Climate Change Adaptation

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Climate Change Adaptation

Outline:

1. Background/global climate change
2. Climate change across the ROADEX areas
3. Predicted impacts
4. Questionnaire & analysis
5. Adaption & good practice measures
6. Summary
Global climate change

What could happen? The effect of a shift in climate:

- Increase in mean
- Probability of occurrence
- Cold
- Average
- Hot
- More hot weather
- Previous climate
- Less cold weather
- New climate
- More record hot weather
Global climate change

World Map of Köppen–Geiger Climate Classification

Main climates:
- A: equatorial
- B: arid
- C: warm temperate
- D: snow
- E: polar

Precipitation:
- W: desert
- S: steppe
- f: fully humid
- s: summer dry
- w: winter dry
- m: monsoonal

Temperature:
- h: hot arid
- k: cold arid
- F: polar frost
- T: polar tundra
- a: hot summer
- b: warm summer
- c: cool summer
- d: extremely continental

Climate classification for the period 2076 - 2100

Resolution: 0.5 deg lon/lat

Version of May 2010

http://koppen-geiger.cn-wien.ac.at
Global climate change

Dfc - snow, fully humid, cool summer
Dfb - snow, fully humid, warm summer
EF - polar frost
ET - polar tundra
Cfb - warm, fully humid, warm summer
Cfc - warm, fully humid, cool summer

Climate classification for the period 1976 - 2000

Climate classification for the period 2076 - 2100
Climate Change

“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and sea temperatures, widespread melting of snow and ice, and rising global average sea level”.

Intergovernmental Panel on Climate Change, 2007

Scientific consensus - “the climate is changing”
but the general population has yet to be convinced ....
Natural weather variability or climate change?

- Uncertainty in climate projections
- Natural variability of weather patterns
- Is this climate change or natural variability?

Storm damage, northern Sweden, late September 2011
Natural weather variability or climate change?

Landslide at Enafors, Jämtland, 2006
Natural weather variability or climate change?
Landslides in Scotland

A83 Cairndow

A9 Dunkeld

A85 Glen Ogle
Climate Change
The ROADEX position

- The scientific consensus believes that the world’s climate is changing.
- Road networks, especially rural road networks, can be affected by weather conditions.
- The ROADEX Partner organisations consider it sensible to review what can be done now to modify current road construction and maintenance practices to meet the predicted changes.
Climate Change - possible impacts on roads:

- Disruption of the network by extreme weather events (rain, snow, high temperatures)
- Damage to roads through deterioration, deformation and subsidence
- Flooding from rivers, seas and inadequate land drainage
- Severance of routes by landslides and avalanches
- Damage to roadside infrastructure by high winds
- New road safety issues

Climate Change - possible impacts on roads:

- **Temperature**
  - Carriageway effects
  - Frost damage (including freeze-thaw cycles and frost heave)
  - Permafrost effects
  - Winter maintenance
  - Increase in sea level

- **Precipitation**
  - Floods
  - Erosion of roads and bridges
  - Drainage problems
  - Landslides

High Bridge, Struie, Scotland
Climate Change
Impacts on road maintenance

Climate Change
Changes in weather conditions
Changes in methods & frequency
Changes in the condition of the road network
Changes in the cost of maintenance

“Impact of climate change on road maintenance”, Finnish Road & Traffic, 2009

Freeze-thaw damage  Flooding  Winter conditions  Rutting
Climate Change Adaptation

Influence of climate change on maintenance cycles

Based on the UK Agency Climate Change Adaptation Framework (2009)
ROADEX climate change adaptation: questionnaire

Contents:
• Introduction
• What are the most important changes and problems?
  – Drainage
  – Freeze-thaw
  – Rutting
  – Erosion
  – Stability
  – Winter
• Organisational strategy?
• Organisation working group or person?
• National strategy/guidance?

Questionnaire in WORD
Climate Change Adaptation: questionnaire

Questionnaire & Analysis:
- Analysed by topic

- Stability problems of road embankments
- Freeze-thaw cycles of paved roads
- Freeze-thaw cycles of unpaved roads
- Rutting due to spring thaw weakening of paved roads
- Rutting due to spring thaw weakening of unpaved roads
- Differential frost heave
- Settlement due to permafrost
- Sheet ice problems
- Winter maintenance problems due to drifting snow
- Winter maintenance problems due to icing
- Winter maintenance problems due to salt
- Avalanches
- Erosion of paved roads due to heavy rains
- Erosion of unpaved roads due to heavy rains
- Flooding
- Landslides
- Rise of sea level
Climate Change Adaptation: questionnaire & analysis:

- By Partner concern: prioritised
Typical impacts:

Greenland (photo Arctic Technology Centre)

Norway (photo Norwegian Public Roads Administration)

Finland

Raattama, Finland (photo J. Leskinen)

More and Romsdal, Norway (photo Norwegian Public Roads Administration)

A9 Raigmore Slip Road, Inverness (photo BEAR Scotland Ltd)
### 8.3 SUMMARY OF GOOD PRACTICE AND ADAPTATION MEASURES

This Appendix summarises the good practice and adaptation measures listed in the boxes at the end of each subsection and chapter in the report.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Impact</th>
<th>Good practice and adaptation measures</th>
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| Higher summer Temperatures | ◼️ | • Testing the road drainage in good condition by implementing the ROADEX drainage maintenance strategies and guidelines [B3]  
• Sealing of cracked and distressed areas  
• Removal of roadside vegetation  
• Increase frequency of grass cutting, etc.  
• Adapting measures  
• Rebuilding pavement material compositions of the new rehabilitation/construction event  
• Building on well-working practices from areas with warmer temperatures  
• Using more hot-resistant and/or stripping-resistant surfacings  
• Surfacing and microsurfacing, especially with chippings with high reflectivity  
• Preventing wearing course  
• Improving surface and sub-surface drainage systems  
• Stabilization of unsealed pavements |
| Increased freeze-thaw cycles, frost heaves and frost damage | ◼️ | • Testing the road drainage in good condition by implementing the ROADEX drainage maintenance strategies and guidelines [B3]  
• Keeping ditches and culverts free of snow and ice by means of good winter maintenance practices  
• Managing the vehicle numbers using the road  
• Applying site level restrictions where necessary  
• Surfacing and/orgrading gravel roads to provide good crossfils |
Climate Change Adaptation

Examples of adaptations in the Partner areas:

**Norwegian Public Roads Administration**

“Climate and transport” project

The need for increased drainage capacity:

\[ Q = C \times I \times A \times K_f \]

Climate factor dependant on the storm return period
Climate Change Adaptation: example
Drainage design - Sweden

Regional drainage factors for climate change:

(SCotland climate change factor for drainage = + 20%, or 1.2)
Climate Change Adaptation: ERA-NET ROAD

**SWAMP**

Blue Spot screening:
“A part of a road that is vulnerable to flooding, either by precipitation, catchment water or sea level rise”
Climate Change Adaptation: ERA-NET ROAD SWAMP

"Blue Spot" - Modelling restrictions in stream flow and river flows:

Free flow system - unrestricted

Blocked waterway - flooding
Summary

Key points:

• Climate change is stated to be happening
• More frequent extreme weather events are likely
• More frequent freeze-thaw cycles
• Uncertainty in projections
• Road owners need to consider their positions
• Maintenance operations, a step at a time
• Solutions may be available in other countries
• Need to share information
• Good road drainage will be a key
• New construction will be different
• The ROADEX report offers a number of recommendations for best practice and adaptation measures
The future?
“The climate change resilient road”

www.foreveropenroad.eu
But for the present”

British Government Ministry of Information poster, 1939
Thank you

www.roadex.org
The ROADEX Network in the Highlands