Hochschule Magdeburg • Stendal

PROMAIDES

Protection Measures against Inundation Decision Support

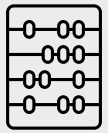
Introducing ProMaIDes: A State-of-the Science Flood Risk Management Tool

Prof. Dr.-Ing. Daniel Bachmann, Roman Schotten, Shahin Khosh Bin Ghomash

NH1.2 Advances in Pluvial and Fluvial Flood Forecasting, Assessment and Flood Risk Management - 23.05.2022

Francis Danby – The Deluge

Agenda



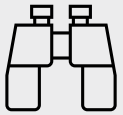
What is the most effective, sustainable flood risk mitigation measure?

Are we well-prepared for very unlikely meteorological events or dike failure?

How are persons and critical infrastructure protected?

Conclusion

Software framework of ProMaIDes



Summary

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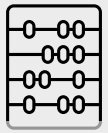

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Decision making and flood risk mitigation measures

Range of measures for risk reduction

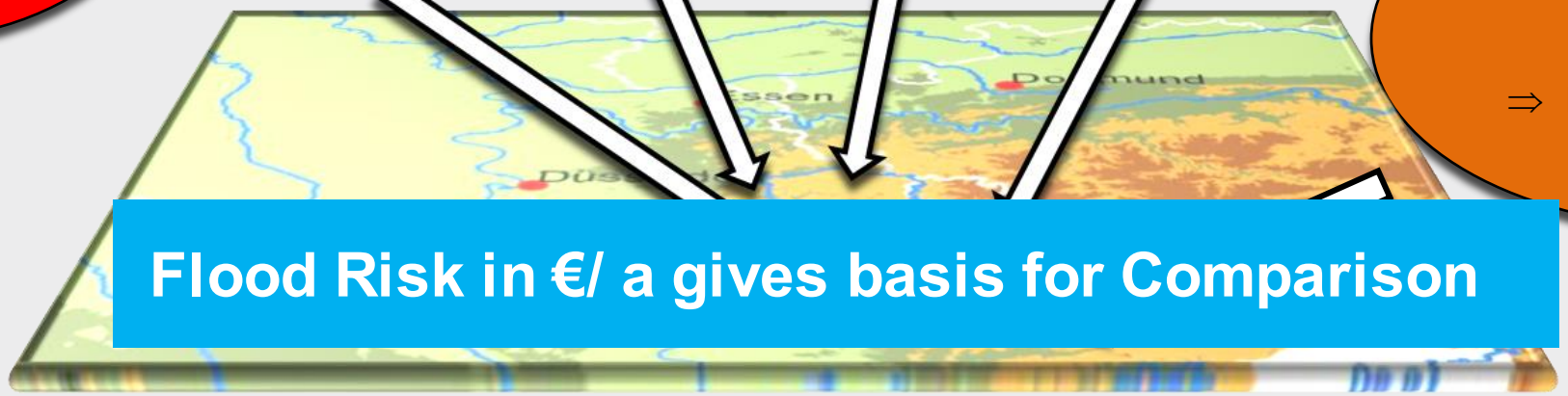
Socio-economic change
e.g. Changes in housing area
⇒ Increase of flood risk by xx **€/a**

River widening
⇒ Reduction of flood risk by xx **€/a**

Dike slope
Modification of safety factor xy -
⇒ Changing flood risk by xx **€/a**

Adapted reservoir management
Reduction of peak discharge xx **m³/s**
⇒ Changing flood risk by xx €/a

Climate change
⇒ Increase of flood risk by xx **€/a**



Flood Risk in €/ a gives basis for Comparison

Decision making and flood risk mitigation measures

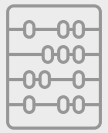
Risk-based planning of measures

Quantification of mitigation measures in a matrix to enable a **transparent ranking** and a criteria-based **decision making** process.

Alternative	Decision criteria				
	Flood dependent (risk reduction)				Flood independent
	Economic direct [€/a]	**Ecologic [€/a]**	**Affected persons [Person/a]**	**Endangered persons [Person/a]**	**Cost [€]**
1	57.307	1.327	7	0,008	1
2	115.991	74	21	0,011	447.052
3	3.497	8	3	0,001	40.407
4	55.692	0	0	0,000	100.000

more info

Agenda



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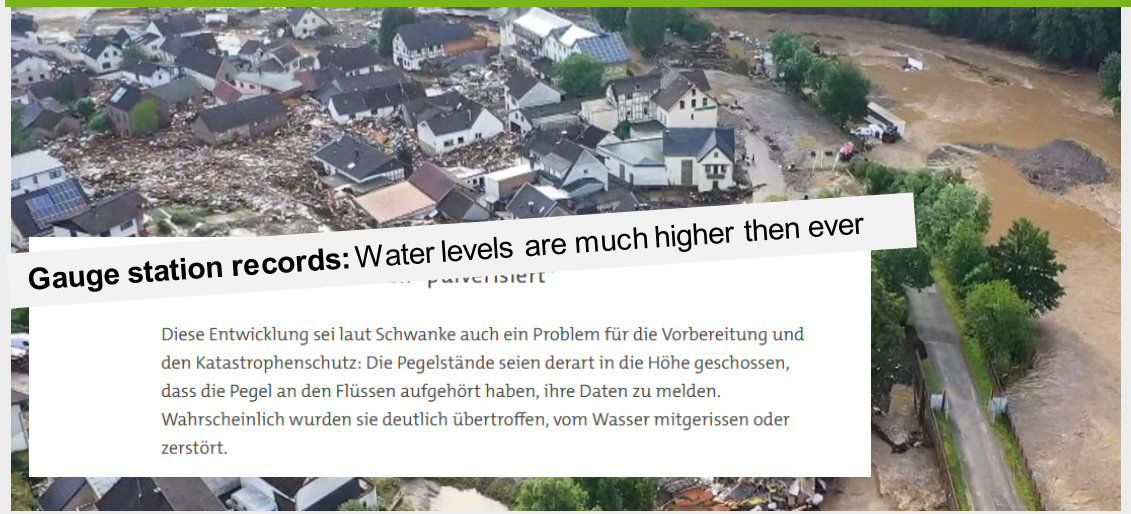
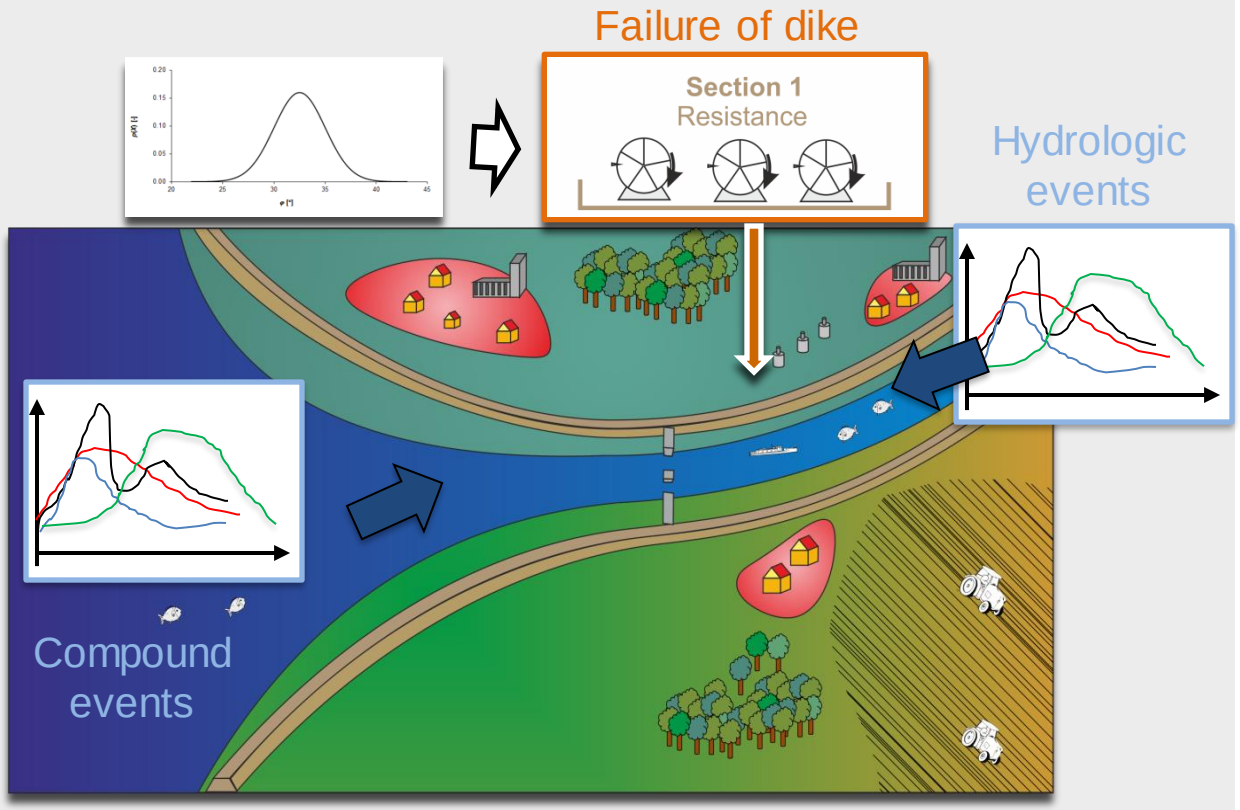
Consideration of Extreme Events and Hazards





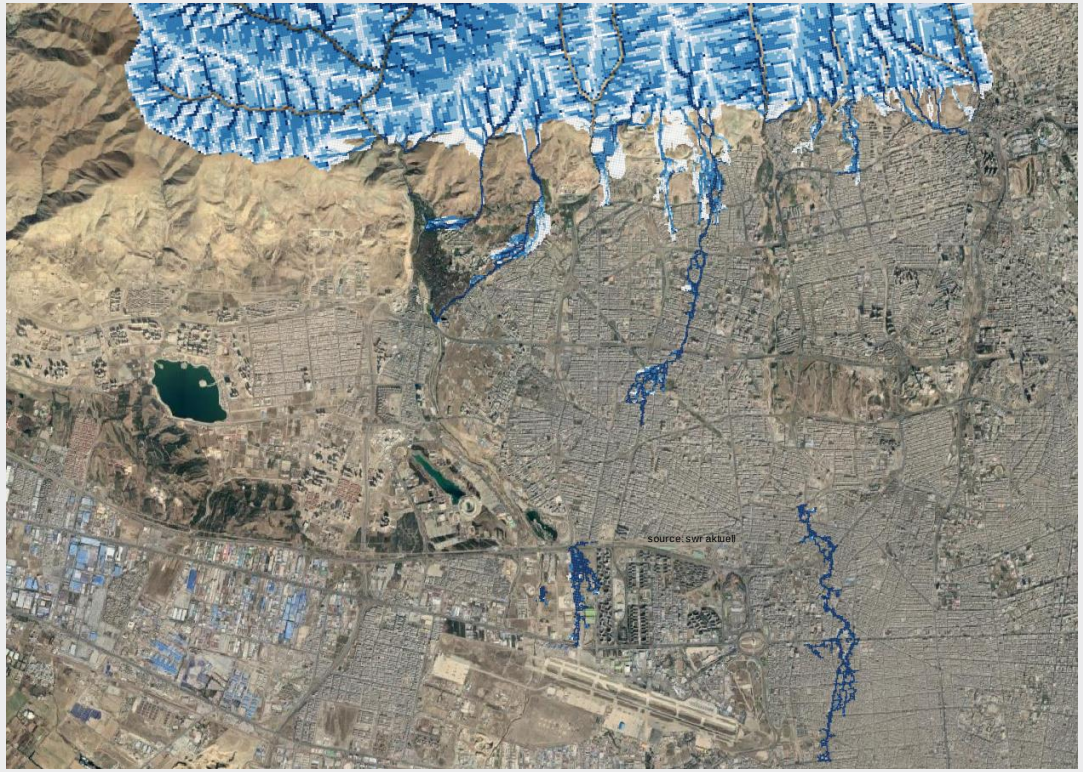
Optimization: **Take more hazards into account!**

- **Multiple hydrological** events (e.g. HQ10 to HQ10000)
- Variate **precipitation pattern** and the resulting discharge (direction, speed)
- Analyse also **failure** events in the **flood defence line**! (Failure of dike)

Consideration of Extreme Events and Hazards

Flood scenarios for Teheran

Iran, IKARIM BMBF-research project 2020:



1 of 28 scenarios: $HQ_{10.000}$ (184 mm / 24h)

*Comparison flood 2021 ca. 150 mm / 24 h

Wed, 25 May | 11:18–11:25 | Room 2.44

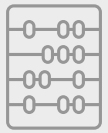
HS7.2 - Virtual presentation

Storm movement effects on the flash flood response of the Kan catchment

Shahin Khosh Bin Ghomash

more infos

Agenda



What is the most effective, sustainable flood risk mitigation measure?

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Type of Flood Concequences

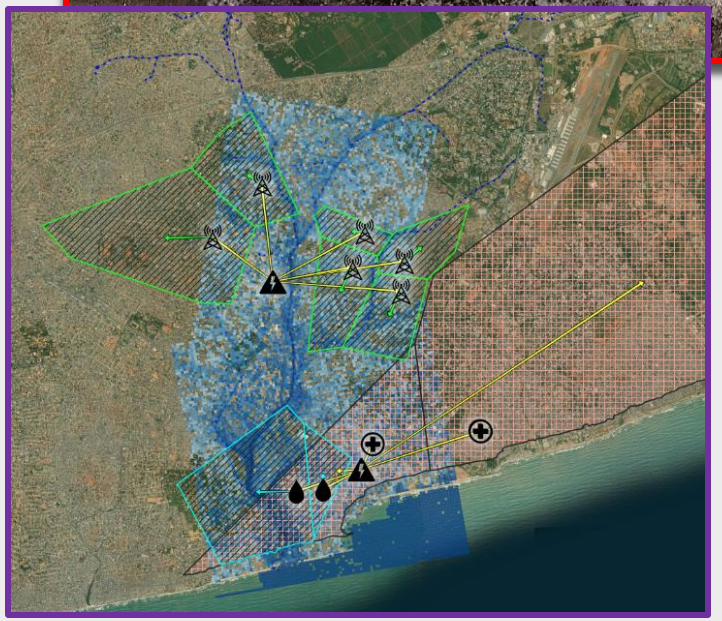
Consideration of people and critical infrastructures

source: eifelschau.de, 2021

Optimization: Take **more types of flood consequences** into account!

- Affected and **endangered** persons
- **Critical infrastructures (CI) and cascading effects**

source: Alsop, 2004



Type of Flood Concequences

Flood Risk Maps including CI – Example Accra, GH

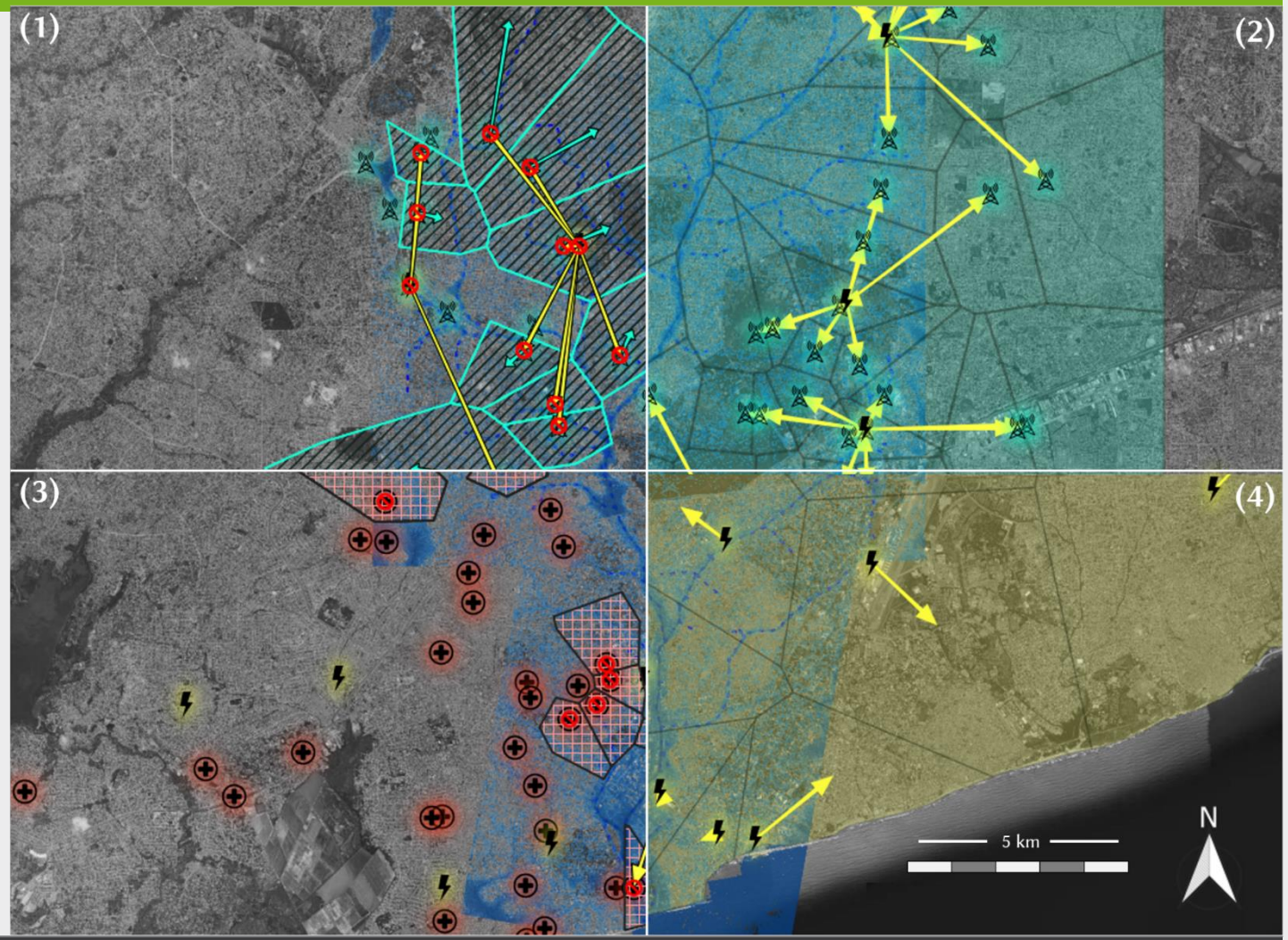
Critical Infrastructure disruption on telco sector (1), connection to electricity sector (2), disruption of health services (3) and area supplied by the electricity structures (4).

Tue, 24 May | 10:45–10:50 | Room 1.34

NH10.3 - On-site presentation

Concept of a Critical Infrastructure Network Modelling Approach for Flood Risk Management

Roman Schotten



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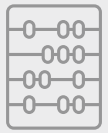

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Conclusion

Questions – Answers - Summary

What is the most effective, sustainable flood risk mitigation measure?

- Risk-based planning of measures

Are we well

- A
- Va
- Ana

r dike failure?

ction, speed)

ine! (Failure of dike)

How a and critical infrastructure protected?

- Affected and endangered persons
- Critical infrastructures (CI) and cascading effects

What we need to solve these challenges:

Open and user-friendly, integrated tools based on state-of-the-Science approaches!

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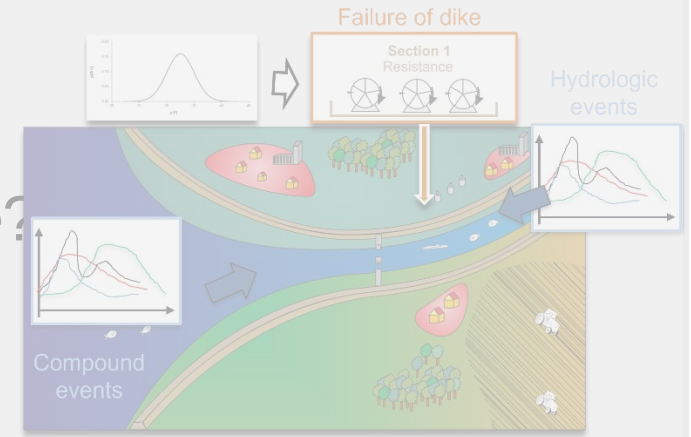

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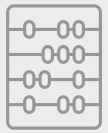

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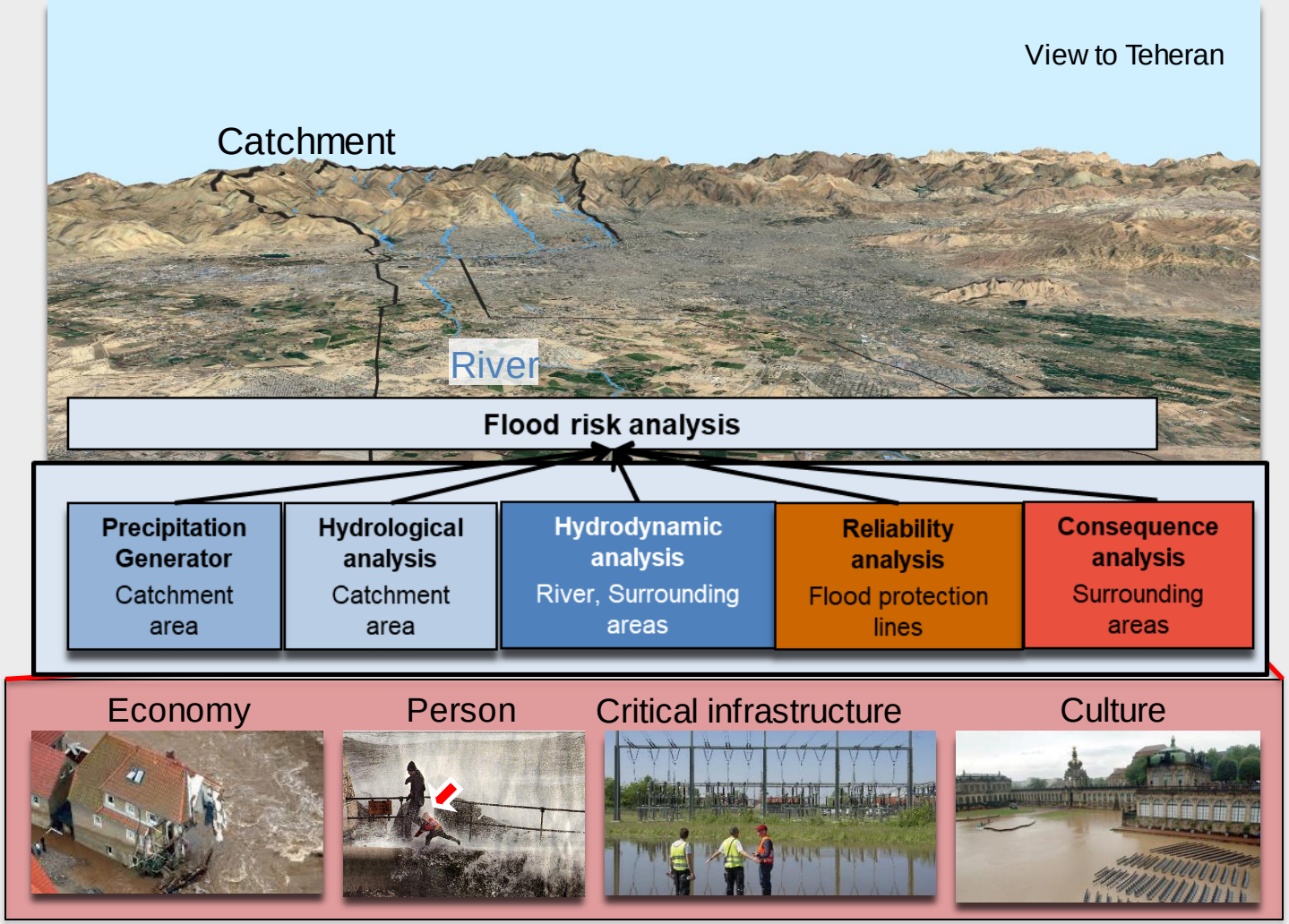
Software Framework of ProMaIDes

Requirements for this approach

Model-based flood risk analysis

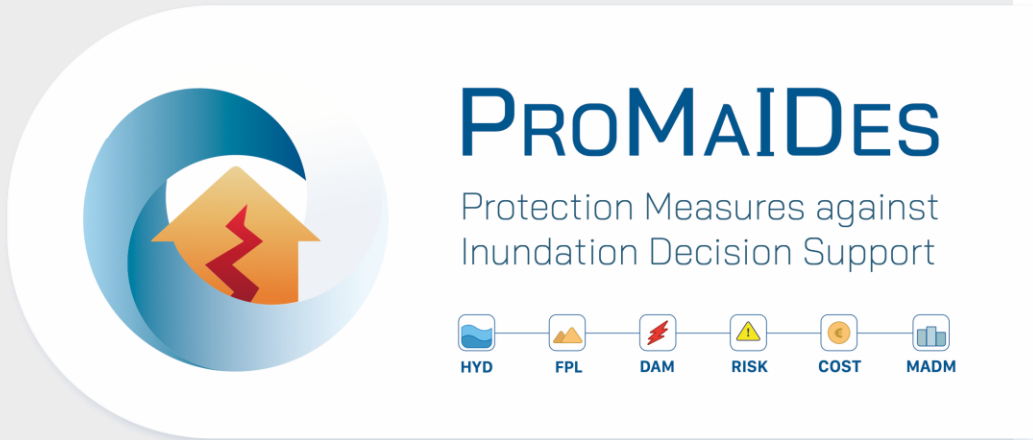
- Catchment based
- Holistic approach (from rain to damage)
- Full spectrum of consequences



Software Framework of ProMaIDes

Background information

- **Freeware (open source)**-Software package written in C++ / QT
- For **riverine** and **coastal** regions
- Has been **developed** in several research projects since 2006 at *Institute of Hydraulic Engineering* ***RWTH Aachen University*** and *AG Flood Risk Management* ***University of Applied Sciences Magdeburg-Stendal***
- **Applied** in **research, teaching** (courses Ba- and MA-thesis) and **practice**

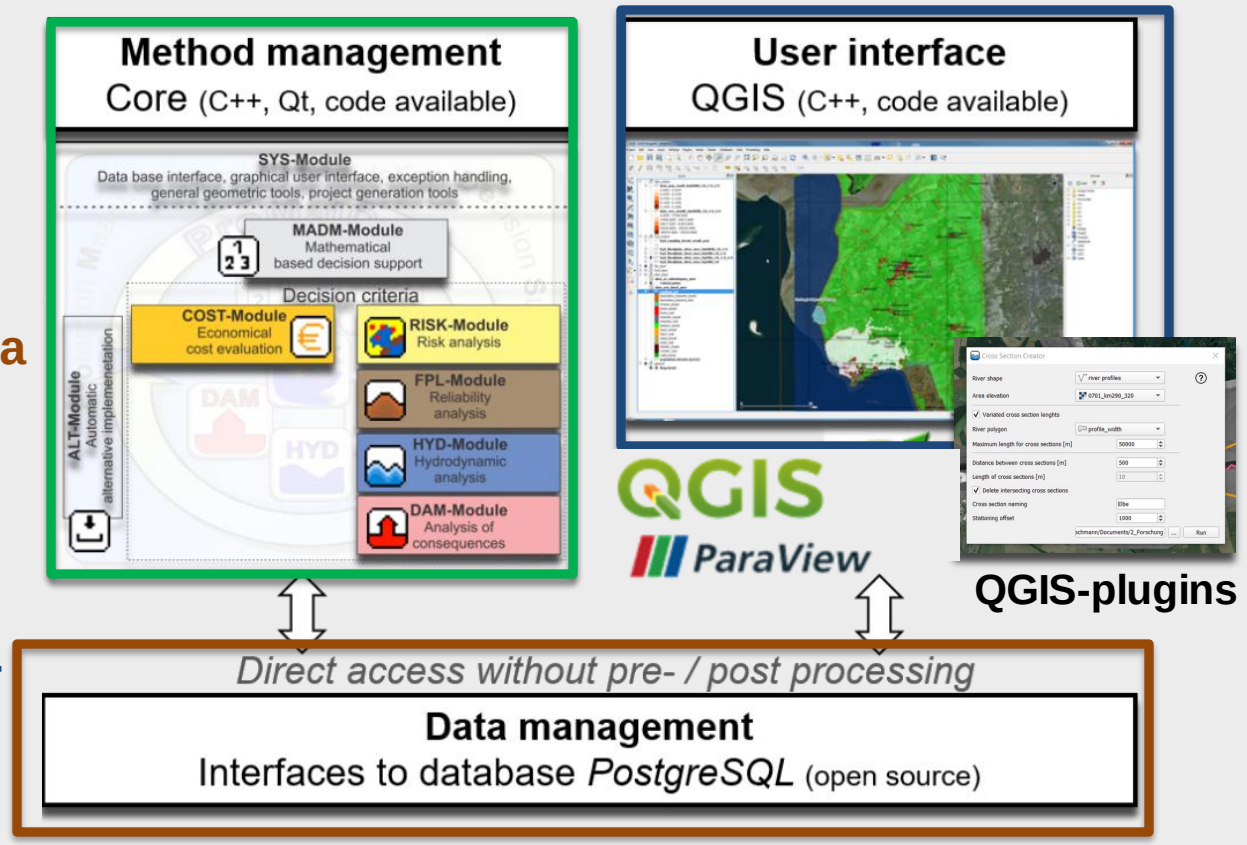


Software Framework of ProMaIDes
Components

- **Modular design**: hydrodynamic, reliability, consequences, risk etc. with
  - **state-of the art/ science** approaches
  - **Optimised** for flood risk analysis

- Interface to **PostgreSQL** (*open source*) as **data management system** (remote or stand-alone)
  - User friendly
  - Failure reduction

- Interface to **QGIS** (*open source*) for model **set-up, visualisation** und **interpretation** via database and QGIS-plugins
  - User friendly



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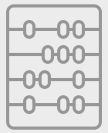

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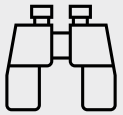

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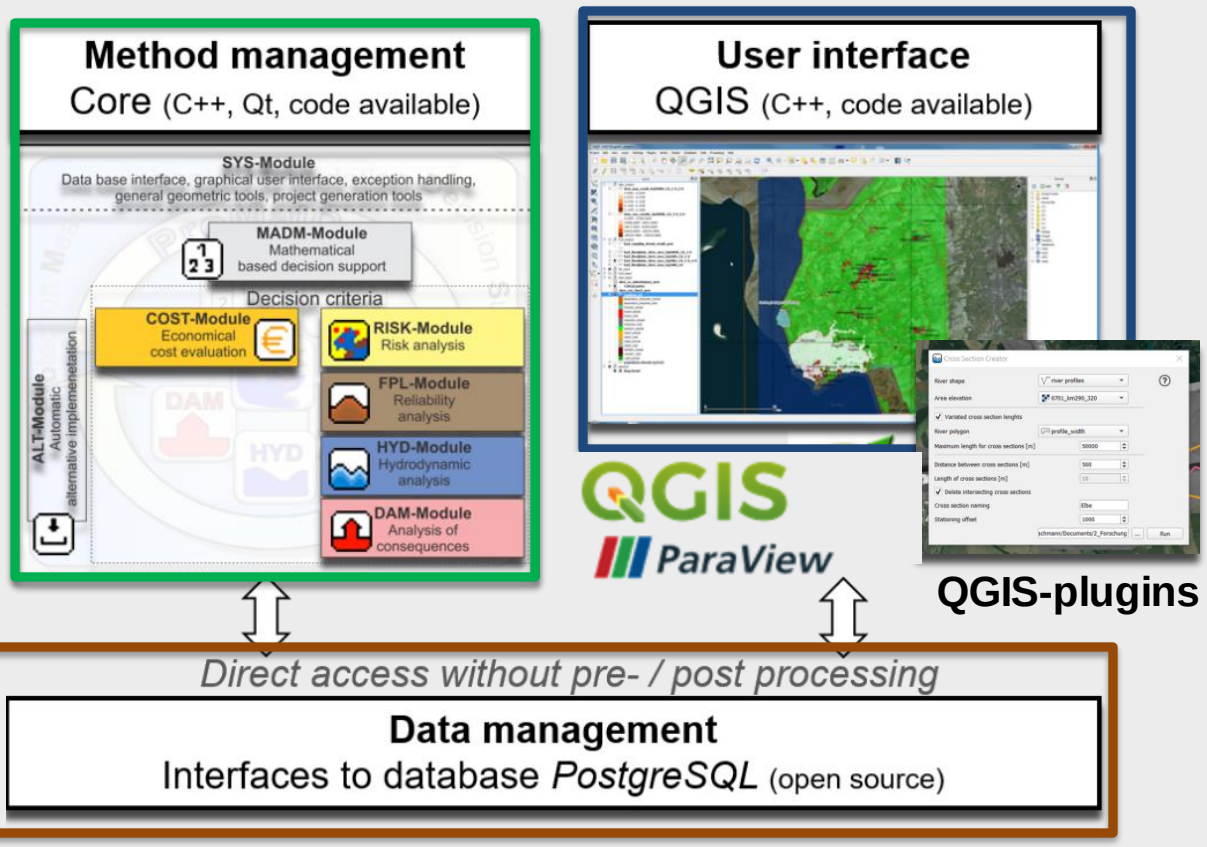

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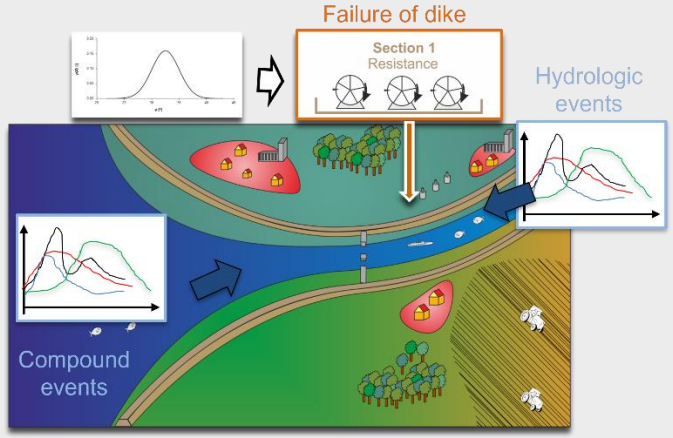

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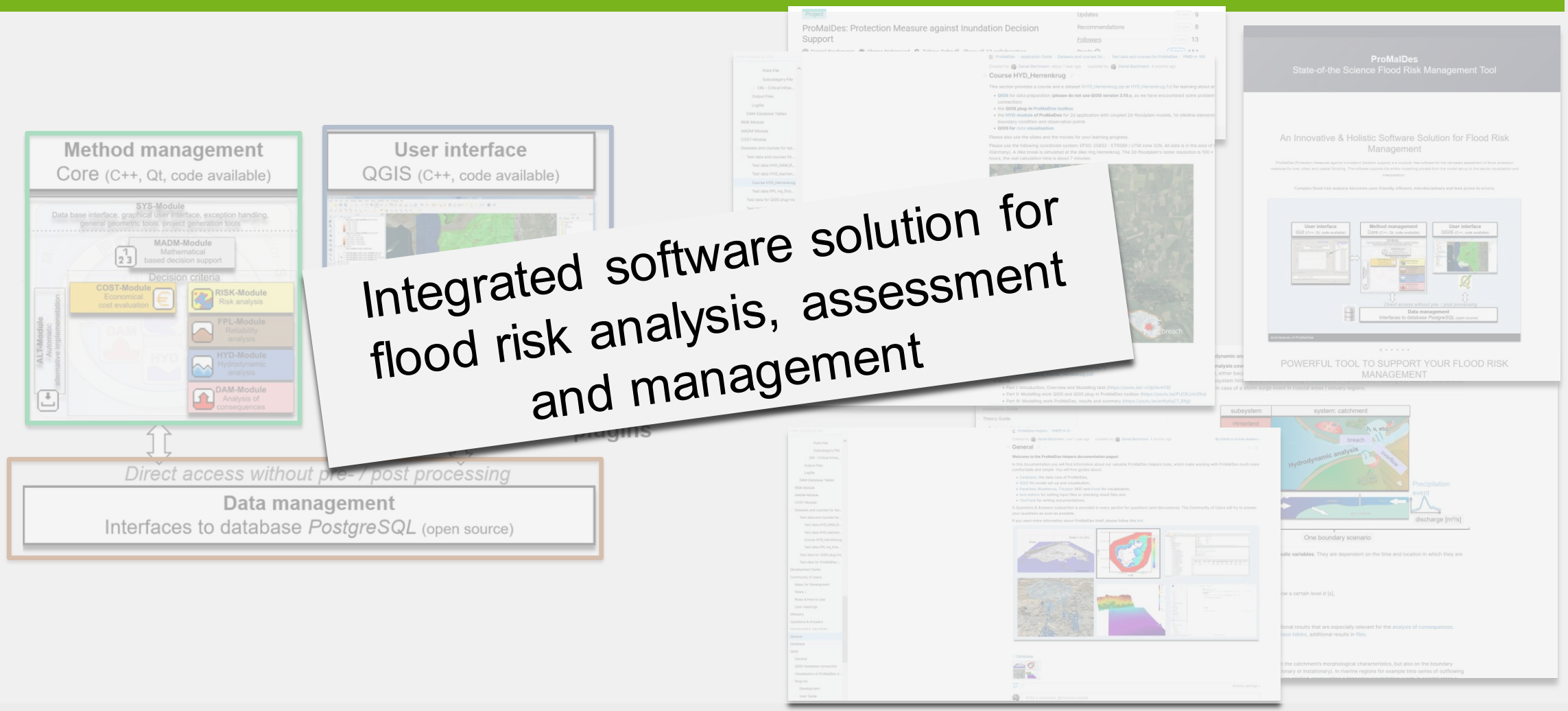
Method management
Core (C++, Qt, code available)
SYS-Module
Data base interface, graphical user interface, exception handling, general geometric tools, project generation tools
MADM-Module
Mathematical based decision support
Decision criteria
COST-Module
Economical cost evaluation
RISK-Module
Risk analysis
FPL-Module
Reliability analysis
HYD-Module
Hydrodynamic analysis
DAM-Module
Analysis of consequences
ALT-Module
Automatic alternative implementation
User interface
QGIS (C++, code available)
Plugins
Direct access without pre-/ post processing
Data management
Interfaces to database PostgreSQL (open source)
Integrated software solution for flood risk analysis, assessment and management
ProMaIDes: Protection Measure against Inundation Decision Support
ProMaIDes
State-of-the Science Flood Risk Management Tool
An Innovative & Holistic Software Solution for Flood Risk Management
POWERFUL TOOL TO SUPPORT YOUR FLOOD RISK MANAGEMENT
subsystem
system: catchment
Hinterland
Hydrodynamic analysis
Precipitation event
discharge [m³/s]
One boundary scenario

Hochschule Magdeburg • Stendal

ProMaIDes

Protection Measures against Inundation [illegible]

Thank you for your attention!

You are invited to use and share this tool for your purposes.

[illegible] Bachmann, Roman Schotten, Shahin Khosh Bin Ghomash

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- **Researchgate project [ProMaIDes]** with literature
- **Website**: https://promaides.h2.de
- **Documentation** about
  - theory, application,
  - courses, data sets, examples,
  - QGIS-plugins and other helpers (e.g. ParaView, Excel etc): https://tinyurl.com/promaides77

Francis Danby – The Deluge

Software Framework of ProMaIDes

Modular structure

ProMaIDes

Protection Measures against Inundation Decision Support

Free download and documentation:
www.promaides.h2.de

HYD

1. Hydraulic modelling – fluvial, pluvial, coastal

FPL

2. Reliability analysis of dikes and dunes

DAM

3. Analysis of consequences

RISK

4. Risk calculation

COST

5. Cost estimation

MADM

6. Decision making matrix

Software Framework of ProMaIDes

Analysis of Consequence with ProMaIDeS

DAM

ECN

Economic Damages

ECO

Ecological Damages

POP

Consequences to Population

SC

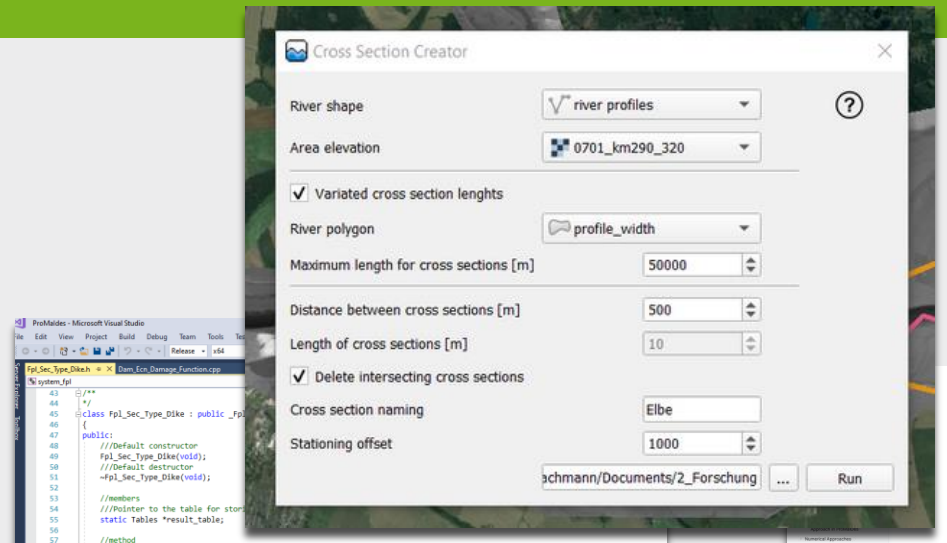
Special Risk Objects

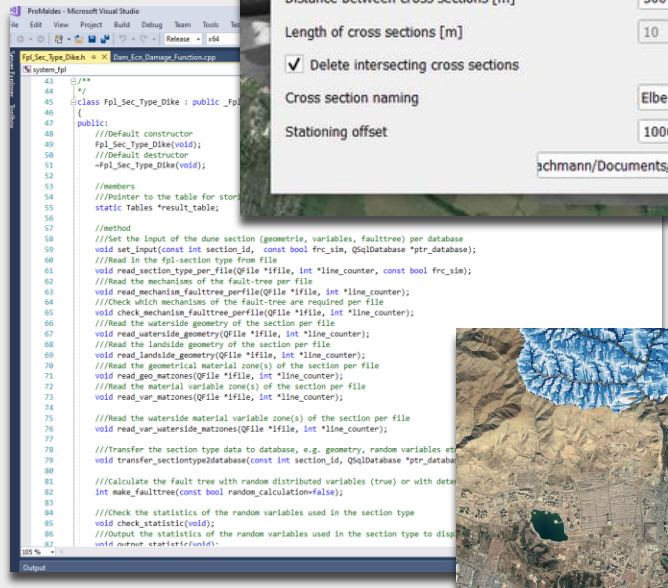
CI

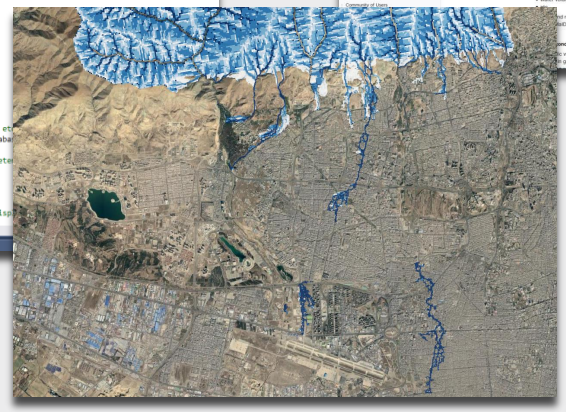
Critical Infrastructure Network

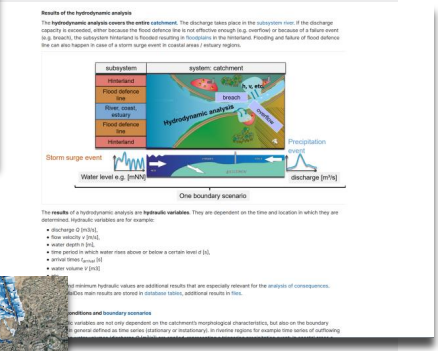
Software Framework of ProMaIDes

- Data management
- Visualization
- User-friendly model set-up („3-clicks-to-a-model“)
- Documentation and courses
- Open Source and freeware
- Community of users / User meetings









Outlook

- **Some Ideas for extension**
  - !Use of GPU calculation!
  - Infiltration for HYD-module
  - Hydrological module
  - Coupling of groundwater
  - ….
- **Applications**
  - Impact- / risk-based forecasting
  - Low flow risk management
  - ….