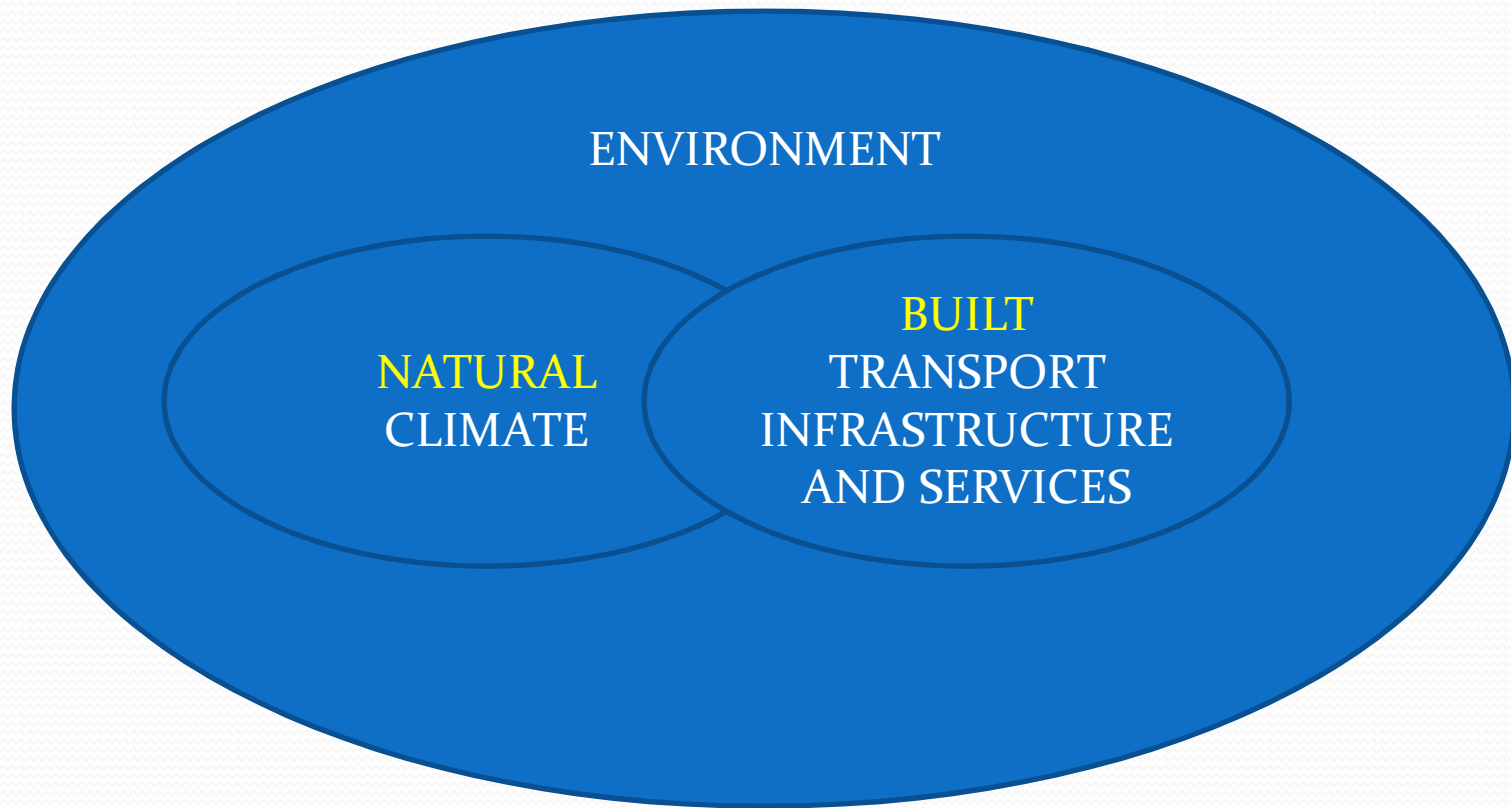


# Adaptation of Transport Networks to Climate Change: Infrastructure and operations

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# Interaction of Climate and Transport



# Why Study Climate Change Impacts on Transportation?

- Climate affects the **safety, operation, and maintenance of transportation infrastructure and systems**
- Four key questions:
  - How important are the anticipated changes in climate?
  - Can we anticipate them with confidence?
  - What information is useful to transportation decisions?
  - How can decision makers address uncertainty?



# The Climate is Changing

- **Temperature has increased and is projected to continue to do so**
- **Increase of global average sea level, likely to accelerate**
- **Extreme climate events i.e. general tendency is a small increase in maximum wind speeds or sudden temperature change**
- **Coastal erosion**
- **Deforestation combined with the lack of water soil absorption**
- **Changes in precipitation patterns (intensity of individual rainfall events is likely to increase )**

# Transport modes affected

- Road
- Rail
- Maritime
- Air
- Public transport

# Categorization of Impacts on transportation networks

- { Infrastructure
- { Operation and maintenance
- { Direct
- { Indirect
- { Reversible (short-term)
- { Irreversible (long-term)
- { Local level
- { Regional/national/international level

# Direct Impacts (1)

- **Increasing temperatures**
  - damage infrastructure (pavement damage, rail track buckling)
  - changes in materials
  - reduce water levels on inland waterways
- **Increasing precipitation**
  - degrade infrastructure and soil conditions
  - accidents (frequency and severity)
  - vehicles (mode choice and traffic speed)
  - operability of transport networks
  - accessibility
  - flooding (e.g. metro stations)

# Direct Impacts (2)

- **Rising sea levels- ice melting**
  - inundate coastal infrastructure
  - hindering inland shipping due to riverine floods
  - Changes in the transport logistics routes
- **Changes in storm activity**
  - damage infrastructure and operations due to increased storm intensity



# Indirect impacts affecting transport

- Economic
- Environmental
- Demographic
- Spatial planning



# Challenges to Research

- Articulating data and information needs
- Identifying most relevant climate information
- Integrating multiple environmental factors
- Incorporating uncertainty
- Assessing costs for needed actions to expected positive impacts

# Approaches to Incorporate Climate Change (1)

- **Risk assessment approach**
  - *Exposure: What is the magnitude of stress associated with a climate factor (sea level rise, temperature change, severe storms, precipitation) and the probability that this stress will affect a transportation segment or facility?*
  - *Vulnerability: Based on the structural strength and integrity of the infrastructure, what is the potential for damage and disruption in transportation services from this exposure?*
  - *Resilience: What is the current capacity of a system to absorb disturbances and retain transportation performance?*
  - *Adaptation: What response(s) can be taken to increase resilience at both the facility (e.g., a specific bridge) and system levels?*

Source: Impacts of climate change and variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I, U.S. Climate Change Science Program, Synthesis and Assessment Product 4.7, 2008

# Approaches to Incorporate Climate Change (2)

- **Planning timeframes**

Need to consider incorporating longer-term climate change effects into planning processes

- **Adaptation Strategies**

What adaptation strategies are employed, and for which components of the system, will be determined considering the significance of specific parts of the network to the mobility and safety of those served, the effects on overall system performance, the cost of implementation, and public perceptions and priorities.

Source: Impacts of climate change and variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I, U.S. Climate Change Science Program, Synthesis and Assessment Product 4.7, 2008

# Recommendations

- Transport infrastructure is built today, but will yield its benefits far along into the future:
  - consider all aspects of the environmental change in order to be viable
  - provide services under all circumstances.
- EU “White Paper on adapting to climate change” :
  - Extreme climate events cause significant economic and social impacts.
  - Infrastructure (buildings, transport, energy and water supply) is affected, posing a specific threat to densely populated areas.
- More **strategic** and long term approach to **spatial planning** will be necessary, in land and maritime transport, regional development, industry, tourism and energy policies.



# Steps Forward

- Adapt and change design standards to cope with new climate conditions (e.g. reduce the time period for extreme precipitation for 50 years to 30 years, increase road embankment height, change to high temperature-resistance materials )
- Develop framework to preset an acceptable level of service during the occurrence of extreme weather conditions.
- Develop framework for the system recovery to normal operating conditions.
- Include the necessary ITS elements to control and monitor:
  - transport system operation during extreme weather conditions occurrence
  - system recovery
  - Advance and real time public information
- Interdisciplinary research that engages both transportation and climate research communities.
- Raise awareness to the relevant stakeholders.



Thank you for your attention!