

# **A process to assess infrastructure related risks due to natural hazards with stress tests – Part 1**

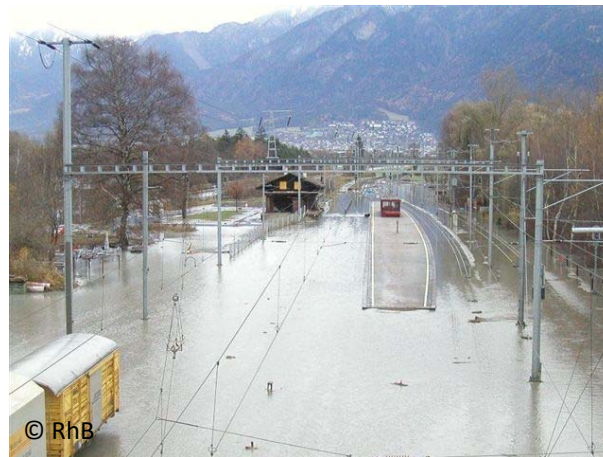
**Infrarisk Consortium**

**ETHZ – Bryan T. Adey, Jürgen Hackl, Juan Carlos Lam and**

**Magnus Heitzler**

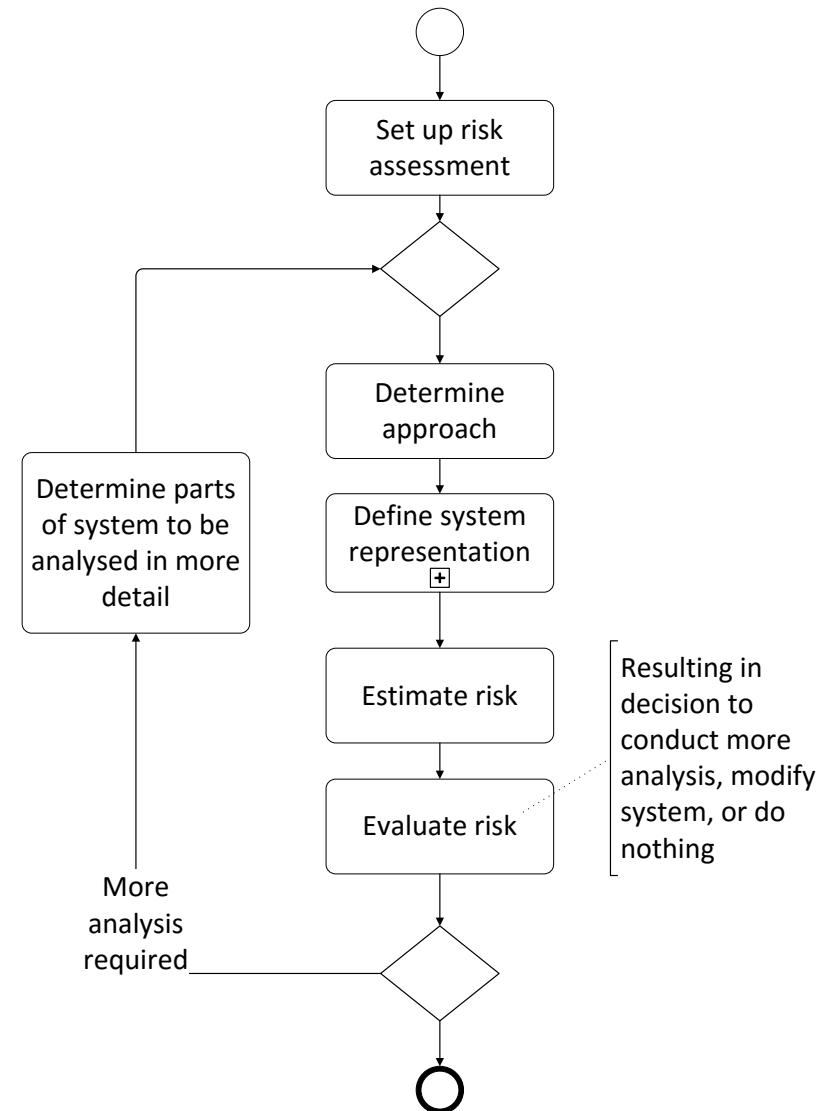
**PSCT – Pieter van Gelder, Noel van Erp**

# Problem

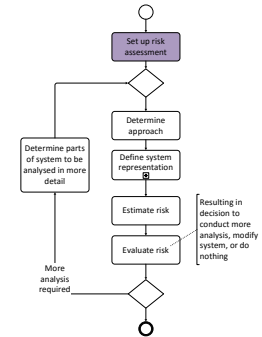


# Process

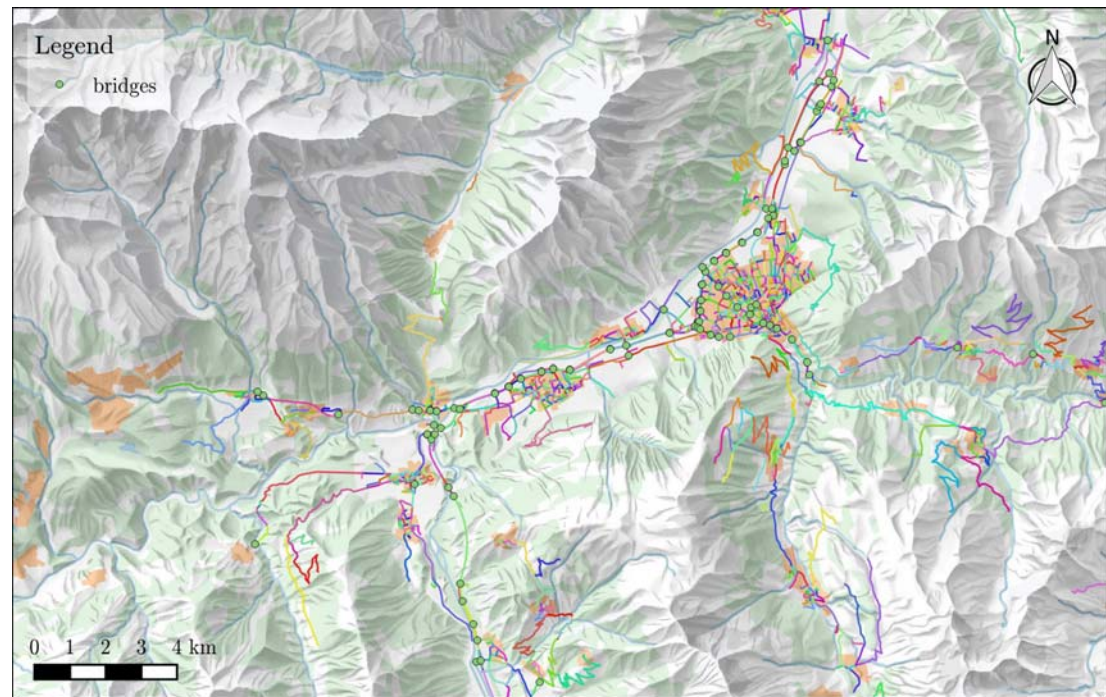
- A process to assess infrastructure related risks due to natural hazards was developed
- For use in a wide range of situations, e.g variations in
  - The types of infrastructure to be included in the assessment,
  - The types of hazards to be included in the assessment,
  - The expertise available,
  - The time available,
  - The need for detailed information, and
  - The computer support available.
- It encourages only obtaining as much information as required.



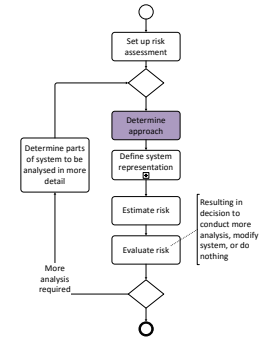
# Set up risk assessment



- determine what needs to be checked
- define acceptable levels of risk,
- affects the definition of the system representation, and the requirements to conduct the risk assessment



# Determine approach



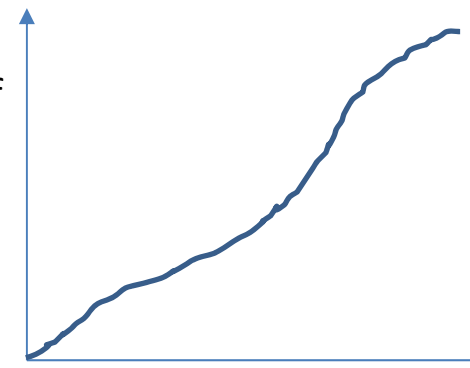
- determine how risk assessment will be conducted
- decide how to aggregate multiple risks

qualitative

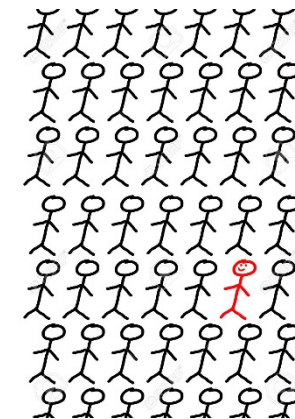
semi-quantitative

quantitative

Amount of computer support



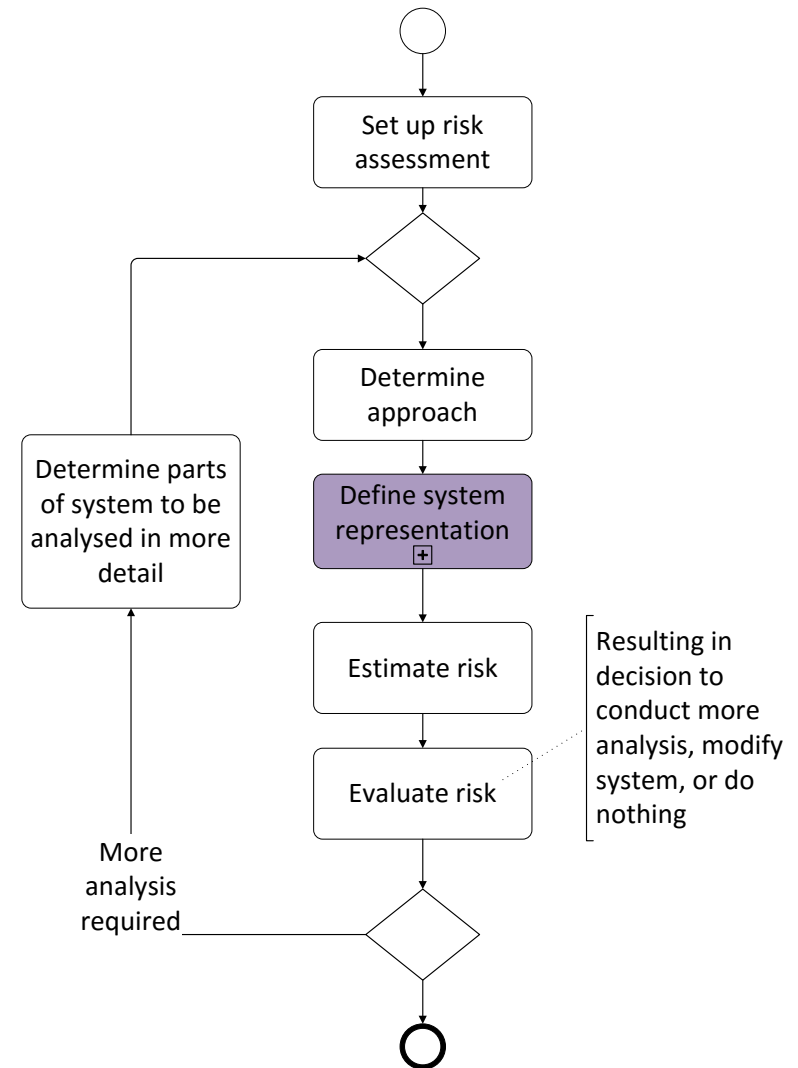
Level of risk assessment



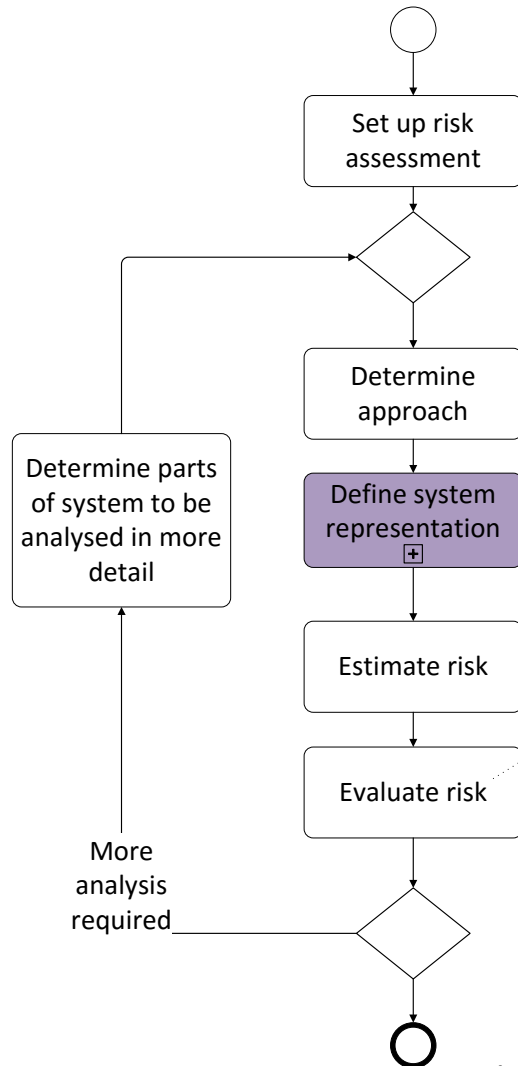
Stakeholders

# Define system representation

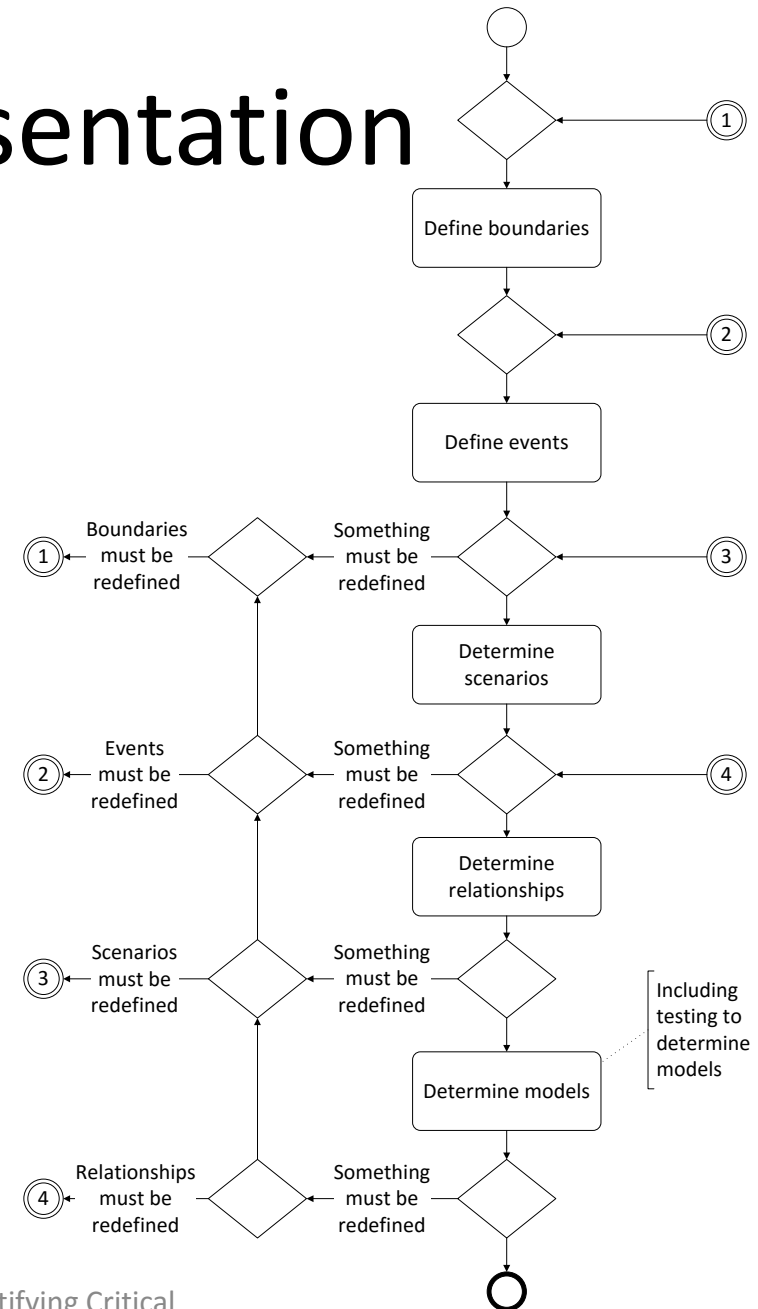
- determining how the system will be modelled both spatially and temporally
- the system includes
  - the natural environment, e.g. amount of rain, amount of water in rivers,
  - the physical infrastructure, e.g. the behaviour of a bridge when subjected to high water levels, and
  - human behaviour, e.g. traffic patterns when a road bridge is no longer functioning.
- The model includes correlations between events and cascading events



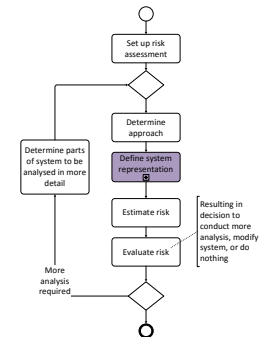
# Define system representation



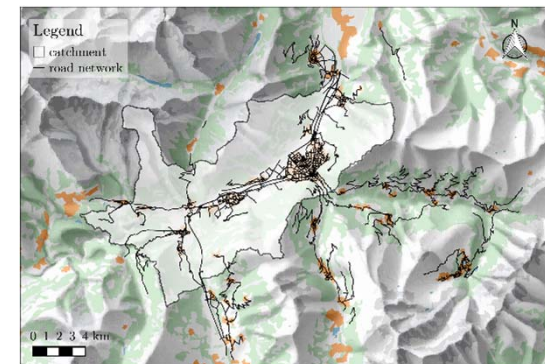
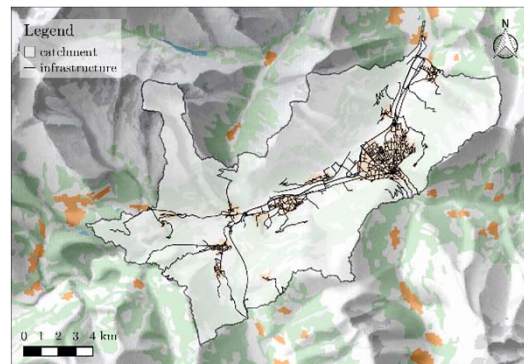
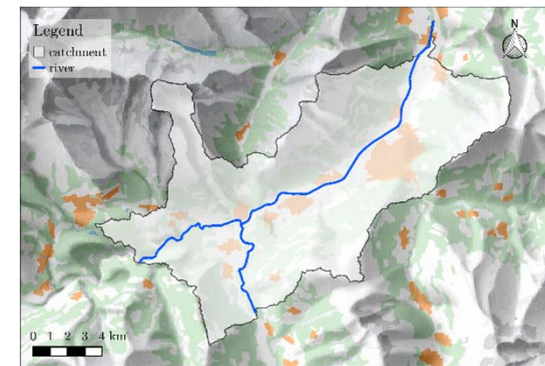
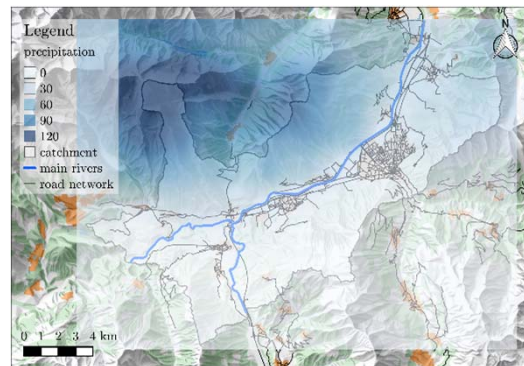
Resulting in decision to conduct more analysis, modify system, or do nothing



# Define boundaries

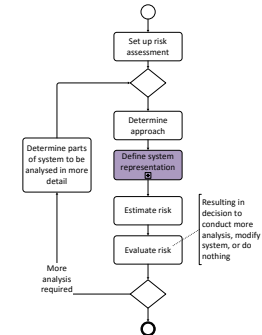


- define spatial boundaries
- define temporal boundaries
- they are different depending on the part of the system being analysed.



# Define events

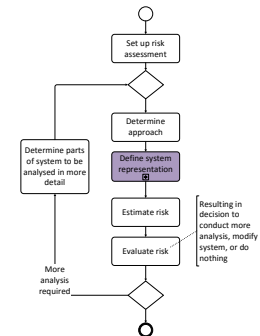
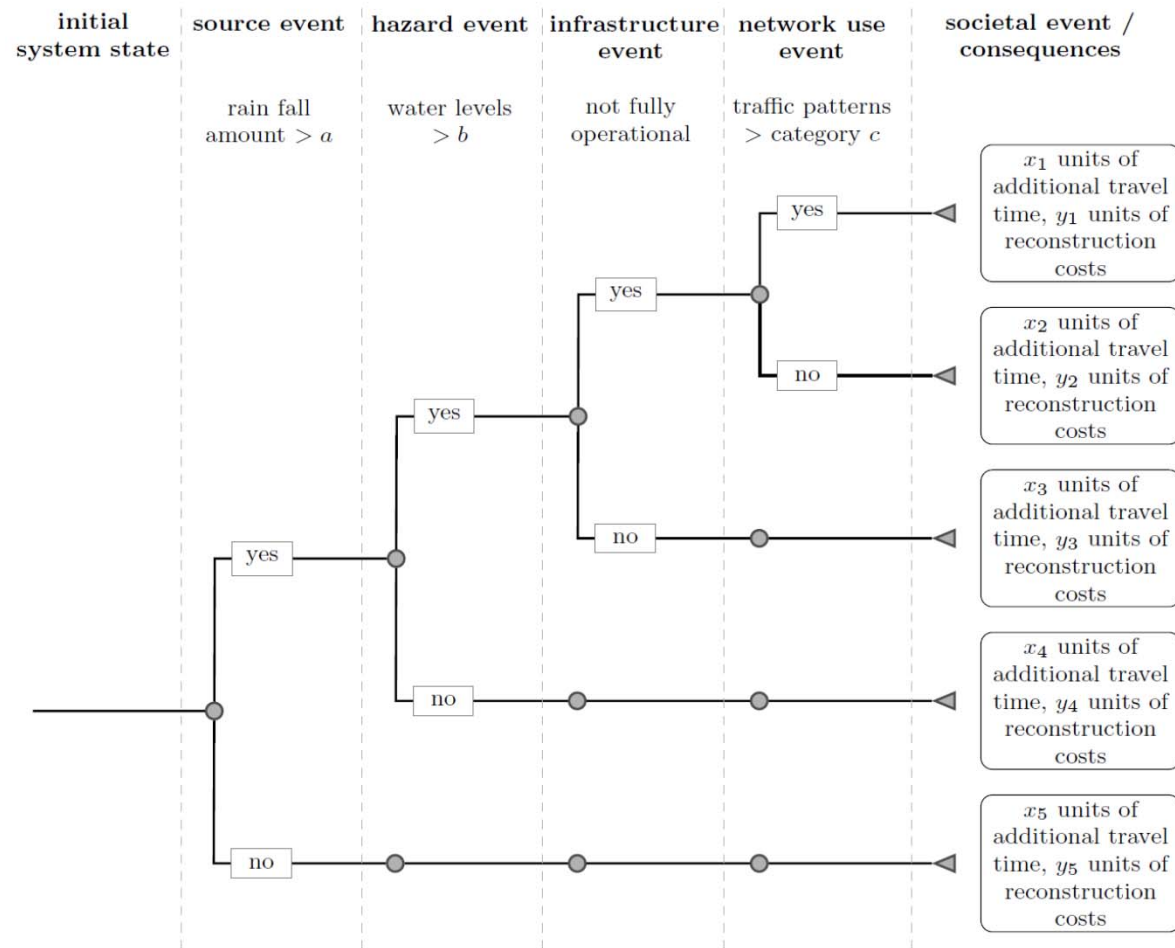
- identify all events (cascading and non-cascading) to be analysed / modelled.



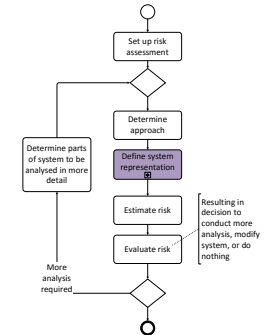
Event type	Examples of event and intensity measures
Source	For a rainfall source event, rainfall of pattern x with water per minute of over y mm <sup>2</sup> /s for more than 5 hours.
Hazard	For a flood hazard event, water levels reaching x m depth in locations a, b and c, and amounts of water per second coming in contact with bridge i over j m <sup>3</sup> /s.
Infra-structure	For a bridge collapse, damage resulting in full closure of the road, damage results in the closure of one lane of traffic, damage resulting in no closure of the road.
Network use	For example, due the freight corridor between Rotterdam and Genoa being closed 50% of goods is put onto trucks, 40% of goods is diverted over other train routes and 10% is not delivered.
Societal	Amounts an infrastructure manager spends on reconstruction amounts users spend in additional travel time

# Define scenarios

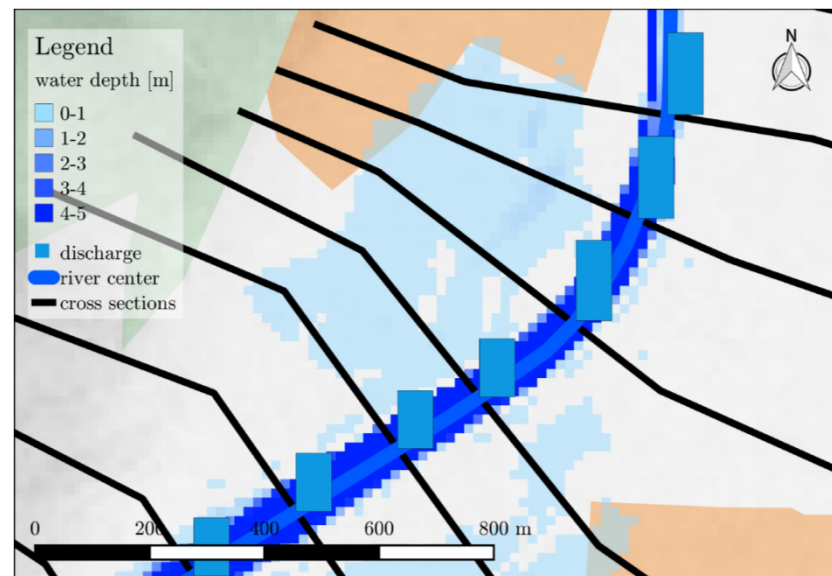
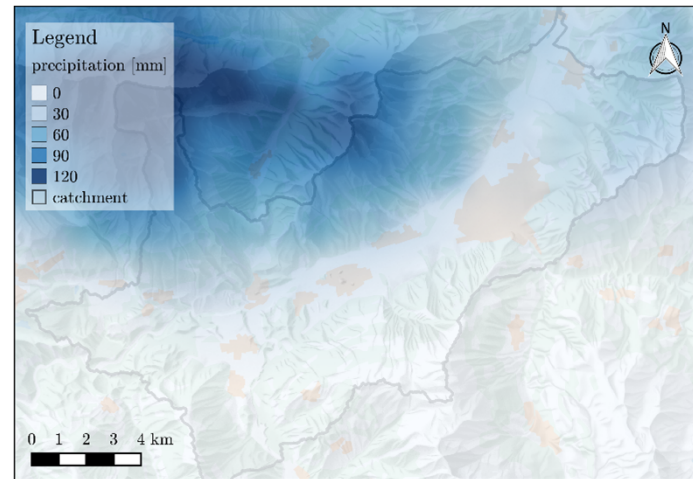
- link events together from the source to the societal events.
- determine the value of the intensity measures to provide clarity on how events are considered to be related
- do not estimate their probability of occurrence or put a value on the consequences



# Define relationships

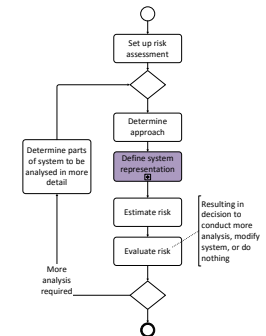
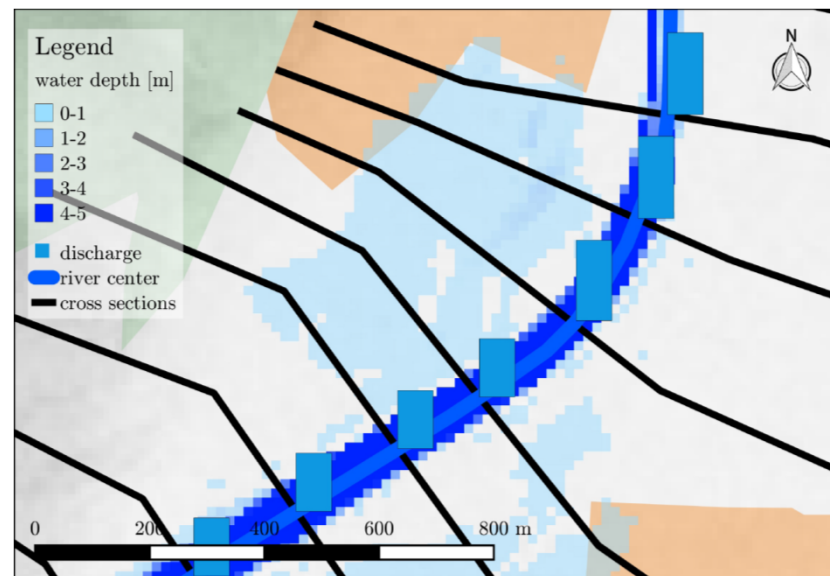
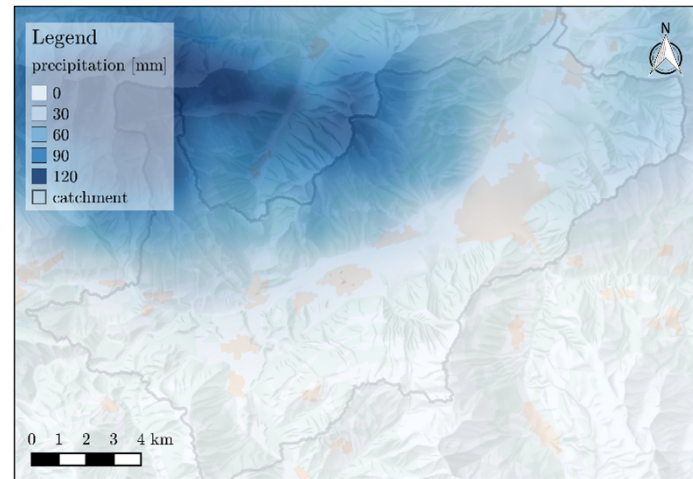
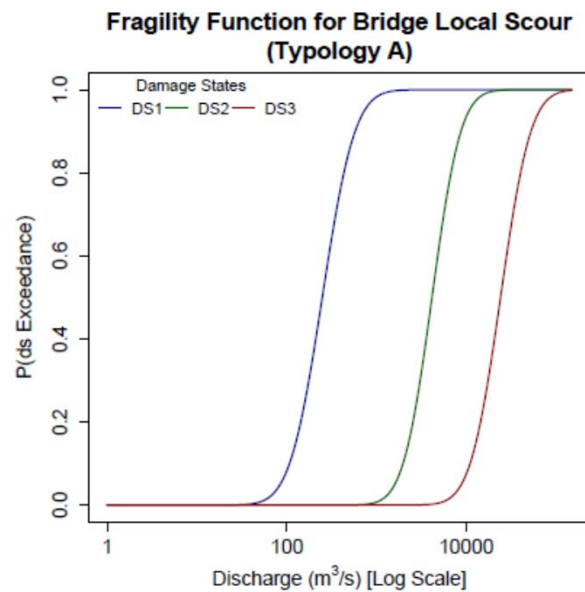


- Determine the relationships between the events
- involve testing to ensure that the relationships between events are defined correctly

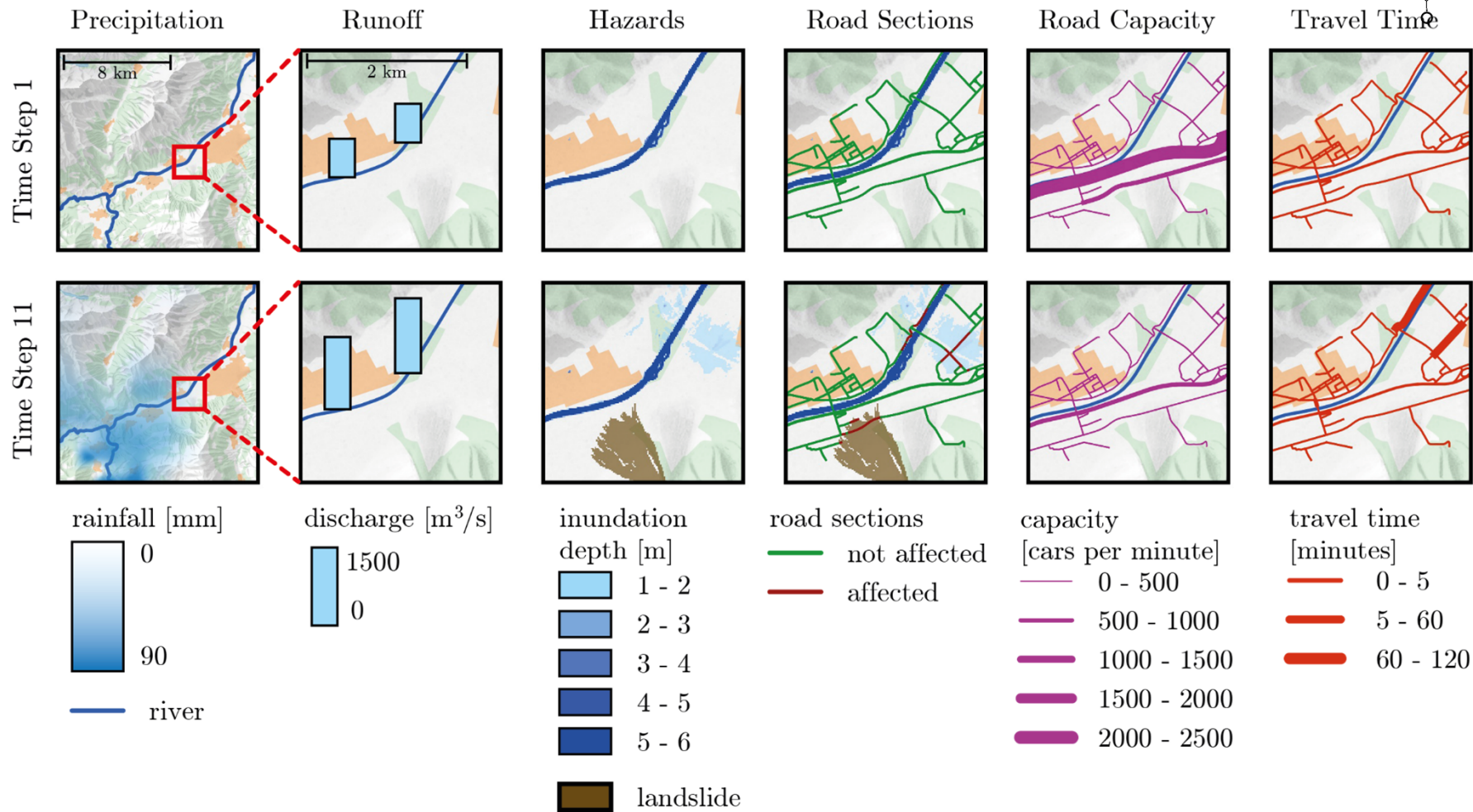
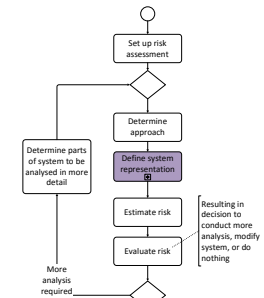


# Define models

- Determine the models of the relationships



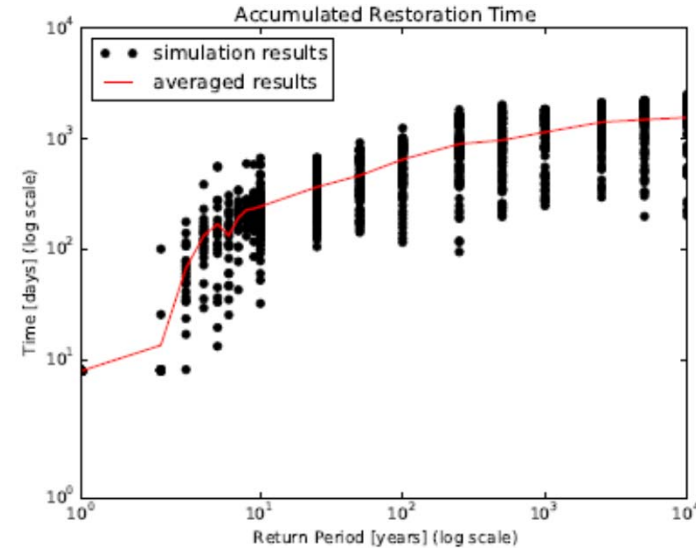
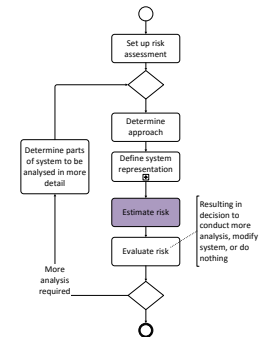
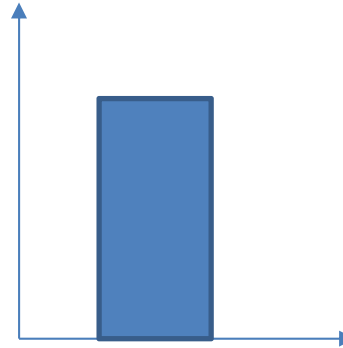
# Define models



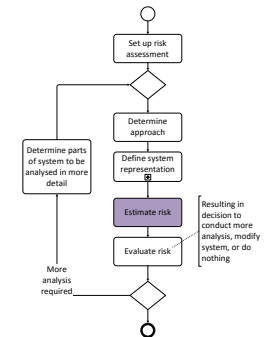
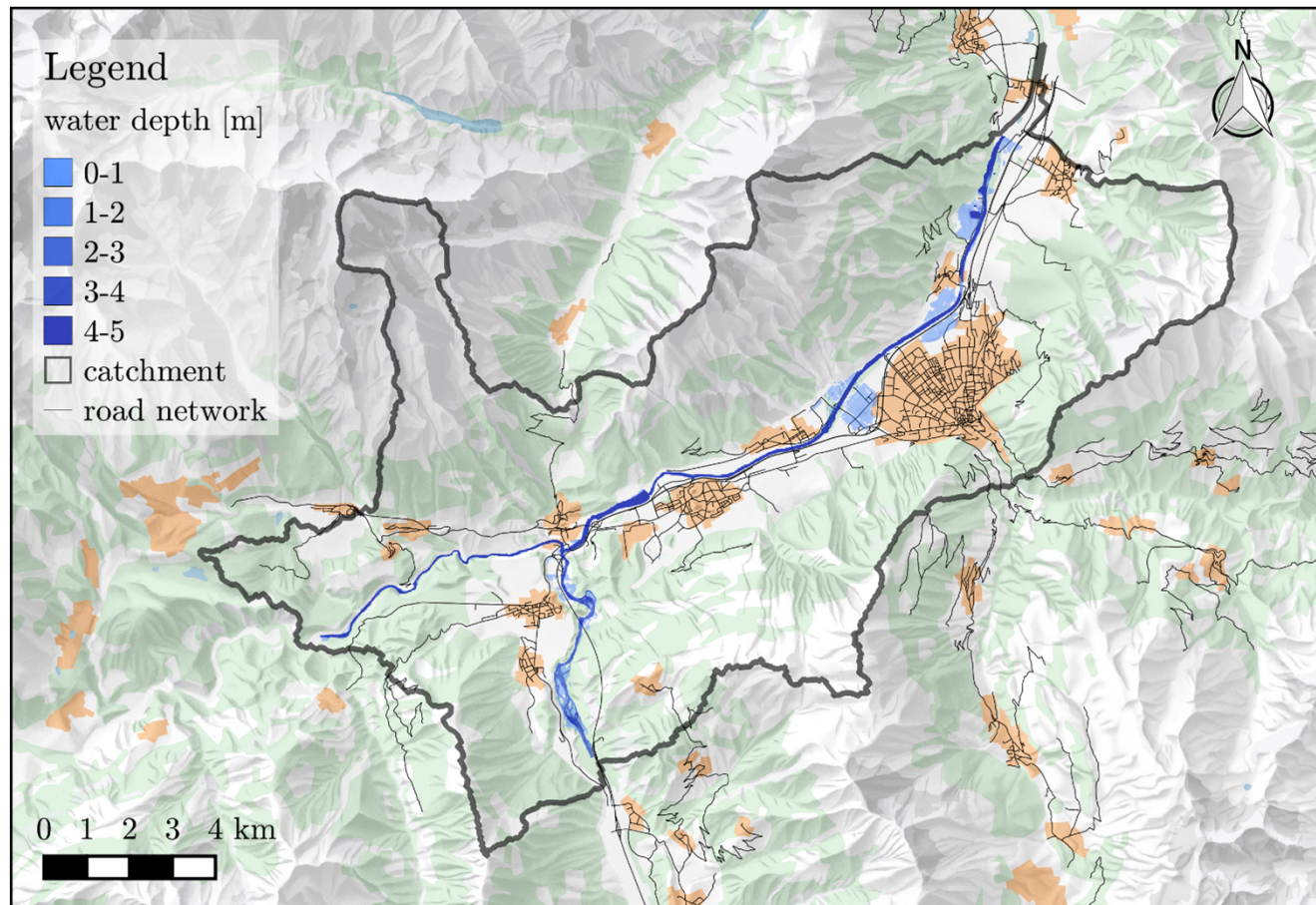
# Estimate risk

- estimate and aggregate
- pay attention to the certainty of the estimation of
  - the probabilities of occurrence and
  - consequences of each of the scenarios

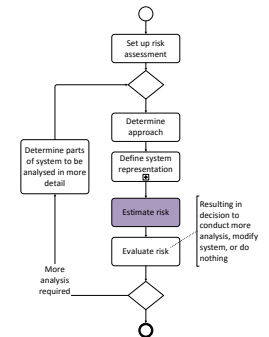
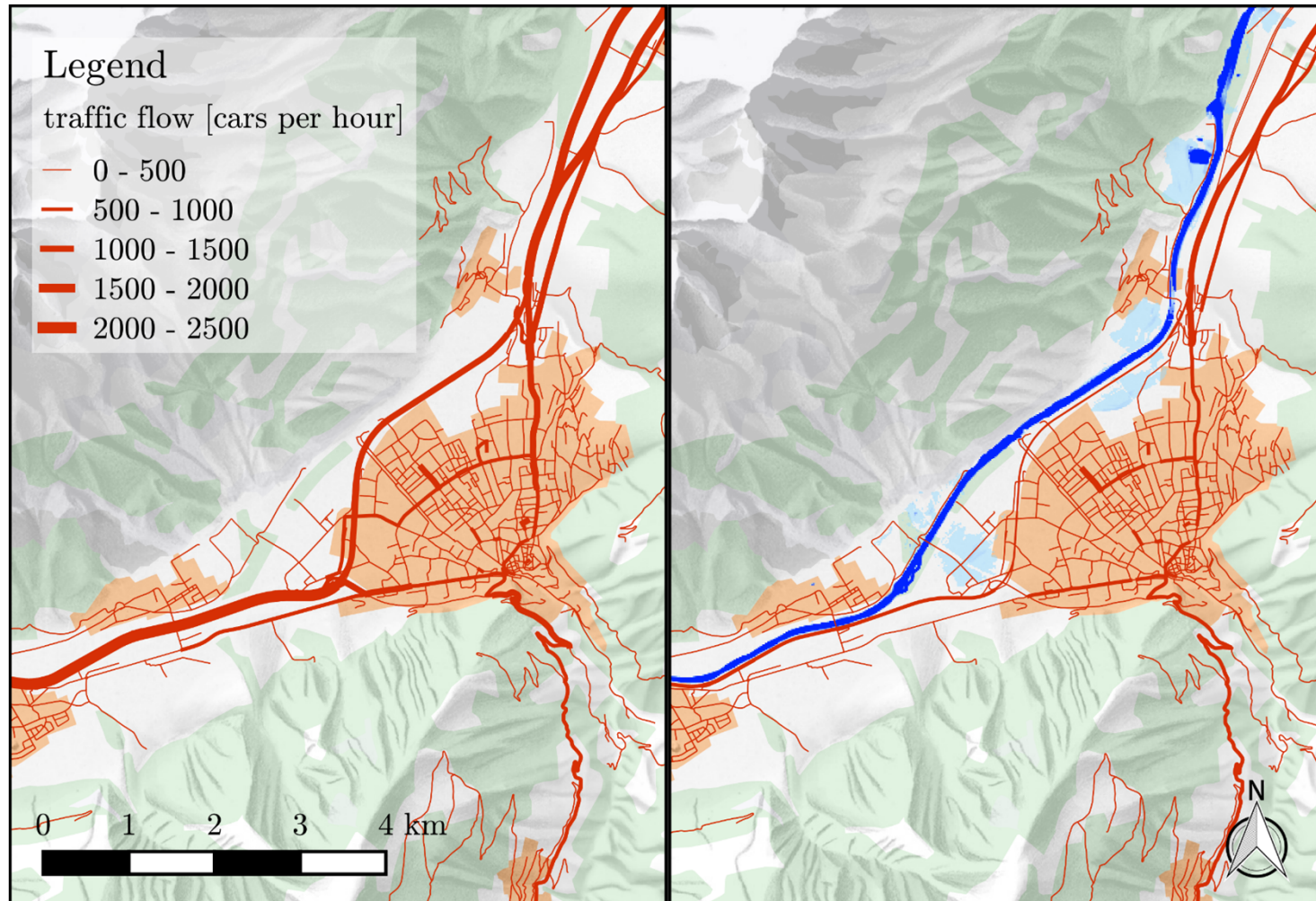
Total risk



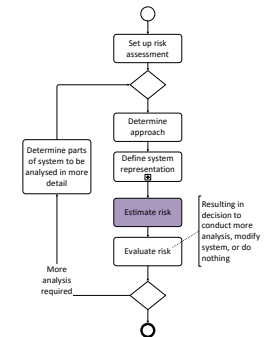
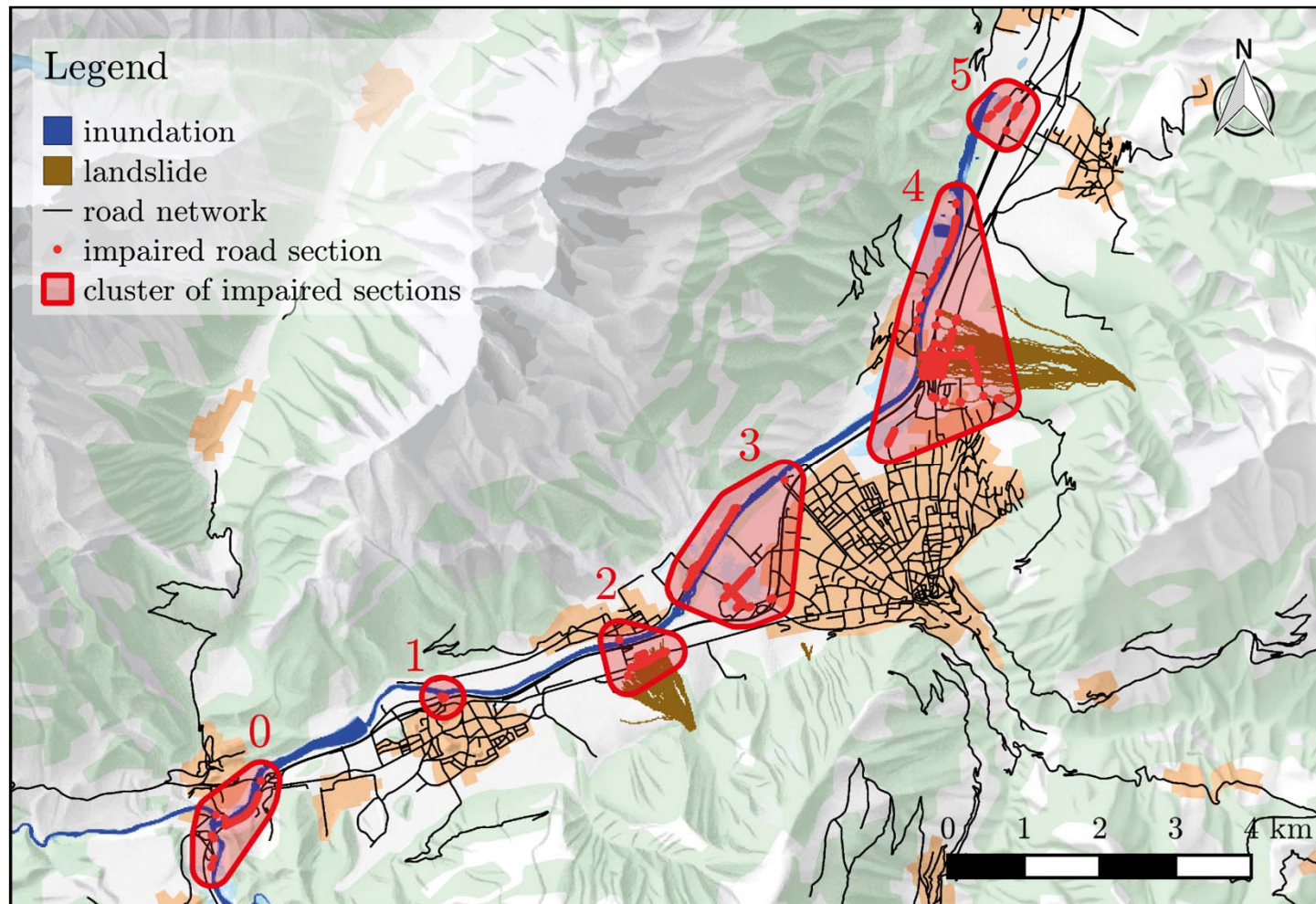
# Estimate risk



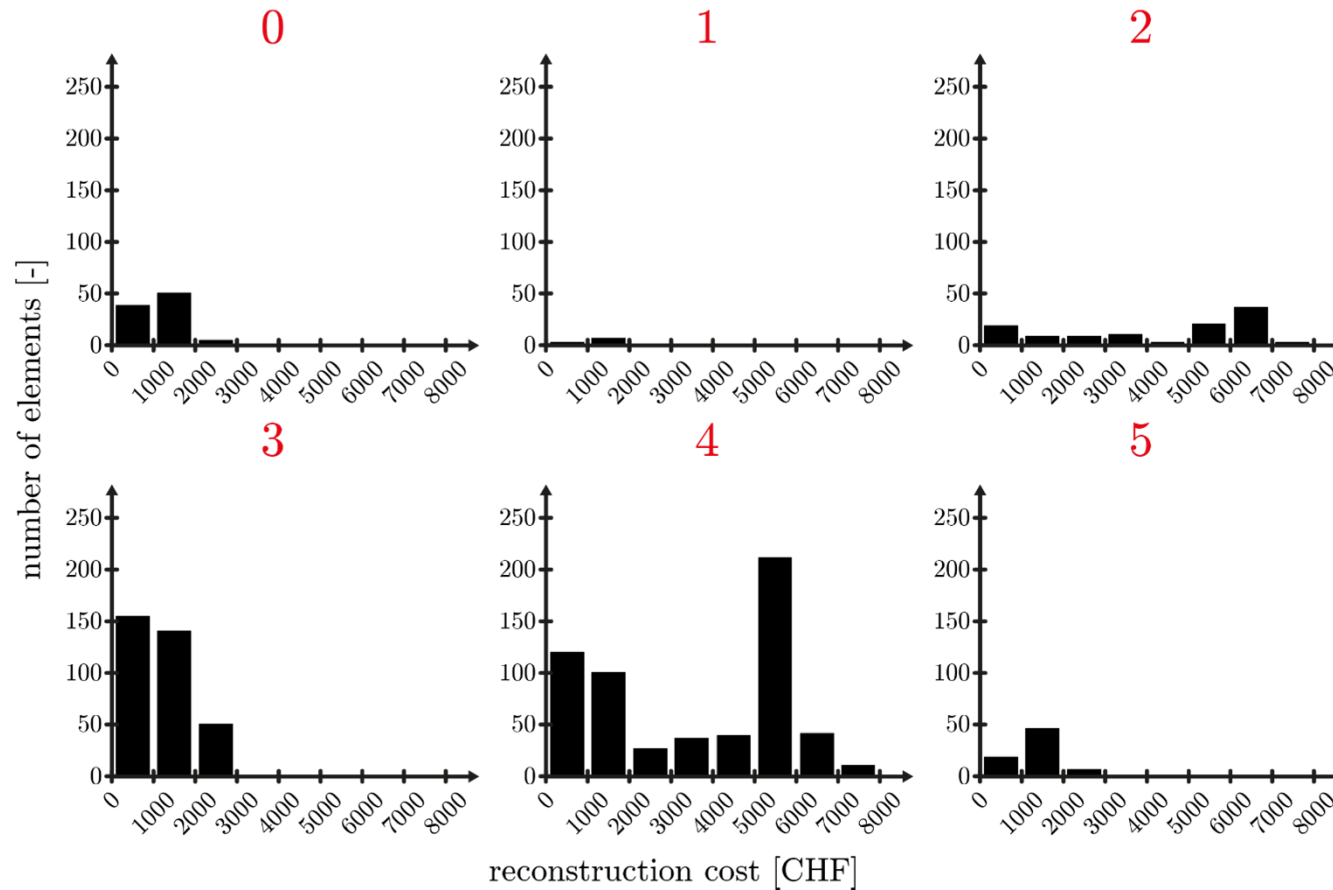
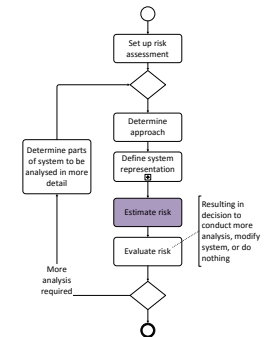
# Estimate risk



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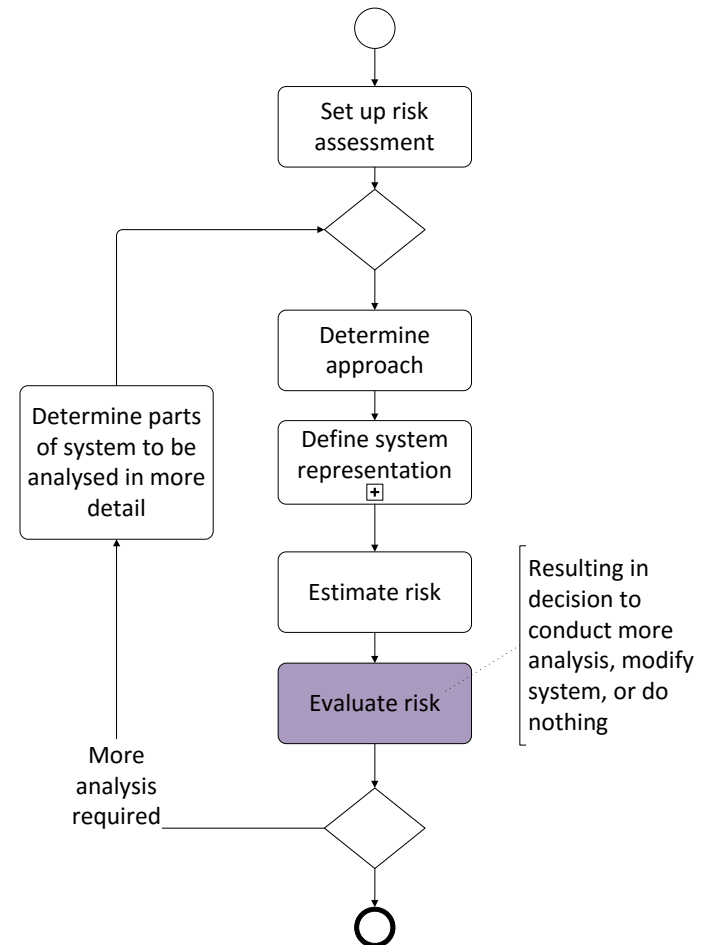


# Estimate risk



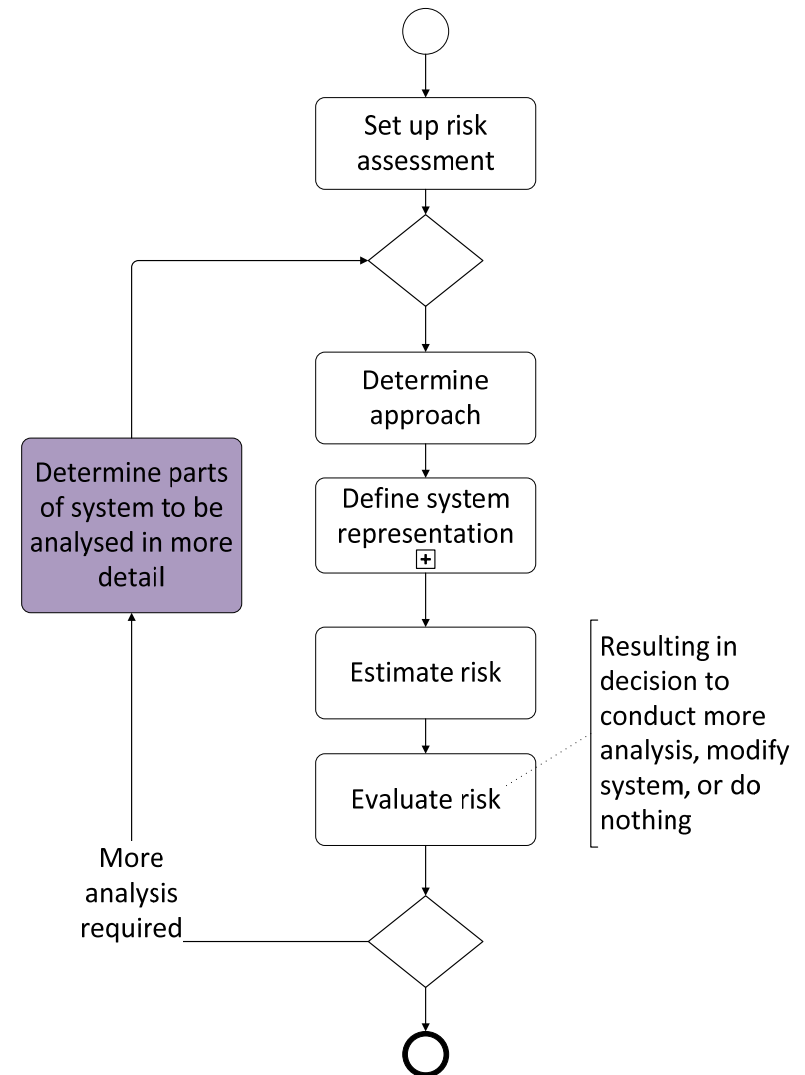
# Evaluate risk

- determine the meaning of the estimated risk to stakeholders
- decide as to whether the risk assessment has been satisfactorily done,
- ends with one of following decisions made:
  - Risk assessment performed satisfactorily and risk levels acceptable
  - Risk assessment performed satisfactorily and risk levels not acceptable
  - Risk assessment not conducted satisfactorily (more analysis is required)



# Determine parts...

- more detail, if any
- select parts likely to generate the most reduction in uncertainty
- do not only select parts where risk is likely to be reduced in a way that will result in a pass
- avoid preferential selection of parts, the uncertainty related to each part of the system need to be determined



# Conclusion

- A process to assess infrastructure related risks due to natural hazards was presented
- It can be used by all infrastructure managers in all of the wide range of situations in which they might be including variations in
  - The types of infrastructure to be included in the assessment,
  - The types of hazards to be included in the assessment,
  - The expertise available,
  - The time available,
  - The need for detailed information, and
  - The computer support available.
- More information on the process, and an example using a road network and flood and landslide hazards, can be found in Deliverable 4.2.



Novel Indicators for identifying critical **INFRA**structure at **RISK** from Natural Hazards

**Website**

[www.infrarisk-fp7.eu](http://www.infrarisk-fp7.eu)

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