Climate adaptation of the Swedish road transport system -

A discussion of measures which can be cost effective to prevent natural disasters

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Outline of the presentation

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3. Method
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Introduction

- Climate change
- Adaptation necessary
- Natural disasters which disrupted the Swedish transport system, examples:
  - Norrland snow melting 2010
  - Flooding in Göteborg in December 2011
- The Swedish transport administration has limited resources – cost efficient adaptation needed
- Lacking knowledge about which types of measures are most efficient to implement and at what kind of places

Aim and research question

The aim of the thesis was to increase the knowledge about which measures that are most cost efficient against natural disasters by studying a number of cases with flooded and swept away roads.

Research questions:

- How does different factors effect which measures that are cost efficient for the different cases?
- How is identified risks' and measures' cost efficiency affected by a changed climate?

Limitation

- Natural disasters: Flooded and swept away roads
- Part of the road infrastructure: damage to roads not bridges or tunnels

Method

- A case study – availability of data deciding chosen cases
- Cost-benefit-analysis analysis is used to calculate how cost efficient different measures are for the different cases:

$$NNK = \frac{Nyttan - Kostnad}{Kostnad}$$

- The consequences of a natural disaster are described as damaged to assets as defined by the Swedish Road Administrations method “Riskanalys Vald Vägsträcka”

Assets

- Person
  - Damage within the road transport system to employees or road users
  - Damage to third party outside the transport system.
- Property
  - Damage within the road transport system to roads, bridges, tunnels, goods, vehicles, etc.
  - Damage to land, buildings and structures in the surrounding area.
- Environment
  - Mainly damage to natural resources, natural and cultural environments
- Finance
  - Damage within the road transport system by increasing costs for travel time, vehicles, emissions, operation and maintenance
  - Damage outside the road transport system - indirect costs for society and the industry due to delayed or cancelled transports. This also includes damage to other infrastructure.
- Immaterial
  - Damage to brand, credibility etc.

Climate change

- Climate change's impact on natural disasters based on the Echam4-model and the A2-scenario (IPCC:s fourth report)
- Present emissions large than A2 + the Copenhagen Diagnosis -> the consequences of climate change worse than IPCC predicted

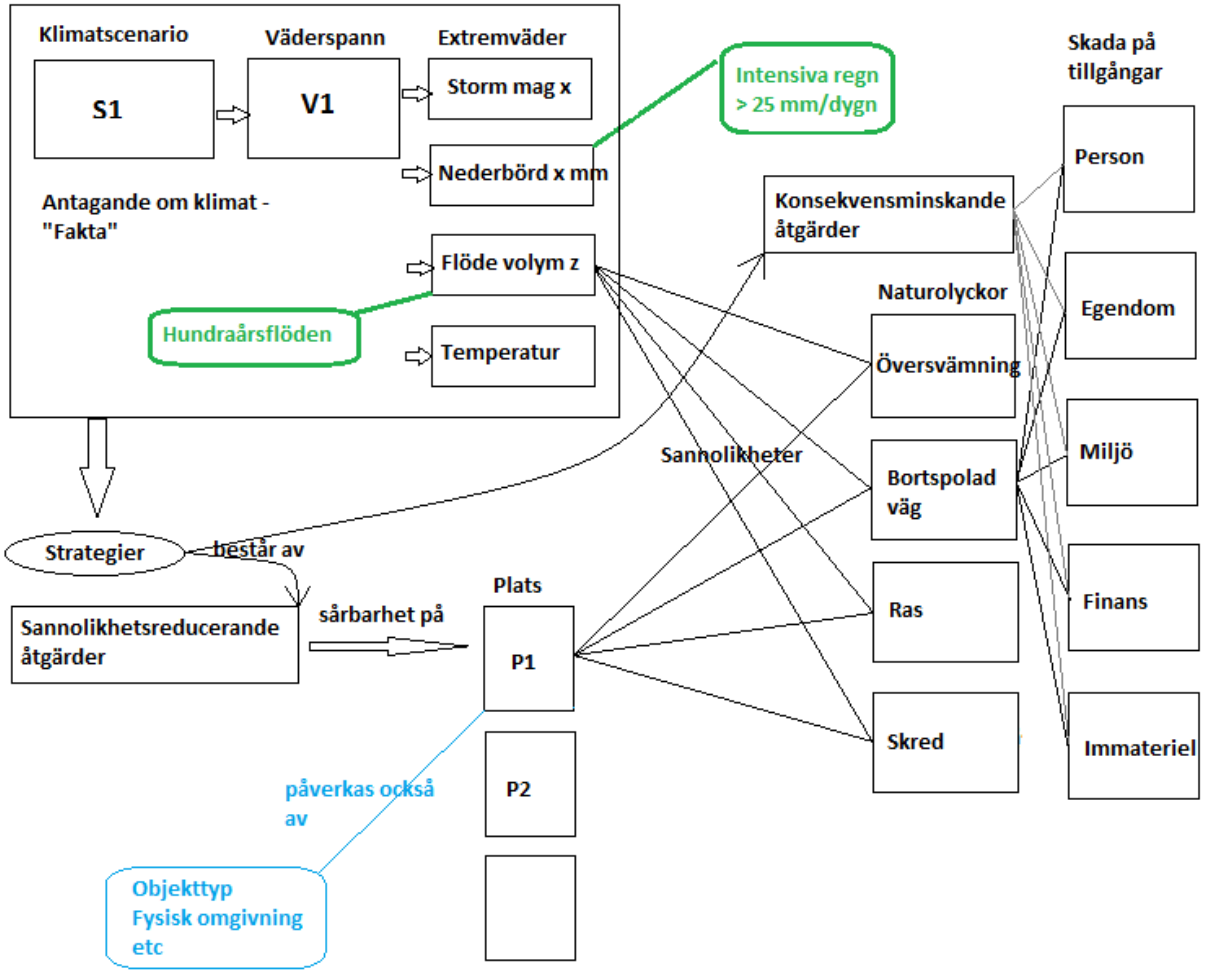
Most important consequences of climate change for this thesis:

- Increased frequency and intensity of extreme rainfall + more rain
- Increased frequency of high water flows – the 100-year flow more common

Historical damage

- No fatalities & serious injuries until Göteborg 2011
- Only property damage (80 Mkr/year 1995-2007) and financial damage are reported – the second estimated to be 10-15% of the first
- No environmental damage reported and no immaterial damage estimated

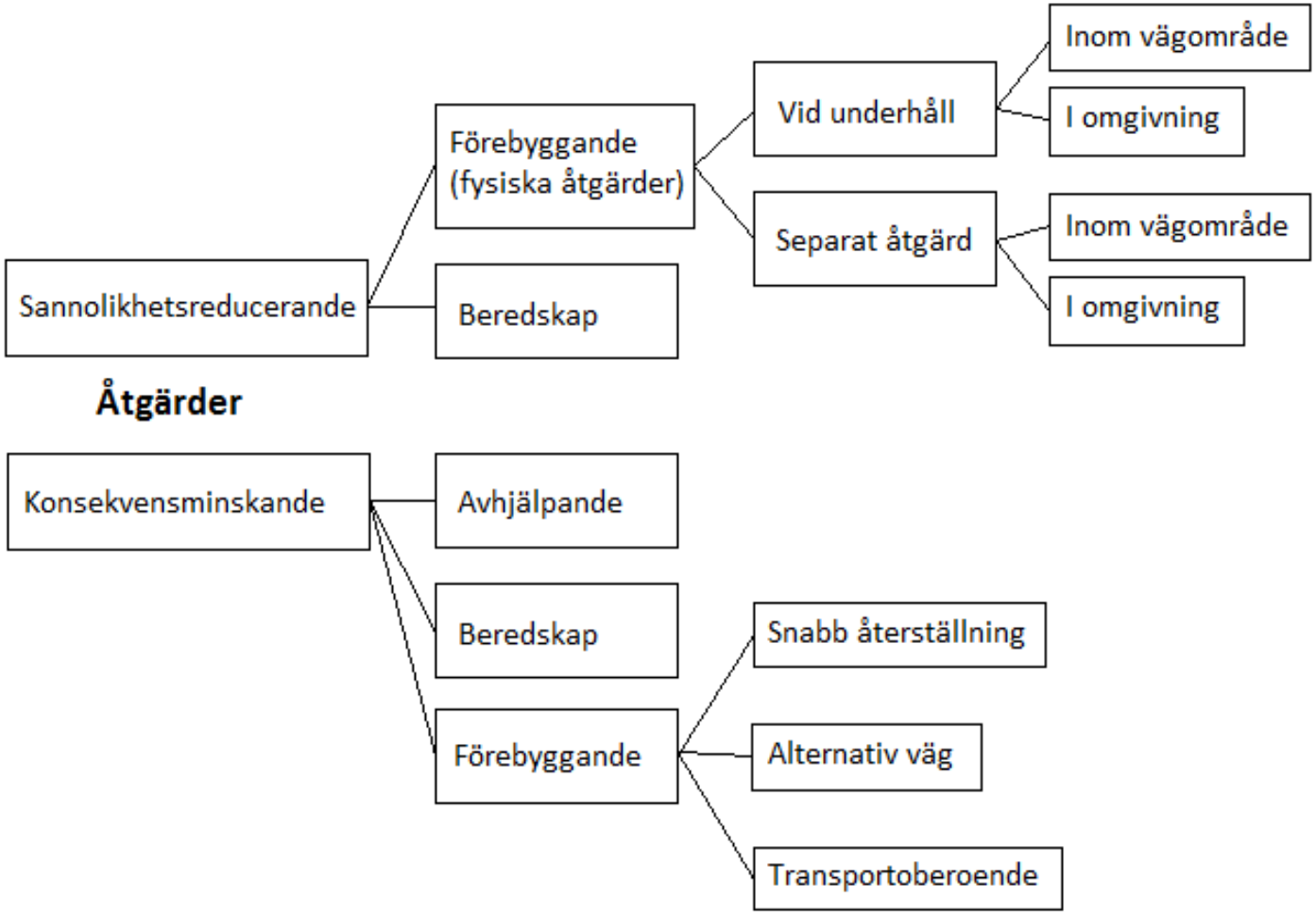
Measures



Measures reducing the:

- Likelihood of a disaster
- Consequences of a disaster

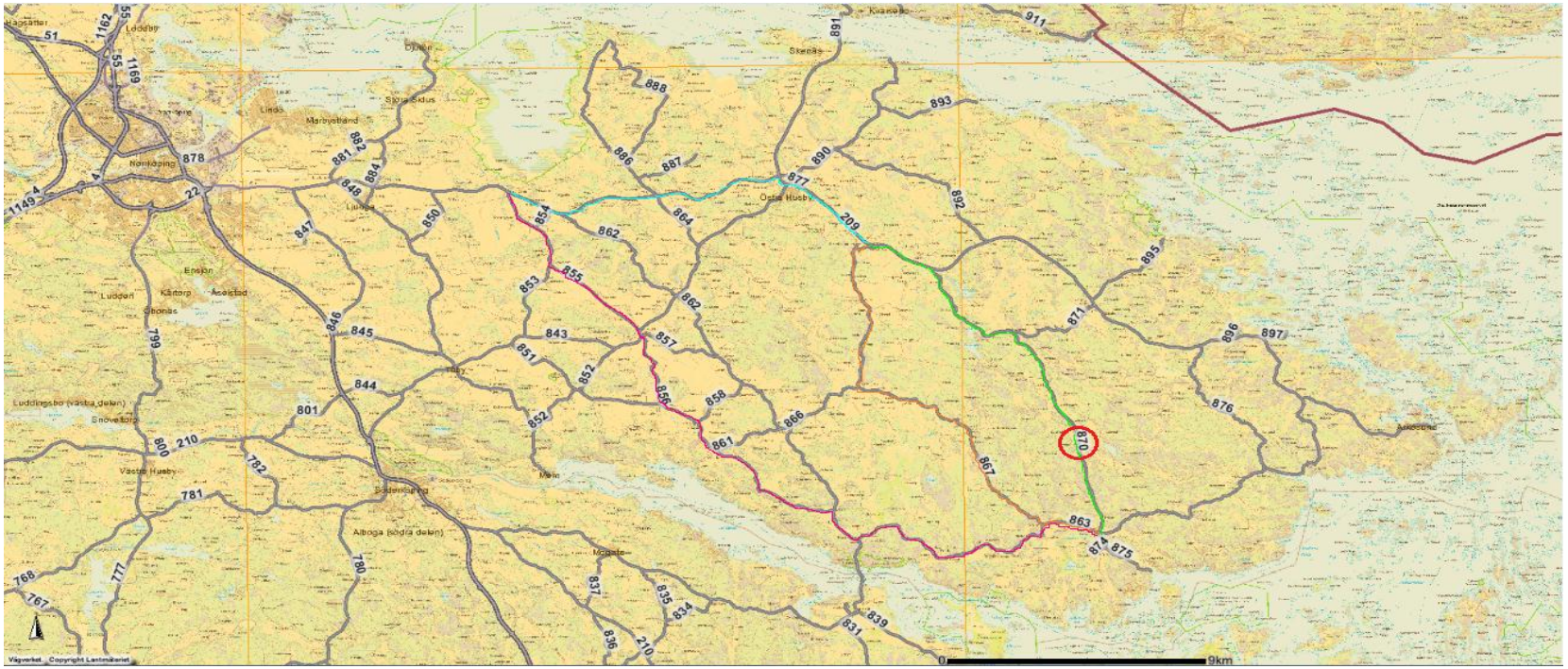
MEASURES


Sannolikhetsreducerande
Förebyggande (fysiska åtgärder)
Vid underhåll
Inom vägområde
I omgivning
Separat åtgärd
Inom vägområde
I omgivning
Beredskap
Åtgärder
Konsekvensminskande
Avhjälpande
Beredskap
Förebyggande
Snabb återställning
Alternativ väg
Transportoberoende

Measures & assets

	Reducing likelihood	Reducing consequences	Reducing consequences
Measures	Physical measures and preparedness for reducing likelihood for disasters	Measures making recovery of road functionality faster or improving alternative routes	Measures reducing risk for serious injuries, damaged goods or vehicles
Examples	Bars protecting road culverts, preparedness to clear culverts	Plan for repairing a road, a new shorter alternative road in case of road closure	Traffic warden
Benefit depend on damage to assets	Property, person, finance, environment and immaterial,	Finance	Person and property(only damage goods and vehicles)

Case Holma mosse in Östergötland



- Before the road was raised 2010 it was flooded 1-4 times per year – duration between 1-2 weeks.
- Cause: Large amount of precipitation + boggy terrain
- Alternative routes in the figure

Case Holma mosse in Östergötland

Cost for the flooding: cost for the road being closed (Asset = Finance)

Alternative measures (different costs and risk reductions):

I. Raise the worst part of the road (NNK = 1.55)

II. Raise a longer stretch of the road (NNK = -0.161)

III. Improve alternative route (Benefit negative)

Or allow the road to be flooded & let the traffic use an alternative route.

The Swedish Transport Administration has implemented the most cost efficient measure (I)

Conclusion

Lack of relevant data make all modeling difficult!

How does different factors effect which measures that are cost efficient for the different cases?

- A measure's cost efficiency is decided by its cost and which assets it prevents or reduces damage on. Factors = Assets.
- The most common and therefore most important: financial cost for a closed road (Finance) and the reconstruction cost for the road (Property).

Conclusion

- The flooding cases:
  - Only cost for closing the road – decides the benefit of implementing all types of measures
- Swept away roads:
  - person, property and finance (cost for the road being closed down). Measures reducing the likelihood of a disaster are dependent on all these assets while measures reducing the consequences of a disaster only are dependent on finance.

Conclusion

How is identified risks and measures' cost efficiency affected by a changed climate?

- roads flooded and swept away by water more common:
  - All types of measures more cost efficient
  - Measures which today aren't cost efficient might become necessary to reduce future risks.
- Existing climate models aren't exact enough to be able to predict how the likelihood is changed in different places and the risks in today's climate need also be known.

Conclusion

- Emission larger than A2-scenario + the Copenhagen Diagnosis' conclusions ⟶ disasters more probable than supposed in the reports cited in this thesis. Future damage costs are therefore large than the Swedish Road Administration anticipated. Thus measures are both more pressing and more cost efficient.
- Exact consequences of climate change unknown - new patterns for natural disasters? A need for new routines to prevent people being injured in disasters?

Questions & other considerations

- Measures promoting transport independency – costs and benefits? Many different stakeholders with decision making power. Good both for mitigation and adaptation.
- How share the cost and responsibility between different stakeholders when a disaster damage both the road transport system and the surroundings?
- Priorities cheap or expensive measures with same NNK?
- How estimate the immaterial damage? Cost larger if risk known before disaster happen?

Questions & other considerations

Needed:

- Structure data – in Sweden's case use Riskanalys Vald Vägsträcka in a consistent way – both in preventive work and after accidents have happened
- More case studies
- Update Klimat- & Sårbarhetsutredning, local climate models, better models for the indirect costs of closing down a road etc
- Develop the four steps principle – to include climate adaptation and risk management