

Towards impact based warnings: examples from Sweden and ARISTOTLE

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The Swedish warning service today

Impact based warnings – a background

Towards impact based warnings within Sweden

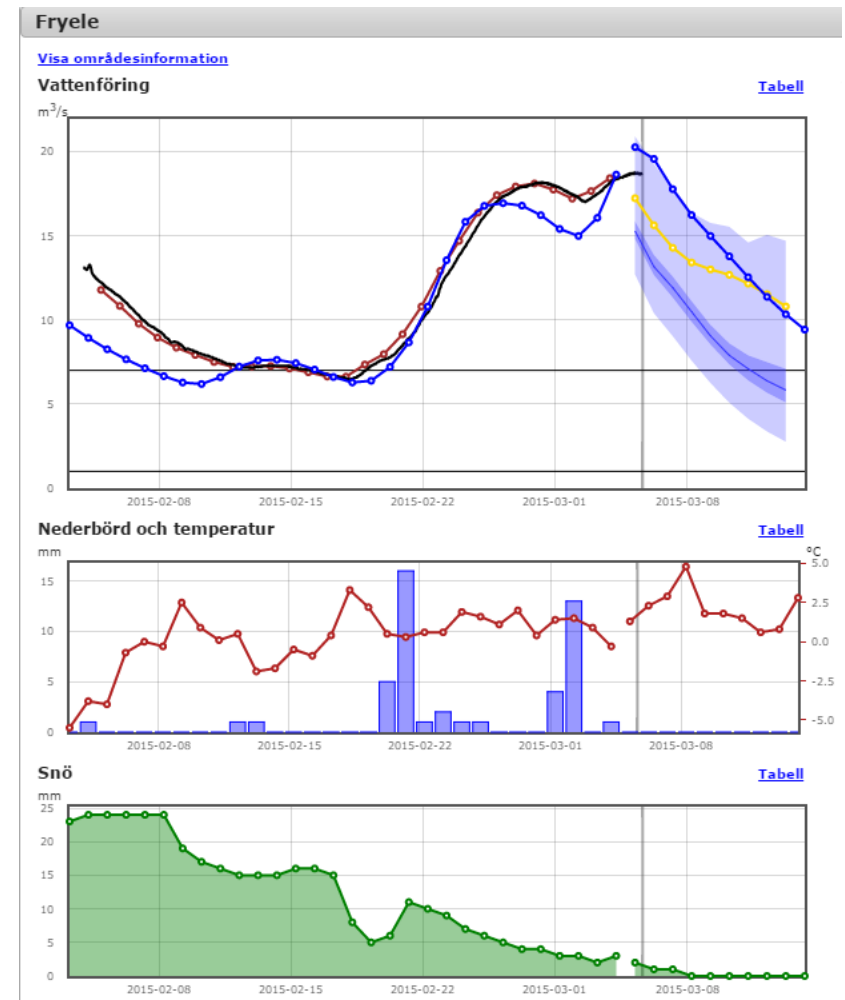
Aristotle, EFAS and impacts

- **1908:** Hydrografiska byrån is founded in Sweden
- **1917:** First flood forecast is issued, using snow measurements and estimates of catchment size
- **1972:** HBV model is developed and used extensively for the first time in 1977 (spring floods in Bergslagen)
- **2005:** HYPE model is developed, becoming operational in 2012
- **2012:** SMHI becomes an EFAS dissemination partner
- **2016:** Move towards impact-based forecasts begins



Hydrological warning service

- 365 days a year, 07-20
- **HYPE** and **HBV** models are currently used in the hydrological warning service
- 37,000 catchments are modelled in Sweden, median area of 7km²
- Driven by ECMWF ensembles and HARMONIE-AROME deterministic forecasts



Hydrological warning service

- Warnings are issued with a lead time of **0-48 hours**, for:
 - Critical water levels in major lakes
 - Extreme flows in rivers

- Fluvial warnings are based on return period river flows, with *generic impacts*:
 - ■ Class 1 (High flows): 2-10 year return period, *can cause limited flooding*
 - ■ Class 2 (Very high flows): 10-50 year return period, *flooding possible in vulnerable locations*
 - ■ Class 3 (Extreme flows): >50 year return period, *severe flooding possible*

Varningar

[ALLA](#)
[Brandrisk](#)
[Nederbörd](#)
[Nedisning](#)
[Plötslig ishalka](#)
[Vattenflöden](#)
[Vattenstånd](#)
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[Värme](#)
[Åska](#)

Sök län, länsområde eller havsområde

Jämtlands län utom fjällen

En varning. Två risker

VARNING KLASS 2 MYCKET HÖGA FLÖDEN

Test

Östersund

Svenstavik

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Test

Utfärdad: 15 april klockan 09:25

Definition för Varning klass 2 mycket höga flöden: Mycket höga flöden i vattendrag på en nivå som uppkommer i snitt vart tionde år. Översvämningssproblem på utsatta ställen.

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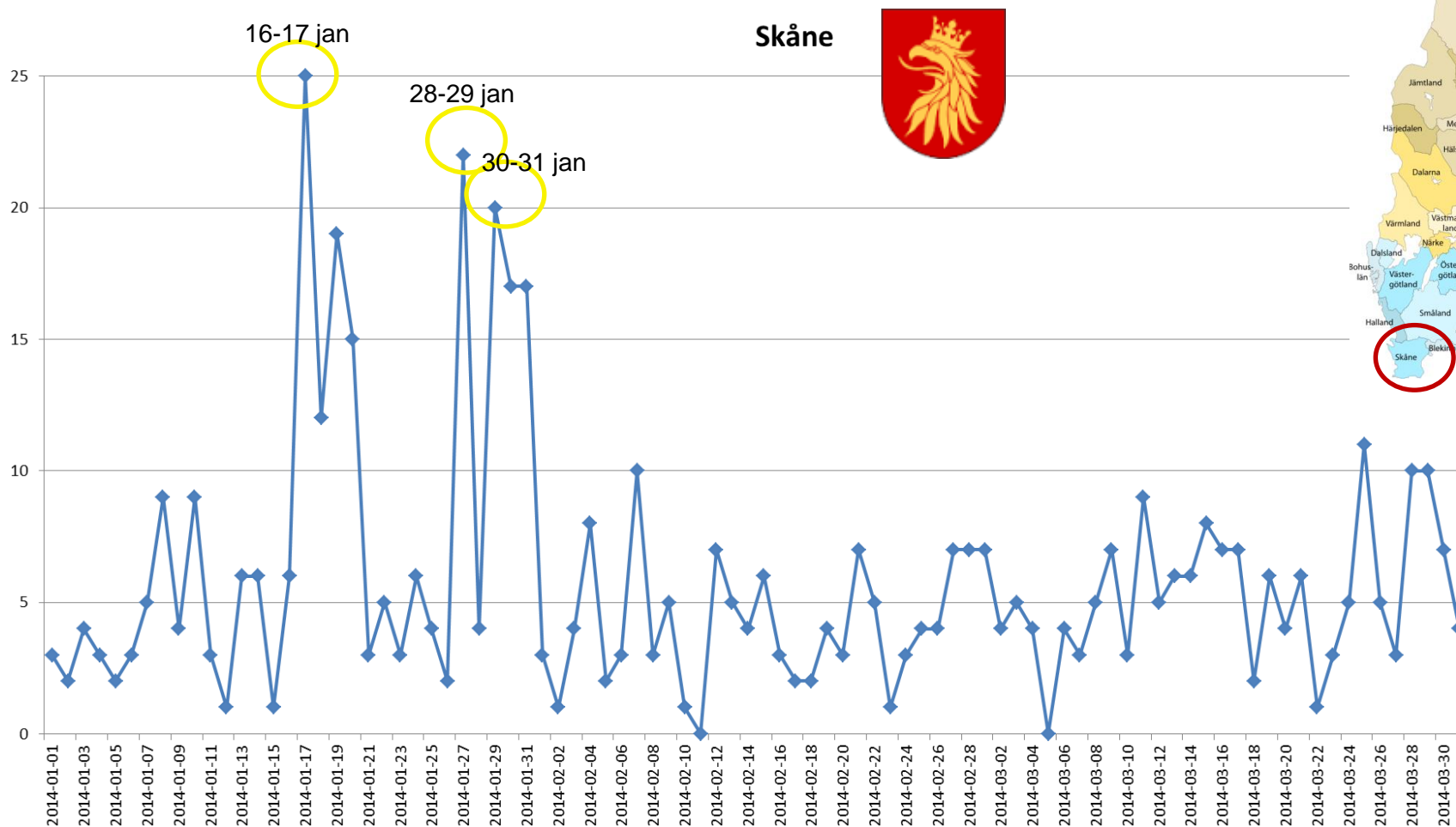
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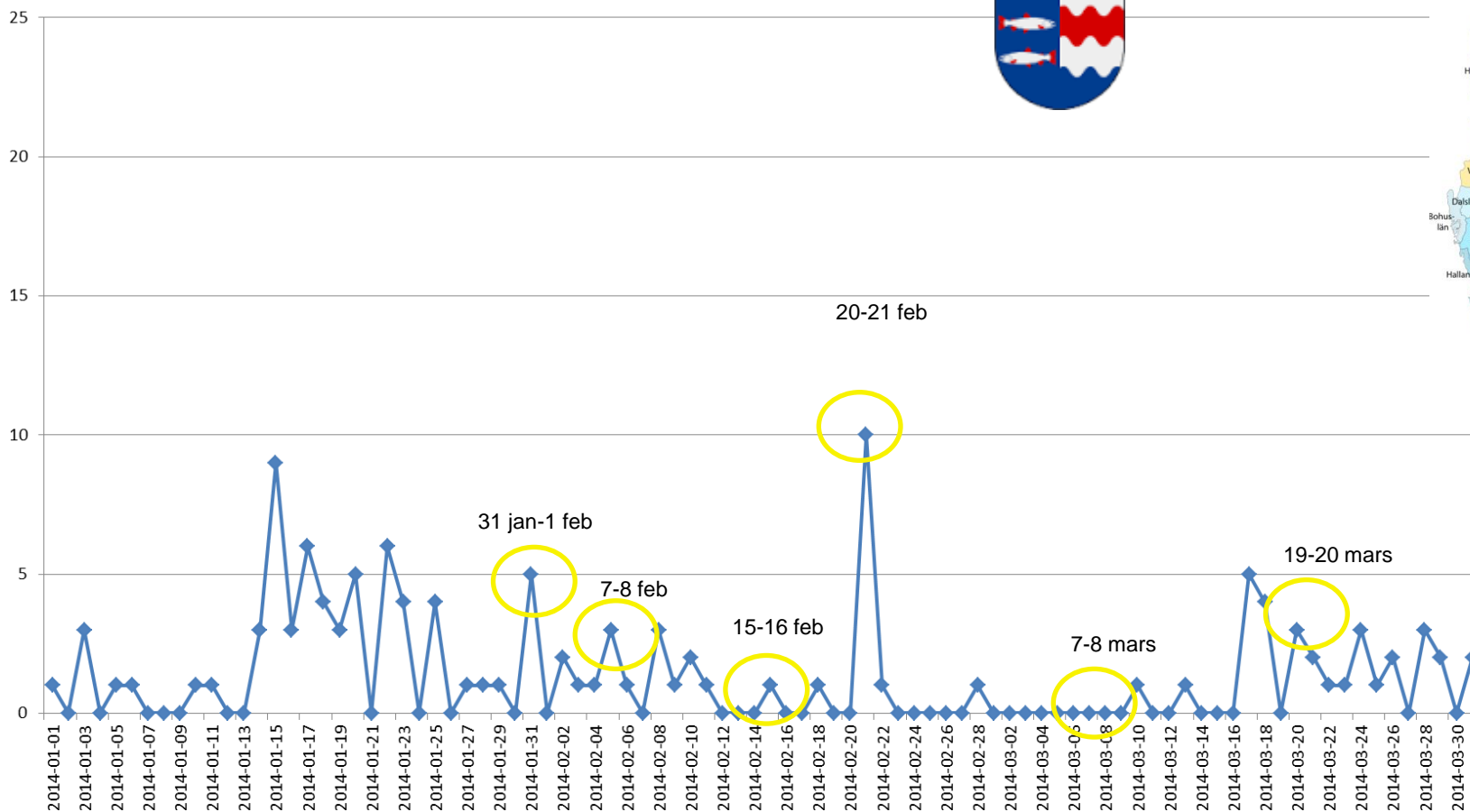
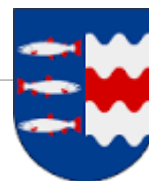
Aristotle, EFAS and impacts

Traffic accidents – class 1 warning for snow



Traffic accidents – class 1 warning for snow

Västernorrland



What are impact based warnings?

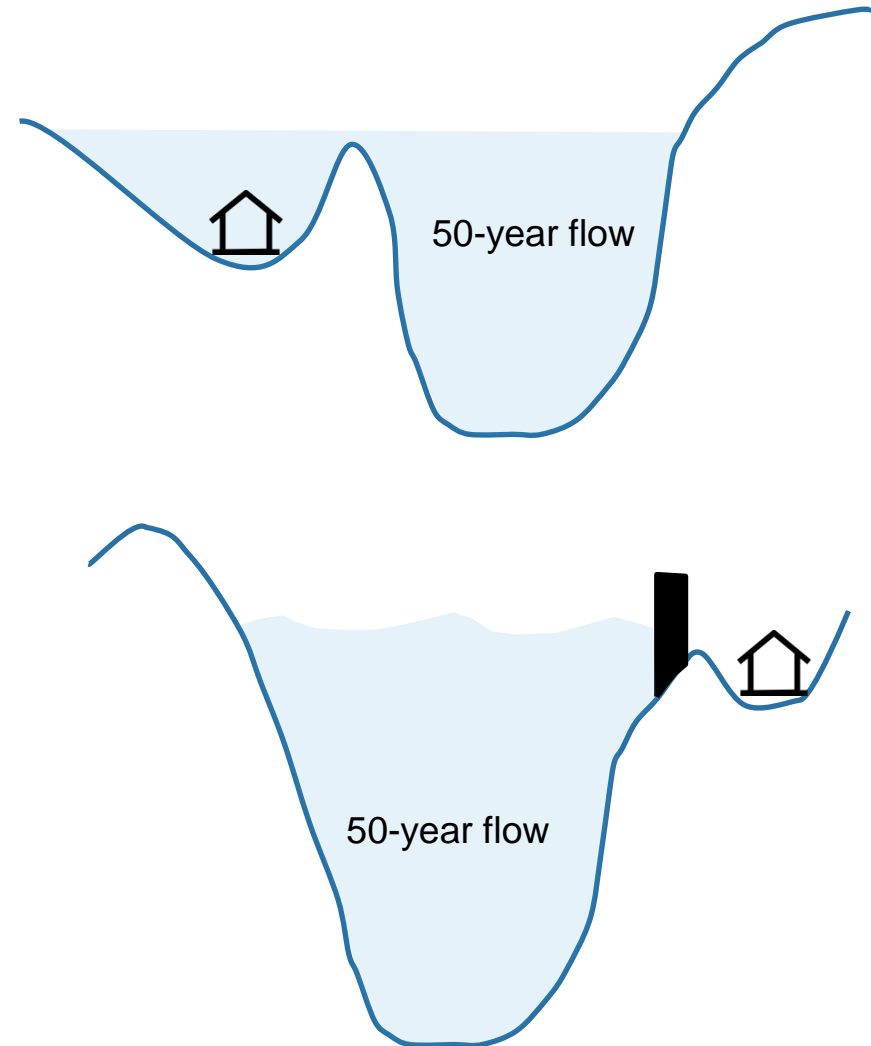
- **Impact = Hazard x Exposure**

Exposure includes number and type of population, locations of critical road and railways, hospitals, schools, time of day, etc.

Hazard based forecast	Impact based forecast
Class 2 warning for very high flows along Kungsbackaån with flooding possible in vulnerable areas.	Class 2 warning for very high flows along Kungsbackaån. Flooding expected in central Kungsbacka in the vicinity of the hospital and train station. E4 highway expected to be closed. <i>Residents should move belongings to a higher floor.</i>

Impacts from flooding

- For meteorological warnings, impacts can often be calculated directly from the currently forecasted variable
- For flooding, the **commonly forecasted variable is in-river flows**, but the variable that determines impacts is the **depth of water on the floodplain**



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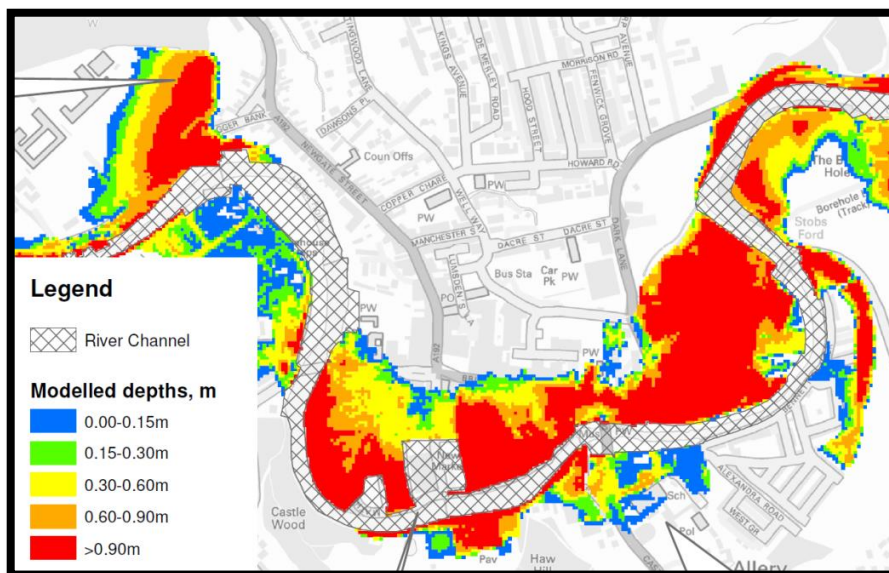
Aristotle, EFAS and impacts

Pilot project within Sweden

- SMHI are working with a number of partnering agencies to determine the potential for moving towards impact based forecasts within each forecasting discipline (met, hydro, ocean)
- Series of workshops has now led to a pilot project within specific regions
- Focus will be on (a) technical method development, (b) definition of new warning criteria and (c) communication of warnings

SMHI

Technical method development



- Methods are being developed to link SHYPE in-river flows to existing 2D hydraulic flood mapping, to provide real-time estimates of predicted inundation area
- New quantitative impact based warning levels will then be derived

Hazard

- SHYPE ensemble flows
 - 2x2m flood mapping
- Ensemble of forecasted flood depths with hourly resolution

+

Exposure

e.g., (1) number of properties at critical depths, (2) population, (3) number of major access roads and railways

=

Impact

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ARISTOTLE



- Pilot project to develop an Early Warning System for natural disasters for the Emergency Response and Coordination Centre (ERCC) in Brussels
 - Flooding; Severe Weather; Earthquake / Tsunami; and Volcanic Eruptions
 - Principal aim is to assimilate and transfer existing information from existing warning systems, so that the ERCC can make more informed decisions
 - Focus on **multi-hazard, impact based** response



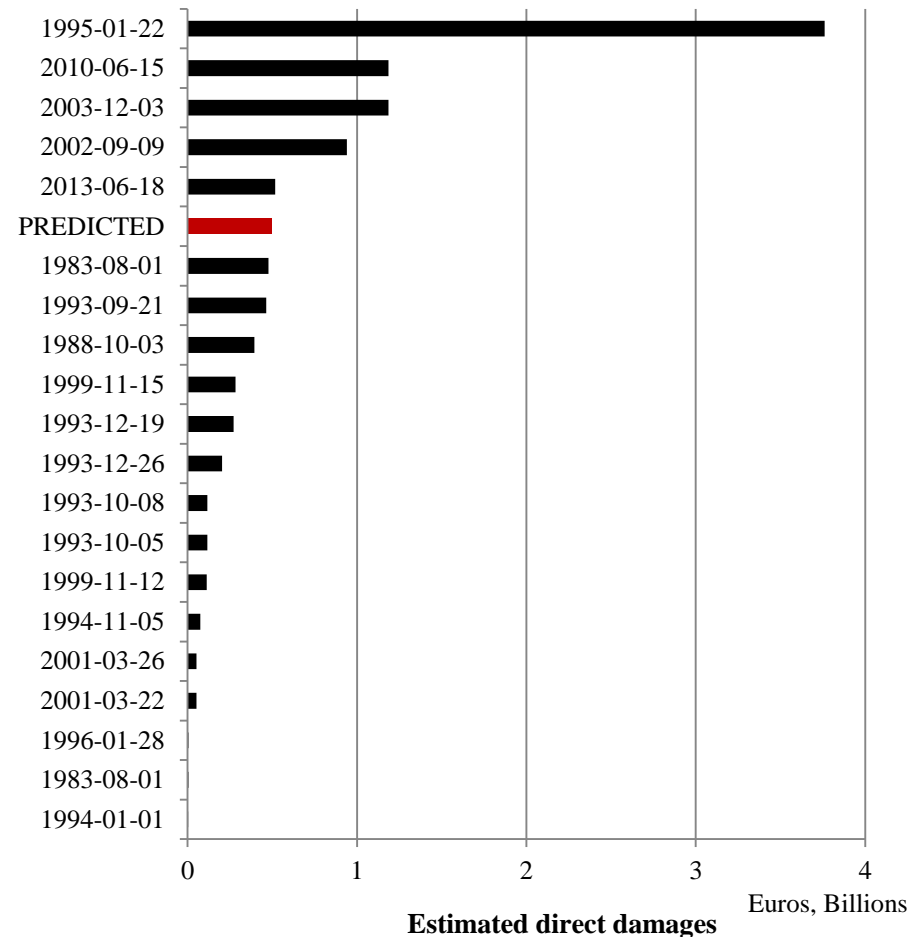
Examples of proposed outputs

- Existing notifications to the ERCC are **hazard based** only (timing and severity)
- New EFAS flood mapping module (Dottori et al. 2015) will provide estimates of flooded area by the end of 2016, from which **impact based** notifications can be generated

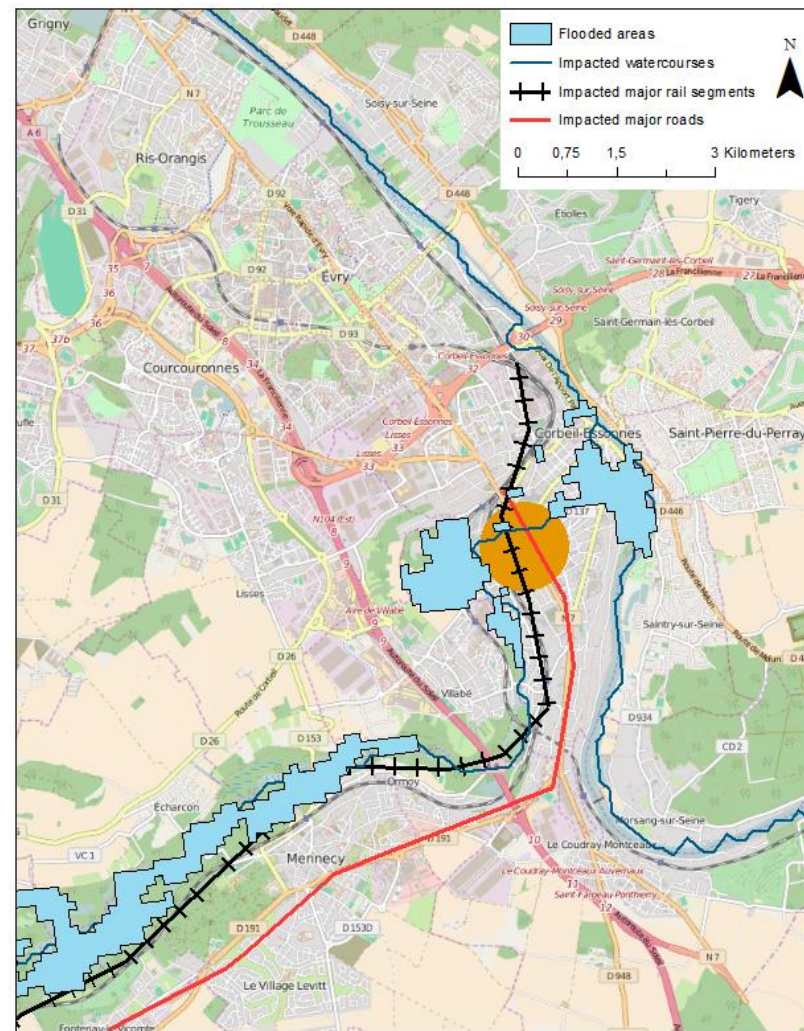
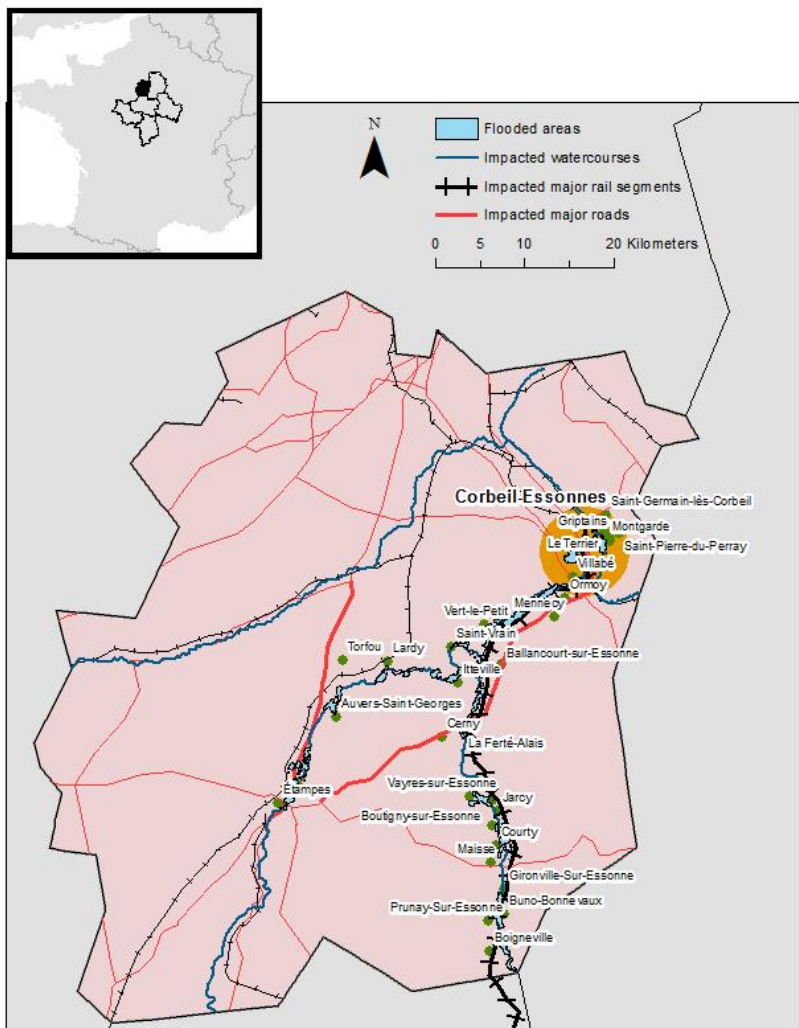
NUTS ID	Region	Population affected	Transportation impacts	Affected cities (population)
FR241	Loir-et-Cher	> 10,000	7 major roads 4 major rail segments	Romorantin-Lanthenay (17,900)
FR242	Essonne	> 10,000	4 major roads 3 major rail segments	Corbeil-Essonnes (40,300)
FR243	Loiret	> 10,000	5 major roads 4 major rail segments	Châlette-sur-Loing (14,600)
FR243	Seine-et-Marne	> 10,000	13 major roads 8 major rail segments	Coulommiers (13,100) Nemours (12,898)

Examples of proposed outputs

- **Economic losses:** historical context of predicted event
- Uses historical data from the European Environment Agency
- EFAS predicted ~500 million EUR of damages for the 2016 France floods (actual estimates between 0.6 and 2 billion EUR)



Examples of proposed outputs



Thank you!

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