Extreme Weather in a changing Climate

Emerging Services to mitigate risks for the transport sector

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Outline

• Background – The need for tailored Weather services in a changing climate
• Characteristics of these services
• Natural Variability and man-made changes
• Scenario-based Risk management
• Operational Challenges
Existing Weather services

- Standard warning products: Severe Weather warnings, storm warnings, flood warnings
- Regionally and phenomena-dependent warning services:
  - Winter Weather- snow, freezing rain.
  - Tornado, Hurricane, Storm surges, Tsunami, Dust-and Sand Storms
  - Typically provided for national and regional authorities and the general /travelling public
- Existing Gaps: Addressing the transnational nature of transport systems!
  (European projects addressing need for continent-wide linking of warning services for Trans European Networks, few similar approaches in other continents)
Future weather (and climate) services to societal sectors such as Transport need to fulfill the following criteria:

- To be Accessible to all: Given the potential impact of climate variability on economic decision, this information must be openly available.
- To be Driven by ongoing research and building on existing collaboration between the meteorological and transport communities dealing with chronic risks.
- To provide Continuous improvement of forecasts in particular for specific regions and locations, and expressed in a clearly understandable way to decision makers.
- Improving the range, availability and accessibility through exchange of data between research and operational agencies for the Earth, Atmosphere and Ocean system.
Increase in extremes

• Observations over the last decades reveal a tendency of increased extremes and unusually persistent weather patterns
• IPCC Assessments also point out to increased likelihood of extremes
• Recent extreme events (snow extremes over EU in 2009-2011, Floods in Central America, Pakistan, China) seem to support findings
And still some do look rather surprised…

Photograph by John Giles/PA
Validation Issue:

• Use of warning information in real-life decision making “requires a common understanding on how to evaluate and verify such highly complex predictions both from a modeling and user perspective “
  – How do we know that we got it right?
  – How can we know the answer is what the users were looking for?
Risk Management Considerations

- Basics: Risk = Exposure x Impact
- Similar risks originate from high exposure but with lower impact, resulting in catastrophic events
- Political and economic decision makers often focus on mitigation of events of a return period within their terms of office
- Difficult to detect significant changes in many types of extremes due to limited observational information.
- Extreme events are rare by definition, and observational records thus are often not long enough
Scenario-Based Risk Management

- Not based on average values
- "Critical Scenarios" to be identified
- Combined effects leading to disasters
  - Example: Strong precipitation associated with warm temperatures in spring over large mountains (snow melt and rainfall combine to high flood risk)
  - Storm Surge, high tides and heavy rainfall swelling river levels leading to coastal inundation
  - Extended droughts and high winds bringing high wildfire risk
Operational Challenges to planning climate-resilient systems

- Transport infrastructure needs to account for climate uncertainties to enable more flexible responses to climate change
  - Off-shore structures and harbors need to be planned anticipating also sea level rises and changes in the severity and frequency of storms
  - Changes to maximum wind speeds would also influence the construction of road and rail bridges
  - Changes to permafrost soils have been carefully assessed and anticipated in the design of the new Tibetan railway line recently completed in China.
Hurricane Dennis woz here

• Picture courtesy Government Fleet
UNCERTAINTY IN WEATHER FORECAST

- Expectation
- GAP
- Service provided
- New Expectation
- GAP
- New level of service provided
UNCERTAINTY IN WEATHER FORECAST

Expectation

GAP

Communicate scientific limitation

Expectation

GAP

Service provided

Based on science and technology

Service provided
Examples of specialized weather services in road transport

• Concentrate on high impact weather
• User interface built together with road/highway authority
• Mix of NWP, traditional nowcasting, and specialized nowcasting techniques for Temperature, Visibility, winds, surface conditions
• Push – and Pull-Systems co-exist
Central Europe: Austria

Radar composite Map with trunk highways overlayed
Surface Parameters, Tabular vs. graphics

Critical values of Rel Hum highlighted in Red in Table
Winter Maintenance: Precipitation type – for type, amount and time of melting agent
Floods, Landslides, Surges

• Multi-disciplinary (Met, Hydro, Geology)
• Sometimes slow build-up, but very rapid “tipping” into catastrophic scenarios
  – Debris blocking flow under bridges (engineering)
  – Excessive rain de-stabilizing mountain/hill slopes
Coastal Phenomena

- Storm Surges, Spring tides (Oceanography)
- Coastal erosion & Rainfall destabilizing coastal roads/rail
- High winds affecting exposed roads/rails/bridges (closures necessary, limitations for special vehicles)
- Extreme waves
Semi-Arid /Arid Areas

- Sand-and Dust Storms –visibility, sand drifts, wandering dunes
- Bush Fires requiring closures
- Rail: Points affected by drifting sand
- Extreme heat – vehicle failures, rail deformation
Conclusions

• Need for intense collaboration with user representatives to define requirements
• Use of user infrastructure and networks
  – Highway signalization, traffic alert system, mobile web applications
  – Optimization of highway/railway maintenance operations - large savings!
  – Sharing of network infrastructure e.g. road weather stations
  – Joint planning of network expansion/improvement for win/win situation
Thank you