# Risk and Vulnerability Analysis of Critical Infrastructures - The DECRIS Approach


Ingrid Bouwer Utne,

SINTEF Technology and Society, Safety and Reliability/ NTNU

Other contributors:

P. Hokstad, SINTEF Technology and Society, Safety and Reliability (Project leader)

G. Kjølle, SINTEF Energy Research, Energy Systems

J. Vatn, SINTEF Technology and Society, Safety and Reliability/ NTNU

I. A. Tøndel, SINTEF ICT, Software engineering, Safety and Security

D. Bertelsen, SINTEF Technology and Society, Road and Transport Studies

H. Fridheim, Norwegian Defense Research Establishment

J. Røstum, SINTEF Building and Infrastructure, Water and Environment

INTRODUCTION

**Background**

Infrastructures

DECRIS approach

Case study

Detailed analyses

Conclusions and further work

- Risk and Vulnerability Analysis (RVA/ROS) was developed as an easy approach to risk modeling in small and medium sized enterprises and the public sector.
- In Norway, RVAs have been applied and adapted for each sector independently.
- The DECRIS project utilizes experience from risk analyses within different critical infrastructures.

Photo: Statens Vegvesen

INTRODUCTION

**Background**

Infrastructures

DECRIS approach

Case study

Detailed analyses

Conclusions and further work

- Main objective of DECRIS is to develop an all-hazard generic RVA methodology suitable for cross-sector infrastructure analysis.
- The objective of the paper is to describe the results of the preliminary risk analysis carried out in DECRIS in cooperation with the City of Oslo.
- The structure of this presentation:
  - Critical infrastructures involved.
  - Outline of the general RVA process in DECRIS.
  - Preliminary results from the risk analysis in Oslo.
  - Remaining work in the project.

- Definition of the term "critical infrastructures"?
  - "The underlying foundation or basic framework".
  - ICT, electric power systems, natural gas and oil, banking and finance, transportation, water supply systems, government services, and emergency services (Rinaldi et al., 2001).
- In DECRIS:
  - Electricity supply, water supply, transportation (road and rail) and ICT.

Photo: NTNU Info

1. Establish event taxonomy and risk dimensions
   a. DECRIS' event categories: Natural, Technical/ human (error/accident), Malicious acts.
   b. DECRIS' consequence categories: Life and health, Environment, Economy, Manageability, Political Trust, and Availability of delivery/supply of infrastructure.
   c. Calibrate risk matrices.
2. Perform a simple analysis:
   a. Identify all unwanted (hazardous) events.
   b. Assess the risks related to each unwanted event.
3. Select events for further detailed analyses.
4. Perform detailed analysis:
   a. Evaluate interactions, couplings, and vulnerabilities.
   b. Suggest risk and vulnerability reducing measures.

Introduction

DECRIS APPROACH

Process

**Challenges**

Case study

Detailed analyses

Conclusions and further work

- Complexity and interdependencies
- Unified approach across sectors
- Risk perception
- Lack of statistical data
- Development speed
- Access to the competence and information
- The distinction between *safety and security*
- Consequences may vary between the infrastructures. Common scale required
- Decisions regarding risk reducing efforts

Photo: Statens Vegvesen

- City of Oslo and representatives from the Emergency Preparedness Group.
- Time period: January 2008-December 2008.
- Meetings every 2 months.
- Discussions in plenum and group work within each infrastructure

Photo: Trondheim kommune

- Electricity power supply:
  - 14 undesired events analysed.
  - Some interdependencies between the infrastructures, the ICT and electricity system.
- Water supply:
  - Nine undesired events assessed.
  - Two events have dependencies to other infrastructures.
  - Several of the events have public communication challenges.
- Transportation (road/rail):
  - Malicious acts included within the 23 events.
  - Dependencies to other infrastructures, especially to ICT.

Introduction

DECRIS approach

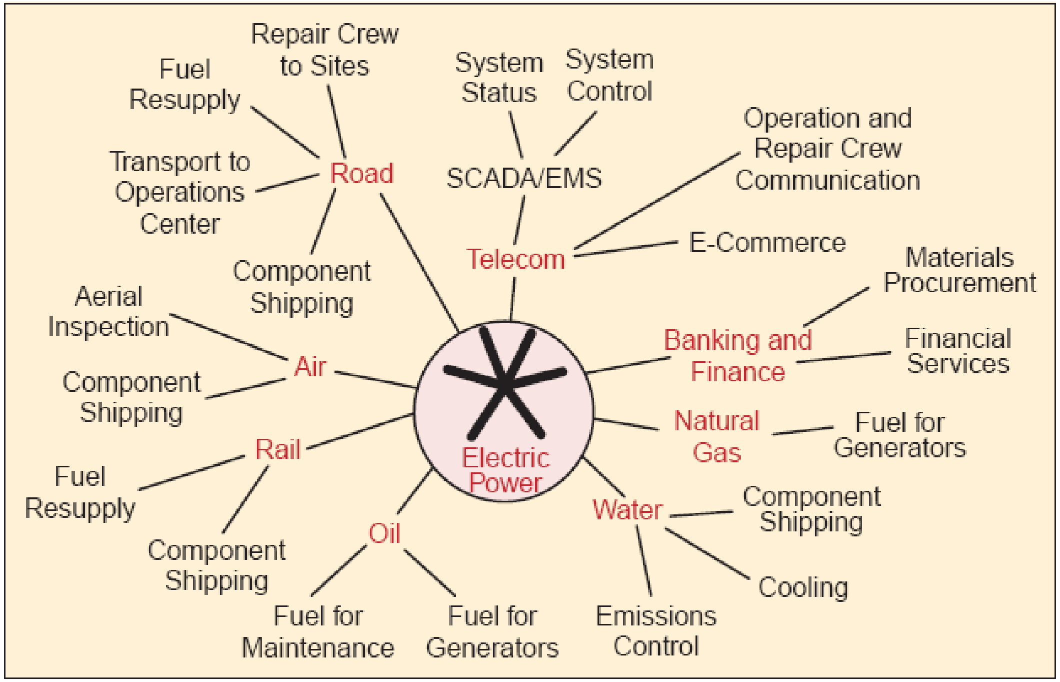
Case study

DETAILED ANALYSES

**Scenario 1**

Conclusions and further work

- Loss of electricity supply:
  - Sogn transformer station and regional grid to Grønland transformer station.
- Causes:
  - Causes can be technical failure, human failure, natural events, malicious acts and so on.

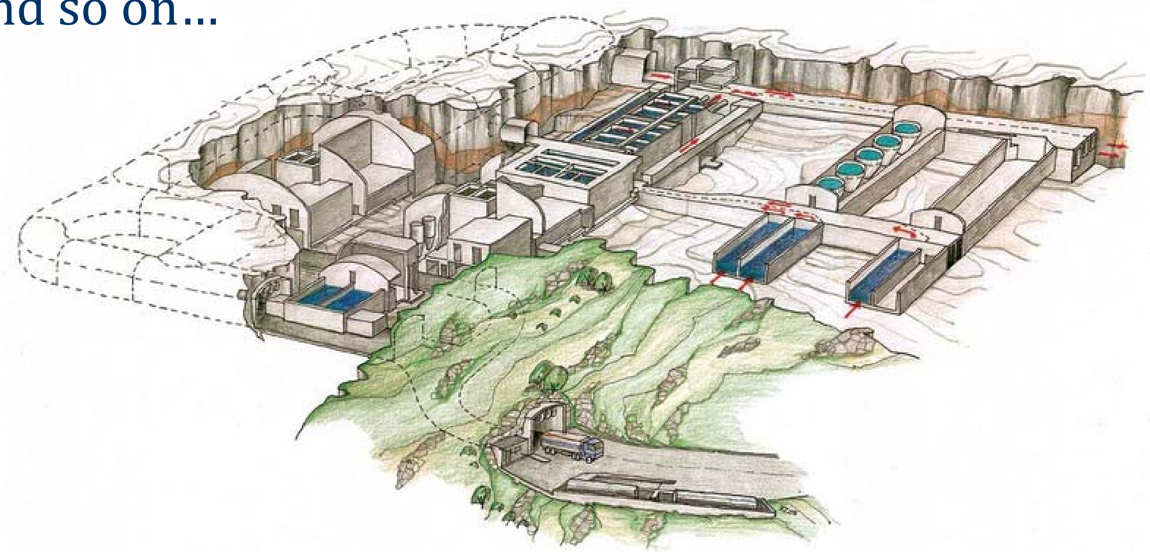



Rinaldi et al. (2001)

- Analyses of consequences for other infrastructures due to loss from Grønland transformer station:
  - Two scenarios: Loss in 4 and 24 hours.
  - Water: Pumping stations (no emergency supply)
  - Water: Vents, electrically controlled
  - Water treatment has emergency supply
  - Sewage and waste water: Pumping stations waste water (emergency supply on some ”critical” ones)
  - Subway: Driving electricity, no back-up, signal electricity, no pumps to pump out ground water, etc.

- Analyses of consequences for other infrastructures due to loss from Grønland transformer station:
  - Railway: Driving electricity
  - Tram: Driving electricity, creates traffic chaos, etc.
  - Roads and tunnels: Affects road and tunnel lights, ventilation - slower traffic?
  - Gas stations: Pumps will stop
  - Telenor's stationary net has emergency power
  - Cellular phone net may or may not have battery reserves
  - And so on…

- Loss of water supply, Oset/Ullevål:
  - Oset: 90 % of the supply to Oslo.
  - Skullerud and Langlia can only deliver 50% of normal consume.
- At Ullevål hospital water is used to:
  - Cool equipment
  - Food production
  - Sanitary facilities
  - And so on…



- Important issues:
  - No national guidelines on how to prioritize between end-users in situations with lack of water.
  - How to evaquate vulnerable end-users in situations with lack of water?
  - These issues are relevant for many parts of Norway, and also in Sweden.
  - Who will pay for improvements of facilities for the hospital, such as a separate UV facility, separate elevated reservoir etc.?

Photo: Oslo kommune

Introduction

DECRIS approach

Case study

DETAILED ANALYSES

**Scenario 3**

Conclusions and further work

- Sjursøya:
  - Which events may create problems regarding deliveries of oil from Sjursøy, especially for aviation at Gardermoen and the cruise ships?
  - What is the probability of such events to occur?
  - What alternatives exist and what are costs and benefits of reduced risk of such solutions?

- Some important aspects regarding the oil store facility in the mountain underneath Ekebergåsen:
  - Oil is not mixed with water.
  - The reservoirs are always full, no damp can ignite or be displaced.
  - Permanent overpressure prevents the oil from leaking into mountain cracks.

- Common lines of transmission :
  - Examples are cables in culverts and bridges
  - Redundancy- are back-up cables in the same culvert?
  - The event at Oslo S last year used as a starting point for consequence analysis.
  - Main consequences for railway and ICT. Other consequences?

Photo: Flytoget

# CONCLUSIONS AND FURTHER WORK

- The case study and the forum with representatives from different infrastructures facilitate analyses of consequences across sectors.
- Knowledge of the systems and their functional capacity in a normal use situation has been attained.
- An analysis often requires information about the systems' maximum capacity and response to changes caused by undesired events. Use of network models will enhance the DECRIS' analysis process.
- DECRIS to be completed by June 2009. Focus on the detailed analyses of the four selected events.

- Acknowledgments:
  - DECRIS is a project included in the SAMRISK research programme, funded by the Norwegian Research Council.
  - Oslo municipality and the Emergency Preparedness Group (In Norwegian: Beredskapsgruppa), especially the Emergency Planning Agency (In Norwegian: Beredskapsetaten) for their engagement in the case study.

- Questions ?