SMHI

HEPEX WORKSHOP 2023
FORECASTING ACROSS SPATIAL SCALES AND TIME HORIZONS

IMPACT-BASED FLOOD WARNINGS IN SWEDEN USING A FLOOD INUNDATION MAP LIBRARY APPROACH

BLESSING OR CURSE?

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SMHI issues warnings for flooding as a consequence of…

Cloud burst

High discharge in rivers and lakes

High seawater level

Modelling strategy

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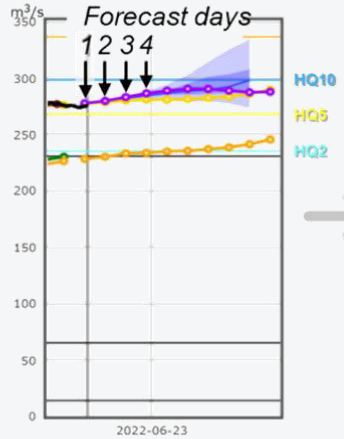
Operational process chain

Hydrological forecast from S-HYPE[3,4]



Water depths interpolation

Intersection with impact data

Warning level calculation

Collaboration with actors in advance of a warning

Pre-compiling of a
Flood inundation map library using LISFLOOD-FP[1] and GRASS-GIS[2]
with return periods 2, 5, 10, 25, 50 and 100 years

[1] Bates, P.D. & De Roo, A.P.J. 2000. A simple raster-based model for flood inundation simulation. Journal of Hydrology, 236(1–2): 54–77.

[2] Neteler, M., Bowman, M.H., Landa, M. & Metz, M., 2012. GRASS GIS: A multi-purpose open source GIS. Environmental Modelling & Software, 31: 124–130.

[3] Lindström, G. 2010. Development and test of the HYPE (Hydrological Predictions for the Environment) model – A water quality model for different spatial scales. Hydrology Research, 41(3–4): 295–319.

[4] Strömqvist, J., Arheimer, B., Dahné, J., Donnelly, C. & Lindström, G. 2012. Water and nutrient predictions in ungauged basins: set-up and evaluation of a model at the national scale, Hydrological Sciences Journal, 57:2, 229-247.

[5] Lantmäteriet. https://www.lantmateriet.se/en/geodata/geodata-portal/ (several data layers, e.g. buildings, water courses, DEM).

[6] Trafikverket. https://bransch.trafikverket.se/ (several data layers: roads, railways, bridges).

[7] Swedish county administrative boards. EBH-kartan, https://ext-geoportal.lansstyrelsen.se/standard/?appid=ed0d3fde3cc9479f 9688c2b2969fd38c (open source, in Swedish).

Modelling strategy

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13.500 sub-catchments with an upstream area >50 km^2 and an average size of 8 km^2 are simulated

Spatial resolution is 5 m for the river models, but was locally increased to 1 m in lake models to better reflect dam structures

~10 000 river catchments are modelled with a **coupled 1D-2D hydraulic flood model** *(80% running, 30% with good quality)*

~3500 lake catchments are modelled with a **simplified GIS-interpolation model** *(65% running, quality assessed but not calibrated)*

Pre-compiling of a
Flood inundation map library using LISFLOOD-FP[1] and GRASS-GIS[2]
with return periods 2, 5, 10, 25, 50 and 100 years

10.000 working models * 6 RP =
60.000 inundation maps

Modelling strategy

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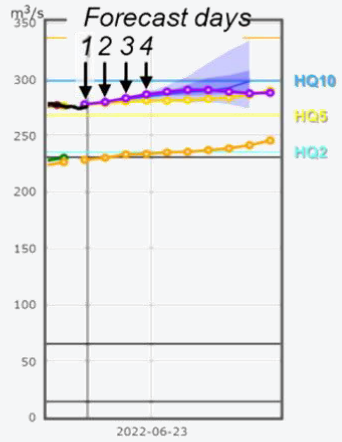
Hydrological forecast from S-HYPE[3,4]



Pre-compiling of a **Flood inundation map library using LISFLOOD-FP[1] and GRASS-GIS[2]** with return periods 2, 5, 10, 25, 50 and 100 years

Start of the operational part of the workflow

S-HYPE: hydrological model used in the forecasting service

Lumped (subbasins)

SLC, Soil and Landcover Classes (HRU concept)

Daily temporal resolution

Modelling strategy

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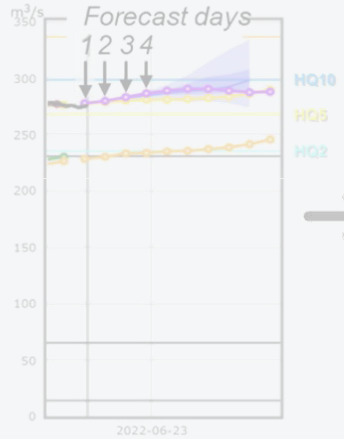
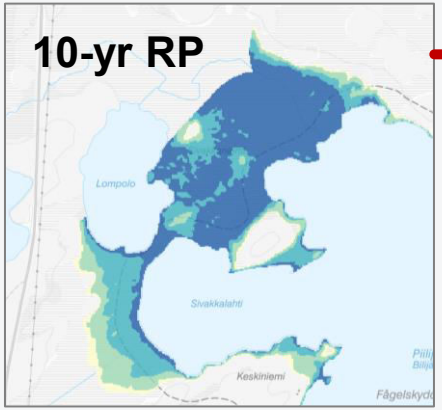
Operational process chain

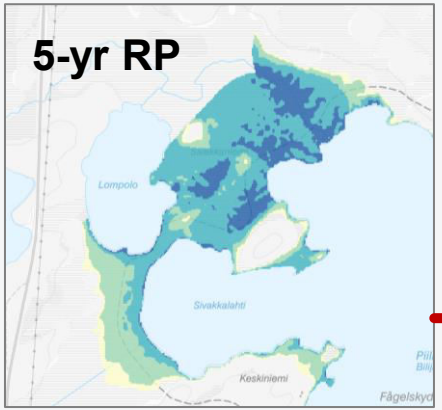
Hydrological forecast from S-HYPE[3,4]

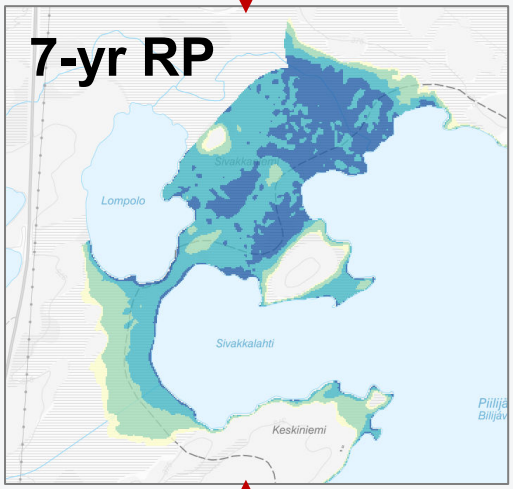


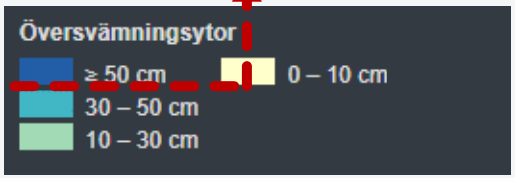
Water depths interpolation

Pre-compiling of a **Flood inundation map library using LISFLOOD-FP[1] and GRASS-GIS[2]** with return periods 2, 5, 10, 25, 50 and 100 years

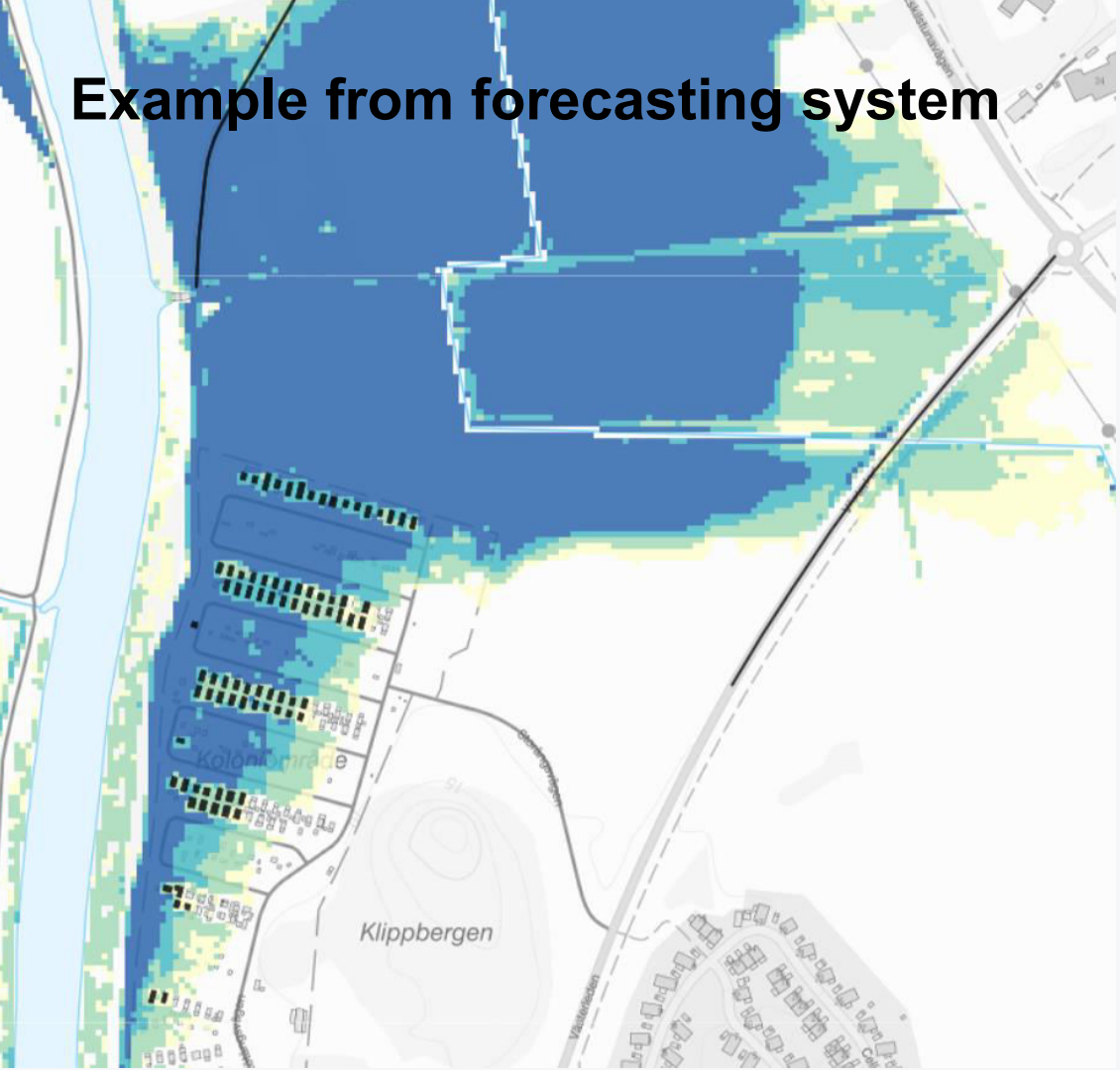








Example from forecasting system



Overlay of operationally computed inundated area with impact layers

→ Affected objects are highlighted

→ Areas without impacts are not highlighted

Example from forecasting system

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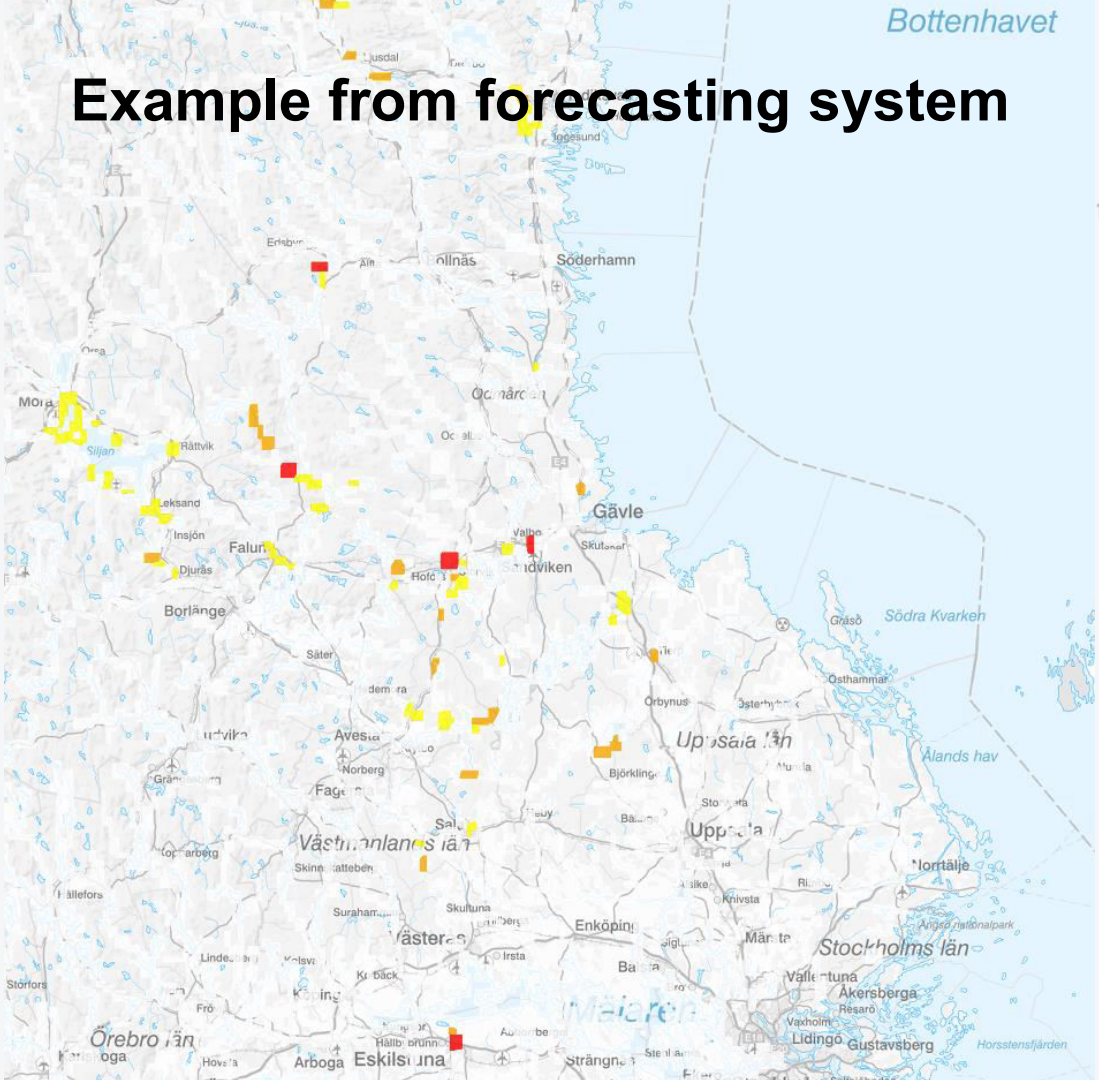

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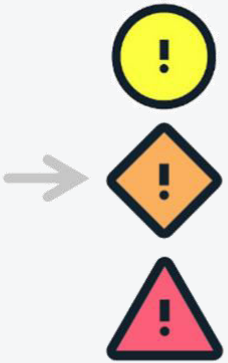
Warning level calculation



E.g. a certain number of houses flooded, length of affected infrastructure, …

Derived for smaller, defined warnings areas

Modelling strategy

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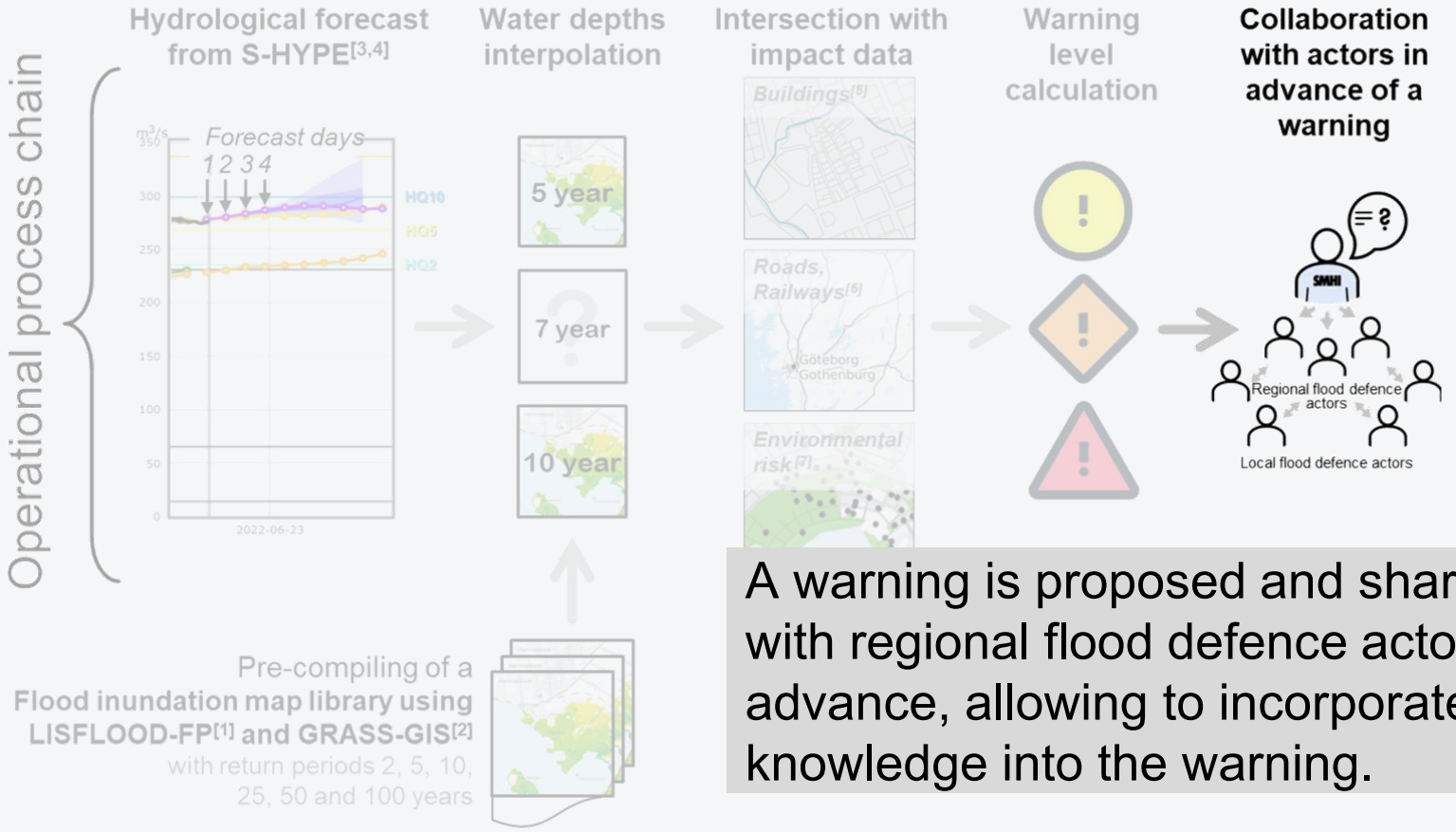

A warning is proposed and shared with regional flood defence actors in advance, allowing to incorporate local knowledge into the warning.

Modelling strategy

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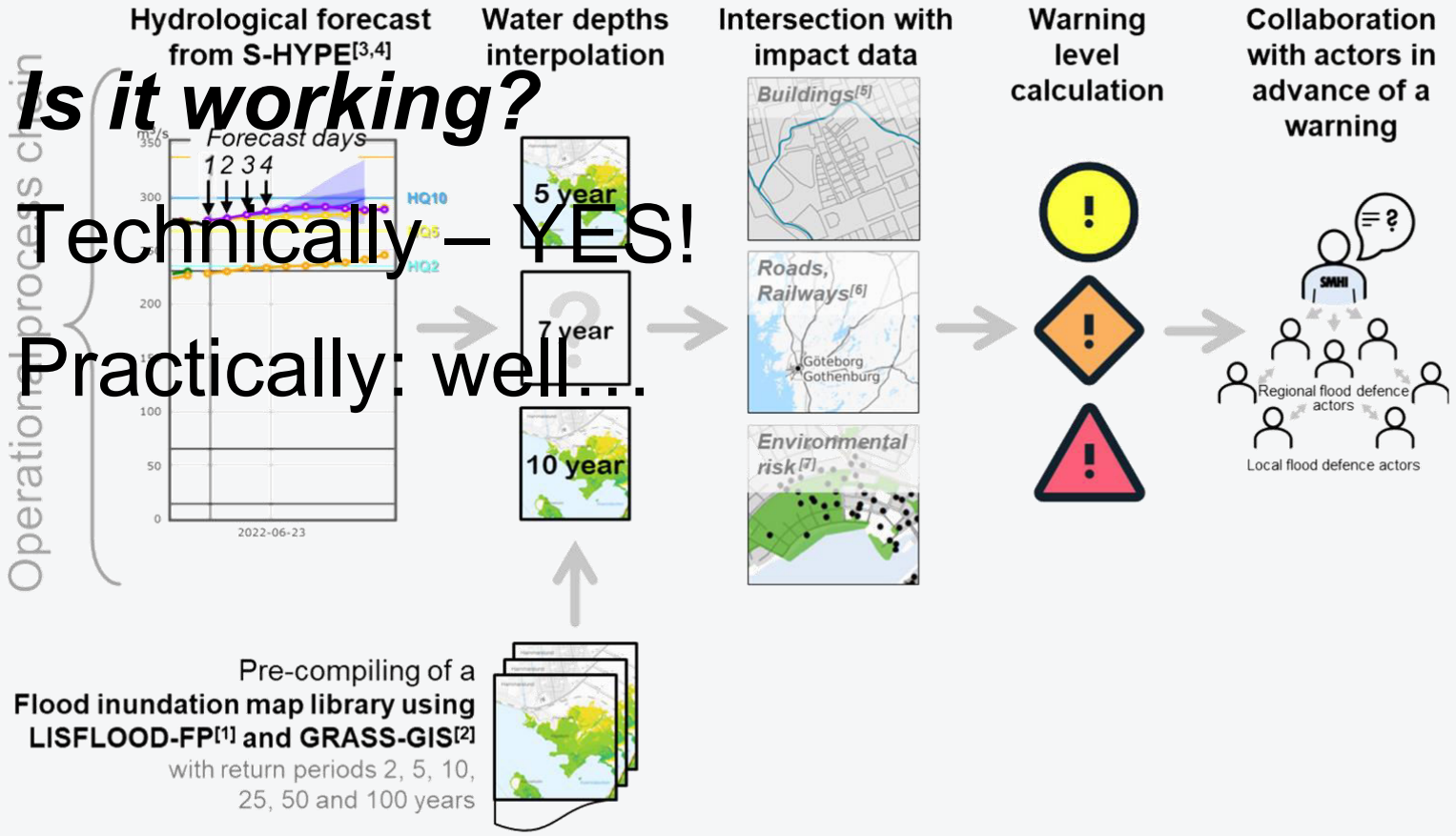

Is it working?

Technically – YES!

Practically: well…

Impact-based flood warnings – both a blessing and a curse

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We are operationally and at a high spatial resolution

» computing flood inundation extent
» over vast areas in Sweden
» on a daily basis.

Currently, numerous limitations negatively affect

» the quality of the modelling results leading to
» a high manual workload that cannot be handled in situations where it's most needed.

What's next? (apart from improving models)

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- **Adjust criteria:** more severe consequences (e.g. more houses affected)
- **Generalize information:** for the public (both visually and content-wise/text)
- **Streamline internal workflows:** more rigourous
- **Simplify procedure:** to notify regional actors (automatisation? no quick fix…)
- **Overall aim:** boil down the vast amount of available data to useful pieces of information (user-specific!)

SMHI

Richard

Marc

Fredrik

Disa

model code

Clara

...and many more!

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WANT TO SHARE **YOUR** EXPERIENCE **OR** IDEAS**?**

We're curious – let's discuss!