

**”Risk
analysis –
chosen road
stretch”**

**WHAT IMPACT WILL CLIMATE
CHANGE HAVE ON ROADS
IN SWEDEN AND HOW TO
DEAL WITH IT?**

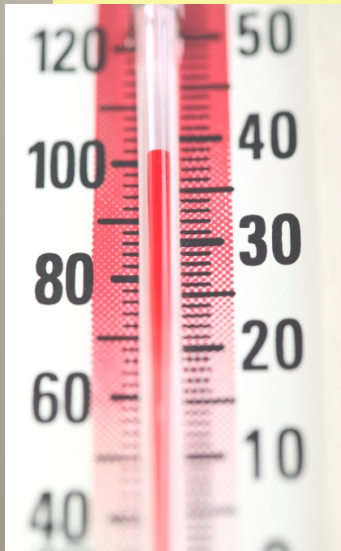
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TRAFIKVERKET

Climate conditions that influence the road system

Temperature



Rainfall



Floodings



Wind



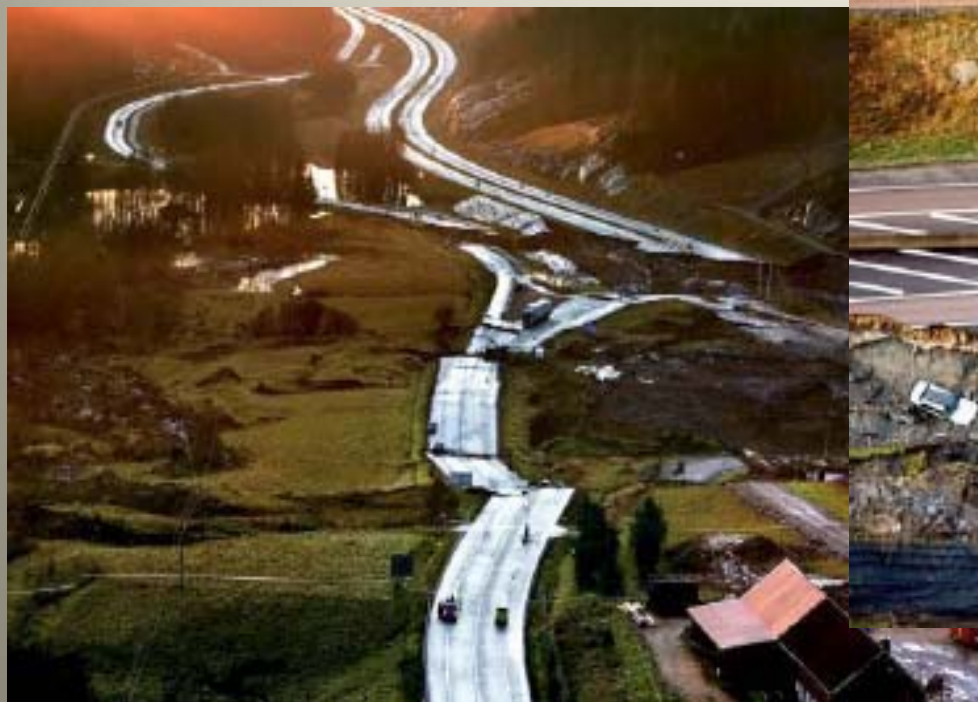
Winter



Sea level



Landslide safety, in the southwest parts of Sweden, will be too low already in a short time.



Road Maintenance and Operations

- Unchanged costs for winter maintenance totally
- More expensive in the north and less expensive in the south
- Removal of water by ditch or otherwise will be the most important issue

BRIDGES, STORM FLOODS

- Stemming at low bridges

Irrespective of the watercourse width

- Bridges over small watercourses

Intensive rainfall on small catchment areas

- Erosion damages on bridge support

Small watercourses with intensive flow during a short time



Landslide at Enafors, Jämtland, 2006

Existing constructions

- Areas with higher risk due to climate change should be specifically noticed at risk analysis.
- Take into consideration that smaller roads often have the highest risks depending on construction.
- Preventive measures are carried out when the risk level is not acceptable or when the measures are motivated on a national economy level.

Review of rules and regulations

- When constructing new roads the effects of climate change should be a part of the dimensioning.
- Risk based functionality specifications ought to be introduced for all components in the whole road network.
- Criteria for accepted risk levels ought to be decided.

Proposals in the long-term planning

- Improvement of competence
- Research and development
- Review of rules and regulations
- Risk analysis of existing constructions
- Studies of vulnerable areas pointed out

”Risk – analysis chosen road stretch”

The method handles the analysis of risk of varying character associated with:

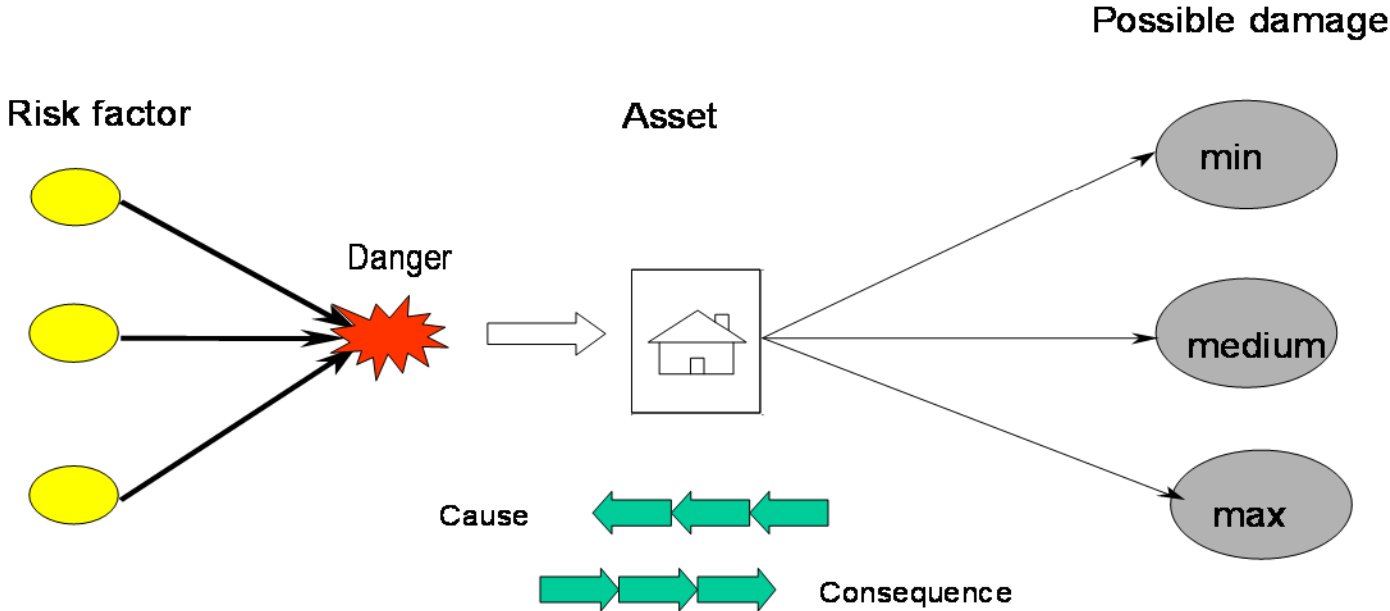
- Roads
- Bridges
- Constructions that concerns the surrounding areas

- Main concerns in the method are connected to:
 - Landslide and collapse risk
 - Risk for damage on road and bridges with high water flow
 - Risk of flooding
 - Risks due to accidents with dangerous goods

Risk Management

Steps	Including parts		
Risk identification	<ul style="list-style-type: none"> • Identification • Description 	Risk analysis	Risk management
Risk evaluation	<ul style="list-style-type: none"> • Crude Estimates • Ranking • Calculations • Strategies 		
Risk operation	<ul style="list-style-type: none"> • Decision • Execution • Follow-up • Evaluation 		

Risk process



Risk analysis

Terms and definitions in this method description follow the scenario model, which the Swedish Road Administration shall use. In the scenario model different **assets** are the starting point for the analysis and risk course described by:

- **Risk factors** (causes), something that can lead to danger
- **Dangers**, something that can lead **damage** to an **asset**
- **Consequence**, value of damage/loss

Asset type

- **Person**

 - damage within RTS: employees and road-users

 - damage to the surroundings: third-party

- **Property**

 - damage within RTS: road, bridge and tunnel constructions, vehicles, freight etc.

- **Property damage** (primarily damage to nature reserves, natural and cultural environments in the surroundings)

- **Finance** (in RTS this means access to a **transport possibility**)

 - damage within RTS: direct cost increase for travel time, vehicles, traffic accidents, emissions, operations and maintenance (general calculation with Effektsamband 2000)

 - damage to the surroundings: indirect cost increase for industry/society due to delayed and cancelled road transportation. Also included here are the public economy costs caused by disruptions/stoppage in other infrastructure (railway services, electricity, telecom, water supply etc.)

- **Intangible** (damage to reputation etc.)

Risk level

Increased risk with movements to the top-right corner

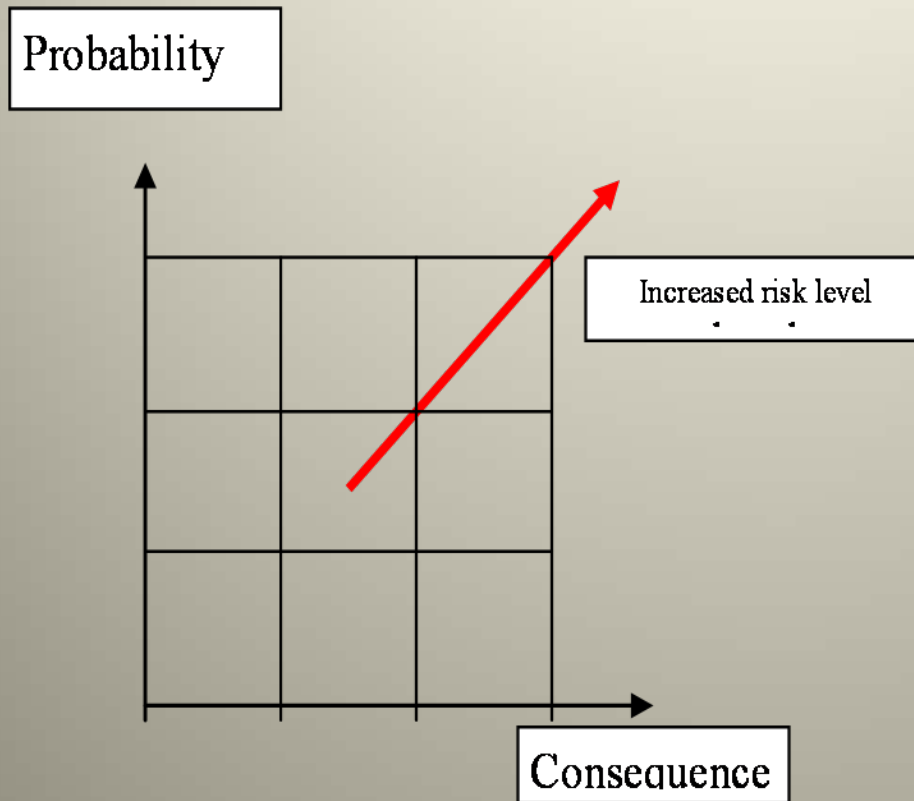
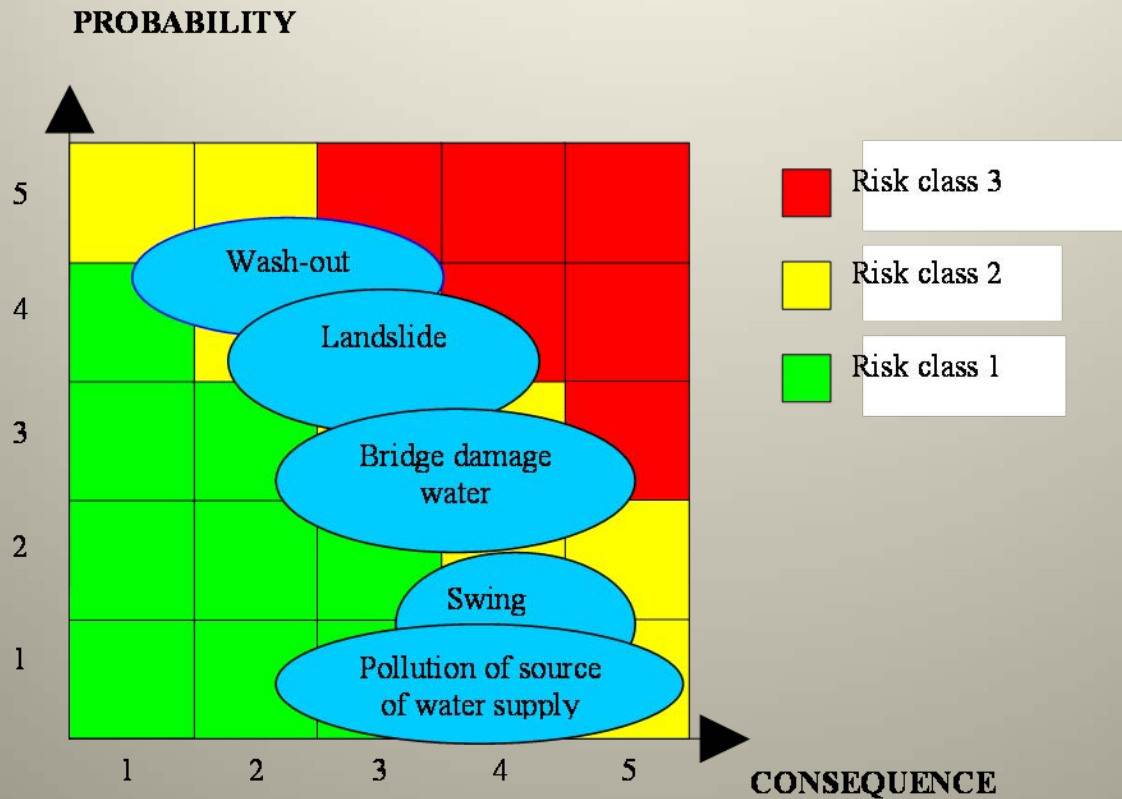


Diagram 3: Risk matrix

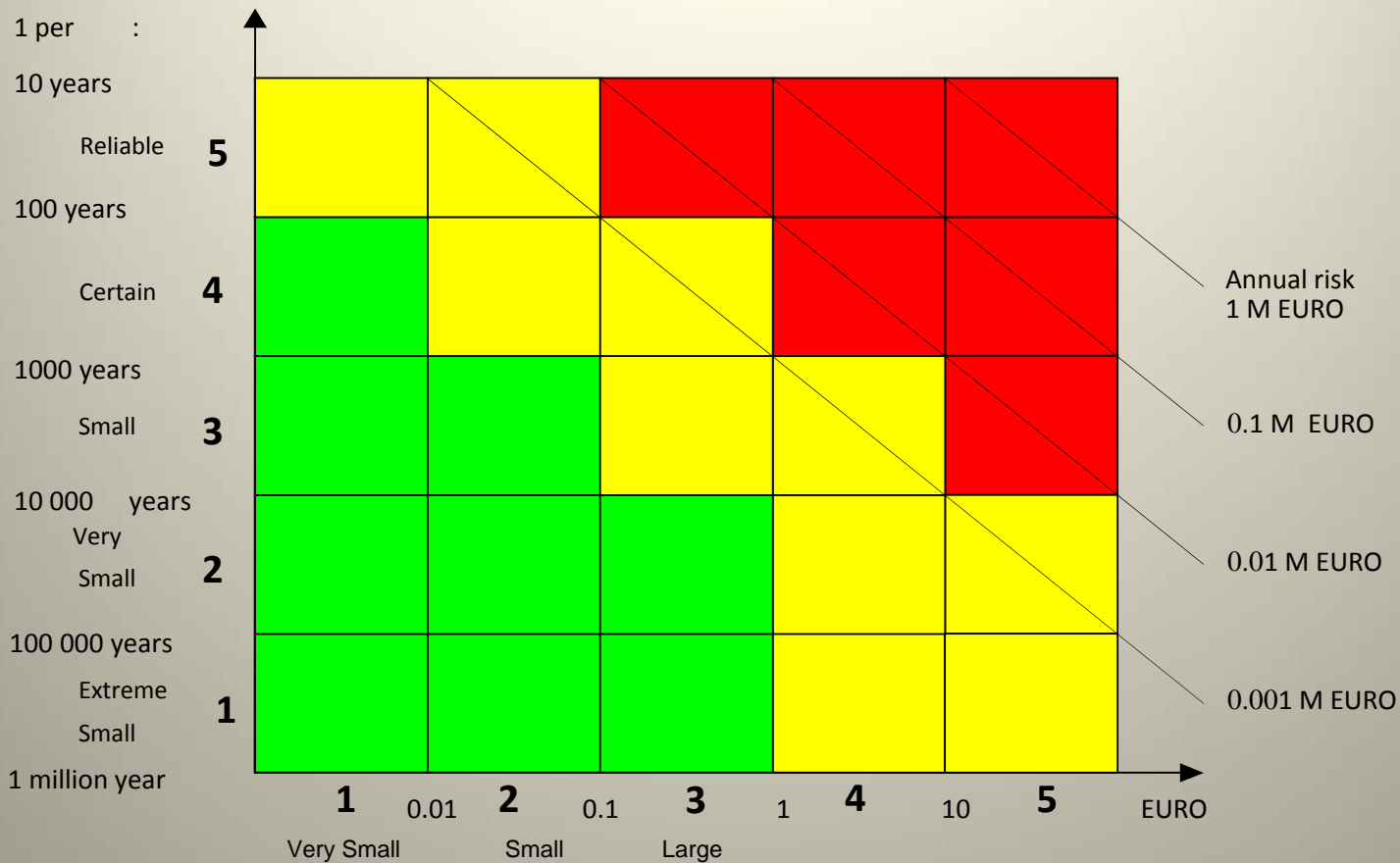
Probability of damage



Risk level/class

- The risk matrix is divided into stages in powers of 10 and that the stages are also defined with words so that the same matrix can be used both in rough estimates of quantitative and qualitative analyses
- Different consequence types (damage to different assets types) are described against a common scale
- Risk levels (risk class) are decided **from the product of probability and consequence**. An adaptation has been made here to the current praxis, i.e., a reluctance to accept the risks with serious consequences. This reluctance is especially comprehensive in personal injury risks and property damage risks

Probability



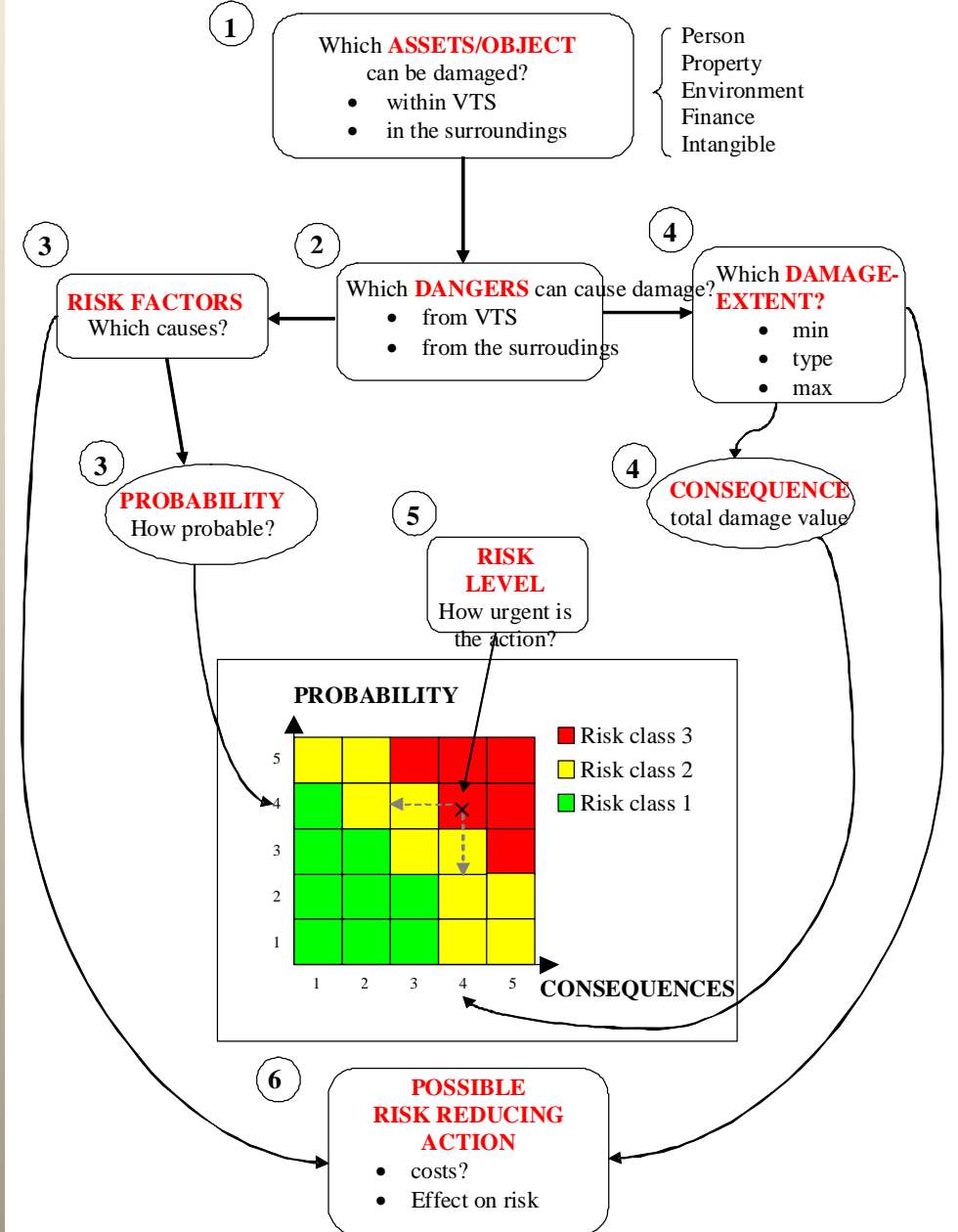
Risk classes in matrices:

- Class 3, high risk level, not accepted in general
- Class 2, medium risk level, safety action should be considered
- Class 1, low risk level, accepted in general

Quality control

The report shall contain

- Which road network had undergone an inventory and the aim of the risk analysis
- A compilation of the dominating risks in the table and in the risk matrix with suggestions for risk minimising measures including responsibility and priority
- A description of the identified dangers on a digital map with the possibility that each danger reports the comprehensive risk descriptions. It can also be justified to specifically report all objects that undergo an inventory and which are assessed to have a risk for damage
- Documentation of inspections in the field and other information (including the submitter of the information) that the risk analysis is built on
- A description of the uncertainties in the risk analysis with any proposals for supplementary investigation that may be required
- A list of the persons who conducted the inventory





Thank you for listening!