Concise summary of presentations, interventions and discussions of the Workshop:

TRANSPORT AND CLIMATE CHANGE:

European Researchers Act

Paris, Monday, July 6th 2015

Organised by:

ETRA - European Transport Research Alliance[1]
&
IFSTTAR - Institute of Science and Technology for Transport, Development and Networks

Held in conjunction with, as a side event, of the CFCC-2015 Conference:

"Our Common Future under Climate Change" - Paris, July 7-10, 2015

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[1] *Partners of ETRA*

The ***European Transport Research Alliance – ETRA*** is a partnership Organisation created, on September 20th 2012, by five Transport Research Associations:

- ✓ ECTRI (European Conference of Transport Research Institutes),
- ✓ EURNEX (European rail Research Network of Excellence),
- ✓ FEHRL (Forum of European National Highway Research Laboratories),
- ✓ FERSI (Forum of European Road Safety Institutes), and
- ✓ HUMANIST (Human cantered design Network for Information Society Technologies).

The strategic objective of ETRA is "to work towards promoting further cooperation, coordination of activities, and common focus in European transport research provision, as part of the process and in full alignment with the objectives of creating the European Research Area in the field of Transport".

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The ***French Institute of Science and Technology for Transport, Development and Networks - IFSTTAR***, is the National Transport research organisation of France that was created on January 1st 2011, from the merger of INRETS and LCPC. It is a Public Institution of a scientific and technical nature, under the joint supervision of the French Ministry of Ecology, Sustainable development and Energy and the Ministry of Higher Education and Research.

The strategic objective of IFSTTAR is to "carry out and commission, direct, lead and appraise research, development and innovation in the areas of transportation of persons and goods, urban engineering, civil engineering, construction materials, natural hazards, systems and means of transport and their safety, and infrastructure. Also to investigate their uses and impacts from the technical, economic, social, health, energy, environmental and human points of view".

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INTRODUCTION

The aim of this workshop is to present the results of the European transport research and solutions as regards the role and interactions of the transport system with the climate change phenomenon. In this sense, it focuses on both mitigation as well as adaptation issues with particular focus on how to move from research to implementation in a constrained funding environment and time frame.

Through this workshop, the organisers intended to show the benefits that can be derived from a multidisciplinary research in the complex problems that are involved in meeting our transport and environmental objectives and the need to adapt any solutions to real societal needs and demands. It also aimed at demonstrating the greater synergies that can be achieved through the collaborative work of European transport research teams an approach that is also promoted by the creation of ETRA as an "alliance" of partner organisations focusing on different transport transversal issues and transport related challenges.

The audience of the Workshop consisted primarily of researchers, research managers, and transport administration officials involved or interested in climate change issues.

Four Sessions have taken place, three of which with oral presentations followed by a discussion period, and one in the form of a Round Table discussion at the end. The full programme of the Workshop is given in ANNEX I.

This present report contains the main points of the presentations (presentations in summary form) and the discussions made during the Workshop and gives a concise summary of its recommendations.

The organisers hope that this summary presentation document will help those interested or working on climate change issues to get a better understanding of the transport and climate change interactions and the actions necessary.

SESSION I: INTRODUCTION AND HORIZONTAL ISSUES

Chaired by: Prof. George A. GIANNOPOULOS,

Director of the Hellenic Institute of Transport (HIT) of the Centre for Research and Technology Hellas (CERTH), and chairman of the European Transport Research Alliance (ETRA)

In his introduction, the chair, ***Prof. Giannopoulos***, explained briefly the main scope and objectives of the *European Transport Research Alliance* as a partnership of five transport research associations (ECTRI, EURNEX, FEHRL, FERSI, HUMANIST). He said that the main strategic objective of ETRA is to promote further the cooperation, coordination of activities and common focus in European transport research within the overall aim of promoting the materialisation of the vision and policies for the materialisation of the *European Research Area* in the field of *Transport (ERA-T)*. He also stated the aims of the workshop as, to:

- Highlight key results of road and transport research related to climate change, for both mitigation and adaptation.
- Offer suggestions regarding the practical steps towards transport adaptation and mitigation actions in the short- and medium-term.
- Recommend the necessary policy actions at European level.
- Provide a concise overview of the research being developed in Europe (and in the US) in the field of transport, with respect to climate change.
- Identify future needs for transport and climate change-related research (round table topic).

Presentation of **Ms. Helene JACQUOT-GUIMBAL,** *Director General of the Institute of Science and Technology for Transport, Development and Networks (IFSTTAR), Vice chair of the European Transport Research Alliance (ETRA),* on: **'Transport issues on the United Nations Framework Convention on Climate Change'**

The United Framework Convention on Climate Change (1992) has 196 states as members (excluding North Korea, Taiwan, Vatican City, etc.) and its objective is to stabilize the Greenhouse Gases concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Central, in this process, is the contribution of the Parties and their annual conference (COP), where crucial objectives are laid out for the year. These include the aim to reduce or prevent the anthropogenic emissions of GHG, to adapt to the impacts of climate change, to exchange proper information and to educate and raise public awareness related to climate change. The goal of COP21 is to reach a binding agreement between all countries, so as to be able to collectively combat climate change and boost the transition to resilient low carbon societies and economies, in combination with a synthesis of national effort, redirected investments and promoted solutions. Non-governmental structures would also assist.

Concerning Transport, discussions about its effects on CO_2 emissions and on climate change in general are insufficient. Some areas of study, such as mitigation; adaptation; developing cleaner, greener vehicles; cost effective and easy to maintain bridges; and re-focusing education on environmental issues are some of the aims.

The European and National Research Agendas acknowledge the need to involve transport research institutes, labs and universities in the issue of addressing climate change. Developing a closer collaboration with researchers will play a major role in future innovations, solutions, policies and measures, and will boost the credibility of the Paris Agreement, putting research solutions developed in labs under further discussion by policy makers and citizens.

Presentation of **Mr. Andrea TILCHE**, *European Commission, Head of Unit I4 – Climate Action and Earth Observation, DG Research & Innovation,* on: **'EU-research supporting the design of decarbonisation pathways'**

The European Commission is actively promoting a number of policies towards the transition to a low carbon and climate-resilient society. In order to reduce the pace of global warming and reduce the risk of dangerous climate change, the European Union is working within the international negotiations in order to limit warming within the 2°C rise since industrialization (+0.8°C already now). Going beyond this will have very serious global impacts. The necessary decarbonisation trajectories require the reduction in Europe of greenhouse gas emissions of at least -80% by 2050 with respect to 1990, and to reach zero carbon emissions before the end of the century. Right now, while the EU is on track, the trajectory keeps going up elsewhere – in particular in Asia – along a pathway that could lead to +4→+6°C projected future rise. The more the world goes on with fossil fuel emissions, the more expensive will be the necessary decarbonisation, and to maintain the planet within the 2°C warming

target it will be necessary to even promote negative emissions (massive reforestation, bioenergy with carbon capture and storage, etc.).

Different countries maintain different approaches. The US has decided on a programme, but, like China and India, they are not yet on track. EU emissions have already peaked in 1990 and are on a reduction path. With respect to its peaking year, the EU has agreed on a two-step strategy:

1) By 2020→20% reduction of GHG emissions, reaching 20% of renewables in the production of electric energy and reaching 20% energy efficiency (the goal has almost been accomplished, with some "help" caused by the economic crisis). This briefly called the 20-20-20 2020 targets.
2) By 2030→ 40% reduction of GHG emissions, 27% renewables share, and at least 27% energy efficiency.

Furthermore, in order to obtain the deep decarbonisation objectives that are needed by 2050 and beyond in order to keep the planet within the 2°C perspective, each sector (Power, Residential & Tertiary, Industry, Transport) is expected to contribute.

The low carbon transition is a huge challenge, and actions have to be carried out in a coordinated manner among the many interconnected sectors. Research must provide evidence-based information for climate-related decision-making at all levels. Horizon2020 is promoting research and innovation to achieve a European transport system that is resilient, resource-efficient, climate- and environmentally-friendly, safe and seamless, for the benefit of all citizens, the economy and society.

The EU is committed to spending at least 35% of the overall 77 billion Euro budget of Horizon2020 on climate-related research and innovation.

Support will also be provided within the Work Programme 2016-17 for the co-design, along with the relevant economic and social actors, of feasible, cost-effective decarbonisation trajectories, in order to achieve the EU's climate objectives for 2030-50, while maximizing societal benefits and economic prosperity. This "Low-carbon Europe" part of the 2016-17 call addresses key areas of research, such as: the risks and cost of climate change scenarios for Europe, including macroeconomic consequences; the planning and management of technology transition; and the adequacy of EU and global climate action in view of the long-term climate goals and impact.

The 2011 White paper, '*Roadmap to a Single European Transport Area*', concerns the transport contribution to the EU climate change mitigation policy. The goal is to cut carbon emissions in

transport by 60% by 2050, decreasing conventionally fuelled cars, maritime bunker fuel emissions, increasing low-carbon sustainable fuels in aviation and the use of mass transit systems in road freight.

Clean Sky 2 and EGVI are also Horizon2020 activities. The first aims to integrate, demonstrate and validate the most promising technologies to achieve Horizon's air transportation goals, with the financial contribution of the EU and of the private sector. The second endeavours to improve the energy efficiency of a wider range of transport vehicles using new types of non-conventional energies in road transport (electricity, CNG and LNG, bio-based fuels), which will eventually lead to the requested decarbonisation of both light and heavy duty vehicles.

Presentation of **Dr. John MUNRO**, *University of Maryland,* on **'Climate Change research and policy making in the US'**

Almost the entirety of US based climate change research is conducted in the context of accepted paradigms, including transportation research on climate change. These paradigms are based on either the new climate belief – that humans are directly accelerating climate change and how it can be resolved, or on the denial climate belief - nature is mainly responsible for this minor problematic situation and we can adapt to it.

Climate change is expected to threaten the U.S. transportation system, because of the extreme weather conditions, the sea level rise and the high cost of adapting to the new conditions. NOAA, NSF, NASA, DOI, USDA, DOE, EPA, as well as USGCRP, which coordinates and funds the climate research of these agencies and its applications, are already conducting studies. The US Transportation Climate Change Research System includes national laboratories, University Transportation Centres, consulting and engineering firms, State DOTs and non-profit agencies. The president's approach to climate change is reflected in various national reports and action plans.

Research about the transportation sector includes commitment to scenario development using down-scaled, sophisticated climate; research around vulnerability assessment and adaptation-related tools (such as the Gulf Coast Study: Phase 1 and 2); and pilot projects, such as the identification of priority assets for protection. For instance, the first FHWA pilot program(2010-2011) addressed transportation climate change adaptation, followed by the pilot program vulnerability assessments (2013-2015): conducting climate change and extreme weather vulnerability assessments and analysing options for adapting and improving resiliency. Several pilot programs and research activities are ongoing by TRB,

NCHRP, AASTHTO and the state DOTs (these studies focus on sea level rise, GHG, infrastructure impacts, etc.).

Reasons why resistance to climate change research persists:

- The public's ambivalence and lack of information and awareness leads to confusion and uncertainty about the phenomenon of global warming and its root causes.
- Differing core beliefs of key advocacy coalitions and political conflicts impede paradigm change.
- Conflicting, constantly changing information (mainly by the media) makes movement towards a new climate change paradigm disjointed and overly hesitant.
- Impreciseness inherent to use of models and simulations and the fact that climatology is only in the initial stages of collecting empirical knowledge on how oceans and the atmosphere process Co2 emissions.
- Severe transportation funding shortfalls making the implementation of climate research rather difficult.

Nevertheless, climate change research, both basic and applied, continues in the US. The current president is committed to maintaining a viable climate change research program. However, political changes resulting from 2016 elections could dramatically affect US research activities.

Session I Discussion

- Dr. Munro's answer to whether or not the TTIP and companies worldwide will put obstacles in countries' law changes for better climate conditions:

  The Transatlantic Trade and Investment Partnership (TTIP) is yet to be concluded. There are ongoing negotiations between the US and the EU, and the settlement issue, regarding the possibility of a country to pass laws relating to climate change and contrary to the TTIP's investment plans, is still being debated. I don't think that TTIP's plans, however, will be incompatible with a climate friendly plan, avoiding, for example, an investment that will lead to a big carbon leakage problem. Nevertheless, reducing climate change impact through legislation, such as an 80% reduction of carbon emissions before 2050, will have an enormous impact on the corporations and enterprises of developing and developing countries.

- Mr. Tilche's definition of *co-design*:

Co-design: transdisciplinary research, rather than mere interdisciplinary between academic approaches. *Co-design* is the inclusion of stakeholders in the research process, that is, the stakeholders' *co-production* with the researchers of the assumptions which have to be made, and of the consequent analysis of the research results. This is not always easy when we carry on long-term research, because in the future there will be new actors, and the market leaders of tomorrow may be very different for today's incumbents. Moreover, not only technology will change, but there will be also new business models. Therefore, the identification and engagement of stakeholders becomes a critical step in this process.

- Dr. Munro's answer to why the US/DOTs appear to have few research funds in 2016:

  The US/DOT pulls money out of funding categories with a lot of discretion and they can be applied relatively easily to climate change research.

  In the US, you have to look across agencies, to the Department of Energy and the range of developing alternative energy sources for vehicles. DOT is infrastructure-oriented and it has limited activities in other basic research areas.

- Mr. Tilche's answer to whether or not manufacturers are in a position to take measures in the mitigation sector right now:

  It is never easy to change sectors which have so high profits linked to the today's situation, but the projection for the future is different. The manufacturers have understood that we are already in a transition phase. It is possible to have growth and job creation even during a drastic transition to decarbonisation. To succeed, a world agreement in Paris this year is needed. Such an agreement would be a very important step forward, since once the process gets underway toward a given trajectory, the possibility of success is already closer, and the transition will only accelerate. In a system which is in transition, being in the forefront is the best position. The counterargument might be that initiating the process too early and with a high-cost, may lead to nothing - but today is not too early at all.

- A comment from one of the attendees:

  There is a need for a different partnership as well: right now we are focusing on what the private sector can do, but there is a need for the strong involvement of the public authorities.

For example, for the car manufacturers, the technology and the market exist, but what is needed is infrastructure that allows the presence in the market of innovative vehicles. So it is one of the main goals to create infrastructure for alternative fuel or charging.

The question is why, in some fields, research funds are limited and therefore the implementation of innovations remains stationary.

- Dr. Munro's additional answer/comment to the attendees:

In the US, there is a lack of vision within the public sector and any of the significant improvements toward aiding the circulation of such vehicles and other technologies is occurring in the private sector. Also, public investment is not "allowed" to fail, based on the political criticism that that will automatically follow.

SESSION II: TRANSPORT MITIGATION ISSUES

Chaired by: Mr. Julien ALLAIRE,

Secretary General of the Cooperation for urban mobility in the developing world (CODATU)[2]

Presentation of **Mr. Markus LEITNER**, *Austrian Environment Agency, Austria,* on: **'Guidance for climate-proofing project planning'**

In order to cope with climate change impacts and its negative effects, there are measures to be taken. The changes of climate parameters have both direct impacts (on ongoing and future projects) and infrastructures that already exist) and indirect ones (by changing the environment (subjects of protection)). The project types include railways, highways, waterways, hydro power plants, ski-lifts and slopes, power grids, wind parks, urban developments and golf-courses, since companies are interested in the direct and indirect effects of the weather condition-related changes.

The aim is to analyse the way that those projects subject to EIA (Environmental Impact Assessment) get impacted by climate related phenomena and develop a decision support for project developers. Several Austrian stakeholders participate in this effort: ASFINAG, Aspern Development, Austrian Power Grid, Energie Burgenland-Windkraft, Fachverband, OBB Infrastruktur, Okoenergie, Stadt Wien, Verbund (AHP) and Via Donau.

The strategic guidance includes complete results from literature review, stakeholder meetings with project developers, personal interviews and feedback from advisors. Currently, the project is on the review of guidance documents for the consideration of climate change's inclusion in EIA, SEA (Strategic Environmental Assessment) and project development. At first, there is a so called climate change check with guiding questions that have to be made about climate change during the project development phase, its impact statement and which of them are likely to impact the project. There are also changes in the sensitivity of environment issues (expansion of thermophile: high temperature-friendly microorganism) with practical relevance in the EIA and project planning:

- Consideration in compensation measures

[2] CODATU is a French based international association for the "Cooperation for the Continuing Development of Urban and Suburban Transportation".

- Changed classification of level of endangerment of animals/plants
- Implementation and monitoring phases like construction, operation and maintenance affect the planning of climate change adaptation options (measures, effectiveness).

Presentation of **Ms. Agnès JULLIEN**, *Institute of Science and Technology for Transport, Development and Networks (IFSTTAR),* on**: 'Transport infrastructures GHG assessment around the world: a way towards mitigation'**

The only way to share objectives and methods is to perform calculation in one country and then to share the database and discuss it with other countries in symposiums and congresses that already take place around the world.

The current project called LCE4ROADS (old name ECOLABEL) has 13 partners thinking not only on global warming potential but also on road sustainability projects and possible certification. The main concepts through the unique methodology include the assessments of different phase levels (planning, design, construction, operation, maintenance, EOL), considering several domains, such as the environmental one, and several certification moments for new and rehabilitated roads. The certifications need to have a kind of reference and particular scope and requirements. The certification moments are phases beginning with the planning and design of both new construction and rehabilitation projects, ending with construction. The stakeholders will be benefited in sectors like public bodies, certification bodies and construction companies:

- Supporting the implementation of procurement process, providing alternative funding.
- Increasing and displaying the sustainability of the road infrastructure projects and products.
- Outweighing the cost for being able to provide assessments

The results of the use phase are significant for the construction and maintenance when it comes to comparing the whole life circle cycle of the infrastructures and their ability to assess maintenance and landfilling/recycling strategy.

The second project, SUPER ITN, is more focused on roads and railways in a common framework. It is a sustainable approach which will deliver a common tool for roads and railways, including recycle materials.

Finally, the Ville10D is a national project focused on underground and traffic planning design applied here toof tunnel structures. Sustainability approaches are used to describe construction maintenance and use phase, comparing different designs and deciding which one is better from a sustainable point of view.

The conclusion of the projects indicates that the approaches performed within the framework of life cycle assessment have data and boundaries that should be refined, thinking of the country and local resources including energy mix specificities, comparing and sharing the projects.

Presentation of **Mr. Iraklis STAMOS**, *Hellenic Institute of Transport (HIT) of the Centre for Research and Technology Hellas (CERTH),* on **'Intelligent Transport Systems for the mitigation of climate change induced impacts'**

Regarding climate change, research so far shows that it's more than a fact, rather than a discussion, and it is experienced through the severity of extreme weather events.

The Transportation Factor is a root cause and at the same time an economic sector that faces the impacts of climate change. Different countries contribute to the climate change with CO_2 emissions; yet transport is the second biggest contributor after energy all over the world (20% in EU, 29% in US, 22% in Africa, 16% in Australia). Regarding transport modes, the road transport is the first contributor (70%), possible highlighting where research should focus (in terms of mitigating impacts).

Mitigation and adaptation are the two complementary but different ways to deal with climate change:

- Mitigation refer to the policies and the strategies that reduce GHG emissions and enhance GHG absorption (such as shifting to public transport), *avoiding the unmanageable.*
- Adaptation includes the initiatives and measures to reduce the vulnerability of human assets against the climate change, *managing the unavoidable*.

With mitigation it is possible to reduce the future measures and buy time. It is the number one preparedness strategy, but it is insufficient if adaptation is not included, since mitigation refers to the impacts evidenced today yet created by past GHG emissions, but its pace is inadequate for avoiding future impacts. Similarly, limiting mitigation activities would increase the adaptation effort that will have to be made in the future. Without aggressive mitigation, transport emissions could become the first contributor and data indicate the first place to act is where the GDP per capita is higher.

Mitigation areas include the following:

- Innovative vehicle technologies
- Use of sustainable biofuel
- Improved transport infrastructure with ITS
- Travellers' information
- Legal instruments

Intelligent Transport Systems (ITS) combine information and communication technologies to create a real time flow of information and enable an intelligent use of infrastructures and vehicles. It is about the connection between vehicles and infrastructure – in that sense, it aims at contributing to mitigation by reducing CO_2 emissions and traffic congestion and improving energy efficiency. There are applications and services that apply to mitigation in specific areas, such as the transport demand/mode choice, the efficiency of traffic and the driver's behaviour.

The levels of CO_2 from the transportation sector are projected to rise, because of the ongoing dependence on fossil fuels, the increasing travelled distance and its growth in the developing world. A mitigation strategy should be developed with ITS comprising key tools for improved road traffic and travel to reduce CO_2 emissions as shown by several ITS applications in the EU and the US. It is also needed to standardize the evaluation of ITS contribution and comply with the EU ITS directive 2010 that discusses the deployment framework for ITS in EU.

Presentation of **Ms. Ariane DUPONT-KIEFFER**, *Université Paris 1 - Panthéon-Sorbonne, France*

on **'Climate Change: New challenges for economic analyses'**

The evaluation framework of GHG reduction measures in the transport sector include:

- The economic costs are high but the GHG emissions, combined with private decisions have external effects that may lead to inefficient allocation of resources with huge impact on the welfare function, the public goods or the common resources. To estimate the cost of the climate change and the strategies presupposes the reduction of negative externalities while evaluating their

feasibility and acceptability and prioritizing among measures within the transport sector in different nations affected by the climate change. It also calls for a methodological focus on economic evaluation of GHG reduction strategies.

- The challenges of climate change economics are:
    - the time and spatial scale,
    - the rebound effects,
    - the discrepancy in price elasticities between the short and the long term,
    - the end-user (macroeconomics) or the societal perspective (welfare economics),
    - the discount rate,
    - the methodology to monetize externalities and
    - the price dynamics of energy and carbon.

To tackle those challenges, certain approaches have been developed regarding the cost effectiveness framework and the abatement costs combined with maintenance, fuel costs and secondary benefits, if necessary.

$$ABT\ COST = Invt - \frac{NPV\ (lifetime\ fuel\ cost\ savings)}{Lifetime\ CO2\ emission\ reduction}$$

The target consistent approach concerns the reaching of the emission level (first reference in 1963). The abatement costs have to be balanced with economic and political factors (especially in the national economies relying on cars production) and the computation needs a sensibility of parameter variation. Indicators of annual evolution of GHG emissions and implementing strategies are also crucial approaches.

A solution is adaptation when combined with mitigation policies, with maintenance of infrastructure as investments, with innovation in relation to mobility plans and measures that drive the reduction of GHG emissions.

Equity is about sharing the common good, aggregating and comparing individual welfare. The approaches that equity imposes include utilitarism (utilitarist and teleological values), efficiency, prioritism/sufficientarism (deontological values) and duty. Then it is possible to have a relevant

discount rate, monetized indirect impacts, reduced time horizon of fossil energy disappearance and a defined baseline or reference scenario.

Session II, Discussion

- Mr. Stamos answering a) whether ITS will increase travel demand, b) how vulnerable ITS' function is to climate change, c) if ITS are "aggressive", d) about the aggressiveness of ITS market even in the same country.

  a) If ITS are purported to reduce congestion and create better traffic conditions for drivers then we should certainly look at the risk of actually creating more space, making traffic infrastructure more efficient, inducing more travel demand and having more travellers that emit more CO_2. By reducing traffic congestion and improving mobility, we can expect more travellers actually travelling with their car than opting for public transport, which is a vicious circle of more emissions, due to induced travel demand.

  b) The vulnerability of ITS, has not yet been researched.

  c) ITS are not aggressive at all, we need aggressive measures in terms of time, not only in terms of content. A lot of things are happening but we certainly need to coordinate these actions to bring them together, correlate them and deploy them in a wider environment so we can expect more results.

  d) One of the main goals of ITS is to improve economic productivity, so that the market has a considerable raise in the last decade and this is why the EU directives coordinate these actions.

- Dr. Dupont Kieffer answering a) on how to reduce GHG in adaptation measures, b) If there could be a regulation on the ITS market.

  a) In different adaptation measures you should focus first on the one that contributes to the reduction of GHG.

  b) Due to climate change, both regulation and marketing controls are needed. Protecting an industry by specific regulations that are innovative and able to develop their own technology for some years can help pushing industries to produce more efficient ideas.

SESSION III: TRANSPORT ADAPTATION ISSUES

Chaired by: Ms. Helene JACQUOT-GUIMBAL,

Director General of the Institute of Science and Technology for Transport, Development and Networks (IFSTTAR), Vice chair of the European Transport Research Alliance (ETRA)

Presentation of **Prof. Angel APARICIO**, *Universidad Politecnica de Madrid, Spain,* on:

'Adaptation of Transport to climate change in Europe: Main findings of the EEA report 8/2014'

The European *Topic Center* is a consortium of different European centres providing technical support in the European environment agencies in the field of vulnerability and adaptation to climate change. With annual programs approved by the EEA, transport became an issue for the agency. In 2013 a first review was made and last year a full report on the issue was prepared.

Coming to the government issues, what needs to be highlighted is that transport is becoming more and more relevant to adaptation and mitigation strategies. The transportation sector was not really a key topic at the beginning but now in a short review, with the more recent adaptation strategies and plans in different countries in Europe, it can be realized that work in the transport domain is all about carrying out the decisions.

The first actions are focused on infrastructures, on guidelines on editions of standards, on identifying particular vulnerable spots throughout our transportation system… There are several barriers to adaptation, including- as perceived by some national specialists surveyed during the preparation of the report-lack of awareness among decision makers and lack of resources. There could be a way for the European commission and agencies to support countries on their transport adaptation efforts, mainly on transport research, with funding, and encouraging more cooperative approaches involving all relevant stakeholders.

Current adaptation actions are mainly focused on infrastructure and maintenance, yet there are not yet significant activities reported on the adaptation of transport services. It is important to keep the system working as it should operate in the next years so that it is not surprising that adaptation action focuses on extreme weather events, with scarce attention to adaptation in long term planning, and there is lack of experience in the use of assessment tools for comparing different adaptation options. CBA could be

an option but there are difficulties to apply it: uncertainty, dealing with risk and difficulty to find concrete examples in which an assessment has been carried out about the different options.

The current adaptation actions include:

- Research and studies: EU FP7 and national research projects
- Vulnerability assessment: pilots based on risk assessment concepts and development of new assessment tools
- Maintenance and design: identification of priorities and comprehensive revision
- Contingency plans: revision of operational practices, and use of better customised weather information by infrastructure managers.
- Long-term planning: consideration of adaptation within long-term scenarios and transport plans.

Transport stakeholders other than infrastructure managers are starting now to pay more attention to adaptation needs. The initial adaptation initiatives, which are typically pragmatic, low-regret actions based on existing in-house knowledge and expertise have lately expanded positively and getting interested in gaining a more solid base through research. Although the knowledge base is rapidly expanding thanks to researchers' efforts, adaptation is still far from being fully integrated within transport planning practice, especially when adaptation strategies and planning scenarios collide, and create conflicts between the various agencies and decision-makers involved.

Presentation of **Dr. Evangelos MITSAKIS**, *Hellenic Institute of Transport (HIT) of the Centre for Research and Technology Hellas (CERTH),* on **'European Transport Research results on Climate Adaptation issues'**

There are different "Climate change" definitions: According to IPCC, climate change may be caused by natural variability than human activity and to UNFCCC, climate change occurs only due to human activity. CC impacts will affect transportation in all transport modes and there will be a need to adapt and maintain the transportation system. The adaptation measures should reduce the vulnerability and the risk because of the exposure to those impacts, to anticipate the adverse effects of climate change with actions that prevent or minimize the damage they can cause.

There are several EU countries with similar adaptation policies and strategies, where the governments or the relevant organizations tried to quantify the impacts of climate change on economic sectors and propose appropriate measures.

Tools for addressing climate change in transportation:

- Identification of critical infrastructures: it is important to identify which parts of the transportation network are critical and to propose a methodology for calculating criticality of network links. (e.g. WEATHER project)
- Substitutability of modes during extreme weather events is about the ability of a traveller to switch from one mode to another in case of a malfunction due to climatic event. With the methodology, the impacts of the EWE are assessed, throughout a combination of real-time climate change impacts on different transport modes (e.g. MOWE-IT project)
- Impact assessment of extreme rainfall is used for the future projections that are related to adaptation planning. (e.g. RAIN-EX project)
- Roadmaps of actions towards reduced vulnerability of transport system is an effort of prioritizing adaptation measures through an extended worldwide survey with temporal (when/what) and financial (cost) dimensions and the extent to which these measures contribute to the protection of transport infrastructure. It is based on a large database of different adaptation measures for all modes. (e.g. MOWE-IT project)

An increased interest on transportation adaptation should take place within Horizon 2020. Research needs to address stakeholders and decision makers, with global cooperation initiatives and links, technical and technological innovations and a more dynamic adaptation plan.

Presentation of **Dr. David JAROSZWESKI**, *Centre for Railway Research and Education University of Birmingham, United Kingdom, o*n **'Projecting the potential impact of climate change on transport**

The presentation was about the *FUTURENET* project, which was funded by the Engineering and Physical Sciences Research Council (EPSRC) in the UK, and academic and industrial partners

(network rail, highway agency) created frameworks about studies in transport resilience and different stakeholders' perspectives.

There is a physical relationship between climate change and transport. The current changes and the weather affect the infrastructure and the traveller's behaviour, while the future projection of the impacts use impact models and topological, geological, hydrological and transport data to extrapolate those relationships into future climate projections. Changes in the network itself to prevent negative circumstances could be done by modifying those projected impacts with reference to scenarios within the sector.

Regarding the stakeholders, the infrastructure managers aim on maintaining their resilience under different climate change projections. On the other hand, policy makers are interested on the transport system's durability, the cost and the assets interdependence, while users care about the social networks and the travel and trade services.

One of the project's approaches is the simulation of a road and rail link between London and Glasgow, with data gathering and surveys, to determine the failure thresholds and the usage scenario affected by the weather.

Future projects concern future impacts on transport and building resilience and adaptation with consequences for society and the economy, such as the delay of train services because of the floods and extreme weather events.

Future research in climate change and transportation interactions calls for high spatial resolution, yet not only under an infrastructural perspective of impacts. It needs to answer the stakeholder's questions with the information that adaptation decision making requires.

Presentation of **Mr. Nicolas HAUTIÈRE**, *Institute of Science and Technology for Transport, Development and Networks (IFSTTAR),* on **'How the Forever Open Road responds to the challenges of climate change faced by the European transport system?'**

The challenges of climate change faced by the European transport system are numerous (i.e. safety and security, reliability, efficiency, quality of life, cost and financing, decarbonisation, etc.). But also opportunities arise as a result of the progress in materials and structures, ICT, Energy.

The *Forever Open Road* is an international alliance prompted by TRL (UK) and by RWS (Netherlands). It is an alliance around national programs and more specifically, die Strasse im 21. Jahrhundert led by BAST, (Germany), Ferry Free E39 led by NPRA (Norway), Exploratory Advanced Research led by FHWA (USA) and Route 5e Génération led by IFSTTAR (France).

La Route 5e Génération (R5G) concept aims at integrating the different components of the Forever Open Road following a system approach to build full scale demonstrators of the next generation of roads. It is a progressive approach that has been put into the national research agenda.

An example is the A199 Urban Highway regeneration. The A199 is a 5 km French motorway opened in 1974 but never finished, under-utilized but negatively impacting the area. It has been classified as a local road in 2006 and could become an urban arteria until 2030. The A199 regeneration project objectives were to develop a demonstrator of the fifth generation road by innovating the services offered by road networks and improve the acceptability of these networks by neighbouring people.

Current inconvenience related to this road could be turned into advantage for innovation. A set of demonstrators was envisaged, which is between the open road and the test track. The different demonstrators will be complementary and will benefit from IFSTTAR experimental facilities.

Concluding, the "road" embeds all the global challenges. In particular, it must contribute to the limitation of "anthropization", when building new roads becomes necessary. Current progress in materials, ICT and energy sciences allows redesigning the future of roads. Future roads have the potential to support a wide range of terrestrial transport modes and to be integrated from an energetic point of view. Neglecting the preservation of these assets could prevent the regeneration of actual roads into 5th generation roads. This would be a choice with regrets. Like other industrial sectors, innovation and upselling are key success factors and must be encouraged by public authorities.

Session III, Discussion

Dr. Mitsakis answering a) if the probability of Extreme Weather Events was welcomed as projection capability for the future, b) how can the generic roadmap project be used in practical way.

a) Such projected values were used, utilizing meteorological models from the Finnish Meteorological Institute until 2100 for the probability of various weather events.
b) The aim of the European commission and the project's itself was to assist decision makers in selecting adaptation measures for transport. Collecting all those measures through an extended

literature review helped in identifying individual measures for adapting road transport to climate change. Through the assessment of various experts from all over the world, it was possible to specify whether those measures are mature enough to be applied in the short-, mid- or long-term, the duration of the implementation of each measure and each cost. After combining them, the roadmap is formulated.

SESSION IV: ROUND TABLE DISCUSSION
FUTURE NEEDS FOR EUROPEAN TRANSPORT RESEARCH ON CLIMATE CHANGE ISSUES

Chaired by: Mr. Geoffroy CAUDE,

Chair of the Permanent International Association of Navigation Congresses (PIANC)

Panel:

Mr. Martial CHEVREUIL, *Egis SA[3] – RoadApt Project*

Mr. Markus LEITNER, *Environment Agency Austrian (EAA), Austria*

Mr. Julien ALLAIRE, *Cooperation for urban mobility in the developing world (CODATU)*

Mr. Patrick MALLEJACQ, *IFSTTAR*

Mr. Thierry GOGER, *Forum of European National Highway Research Laboratories (FEHRL[4])*

Prof. Angel APARICIO - *European Conference of Transport Research Institutes (ECTRI[5])*

Dr. El-Miloudi El-Koursi, *EUropean Rail Research Network of EXcellence (EURNEX[6])*

[3] Mr. Chevreuil introduced his company as a medium-sized engineering Swiss company with activity on transport and research projects focusing on climate change.

[4] Mr. Goger introduced FEHRL as an international association comprising over 30 national research and technical institutes from across Europe. There are also associates from non-European countries which provide FEHRL with strong links to the considerable research capacity available globally.

[5] Mr. Aparicio introduced ECTRI as the leading European research association for sustainable and multimodal mobility. It was founded in April 2003 as an international non-profit organization. Its members are 26 major transport research institutes or universities from 19 European countries. Together, they account for more than 4000 European scientific and research staff in the field of transport.

[6] Mr. El-Miloudi introduced EURNEX as a well-known organisation that has successfully turned into a self-standing legal entity in November 2007 (from a Network of excellence). It comprises 44 scientific institutes in the area of transport and mobility all over Europe.

Discussion

One of the main research needs is for issues that will facilitate the fast "transformation" of the transportation system to meet the impact of Climate Change on transportation infrastructures. A major example of such research would be the "*open road*" project that aims at developing of adaptable, resilient road structures. This project would be expected to produce the following outputs: guidelines for using climate data, a new methodology related to the road networks to be used by road owners including socio-economic impact assessment as well as a toolbox referring to the different types of assets, type of threats and type of adaptation measures.

Another research need mentioned – particularly suited for transnational research – is the issue of forecasting precipitation levels and their impact on transport system operation. According to Mr. Chevreuil, the main research needs, in this perspective are:

- Better forecasting of precipitation levels (which is also crucial for the waterborne sector);
- In-depth analysis of rain periods;
- Forecast methodology based on a life-cycle assessment.

The FEHRL representative mentioned that in the *forever-open road* initiative of FEHRL which is about the creation of conditions for more adaptable and more resilient roads. He stressed that in terms of adaptation to climate change, not only extreme weather/extreme events should be taken into account but there is also great need of research on less visible events. The latter may not have major immediate impacts but have great later impacts (heating, ground waters, etc…). FEHRL also acknowledges that future research needs are not directly linked to transport research but that have a great impact on it such as for instance: how to decrease mobility needs for passengers and freight.

The moderator who recalled some research work held in the Port of Rotterdam about the conditions of the port in year 2100 and which showed three different results, shared this attitude: One showed that it will be peaked, rather than decreased because of the high demand on trade, causing even worse conditions of the port's local environment. If the example should be generalized, travel, as it is already known, is continuously increasing, thus contributing to increasing CO_2 emissions and, in extension, to the worsening of the climate. Measures are needed to decrease this demand or make transportation environmentally friendly. To achieve that, further research should be carried out, keeping in the significance entailed in raising public awareness.

The transportation systems and infrastructures as a whole are linked with human, regional and land planning. Therefore, in order to cope with the adaptation measures (by as early as 2030), it is necessary to meet the requirements on the vulnerability assessment, the development of new transport technologies especially in the field of geotechnics and the planning of management strategies and government principles between transport, climate change and the part of the society that it concerns. It becomes more and more critical to look at transportation as one part of the system and not as its sole scope in terms of research but also in terms of policy.

Mr. Mallejacq stated that the IFSTTAR's scientific strategy is made of four challenges which are all related to climate change and guide the research of its scientific and technical teams. They are:

1. Inventing sustainable transport and mobility;
2. Adapting infrastructure;
3. Controlling natural hazards and our environmental impacts; and
4. Thinking and planning the cities and the regions of the future.

This strategy is also about activity motivational processes, to motivate the researchers to use available tools and decision makers to raise funds.

As far as the future research needs are concerned, IFSTTAR summarizes them as follows:

- Need of greater incentives for transnational research. This was shared by FEHRL. Both agree on the fact that in Europe tools and funds exists to create the conditions for transnational research among European countries. They stress however, that is not at all the fact for transnational research at the world level, which explain why this domain is still weak.
- Currently in European transport research, there is a focus on what matters most at one moment and not on the transport system, which is the focus of the future
- Transport infrastructure still should be a scope of transport research in Europe and worldwide. Vehicles and vessels ride on the infrastructure. If the latter is not maintained or adapted to new technologies, the vehicles and vessels innovation will not to be usable.

The representative of EURNEX, Mr. El-Miloudi El-Koursi, said that in the railway sector, research needs concern:

- Energy supply;
- Use of renewable energy sources;

- Adaptation of new rail infrastructure/critical points, rehabilitation of the existing infrastructure/critical points;
- Reduction of noise and vibration;
- Management of the whole freight system (without decreasing the safety level at the European scale.

The adaptation planning and execution of such research should be continuous with a focus on the vulnerability of the transport system and the vulnerability assessment. It is significant for adaptation to make a link between practitioners and researchers.

Mr. Allaire stated that the experience of CODATU shows that in developed countries, the (transport) researchers are often close to the decision makers and this practice would be good to be extended to all other countries and territories where the CO_2 emissions reach 90% of the global emissions. To cope with this issue, it is important to annihilate the lack of data. The further information that will be gained, could lead to a better work on the problem and easier public acceptance, using for instance ITS. The scientific research side is now growingly listened and followed, in particular in the climate change area where the IPCC is the leading body.

Research about "adaptation" is affected by the economy and its development, the performed actions by the decision makers and the dedication of the research group on the assessment. Similarly, the early awareness of problems, i.e. their early detection is another research area where transport research can focus on (early stage detection can allow for early stage crisis management thanks to new technology, ITS as well as cross-collaboration in-between transport modes). This also implies that there is room for on-demand traffic information, on-demand weather information etc.

The overall criterion for Climate Change related transport research would be for Topics that provide an effective combination between mitigation and adaptation measures and which make the transportation system more sustainable, environmentally friendly and adaptable. This issue was stressed several times and shared by most round table participants. The Environment Agency Austrian representative, Mr. Leitner, added the need for an interactive management approach and the need to develop cross-linkages with other research areas such as energy for instance.

A final conclusion was that there is a need to benchmark the knowledge about critical infrastructure and vulnerability assessment and the need to provide continuous research application and implementation mechanisms that take into account the social and economic aspects systemically.

Annex I: Workshop Agenda

Final Programme

Time	Sessions and Themes
09.00 - 09.30	Welcome coffee and registration
	Session I: Introduction and horizontal issues *Chair: George A. Giannopoulos, Director HIT/CERTH, chairman ETRA*
09.30 - 11.00	a. *"Introduction, Aims of the Workshop and main issues" (chair)* b. *"Transport issues on the United Nations Framework Convention on Climate Change", Ms. Helene Jacquot-Guimbal, Director General IFSTTAR, Vice chair of ETRA* c. *"European Climate Change and Transport, Policy Review", Mr. Andrea TILCHE, Head of Unit, M – Climate Action and Earth Observation, DG Research & Innovation* d. *"Climate Change research and policy making in the US", Dr. John Munro, University of Maryland* - *DISCUSSION*
	Coffee break – 30 minutes
	Session II: Transport mitigation issues *Chair: Julien Allaire, CODATU Secretary General*
11.30 - 13.00	a. *"Guidance for climate-proofing project planning", Markus Leitner,* Environment Agency, Austria b. *"Transport infrastructures GHG assessment around the world: a way towards mitigation", Agnès Jullien, IFSTTAR, France* c. *"Intelligent Transport Systems for the mitigation of climate change induced impacts", Iraklis Stamos, Hellenic Institute of Transport, Greece* d. *"Climate Change: New challenges for economic analysis", Ariane Dupont-Kieffer, Université Paris 1 - Panthéon-Sorbonne, France* - *DISCUSSION*
	Lunch Break – 1h

Session III: Transport adaptation issues *Chair: Helene Jacquot-Guimbal, Director General IFSTTAR*	
14.15 - 16.00	a. *"Adaptation of Transport to climate change in Europe: Main findings of the EEA report 8/2014", **Angel Aparicio** , UPM, Spain* b. *"European Transport Research results on Climate Adaptation issues", **E. Mitsakis,** Hellenic Institute of Transport* c. "Rail transport adaptation measures", ***David Jaroszweski,*** Centre for Railway Research and Education University of Birmingham, United Kingdom d. *"How the Forever Open Road responds to the challenges of climate change faced by the European transport system?" **Nicolas Hautière**, IFSTTAR, France* - *DISCUSSION*
16.00 – 17.30	
Session IV: Round Table Discussion **Future needs for European Transport Research on climate change issues** *Chair: Mr. Geoffroy Caude,* *Chairman PIANC (Permanent International Association of Navigation Congresses)*	
Panel of experts: *Markus Leitner (EA-Austria), Julien Allaire (Codatu), Patrick Mallejacq (Ifsttar), Thierry Goger (Fehrl), Angel Aparicio (ECTRI), M. Chevreuil (Egis SA), El Mlloudi El-Koursi (EURNEX)*	
17.30 - 17.40	**Conclusions and Wrap up**

Annex II: List of registered participants

	LAST NAME	FIRST NAME
1	Allaire	Julien
2	Allio	Robert
3	Anelli	Pierre
4	Anfosso	Fabienne
5	Angeles	itzcoatl
6	Aparicio	Angel
7	Ariyibi	Johnson Oladapo
8	Arpaci	Alexander
9	Belarbi	Nassera
10	Besson	Emmanuel
11	Bocquentin	Marie
12	Bonnard	Arnaud
13	BOUCHET	Jean-Paul
14	Boulbayem	Hinde
15	Bourguignon	Laurence
16	Boussafir	Yasmina
17	Bouvelot	Pierre
18	Braschi	Andrea
19	Bredimas	Alexandre
20	Burbidge	Rachel
21	Castanares Hernandez	Gabriel
22	Caude	Geoffroy
23	Chevreuil	Martial
24	Colin	Marie
25	Daniel	Yolande
26	Djoric	Vladimir
27	Driss	Bourahi
28	Dupont	Ariane
29	Eisenbach	Stefan
30	El Faouzi	Nour Eddin
31	El Koursi	El Miloudi
32	Espinosa	Monica
33	Fifer Bizjak	Karmen
34	Firion	Sonia
35	Fragnet	Thierry
36	Giannopoulos	George
37	Goger	Thierry
38	Gouin	Thierry
39	Grauert	Marianne
40	Gutiérrez	Alba Lucila
41	Habibzai	Abdullah
42	Habibzai	Shamsullah
43	Hamoud Ep Sedrati	Nadjette
44	Hautière	Nicolas

	LAST NAME	FIRST NAME
50	Hullah	Peter
51	Huzayyin	Ali S.
52	Jacquot-Guimbal	Hélène
53	Jaroszewski	David
54	Jullien	Agnes
55	Khotivari	Rusudan
56	Lacaze-Masmonteil	Mathilde
57	Lam	Quoc DaT
58	Laval	Farida
59	Le Du	Helene
60	Leitner	Markus
61	Lopes d'Azevedo	Stephanie
62	Lorenza	Tomasoni
63	Louette	Eric
64	Malléjacq	Patrick
65	Marolda	Cristina
66	Maschek	Michael
67	Mathieu	Flonneau
68	Medevielle	Jean-Pierre
69	Meliot	Stephane
70	Mendoza	Lucile
71	Mizzi	Jean-Paul
72	Mitsakis	Evangelos
73	Molero	Gemma
74	Munoz	Michel
75	Munro	John
76	Nguyen-Luong	Dany
77	Oluwaleke Desola	Ojugbele
78	Papon	Francis
79	Paulina	Potemski
80	Pelissier	Serge
81	Perez Muleiro	Paula
82	Philippe	Marie-Luz
83	Pinton	François
84	Rossi	Luca
85	Santarremigia	Francisco
86	Sebille	Robin
87	Seibt	Claus
88	Seum	Stefan
89	Smit	Frank
90	Stamos	Iraklis
91	Sulimankhil	Abdul Hai
92	Thiery	Mickael
93	Tilche	Andrea

45	Hecht	Markus
46	Hermel	Kristel
47	Herrmann	Carina
48	Heyndrickx	Christophe
49	Horvath	Peter

94	Tomasoni	Lorenza
95	Uzumoglu	Tugce
96	Vidal	Emilie
97	Watrin	François
98	Zakowska	Lidia