For discussing DSB guidelines regarding climate adaptation and guideline community emergency responsibility, and applying ROS assessment tools. 14.01.2010

# A ROS Assessment Tool for Adapting Community Urban Flood Risk and Vulnerability caused by Climate Change


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* Result of AdaptCRVA.



# Outline of the presentation

- Aim of AdaptCRVA
- Approach of risk assessment and management analysis
- A case study in Trondheim
- Conclusions and perspectives for future development
- Questions and recommendations for discussion regarding a risk assessment tool for community ROS analysis (floods and other natural hazards)

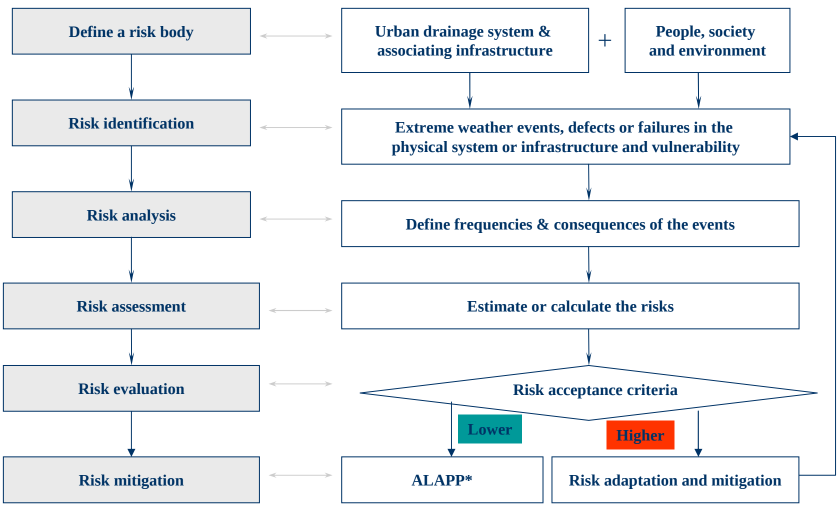
# Aim of the AdaptCRVA

- Develop methodology and a software tool to assess risk and vulnerability of urban flooding and pollution problems based on the foreseen risk and vulnerability scenarios (cc.+ other events)
- Adapting InfraRisk[1] to FloodRisk[2]

1. Vatn J. (2007). Description of tool for Identification and Estimation of Risk-related Critical Infrastructure (InfraRisk). Department of Production and Quality Engineering, Norwegian University of Science and Technology.
2. Nie,L.M., Heilemann, K. et al.(2009). Adapting Community to Flood Risk and Vulnerability caused by Climate Change. The proceedings of the COST C22 and UNESCO of "Road Map Towards a Flood Resilient Urban Environment", Paris, 26/27.11.2009.



# Structure of flood risk management




*ALAPP: As Lower As Practically Possible

# Risk identification

- Main events
  1. Meteorological extreme events
  2. Technical failures in the physical systems
  3. Accidents
- Social Manageability and Critical Infrastructure Functions (SCFs)
  **Functions of the infrastructure (such as electric power, telecommunication and transportation system, water drainage system or flood forecasting system), community manageability and individuals**
- Vulnerability Influence Factors (VIFs)
  **Dimension of the area, geographical location, population density, climate type, time and duration of occurrence of the events, dependency and relation with social critical functions and preparedness to cope with emergency**



# Frequency of main events

- Extreme weather events,
  Frequency is usually expressed in terms of return periods, e.g. 1 in n years or n times per year.
- Technical failure,
  Assume or give expected number of failure occurrence per year, e.g. twice per year of pumping station our of work.
- We used the same frequency for different risk events.

**Table 2.** Frequency of urban flooding

| **Likelihood** | **Return period (1 in n in years )** |
|---|---|
| Rare | Rarer than 1 in 1000 years |
| Unlikely | Rarer than 1 in 200 years |
| Occasional | Once in 100 years |
| Likely | Once per 10-50(20) years |
| Almost certain | Once or several times per year |

*Table 2 integrates the frequencies for designing sewers and flood protection for rivers.
* DSB Guideline uses frequency of 10 and 50 year. P9.

## Weighting the relation of SCFs and main events

| Code | Description | Relation |
|---|---|---|
| I100* | Loss of the SCF is the cause for the main event | SCF < before> the main event |
| B100* | The SCF acts as a complete barrier | |
| R90* | The SCF is very important for the main event | SCF <before and after> the main event |
| R60 | The SCF is important for the main event | |
| R40 | The SCF is medium import for the main event | |
| R15 | The SCF is not very important for the main event | |
| R05 | The SCF is less important for the main event | |
| V90* | The SCF is very vulnerable with respect to the main event | SCF < affected> by the main event |
| V60 | The SCF is vulnerable with respect to the main event | |
| V40 | The SCF is medium vulnerable with respect to the main event | |
| V15 | The SCF is not very vulnerable with respect to the main event | |
| V05 | The SCF is less vulnerable with respect to the main event | |

* I, B, R and V represent the relation between the SCFs and the main events, I – initial (cause) to the main event; B – barrier; R – relation of SCF to main event; V – vulnerable degree of the SCFs versus the main events.



## Frequency calculation of TOP event

For a TOP (joint) event that frequency of occurrence is a combined result of several other basic events, frequency is calculated according to the logic relations of the events:

- AndGate: Two of both
- OrGate: More than one of two or more
- KooNGate: K occurrences in N events

(Vatn, 2007)

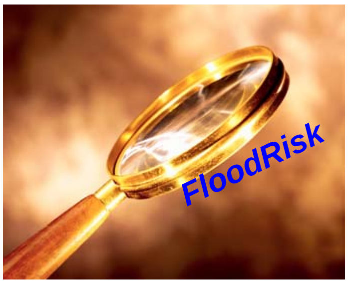
# Type of consequences

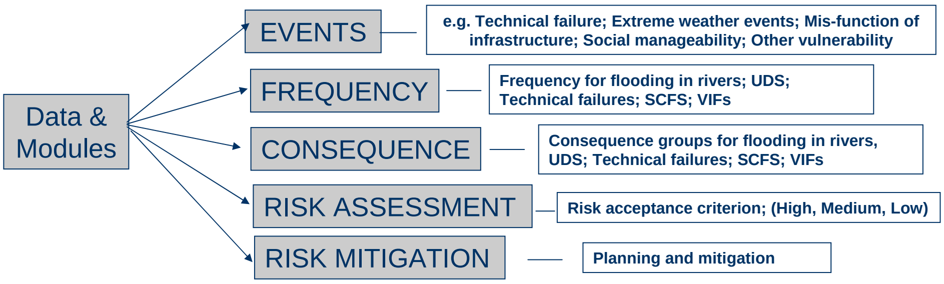
| Likelihood | People | Economic damage (e.g. affected basements) | Community and infrastructures | Environment |
|---|---|---|---|---|
| Insignificant | No person is affected. | Minor damage in basements or other places | Limited or no impact on daily community activity. | No pollution to environment |
| minor | People are getting affected. | Up to 50 house basements are flooded. | Impacts are visible and some economic damage. | Some pollution to receiving waters |
| moderate | Up to 1 house evacuated. | Up to 100 house basements are flooded. | Significant impacts on community activities. | Increased pollution to receiving waters or in house basements. |
| Major | 1 - 2 persons was drawn due to flood. | Over 100 house basements are seriously flooded. | Serious impacts on community activities and infrastructure. | Serious pollution in flooding houses or basements, receiving waters and on surface. |
| Catastrophic | Over 10 persons are drawn to dead, and a group of local people are evacuated. | Over 500 house basements are flooded. | Serious and long time impacts on community activities and infrastructure. | Very serious and long period pollution and impacts to diverse environment. |

*Economic damage is interesting and accepted globally.



# FloodRisk – a risk assessment tool



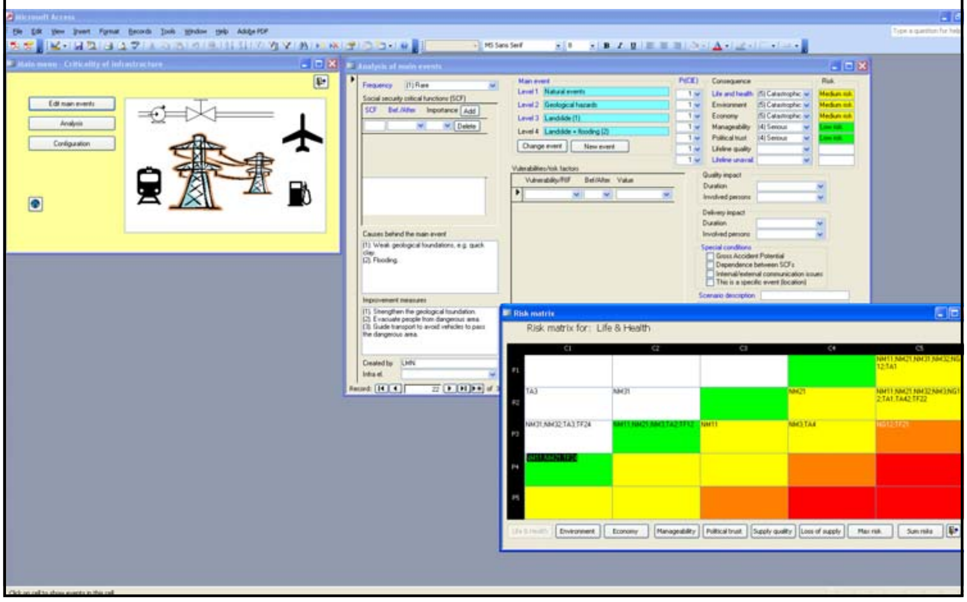



# Case study – Trondheim, Norway

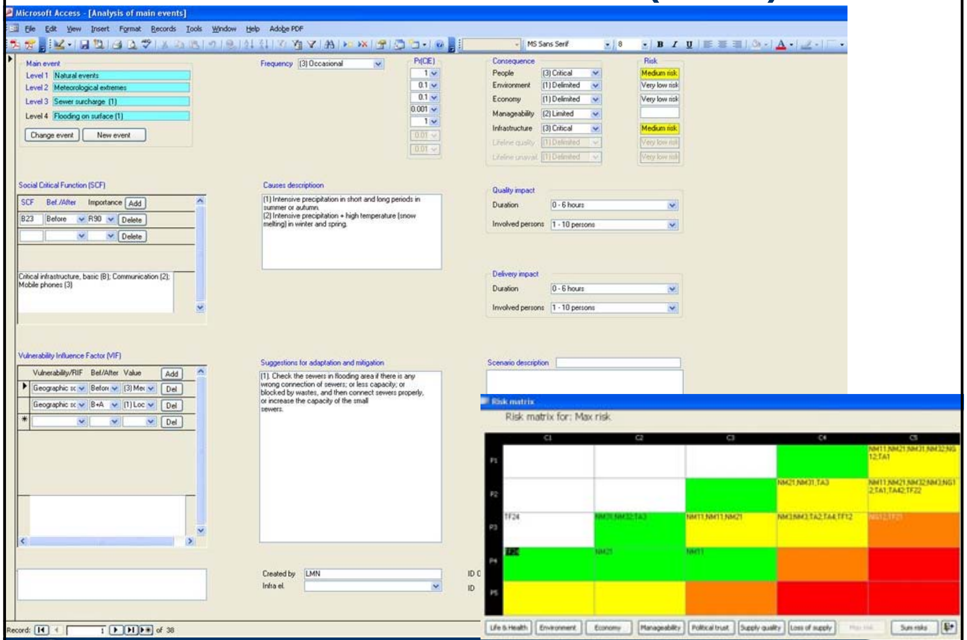

Flood risk: River Nidelva; affecting from the sea; urban drainage systems



# From InfraRisk to FloodRisk – a risk assessment tool (vers.1)



# FloodRisk – a risk assessment tool (vers.2)





# Ideas for future development

**Risk assessment**

| | | |
|---|---|---|
| **Edit main events** | **Edit frequency** | **Edit consequence** |
| L1 zzzzzzzzz | L1 Frequency G1 | L1 Consequence G1 |
| L2 yyyyyyyyy | Li Frequency Gi | Li Consequence Gi |
| L3 xxxxxxxxxx | | L3 Life and health — Level |
| L4 cccccccccc | **Edit probability** | L4 Economic damage — Level |
| Add Delete | L1 Probability G1 | L5 Environment — Level |
| | Li Probability Gi | L6 Indrastrcture — Level |
| | | L7 Societal manageability — Level |
| | | L8 Political trust — Level |

**Ranking of risk**

Sum of risks: Level, Level, Level, Level, Level, Level, Level

| | | |
|---|---|---|
| **Social manageability**<br>Add Delete<br>Event i | **Measure of SCFs**<br>Add Delete<br>Time Functions | **Scenarios descriptions** |
| **Vulnerability**<br>Add Delete<br>Indicator i | **Measure of VIFs**<br>Add Delete<br>Time Functions | **Recording of events**<br>*Refer InfraRisk* |
| **Barriers**<br>Add Delete<br>Measure | **Measure of Barriers**<br>Add Delete<br>Time Function | **Tool bars** |

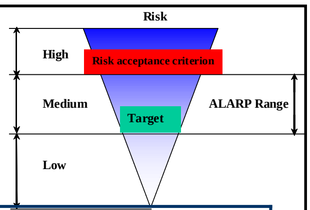
# Prepare input data

- Data and coding for main events, SCFs and VIFs

| Main events | | | | Code | | | |
|---|---|---|---|---|---|---|---|
| **L1. Event domain** | **L2. Event domain** | **L3. Event (cause)** | **L4. Scenario of events** | **L1** | **L2** | **L3** | **L4** |
| Natural events | Meteorological extremes | Flooding and sewer surcharge (1) | Flooding on surface (1) | N | NM | NM1 | NM11 |
| | | | Flooding or rainwater in house basements (2) | N | NM | NM1 | NM12 |
| | | | Combined Sewer Overflow (CSO) (3) | N | NM | NM1 | NM13 |
| | | Sea level rise + storm surge (2) | Storm surge in the sea (1) | N | NM | NM2 | NM21 |
| | | | Flooding in lower areas near the sea or fjord (2) | N | NM | NM2 | NM22 |
| | | | Flooding inundation on streets and in buildings (basements) (3) | N | NM | NM2 | NM23 |
| | | | Overflow from sea to sewers (4) | N | NM | NM2 | NM24 |
| | | | Combined Sewer Overflow (CSO) from sewer systems to receiving waters (5) | N | NM | NM2 | NM25 |
| | | River flooding (3) | Flooding in river flood plains (1) | N | NM | NM3 | NM31 |
| | | | Flooding on river sides/banks (2) | N | NM | NM3 | NM32 |
| | Geological hazards | Landslide (1) | Landslide (1) | N | NG | NG1 | NG11 |
| | | | Landslide + flooding (2) | N | NG | NG1 | NG12 |
| Technical problems | | | m (1) | T | TA | TA1 | TA11 |
| | | | | T | TA | TA2 | TA21 |
| | | | 2) | T | TA | TA2 | TA22 |
| | | | | T | TA | TA3 | TA31 |
| | | | 2) | T | TA | TA3 | TA32 |
| | | | | T | TA | TA4 | TA41 |
| | | | | T | TA | TA4 | TA42 |
| | | | | T | TF | TF1 | TF11 |
| | | | | T | TF | TF1 | TF12 |
| | | | er equipments out of | T | TF | TF2 | TF21 |
| | | | her equipments out | T | TF | TF2 | TF22 |

| Frequency or Probability ↓ / Consequences → | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| P1 | Very lower | Very lower | Very lower | Low | Medium |
| P2 | Very lower | Very lower | Low | Medium | Medium |
| P3 | Very lower | Low | Medium | Medium | High |
| P4 | Low | Medium | Medium | High | Very high |
| P5 | Medium | Medium | High | Very high | Very high |

# Ranking of risks and adaptation priority




| Ranking risks | Adaptation and mitigation | Event scenarios (for Trondheim case study) |
|---|---|---|
| Very high | Immediate action needed to protect its occurrence | No |
| High | Have buffer time for analysis and discussion | NG12 (flooding plus landslide); TF21 (basement flooding and CSOs) |
| Medium | Usually do not need immediate actions, maybe some analyses for long term planning and design for adaptation and mitigation | NM11; NM21; NM31;NM32;TA4; NG12;TA1;TA42;TF22 |
| Low | Usually do not need any measures for adaptation and mitigation, but reduce the risk level to ALAP by service maintenance. | NM11; NM21; TF24;TA2:TF12 |
| Very Low | No need for adaptation | TA3; NM31; NM32; TA3; TF24 |

# Conclusions and perspectives

**The current development** :

- It is possible to include climate variables in ROS analysis
- The overall flood risk can be assessed by the software tool, and provide visual risks in a risk matrix with different concern and levels.
- Easy to learn
- Time consuming in preparing the input data (main events, SCFs, VIFs, and coding)

**Need for further development/ Improvement**

- Decide properly the frequency or probability of different basic events and calculate the frequency of joint events;

  with regard to climate change, we need change in frequency of (P;T; Sea level; Q, etc.)
- Evaluate properly of consequences (tangible & intangible)
- Assess the risk quantitatively, if possible
- To be improved for general use (interface, database, access to update)



# Questions and recommendations

**of a risk assessment tool for community ROS analysis**

- Simple and user friendly, basic training
- Time-consuming of identifying events, SCFs, VIFs; deciding frequency, consequences, mitigation measures etc, better to establish a national database for different natural hazards or accidents (e.g. water disease outbreaks); or use as appendices in the guideline.
- Assessment the economic damage (Municipalities + FHN)
- The data base (appendices) should be updated, e.g. every 2nd year
- Risk acceptance criterion/a
- Update the guideline in good time, DSB 1994 – 2010

*Thank you very much for your attention*