Climate Change Impacts on Transport: An Overview

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International Transport Forum – OECD
UNCTAD-UNECE Conference on Climate Change Impacts on International Transport Networks, Geneva, 8 September 2010
Outline:

- Uncertainty
- Impacts
- Policy-making principles

Not covered (but crucial!):

- Costs
- Climate change impacts on transport/trade flows
- In-depth discussion of adaptation measures
Climate vs. Weather

- **Climate** is how the atmosphere "behaves" over relatively long periods of time.

- **Weather** relates to atmospheric conditions over a short period of time (localised).
Emissions

Atmospheric Concentrations

Radiative Forcing

Climate Change

Impacts of Climate Change

Increasing Uncertainty

Increasing Policy Relevance

GHG Emission – Impact Pathway

Human Activity

Damages, Benefits
Infrastructure planned and built with past climate and weather in mind – no longer a good predictor of future conditions

Source: CCSP 2008
Impact Vectors: Global vs. Regional

- Changing Regional Temperature
- Strength & Frequency of Wind/Storms
- Changes in Precipitation
Global Temperature Change (1/2)

Sea level rise (& tidal/storm surges)

• Road, rail, inland waterway and air infrastructure vulnerable because of location
• Intermittent or permanent flooding
• Erosion, road/railbed collapse, runway and road surface damage
• Scouring/weakening of critical infrastructure support (bridge pilings, levees, etc)
Global Temperature Change (2/2)

Sea level rise (& storm surges)

• Damage to critical drainage infrastructure

• Exacerbates subsidence and salinity (corrosive effect on infrastructure)

• Temporarily or permanently renders some infrastructure unusable (Quays, waterways under bridges, etc.)
Changing Regional Temperatures (1/3)

Increased temperatures and heat waves

• Buckling/fissuring of road and runway asphalt, buckling of rails impact network performance.

• Damage to concrete and bridge expansion joints.

• Drought and prolonged evaporation from navigable waterways can render these un-navigable.
Changing Regional Temperatures (2/3)

Increased temperatures and heat waves

• Vehicle overheating and accelerated tire degradation for road transport,

• Degraded electricity transmission impacts rail services.

• Increased AC requirements impacts fuel economy

• Lower air density reduces permissible payload weights for aircraft – or calls for longer runways and changes in climb patterns.
Changing Regional Temperatures (3/3)

**Fewer cold days and shorter winters**

- Reduced snow removal but increased freeze-thaw degradation of asphalt, substructures
- Less ice-disruption of inland waterways but reduced operation of regionally important snow and ice roads
- New shipping routes may deliver significant time gains in Asia-EU and Asia-N. America trades (old routes impacted as well)
Transport Infrastructure Vulnerable to Permafrost Melting

yellow lines = winter trails
blue lines = railroads
red dots = airfields
Changing Regional Temperatures (3/3)

**Fewer cold days and shorter winters**

• Reduced snow removal but increased freeze-thaw degradation of asphalt

• Less ice-disruption of inland waterways but reduced operation of economically important snow and ice roads

• New shipping routes may deliver significant time gains in Asia-EU and Asia-N. America trades

• Permafrost upheaval damaging to critical northern road, pipeline and air infrastructure
Changing Precipitation Patterns (1/1)

Increase in extreme precipitation

• May overwhelm drainage infrastructure
• Erosion, scouring, slope failure, rapid sedimentation (dredging)

Decrease in precipitation

• Decreased soil moisture leads to subsidence of road and rail beds
• Lowers inland waterway levels,
• Summer wildfires can lead to denuded soils prone to slope failure under rain
Extreme Wind and Storms

Increase in frequency/strength of storms

• Warming compounds natural variation and may contribute to more frequent and/or stronger storms.

• Storm surge damage to infrastructure, damage from increased wave height and strength

• Wind damage to bridges, gantries, signs, electricity networks, radars and lighting.

• Wind reduces airport operations – long-term shifts in wind patterns may render runway orientation sub-optimal
Policy Implications

- 3 adaptation strategies: **Avoid** (retreat), **Protect** and/or **Accommodate**

- **Network unreliability** impacts at least as great as physical impacts on infrastructure.

- **Prioritisation** on network-essential infrastructure important – different strategies for different parts of the network

- **Design standards** and practices must account for increased uncertainty re. climate

- Focus on **robustness** for key infrastructure as well as network **redundancy** and **resilience**
Thank You...

SAVE THE DATE

25-27 MAY 2011
Leipzig, Germany

TRANSPORT & SOCIETY
<table>
<thead>
<tr>
<th>Event</th>
<th>Certainty</th>
<th>Probability</th>
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<tbody>
<tr>
<td>Global Warming: Sea Level Rise</td>
<td>Virtually certain</td>
<td>≥99%</td>
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<tr>
<td>Regional Temperature Changes</td>
<td></td>
<td></td>
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<tr>
<td>• Decreases in very cold days</td>
<td>Virtually certain</td>
<td>≥99%</td>
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<tr>
<td>• Increases in Arctic Temps.</td>
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<tr>
<td>• Later onset of freeze, early onset of thaw</td>
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<tr>
<td>• Increases in very hot days/heat waves</td>
<td>Very likely</td>
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<tr>
<td>Precipitation Changes</td>
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<tr>
<td>• Increase in extreme events</td>
<td>Very likely</td>
<td>≥90%</td>
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<tr>
<td>• Increase in drought</td>
<td>Likely</td>
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<tr>
<td>• Change in patterns/seasons</td>
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<tr>
<td>Storms</td>
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<tr>
<td>• More intense/frequent hurricanes/typhoons</td>
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<td>≥66%</td>
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<tr>
<td>• More intense cold-season storms, with more intense/frequent winds, waves, surge</td>
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Sea Level Rise and Coastal Infrastructure: Bridges and Waterways