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Climate Change Adaptation

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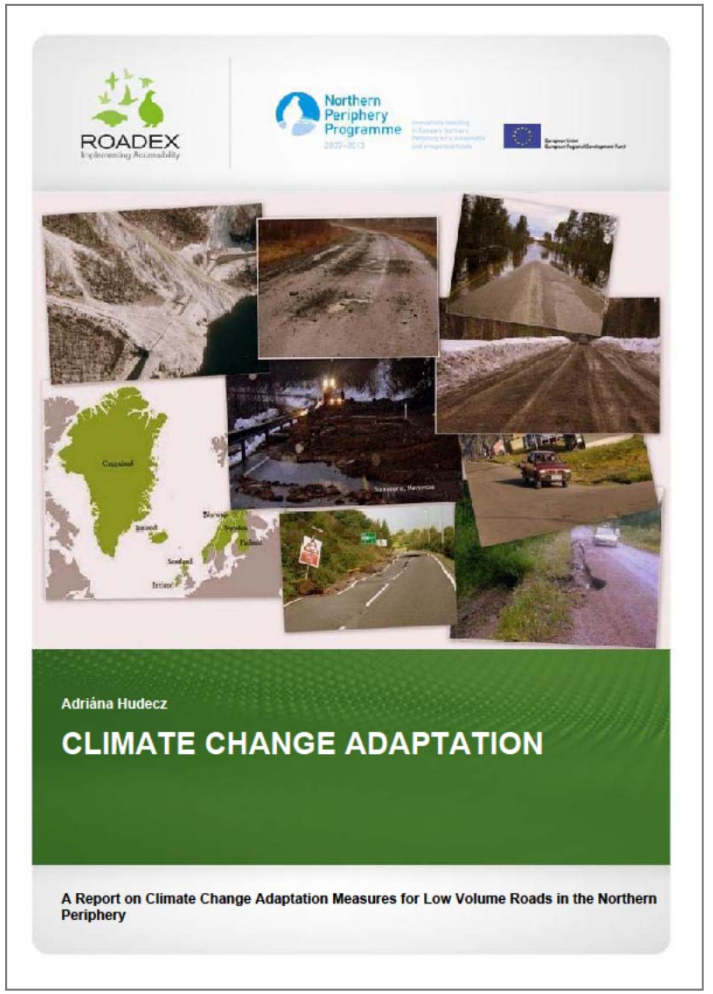
ROADEX Final Seminar

Rovaniemi, 25 April 2012

Climate Change Adaptation

Outline:

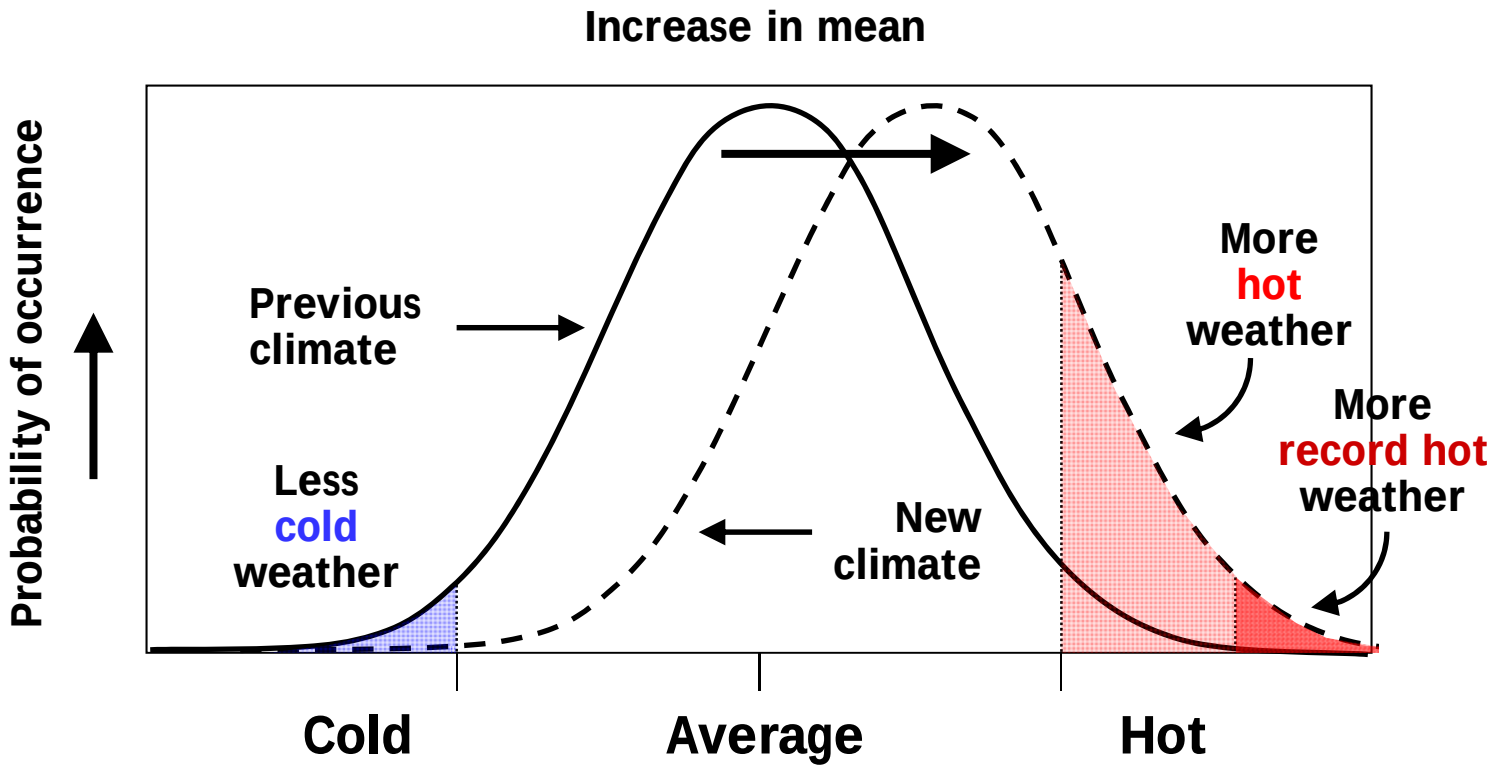
1. Background/global climate change
2. Climate change across the ROADEX areas
3. Predicted impacts
4. Questionnaire & analysis
5. Adapation & good practice measures



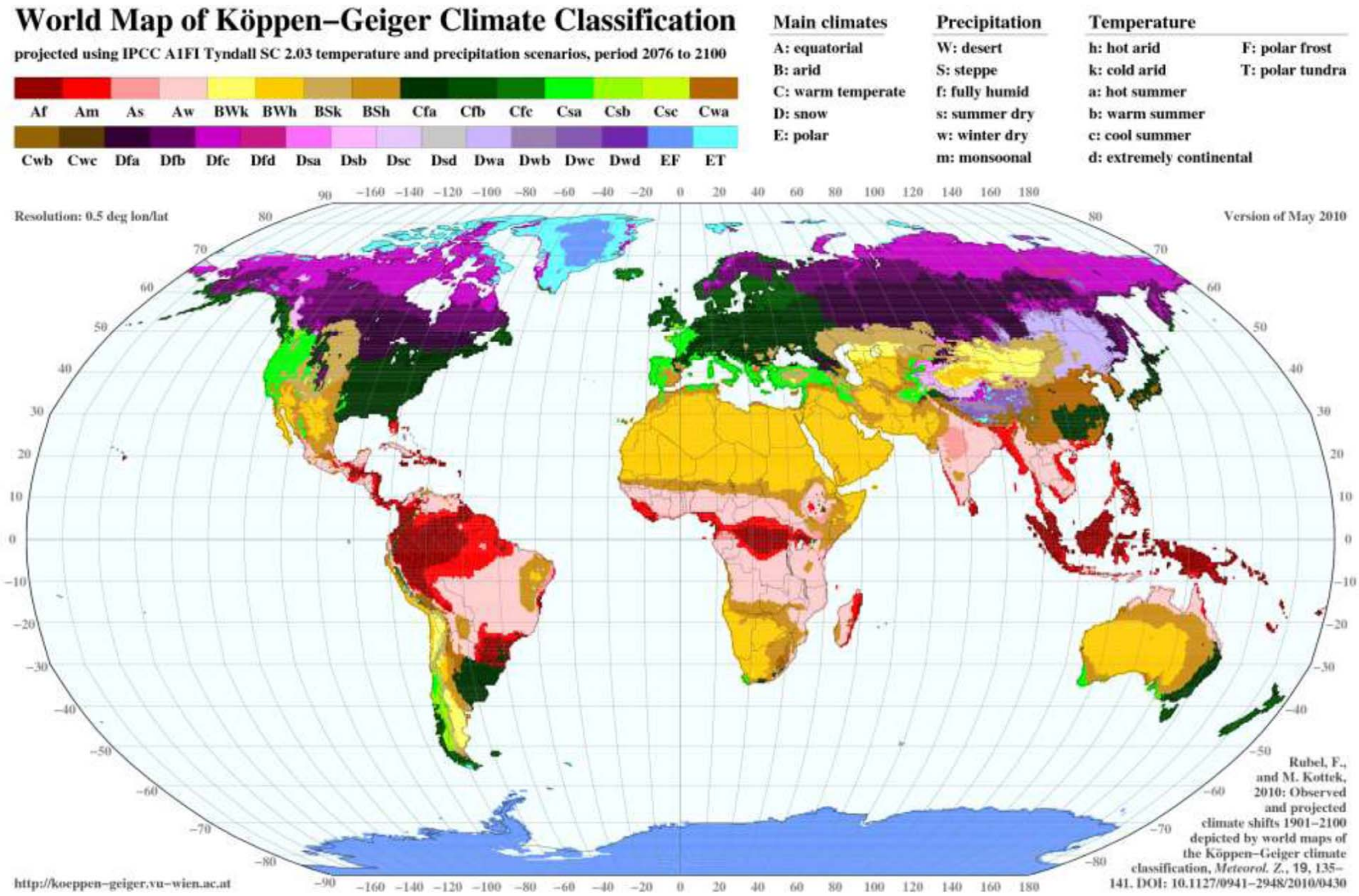
Climate Change Adaptation report, 2012

Global climate change

Effect of shift in climate:



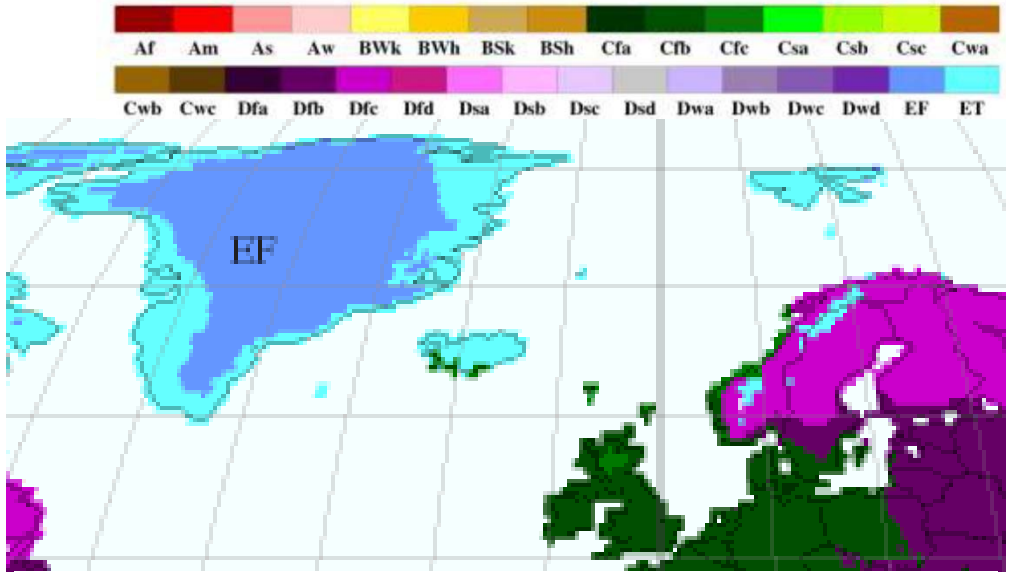
Global climate change



Climate classification for the period 2076 - 2100

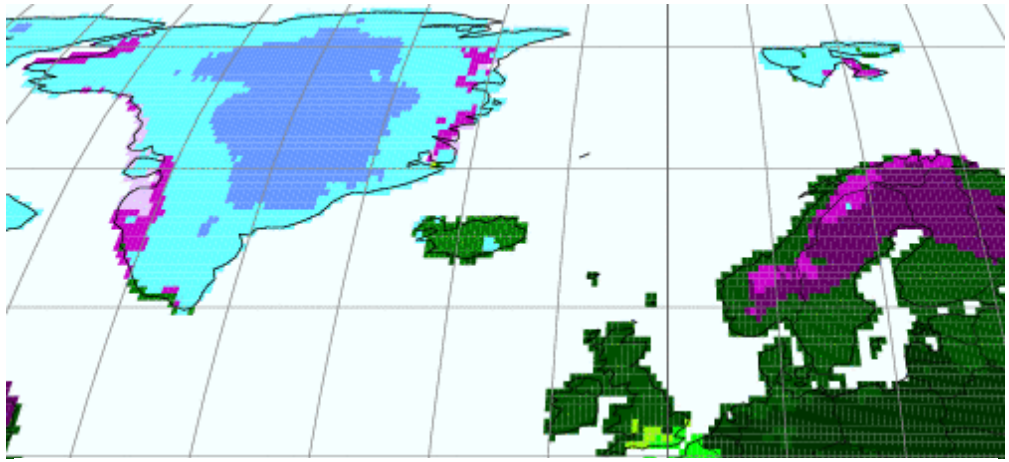
Global climate change

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

Dfc –snow, fully humid, cool summer
Dfb – snow, fully humid, warm summer
Dsb – snow, steppe, warm summer
EF – polar frost
ET – polar tundra
Cfc – warm, fully humid, cool summer



Climate classification for the period 2076 - 2100

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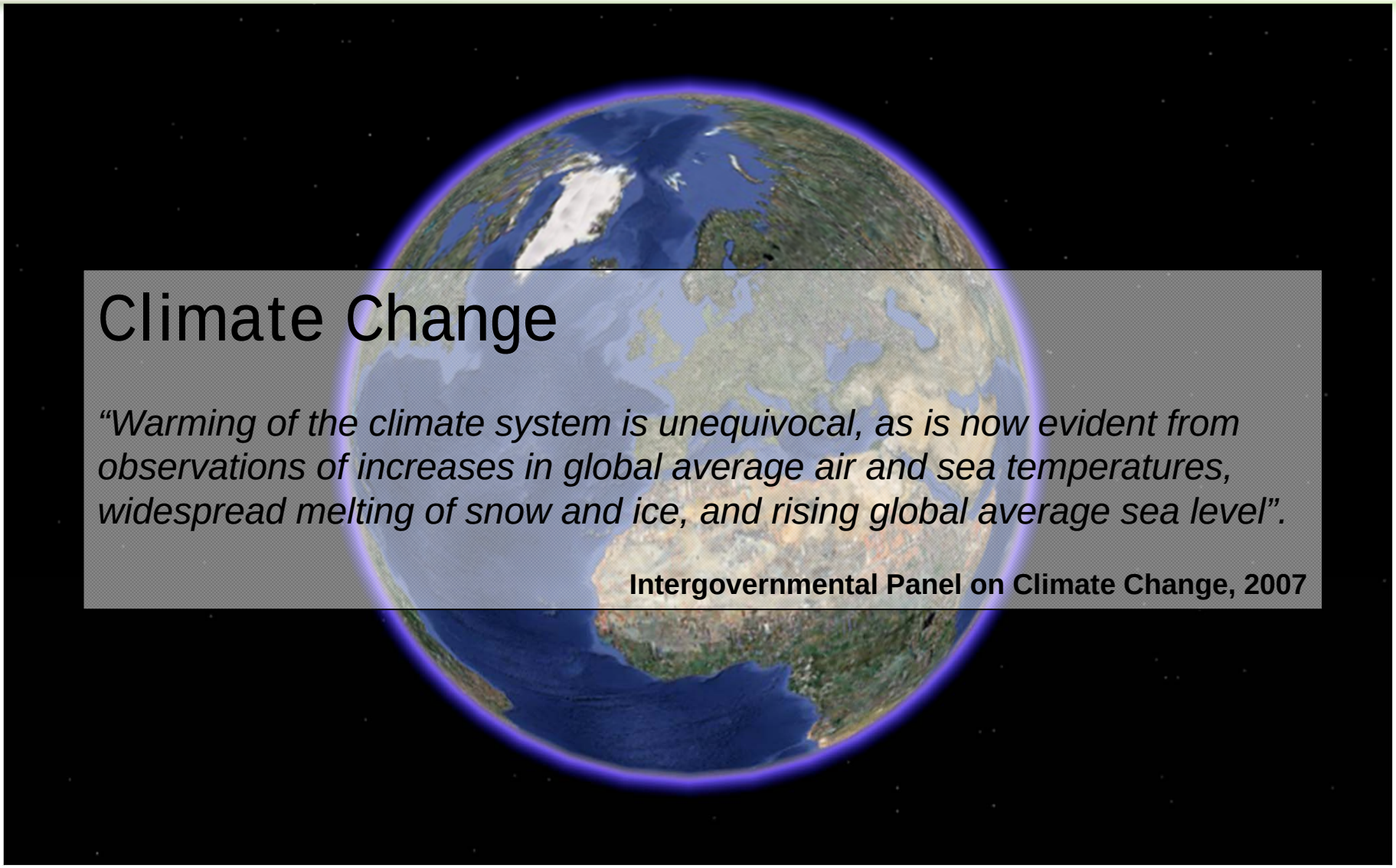

Scientific consensus – "the climate is changing"

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…. but the general population has yet to be convinced ….

Natural variability or climate change?

Storm damage, northern Sweden, late September 2011

Natural variability or climate change?

Landslide at Enafors, Jämtland, 2006

Natural variability or climate change?

Landslides in Scotland

A83 Cairndow

A9 Dunkeld

A85 Glen Ogle

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

"*The Changing Climate: Impact on the Department of Transport*", 2004

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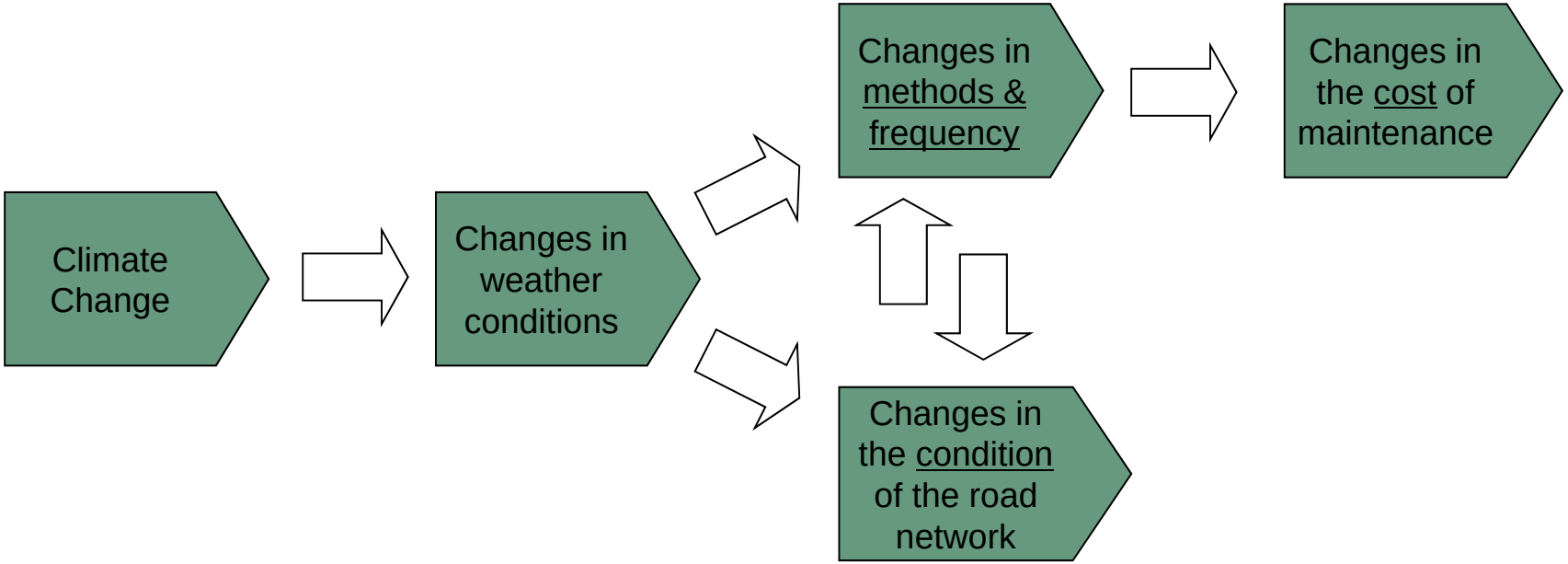
Climate Change – possible impacts on roads:

- **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



"*Impact of climate change on road maintenance*", Finnish Road & Traffic, 2009

Freeze-thaw damage

Flooding

Winter conditions

Rutting

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?

H. Sheet ice problems		
Might significantly increase		Additional comments:
Might slightly increase		
No change		
Might slightly decrease		
Might significantly decrease		

Are you aware of any documentation, guidelines or strategy was produced to help engineers to deal with this problems?

I. Winter maintenance problems due to drifting snow		
Might significantly increase		Additional comments:
Might slightly increase		
No change		
Might slightly decrease		
Might significantly decrease		

Are you aware of any documentation, guidelines or strategy was produced to help engineers to deal with this problems?

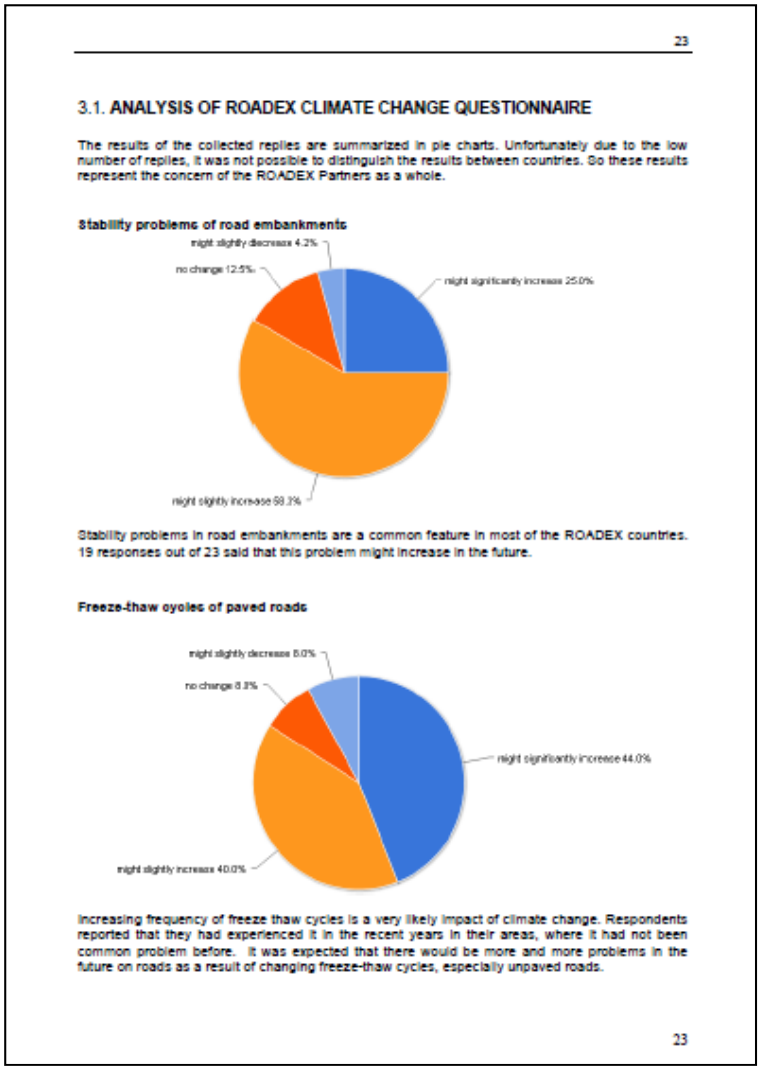
Questionnaire in WORD

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



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3.1. ANALYSIS OF ROADEX CLIMATE CHANGE QUESTIONNAIRE

The results of the collected replies are summarized in pie charts. Unfortunately due to the low number of replies, it was not possible to distinguish the results between countries. So these results represent the concern of the ROADEX Partners as a whole.

Stability problems of road embankments

Stability problems in road embankments are a common feature in most of the ROADEX countries. 19 responses out of 23 said that this problem might increase in the future.

Freeze-thaw cycles of paved roads

Increasing frequency of freeze thaw cycles is a very likely impact of climate change. Respondents reported that they had experienced it in the recent years in their areas, where it had not been common problem before. It was expected that there would be more and more problems in the future on roads as a result of changing freeze-thaw cycles, especially unpaved roads.

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Climate Change Adaptation: questionnaire

Questionnaire & Analysis:

- By Partner concern:

Might significantly decrease: -2
Might slightly decrease: -1
No change: 0
Might slightly increase: 1
Might significantly increase: 2

Impacts	Might significant decrease	Might sightly decrease	No change	Might sightly increase	Might significant increase	*Rate*
Stability problems with road embankments	0	1	3	14	6	25
Freeze-thaw cycles problem with paved roads	0	2	2	10	11	30
Freeze-thaw cycles problem with unpaved roads	0	2	3	7	12	29
Rutting due to spring thaw weakening of paved roads	0	1	2	16	6	27
Rutting due to spring thaw weakening of unpaved roads	0	1	4	11	9	28
Differential frost heave	0	2	5	13	5	21
Settlement due to permafrost	0	1	11	11	2	14
Sheet ice problems	0	5	4	14	2	13
Winter maintenance problems due to drifting snow	0	6	10	8	1	4
Winter maintenance problems due to icing	0	1	6	12	6	23
Winter maintenance problems due to salt	0	3	6	13	3	16
Avalanches	0	2	12	9	2	11
Erosion of paved roads due to heavy rains	0	0	0	17	7	31
Erosion of unpaved roads due to heavy rains	0	0	0	13	12	37
Flooding	0	0	3	12	11	34
Landslides	0	0	3	15	7	29
Rise of sea level	0	0	6	16	3	22

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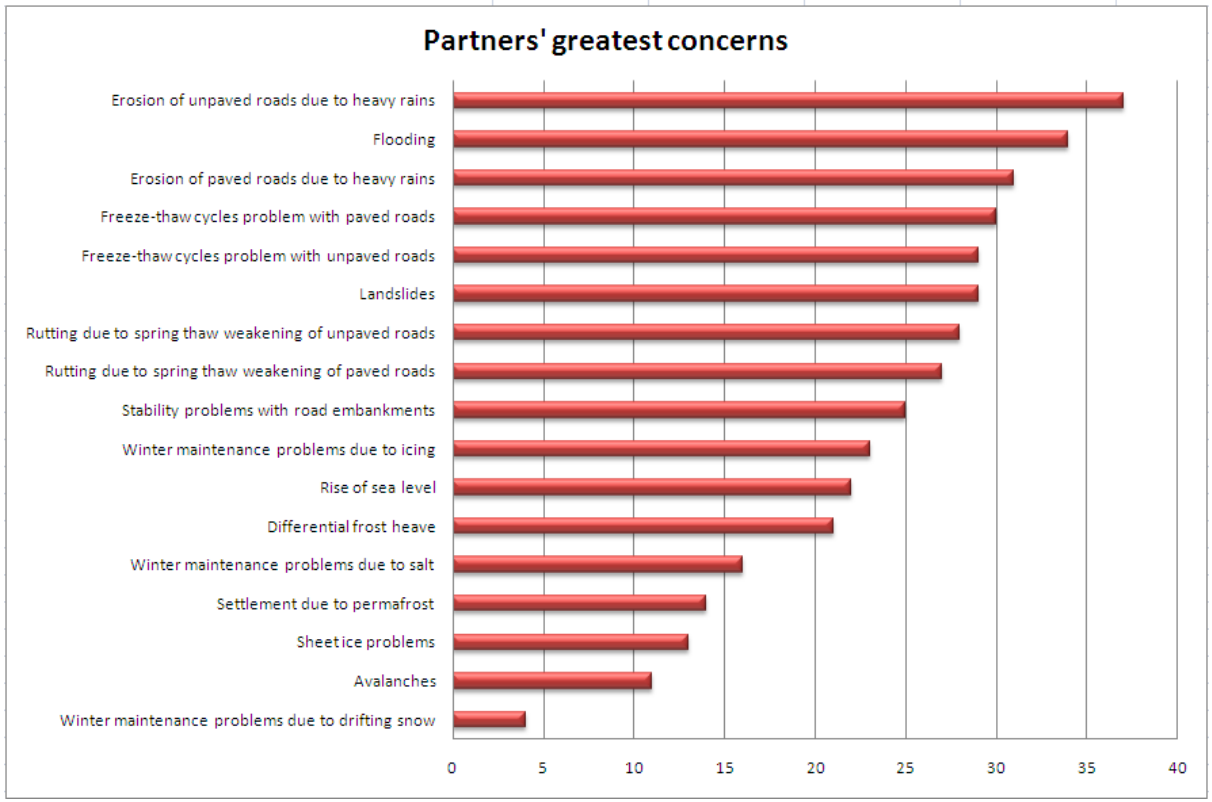
Climate Change Adaptation: questionnaire

Questionnaire & Analysis:

- By Partner concern:



Adaptation & Good Practice Measures


Greenland (photo Arctic Technology Centre)


Norway (photo Norwegian Public Roads Administration)
E10 Lofoten


Finland


Raattama, Finland (photo J. Leskinen)


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


A9 Raigmore Slip Road, Inverness (photo BEAR Scotland Ltd)

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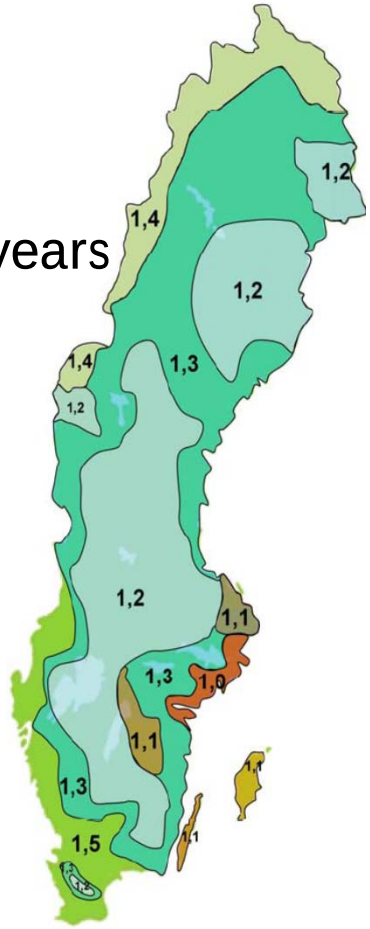
Adaptation & Good Practice Measures

Examples of adapations in the Partner areas:

Reviewing design standards

- *Iceland*: increase the design sea level with 50 cm
- *Scotland*: one storm event in 100 years to one in 200 years
- *Sweden:* regional drainage factor (1-1.5)
- *Norway:* introducing climate factor in drainage design

$$Q = C \times I \times A \times K_f$$



Adaptation & Good Practice Measures

Examples of adapations in the Partner areas:

Mapping

- *ERANET-ROAD – SWAMP*

  ”Blue Spot” - Modelling restrictions in stream flow and river flows

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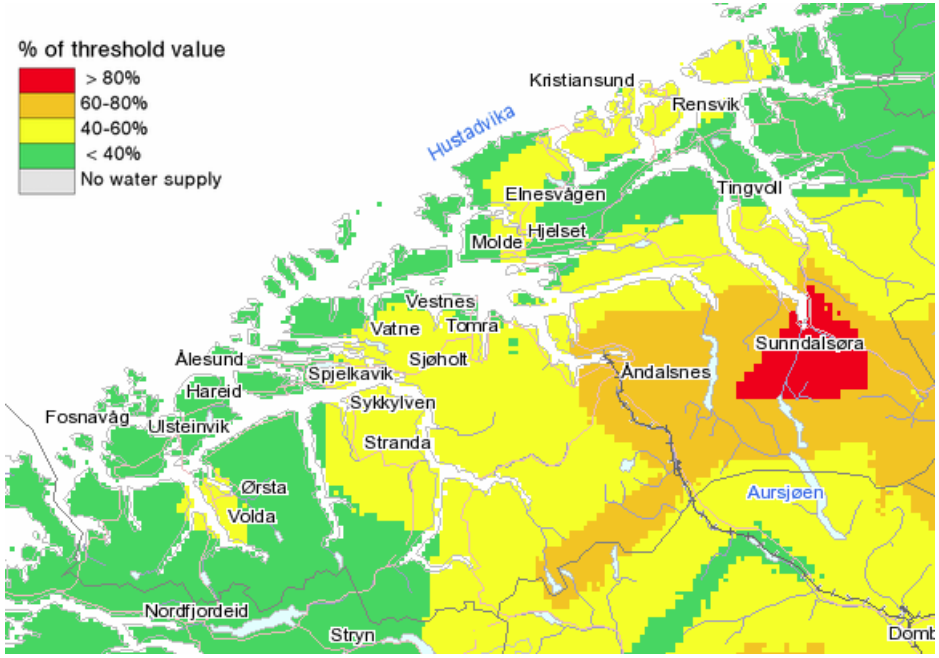
Adaptation & Good Practice Measures

Examples of adapations in the Partner areas:

Mapping

- *Climate and Transport*

  Landslide risk analysis



Conclusion

Key points:

- Climate change is happening
- More frequent extreme weather events
- More frequent freeze-thaw cycles
- Actions are needed
  - Mapping likely threatened areas
  - Risk assessment
  - Frequent inspection and if needed maintenance
  - Reviewing design standards
- Keeping the road drainage in good condition
- In case of new construction – avoid threatened areas

Thank you

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