.76
Travel companies should only do green practices that result in immediate \$ return	243	5.3	8.6	29.6	26.7	21.8	7.8	2.74



Deliverable 2: Current Situation Analysis

I am not willing to pay additional costs for green practices	247	2.0	14.2	32.0	25.9	16.6	9.3	2.69
I have booked/used a travel service provider in the last year primarily because it employed green practices	247	10.5	8.9	15.8	39.7	17.8	7.3	2.67
Global warming is not nearly as great as media says	247	2.0	27.9	24.3	12.1	17.4	16.2	2.64
I do not care if a travel company adheres to green practices	244	2.9	16.4	37.3	23.0	10.7	9.8	2.52
Travel industry should wait before starting green practices	244	3.3	25.0	25.8	21.7	17.2	7.0	2.45
Scale: 0= Don't know, 1=Strongly disagree, 2=Disagree, 3=Neither disagree or agree, 4=Agree, 5= Strongly agree								

As Table 6.5.1 indicates, among questioned tourists, the majority of respondents agreed or strongly agreed that it was *imperative that the travel industry become more green and eco-friendly* (83.0%) and that *our children's future depends on moving towards more green practices* (76.1%). More than a half of respondents strongly agreed or agreed their *family or friends encourage them to support green practices* (54.0%), they *cared if a travel company adhered to green practices* (53.7%). Only 9.3% strongly agreed they were *NOT willing to pay any additional costs for green practices*. Nearly one third of respondents (31.5%) agreed or strongly agreed *most green practices are just for public relations and have little real substance*. Nearly 30% of respondents (29.6%) agreed or strongly agreed that *travel/tourism should implement only those green practices that result in an immediate financial return*. Approximately 24% of respondents (24.2%) agreed or strongly agreed *the travel/tourism industry needs to wait longer before we can justify implementing green practices*.

Regarding different types of green practices, the same study identified Green Transportation practices as the second most frequent option (26%) among six studied possibilities:

1. Solid waste reduction (30.9%)
2. Green transportation (26.0%)
3. Green procurement/toxic-free products (25.5%)
4. Green services/programs (7.3%)
5. Water Conservation (5.5%)
6. Organic food (3.6%).



A detailed description of Green Transport-related findings is presented in Table 6.5.2.³

Table 6.6.2 Reported Green or Eco-Friendly Green Transport Service Purchased/Used In Last Year (Source: Tierney, P., Hunt, M. & Latkova, P. (2011). Do Travelers Support Green Practices and Sustainable Development, Journal of Tourist Insights, 2(2):5.)

Transportation	N	Percentage
Use public transportation from airport	2	.4
Rent small vehicle not SUV	2	.4
Public transportation/bus instead of my own car	1	.2
Carpool to work or events	1	.2
Use cable car instead of driving	1	.2
Walk instead of driving	1	.2
Carbon footprint airline program	1	.2
Carbon neutral airline provider -regularly for business	1	.2
Look for destinations where not rental cars are required	1	.2

³ According to author's note: "...responses to the open-ended questions were content analyzed to determine what type of product or service was listed. Respondents could list up to three green products or services (N=56)".



Electric bus	1	.2
Rent hybrid car	1	.2
Total	14	2.6

The size sample makes conclusions only indicative of tourists' perceptions and tendencies; however, the most frequent practices related to green-transport seem to be *the use of public transport from airport* and *the rental of smaller than SUV vehicles*. Other options like carpooling, walking instead of driving, hybrid and electric cars or carbon footprints do not seem to be so famous among the studied sample.

On the other hand, there exist a whole other number of studies which indicate an inconsistency between tourists' good will for selecting environmentally sensitive alternatives and their final actual selections, since as mentioned before, parameters such as: personal knowledge of a destination, cost and reputation, safety and security issues, flight and transportation logistics and availability and political and social conditions in the destination country turn to play a more decisive role (Young et al., 2008).

Despite this doubt it is accepted that some tourists are more sustainably-conscious than others and are also more active in addressing these concerns with regard to how they live their lives. Swarbrooke and Horner (2007) highlight that whilst the idea of green consumers/tourists is acceptable they should not be seen as an homogenous group, instead they, among other researchers (McDonald, Oates, Alevizou, Young & Hwang, 2006) suggest a differentiation of green consumers in terms of shades of green – from 'very dark green' to 'no green at all' in three main groups: Translators, Exceptors and Selectors (Table 6.5.3).

The three different typologies indicate categories of consumers and tourists with regard to their level of awareness, consciousness and knowledge of green issues, general attitudes towards the environment and priorities in life. However, it's worth mentioning that even the dark green consumer only considers green or ethical elements 'for some of their purchases, some of the time' (McDonald et al, 2006)

The major issue arising is thus, how green concerns of consumers correlate to tourists and how these concerns convert to travel or holiday responsible action. Even though, its ambiguous whether tourists environmental behaviour or concern influences their decision making process, there actually exist a certain number of them that will consider choosing an airline based on its environmental management practices, or will boycott events involving animal cruelty (for example bull-fights) or campaign against tourism development that destroys wildlife habitats. The level of change varies according to the shades of green mentioned earlier. In any case, green tourists compose an important (and increasing) share of the tourism market and their needs and requirements should start to be considered more seriously.

Table 6.6.3 (Source: Swarbrooke and Horner, 2007; McDonald, Oates, Alevizou, Young & Hwang, 2006)

<p>Translators</p>	<p>For this group, awareness usually translates into action:</p> <p>They feel very guilty about not doing it before, They gradually include more and more activities, Their concern is often at the level of products rather than companies or industries, They are prepared to make some sacrifices and are open to change if they can see the impact of their actions, Their information seeking is largely passive, Word of mouth and opinion leaders are important to this group, They are uncritical of information sources.</p>
<p>Exceptors</p>	<p>This group have a complex understanding of a wide range of interdependent sustainability ideas:</p> <p>They are change-seeking, Their information seeking is active, company level and very critical, They are comfortable with non-mainstream outlets, products and information sources.</p> <p>BUT: There is one exception to their green lifestyle:</p> <p>This is usually a conscious exception, It is usually a 'small' exception, During the purchase process for this item they will completely ignore their usual green and/or ethical criteria, They will have a specific justification for this purchase which allows them to be happy with their decision.</p>
<p>Selectors</p>	<p>This group are green or ethical in one aspect of sustainability only - Greenpeace OR recycling OR green energy OR organic:</p> <p>Probably the most common group, This would explain why green marketing fails and green marketing research can give conflicting results, Support for Peattie's notion of a context dependent portfolio of (possibly inconsistent) purchases, Could be a starting point for the other groups, Information seeking is selective, ad hoc and can be active, depending on the issue.</p>



6.7 Green Tourism Certificates

6.7.1 Introduction

Following the Earth Summit of 1992 on Sustainable development, a number a policy instruments have been developed to promote quality standards in the tourism sector on a voluntary basis and beyond legislation compliance. Among them, Green Tourism Certificates (GTC) aim to assure market interest in ethical and eco-friendly forms of services, sector transparency through the application of standards and quality criteria, and thus the provision for sustainable tourism and tourism management approaches. The exact procedure of green certification includes auditing and the attribution of a written assurance that a facility, product, process or service meets specific sustainability (environmental, social, and economic) performance standards, while a logo or seal is awarded to those that meet or exceed baseline criteria or standards that are prescribed by the program (TIES, 2012).

Aware of the fairly large number of certification schemes in the market, WTO and UN published in 2002, a worldwide inventory and comparative analysis report of the existing 104 eco-labels, awards and self-commitments (WTO, 2002). Even though exact figures depend on the actual definition of a green certification program, nowadays, the Centre on Ecotourism and Sustainable Development (CESD) estimates that there close to 80 GTC programs in Europe, with more developing in Latin America, Asia, and to a lesser extent in Africa (CESD, 2012).

As mentioned by WWF in a synergy report in 2000 (WWF, 2000), the great difficulty to define a Green Certificate for the tourism sector lies primarily in the fact that sustainable tourism is poorly defined in practical terms and that sustainability issues are slowly perceived to be a key factor in tourist decision making processes. Moreover, tourism industry is fragmented (mainly comprises small and medium sized businesses which have limited resources to address sustainability issues) and still exists a generic belief that 'green labelling' and certification programs do not address the specific needs of the industry. With the exception of ecotourism and some other special interest forms of tourism (e.g. winter, mountainous) where accreditation is considered a mean for legitimacy and visibility (Bien, 2005), not many things have changed since then. Today, the majority of GTC's is nationally-based and accredits primarily accommodations (approximately 63%), whereas only 7% address tour operators (STI, 2012), however, programs have increasingly been developed for other aspects of the tourism industry, including parks, beaches, attractions, tour operators and transportation (Chafe & Honey, 2004).

The main issue influencing demand for GTC's is the extent of consumer and industry market demand for sustainable tourism and green tourism certification. The International Ecotourism Society (TIES) has been studying the market demand for sustainable tourism certification since 2004, in order to determine those parameters influencing customer and industry preferences and to propose effective marketing strategies. In any case, the accreditation of a GTC should be seen as a two-fold benefit, since: (a) on one hand, provides credible information to suppliers and consumers and assurance of the quality and sustainable standards underlying the offered services, and (b) through the recognition of this added-value attributes by consumers and distribution channels, offers trade and marketing advantages to



certified companies and services and encourage more sustainable production and consumption.

Despite these challenges, existing GTCs exhibit a series of common attributes (Honey, 2002; Font, 2002a) since they all originate in (a) the guidelines for certification programmes that emerged from the Commission on Sustainable Development (CSD) in 1999, which (UNEP, 2006):

- require companies to comply with national and regional regulations as an absolute minimum,
- have the potential to surpass regulatory requirements in a way which is cost effective,
- be developed with multi-stakeholder participation,
- include monitoring, assessment and verification systems to generate confidence and support from all parties, and
- include reference to the need for education focusing on travellers, investors, workers and host communities,

and (b) a growing set of environmental management, sustainable management, reporting and social, ethical and quality assurance auditing tools (eg. ISO 9001, ISO 14001, SIGMA, GRI, SA 8000 and AA 1000).

In general, Green Certificates in the tourism industry could be differentiated into two main types: *performance-based* and *process-based* (Honey, 2002; Font, 2002a; 2002 b).

Performance-based schemes identify products, services or operators that are sustainable rather than whole businesses or sectors. The approach recognizes minimum level of standard compliance and is accredited to those businesses or products that demonstrate exceeding performance over a specific level considered as best practice (e.g. 50 % energy saving lamps, max 3 litre/minute water consumption). Even though, such certificates demonstrate more consumer-friendly attributes, their potential to provoke improvements across the entire tourism industry is rather limited, since they maintain stringent and specific thresholds within clearly defined standards for businesses or destinations of higher impact (especially the mass market and transport operators) to meet.

The majority of GTCs fall into the performance-based category, which utilizes externally determined criteria and benchmarks that are applied uniformly to all tourism venues seeking certification. The main benefits of performance-based certificates include simpler means of monitoring performance, lower cost, and increased comparability among other certification programs. Its main drawback is its difficulty measuring the qualitative, subjective, and often imprecise nature of many tourism-related standards and criteria (Honey, 2002).

Process-based certificates seek to provide an overall improvement plan that encourages gradual changes towards sustainable performance of an individual company, without making any reference to baseline standards but rather award eco-labels for progress toward internal goals, such as reducing electricity and water consumption. In most of the cases, such certificates are aligned to company's Environmental Management Systems (EMAS) or Quality Management System (QMS), which serves simultaneously as an internal process monitoring and improving



procedures/practices system. Despite making only limited reference to a company's current sustainability state, process-based certificates tend to be more collaborative and responsive to the needs of companies of all sizes, while encouraging performance improvement over time rather than simply awarding the best companies (Font, 2003; Honey, 2002).

Advancing needs of tourism industry however, suggest that new-age GTCs should incorporate elements from both performance and process-based approaches, to develop their own hybrid approaches built on a uniform set of principles, guidelines, and certification standards that will facilitate comparability, complementarity and provisions for tourism related sectors (e.g. transportation, attractions). Moreover, apart from performance or process-based criteria, they should include a set of indicators that determines the effectiveness and impact of the certification process itself, measure the benefits that certification can deliver and thus, provide tangible data that will enhance the credibility and value of certification (Font, 2004).

There are many certification schemes regarding tourism that relate to sustainability. The best known NGO or country initiatives include Voluntary Initiatives for Sustainable Tourism VISIT (Europe-wide), the Costa Rican standard Certification for Sustainable Tourism (CST), Green Deal (Guatemala), and British's Green Tourism Business Scheme (GTBS). The best known industry certification programs are Green Globe and Blue Flag (CESD, 2012). Green Globe offers product as well as destination certification, while Blue Flag certifies beaches. There are also two industry based standards which do not solely address tourism: ISO 14001 which addresses environmental impacts and ISO 9001 which addresses quality assurance (both mainly used by larger hotels rather than small operators or accommodations).

Among the great number of business-oriented GTCs one meets in the international literature and the web, most of which address sustainability in specific tourism-related sectors (detailed description per sector will be presented in the following sections), Green Globe 21 is the most prominent, internationally recognized and complete, as it claims to cover the full scope of tourism activities globally, from destination management (Green Globe 21 Community/Destination Standard) to each of the individual sectors (Green Globe 21 Business Standard) that comprise the international travel and tourism industry (Green Globe, 2012).

Green Globe is developed based on a number of International Standards and agreements among which: Global Sustainable Tourism Criteria, Global Partnership for Sustainable Tourism Criteria (STC Partnership), Baseline Criteria of the Sustainable Tourism Certification Network of the Americas, Agenda 21 and principles for Sustainable Development endorsed by 182 Governments at the United Nations Rio de Janeiro Earth Summit in 1992 and ISO 9001 / 14001 / 19011 (International Standard Organization), and nowadays is available to operations in 20 different sectors of the travel and tourism industry (Green Globe 21, 2012):

Accommodation, Administration Offices, Aerial Cableways, Airlines, Airports, Bus Companies, Car Hire, Convention Centres, Cruise Boats, Exhibition Halls, Farmstays, Golf Courses, Marinas, Railways, Restaurants, Tour Companies (Wholesale), Tour Operators, Trailer Parks, Vineyards, & Visitor Centres

The Green Globe 21 is a process-based Standard, compiled by a collection of 337 compliance indicators applied to 41 individual sustainability criteria of four main dimensions (Green Globe, 2012):



- a) **Sustainable Management:** Implement a Sustainability Management System, Legal Compliance, Employee Training, Customer Satisfaction, Accuracy of Promotional Materials, Local Zoning, Interpretation, Communications Strategy, Health & Safety.
- b) **Social / Economic:** Community Development, Local Employment, Fair Trade, Support Local Entrepreneurs, Respect Local Communities, Exploitation, Equitable Hiring, Employee Protection, Basic Services.
- c) **Cultural Heritage:** Code of Behaviour, Historical Artefacts, Protection of Sites, Incorporation of Culture.
- d) **Environmental:** Conserving Resources, Reducing Pollution, Conserving Biodiversity, Ecosystems and Landscapes.

The applicable indicators vary per type of certification (company or destination) and geographical area, however, its global scope and focus on mainstream (mass) tourism businesses puts in jeopardy Certificate's ability to make reference to the very specific issues that influence individual companies or destinations. Moreover, by accrediting simultaneous certification to corporate businesses as well as individual units (mainly accommodation sector and tour operators), despite minimizing cost and promoting centralized management systems, it turns practical implementation of the standards quite problematic and misleading.

In an effort to harmonize and be compatible with other established certification programmes, particularly at regional and local level, Green Globe maintains a core set of process criteria, less stringent requirements and sets regulatory compliance as a bare minimum requirement. In this way, it fits well with existing quality and health and safety systems approaches, lends itself easily to the development of management manuals and the systematic training approaches used, while being easily adjusted or incorporated to the locally developed standards and thus, being adopted easily by any individual company or sector in any location (e.g. Sustainable Tourism Cooperative Research Centre (STCRC) in Australia, serving as a regional research facility on sustainable tourism, actively promoting the Green Globe program). After all, in terms of environmental management, Green Globe 21 as the majority of GTCs is based on ISO 14001, a detailed and credible system, that monitors continuous improvements and documents achievements leading to enterprises' sustainable operation and management certification.

Following more or less the same line of thinking, a number of schemes have been developed around the world, aiming to accredit green certification primarily in specific tourism-related sectors. The following sections will elaborate on green certificates of the most prominent tourism-related sectors: transportation (at macro and micro level) and accommodation; while special mention will be made for Green Globe 21 Destination Brand, as it is at present the only certification accrediting green tourism qualities at destination level. The chapter concludes, with some observed drawbacks of existing GTCs.



6.7.2 Transportation

6.7.2.1 Macro Level

As discussed previously transport and tourism are interrelated. The use of transport is required both at and within the destination. Surface transport, including car use is popular while at the destination. Surface transport, road transport in particular can be identified in two main categories, coach transport and car transport, including car rental. Despite the volume of international tourism and its dimension a limited number of steps has been implemented at an international level with the exception of scepticism towards climate change and its impacts on tourism. Within the UK for example, the total number of tourist trips taken by UK residents, has risen dramatically over the 1990-200 decade, by 61.4%, from 114.7 million in 1990 to 185.1million trips in 1999. Tourist nights by UK residents spent away from home have followed a similar pattern, rising by 44.4% from 608.7 million nights in 1990 to 879.2 million in 1999. One of the main factors leading to such growth has been the availability and cheapness of air travel, which experiences exponential growth.

Despite the economic prosperity and the tourism growth, there is a lot of concern related with the negative environmental impacts of air travel such as noise, which can be severe around the airport area, and the widespread scattering of major pollutants that include nitrogen oxides, volatile organic compounds, particulates, carbon monoxide, sulphur dioxide and very significant amounts of carbon dioxide which is linked with air pollution. Another concern related to air transport is the land use related to airport development and their related ancillary services.

It seems that there is not any global accreditation system that validates the green characteristics of an operation. It is widely known that car manufacturers for instance, are working towards more fuel efficient engines and that fuel manufacturers are working towards biofuels. In the same line, aircraft manufacturers tend to produce more fuel efficient aircraft and engines. The motive behind the latter though, is primarily focused on the operator of the aircraft or the vehicle and the economic benefits associated with less fuel consumption rather than environmental protection which comes second on the priority list.

The only policy and not a certificate applied to a wide audience is the European Union, Emissions Trading Scheme (EU ETS), which was launched in 2005, the first large emissions trading scheme in the world. The aim of the scheme is to combat climate change forming a major pillar of EU climate policy. Under the EU ETS, large emitters of carbon dioxide within the EU must monitor their CO₂ emissions, and annually report them, as they are obliged every year to return an amount of emission allowances to the government that is equivalent to their CO₂ emissions in that year (European Commission, 2012). In January 2008, the European Commission proposed a number of changes to the scheme, including centralised allocation by an EU authority. These changes are still in a draft stage; the mentioned amendments are only likely to become effective from January 2013 onwards. The EU ETS now operates in 30 countries (the 27 EU Member States plus Iceland, Liechtenstein and Norway).

Airlines joined the scheme in January 2012. This action was not welcomed by all airlines, causing turbulence even at diplomatic level, as EU suggests that all carriers operating in the European air space are obliged to join the scheme. The greater

reaction received, was from Chinese carriers who have threatened to cease operations to Europe as well as cancel or stop purchasing European manufactured aircraft. ATAG (Air Transport Action Group - an international non-profit organisation representing all sectors of air transport industry, including airlines, airports, engine manufacturers and aircraft manufacturers) has launched since 2008 a campaign amongst its members to reduce the footprint produced by aviation providers. This will be accomplished on a short term and long term goal. The short term goal is to provide fuel efficiency improvement of 1.5% per annum through to 2020 and the long term goal is to cap net aircraft carbon emissions from 2020 and work to achieve an ambitious goal of a 50% reduction in net carbon emissions by 2050 compared to 2005 levels (ATAG, 2012). Moreover, ATAG is in cooperation with fuel producers and are working towards bio fuels to be used by aircraft. Test flights have taken place over the 2008-2011 period and fuel producers are in the process of commercialisation. The aviation industry argues that aircraft operations are the most efficient means of transport as the load factor on airplanes is the higher among any other means of passenger transport, reaching 78% on a global basis, reducing the fuel consumption per passenger (ATAG, 2012).

The biggest concern on global level though is climate change. Deutsche Bank in a 2008 report argues that many countries, especially those in the Mediterranean, will experience negative effects of the climate change such as water shortage and higher temperatures (Deutsche Bank, 2008). In the long run, after 2030 the rise of the sea level will also result in the destruction of tourism infrastructure at coastal areas.

There are more national schemes which are associated with green transport or green operations such as the car/road tax discount on hybrid cars or subsidy on production of green energy. For example, Romania implemented an incentive scheme supporting renewable energy in 2004, when it opted for a mandatory quota system combined with the trading of Green Certificates (the GC system) that remained the main incentive mechanism for the producers of green energy. Romania uses national quotas for renewable energy sources (RES) and individual quotas for green certificates. (The post-2012 climate policy of Romania: challenges and expectations). Similar initiative and certification apply to many countries around the world but they are not directly related to tourism or transport.

The Irish Tourist Board has issued a report stating the strategy towards environment protection but this study does not form a policy or a certification. Similarly WWF has issued a document titled tourism certification where they analyse the Green Globe 21 certification and the Centre for Ecotourism and Sustainable Development has issued a study titled practical steps for marketing tourism certification. The common characteristic of both these studies is that they are addressed to companies or group of companies without providing a common ground for certification or applying an international or national policy.

In conclusion, it seems that there is not a single or even multiple policies applied to transport related operators at national or international levels with the exception of the Emissions Trading Scheme which is not a certification though. It is clear that there is concern about the environment, the greenhouse effect and the emissions but there is not a common framework or a certification. Even the earth summit declarations have not been signed by all members, reflecting the controversy and the different approach on the subject.

6.7.2.2 Micro Level

Tourists arriving at international cities need mobility and few decide (or can afford) to hire private transport. Therefore, the public transport system is an essential service for tourists, especially in cities large enough to need bus, metro and train systems. Congested cities with weak public transport networks, face pressure from tourists as additional demand adds pressure on the transport system. Tourists may end up competing with residents for limited urban resources. The importance of transport networks and infrastructure in tourism development has been stressed by many authors (Abeyratne, 1993; Chew, 1987; Kaul, 1985; Khadaroo & Seetenah, 2007, 2008; Prideaux, 2000). One likely reason for this is the difficulty in identifying tourism transport as a discrete functional entity in order to conduct analysis and define policies (Page, 1999).

The growth in car ownership in the UK, from just over 2 million in 1950 to 22 million by 2000 follows a similar pattern to air travel, reflecting economic growth, and general prosperity. Car journeys now account for 82% of all journeys in the UK in terms of distance travelled, and 40% of such journeys are for leisure purposes. The reasons behind the success of car use as a leisure means of transport are obvious. A car is flexible, able to travel to places with no public transport, at times the user prefers which gives them greater freedom, greater choice. Carriage of luggage is not a problem, nor the transport of equipment, children, or elderly relatives.

The impacts of such travel are not insignificant or can be ignored. All travel, including boats, trains, buses, coaches, even walking and cycling, have some environmental impact. In the case of rail and bus services these can be significant, but as buses and trains operate along relatively restricted corridors far less frequently than individual private cars, and, with moderate loadings, have a far lower consumption of fuel (and therefore production of pollution) per passenger kilometre, their impact is negligible compared with the 80% or so of leisure journeys made by private car. Water transport is also very energy efficient compared with land travel, which means that ferries are likely to make relatively little impact, ignoring such issues as possible oil spills or sewage.

The use of different, less polluting fuel technologies and sophisticated multimodal transportation systems are of high priority for several governments, both national and local ones. These plans are considered to be initiatives of high importance towards the reduction of greenhouse gas emissions' concentration and the decline of a destination's dependence upon the obsolete, defunct, expensive and polluting energy sources.

The idea behind the upgrading and sophistication of current certification programs or/and the development of new programs could facilitate the tourism and the transport industries' operation to be more environmentally friendly. This could be accomplished through the development of greener modes of transportation that integrate the reduction of fuel and energy consumption and the minimization of the pollution phenomena.

Certification programmes could help the tourism and the transportation industry capitalize on their track records as more environmentally friendly forms of recreation and transportation. Furthermore, the development of targeted certification initiatives could assist individual businesses with:



- gaining knowledge of the utilization of alternative fuels and greener technologies
- forming marketing incentives for individual operators and entrepreneurs willing to incorporate alternative energy sources, accomplish energy consumption economy and implement increased eco-friendly technologies and procedures
- capitalizing on augmenting demand for greener and more energy saving products and modes of transportation

Business parameters such as services' quality, customer service, efficient pricing policies, convenience and safety are considered to be of high importance for the majority of tourists when they decide upon the means of transport that is going to be included in their holidays. However, as eco-friendly trends have manifested into new sets of consumer values, several industries have responded with individual and targeted certification programs. The problem with a combined greener approach remains since there are several sub-sectors of the two major industries in question, tourism and transport, that cannot be officially and adequately evaluated since there are no specialized and widely accepted programs to certify a company's eco-friendly performance.

As far as official recognition for green and sustainable practices of a number of sub-sector companies operating at a micro level is concerned, there are few and usually non-specialized initiatives which most of the times constitute vaguely customized existing certifications programs. An attempt to overpass the absence of targeted programs is the development of corporate certification initiatives where multinational enterprises that operate the franchiser-franchise business model have built up certification procedures and audit controls to ensure the quality of services of their franchisee daughter and non-daughter companies. Typical examples of the certification procedures presented below are several rental organizations with European or global business presence.

a) Rental Services

ISO 14001 that is included in the ISO 14000 family represents the core set of standards used by companies and organizations for designing and implementing an effective environmental management system (International Organization for Standardization – ISO). The ISO 14001 is not considered and awarded as a complete environmental management certification and therefore does not dictate absolute performance requirements. On the contrary, it supplies and supports a framework to help organizations in developing their own parameterized environmental management structures. This standardization program could be supplementary integrated with the rest of the corporate functions and facilitate the business entities meet their green and sustainability objectives and improve their environmental performance while it provides them with monitoring and measurement tools.

The implementation success of a certification program like the ISO 14001 extremely depends upon the commitment from all hierarchy levels of the organization involved because there is a constant need for active involvement in the development, implementation and maintenance of such a performance system. ISO 14001 is an



integral part of the Eco-Management and Audit Scheme (EMAS) which is a voluntary environmental management instrument. EMAS was developed in 1993 by the European Commission. Since ISO 14001 is a fundamental part of EMAS, the organizations that are EMAS-certified automatically comply with the ISO requirements as well. EMAS registered organizations demonstrate (European Commission – EMAS):

- Credibility: the proper implementation of EMAS is assessed by qualified and independent environmental verifiers.
- Transparency: by periodically reporting on their environmental performance. Those reports include information on key performance indicators. The reports must be validated by an environmental verifier.
- Continuous improvement process: by committing themselves to continuous improvement of their actual environmental performance. This performance is also evaluated by an environmental verifier. ISO 14001 only requires improving the environmental management system itself.
- Compliance: by fully complying with applicable environmental legislation.
- Stakeholder engagement: by involving employees and other stakeholders in order to benefit from their commitment, ideas, skills and experiences.

Europcar International, which is one of the biggest European companies supplying car rental services, was awarded ISO 14001 certification by Bureau Veritas for its programme and processes implemented to promote sustainable development. The certification referred to the organization's quality, safety, health, environment and corporate social responsibility. Europcar's charter satisfied the compliance requirements in four main areas:

- Green fleet - inclusion of electric vehicles in the fleet,
- Fleet maintenance - Europcar has set up a recycling program for waste, fluids and wastewater from all its washing stations,
- Awareness-raising for employees and customers - the organization launched best green idea competitions among the employees and invoicing programs for its customers stating the emissions quantities emitted for each vehicle rental, and
- Internal processes – because of the internal environment management processes in several countries across Europe such as Germany, Spain, Italy.

Furthermore, Hertz car rental firm was ISO 14001 certified in several countries across the globe. Hertz enacted a practical Sustainability Program with is based upon principles of preventing and minimizing environmental impact from its operations. The main goals of the program are a) the conservation of natural resources by minimizing the non-renewable materials, b) the utilization of sustainable or recycled products and packaging wherever possible, c) the regular review of operations and programs to accomplish an efficient use of resources and d) the provision with product and service products and options which promote sustainability objectives (Hertz).

b) Bus Services

The Green Coach Certification Research initiative (G.C.C.) is a long-run project carried out by the Transportation Research Centre of the University of Vermont, the American



Bus Association (A.B.A.) and the United Motorcoach Association (U.M.A.). This ambitious initiative focuses upon a) the interaction between corporate and environmental issues among bus service organizations, tour operators and the passengers, and b) the growth, testing, and thorough assessment of an 18-month pilot Green Coach Certification program for the bus service industry. The pilot G.C.C. is based upon principles of transparency and deliberate partaking providing operators with the opportunity to be recognized for existing and emerging efforts to enlarge their already increased level of environmental awakening. During this transformation stage, the G.C.C. initiative should reach a wide audience and keep on developing in sophistication over time (University of Vermont).

In late 2009 more than twenty companies from across North America have volunteered to be included in the G.C.C. pilot programme. This pilot/field test will provide answers to a number of vital research questions and prepare the groundwork for a long-term enduring environmental certification program for the bus services industry. Throughout the testing period, the organizations that are voluntarily participating in the project are qualified for a pilot G.C.C. label/recognition for any bus of their fleet complying with the project's main criteria

6.7.3 Accommodation Sector

With 63% of existing GTCs accredited to hotels (STI, 2012), the accommodation sector is by far the most certified tourism-related industry. The increased tendency for eco-conscious travel and the necessity for legitimacy in the ecotourism product, forced tourism accommodation industry to turn into non-governmental, independent Certification Programs (mostly developed by NGO's) in order to certify their green profile and initiatives (Honey, 2002). Some of the best known green labels of the accommodation sector include: the Green Star Hotel Initiative, the Green Leaf, the Green Key, the Green Globe, the Green Seal and the Eco Crown's Hospitality Certification designed appropriately to consider specificities of bed & breakfasts accommodations. Each programme has its benefits and drawbacks, while some offer more legitimate measures of eco-consciousness than others. In a broader sense, GTCs in the accommodation sector aim either to establish minimal requirements/benchmarks in each domain (performance-based certificates), or compensate /balance some of them through overall improvements in the process chain and the development of performance guidelines and training tools.

Although primarily intended to foster environmental awareness among hotel guests, tour operators, hotel staff and residents and to build capacity for environmentally sound hotel management, Green certification schemes expanded environmental assessment process to include apart from issues related to (Font, 2002b; TIES, 2012):

- water use and management,
- waste management and use of recycled material,
- energy efficiency and increased use of renewable energy,
- indoor environment quality (acoustic, light, thermal, indoor air quality),
- rural/urban planning,
- integration in landscape,
- emissions of pollutants,



- building infrastructure,
- acoustic nuisances to the surrounding,

as well as a number of overall quality criteria regarding: the involvement of employees, environmental information for customers (documents, appropriate signage etc.), safety and cleaning, green food, nature-based activities, conscious office administration, in order to combine sustainable performance and management criteria (UNEP, 2006). Such actions result benefits from lower operating costs and productivity benefits, higher return of the investment, enhanced marketability and tenant attraction, reduced liability and risk, a healthier place to live and work, demonstration of Corporate Social Responsibility and an overall quality competitive advantage (UNEP, 2005).

In each case, certification criteria are weighted according to the specificities of the local environment and tourism product (e.g. water availability and water treatment) to reflect diverse importance of environmental concerns. Accreditation is based on the intensity of a hotel's commitment to environmental-friendly and sustainable practices (including integration and utilization of the local economy and employment) as well as the application of environmental measures in line with certificate's criteria (Font, 2002b). In most of the cases, Green Certification tools are point based systems which assign ratings based on the environmental impacts associated with the project's design, construction and operation and as such, in most of the cases it is possible to identify different certification ratings (e.g. number of keys or stars, bronze, colour of leaf).

Main players in the Green Lodging Certification worldwide include:

Green Key Global: With more than 1 200 hotels certified in Canada since its inception, Green Key is presently the largest global eco-label for accommodation Certification is based on a 140-question online audit of qualitative indicators, which awards hotels an environmental rating of one to five Green Keys. Green Key pays particular attention to hotel operations and best practices (Green Key Global, 2012).

Green Globe International: Utilized by the travel and tourism industry since 1993, the Green Globe brand is internationally recognized in Europe, Latin America, China, the Middle East, and the Caribbean, and is starting to gain traction in the U.S. As part of its certification program, Green Globe looks at behavioural, facility and product issues at the hotel (Green Globe 21, 2012).

Green Seal: Consists a recognizable brand worldwide beyond hospitality, representing a mark of sustainability excellence for more than forty product categories and services. Green Seal is a trustworthy label since guests are familiar with it from products they have in their homes (Green Seal, 2012).

Green Leaf: Certification process begins with a self-evaluation survey, and is followed up by a Green Leaf assessment and verification. Hotels are awarded one to five Green Leaves based upon the hotel's commitment to certificates standards (Green Leaf, 2012).

EcoRooms & EcoSuites: Initiated as an online directory of the most environmentally responsible hotels, motels, inns and B&Bs in the U.S. and abroad, EcoRooms & EcoSuites has developed a strict set of EcoCriteria. There are two levels of green designations – approved status is based upon satisfactory completion of an application, and certified status requires an on-site audit of the claims made on the application by one of the program's board of advisors. EcoRooms & EcoSuites is the only program



that mandates 100% compliance with all eight of their criteria comprising it as the most stringent certification programs in the industry (EcoGreen Hotel, 2012).

Green Tourism Business Scheme (GTBS): Launched in the UK, GTBS aimed to offer guidelines to tourism businesses on how to make their operations more sustainable while still delivering a high quality service. Certificates criteria are divided into ten areas and deployed into 150 different indicators. There are four levels of certification under GTBS: Going Green, Bronze, Silver and Gold. Each property is assessed every two years to ensure that the program's rigorous standards are met (VISIT, 2012).

Sustainable Tourism Eco-Certification Program (STEP): Developed by a non-profit organization called Sustainable Travel International (STI), is an eco-certification program aimed at achieving worldwide reach, and as such it is aligned with the Global Sustainable Tourism Criteria – a benchmark that seeks to rally the tourism industry around a set of core values that are the minimum that any tourism business should aspire to reach. STEP was publicly launched in 2007, and is currently certifying hotels in the United States, Canada, the United Kingdom, China, Australia and Brazil. STI's Self-Assessment Tool is a standalone educational, measurement and management framework which doubles as an application for companies wanting to become Eco-assessed or Eco-certified through STEP (STI, 2012).

6.7.4 Green Globe 21 Destination Brand

Long term benefits of sustainable tourism for consumers and businesses require overall strategic planning at destination level. Recognizing this need, the Green Globe Destination programme was designed in 1997 to extend corporate improvement and Agenda 21 principles to communities, to tackle issues of pollution reduction, ensure equitable resources distribution, enhance tourism experience and ensure profitability and sustainability for the hosting destination and its residents. Pilot programmes were initiated in Vilamoura (Portugal), Crete and Corfu (Greece), while by now some of the accredited destinations include: Cumbria and Bournemouth (UK), Cape Met (South Africa), Ko Somui (Thailand), DouglasShire (Australia), Huatalco (Mexico) and Kaikoura (New Zealand).

In the framework of Green Globe 21, Tourism Destination refers to a: (a) *defined region with recognizable travel and tourism capacity comprising a range of tourism operations;* (b) *where there is infrastructure support, such as transport, sewage, water treatment etc.;* (c) *which takes into account the needs of the local population and protects unique cultural heritage and diversity;* (d) *where a group of stakeholders from the public and private sector (the destination management group) are prepared to take responsibility for ensuring the implementation of the SDMS;* (e) *that is promoted by a Lead Agency, and has declared its commitment to sustainable tourism development based on Agenda 21 for Travel & Tourism;* (f) *that has committed to year on year improvement of the environment;* and (g) *that provides a strategic context to support the Green Globe 21 certification of individual tourism businesses (Green Globe 21, 2012).*

The Destination Certificate is not prescriptive but rather specifies a number of certification criteria developed in respect to the principles of sustainable development and the special characteristics both of the destination and the developed tourism product. It provides governing authorities, travel and tourism companies and the communities that reside within the destinations with: a clear set of criteria for achieving year on-year improvements, a framework for application of the criteria, as well as the



exact process for meeting these criteria. Moreover it includes commitment to compliance with legislation and regulation (international, national, regional and local-environment, public & occupational health, safety, hygiene, employment legislation and planning requirements etc.), a clear vision on environmental and tourism policies, strategies and improvement targets (Regulatory Framework and Action Plan) and communication with stakeholders and Green Globe Destination Community Authorities (e.g. Lead Agency, Destination Management Group).

In this regard, the development of the Green Destination Certificate is based on criteria of environmental and social (a) performance: production of greenhouse gas emissions, air quality protection and noise control, waste minimisation, reuse & recycling, use of environmentally harmful substances, energy efficiency and (b) management of: freshwater resources, waste water management, drainage and streams, ecosystem conservation, cultural heritage and conservation and land use planning.

To attain all above performance and management criteria, the Green Globe 21 Destination program is implemented in six key phases (Green Globe 21, 2012):

Stage I, Scoping Study: performance of a Preliminary Environmental Review by the Lead Agency. Establishment of a Destination Management Group, responsible for the development and implementation of the SDMS.

Stage II, Environmental Policy Development and Destination Visioning: determine multiple stakeholder views and agree on a shared vision of a sustainable tourism destination program by all stakeholders.

Stage III, Strategic Environmental Assessment and Environmental Action Plan: create an environmental policy for the destination, establish the overall objectives and priority areas for action; develop an evaluation plan and assess the impacts on the environment through a Strategic Environmental Assessment.

Stage IV, Implementation: development of organisational structure, define a programme of actions for improvement by setting targets, timelines and responsibilities and minimising impacts identified in the SEA, communicate objectives to stakeholders and communities and measure current performance against set benchmarks.

Stage V, Capacity Building and Training Programme: develop training, awareness and competence.

Stage VI: Assessment and Award of Destination Recognition: Third-Party Certification Audit, annual re-assessment by Green Globe to ensure continuous improvement, monitoring of results periodically to redefine targets and objectives when necessary.

6.7.5 Drawbacks of Existing GTCs

Since their introduction in the 1990s, significant progress has been made by many tourism certification programmes to develop a more global profile and a rather flexible core monitoring and assessment framework easily adjustable to different products and realities. Despite their significant role in directing tourism industry towards more sustainable, quality-assured and long term strategies, certain issues still need to be addressed.

- a) Overall, certification within the tourism industry has been difficult to achieve as tourism is multifaceted and includes a mix of services and products. Most certification and supplier development is voluntary (between 10-25% of

- suppliers have met the voluntary sustainability related standards), but there is little consensus that certification is actually viable.
- b) Due to their alignment to the ecotourism product, most GTCs focus specifically on eco-lodges or other small scale accommodation, such as agro-tourism accommodations. Although this form of tourism has more potential to meet sustainability goals and to bring positive benefits to the areas in which it operates, its very nature does not make it suitable for mass tourism hotels and operators who control the vast majority of travel.
 - c) For the majority of GTCs, accreditation of certificate requires from the business a minimum of achievement of best practice performance standards/benchmarks. To attain the goal of continuous improvement, GTC's need to adjust better to the internal management schemes and consists the basis of an overall monitoring system in support of continuously improved initiatives.
 - d) Resulting from the necessity of eco-friendly legitimacy, new-age GTCs should promote certification of sustainable –initiatives rather than purely environmentally responsible processes. This requires mainly good interactions with local communities in terms of employment, local product consumption, natural /cultural heritage and local attractions promotion.
 - e) The literature review on Tourism Certificates worldwide, high-lightened the necessity for improved consideration and inclusion of all supplementing sectors of the tourism product, including transport, tour operators, catering and SMEs. This requires improved communication of the elements of sustainable tourism and its merits to businesses across the full spectrum of the travel and tourism sector and the recognition of the importance of all stakeholders involved participation, towards the achievement of an overall sustainable tourism product, particularly in reference to the destination dimension.
 - f) International marketing experiences show that demand for Certification is not always led by consumer demand, but rather by other forces. At present consumer recognition is very low, and industry intermediaries are just beginning to consider certification as a tool for due-diligence and preliminary selection of suppliers. An effective promotion strategy from certified businesses or accrediting organizations is thus, necessary to educate consumers and enable tour operators to fill their catalogues with sustainable products.
 - g) In an effort to improve applicability, existing GTCs fall mainly into two broad categories: (i) country or region specific, developed under the circumstance of eco-consciousness of a specific government of body, and developed to address specific country or region specific realities and (ii) internationally-oriented, and thus, limited to the designation of a rather broad set of core criteria that can be assessed through a number of different indicators. To bridge this gap, a need emerges for the creation of a centralised umbrella accreditation body that oversees the creation of universal standards and increases comparability amongst different level schemes. Moreover, it improves transparency through openly-accessed and easily-accessible criteria and performance assessment, while in the same time being able to report both at company and cumulative (sector) levels.
 - h) In this way, the drawback of worldwide-recognition will also be dealt. With the existence of a great number of case, sector or region specific standards, it becomes problematic both for customers to be assured of the product's /service's green performance criteria, but also for businesses to achieve an

effective marketing and promotion strategy. Moreover, considering that the certification cost is rather unbearable for the majority of SME's that comprise the basis of tourism sector worldwide, the existence of an umbrella accreditation body will serve both sides.

6.8 Case Studies: Chios and Lesvos

6.7.1 Chios island

The population on the island of Chios can be categorized as civil, since the vast majority (about 44%) of the population is residents of the town of Chios. The inhabitants are principally engaged in the tertiary sector, with particularly low employment rates in the primary and secondary sector of production. The primary sector's levels of production could be characterized low and focused, since the production of mastic and the aquaculture industry are the only primary sector's industries that nowadays experience intense activity. The unique production of mastic was severely threatened by the destroying summer forest fire of August 2012 when the majority of the island's mastic groves was burnt out by a fire sweeping through the southern part of the island. The secondary sector of production that is the transformation of raw materials into goods, experiences low level development since the related business activity is not sufficiently active. On the other hand, there is intense activity in the service (tertiary) sector which is responsible for the 78.8% of the aggregate local economic activity. Consequently and beyond any doubt, the island's economy depends heavily upon the tertiary sector.

The coastal areas of the island of Chios, like most of the inhabited islands of the Greek territory are highly populated and experience the results of intense human activity of all kinds such as activities directly or indirectly related to different kinds of tourism infrastructure, shipping and boating, commercial and recreational fishing etc.

While most of the classic leisure destinations just seek ways to restructure and modernize their mature and overblown tourism product and create new leisure experiences, Chios favours the view of tourism as an economically expansive industry and as a way that could result to the rise in value of its natural and cultural heritage. Several attempts of the local authorities are directed towards policies that could inspire the diffusion of the supply towards new alternatives and result to growth of the demand for nature, rural or cultural tourism activities.

Unlike the tourism industry' situation during the golden days of the Greek coastal tourism back in the 1980s and 1990s, the diversification procedure and the rebranding of Chios from a mature destination to a sophisticated alternative one is now unhurriedly taking place within a perplexing and vague political framework where the mediation of local and regional authorities prevails.

The island of Chios faces a plethora of perspectives towards the supply of a new form of non-exploitative, more environmental and cultural friendly tourism to relatively undisturbed and under visited areas of natural beauty so as the visitors understand and appreciate what the host destination has to offer. The attempt towards a noteworthy modification of the tourism product is expected to result in marginal negative impacts

upon the host destination, elevated concern towards environmental protection and dynamic conservation of resources and in better interaction, understanding and coexistence between the locals and the tourists.

The supply side of the tourism product and the relevant level of available information are considered to be key factors that could result to the success and balanced development of the region’s tourism industry. Therefore, the identification of the local tourism resources such as tourism attractions and infrastructure or support services is a prerequisite in order to examine the overall tourist product. Tourism attractions could include geographic features, sites of historic significance, special events such as seasonal festivals and fairs or sporting events and recreational facilities linked to special activities such as hiking trails. Infrastructure or support services could include hotel accommodations, restaurants, transportation and other tourism support services. The inventory elements of a destination do not draw tourists to a destination but are of high importance to the overall tourism experience.

Table 6.87.1 (Rooms and Beds at Chios island)

Rooms: 1396		Beds: 2399	
19	(1.36%) 5 star hotels	31	(1.29%) 5 star hotels
652	(46.70%) 4 star hotels	1043	(43.48%) 4 star hotels
450	(32.23%) 3 star hotels	853	(35.56%) 3 star hotels
231	(16.55%) 2 star hotels	395	(16.47%) 2 star hotels
44	(3.15%) 1 star hotels	77	(3.217%) 1 star hotels
Source: GNTO Chios office			

The above table shows that the number of 4 star beds and rooms account for almost 50% of the total hotel supply at the island of Chios. It is a clear indication of the higher quality tourism product offered at the island of Chios. Nevertheless, as Chios is not an established tourism destination there are only 4 hotel establishment with more than 100 rooms. This finding shows that there are room for improvement, provided that the

island pioneers on a form of tourism. Cultural aspects of the island can be used in

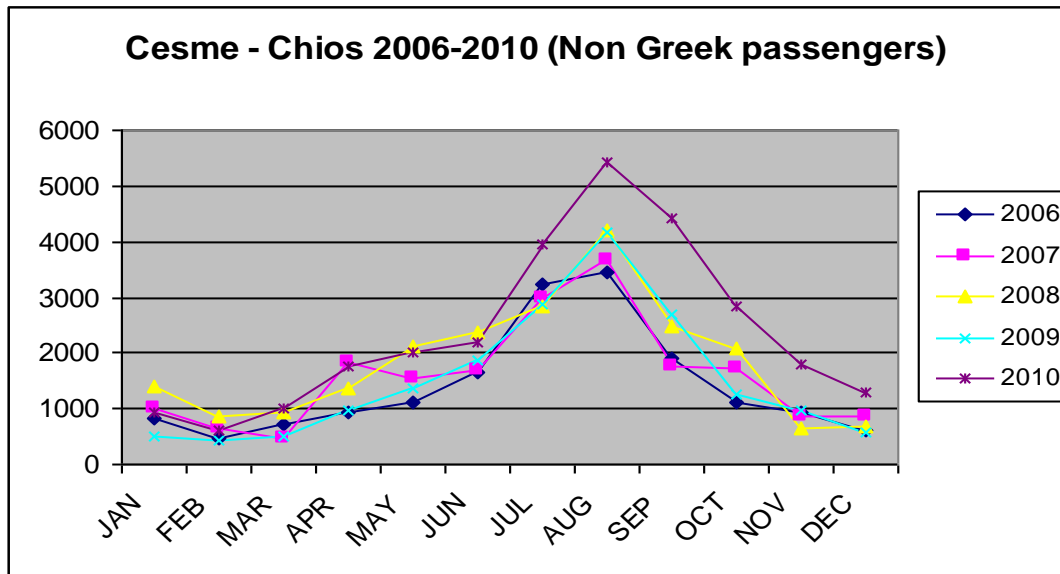


Figure 6.8.1 Cesme Chios short sea passenger traffic

order to proceed to the transition.

Mere recording of the tourism’s supply side though is not enough. The individual elements’ evaluation (significance level) is rather crucial. Through the evaluation process the attractiveness of the resources and the degree of utilization could be sufficiently determined. A resource cannot attract tourists when e.g. there are accessibility issues, while there are numerous other factors that could affect its attractiveness, such as labelling, the existence of information material, possible activities in the field, the ability to purchase souvenirs etc.

The volume of Turkish visitors to Chios is illustrated in the above graph. It is clear that there is an increasing trend in the number of Turkish visitors. The non promising finding though is that the volume of traffic follows the standard peak in the summer months. This weakness can be turned into an opportunity by creating more traffic in the shoulder months. This can be actually be an opportunity for both receiving and generating tourists at/from Chios.

Further upgrading of Chios as a tourist destination is very important for the improvement of the regional tourism activity since there is intensifying both domestic and international competition. Partnerships among local authorities, tourism industry’s business players, the University of the Aegean and locals are a prerequisite for achieving this goal. The development of a plan that could lead to further tourism development taking into account the external risks such as development of new destinations would engage the existing opportunities highlighting the relative merits of the destination. A tourism development plan could include product diversification, advancement of special interest tourism activities, upgrading and enrichment of

services, introduction of innovations in the processes related to the tourism product, efforts towards seasonality phenomena mitigation etc.

6.7.2 Lesvos island

Lesvos is the third largest island in Greece; the Prefecture of Lesvos comprises Lesvos, Limnos and Aghios Efstratios. Lesvos cannot be characterized a popular tourism destination. It has a number of hotel establishments out of which over a quarter (25%) operate on annual basis. An analysis of the distribution of the hotel rooms and beds by category type is illustrated below. It is more than evident that almost half of the available hotel capacity is a 3star accommodation; which stands both for rooms and beds. It is worth mentioning though that there are no 5 star hotels on Lesvos island.

Table 6.7.2 (Rooms and Beds at Lesvos island)

Rooms: 3611		Beds: 6907	
462	(1.79%) 4 star hotels	902	(13.06%) 4 star hotels
1791	(49.60%) 3 star hotels	3383	(48.98%) 3 star hotels
976	(27.03%) 2 star hotels	1886	(27.31%) 2 star hotels
215	(5.95%) 1 star hotels	419	(6.07%) 1 star hotels
Source: Hellenic Hotel Chamber			

On the following table, a comparative analysis of the hotels offered at Lesvos, Chios and other islands in the North East Aegean is illustrated. Amongst all islands listed below, Kos is the most popular one, followed by Samos. This can be easily seen by the number of hotels, especially the 5 star ones on each island, as well as the volume of international passenger traffic.

Table 6.7.3 (Accommodation Establishments at NE Aegean islands)

	Lesvos	Chios	Samos	Ikaria	Kos
Establishments	114	48	180	24	266
5 *	0	2	2	0	21

4*	7	9	6	0	42
International Passenger Traffic (by air)					
	Lesvos	Chios	Samos	Ikaria	Kos
2009	140,135	22,582	230,968	0	1,257,599
2010	123,240	23,688	217,035	0	1,396,183
2011	124,800	19,839	236,048	0	1,705,302
Source: Hellenic Statistical Authority & HCAA					

Ikaria, west of Samos island, has an airport but it does not receive any international traffic at all, that is why there is no international traffic over the last three years. Lesvos is the third more popular island among those listed on the table, but has a very small number of hotels at the top 2 categories. This underlines the fact that there is a huge potential for hotel development in line with the tourism policy the island authorities and its local government are about to implement.

The following table clearly illustrates how much domestic tourism has been affected as a result of the financial downturn the country is facing. On the other hand, international tourist arrivals have not declined as much as the nights spent on the island which probably indicates that the length of stay has shortened or international tourists tend to spend their holidays at non registered accommodation establishments or renting a villa/apartment.

Table 6.87.4 (Tourist arrivals at Lesvos island)

	Arrivals 2009	Arrivals 2010	Change 09/10	Nights 2009	Nights 2010	Change 09/10
Domestic tourists	85167	71332	-16,24%	276974	221588	-20,00%
International tourists	48283	45740	-5,15%	371734	321398	-13,54%
Total	133450	117072	-12,27%	648698	542986	-16,30%
Source: Hellenic Statistical Authority (Limnos is included)						

This table adds to the previous argument as the average length of stay of international tourists has been slashed by over 8% to 7,03 days. On the contrary the average length of stay of domestic tourists has not declined as much as the one of the international tourists.

Table 6.87.5 (Average length of stay at Lesvos island)

	Average length of stay		Change
	2009	2010	
Domestic tourists	3,25	3,11	-4,31%
International tourists	7,70	7,03	-8,70%
Total	4,86	4,64	-4,53%
Source: Hellenic Statistical Authority (Limnos is included)			

An interesting observation is linked to the number of Turkish visitors who started visiting Lesvos, as a result of a more relaxed policy by the Greek authorities. Although the number listed below come from the Lesvos Port Authority and local press, it is more than evident that there is a clear increasing trend in the number of arrivals at the island. Most of them are day visitors, although there is a percentage of Turkish visitors who spend the weekend or a short break at Lesvos. The close proximity of the island to the Turkish coast can work in favour of Lesvos to attract a significant number of visitors especially in the shoulder months of April –May and September-November.

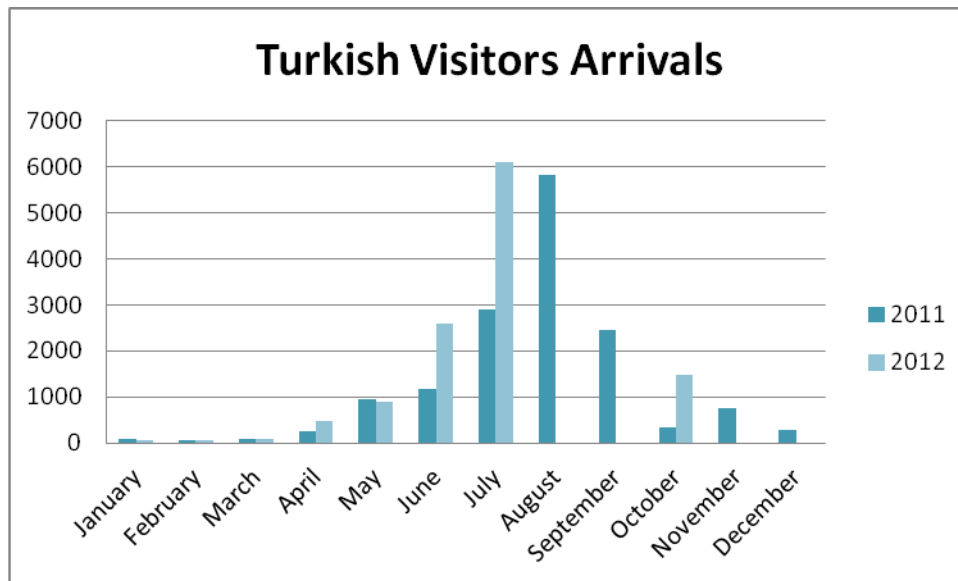


Figure 6.87.6 Turkish visitors to Lesvos by sea

A few concluding remarks on the tourism characteristics of Lesvos island can be summarised in the following.

- 40% of all hotel establishments are located at the Northwest end of the island, over an hour drive from the two main points of entry, the port and the airport.
- There are no 5 star hotels and the size of the existing ones is very small. The largest has 130 rooms, the smallest just 6!
- There is great potential to attract international tourists as the airport has the capacity to do so in combination with the promotion of the unique characteristics the island can offer to the tourists.

6.9 Conclusions

Tourist mobility corresponds to an evident demand for local mass transportation since there is close relationship and interdependence between these two service oriented industries. Nonetheless, the pressure that the aggregate demand imposes upon the micro level supply side of the transport services seems to have no noteworthy results. The most common result of this malfunction concerning the development, modernization and functionality of the transport networks is substantial stagnation phenomena. The motivation behind the development of certain policies and strategies could be justified and enforced by the revenue generating results that are directly related to the volume of incoming visitors of a destination. Tourism should be seen by the authorities as an effective way to subsidize the local economy so as to survive during the periods of year in which seasonality phenomena and low demand occurs.

Furthermore, high peak tourist arrivals and the relevant supplementary demand for transport services impose negative external costs upon the locals in terms of comfort and unconstrained mobility. In such cases proper pricing policies and functional operation planning should be imposed so as the externalities to be productively internalized. Successful policies' development and supply management could balance



the effects of the increased demand for transport services. Moreover, increased revenue during high peak periods could lead to lower charges for local users in the off-peak periods. What should be of high priority for the local authorities is the preservation of the transport services to a high level since increased demand could cause less efficient and uncomfortable services that could result to a corrosion of a destination's reputation.

Certification initiatives around the world are structured and implemented in quite different and opposing ways. Most of the certification programmes, referring both to micro and macro spatial level, require a compulsory fulfilment of a certain minimum number of the criteria imposed by the respective program. Still, there are many certification attempts, especially the ones that concern organizations operating in a micro spatial dimension, which are less formalized. The majority of these initiatives experiences lack of audit & implementation systems and mechanisms to verify the minimum required compliance. A significant segment of these projects passively rely upon voluntary loyalty to meet the minimum conformity concerning several flexible sets of criteria.

The possibility of a probable collapse concerning these programs that do not have firm criteria structures is directly related to the fact that their significance and subjective accomplishment could be questioned under certain circumstances. The soundness of an entire certification initiative and implementation can be jeopardized in cases when the public or some certified business entities find out about the business performance of a non-compliant organization. If some certified members of the program realize that several non-participants enjoy effortlessly the same amount of appreciation and business viability they worked hard to achieve, they probably skip the effort to continue meeting the criteria of the certification.

Furthermore, a complicated and incomprehensive certification program could be aborted by the majority of the local businesses of a destination because of the difficulty to manage and the confusion it may create. In cases of small entrepreneurial local initiatives a complex certification program could be easily considered as a luxurious activity that offers zero result to the company's prosperity.

7 STAKEHOLDERS ANALYSIS

This task includes: (a) consultation with stakeholders from the tourism industry and the local government to record their views on their destination's particularities and (b)



interviews with key decision makers to identify the factors influencing the promotion of green development initiatives in insular regions. The task aims to depict in detail all attributes composing the modern internal and external business environment of the North Aegean islands.

7.1 Consultation event material and description

The first consultation event took place in Chios on the 14th of June 2012. The venue of the event was in Chios prefecture and more specifically in the meeting room of Chios prefecture (room: “Michael Vournous”). A total of 70 people were invited. Among them there were representatives of the local authorities; of environmental organisations; of local tourism enterprises and of the local press.

In Appendix A material of the consultation event (in Greek) is presented.

The event was divided in two thematic sections as follows:

- a) Transportation and Environment in Chios
- b) Tourism and Environment in Chios

During the break between the two sections the attendants filled in questionnaire one for the transportation part and one for the tourist and environment part.

7.2 Consultation results

In this section the consultation results are presented. The public consultation minutes are presented in Appendix B.

After the welcome speech and the brief presentation of the project to the stakeholders, the discussion on the first thematic section began. The representatives of the local authorities highlighted the contribution of a previous study, conducted by the University of the Aegean for the implementation of traffic lights, to the reduction of accidents in Chios. It was a common belief to all the attendants that the major transportation problem in Chios is the noise pollution especially by the motorbikes. Another big issue identified was the lack of cycle and walking paths in the places with outstanding beauty in Chios. Local environmental organization representatives welcomed the promotion of cycling not only for recreation but also for every day moves. The simulation of the road network will show where biking paths can be created. The application of green buses was also proposed. Finally, the urgency of creating safe walking passes for kids to go to school.

The second section was dedicated to tourism. The importance of the areas with natural beauty was highlighted. Furthermore, it was cleared out that “Green Tourism” can be achieved through certifications, eg Green car rental certification, green certification destination. Specialists stressed out that specific criteria should be used to qualify the island as a green destination and that a holistic approach is very important to achieve that. Furthermore, the contribution of the agrotourism exposition that takes place each summer the promotion of a new type of summer agrotourism in the Southern of the island to collect mastic was proposed. On the other hand, the poor quality of the touristic product offered in Chios was mentioned by a member of the audience. Finally, the urgency of establishing Chios as a 3 hour destination from Athens was highlighted.

To conclude, the results for the consultation contribute to the efficient design of the project. Consulting stakeholders will provide an insight to address to all the local transportation issues. Thus, through consultations a strong relationship of trust and support can be developed between the public and the university. Finally, after the end of the project the results can be implemented by the local authorities.

7.3 Public Consultation Questionnaire analysis and results

As described in the previous section two questionnaires were distributed to the stakeholders that participated in the consultation. In this section the results are analysed and presented in detail. Questionnaires are given in APPENDIX C

7.3.1 Transportation Questionnaire results

A sample of 50 questionnaires was collected. Stakeholders were asked about their perceptions concerning some important traffic problems and measures to confront them identified by the research team.

In Figure 7.3.1 the main transportation problems in Chios are identified. Most of the participants agree that the situation is worse during summer months, regarding both the air pollution and the traffic congestion. The vast majority of the attendees in the public consultation think that noise pollution is a big problem in Chios.

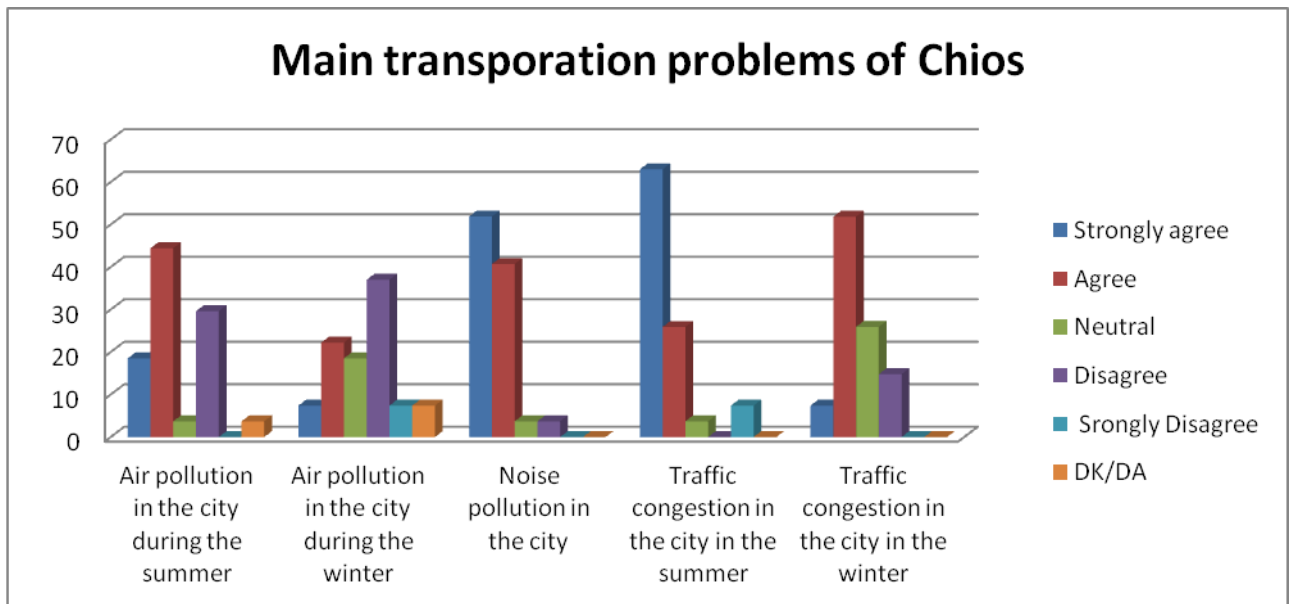


Figure 7.3.1 The main transportation problems in Chios

The perceptions of the stakeholders regarding parking, pedestrians, bikes and traffic measures are presented in Figure 7.3.2. The problem with parking space and the walking problem of pedestrians are highly valued problems. Most of the people asked are in favour of bicycle use in the city but more neutral about the use of it in the countryside. Opinions are divided regarding the efficiency of the traffic measures.

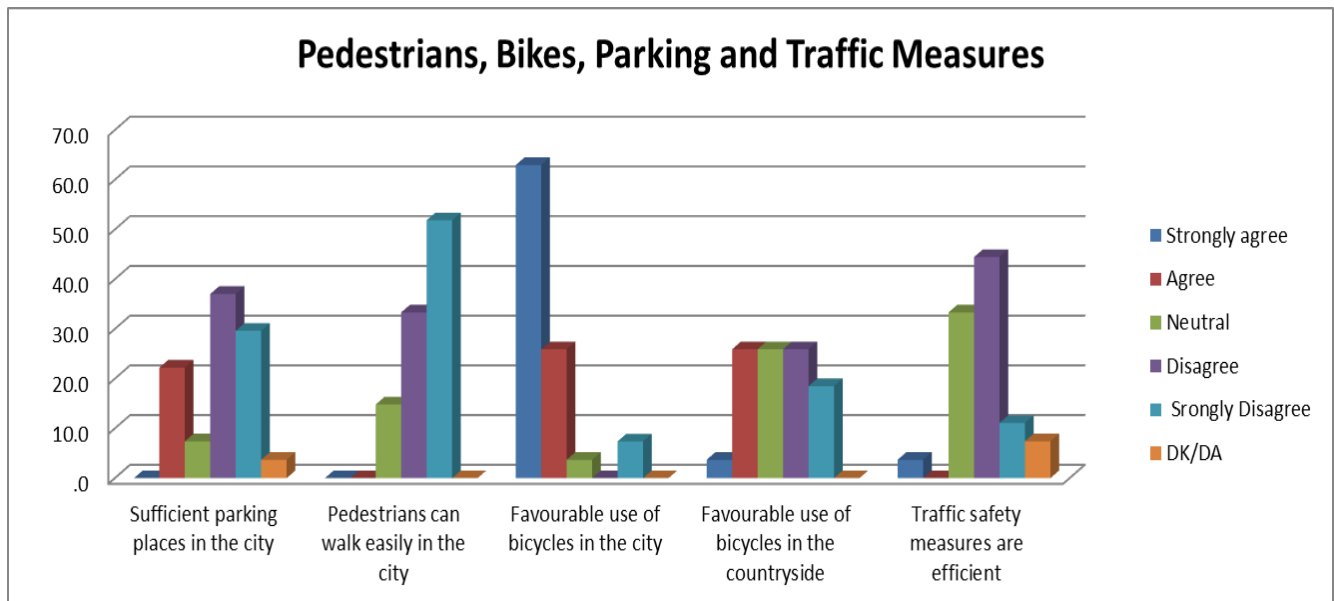


Figure 7.3.2 Parking, pedestrians, bicycles, traffic measures

The irrational use of non-renewable energy sources, the non existence of renewable ones and the insufficient protection of the island’s eco-system are pointed-out in Figure 7.3.3. Opinions vary on the performance of the waste treatment and management. This may occur because of the lack of information about the waste management among the locals. Most people are neutral about the deterioration of the historical and cultural environment, mainly due to the comparison with larger urban centers where the situation is much worse.

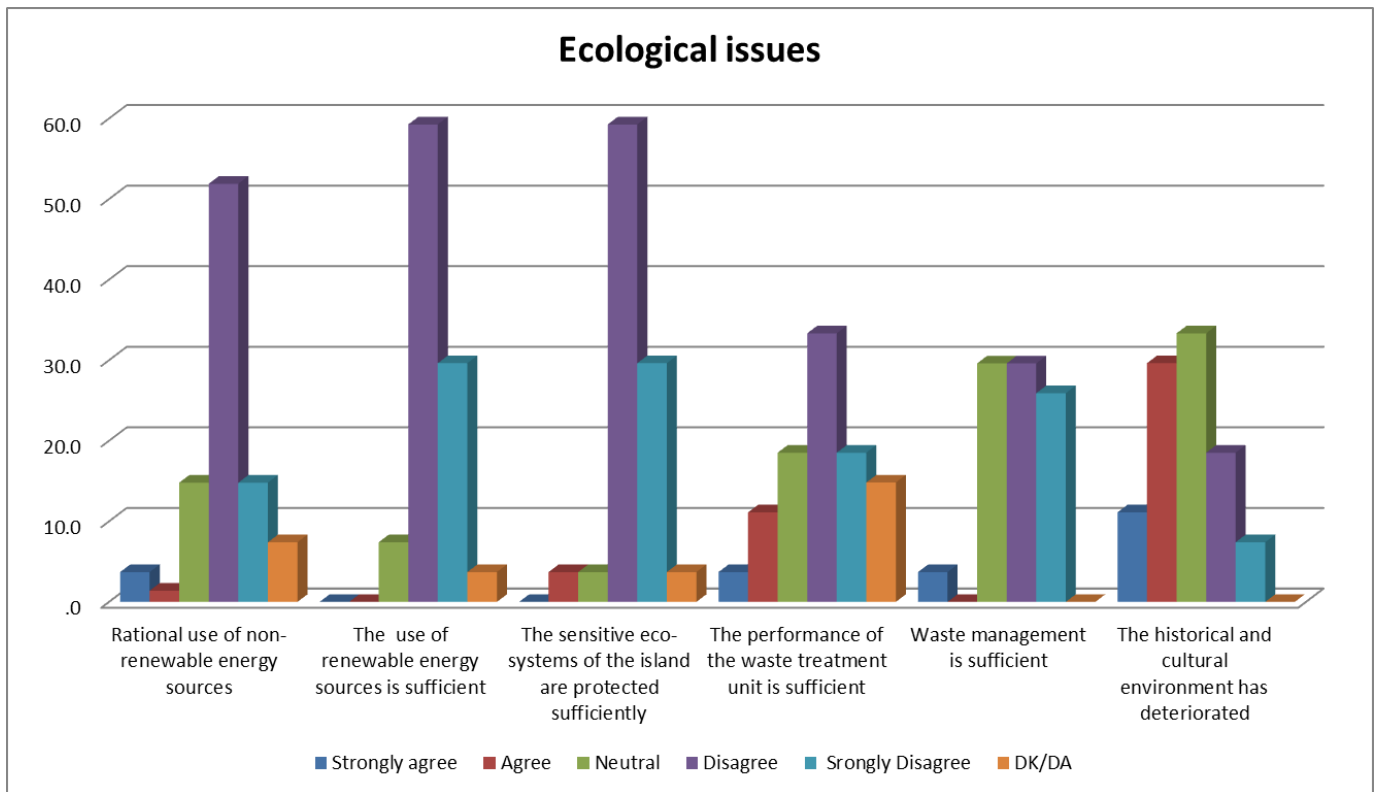


Figure 7.3.3 Ecological issues

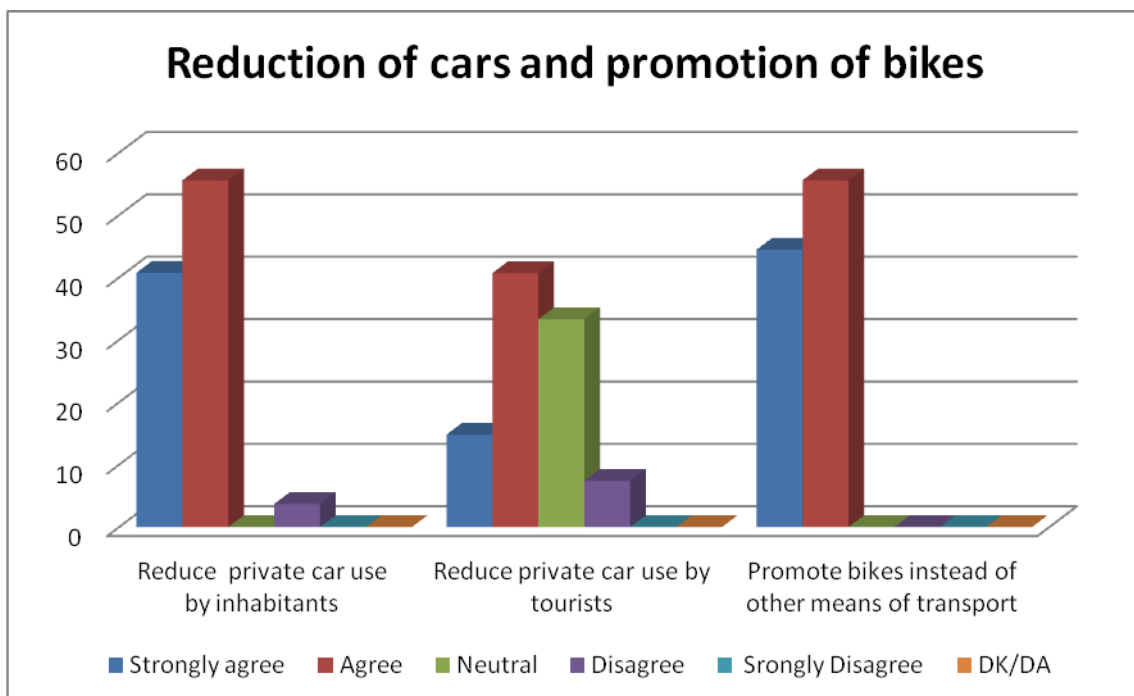


Figure 7.3.4 Reduction of cars and promotion of bikes

In Figure 7.3.4 the perceptions of the respondents towards the reduction of car use and the promotion of bicycles is illustrated. The vast majority is in favor of the reduction of private car use and the use of bikes is regarded as positive alternative. However stakeholders are reserved towards their reduction of private cars by tourists maybe because of the lack of alternative means of transport.

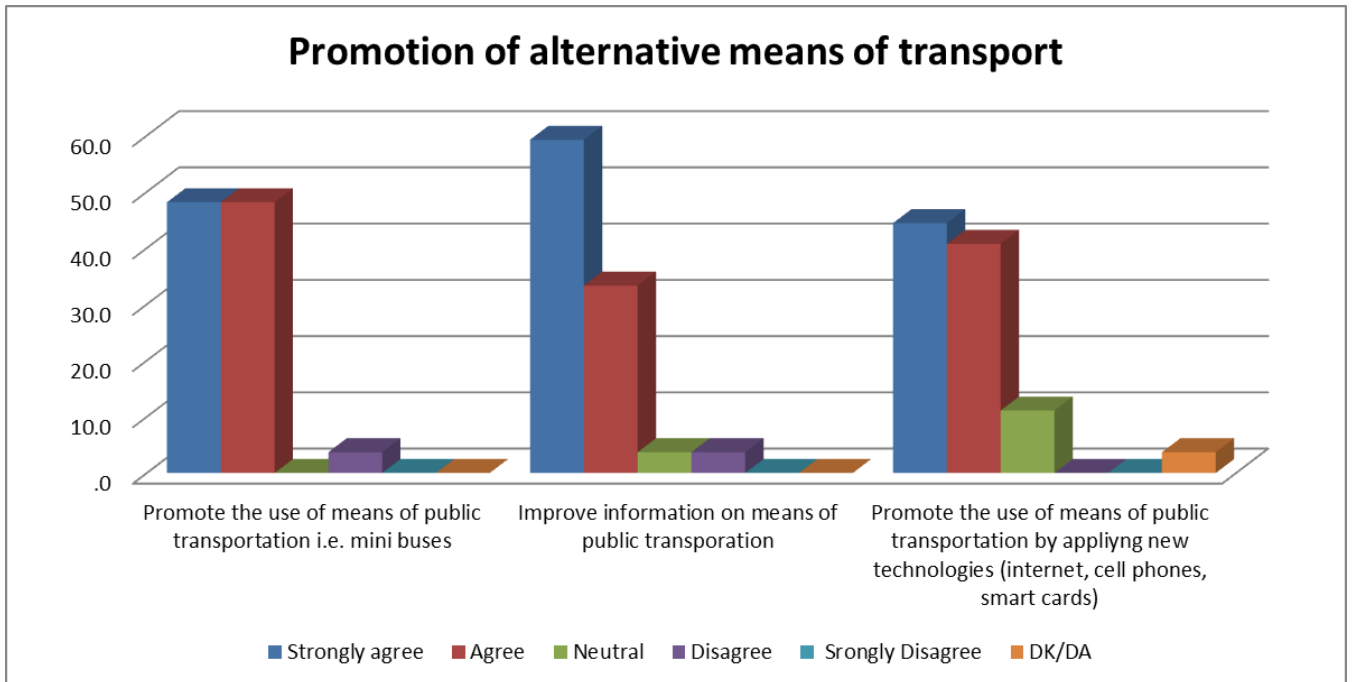


Figure 7.3.5 Promotion of alternative vehicles

When asked about which alternative vehicles should be promoted, most of them prefer electric bikes or bike-sharing (Figure 7.3.5). Hybrid and electric cars also receive positive credit but in a more reluctant way.

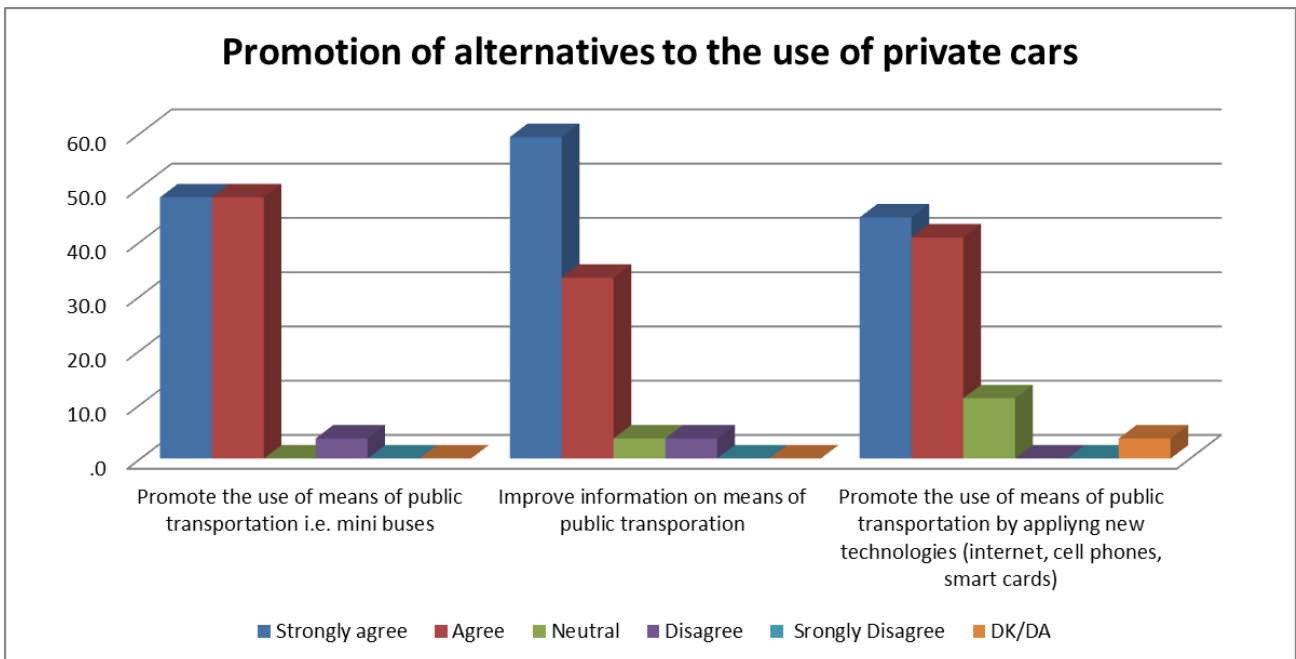


Figure 7.3.6 Promote alternatives to the use of private cars.

According to Figure 7.3.6 the majority of the attendants agree that an improvement in the information received by users on the itineraries of public transport is a solution towards the reduction of private cars. The promotion of public transportation by applying new technologies and social networks receives positive feedback.

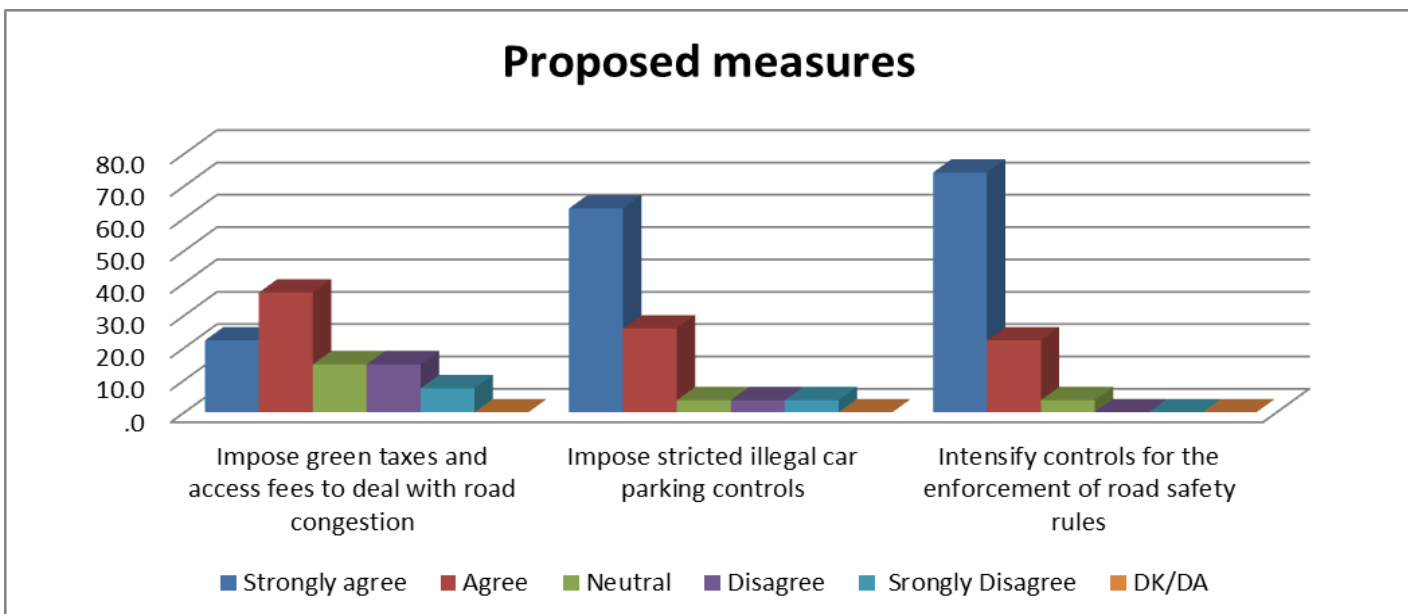


Figure 7.3.7 Proposed measures

Furthermore, stakeholders were asked about the measures that can be imposed to improve traffic conditions in Chios. Strict measures against illegal car parking and improvement of road safety were highly valued. However the impose of green taxes were not so highly appreciated.

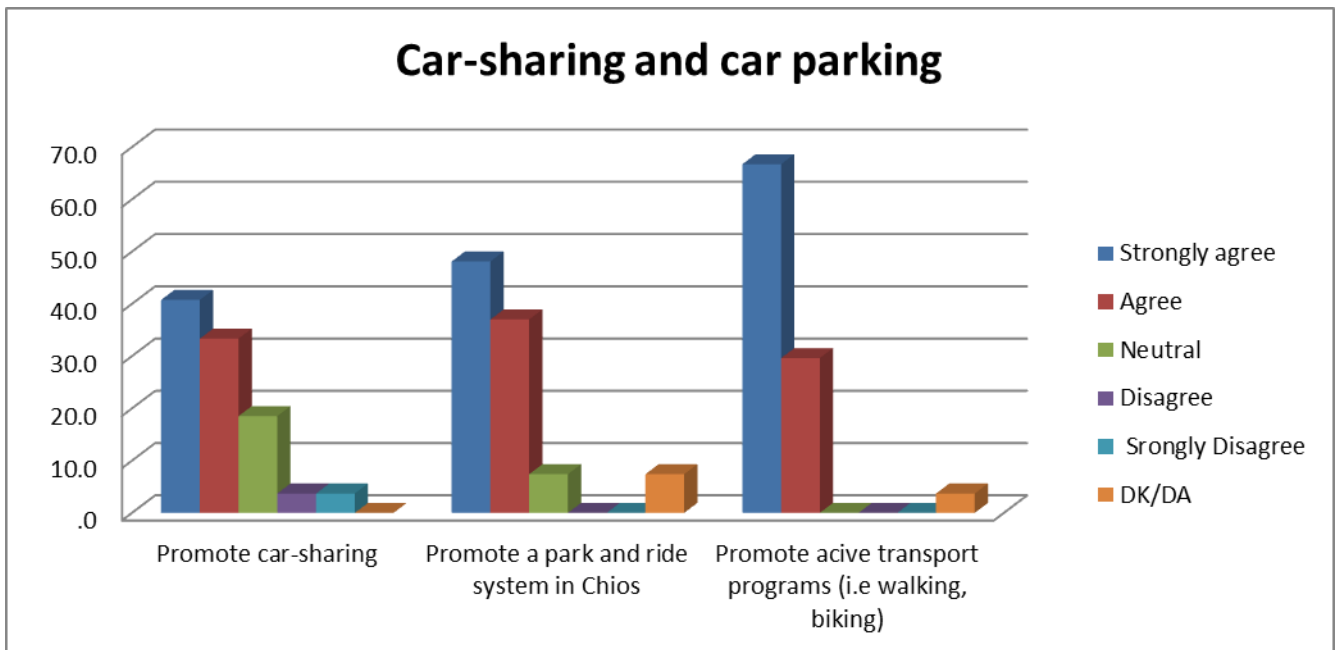


Figure 7.3.8 Car-sharing and car parking

Respondents highlighted the importance of promoting active transport programs. They also embraced the idea to promote a park and ride system in Chios.

Citizen education on green transport measures receives almost total positive opinions. The modification of working and shop hours on the other hand, receive neutral opinions.

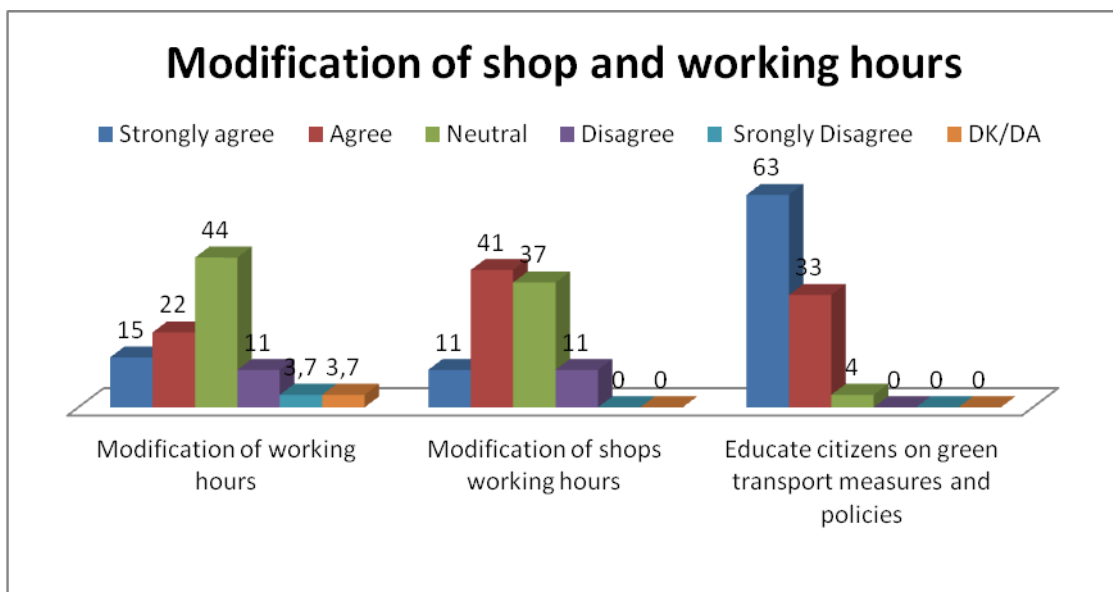


Figure 7.3.9 Modification of shop/working hours

7.3.2 Tourism Questionnaire results

7.3.2.1 Questionnaire Outline

The questionnaire consists of 3 main categories. The first set of questions captures the perception of the respondents on the current state of tourism on Chios Island. The second set of questions reflects the thoughts and beliefs towards the future of the island in terms of tourism development. The last set of questions focuses on the impact and role green transport can play upon achieving the targets set at the previous set of questions. The questionnaire concludes with demographic characteristics of each respondent. All answers are Likert-scaled from 1-6 where 1 stands for strongly agree down to 5 strongly disagree. 6 stands for prefer not to answer/don't know. The questionnaire was answered by 30 respondents. 8 of them are tourism professionals, 19 are not and 3 did not answer this particular question.

7.3.2.2 Analysis

In the first set of ten questions which deal with the current situation on Chios Island, the vast majority of the respondents (96.6%) agree that there is a high seasonality of the tourism product offered on the island of Chios. 90% of the respondents also agree that the tourism product at Chios is explicitly linked to Sea and Sun. Three questions address the tour operators' influence and impact on price, quality and variety of services offered by hotels at Chios. Another issue facing the hospitality sector is the unlicensed establishments, i.e. these which operate without a valid registration. 53% of the respondents believe that this is a big issue on Chios Island, when 16.7% hold a neutral view and 20% disagree with the statement.

The most interesting finding on this set of questions has to do with the cooperation between the local and national stakeholders in policymaking. Over 50% of the respondent disagree and strongly disagree, another 30% has neutral opinion and just 6.7% agrees that there is fruitful cooperation at national and local level.

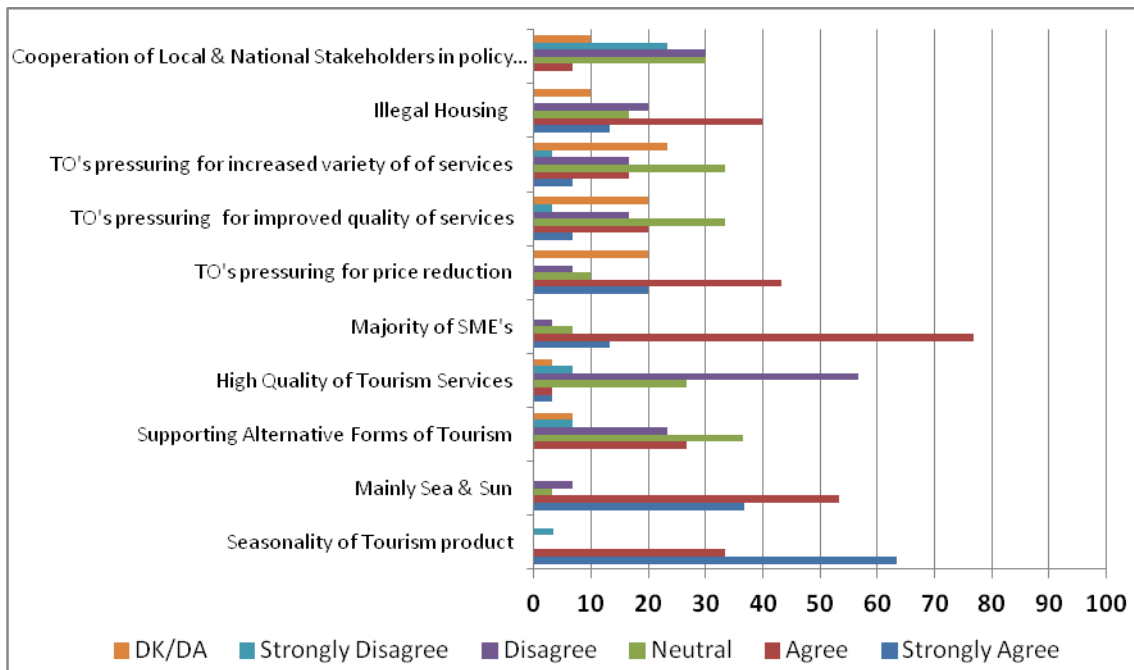


Figure 7.3.10. Current state in tourism

The respondents almost unanimously agree that Chios' tourism product is seasonally based. They also agree that the product offered is directly related to Sea & Sun, as illustrated in the following pie. It should be mentioned that the respondents are well aware of the situation of the tourism product offered on the island of Chios. This means that by being aware of the status, they can potentially provide solutions to it.

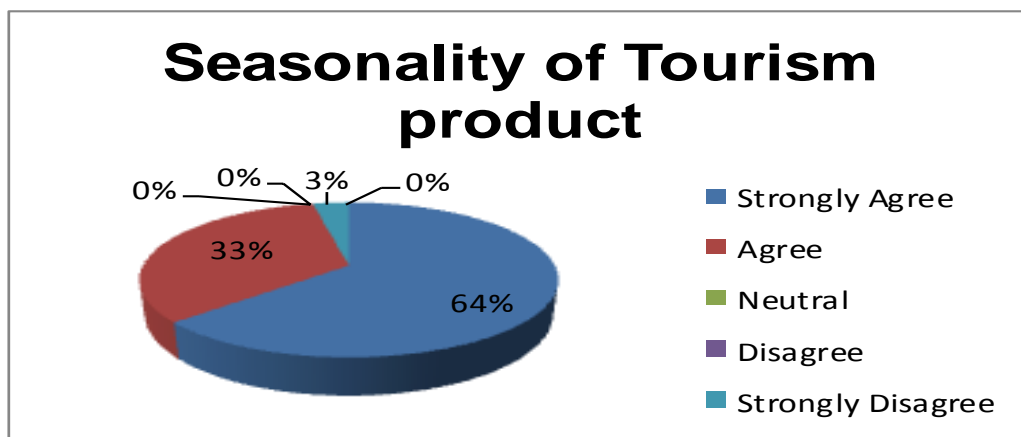


Figure 7.3.11. Seasonality of Tourism

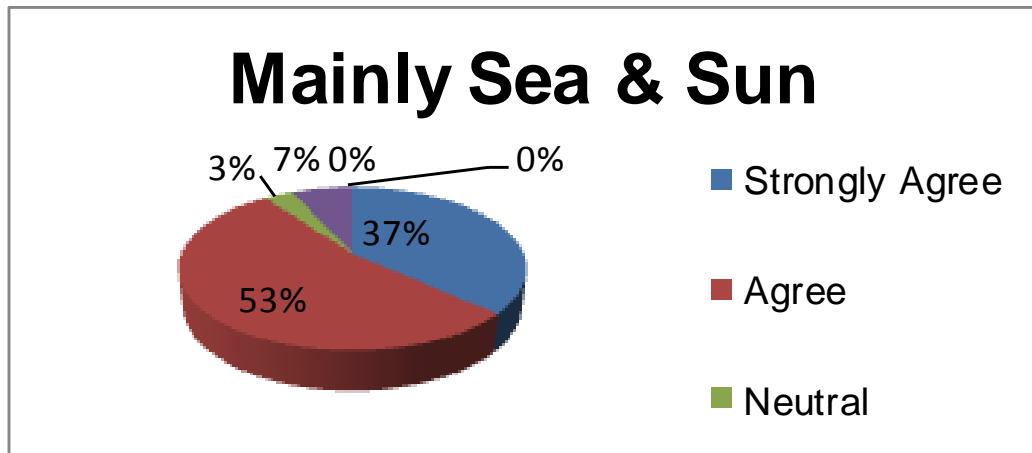


Figure 7.3.12 Seasonality of Tourism

In Figure 7.3.13, the respondents are not certain whether there is a sufficient number of alternative forms of tourism on the island. Their attitudes vary with neutral being the dominant one.

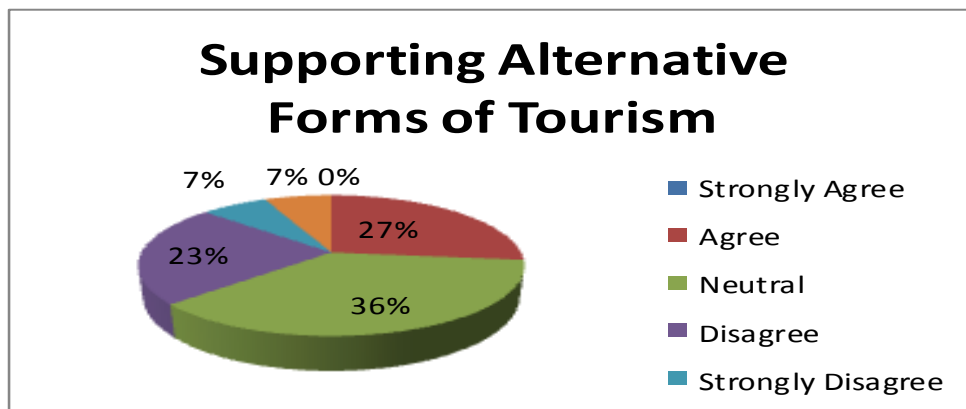


Figure 7.3.13. Importance of Alternatives Forms of Tourism

The majority of the respondents disagree that the tourism services offered are of high quality; in fact, only a quarter seems to believe that the tourism services offered are of high quality standards.

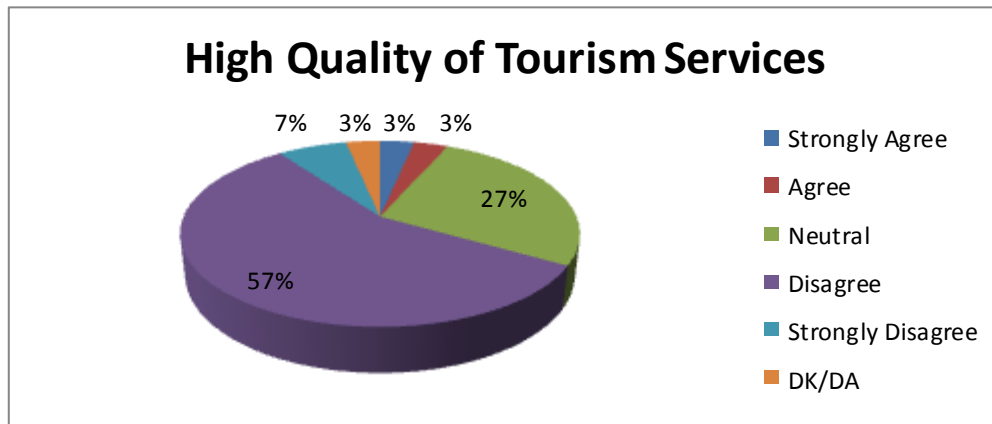


Figure 7.3.14 Quality of Tourism Services

As shown in Figure 7.3.15 , the great majority of respondents stress the importance of small and medium enterprises (SME) as a structural characteristic of tourism supply on the island of Chios.

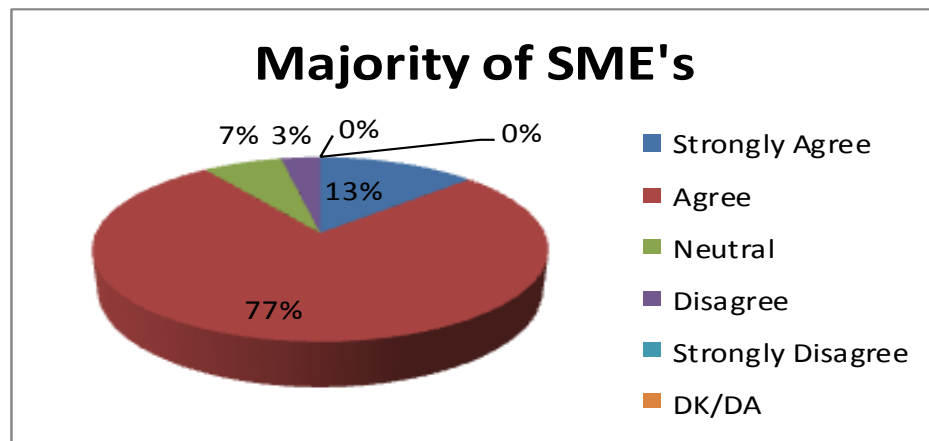


Figure 7.3.15 Importance of Small and Medium Enterprises

Almost 60% of the respondents believe that the tour operators (TOs) ask pressure towards price reduction. A fair percentage did not answer or did not express their opinion on this particular question.

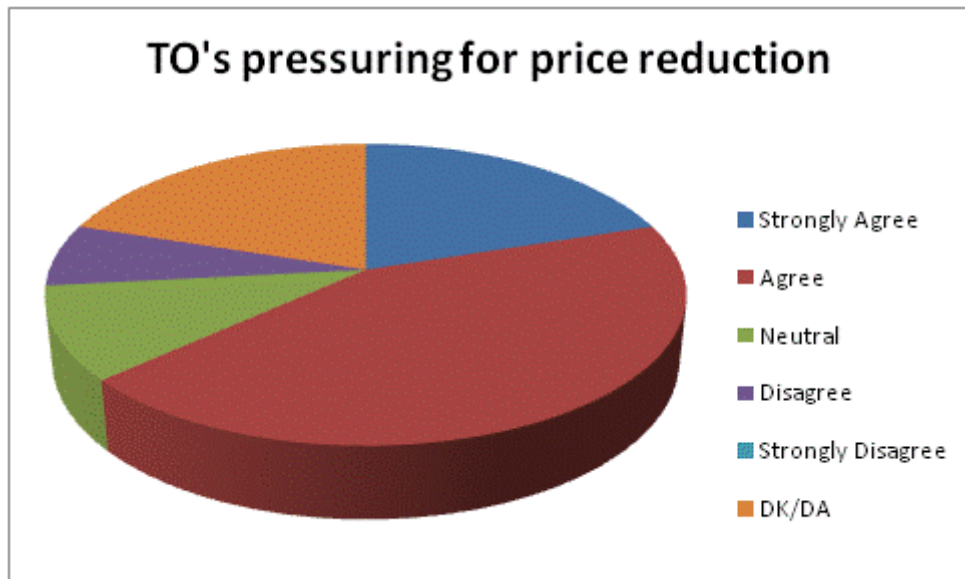


Figure 7.3.16 TO's pressuring for price reduction

The respondents seem to be confused on whether tour operators ask for improved quality services or not. A third of the respondents are neutral to that statement, a quarter is positive and another quarter is negative.

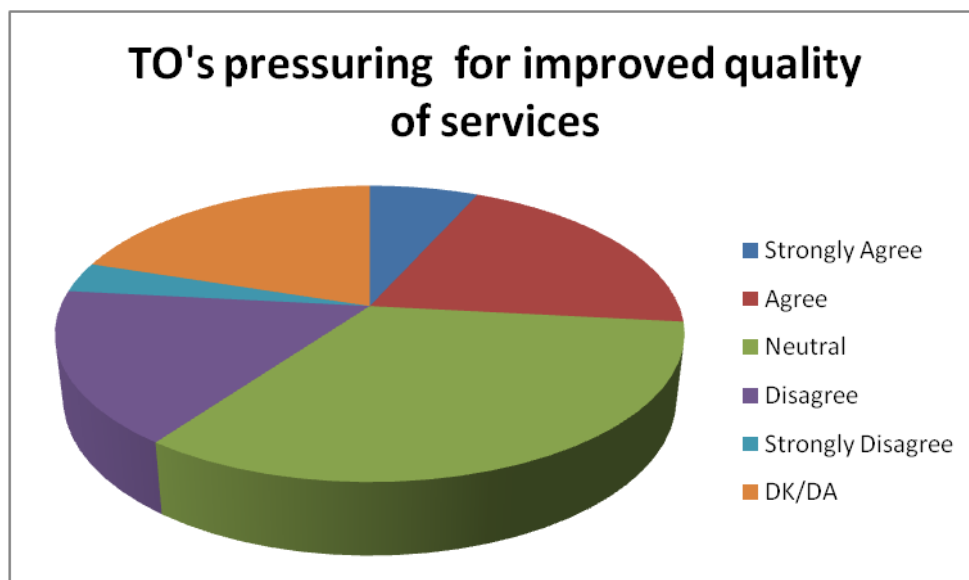


Figure 7.3.17 TO's pressuring for improved quality of services.

Licensing of accommodation is of major importance in Greek hospitality business as there are many establishments that do not operate under license, usually called illegal housing. Although over 50% of the respondents agree that it is a big issue, about 20% is neutral and about a quarter disagrees with the statement.

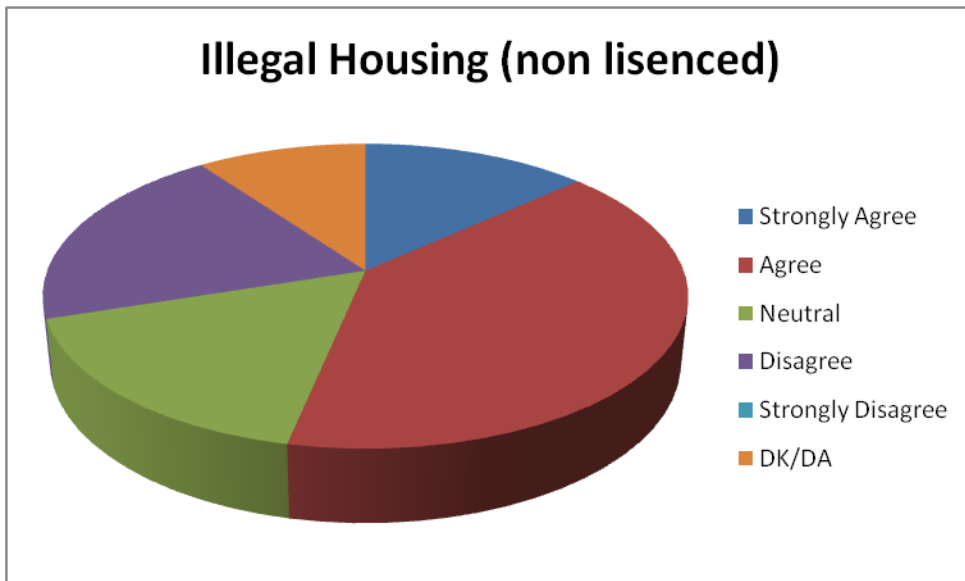


Figure 7.3.18 Illegal Housing (non-licenced)

Another issue in Greek tourism sector is the cooperation and coordination between different institutional and regional levels as far as policy making is concerned. The majority of respondents underline the issue of lack of cooperation although a significant percentage holds a neutral approach to that statement.

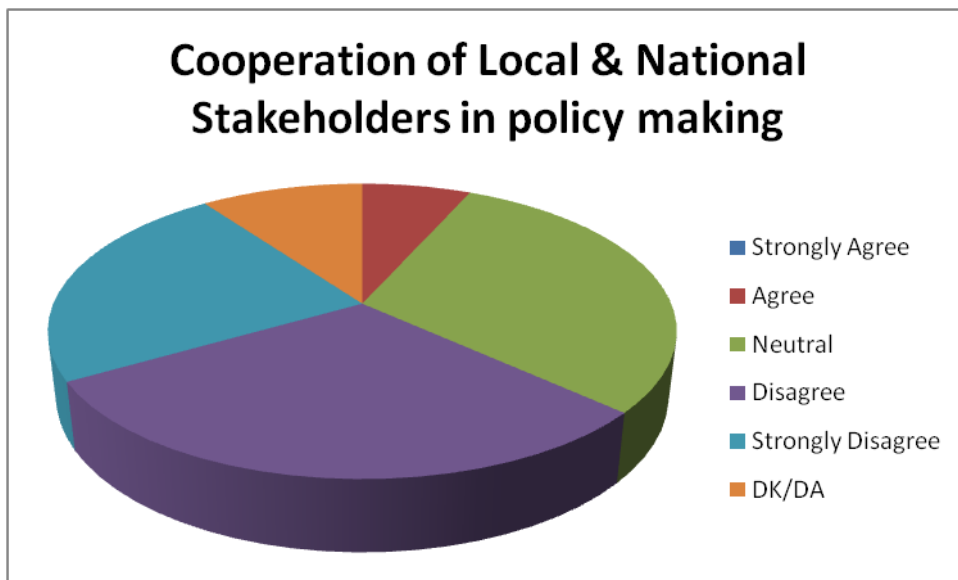


Figure 7.3.19 Cooperation of Local & National Stakeholders in policy making.

7.3.2.3 Targets to be achieved concerning tourism development

This set of questions aims to highlight the views on the possible developments and improvements that can take place on Chios Island regarding tourism. The need to reduce the seasonality of tourism flows was examined in the first question where 33%

of the respondents strongly agreed and 60% agreed. Slightly less than 7% disagree on the need to decrease seasonality.

When asked on reducing the emphasis on Sea and Sun tourism the respondents seem to be undecided. 46% has a positive approach, 13% a neutral one and 40% a negative one. It is reasonably arguable that such a reduction might have adverse impacts on the incoming tourism flows of Chios and lead to uncharted territory, a situation not everyone is willing to experience. Interestingly, however, 100% of the respondents want the island to focus on alternative forms of tourism as well as on higher quality of service. Judging from the reactions on the previous question, such a shift towards alternative forms of tourism should complement rather than substitute the tourism product currently offered.

The question on the need to increase the size of tourism enterprises, divided the respondents. It seems that almost half of them disagree or strongly disagree, whereas just over a quarter agrees or is neutral. Moreover, 60% of the respondents are keen on the idea of creating business clusters among tourism enterprises. The majority of the respondents are also keen on the idea of Chios becoming less dependent on tour operators: 20% strongly agree with this statement when over 53% agree and 10% disagree.

A positive approach is also adopted towards dealing with unlicensed hotel establishments since the total number of the respondents want to tackle this issue. In fact, the majority of the respondents are keen on the introduction of legal measures to combat illegal tourism accommodation, an issue that constitutes pathology of the tourism industry at a national level, not only in Chios. No one disagrees, although around a quarter are skeptical by either being neutral, or not providing a specific answer.

The last question in this set of questions on the collaboration among the tourism stakeholders split the respondents to almost every possible alternative answer. There are two totally contradictory answers that were chosen by the majority of the respondents: in fact, 23% believe that local and national tourism authorities should function independently and 16.7% believe the opposite. Just 10% holds a neutral position with the majority (46.7%) holding a negative approach. Their responses are almost equally scattered between agree and disagree. This is probably a result of the instability of tourism policy and initiatives deriving from different levels of public bodies.

All the above are collectively shown graphically in Figure 7.3.20.

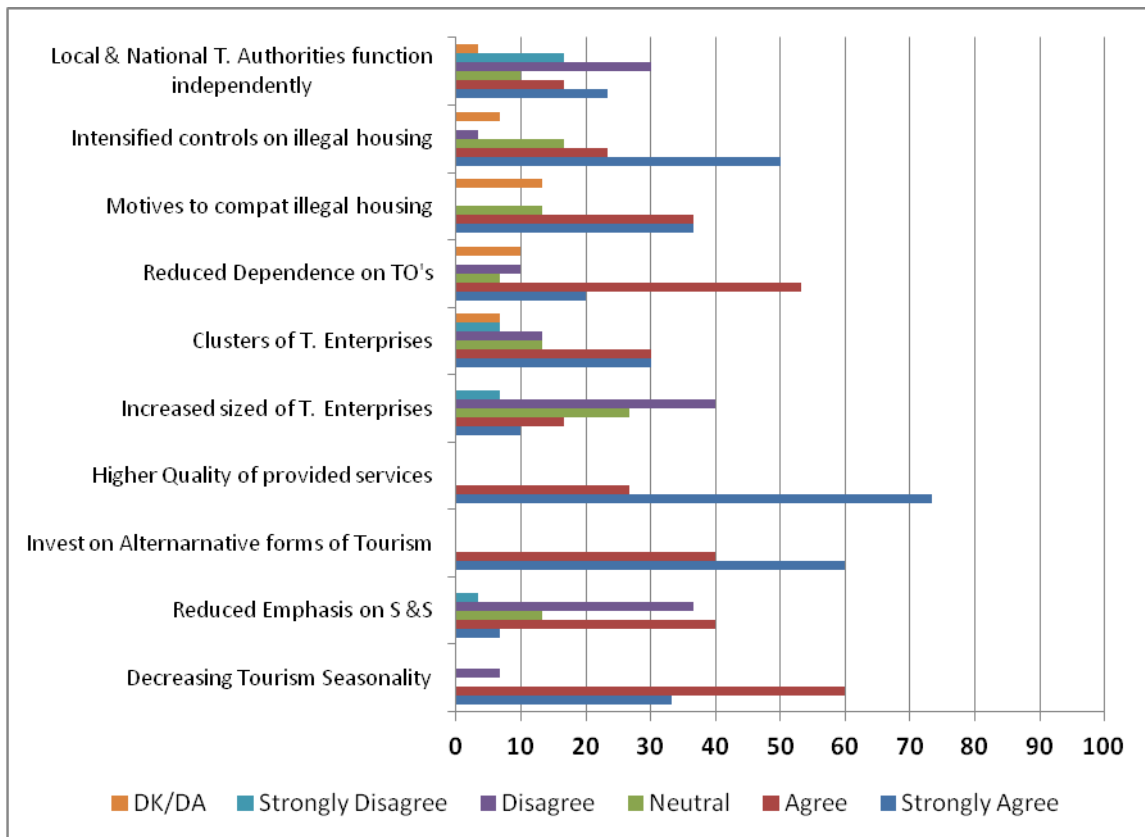


Figure 7.3.20 Targets to be achieved concerning tourism development.

There are nine questions dealing with green transport on Chios. The respondents were asked to what extent they believe that green transport can support actions such as the reduction of seasonality, the reduction of the emphasis on the sea and sun tourism product, the undertaking of investment on Special Interest Tourism, the improvement of the service quality etc.

Over 80% of the respondents believe that green transport can lead to reduction of seasonality, 70% that there will be less emphasis on the sea and sun leading to the investment on Special interest Tourism (100% agree) and 90% that the service quality will be improved. Another 73% believes that green transport can improve the cooperation between local and national tourism authorities.

On the other hand, however, responses do not follow a clear pattern in other statements. In particular, respondents seem to be uncertain, whether green transport will have a strong and distinct impact on issues such as the size of each enterprise, business clustering, and reduction of the dependence on tour operators. Although the latter do not emphasize improvements in service quality and/or differentiation in product offerings, the respondents again believe that this should change. None of the respondents is negative on this idea; just a small percentage is skeptical by being neutral.

In all the above questions, the positive response rate is around 45%. A third of the respondents (around 30%) are neutral on all these questions and the negative

responses range from 10% to 36%. Moreover, 36% percent disagree that the implementation of green transport will increase the size of the business possibly because of the cautiousness to undertake investment risk in a period of severe economic recession. All the above are collectively shown graphically in Figure 12.

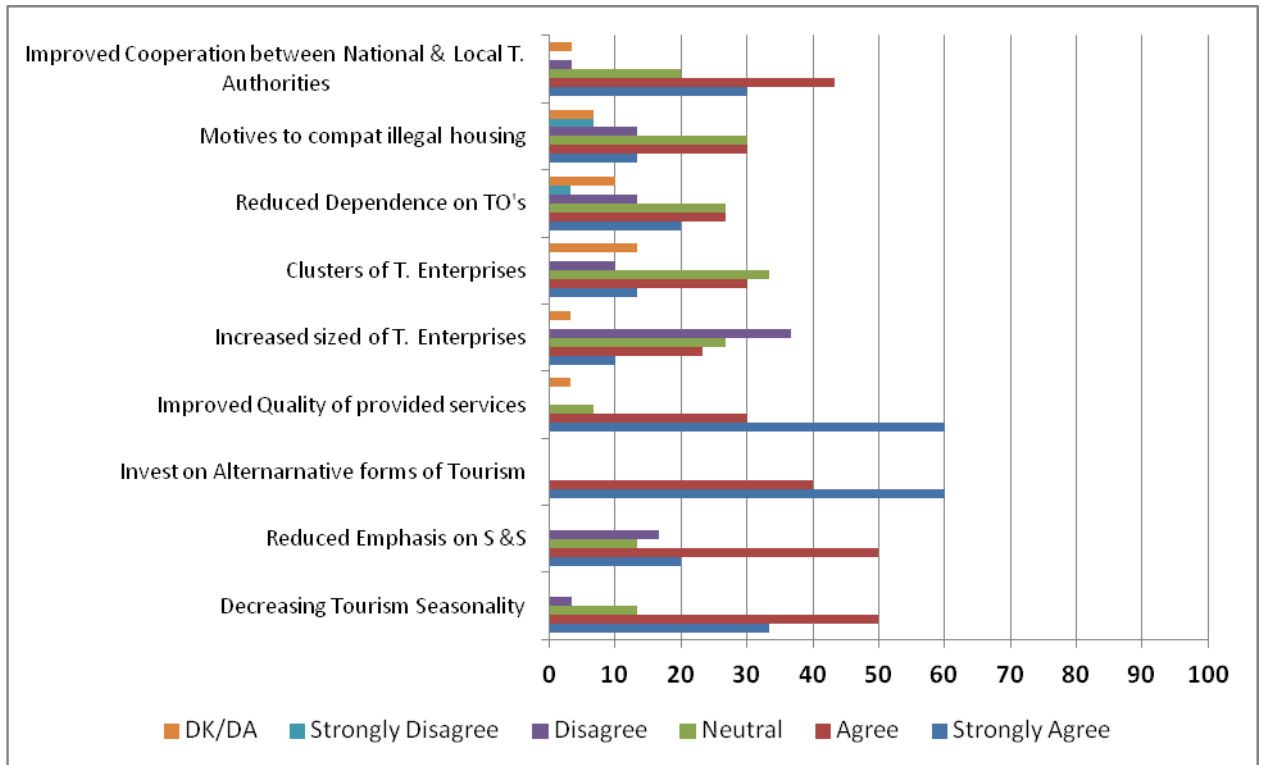


Figure 7.3.21 Implications of Green Transport

7.3.3 Conclusions

It is common ground that almost everyone is keen on economic growth and tourism development in particular. It is evident from the responses that seasonality is a contestable topic. Moreover, 20% of the respondents preferred not to answer or comment on three questions related to tour operators. This high percentage of non-respondents is alarming.

In the second set of questions just a small percentage of the respondents did not answer at all. This probably reflects the ambitions of the respondents towards tourism development. The respondents seem to have a clear view on what needs to be done and how this can be achieved. Nevertheless, they are skeptical towards some aspects that green transport will have on tourism development. An interesting observation is linked with the impact green transport will have on tourism. It seems that there is a great expectation that green transport will reduce seasonality, the emphasis on sea & sun and lead to the promotion of special interest tourism.

It is promising that the respondents are interested and conscious about the impacts of the potential new transport and tourism developments. The majority are aware of the issues tourism is facing at local and national level. The same respondents believe that a new idea (such as green transport) may provide a valid solution to many of the problems challenging national and local tourism.



7.3.4 Consultation Questionnaire Conclusions

In this section the conclusions drawn from the questionnaires of public consultation are presented.

Respondants identified noise pollution and traffic congestion during summer months as the major transportation issues of Chios. Illegal parking as well as improvement of road safety were regarded as rather problematic areas. Stakeholders were positive towards promoting the use of bikes combined with green transport initiatives especially active transport and park and ride programs. They also agreed on improving the public transport service of the island. Measures against illegal parking and road safety were highly ranked but reluctance was observed towards imposing green taxes.

8 CONCLUSIONS

In this section the main findings of WP2 report will be synthesized into conclusions.

Air pollution models produced by transport follow the same pattern and concepts as general air pollution. The most popular methods applied are the ones using the Eulerian grid but also alternative methods including the estimation of street canyon effect or the use of Microscale Computational Fluid Dynamics (CFD) models.

Accurate estimation of vehicle emission is used as input to the models. The accurate and detailed emission estimation during the day or the estimation of emission's seasonality is important to identify the daily and seasonal peaks in pollution due to transport. The allocation of transport emissions in space, within major roadways, facilitates the identification of hot spots where the pollution and the exposure of the population is higher than the surroundings.

The case studies presented in Section 2 of the report presented the best practices applied to solve the major issue of air pollution in small-sized cities such as Lesvos and Chios.

In terms of planning green transportation policies the review of best practices and case studies as well as the collection of accurate data is of critical importance. Once the policies are developed and applied the establishment of monitoring and evaluation procedures is necessary. Therefore, a holistic green transportation plan and system should be designed and materialized to achieve "greener" results.

New generation activity-based models are gaining ground in transportation modeling. The most important attribute of this model is the unincorporation of intra-household interactions. They are based on the detailed classification of activities and travel segmentation. In particular, activities are grouped by type (mandatory, maintenance, discretionary) and setting (individual, allocated, joint) where a special modeling technique is applied for each particular type and setting. 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.

Instead of fractional-probability calculations at the level of origin–destination pairs of zones, the model is applied at the level of individual households, persons, and tours with no explicit restrictions on the number of variables or population/travel segments. Finally, it is important to promote the advantages of these models to transportation planners and decision-makers.

The analysis of the current situation in the study is showed that the town of Chios faces traffic congestion problems during rush hour, which are deteriorated during the summer months, due to the mass arrival of tourists. Furthermore, Chios presents high car ownership rates compared to the other Greek rural cities. Excluding the new Mesta-Chios road, roads connecting the capital with big villages (like Kardamyli) and the network of the city are in a bad condition. Most of the roads are build on existing trails and dirt roads and are full of sharp turns and run through villages.

On the other hand, the capital of Lesvos is Mytilene where the majority of recreation, educational and administrative activities are concentrated, faces traffic congestion



problems during rush hours, which are deteriorated during the summer months. Kalloni, the second largest town, also plays an important role in the island's economy and transportation system, as it is located in the center of the island. Lesvos, like Chios, has high rates of car ownership. The island's roads are generally in a good condition. Recently, there have been made important improvements in many roads on the island, such as the new Mytilene-Kalloni road and the new Mytilene-Polichnitos road. Thus, there is a bicycle trend growing the recent years, which should be encouraged by policy measures and new infrastructure.

In the literature of section 6 the major finding was the *Sustainable Tourism Dilemma* (STD) meaning that green touristic destinations such as the Seychelles derive their income from overseas tourists at the expense of the rest of the world that pays an exorbitant price in greenhouse gas emissions.

Tourism is one of the major factors that derive demand for mass local transportation. Modern transportation infrastructure should be regarded as a pole of attraction for tourists. Nonetheless, this is not the case.

Furthermore, high demand for transportation services during summer peak periods produces externalities to local communities. Hence these costs should be efficiently internalised in order to balance the effect of increased transport services. Implementation of effective policies that increase revenues during high peak periods could preserve the level of service all year long.

In addition, certification initiatives are necessary. In section 6 many certification attempts are described. Nonetheless, the initiatives lack of implementation mechanisms which can verify minimum compliance. The accomplishment these certification programs can be easily questioned since they do not impose firm criteria.

For example, if some certified members of the program realize that several non-participants enjoy effortlessly the same amount of appreciation and business viability they worked hard to achieve, they probably skip the effort to continue meeting the criteria of the certification. Another factor that hinders the implementation of certification programs is their complication and incomprehensiveness.



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Deliverable 2: Current Situation Analysis

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APPENDIX A

Public consultation material



Πρόσκληση διαβούλευσης

Αξιότιμοι κύριοι,

Στα πλαίσια του Προγράμματος GreTIA-Ανάπτυξη Πράσινων Μεταφορών στο Νησιωτικό Χώρο διοργανώνεται διαβούλευση στο νησί της Χίου, στις 14 Ιουνίου 2012, και ώρα από 18:00 έως 20:30 στην αίθουσα συνεδριάσεων «Μιχαήλ Βουρνούς» στο κτίριο της Περιφερειακής Ενότητας Χίου.

Το GreTIA χρηματοδοτείται από το Επιχειρησιακό Πρόγραμμα Εκπαίδευση και Δια Βίου Μάθηση του Υπουργείου Παιδείας, Δια Βίου Μάθησης και Θρησκευμάτων, με συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης. Στο πρόγραμμα GreTIA συνεργάζονται τα ακόλουθα τμήματα:

- Τμήμα Ναυτιλίας και Επιχειρηματικών Υπηρεσιών, Εργαστήριο Λήψης Αποφάσεων και Μεταφορών, Πανεπιστήμιο Αιγαίου – Υπεύθυνος Έργου.
- Τμήμα Διοίκησης Επιχειρήσεων, Εργαστήριο Τουριστικών Ερευνών και Μελετών Πανεπιστήμιο Αιγαίου.
- Τμήμα Περιβάλλοντος, Πανεπιστήμιο Αιγαίου.
- Τμήμα Οικονομικής Επιστήμης, Πανεπιστήμιο Πειραιώς.
- Τμήμα Διεθνών και Ευρωπαϊκών Σπουδών, Πανεπιστήμιο Πειραιώς.
- Department of Geography, University of California, Santa Barbara.

Σύγχρονες πολιτικές αποφάσεις και μέτρα προωθούν τις πράσινες μεταφορές και τη δημιουργία πράσινων νησιών. Οι επιπτώσεις όμως των προτεινόμενων μέτρων και κυβερνητικών παρεμβάσεων δεν είναι άμεσα μετρήσιμες. Το προτεινόμενο έργο στοχεύει στην εκπόνηση συνδυαστικής έρευνας και ανάλυσης στους τομείς των μεταφορών, του τουρισμού, του περιβάλλοντος, της οικονομίας και των νέων τεχνολογιών με στόχο:

- ✓ την ανάπτυξη των πράσινων μεταφορικών συστημάτων στο νησιωτικό χώρο,
- ✓ την αύξηση της ανταγωνιστικότητας του τουριστικού προϊόντος, καθώς και
- ✓ την αύξηση της ελκυστικότητας των νησιών, της ευημερίας και της βιώσιμης ανάπτυξης της περιοχής του Β. Αιγαίου.

Η παρούσα διαβούλευση αποτελεί σημαντική συνιστώσα της μελέτης και περιλαμβάνει δύο ενότητες:

- Η πρώτη ενότητα αφορά τις Μεταφορές και το Περιβάλλον.
- Η δεύτερη ενότητα αφορά τον Τουρισμό και το Περιβάλλον.

Οι άξονες συζήτησης παρουσιάζονται αναλυτικά στη συνέχεια.

Η διαβούλευση έχει ως στόχο τη συλλογή, ταξινόμηση και αξιοποίηση των απόψεων (πολιτική, στόχοι, αναπτυξιακές κατευθύνσεις, προτεραιότητες) των φορέων και ειδικών που έχουν άμεση σχέση και εν μέρει προσδιορίζουν το εσωτερικό και εξωτερικό περιβάλλον των μεταφορών, του τουρισμού και του περιβάλλοντος της Χίου και συγκεκριμένα:

1. την καθιέρωση του διαλόγου για την ανάπτυξη μίας νέας προσέγγισης βασισμένης στις ανάγκες των πολιτών, αλλά και των φορέων.
2. την κατάθεση θέσεων και προτάσεων, την ταξινόμησή τους και την αξιοποίησή τους για την άριστη πραγματοποίηση του GrOTIA, και
3. τη δημιουργία και λειτουργία δικτύου φορέων-κοινωνικών εταιρών, με στόχο τη διάδοση των αποτελεσμάτων του έργου.

Για περισσότερες πληροφορίες μπορείτε να επισκεφθείτε το site του GrOTIA <http://grotia.aegean.gr>.

Ευελπιστούμε ότι θα μας τιμήσετε με την παρουσία σας και την ενεργή συμμετοχή σας στη συζήτηση.

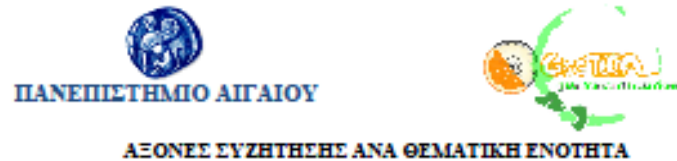
Για την οργανωτική επιτροπή

Αμαλία Πολυδωροπούλου
Καθηγήτρια
Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών

Οργανωτική Επιτροπή

Γεωργία Κωνσταντίνος, Καθηγήτριας του University of California, Santa-Barbara
Κάπρος Σπυρίδης, Αναπληρωτής Καθηγητής Πανεπιστημίου Αιγαίου
Κοτσόλα Άννα, Επικουρη Καθηγήτρια Πανεπιστημίου Αιγαίου (υπό διορισμό)
Μπίτσας Γεώργιος, Επικουρος Καθηγητής Πανεπιστημίου Αιγαίου
Νησιτάκος Νικήτας, Καθηγητής Πανεπιστημίου Αιγαίου
Παπαθεοδώρου Ανδρέας, Αναπληρωτής Καθηγητής Πανεπιστημίου Αιγαίου
Παραβάντης Ιωάννης, Επικουρος Καθηγητής Πανεπιστημίου Πειραιώς
Πολυδωροπούλου Αμαλία, Καθηγήτρια Πανεπιστημίου Αιγαίου
Πρόπος Γεώργιος, Δεκτορας Πανεπιστημίου Αιγαίου
Σαμπράκος Ευάγγελος, Καθηγητής Πανεπιστημίου Πειραιώς
Στοιχωνίδου Μαριάνθη, Επικουρη Καθηγήτρια Πανεπιστημίου Αιγαίου
Χατζοπούλος Ιωάννης, Καθηγητής Πανεπιστημίου Αιγαίου
Ψυλλάκη Μαρία, Επικουρη Καθηγήτρια Πανεπιστημίου Πειραιώς

Figure A.2 Invitation to the public consultation, p.2



ΑΞΟΝΕΣ ΣΥΖΗΤΗΣΗΣ ΑΝΑ ΘΕΜΑΤΙΚΗ ΕΝΟΤΗΤΑ

ΕΝΟΤΗΤΑ 1^η: ΜΕΤΑΦΟΡΕΣ ΚΑΙ ΠΕΡΙΒΑΛΛΟΝ ΣΤΗ ΧΙΟ

Ωρα διεξαγωγής: **18.00-19.00**
 Τόπος διεξαγωγής: **Αίθουσα συνεδριάσεων «Μιχαήλ Βουρουός» στο κτίριο της Περιφερειακής Ενότητας Χίου**

Εξετάζονται οι στρατηγικοί στόχοι και οι πολιτικές των μεταφορών στην περιφέρεια Χίου και πώς επηρεάζουν το φυσικό περιβάλλον. Επίσης θα διερευνηθούν τρόποι βελτίωσης και αναβάθμιση του παρεχόμενου επιπέδου εξυπηρέτησης στους μετακινούμενους αλλά και ελαχιστοποίησης των επιπτώσεων τους στο περιβάλλον.

Αξονες Συζήτησης:

- Ποιες είναι οι προβλέψεις για την αύξηση ή όχι του πληθυσμού τα επόμενα (π.χ. 10- 20 χρόνια) στην πόλη της Χίου (πχ εσωτερική μετακίνηση στο νησί, επιστροφή Χιωτών από την Αθήνα);
- Ποια είναι η κατάσταση του περιβάλλοντος στην περιοχή μελέτης;
- Υπάρχουν σημεία στην πόλη που θεωρείτε ότι τα αυτοκίνητα προκαλούν αισθητή ατμοσφαιρική ρύπανση;
- Υπάρχουν σημεία στην πόλη που θεωρείτε ότι τα αυτοκίνητα προκαλούν αισθητή/ενοχλητική ηχορύπανση;
- Ποια είναι τα χαρακτηριστικά του οδικού δικτύου της Χίου;
- Ποια είναι τα επίπεδα λειτουργίας κατά τη διάρκεια του χρόνου;
- Υπάρχουν σημεία (δρόμοι) στην πόλη όπου παρατηρείται κυκλοφοριακή συμφόρηση;
- Σύγκριση δημόσιων μεταφορών με ΙΧ;
- Χρήση ποδηλάτων-ποδηλατοδρόμοι.
- Ηλεκτρικά αυτοκίνητα.
- Υπάρχουν μέτρα που σχεδιάζονται για τα επόμενα (πχ 10 – 20 χρόνια) χρόνια και μπορεί να επηρεάσουν τις μετακινήσεις στην πόλη (πχ πεζοδρομήσεις, ποδηλατοδρόμοι, νέοι χώροι στάθμευσης, ανάπτυξη ΜΜΜ, κατασκευή μαρίνας);
- Ποια η στάση απέναντι στα προτεινόμενα οδικά έργα (περιφερειακός δρόμος πίσω από το Καστρο, πεζοδρομηση παραλίας);

ΕΝΟΤΗΤΑ 2^η: ΤΟΥΡΙΣΜΟΣ ΚΑΙ ΠΕΡΙΒΑΛΛΟΝ ΣΤΗ ΧΙΟ

Ωρα διεξαγωγής: **19.15-20.15**
 Τόπος διεξαγωγής: **Αίθουσα συνεδριάσεων «Μιχαήλ Βουρουός» στο κτίριο της Περιφερειακής Ενότητας Χίου**

Εξετάζεται η επίπτωση των τουριστικών δραστηριοτήτων στο περιβάλλον της Χίου και θα διερευνηθούν τρόποι βελτίωσης και αναβάθμισης του παρεχόμενου τουριστικού προϊόντος σε συνάρτηση με το περιβάλλον.

Αξονες Συζήτησης:

- Ποιος είναι ο αριθμός και η σύνθεση των τουριστών που φθάνουν κάθε χρόνο στο νησί της Χίου;
- Ποιος είναι ο μέσος αριθμός ημερών διαμονής τους στο νησί;
- Ποια μέσα μεταφοράς χρησιμοποιούν;
- Ποια είναι τα δημοφιλέστερα τουριστικά αξιοθέατα στο νησί;
- Πώς συνδέεται η τοπική οικονομία με τον τουρισμό;
- Ποιοι δείκτες;
- Πώς μπορεί η ανάλυση Πράσινου Αποτυπώματος να χρησιμοποιηθεί για την ελάττωση κατανάλωσης ενέργειας και των αποβλήτων στις τουριστικές επιχειρήσεις;
- Το Πράσινο Αποτύπωμα μπορεί να χρησιμοποιηθεί και για ζητήματα μόλυνσης;



Figure A3. Discussion Axes for the public consultation



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Δελτίο τύπου

Αξιότιμοι κύριοι,

Στα πλαίσια του Προγράμματος **GreTIA-Ανάπτυξη Πράσινων Μεταφορών στο Νησιωτικό Χώρο** διοργανώνεται διαβούλευση στο νησί της Χίου, στις 14 Ιουνίου 2012, και ώρα από 18:00 έως 20:30 στην αίθουσα συνεδριάσεων «Μιχαήλ Βουρνούς» στο κτίριο της Περιφερειακής Ενότητας Χίου.

Η εν λόγω διαβούλευση αποτελεί σημαντική συνιστώσα της μελέτης και περιλαμβάνει δυο ενότητες:

- Η πρώτη ενότητα αφορά τις Μεταφορές και το Περιβάλλον.
- Η δεύτερη ενότητα αφορά τον Τουρισμό και το Περιβάλλον.

Η διαβούλευση έχει ως στόχο τη συλλογή, ταξινόμηση και αξιοποίηση των απόψεων (πολιτική, στόχοι, αναπτυξιακές κατευθύνσεις, προτεραιότητες) των φορέων και ειδικών που έχουν άμεση σχέση και εν μέρει προσδιορίζουν το εσωτερικό και εξωτερικό περιβάλλον των μεταφορών, του τουρισμού και του περιβάλλοντος της Χίου και συγκεκριμένα:

1. την καθιέρωση του διαλόγου για την ανάπτυξη μίας νέας προσέγγισης βασιζόμενης στις ανάγκες των πολιτών, αλλά και των φορέων.
2. την κατάθεση θέσεων και προτάσεων, την ταξινόμησή τους και την αξιοποίησή τους για την άριστη πραγματοποίηση του **GreTIA**, και
3. τη δημιουργία και λειτουργία δικτύου φορέων-κοινωνικών εταιριών, με στόχο τη διάδοση των αποτελεσμάτων του έργου.

Για περισσότερες πληροφορίες μπορείτε να επισκεφθείτε το site του **GreTIA** στο:

<http://cretia.aegean.gr>.

Ευελπιστούμε ότι θα καλύψετε την εκδήλωση επικοινωνιακά, παρέχοντας τη δυνατότητα σε όσους δεν παρευρεθούν να λάβουν γνώση όσων ειπωθούν από τους συμμετέχοντες.

Για την οργανωτική επιτροπή
Αμαλία Πολυδωροπούλου
Καθηγήτρια
Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών



Figure A.4 Press Release for Public Consultation



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Table A.1 . Program of the consultation

Ώρα	Ενότητα Διαβούλευσης
17:30-18:00	Προσέλευση
18:00-18:05	Χαιρετισμός Νικόλαου Λίτινα, Γενικού Γραμματέα Ναυτιλίας, Υπουργείο Ανάπτυξης, Ανταγωνιστικότητας και Ναυτιλίας
18:05-18:10	Χαιρετισμός Κωνσταντίνου Γαννιάρη, Αντιπεριφερειάρχη
18:10-18:15	Χαιρετισμός Παντελή Στεφάνου, Αντιδημάρχου Χίου και Περιβάλλοντος
18:15-18:20	Χαιρετισμός Κωνσταντίνου Μούνδρου, Αντιδημάρχου Χίου, Προέδρου Επιτροπής Τουριστικής Προβολής και Ανάπτυξης
18:20- 18:30	Παρουσίαση GreTIA Αμαλία Πολυδωροπούλου, Καθηγήτρια Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών, Πανεπιστημίου Αιγαίου
18:30-19:15	Ενότητα 1^η : «Μεταφορές και Περιβάλλον στην Χίο» Συντονισμός: Σεραφείμ Κάπρος, Αναπληρωτής Καθηγητής, Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών, Πανεπιστημίου Αιγαίου Ιωάννης Παραβάντης, Επίκουρος Καθηγητής, Τμήματος Διεθνών και Ευρωπαϊκών Σπουδών, Πανεπιστημίου Πειραιώς
19:25-19:30	Διάλειμμα
19:30-20:15	Ενότητα 2^η : «Τουρισμός και Περιβάλλον στη Χίο» Συντονισμός: Ανδρέας Παπαθεοδώρου, Αναπληρωτής Καθηγητής, Τμήματος Διοίκησης Επιχειρήσεων, Πανεπιστημίου Αιγαίου Άννα Κοτρίκλα, Λέκτορας, Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών, Πανεπιστημίου Αιγαίου
20:15-20:30	Συμπεράσματα Συντονισμός: Νικόλαος Λίτινας Γενικός Γραμματέας Ναυτιλίας, Υπουργείο Ανάπτυξης, Ανταγωνιστικότητας και Ναυτιλίας, Ευάγγελος Σαμπράκος, Καθηγητής, Τμήματος Οικονομικής Επιστήμης, Πανεπιστημίου Πειραιώς Κωνσταντίνος Γκουλίας, Καθηγητής, Department of Geography, University of California, Santa Barbara.



APPENDIX B

Public consultation minutes

In this section the consultation meeting minutes are presented.

The meeting started with a welcome speech from prof. Amalia Polydoropoulou, who welcomed the attendants and introduced them to the topic. Her speech was followed by a welcome speech from prof. Nikolaos Litinas, secretary general of the ministry of shipping. He pointed out 3 important aspects of the project:

- 1) It is very interesting and important because of the energy / environment solutions the project will propose in this time of crisis
- 2) Prof. Polydoropoulou has created a very strong scientific team with members from important universities such as University of Piraeus, MIT, University of Santa Barbara, and University of the Aegean.
- 3) The project may be useful for Chios because it aims to: simulate the road network, and the transportation behavioral patterns of the inhabitants that can be applied in future transportation projects and will be a useful tool for decision-making.

His speech was followed by the welcome speech of the prefect, Kostas Ganiaris. He emphasized on the already existing collaboration of the University of the Aegean with the prefecture on transportation issues. He pointed out that the quality of life in Chios suffers from the transportation conditions and he expressed his hopes for applicable results that will protect the environment and save resources of the region.

Then, Mr. Stefanou, deputy mayor of the environment stressed the importance of the existence of a Shipping Department in Chios which has an outstanding tradition on shipping and maritime issues.

Mr Moundros, deputy mayor of tourism pointed out the following main topics. In order to cope with the increasing tourism needs the environment had to be modified. In Chios however, many natural and historical monuments have been preserved, He also stated that it is a blessing that Chios did not turn into touristic destinations such as Chios and Santorini where the local character has been destroyed. Although, Chios was awarded by the EU for its coastal regions (purity, authenticity, coastal natural resources) the connection with other Greek islands and the mainland remains (by air and sea) remains problematic.

Amalia Polydoropoulou described the project briefly.

Beginning of the first thematic section.

Prof. Serapheim Kapros and Prof. Anna Kotrikla were the coordinators of this thematic.

The discussion began with Prof. Kapros who stated that:

- This is the second or third time the department of Shipping, Trade and Transport (STT) cooperates with the Prefecture. 3 years ago STT proposed

a new plan for the traffic rationalization of Chios focusing mostly at the south of the island. This study resulted to a 40% reduction of accidents.

- The project can propose workable and cheap solutions,
- needs for a center of excellence in this area,
- need for exchange of views and ideas
- the main problems of the island are the bad traffic and travel organization, the disproportionately high rate of car ownership, the high accident rate,
- radial transportation can be seen in the island
- bad connection between the North and the South of the island
- 2 gateways to the city of Chios (port and airport) and the traffic they generate

The project proposes many solutions (cycle lanes, pedestrian, etc.).

The public is very reluctant when new measures are proposed. He gave the example of the previous project when after the first reactions everyone was convinced about the usefulness of the measures and implemented them. He also pointed out the reciprocal benefits created by the project. According to Prof. Kapros although Chios is a cosmopolitan island it is a shame that it is not a Greek leader in applying innovative methods. Anna Kotrikla, gave an outline of her work in the projects. She described how she and the environmental team will carry out measurements and air pollution modeling.

Discussion on the 1st thematic section

Prefect Kostas Ganiaris highlighted the importance of the previous study resulting in the installation of traffic lights. But since there are no data available before and after the installation of the lights it is very difficult to evaluate them. Prof. Kapros expressed his belief that after the installation of the traffic lights the number of accidents has decreased significantly. Mr. Stephanou agreed with Prof. Kapros on the rapid reduction of fatal accidents and he highlighted the absence of studies on major transportation problems of Chios. He expressed his eagerness to present to the City Council the results of the project and he addressed noise as one of the major transportation and environmental problems of the city. Finally, he proposed to implement control (KTEO) in motorbikes.

Then Mrs. Lykou took the floor and she pointed out that the public electric power factory produces many air pollutants, that bother those living nearby, and the lack of renewable energy infrastructure in the island.

Mrs. Isabella Bournia (ex-member of the prefectural council) welcomed the importance of this project in Chios and she proposed to start from creating cycle paths in areas of outstanding natural beauty such as Kleidou and in the southern Chios (Kataraktis / Kalimasia, Melanios).

Prof. Kapros stated that bikes should not be used only for leisure but also for daily needs

Prof. Polydoropoulou then added that the simulation of the network will show the bike paths that should be created. She added that during this summer the first data will be collected and that in the winter the policies will be tested in order to also look into the seasonality effect on the transportation needs and behavioural patterns.



Deputy Mayor of Tourism (Mr. Moundros) asked about the costs of the projects following by Ms. Krousouloudi who pointed out that inhabitants do not tend to use the highways.

Prof. Kapros stated out that the trucks did not want to enter the highway in Campos

Mr. Arabatzis, deputy of traffic police highlighted the urgent need for solutions in the traffic problems of the city of Chios. According to him all proposals discussed were positive thus cycling is a more practical and a more economic means of transport. He proposed the promotion of biking from parking places in the edge of town to the city center as were as the implementation of green buses. Finally according to him the most important traffic problems in the city are illegal parking, although sufficient parking control exists, and noise pollution.

Mrs Argyroudi, president of HELIX (Environmental NGOs) welcomed the efforts to promot bicycles as an alternative means of transport and alternative tourism. She also proposed the promotion of the island to Turkish cyclists and the creation of centers for environmental education. She stressed out the lack of pavements (eg narrow Campos) as an important problem and she added the noise pollution from traffic and the contamination of the waterfront as environmental issues that should be solved.

Mrs Tsikoli (director of the Transportation and infrastructure department of the prefecture) pointed out the lack of pavements in many roads that are extremely dangerous especially for children. According to her solving the problems of the pedestrian is of higher importance than biking.

Mrs Voutierou (psychologist) pointed out that road safety should be part of the project as well and she outlined the local effort towards safer roads that started in 2008.

During the break that followed, a questionnaire for transportation and environment topics was distributed to the participants.

Beginning of the 2nd thematic section.

Firstly, Prof. Andreas Papatheodorou outlined his work on tourism and his contribution in the project.

Prof. John Paravantis completed the coverage gaps by adding the following questions:

1. What is the benefit of the local community for working with the university in the context of this project? There are dozens of examples globally of similar researches and also there are many cases marrying tourism and transportation means friendly to the environment from around the world.
2. How to reach agreement for the proposed measures? First it is important to identify the views of local stakeholders and of the society, so that their wishes can be translated into specifications for the project but it is also a great chance for consultation and negotiation.
3. The outcome of today's meeting: for example, it became clear that the issue of noise is more important than we first thought.



Afterwards, Mrs. Bournia asked if the project could also deal with areas of special beauty such as Natura areas.

Prof. Papatheodorou highlighted the importance of these areas and he added that “Green Tourism” can be achieved through certifications, eg Green car rental certification, green certification destination. He also stressed out that specific criteria should be used to qualify the island as a green destination and that a holistic approach is very important to achieve that eg. Next to a green destination a hotel that pollutes the water should not exist.

Then, the deputy of municipal police stated out that they cannot control rental cars which use diesel that causes a lot of contamination but they have to change cars every 5 years. He added that the local government can give initiatives to car rental companies to use hybrid cars (which have zero fees) for example extra parking spaces.

In addition, a member of the audience added that there are NGOs that clean walking paths in many parts of the island with outstanding natural beauty. He also reminded the attendants of the importance of the the agrotourism exposition in the summer and he proposed the promotion of a new type of summer agrotourism in the Southern of the island to collect mastic mastic.

Mrs Argyroudi from HELIX emphasized that the unique character if Chios should be neglected and she described the bad quality of touristic accommodations which are very clean and offer very poor level of service. She also added the poor water quality and that the island should be able to compete with other touristic destinations.

The representative from thr Ecologists Greens party asked if the total ecological footprint could be calculated in the project but Prof. Paravantis replied negatively. He said that only the transport footprint will be calculated.

Prof. Kapros proposed that the harbor has to leave from the city and go to Mesta and he also stressed out that Chios should be established as a “Green” destination and that it can also become become a 3 hours destination Athens.

Prof. Papatheodorou added that the level of touristic service not relevant to the project but it is important and he also presented the seminars to the local touristic companies that are organized by the university.

Distribution and fill in of the second questionnaire (for tourism)

Conclusions part



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Prof. Costas Goulias expressed his satisfaction that the local institutions have very good ideas and are willing to collaborate. According to him the design of the project never ends. Chios can become an example to follow. He also informed the attendants that there will be more consultation events and focus group meetings.

Prof. Samprakos focused on the very satisfactory results. He was glad that many stakeholders took part at the event. He hoped that Chios' environment will continue to be gain awards.

Finally Prof. Litinas proposed that simple methods can be found to finance these ideas. He stressed out the importance of the decision aiding platform for the stakeholders. According to him although the air is clean in Chios marketing of the environment is of great importance but. Environmental and energy footprint are very handy tools in our pockets helping to achieve better quality of life. Furthermore he highlighted the possibility of creating new business opportunities, eg such as the modification of conventional bicycles to electric and then to sell them to other islands. He added that people in Chios have an advanced business / commercial awareness. Finally he concluded by complementing the pioneers and the volunteers that can change the islands.



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APPENDIX C

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1. Ασχολείστε επαγγελματικά με τον τουρισμό; ναι όχι

2. Αν ναι, σε ποιον κλάδο;

3. Σε ποιο βαθμό συμφωνείτε ή διαφωνείτε με τα ακόλουθα που περιγράφουν την **υφιστάμενη** κατάσταση στη Χίο;

	Συμφωνώ Εξαιρετικά (1)	Συμφωνώ (2)	Ουδέτερος (3)	Διαφωνώ (4)	Διαφωνώ Εξαιρετικά (5)	Δεν ξέρω Δεν απαντώ
Το τουριστικό προϊόν χαρακτηρίζεται από εποχικότητα						
Το τουριστικό προϊόν δίνει έμφαση στον ήλιο και τη θάλασσα						
Υποστηρίζονται εναλλακτικές και ειδικές μορφές τουρισμού						
Παρέχεται υψηλό επίπεδο τουριστικών υπηρεσιών						

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Οι περισσότερες ξενοδοχειακές και τουριστικές επιχειρήσεις είναι μικρού μεγέθους						
Οι tour operators πιέζουν τις τουριστικές επιχειρήσεις για μείωση τιμών						
Οι tour operators πιέζουν τις τουριστικές επιχειρήσεις για βελτίωση της ποιότητας των παρεχομένων υπηρεσιών						
Οι tour operators πιέζουν τις τουριστικές επιχειρήσεις για αύξηση της ποικιλίας των παρεχομένων υπηρεσιών						
Υπάρχει πρόβλημα παραξενοδοχίας						
Οι τοπικοί και εθνικοί φορείς τουρισμού συνεργάζονται αρμονικά για τη διαμόρφωση						



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τουριστικής πολιτικής							
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Deliverable 2: Current Situation Analysis

4. Σε ποιο βαθμό συμφωνείτε ή διαφωνείτε με τους ακόλουθους **μελλοντικούς** στόχους για τον τουρισμό στη Χίο;

	Συμφωνώ Εξαιρετικά (1)	Συμφωνώ (2)	Ουδέτερος (3)	Διαφωνώ (4)	Διαφωνώ Εξαιρετικά (5)	Δεν ξέρω Δεν απαντώ
Η εποχικότητα του τουριστικού προϊόντος να μειωθεί						
Το τουριστικό προϊόν να δίνει μικρότερη έμφαση στον ήλιο και τη θάλασσα						
Να δοθεί μεγαλύτερη έμφαση σε εναλλακτικές και ειδικές μορφές τουρισμού						
Να παρέχεται υψηλότερο επίπεδο τουριστικών υπηρεσιών						
Το μέγεθος των τουριστικών επιχειρήσεων να αυξηθεί						
Οι τουριστικές επιχειρήσεις να δημιουργήσουν συστάδες						

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(clusters)							
Οι τουριστικές επιχειρήσεις να περιορίσουν την εξάρτησή τους από τους tour operators							
Για την αντιμετώπιση της παραξενοδοχίας να δοθούν κίνητρα στις σχετιζόμενες επιχειρήσεις							
Για την αντιμετώπιση της παραξενοδοχίας να εντατικοποιηθούν οι έλεγχοι στις σχετιζόμενες επιχειρήσεις							
Οι τοπικοί και εθνικοί φορείς τουρισμού να λειτουργούν ανεξάρτητα							

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5. Σε ποιο βαθμό συμφωνείτε ή διαφωνείτε ότι η ανάπτυξη των **πράσινων μεταφορών** μπορεί να βοηθήσει στην επίτευξη των ακόλουθων μελλοντικών στόχων για τον τουρισμό στη Χίο;

	Συμφωνώ Εξαιρετικά (1)	Συμφωνώ (2)	Ουδέτερος (3)	Διαφωνώ (4)	Διαφωνώ Εξαιρετικά (5)	Δεν ξέρω Δεν απαντώ
Μείωση της εποχικότητας του τουριστικού προϊόντος						
Μείωση της έμφασης του τουριστικού προϊόντος στον ήλιο και τη θάλασσα						
Αύξηση της έμφασης σε εναλλακτικές και ειδικές μορφές τουρισμού						
Βελτίωση του επιπέδου τουριστικών υπηρεσιών						
Αύξηση του μεγέθους των τουριστικών επιχειρήσεων						
Δημιουργία συστάδων (clusters) τουριστικών						

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επιχειρήσεων							
Μείωση της εξάρτησης των τουριστικών επιχειρήσεων από τους tour operators							
Ένταξη της παραξενοδοχίας στον παραγωγικό τουριστικό ιστό							
Βελτίωση της συνεργασίας μεταξύ τοπικών και εθνικών φορέων τουρισμού							

6. Υπάρχει κάτι άλλο που θα θέλατε να προσθέσετε;

7. Εάν θέλετε να επικοινωνήσουμε μαζί σας στα πλαίσια της συνεχιζόμενης διαβούλευσης, παρακαλούμε δώστε μας τα στοιχεία σας.