Extreme events from climate change:
their related impacts on transport & connectivity

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Driver 1: sea level rise

- Thermal expansion (58%)
- Glacier & ice cap (28%)
- Ice sheets (15%)

Observed rate of sea level rise [mm/year]

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Observed rate</td>
<td>1.8 ± 0.5</td>
<td>3.1 ± 0.7</td>
</tr>
</tbody>
</table>


By 2100: 0.22 m to 0.5 m (some experts say up to 1 m!)

Impacts on transport through:
- Coastal erosion (retreat)
- Coastal flooding
Driver 1: Sea level rise (ASLR), process

Beach erosion (defined as irreversible coastline retreat) due to increased sea level
Main transport at threat: harbours
Sea level rise impacts on harbours
Increasing coastal exposure: Dakar (Senegal)
Airport & sea level rise: Barbados
Sea level rise & airport: Solomon islands
Sea level rise & airports: Honk Kong (China)
Sea level rise & airports: Kingston (Jamaica)
Sea level rise & coastal erosion: roads
Coastal flooding: impacts on roads
## Driver 2: extreme events

<table>
<thead>
<tr>
<th>Phenomenon and direction of trend</th>
<th>Likelihood that trend occurred in late 20th century (typically post 1960)</th>
<th>Likelihood of a human contribution to observed trend</th>
<th>Likelihood of future trends based on projections for 21st century using SRES scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer and fewer cold days and nights over most land areas</td>
<td>Very likely</td>
<td>Likely</td>
<td>Virtually certain</td>
</tr>
<tr>
<td>Warmer and more frequent hot days and nights over most land areas</td>
<td>Very likely</td>
<td>Likely (nights)</td>
<td>Virtually certain</td>
</tr>
<tr>
<td>Warm spells/heat waves. Frequency increases over most land areas</td>
<td>Likely</td>
<td>More likely than not</td>
<td>Very likely</td>
</tr>
<tr>
<td>Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas</td>
<td>Likely</td>
<td>More likely than not</td>
<td>Very likely</td>
</tr>
<tr>
<td>Area affected by droughts increases</td>
<td>Likely in many regions since 1970s</td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
<tr>
<td>Intense tropical cyclone activity increases</td>
<td>Likely in some regions since 1970</td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
</tbody>
</table>

2010 Pakistan flood: unusually intense monsoon rains

Sources: NASA 2010
http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=45177
Should not comes at a surprise:

Pakistan ranking
9 / 162 countries in terms of flood exposure.

UNISDR, UNEP, 2009
Landslides in mountainuous areas
Heatwaves, destabilisation of north slopes in high altitude areas: rock fall & impacts on roads
Melting permafrost in mountainuous areas & high latitudes: impacts on roads
Melting permafrost in mountainuous areas & high latitudes: impacts on pipelines
Extreme precipitations in mountainous areas: impacts on roads and rails (Peru)
Heat & train: rail dilatation

Badly designed railways can suffer from extreme temperatures
Heat & train: rail dilatation in Canada

Sources: transportation safety board of Canada: http://www.tsb.gc.ca
14 August 2003, part of north-east USA and South-east Canada had a major blackout: 65 millions people affected.
Drought & electricity production: nuclear power Plant in France (some shut down during 2003 heatwave)

The nuclear power plants of Saint-Alban (Isère), Golfech (Tarn-et-Garonne), Cruas (Ardèche), Nogent-sur-Seine (Aube), Tricastin (Drôme) and Bugey (Ain) continued functioning, although the upper legal limits were exceeded.

Santa Maria de Garona (Spain) was shut down in summer 2006) due to lack of cooling water.
Drought & electricity production
Drought & boat transport
Panama canal

- In 2009, nearly 300 million tons of shipping. Yearly shipping may increase to 340 million tons in 2012.
• Every lock going downward requests more than 100,000 m³ of water to operate.
• Water management is a critical issue, both floods and droughts need to be controlled.
Deforestation might induce local change in precipitation patterns.
Arctic ice retreat: new shipping road(s)

1979-2003: Progressive loss of ice in arctic ocean

Sources: UNEP (2005) *One planet Many People*
Transport is not **only** a victim from climate change

**GHG Emissions by sectors**

- Agriculture
- Forestry, deforestation
- Waste
- Energy supply
- Transport
- Residential
- Industry

Transport is not only a victim from climate change

Demand in energy for transport might double by 2050

Energy crisis: the only petrol producers are bacteria … it takes them 200 millions years to transform 24 tons of fern into one litter of petrol!

Transport: more rational thinking is needed

An example on world top importers / exporters of potatoes

<table>
<thead>
<tr>
<th>Top 10 exporters</th>
<th>Top 10 importers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>Spain</td>
</tr>
<tr>
<td>France</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Germany</td>
<td>Belgium</td>
</tr>
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<td>Belgium</td>
<td>Germany</td>
</tr>
<tr>
<td>Canada</td>
<td>UK</td>
</tr>
<tr>
<td>Isrël</td>
<td>Italy</td>
</tr>
<tr>
<td>Spain</td>
<td>France</td>
</tr>
<tr>
<td>USA</td>
<td>USA</td>
</tr>
<tr>
<td>UK</td>
<td>Portugal</td>
</tr>
<tr>
<td>Italy</td>
<td>Greece</td>
</tr>
</tbody>
</table>
Conclusions

• Transport activities will be affected by climate change.
• Main drivers are sea level rise and extreme events.
• Coastal, mountainous and high latitude areas will face the highest consequences.
• But:...transport is partly responsible for climate change.
• In the next few decades, energy crisis is very likely to have much more impact on transport than climate change.
Conclusions

Due to:

• Climate change impacts on transport
• Impact of transport on climate
• The energy crisis
• Current waste in transport practices

A shift in transport policies is needed!
Summary on sea level rise impacts

- Increase coastal erosion
- Submerge infrastructures

This can impact:
- Harbours
- Airports
- Coastal roads & railways
Summary heat impacts:

- High energy demand (blackout)
- High ground ozone level.
- Forest fires (and smoke for flights)
- Destabilisation of slopes (rock fall, landslides, …)
- Dilatation of (badly designed) railways
- Melting of permafrost (in northern latitudes and high altitudes).
Summary on drought impacts:

• Reduces (or prevents) river navigation capacities
• Reduce electricity supply from both nuclear power plant (cooling) and dams thus may affecting trains, subways and other transports depending on electricity.
Summary on extreme precipitation events

Heavy precipitations may lead to:

- Flooding,
- landslides,
- blocking or destroying transport infrastructures (roads, bridges,...)