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Enabling Delta Life

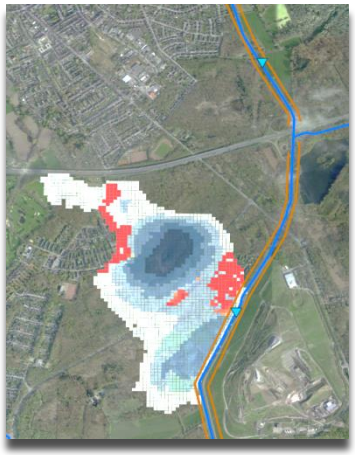
Impact-based flood forecasting and critical infrastructure

Bachmann D. et al.

2. Dutch-German workshop on flood forecast and emergency measures, Cologne (GER)

9th November 2017

Impact-based flood forecasting

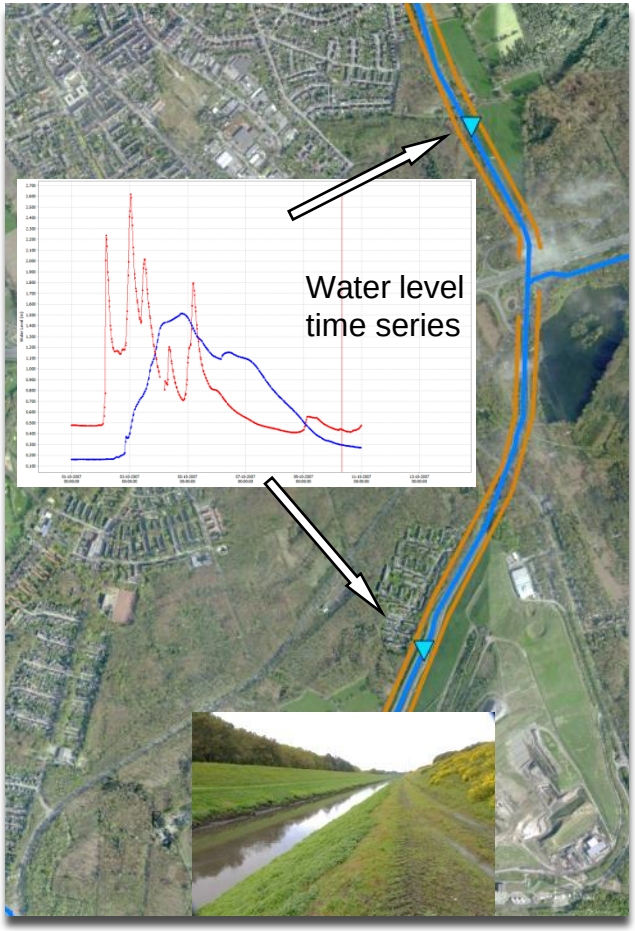


„All is about impacts!“

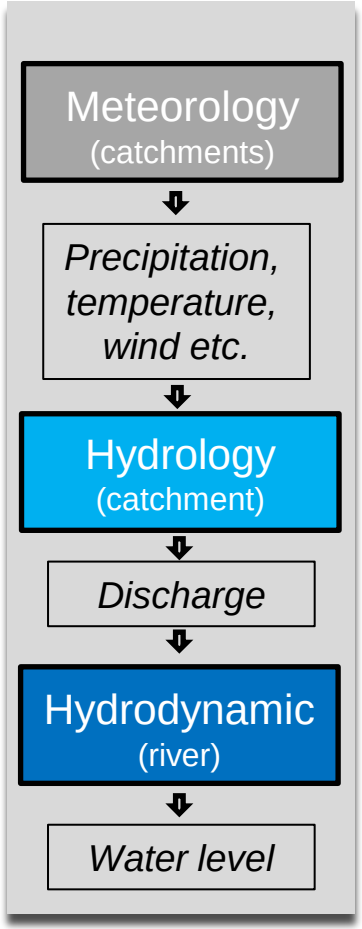
[Comment during FEWS-User days 2017 about impact-based flood forecasting]

Common practice in operational flood forecast

System river



Forecasted
process chain



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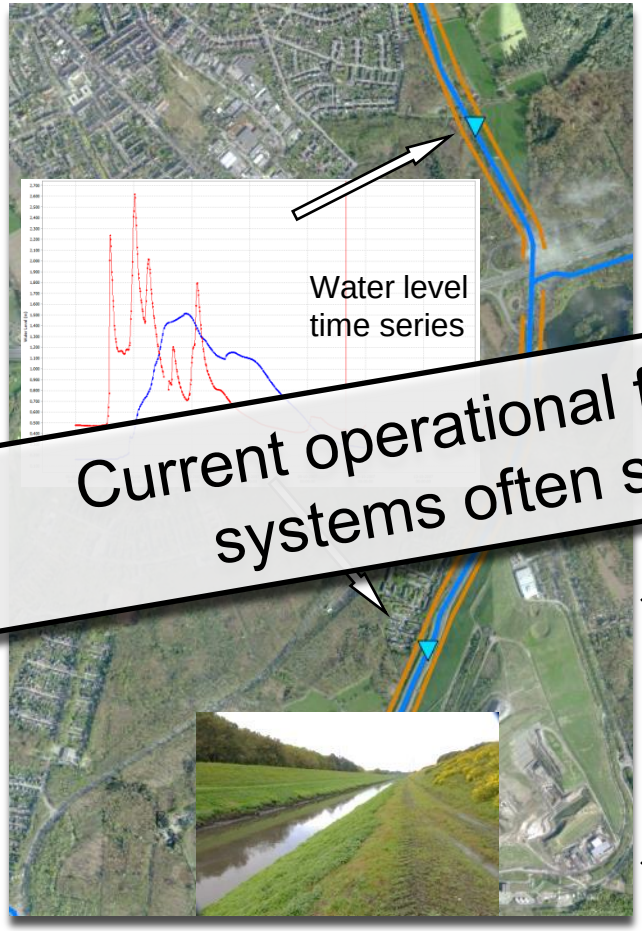
Common practice in operational flood forecast

System river



Forecasted
process chain

Current operational flood forecast systems often stop here!

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Which information is required for whom?

source: THW

First responders

Public

source: Bez. Reg. Duesseldorf

Crisis managers

- Where is the weakest link in my defense line?

- When, how much and where the water will flow?

- When and where is greatest impact to people and critical infrastructure expected?

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Which information is required for whom?

source: THW

First responders

Public

source: Bez. Reg. Duesseldorf

Crisis managers

WE can forecast these information!

- Where is the weakest link in my defense line?

- When, how much and where the water will

- When and where is greatest impact to people and critical infrastructure expected?

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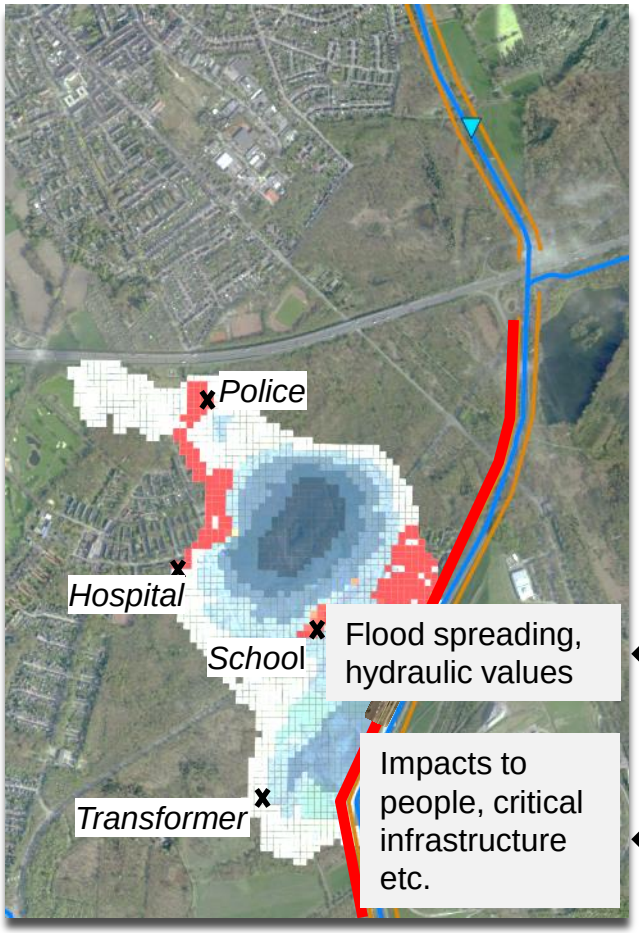
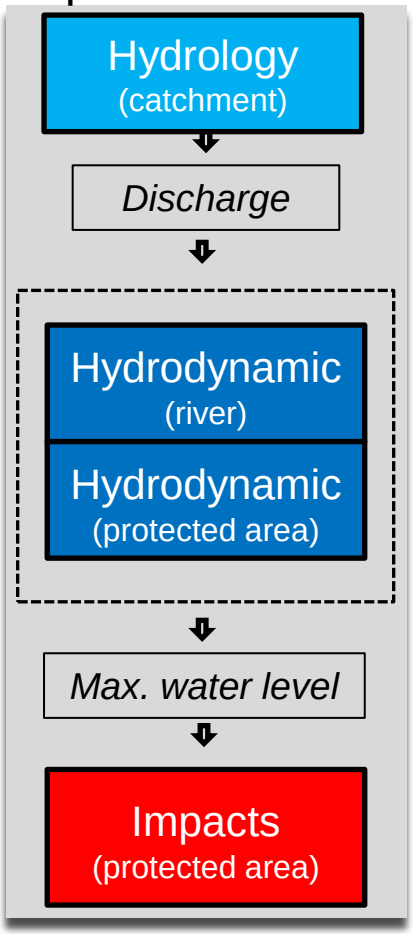
Extension of the model chain (without flood defence line)

System river, protected area



Forecasted process chain



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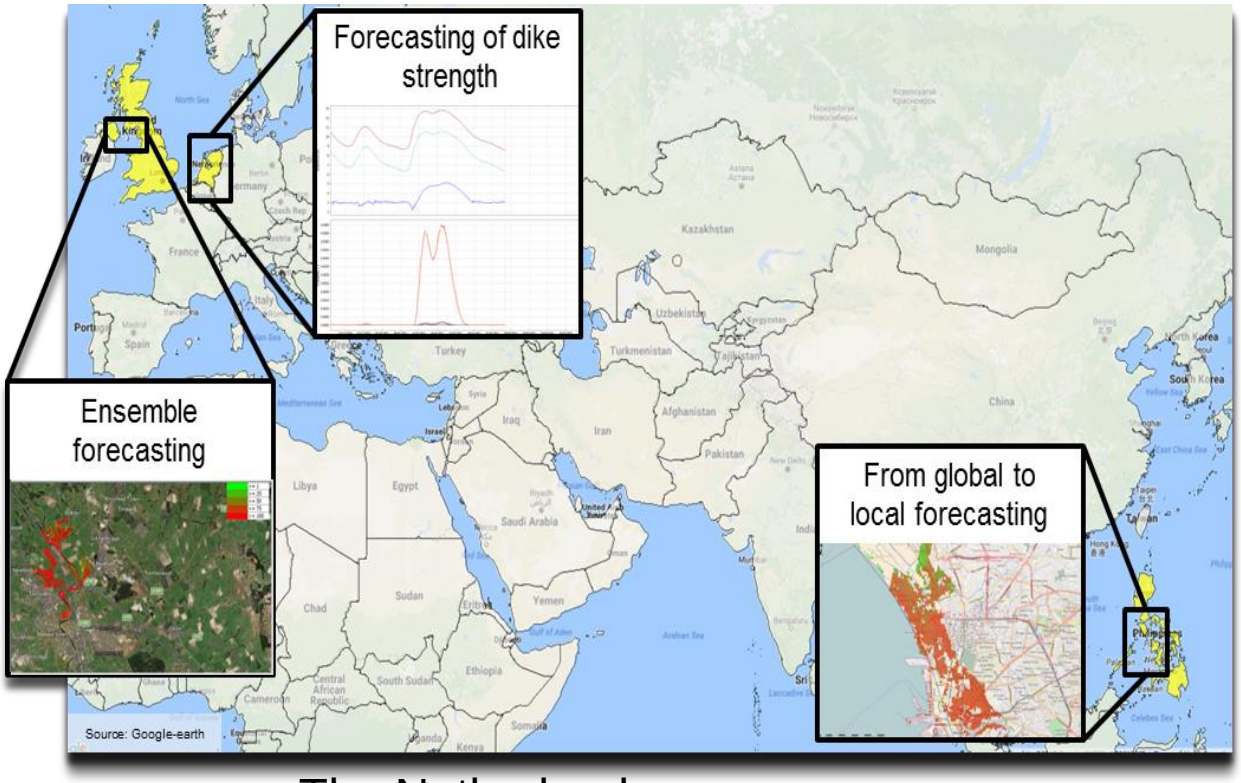
Prototypes of extended forecasting (impacts)

Scotland
(Dumfries)



The Netherlands
(Rotterdam, Delfzijl, Rivierenland)

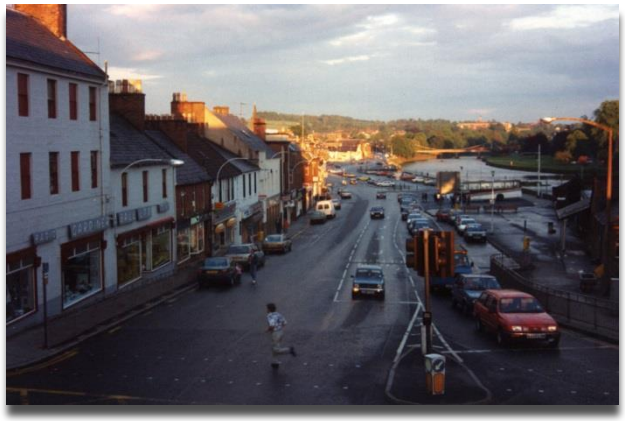
Philippines
(Manila)

Sri Lanka
(Colombo)

Application for Dumfries (Scotland)

- South-Western part of Scotland
- About 50.000 inhabitants
- At the Nith river close to the sea

Whitesands, Buccleuch Street



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Challenges for Dumfries (Scotland)

Storm Desmond
5/12/15 – 6/12/15

Storm Frank
30/12/15–31/12/15

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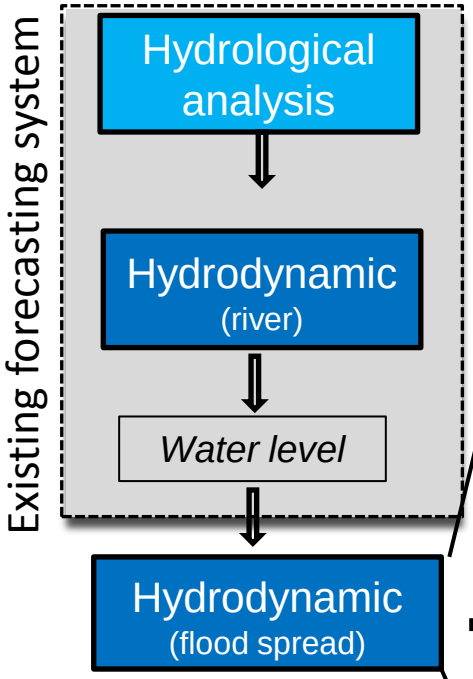
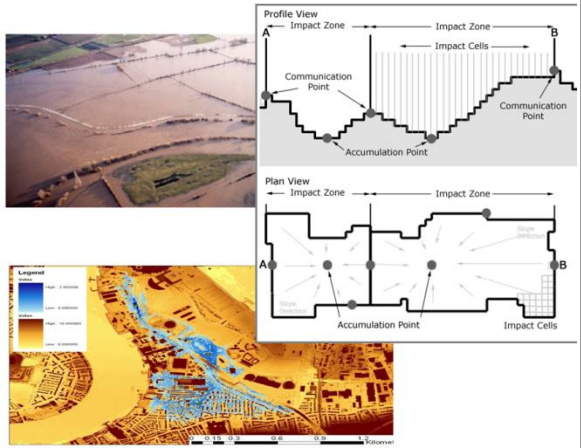
Extend existing forecasting system: flooding



Use of RFSM [Rapid Flood Spread Model] tool (HR Wallingford)

- Large elements
  - variable shape,
  - automatic analysis of topography
- Element properties derived from underlying DTM
- Fewer computational elements, faster computation, but good accuracy because of sub-element topography



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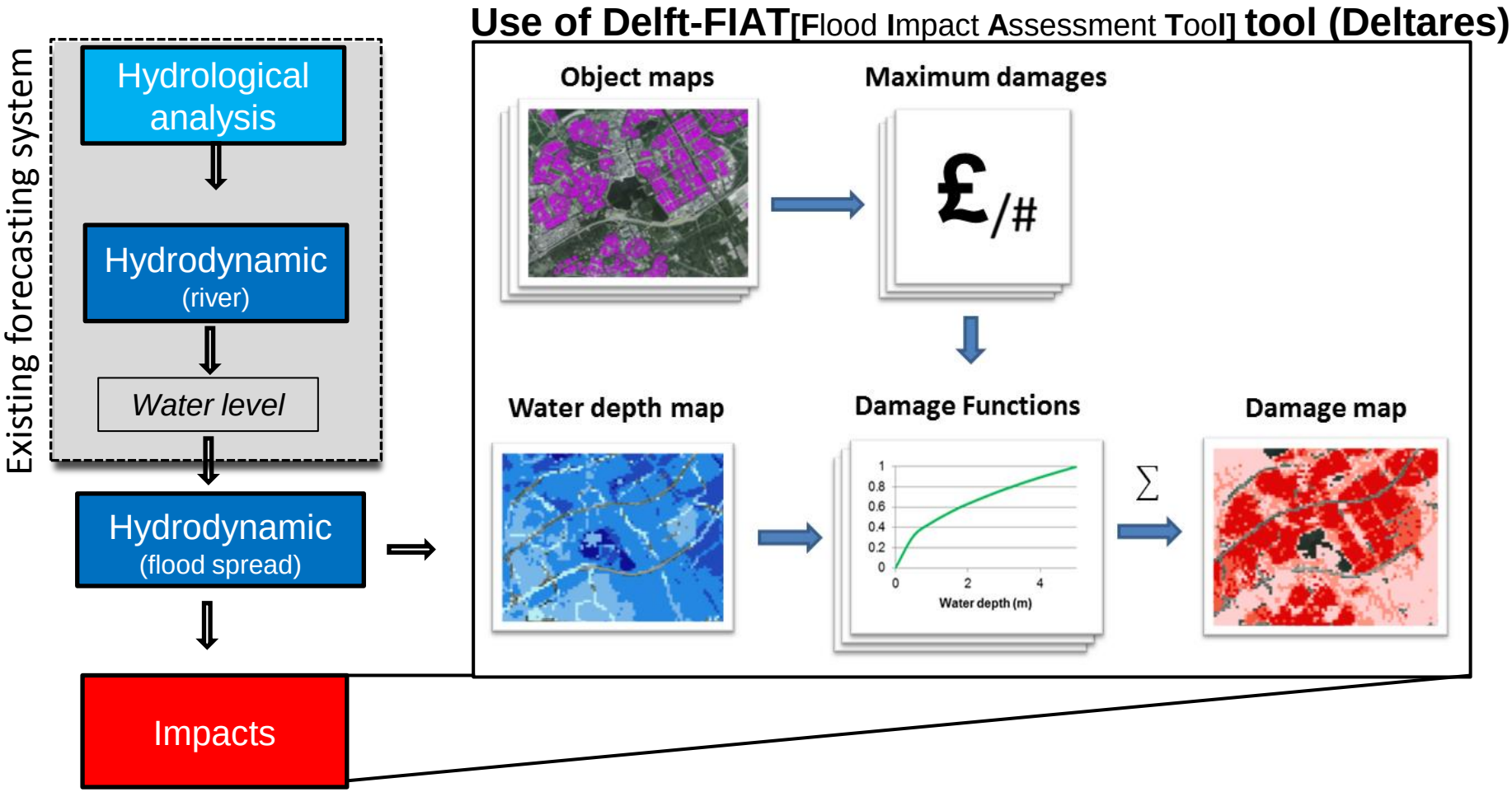
Extend existing forecasting system: impacts



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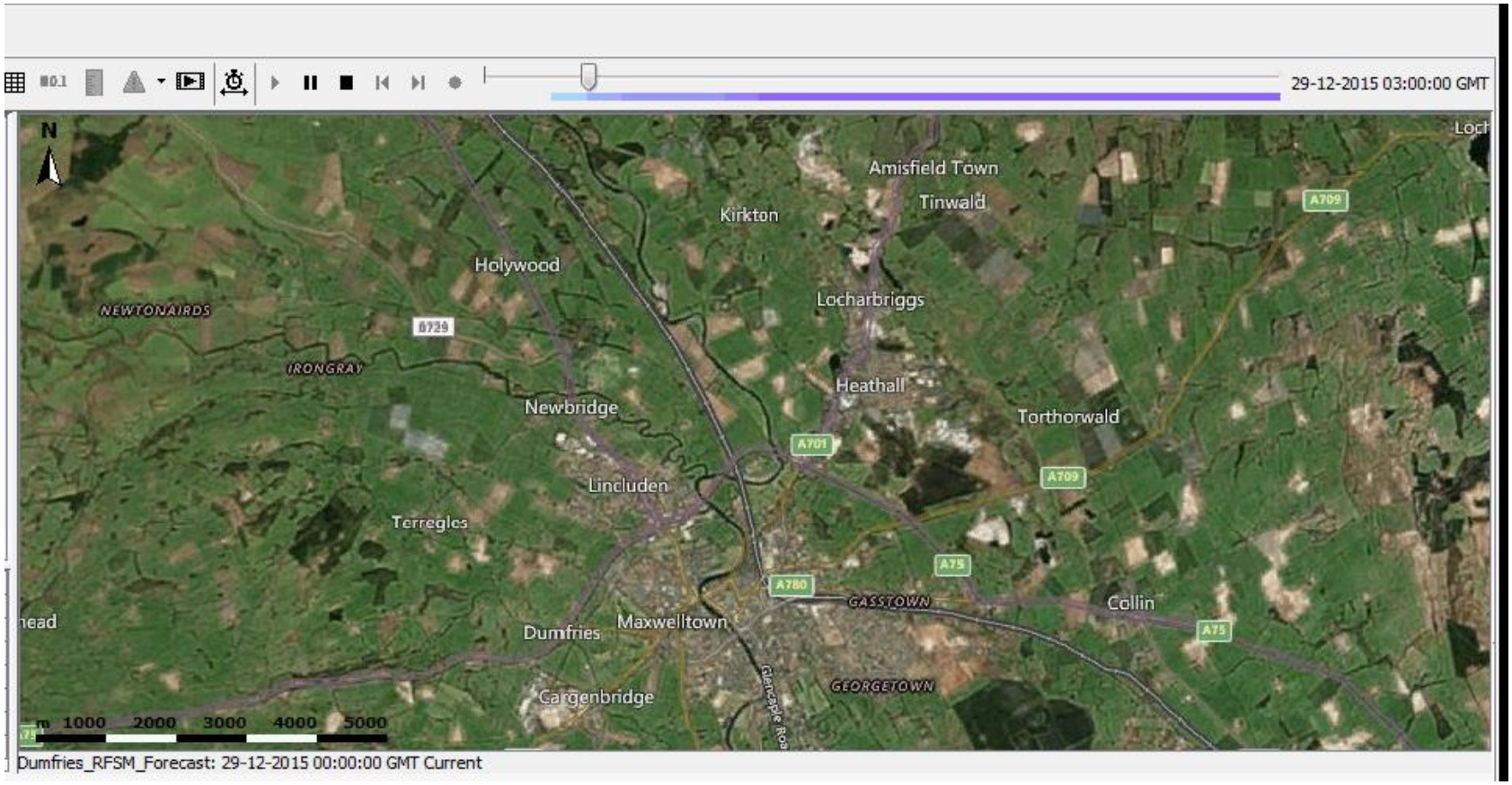
New information: Hindcast for Storm Frank (Dec. 2015)

Flood spreading



How the flood will spread?

Deltares

New information: Hindcast for Storm Frank (Dec. 2015)

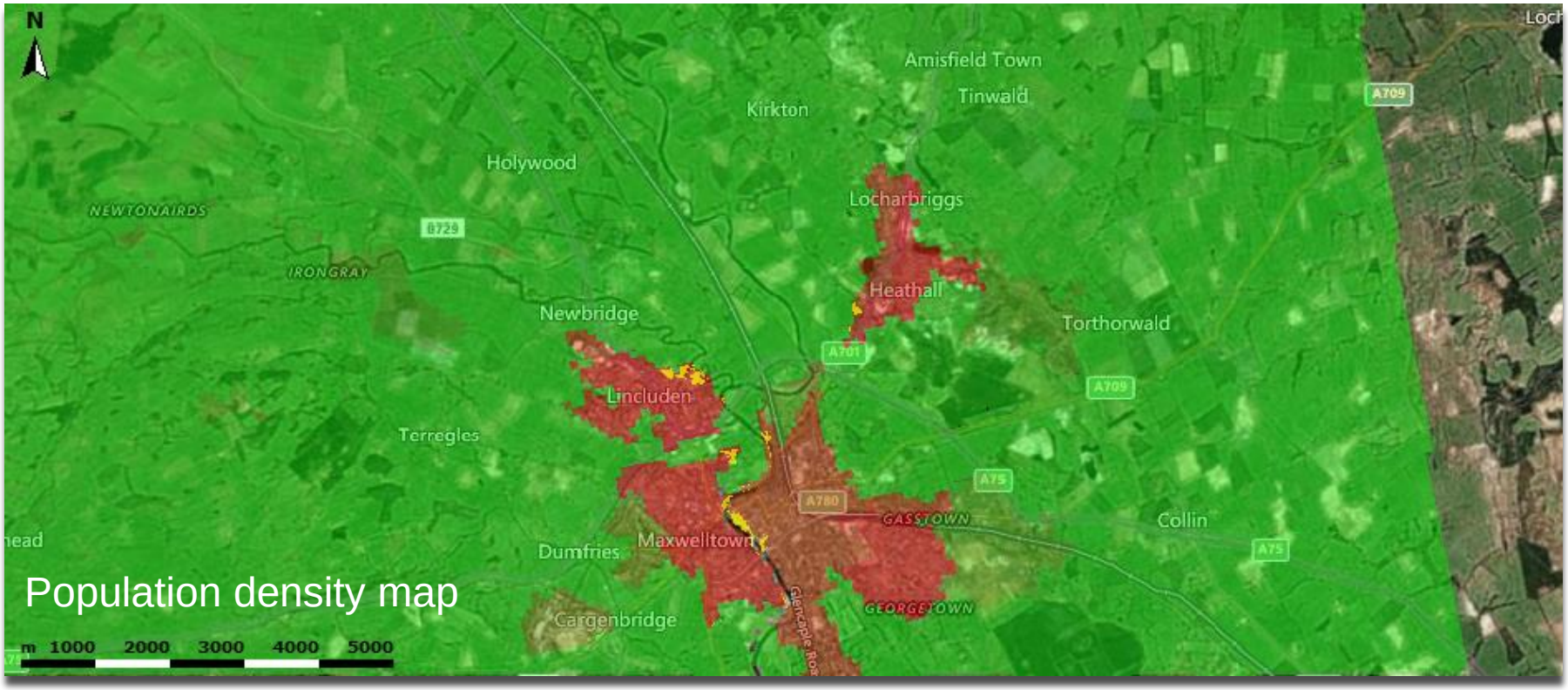
Arrival time

When and where a certain water depth will be reached?

Deltares

New information: Hindcast for Storm Frank (Dec. 2015)

Impacts to people (affected people)



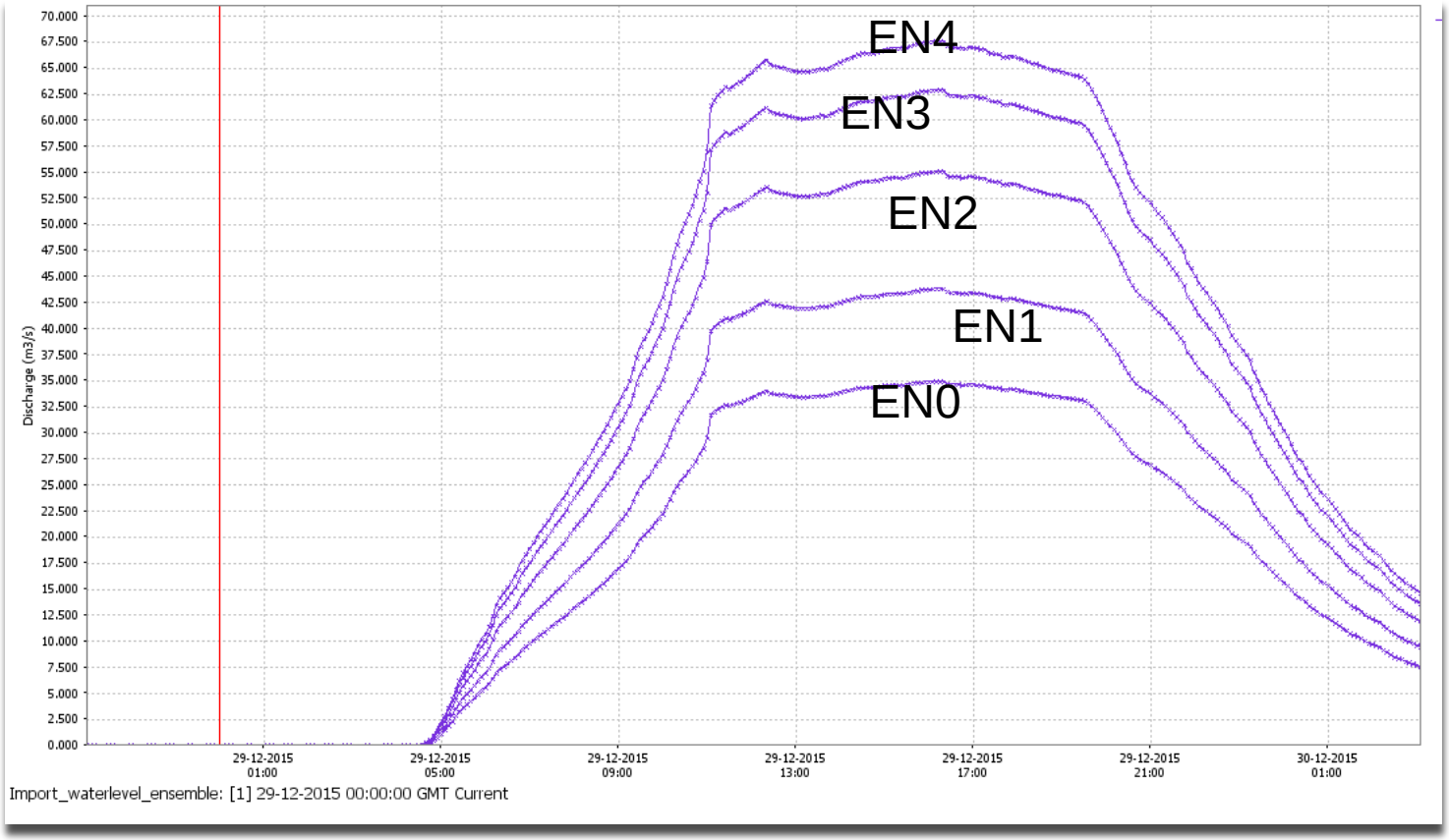
Population density map

Where and how much affected people can be expected (yellow areas)?

Deltares

New information: Hindcast for Storm Frank (Dec. 2015)

Use of ensemble forecast including uncertainties



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New information: Hindcast for Storm Frank (Dec. 2015)

Maximum water depth EN1

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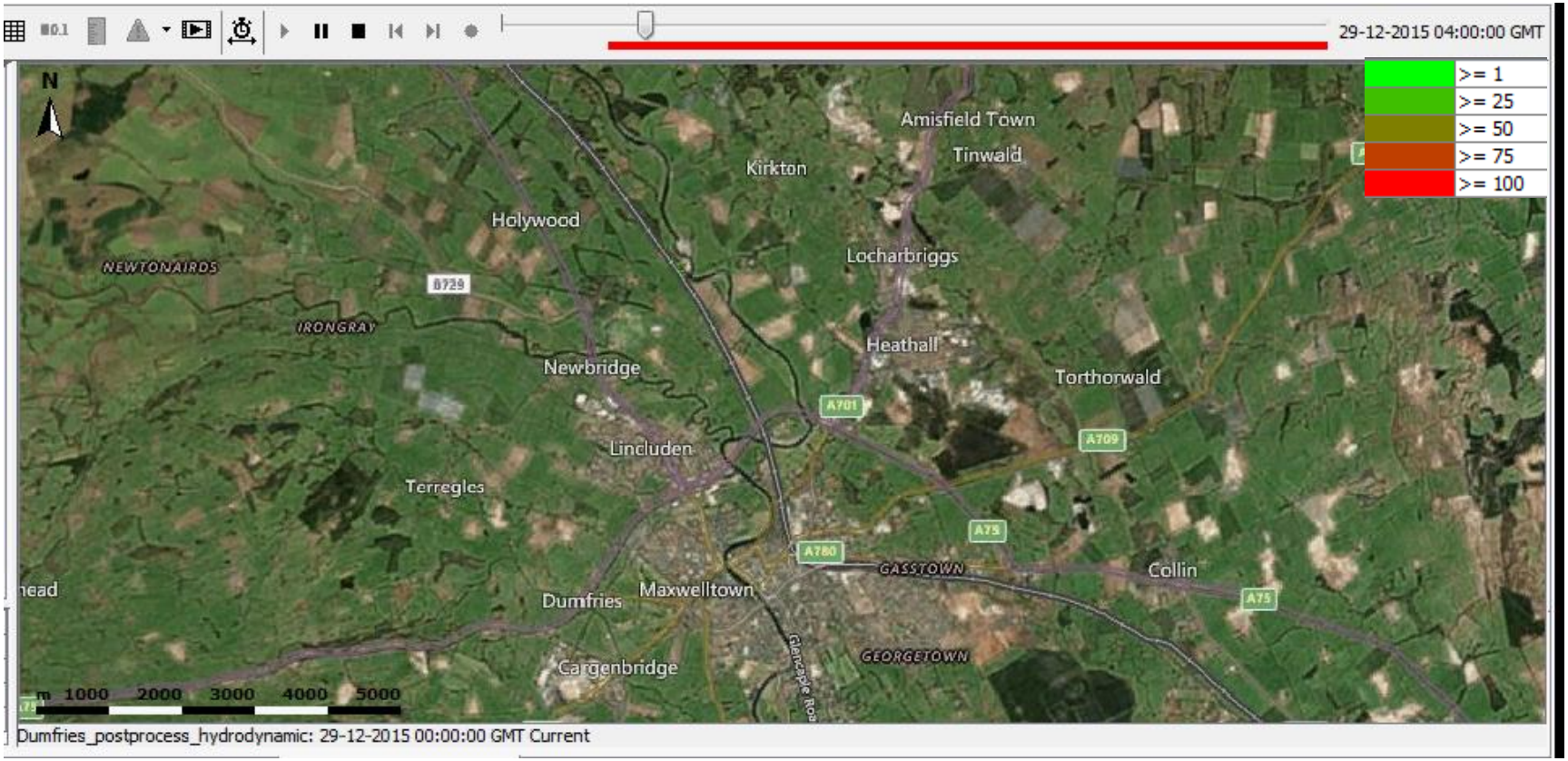
New information: Hindcast for Storm Frank (Dec. 2015)

Maximum water depth EN4

Deltares

New information: Hindcast for Storm Frank (Dec. 2015)

Probability(water depth > 0.5 m)

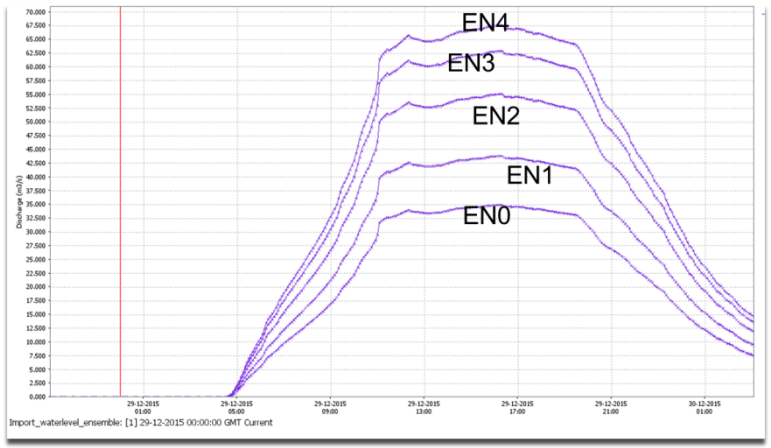


How probable is it, that a certain water depth is reached in a given place and a specific time?

Deltares

New information

Forecasting of flood risk



Probability

X

Consequences

=

Risk

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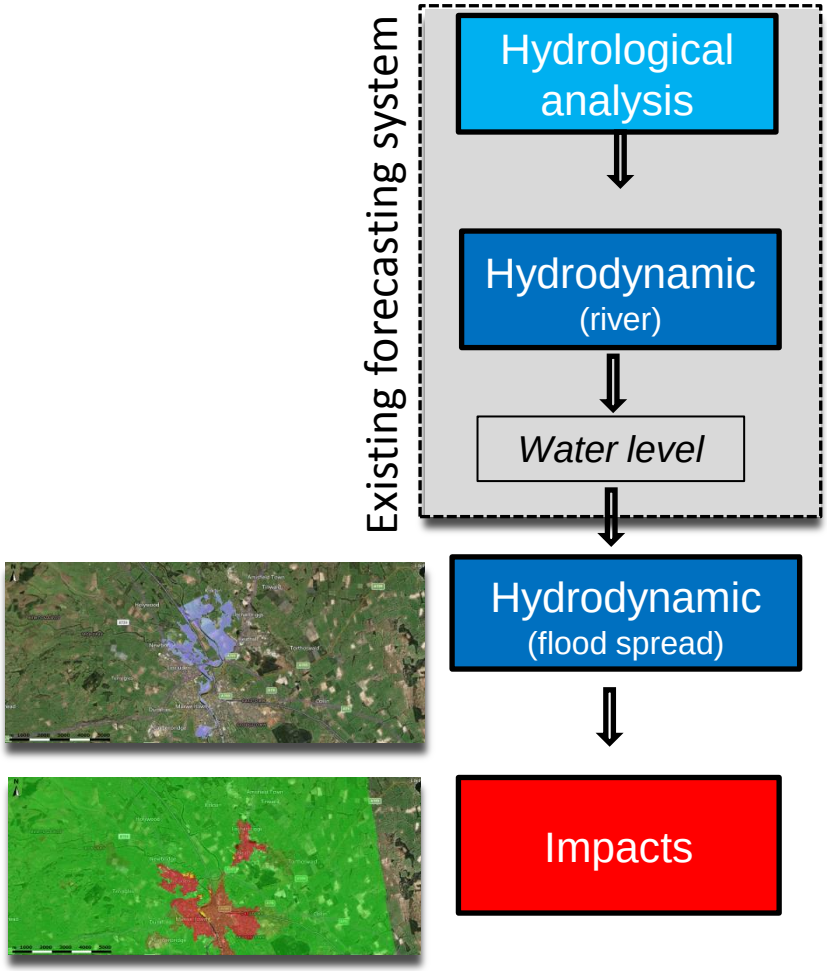
Status of the extended forecasting system

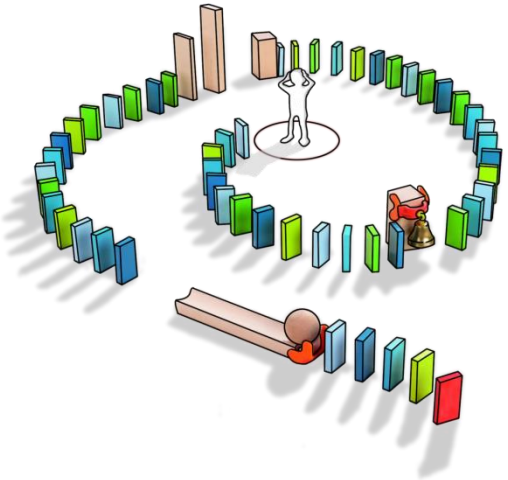
- Currently running at a **shadow forecasting** system by Deltares
- **No ensemble** mode

- **24 h forecast** is done every **12 h**

- **Calculation time** extended chain: about **20 min**



Critical Infrastructures and cascading effects



Relations and Consequences for Life and Environment

What are critical infrastructures (CI)?

"**Assets** of **special importance** for the country and its people where **failure** or functional impairment would **lead to** severe supply bottlenecks, **significant disturbance** of public order or other dramatic consequences" (Federal Ministry of the Interior [BMI])

Source: A. Burzel

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Sectors of critical infrastructures

Sectors	Subsectors
Energy	• Electricity • Gas • Oil
Information technology and telecommunications	• Telecommunications • Information technology
Transport and traffic	• Air transport • Maritime transport • Inland waterways transport • Rail transport • Road transport • Logistics
Health	• Medical services • Pharmaceuticals and vaccines • Laboratories
Water	• Public water supply • Public sewage disposal
Food	• Food industry • Food trade
Finance and insurance industry	• Banks • Stock exchanges • Insurance companies • Financial service providers
Government and public administration	• Government and public administration • Parliament • Judicial bodies • Emergency/rescue services including civil protection
Media and culture	• Broadcasting (television and radio), print and electronic media • Cultural property • Structures of symbolic meaning

Source: BMI

Source: http://cssd-ngo.org/

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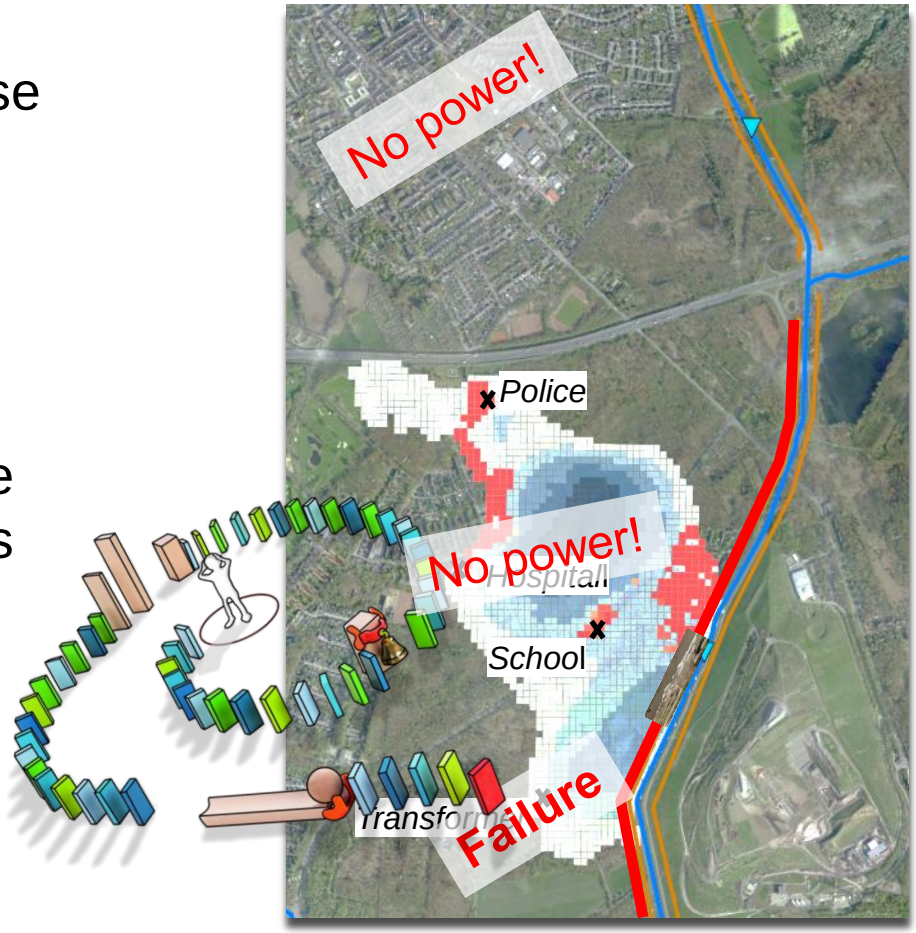
What are cascading effects?

- One failure in a network will cause cascading failure in the network
- Impacts are not restricted to the flooded area
- Failure in one network can cause failure in other networks / sectors

System river, protected area



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Critical infrastructures and floods (example)

HOCHWASSER IN NIEDERBAYERN

2016

Tausende Haushalte ohne Strom

AKTUALISIERT AM 01.06.2016 - 21:38

Source: FAZ

Hochwasser: So stark sind Handy, Festnetz & Internet betroffen

2013

Netzbetreiber versuchen Kunden schnellstmöglich zu helfen

Von Thorsten Neuhetzki

Kommentare (7) A A A Teilen

Inhalt:

1. Telekom mit mobiler Technik, Vodafone mit Task Force
2. E-Plus: Wo es geht, wurden Generatoren aufgebaut

Die Hochwassersituation im Osten und Süden Deutschlands macht auch zahlreichen Netzbetreibern zu schaffen. Sie können ihre Kunden nicht mehr versorgen. Da aber Hilfe in den Regionen auch über Facebook organisiert wird und

Source: https://www.teltarif.de/hochwasser-flut-telefon-internet-handy-stoerung-ausfall/news/51261.htm

Hochwasser in England

24. Juli 2007 07:47 Uhr

2007

100.000 Menschen ohne Trinkwasser

In den Hochwassergebieten im Süden und Westen Englands steigt das Wasser weiter. Drei Milliarden Euro Schaden hat die Sintflut bisher angerichtet. Mehr als 100.000 Menschen haben immer noch kein Trinkwasser, die Stromversorgung konnte aber wieder hergestellt werden.

Source: stern

2017

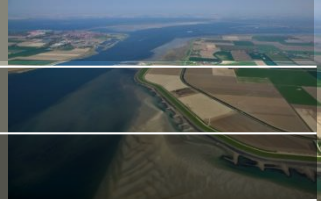
heute

Florida

Nach "Irma": Fast 6 Millionen Haushalte ohne Strom

11.09.2017 12:30 Uhr

Data and Modelling



- **How to get the data?**
  (often difficult to get it from the operators)
  - Location of CI
  - Connection between nodes
  - Connection between sectors

- **How to model the cascading effects?**

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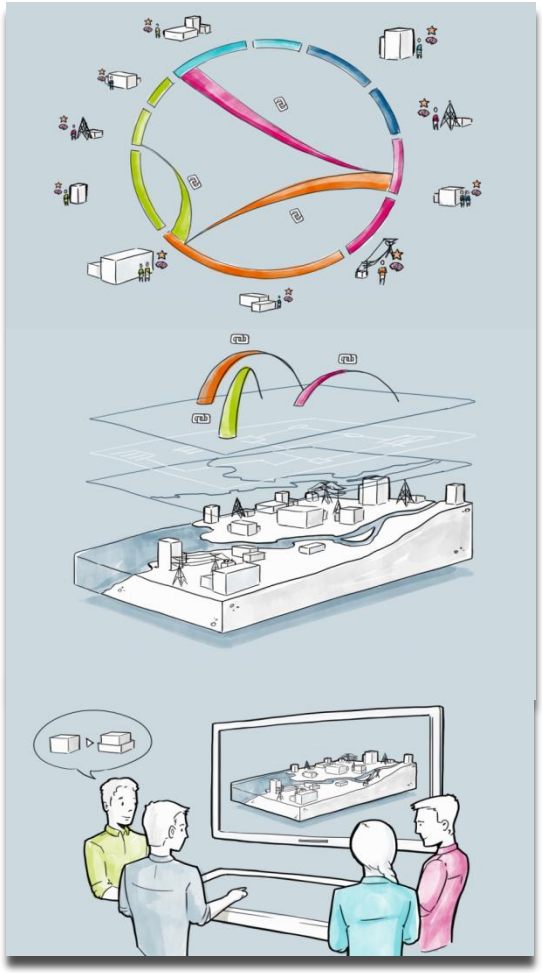
The circle approach

- Gather (open) data on CI and vulnerable objects
- Gather expert knowledge on direct impact, network vulnerability and interdependencies
- Combine (open) data with expert knowledge into cascading effects analyses



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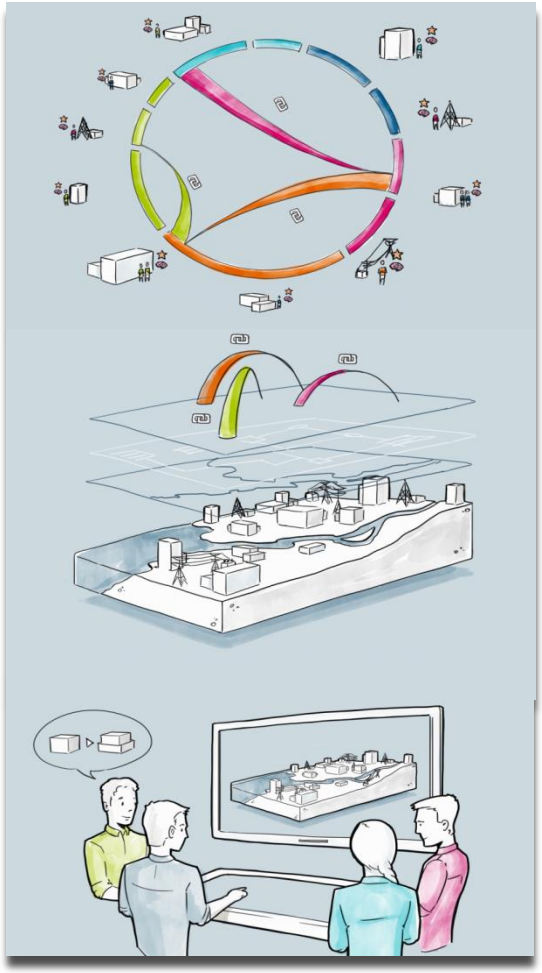
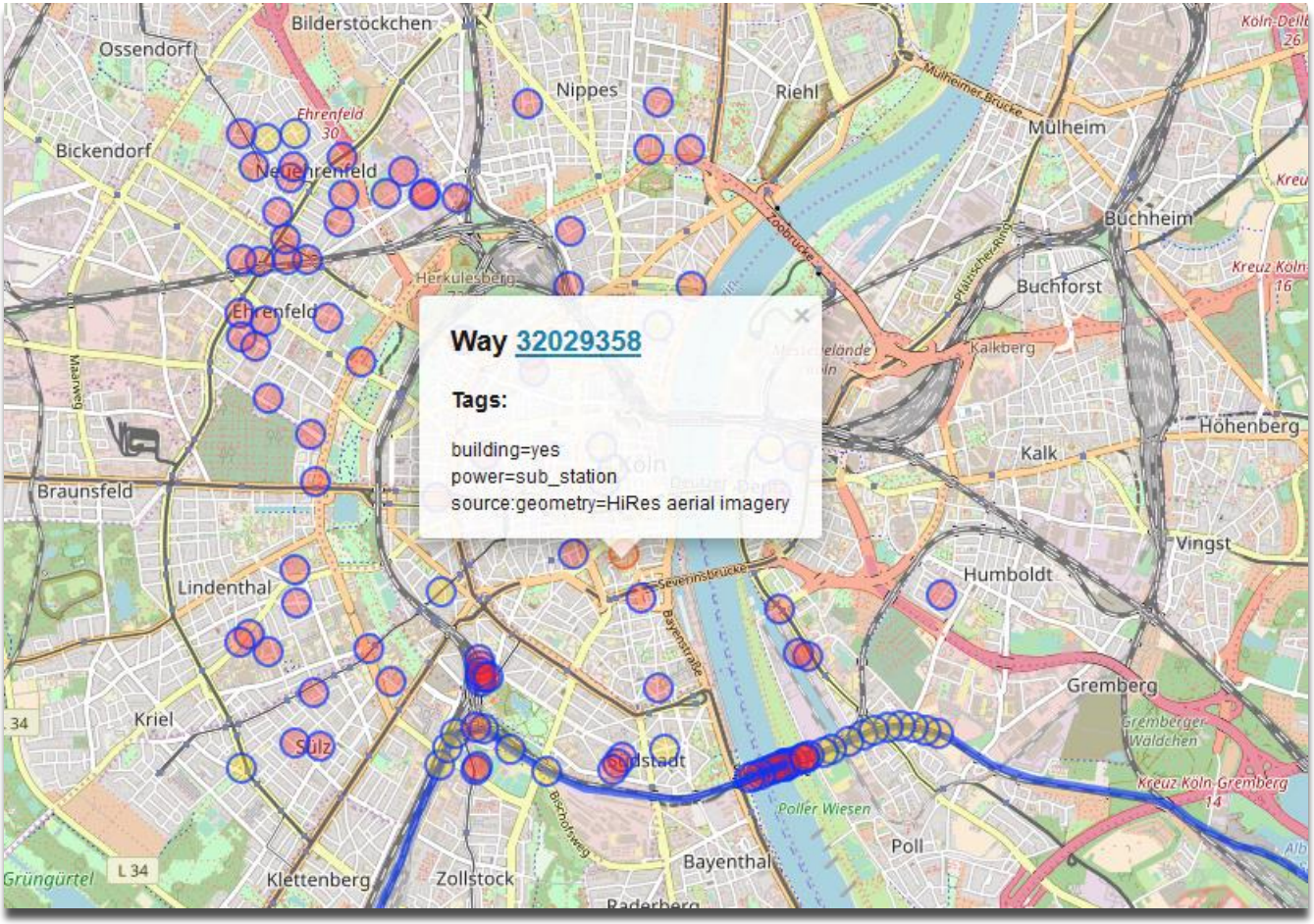


OSM-data “power” for Cologne



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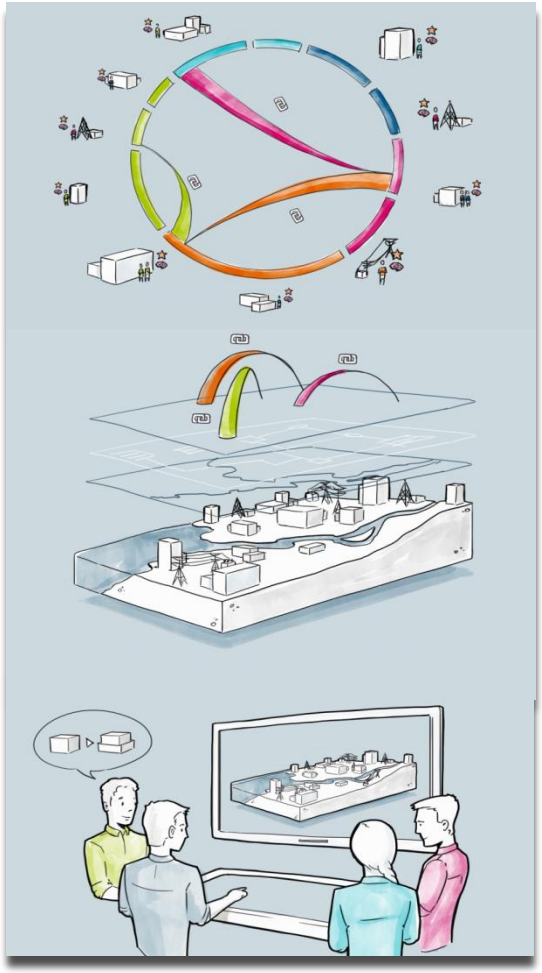
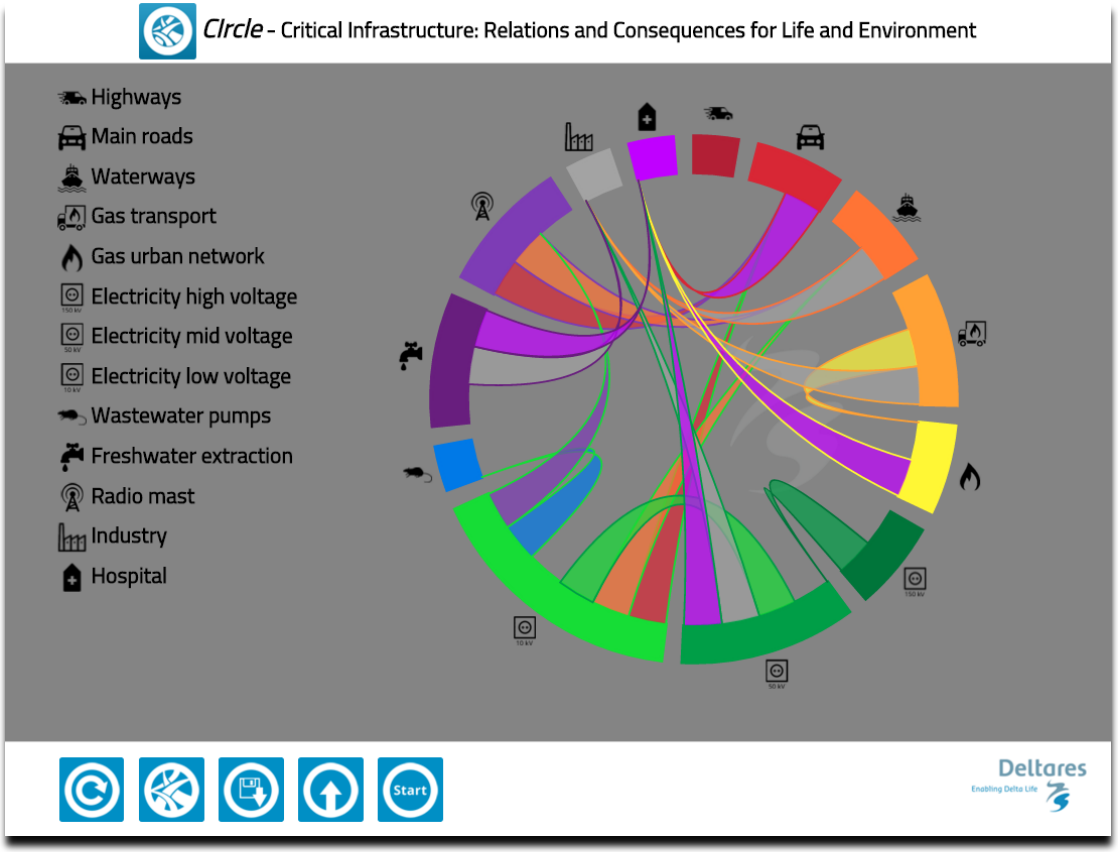


Expert knowledge and stakeholder engagement

Workshop

- Raising Awareness
- Share information

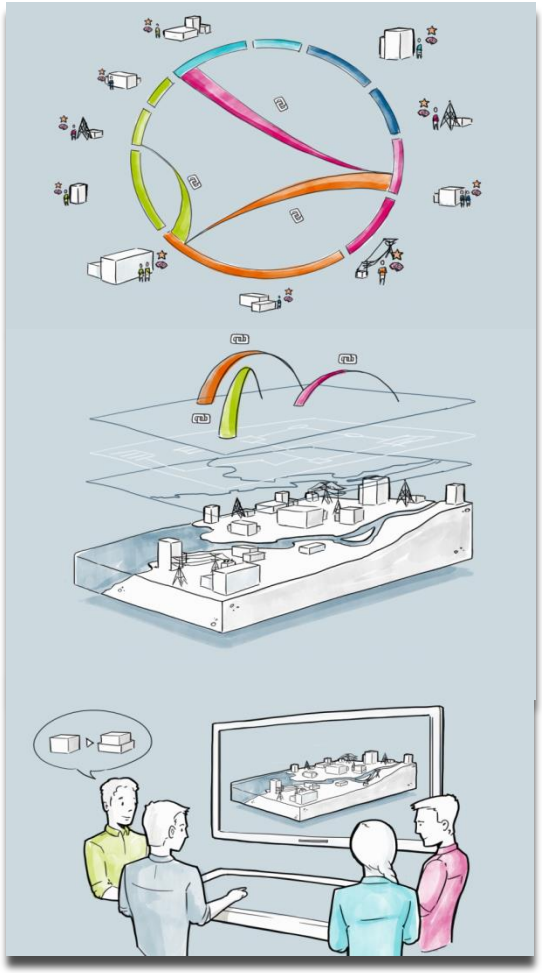


Result

Connection between the sectors for a region

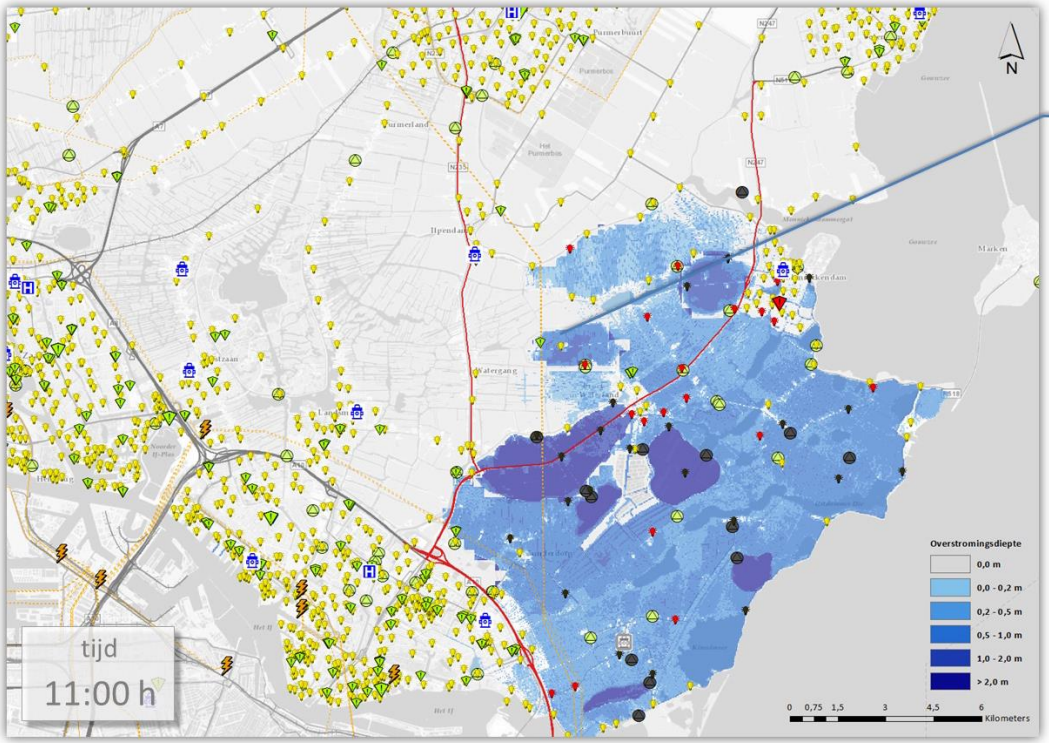
The circle approach

- Gather (open) data on CI and vulnerable objects
- Gather expert knowledge on direct impact, network vulnerability and interdependencies
- **Combine (open) data with expert knowledge into cascading effects analyses**



Modelling of cascading effects (example)

CIrcle case study - Cascading-effects in Waterland 1916 – 2016



Telecommunication towers fail. Nearby radio-controlled pumps cannot be operated any longer.

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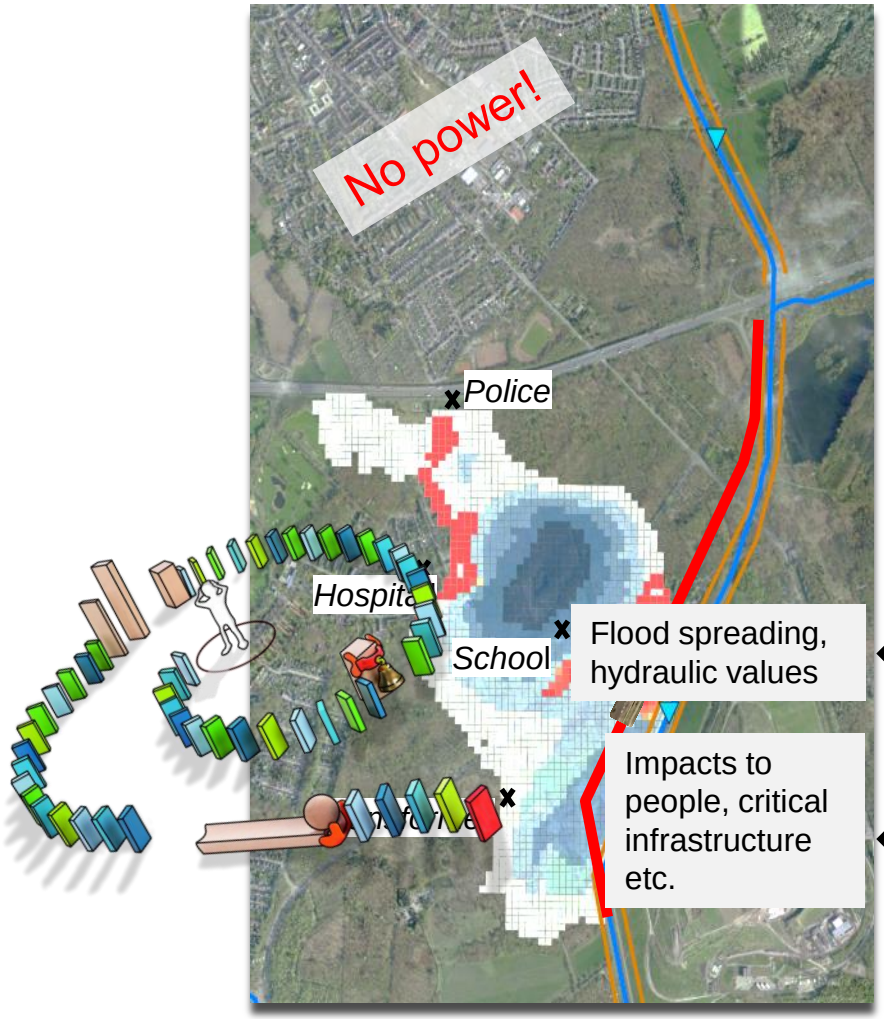
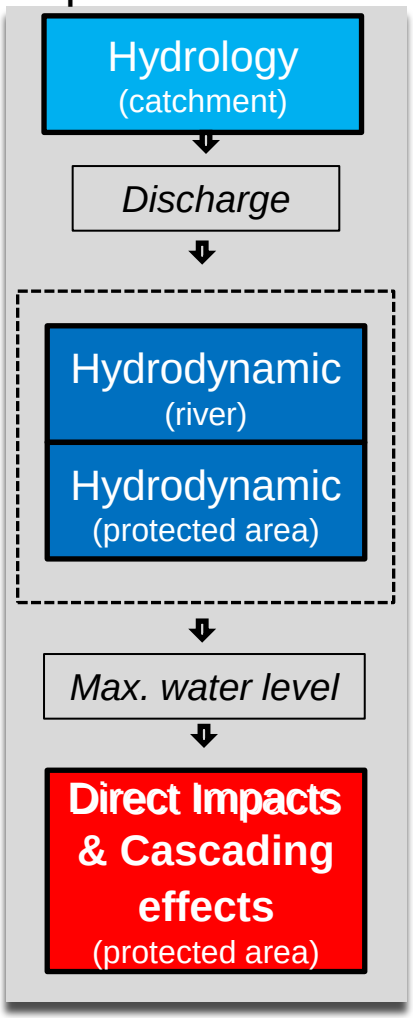
Impact-based forecasting and Critical infrastructure: A vision

System river, protected area



Forecasted process chain



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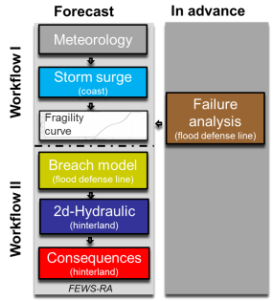
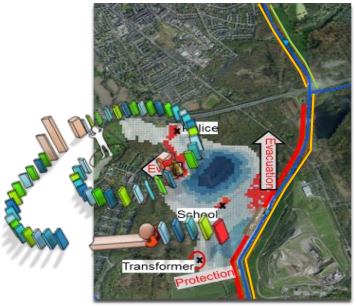
Conclusions

- **Technical point of view:** it is possible to provide information beyond water levels or discharges in flood forecasting systems like:
  - Flood spreading
  - Impacts
  - Cascading effects





- **Added value**:
  - Further Information for first responders, crisis managers and the public
  - Supports the development and adaptation of emergency measures in real-time


source: THW

First responders

Public


source: Bez. Reg. Duesseldorf

- **Organizational point of view:**
  - Major challenge is bringing different organization together (e.g. forecasters and crisis managers)

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Thank you for your attention!

Impact-based flood forecasting

www.deltares.nl/impact-based-forecasting

www.researchgate.net/project/Towards-risk-based-flood-forecasting

CI and cascading effects

www.deltares.nl/circle

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