PROJECT ACT

ADAPTING TO CLIMATE CHANGE IN TIME

Climate change and infrastructures

Rome 20th July 2010

ISPRA Institute for Environmental Protection and Research

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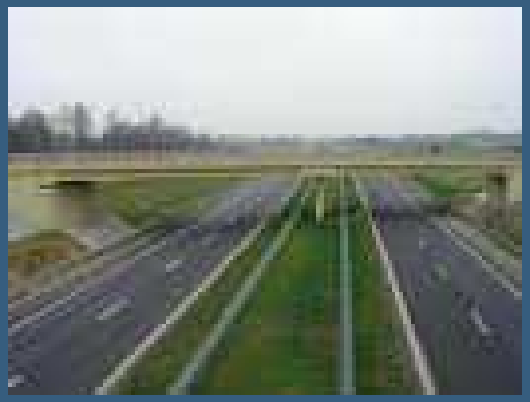

Summary

- ✓ Background on Climate change and transportation sector
- ✓ Vulnerability of infrastrucutres to climate changes
- ✓ Risk management
- ✓ Adaptation strategies
- ✓ Conclusions

Background

Already developed methodologies on principal economic sectors:

- ✓**Primary industries (for emission impact only)**
- ✓**Fisheries**
- ✓**Agriculture and forestry**
- ✓**Tourism**

Lack of studies on infrastructure sector including:

- ✓**Water facilities**
- ✓**Energy**
- ✓**Transportation**
- ✓**Public health systems.**

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Background

Transportation infrastructures:

- ✓ **land transportation networks (highways and rail, including bridges and tunnels)**
- ✓ **marine transportation**
- ✓ **air transportation**
- ✓ **pipelines**

Implications for:

planning, designing, constructing, operating, maintenance and retrofitting

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Background

Sectoral Organizations and reports about climate change impacts on transportation sector:

- ✓**US Transportation Research Board (TRB)** Potential Impacts of CLIMATE CHANGE on U.S. Transportation (2008)
- ✓**World Road Association (PIARC)** – International Technical Committee on Managing Operational Risk in Road Operations
- ✓Canadian Council of Professional Engineers First National Engineering Vulnerability Assessment of Public Infrastructure 2008
- ✓**…**

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Background

General reports including transport infrastructures:

- ✓**UNDP.** A no regrets risk based approach to climate change proofing of public infrastructure (2010)
- ✓**Institute for Catastrophic Loss Reduction Toronto,** Infrastructure Climate Risk Assessment: Principles and Applications 2010
- ✓**Asian Development Bank (ADB)-** Climate Proofing:A Risk-based Approach to Adaptation 2005
- ✓**World Bank -** Adapting to Climate Change in Europe and Central Asia - 2009
- ✓**UNDP** World Development Report 2010.
- ✓**UE -** Impact Assessment - Commission Staff working document accompanying the White Paper - 2009

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Climate change and transportation sector: challenges

- ✓different level of concerns: national, local, network or single infrastructure.
- ✓wide areas involved by local decision
- ✓cross-border cooperation
- ✓network character of transportation infrastructure
- ✓intermodality
- ✓redundancy
- ✓financial and insurance constraints
- ✓intersectoral aspects (industrial development, tourism, health..)

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Climate change and transportation sector: challenges

- ✓communication among transportation professionals, climate scientists, and other relevant scientific disciplines
- ✓past series and standards no longer reliable for future plans (typical weather patterns, local climate, assumed range of temperatures and precipitation)
- ✓differences in time frames (timescale of climate changes, lifetime of transportation, return period of events)

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Climate change and transportation sector: challenges

Specific problem for future adaptation of existing networks, including:

- fixed pathway (rail lines)
- lack of alternative paths –low redundancy
- low level of robustness and protection,
- unchangeable parameters (depth of harbor, length of airports runway).

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Climate change and transportation sector: challenges

There is a lack of:

- ✓transportation-relevant information on climate change
- ✓space scaling of data at the proper level
- ✓sectoral evaluation (vulnerability and risk) tools
- ✓comprehensive inventory of transportation infrastructure and integrated management systems
- ✓new design standards
- ✓monitoring technologies for advance warning
- ✓integrated intermodal management systems
- ✓sharing best practices
- ✓decision support tools
- ✓funding

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Establishing an adaptation framework for transport sector

People to involve:

– Engineers, planners and other professionals, policy-makers, politicians and the public

Tools

– relevant data, models and projections
– vulnerability and risk assessment tools
– economic and social impact analysis
– desing standards
– insurance, regulations, land-use planning
– integrate risk management
– sharing best practices !

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Vulnerability of the system/sector to climate change

Vulnerability of transportation infrastructure can be considered proportional to difficulty in physical or operational adaptation to climate changes.

key factors:
EXPOSURE as character, magnitude and rate of change in the climatic conditions to which infrastructure is predicted to be exposed;
SENSITIVITY as level of response of infrastructure to the changes, in terms of positive or negative consequences of changes in applicable climatic conditions;

→ IMPACTS

ADAPTIVE CAPACITY of infrastructure to absorb any net negative consequences from the predicted changes in climatic conditions.

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Discussion about indicators to assess vulnerability and risks

Exposure- "object" exposed identification:

- Physical infrastructure: structures of roadways, runways, rail lines, tunnels, airports, bridges, ports, etc, developing patterns, design criteria

- Services connected: functioning conditions (i.e. periods, weight allowed, interruptions), operation procedure, emergency management

-Local community: people served, business assets, social activities, land use planning

-Network and intermodal concerns

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Discussion about indicators to assess vulnerability and risks

Sensibility involve:

- physical elements (trench, embankment, drainage channels)
- fixed parameters (pathway, depth of harbor, lengths of airport runways)
- location (coastal or low laying areas, sea water ingression, landslides, flooding, high levels of erosion, land subsidence)
- type of materials
- age and present maintenance condition
- type of vehicle and costumers;
- level of importance (i.e. urban road or runway, local or intercontinental airport), traffic (average number of vehicle or flight or ships);
- Inter-modal connections and function as evacuation routes
- criticality of components (i. e., congestion, bottlenecks).
- lack of alternative paths, population density and land extension served
- facilities connected and business assets served

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Discussion about indicators to assess vulnerability and risks

Present impacts	inadequate risk management systems, land planning and design standards
potential positive impacts	benefit from longer transport seasons and (high mountain), reduced costs of snow and ice control, safer travel conditions
Future impacts	Negative impacts on infrastructure and operation, on network, local area, regional effects and impacts on economic system

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Discussion about indicators to assess vulnerability and risks

Potential Climate Change	Examples of Impacts on Infrastructure	Examples of Impacts on Operations
Rising sea levels	-more frequent inundation and severe flooding of roads, rail lines, airport runways, underground tunnels in coastal and low-lying areas -Reduced clearance under bridges -Increased coastal erosion and indirect effects on infrastructures -Impact on foundation by increased sea water ingression -Less protection	-More frequent interruptions and evacuation of coastal and low-lying roadway, railway and airports -Changes in development patterns -changes in navigability of channels and related facilities

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Discussion about indicators to assess vulnerability and risks

Potential Climate Change	Examples of Impacts on Infrastructure	Examples of Impacts on Operations
Increased intensity of weather extremes and changes in seasonal precipitation and flooding patterns	• more frequent flooding •damages to drainage systems • damages to pavements, drainage systems and road support • increasing in landslides and mudslides • impacts on structural integrity of facilities • damage to pipelines • changing in soil moisture level affecting structural integrity of roads, bridges and tunnels impact on channels regime	• increases in weather-related delays and traffic disruptions for roadways, rail lines, subterranean tunnels, airports, channels • higher costs of facility maintenance, safety management and emergency planning •disabling of navigation aid instruments

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Discussion about indicators to assess vulnerability and risks

Potential Climate Change	Examples of Impacts on Infrastructure	Examples of Impacts on Operations
Increases in very hot days and heat waves Increasing in very cold days	• Thermal expansion on bridge expansion joints and paved surfaces • Concerns regarding pavement integrity (e.g., softening), traffic-related rutting, migration of liquid asphalt • Rail-track deformities	• Impact on airports with flight cancellations or limits on payload (i.e., weight restrictions) • Limits on periods of construction • Emergency management costs (warning, rescue and recovery) • Longer working seasonal period • Efficiency of services • Increase costs of maintenance
Increases in drought conditions	•increases in susceptibility to wildfire and mudslides	Impacts on river transportation routes Decrease visibility for airports due to wildfires

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Discussion about indicators to assess vulnerability and risks

Potential Climate Change	Examples of Impacts on Infrastructure	Examples of Impacts on Operations
More frequent extreme whether events	• Greater probability of infrastructure failures • Damages to facilities • Impact on stability of bridge decks and robustness of infrastructure • Impacts on port structures and facilities	• More frequent closure, restrictions or evacuation • Disabling of navigation aid instruments • More debris on roads, rail lines and runways • Higher costs of maintenance, safety management and emergency planning • Decreased expected lifetime of infrastructure

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Discussion about indicators to assess vulnerability and risks

Adaptive capacity involve:

- land plans based on analysis of vulnerability
- inclusive transport services plans (including infrastructure) and design criteria
- risk management approach, inventories and analysis models
- redundancy of transport systems and alternative path
- robustness of network and protection of critical links (strategic highway and rail bridges)
- costs of maintenance
- monitoring and early warning systems
- criticality of functions (high density areas, strategic business assets, intermodal connections, evacuation routes)
- public and private bodies managing adaptation options for infrastructures
- specific funding instruments
- research about materials (i.e. resistance to high temperature, porous pavement for fast drainage, technologies for monitoring and alert, etc)

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Discussion about indicators to assess vulnerability and risks

A probabilistic approach is a present challenge:
•lack of complete data on vulnerability
•reliability of projections of future climate change,
•few simulations,
•uncertainty about effects on vulnerability and resilience,
•of actions to be taken by future managers

Disaster risk management and probabilistic risk analysis can better be used to assess risks in the near future.

A qualitative approach, based on a screening analysis of vulnerability of individual assets and resilience of the system, must be applied to long term changing management.

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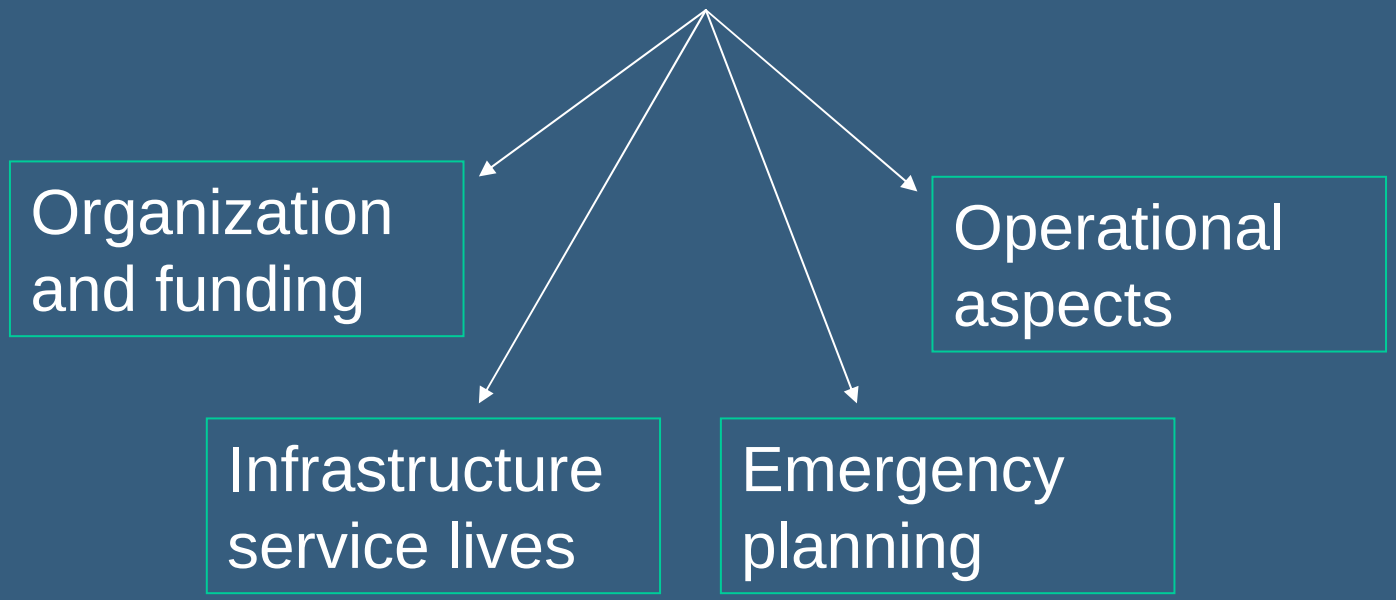
Adaptation options

Adaptation strategy for infrastructures



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Adaptation options

Focus on:

- Risk management system associated with climate change
- Information programs to users and workers
- Identification of critical infrastructure potentially at risk
- Monitoring of changing and impacts
- New operating practices, maintenance and infrastructure design
- Land planning including facilities for relocation
- Relocation options for vulnerable infrastructure
- Coastal protection and actions to improve robustness
- Funding
- Insurance programs

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Adaptation options

But first…
let’s start involving togheter transportation professionals, regional and local authorities, climate scientists and other relevant scientific disciplines

THANK YOU!

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