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Sustainable Development Variables to Assess Transport Infrastructure in Remote Destinations

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***Abstract*—**The assessment variables of the accessibility and the sustainability of access infrastructure for remote regions may vary significant by location and a wide range of factors may affect the decision process. In this paper, the environmental disturbance implications of transportation system to key demand and supply variables impact the economic system in remote destination are descripted. According to a systemic approach, the key sustainability variables deals with decision making process that have to be included in strategic plan for the critical transport infrastructure development and their relationship to regional socioeconomic system are presented. The application deals with the development of railway in remote destinations, where the traditional CBA not include the external cost generated by the environmental impacts that may have a range of diverse impacts on transport infrastructure and services. The analysis output provides key messages to decision and policy makers towards sustainable development of transport infrastructure, especially for remote destinations where accessibility is a key factor of regional economic development and social stability. The key conclusion could be essential useful for relevant applications in remote regions in the same latitude.

***Keywords*—**Sustainable development in remote regions, sustainability variables, transport infrastructure, strategic planning.

I. Introduction

ENHANCING the climate resilience of transport networks requires a coherent understanding of the different types of impact that CC affect infrastructure and operation across the different modes of transport. Current troubles faced by the transport industry arising from the energy price variations, the scarce of natural resources and the economic downturn belie an ongoing growth in demand the societies supporting that consumption is a key driver of growth and welfare.

Forecasts suggest that climate implication have the potential to have a major impact upon levels and patterns of demand for travelling as seasons change, as some traditional locations become less attractive and as new markets emerge, either at different times of the year or in new geographical regions, [1], [12]. Such changes could have significant effects for the economies of a number of regions across Europe, especially remote destinations where restrictions on transports may lead to constrains in connectivity to lager cities/markets or intra-regional mobility.

The world class city-regions need international route networks to support globalisation and remain competitive. The challenge is, however that while these socio-economic benefits are significant, so too are the environmental 'cost' and this cost threatens the future growth of the industry at both passenger and freight patterns.

Among the many effects of environment disturbance by the human activity the existing unforeseen strain on extend capacity by new infrastructure and business as usual model of growing economy must be constantly revaluated. Based on traditional cost-benefit analysis, the high implementation cost, the low competition and the revenues uncertainty are key decisions barrier for the implementation of critical transport infrastructure towards low emission transportation options, such as the development of railway services in remote destinations. Therefore, the sustainability variables and their relationship to socioeconomic impact have to be well defined providing quantified short and long run estimations, which have to be included in the regional strategic sustainable development plan. However, despite the potential wide broad implications of adverse Climate Change (CC) impacts on transport industry, detailed relevant research is limited. This may happen because the CC impact assessment in a high competitive and turnover industry such as transports may need a holistic multiobjective analysis and the estimation of the range for the various types of effects including collaboration of different professionals and methodology framework. In UNECE report [1] is highlighted the need for a multifunctional analysis to depict the footprint of these implications extending from the classical The paper key objective is to present a conherent and comprehensive designation of the broad impacts of environmental disturbance caused by transport industry in terms of business and economic outputs on one hand; and social values on the other. In any national or regional plan and policy paper, the transport development and the economic growth is correlated to investments upon capacity expansion, operation efficiency and demand simulation extrapolating the benefits by importing new capitals in the national or regional economic system, acting as Foreign Direct Investments [2]. Taking this into consideration, the content of this paper is designed merely to define the key functions of sustainable transport development and illustrate the links with the key drivers upon economic growth and social values. This will be achieved through functional analysis where the environmental implications for transport businesses are presented illustrating the nature, and the potential magnitude of change, and their potential impact upon socioeconomic development. The application deals with transport network in Greece, which is selected, for two

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reasons: firstly, the Greek economy is heavily dependent on transport because of its location attracting passenger and freight demand from European and Asian destinations; and secondly, given the recent long term economic recession of the country, the income from transport growth is seen as a key element of Greece's economy recovery plan [3].

II. Transport Sustainable Development

In principal, the concept of sustainable transport system mainly deals with the avoidance and maintenance of the environmental impacts on transport industry. Therefore, the stakeholders of all functions of transport, economic and social system involved in decision process could be considered different perspectives. These different expectations may lead to conflicts in planning and implementation of strategic plans, making authorities and NGOs defense to demand growth and economic system very welcome to more demand and investments in transport infrastructure.

The implementation of the transport infrastructure may lead form few years to many decades (e.g. the first discussions for the rink road serving Athens were 40 years before its operation). This happens because the high capitals have to be invested and the long payback period as well as the strong conflicts between the stakeholders and decision makers on transport project feasibility, financial viability and sustainability. Sometimes the objections by residents and NGOs are so strong that even that a project is well prepared in terms of financials its fully unacceptance in terms of suitability and social resistance, (e.g. London Heathrow airport 3rd runway project).

Organisations, governments and authorities are recognizing that transport system resilience deals with transport infrastructure sustainable policy. European Union is committed to integration of sustainable development into all its policies. Thomas et al. [4] highlight that Common Transport Policy paper in Europe is adopting the freedom right to travel to/from everywhere, but also the following needs are recognized:

- The continuing growing of transport industry to maintain regional economic development;
- A comprehensive and well connected transport system;
- The assessment of impact and risk by climate change is promoted as a key decision tool for new transport infrastructure projects;
- The promotion and substation of transport services should be take into consideration climate change and social equality;
- The supply and demand equilibrium lead to optimum transport mode to deliver the task required, avoiding overscheduling, inefficiencies and risks over time.

The key principle overlying sustainable development concept is the environmental implications of transport supply growth. In other words, that transport industry has to mitigate the concerns about environmental impact, therefore, mitigation actions and adaptation plan have to be into consideration towards further growth. Furthermore, while the benefits of transport system developed is well recognized the external cost to adopt and mitigate environmental implications have to be considered and the environmental risks have to be assessed in project financing decisions.

Concluding, the strategy towards transport sustainable development include analysis in both, the demand side and supply side taking into consideration sort and long run risks caused by environmental implications. The supply-demand equilibrium is key objective to define sustainable development for transport. The sustainability assessment for investment plans have to take into consideration the following:

- The accommodation of existing and future level of demand by improving efficiency and implementing investments support sustainable infrastructure development;
- The maintenance of high economic rates and social return, supporting regional economic development and promoting social values;
- Effective protection of the environment and policies to adverse existing climate change curve;
- Prudent use of natural resources and promotion of low carbon development services and neutral infrastructure operation.

III. Environmental Impact on Transport Modes

Tourism demand for transport strongly related with global economy, trade and population. Transport is a typical demand driven industry where the origin-destination pairs and mode choice defined by the cost, time and level of services variables. The climate change implications are heavily effected transport industry because of the changes in demand pattern and the additional cost is generated to maintain transport infrastructure and accommodate safe and secure demand. The population distribution, the spatial allocation of commodity production, the tourism choices, the trade and consumption patterns are key factors that affected by environment condition change, therefore, they stimulate or fragment passenger and freight demand to/from regions and shift demand between different transport modes and services.

It is noteworthy that capital resources to maintain environmental impact could range from few millions to many billions depending on time and the schedule to mitigate environment implications and the budget allocation in sort and long run. While mitigation mainly focused on actions for short term impacts, adaptation strategy deals with the industry action plan including technology innovations to adverse existing trends for global warming and its effects. Therefore, the optimum allocation of capitals in terms of time and activity between adaptation and mitigation it's a key question for managers and decision makers and for the most of the cases very difficult to deliver a clear answer.

The projected implication of climate change will certainly impact infrastructure, operations, level of safety and maintenance of the transport system, affecting essentially supporters of business as usual scenarios avoiding cost for proactive plans Main impacts in transportation system include direct damages in transport infrastructure; indirect effects on

network accessibility and attractiveness; and induced effects related with the system management and operation.

The demographic and spatial production allocation leads to substantial problem on transport infrastructure capacity as it was planned to accommodate different population and productivity volume and patterns. These changes may result lower contribution of the transport system to regional economy and inefficiency to maintain transport infrastructure from large investment, leading to limited rate of economic and social return.

The direct and indirect effects provide effects in operator's financial results, as the system productivity is reduced and even more capital for maintenance and reconstruction have to be secured. Taking into account that most of transport infrastructure project and associated constructions have been developed according to Public Private Partnerships (PPPs) financing schemes with long term contracts, this may affect essential the operators, investors and suppliers' financial viability, and finally, the financial risks are rising in unacceptable levels. In addition, the reduced traffic volumes lead to less jobs and high unit cost leading to unemployment, and limited social return [5].

The direct effects caused by climate change implication for the transport infrastructure for the different transport systems are briefly presented in following paragraphs.

A. Road Transports

The damages in road infrastructure related to technical specifications in construction material (e.g. pavements deterioration and deformation, asphalt surface melt, reduction of structural life cycle, etc.), network interruption caused by extreme physical events (e.g. flood effects in tunnels and bridges, land bank erosion, etc.), traffic problems affect safety conditions and ability to drive (e.g. heavy rains, fog, frost, strong winds, etc.).

B. Rail Transports

The direct impacts on rail related to truck damages because of the climate changes. Because of the warm rise, truck bucking and sliding, rolling stock overheating and failures in signaling and telecommunication increased the construction, maintenance and operation cost. Additionally, embankment and earthwork failures, drainage system overwhelming and truck flood because of increased rainfall levels and sea rise in rail aliments close to coastline and river embankment, are key issues lead to delays, operation disruptions, accidents and high maintenance cost.

C. Seaports and Waterways

The increase of water level is the major challenge for seaports and waterways infrastructure, because of its location at the end of seas and land or its placement at gulfs and land embankment. The majority of sea and river ports are currently vulnerable to coastal/river flooding, estimating that this could be a situation is foreseen more often in future. At the same time, the sediments through the water ways between land and see because of extreme rain, strong wind and storms are also making ports very vulnerable. In addition, wave energy changes making port infrastructure too exposed to damages in one hand and the seaways too vulnerable for cargo and passenger operation. Therefore, the changes in waterways because of wave energy severity lead to additional insurance cost and longer travel routes.

D. Airports

Strong winds, snow, extreme storms and the changes in air and ground air temperature are key challenges for aviation. Despite the technological innovation in aircrafts and air navigation, air turbulence and crosswinds are heavily impact flight speed, air travel comfortability and safety on one hand; and caused changes in flightpaths and delays in operation. Additionally, the airport location is a key component to examine the severity of the environment implication impact as it depends on landscape and natural environment in airport territory and demand catchment area. Obviously, the severity is much higher for airports close to coast line (tourist destination, e.g. islands in Mediterranean) or other technical or natural land embankments (London City airport located in an embankment inside Tames River, runway and other airport facilities for many airports extended in technical embankments in the sea, river, lakes, etc.). Furthermore, the technical problems of road infrastructure resilience are also common for the airport infrastructure, including the energy supply issue (heating – cooling) for terminals and landside facilities.

IV. Link between Transport and Regional Economy

Many researchers review the relationship of transport system and economic development. Dwyer et al. [6] underline that tourism benefits include investments in infrastructure, the development of management expertise and cultural exchange benefits which affect various sectors of the regional economy. Lee et al. [7] highlight that the tourism industry contribution is essential to regional economic development; and Dimitriou et al. [8] provide the methodology to estimate the impact on the economic system for the regions heavily depended on aviation. The passenger's decision for choosing the most suitable transport option depends on a variety of factors such as the consumer profile, the distance of the final destination, the price of services, the safety and security issues. Forsyth [9] underline that tourism remains heavily dependent upon the transport industry and any changes in its efficiency can have a significant impact on tourism development.

Institutions, associations and governmental bodies widely recognize the need for monitoring transport demand and adopting strategies to exploit the economic benefits for local society. Dimitriou et al. [7] estimate the contribution of aviation in regional development providing evidence that this relationship needs to be investigated not only to extrapolate the demand trends, but also to adopt policies, define strategies and support decisions towards transport policies and investments in new infrastructure to accommodate additional demand.

V. Environmental Implications for Remote Tourism Destinations

Special care should be given for the environmental implications for remote tourist destinations. Different climatic changes may have a range of diverse impacts on transport and tourism infrastructure and services. These may vary significant by region and depend on the local or regional circumstances and vulnerabilities, including those associated with the natural environment, as well as abroad range of socioeconomic factors, [10]. CC has the potential to have significant impacts on the pattern of transport demand and the ability of destinations to supply their product to international and domestic customers, [11].

According the concept of gap analysis, Fig. 1 illustrates how CC variables can impact on demand and supply side variables which produce a market. The demand side consists primarily of mitigation and adaptation policies that will impact consumer choice (carbon pricing, climate change awareness and sensitivity). The orange middle arrows list ambient weather conditions (which are both demand and supply variables) in Northern and Southern Europe. Budgeting the CC implications could estimate the determinant of the tourism-aviation supply-demand equilibrium [12], [13].

VI. Sustainable Development Variables

Transport has become a major contributor to economic growth that requires operational productive and efficient infrastructures and services [8]. At the same time, CC is likely to have essential implication for transport industry infrastructure. The need and the budget for the inclusion of adaptation measures in the transport industry are highlighted by UNECE, [1]. Dimitriou et al. [14] review the CC adaptation strategies and environmental mitigation actions for 15 European airports, highlighting the low performance of Greece and South Europe. Taking all these factors into account, a mitigation/adaptation chart (Fig. 1) is constructed to demonstrate that the supply/demand elements are two sides of the same coin. This is because mitigation and adaptation will impact the supply/demand relationship differently in the short and long-run. Fig. 2 divides the variables between classical (those which are used in existing tourism demand models in European destinations) and the new climate related variables which need to be included in the models. Therefore, as the climate stabilizes towards mid-century, transport demand could continue to be viable into the 22nd century. Mitigation will also hopefully promote research and development policies that will drive technological development so that aviation becomes carbon neutral (without offsetting) and is therefore not constrained by CO_2 abatement targets, which can help overcome one of its major challenges to growth. This could counteract the medium-term (5-10 years) demand shock for existing attractive tourist destination such as Greece and other attractive Mediterranean destinations

VII. Environmental Implications for the Greek Transport Market

A. Brief Presentation of Transport Business Environment

The Greek economy is heavily dependent on tourism which accounts for 20% of Greek GDP. Approximately 73% of tourists arrive in Greece by air while 80% of international arrivals are tourists, [8], [12]. CC not only has the potential to have significant impacts on the pattern of demand, it also has consequences for the ability of some locations to meet demand when and where it arises (for example as a result of water shortages). Through a systemic approach this paper maps the CC variables which impact the transport and economy supply-demand equilibrium. The broad findings of this paper deals with the break down and the review of the CC implications on railway system and regional economy supply-demand equilibrium, providing the framework for other similar applications.

The completion of the national transport system, with emphasis on Trans-European corridors, has been a major objective in the strategic planning of the national transportation system. Concerns about the environmental impact of the national transportation system in Greece are an important issue in the planning process of sustainable development. Indeed, road transportation has been posited as the main threat to the environment in the field of logistics and freight transportation.

Taking into account the innovation in energy consumption and low emission engines, the key strategic attitude involves more than achieving higher energy efficiency with the same transport business structure, in terms of the resources used and the emissions generated; there is also a high need to promote the combination of alternative transport modes, intermodality, under the concept of the optimum resources allocation and spare capacity effective use, in order to achieve higher performance, competitive fares and greater environmental sustainability.

B. Environmental Impact Implications for Tourist Demand

The purpose of the demand side analysis is to identify key variables from the literature and provide a qualitative assessment of climate change impacts on demand [11], [12], [16]. A substantial literature exists on tourism demand models for Greece using the classical variables listed in Fig. 1. These forecasting approaches are based on quantitative methodologies using causal econometric models [17]. The operation of demand variables is intuitive; however, their precise values in the models vary significantly. In general, income, stability and advertising are positively correlated with tourism demand, while prices, exchange rates and transportation costs are negatively correlated.

CC variables will have significant overall effects on Greek tourism demand, because not only are new variables that should be internalized in existing causal models, but they will impact the classical variables in such a way that is likely to reduce overall demand. The branch of economics, economic geography, indicates that the values assigned to classical

variables for the models that forecast tourism demand in Greece are unique to the country and Fig. 2 illustrates this. These variables are self-explanatory and interrelated. For example, although natural and climatic capital may exist in many countries, it is a combination of the existing tourism infrastructure and historical levels of tourism that together with the natural and climatic capital explain why volumes of tourism are higher in certain countries.

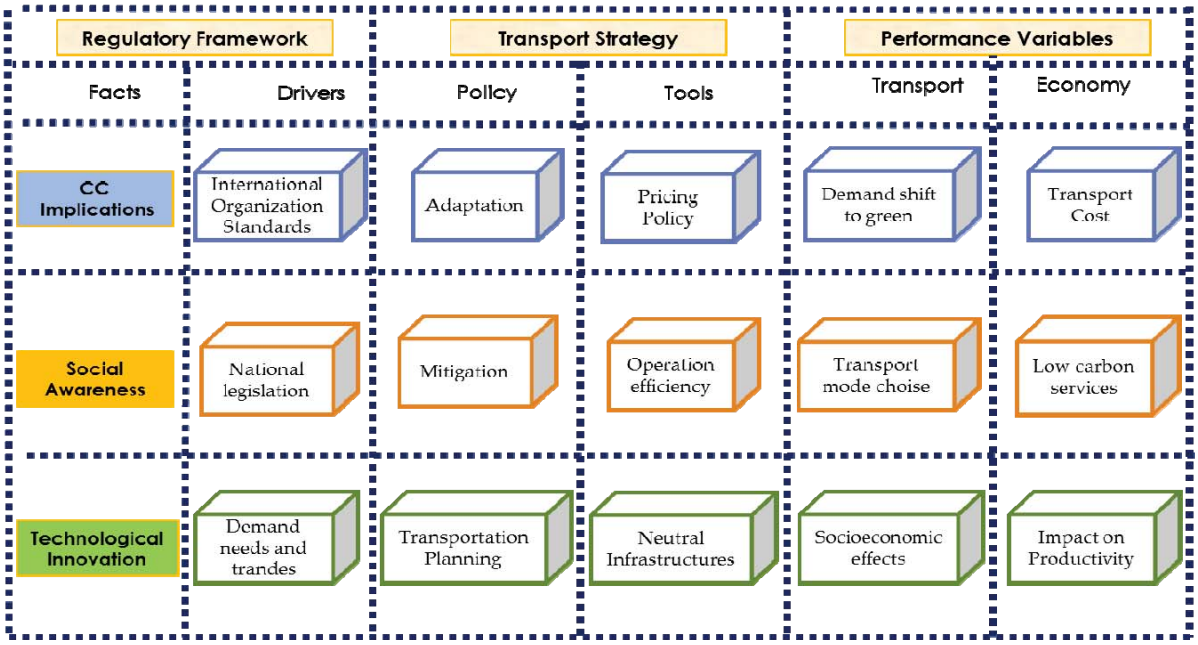

Fig. 1 Demand -Supply variables influence the Transport- Regional economy equilibrium

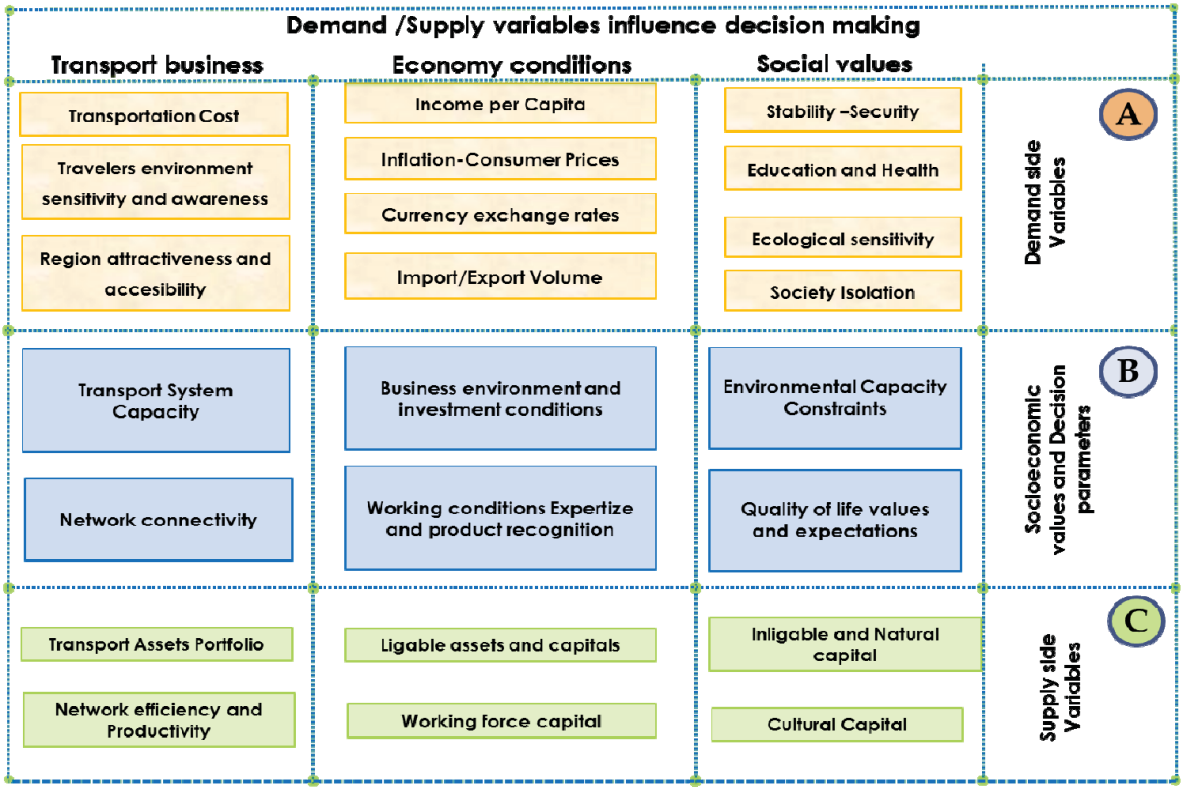

Fig. 2 Demand-Supply variables influence transport development decision making

Indeed, the costs of trade, like trade in general, explains these patterns. A country's comparative advantage in market prices is a function of the costs associated with distance, infrastructure and the agency and transaction costs associated with industry and institutional structures. These accumulated comparative advantages are more complex than simply ambient temperature or even aviation infrastructure, they take time to develop and therefore the comparative advantages also take time to erode. In short, the classical variables assume existing assets and cannot be viewed as operating in a vacuum.

C. Sustainable Business Development and Transport

The sustainability of production is an additional variable to the carbon intensity of transportation. The literature on sustainable production allocation is not very developed. Although most studies have not found that sustainability ranks highly on factors affecting demand destination choice [18] it is possible that as climate change impacts become more severe and public awareness increases, sustainability will become a significant variable for tourism demand. This is a variable Greece will have to control. It should therefore develop a strategy to be ahead of the curve in sustainable tourism destinations to compensate for the carbon intensity of its reliance upon long distance transport. Another possibility is for Greece to pay for offsetting the emissions from tourism related transport, energy and water use. This may be contrary to EU state aid rules, but exceptions could be discussed for tourism dependent EU countries.

Literature reveals that passengers have a general understanding of climate change and the link between aviation and climate change [11]. However, passengers seem to believe their aviation use is acceptable and that the responsibility for addressing aviation's impact on climate change lies with the government, airlines and manufacturers. This demonstrates that in Europe a high value is placed upon air travel to go on holiday, for weekend breaks, to visit friends and family and to meet religious and cultural demands. The multi-cultural nature of many European states, their relative geographic isolation and the poor quality of 'holiday weather' in home countries increases the perceived value of an "ability to fly". They therefore appear reluctant to give up the high-speed-long-distance services offered by the aviation industry unless a comparably priced alternative mode of transport, like high speed trains, becomes available. These generalizations can in principle be extended to the other major source countries for Greek tourism like Germany and Holland. Consequently, passenger demand for leisure air travel is unlikely to diminish in the near future, without severe price or other forms of aviation rationing by government.

D. Regulatory Impacts

Policies that restrict transport growth or price carbon will increase the cost of transportation to Greece. The exact value of demand decrease depends primarily on the estimated carbon price and price elasticity for each service, class and route as well as the ability of carriers to pass-through costs to passengers. If governments decide to constrain transport growth—this is uncertain in the short to medium term—there are three regulatory options being discussed to deliver this objective:

- Personal carbon allowances (for domestic consumption (utility bills), travel (car, public transportation)
- Fiscal responses designed to constrain demand
- Transport infrastructure constraints to restrict the ability to respond to demand.

Policies (rationing forms of transport, informational campaigns, etc.) intended to promote local tourism as a way of meeting national carbon budgets and prioritizing 'necessary' transport, could have a similar effect as carbon pricing. Control mechanisms existed in the past when traffic distribution rules were in place. These could be reinstituted and motivated less by who (which carriers) and more by what (what destinations for what purpose).

E. Demand for Modal Shifts

Emissions from transport contribute the largest share of total Greek tourism industry emissions. If the transport industry faces carbon pricing and caps on growth, there may be a significant demand for alternative forms of transportation to tourism destinations. Development plans for high speed rail lines are extensive in some parts of Europe and tourists could decide to use high speed rail links for Mediterranean or Atlantic destinations, particularly in Southern France, Northern Italy and Northern Spain. This combined with the heat stress induced by climate change could also shift transport demand patterns away from the Southern Mediterranean and Aegean area [12] with a consequential significant impact upon economies in that region.

Due to the fact that Greece is isolated in South-East Europe, where no plans for high-speed rail exist, and 80% of tourists arrive in Greece by air, its tourism is particularly vulnerable to policies that increase the price of aviation and decrease (in relative or absolute terms) the price of modes such as maritime and rail. Greek tourism is also vulnerable to changes in consumers' attitudes towards aviation for tourism transport [11]. However, policies that promote and incentivize other modes of transportation like maritime and rail, combined with warmer dryer summers in Northern Europe could have a significant negative effect on Greek tourism demand. Subsidies or simply greater consumer demand for high-speed rail would bring down the cost of rail journeys on high density routes making transport and tourism packages for these routes cheaper compared to Greece which remains dependent on high carbon aviation.

F. Sensibility of Transport Infrastructure to Climate Factors

The analysis of the environmental implications impact key parameters of transport industry, presented in above sessions, highlights that the key factors making transport system sensible to direct, indirect and induced effects. Conclusively, climate variations in frost, snow, fog, wind, rain, sea water level and heat are key climate factors impact each transport system business as usual scenario. Therefore, the assessment of the sensibility of each transport option to these climate

factors is essential to evaluate the importance for mitigation actions and adaptation changes on one hand; and define strategy towards sustainable development of transport infrastructure. The sensibility of transport system is associated to additional cost to maintain demand. For instance, the sea level rise is gradually making most of the existing sea ports unused, therefore, additional cost for ports replacement and reallocation represents the severity of this climate factor for maritime transports.

Taking into consideration the existing transport infrastructure location and the expected variation of each climate factor in the lifecycle of each infrastructure (50-100 years), the sensibility analysis for the transport infrastructure in Greece is presented in Table I. The sensibility scale is selected from 1 to 5, where 1 is the impede and 5 is the impossible level of business as usual scenario. The average severity rate for each climate factor and transport system represents the level of importance.

G.Results for Greek Transport Sustainable Development

The central message for decision makers is that the positive impacts on regional development, the national economy, and transport businesses are essential in terms of economic and social development. This is because of the high potential of new investments and the changing environment in Greek transport system management, lead to stimulate additional traffic. However, environment protection policies and the competitive environment in transport are expected to be a significant threat for the further development of transport associated industries in Greece, such as transport. By mitigating or adapting to the environmental weaknesses and threats, the decision to promote transport industry growth is strengthened the Greek economy recovery.

The sensibility analysis results show that highest financial risks respond to road because of the new investments are necessary to reallocate infrastructure avoiding coastline alignment and to replace materials sensitive to heat stress because of the temperature rise. The heat stress expected to impact essential demand patterns (especially, leisure travelers) increasing the business risks for operators and carriers. While railway is attracting the lowest levels of demand and its infrastructure implementation and maintenance cost is the higher compared to others, it achieves the lowest sensibility rate representing the lowest risk in term of additional cost to maintain climate factors and climate change severity to its existing changes, rating railway a very sustainable transport option.

The heat stress and sea level rise is very crucial for Greece, because of its 1.6 million kms coastline and the numerus spatial located island in Mediterranean. All infrastructure located close to coast is expected to very sensitive to sea lever rise and rain flood, therefore, sea ports and airports are too sensible to future climate changes, Frost and snow are the climate factors with the lowest severity for Greece, because of its geographical location with calm winders. However, strong winds and storms expected to impact essential maritime and air transport services.

The climate change factors and their implication to transport system operation expected to represent essential impact to mode choice and demand patterns. The sensibility of road and aviation systems expected to shift demand to railway, especially for short duration travels. Furthermore, the additional cost to maintain air and see transport on one hand; and the replacement of materials and alignments for road network on the other, provide essential benefits to railway where the severity of climate change is low. Therefore, investment to increase railway connectivity and operation speed are key priority for railways in Greece.

TABLE I
SENSIBILITY OF TRANSPORT NETWORK INFRASTRUCTURE

Item	Climate Factors	Sensibility of transport network infrastructure				
		Inlands		Water/Air Ports		Severity per Factor (Average)
		Road	Rail	Maritime	Aviation	
1	Frost	2	1	1	1	1.25
2	Snow	2	2	1	2	1.75
3	Fog	3	1	2	3	2.25
4	Wind	2	2	4	3	2.75
5	Rain	4	4	2	2	3.00
6	Water rise	3	2	5	3	3.25
7	Heat	4	4	2	4	3.75
Overall Severity (*max 5*)		2.86	2.29	2.43	2.57	2.54
Scale	1 – impede		2 - limitative		5 - impossible	

For Greece, the adaptation and mitigation functions in Fig. 1 is a push factor which will increase or help stabilize tourism demand in the short and medium-term. For example, Greek and even EU governments could promote Mediterranean tourism by shifting the school holiday period to the months where comfort-indexes are appropriate for Northern Europeans. Greece could do the same to encourage its citizens to continue holidaying domestically rather than travelling north to avoid the increasing summer heat. [15]. Despite these, certain conclusions can be drawn with respect to demand for Greek tourism at least in the short-term (1-5 years) and medium term (5-10 years), it is likely that significant improvements in high speed rail combined with improving ambient summer temperature in Northern Europe will decrease demand for Greek tourism in the medium-term. In the long-term (after 2030) the interaction of these variables will be very significant. Maritime based tourism could help Greece fill the Northern European tourist gap, however this depends on the carbon price and the ability of Greece to attract tourists from nearby countries.

The severity analysis indicates that the following issues will reduce the environment impacts associated with the development of both the transport industry and the regional economic development:

- Land use planning in transport network areas;
- Improved inland transport, by railway presenting the higher potentials;
- Reduced consumption of energy and water;
- Use of renewable energy;

- Introduction of specific regulation to address wastes;
- Re-development and modernization of the existing transport infrastructure to reduce carbon intensity of their operations and mitigate future environmental implication.

VIII. Conclusions

In this paper, the environmental implications for key demand and supply variables impact the transport-economy linkage are described. The need for new actions and an updated strategic plan is highlighted. The findings of this research provide important messages for decision and policy makers for Greece, which is a very attractive remote tourist destination and a key pathway for freights to Europe, promoting key issues for effective sustainable development that will be of equal importance and significance for many other regions in the same latitude and physical characteristics.

The key findings provide evidence that the environment implications for transport require not only for demand accommodation activities but also national strategies to sustain these activities in long run. Ultimately, the costs of adaptation policies must be weighed against the economic benefits, which are very substantial in Greece. Consideration at the EU level must also be given, because most of the passenger traffic delivered to/from Europe and most of the freight volumes rich central Europe market. This has been a strategic target for EU fund allocation, promoting sustainable economic development in remote European destination at the edge of its territory. While the costs of adaptation and mitigation will likely be born in part by the EU, so too will the costs of inaction in the form of transfers to a weakened Greek economy; weighing that it's an exercise worth pursuing through further research.

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