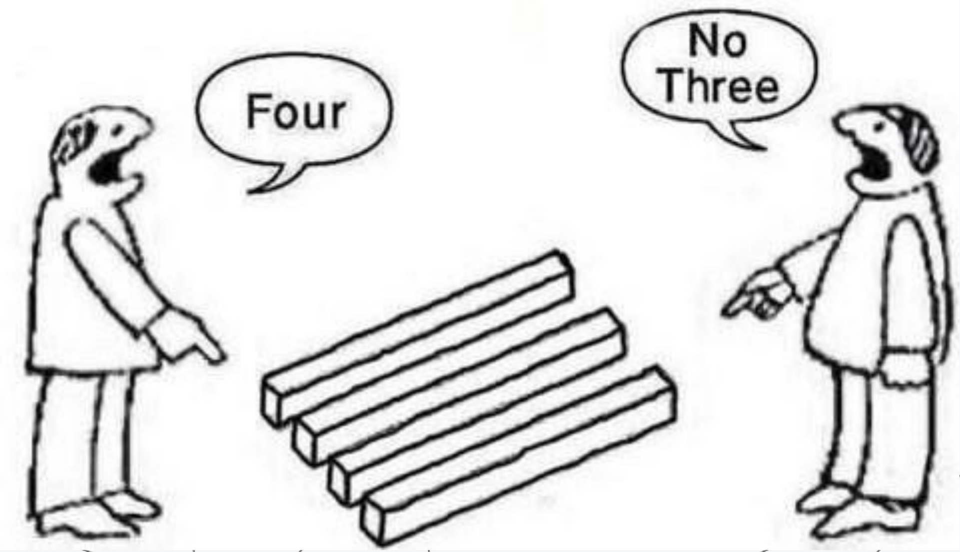
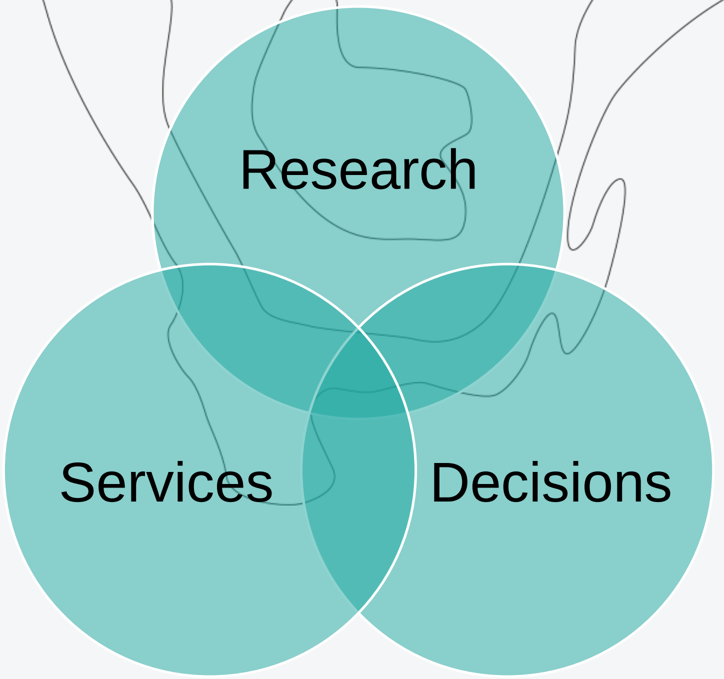


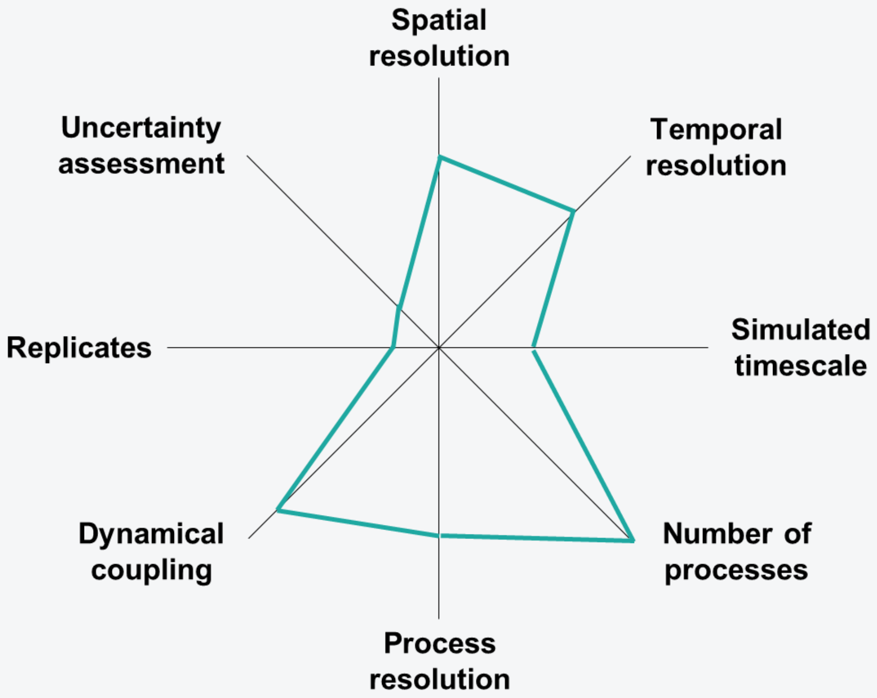


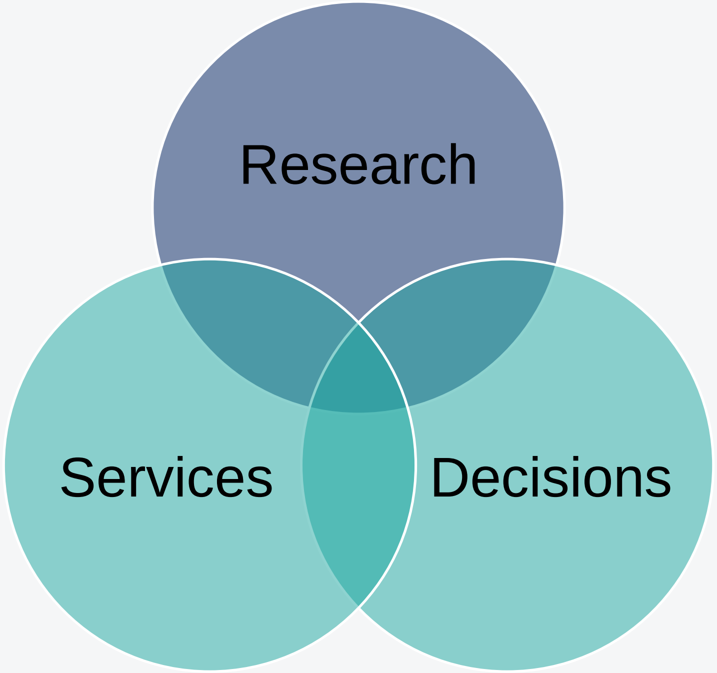
ILIAS PECHLIVANIDIS ET AL.

FLOODING BEYOND PREDICTION A REALITY OF DIFFERENT PERSPECTIVES

SMHI

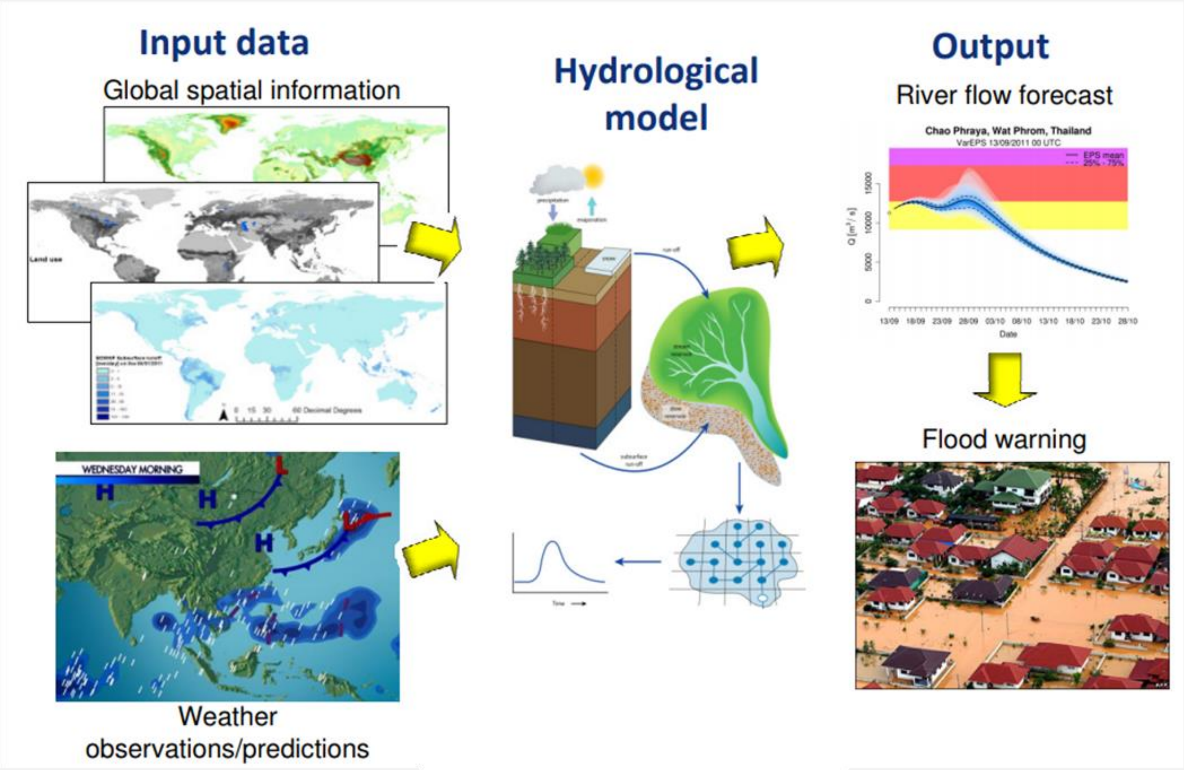
Different perspective on the future evolution of models



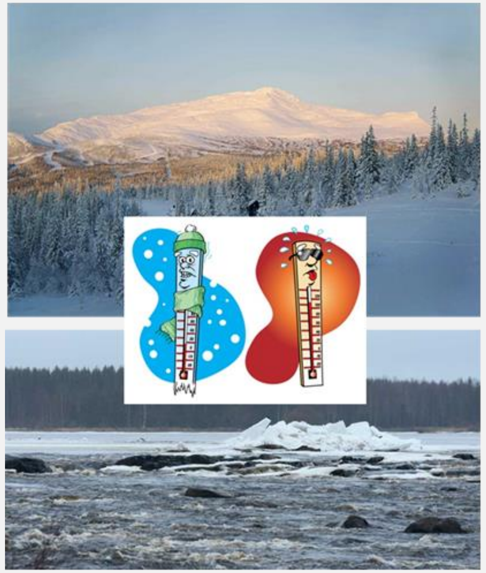


Understanding flood prediction chain and the sources of predictability

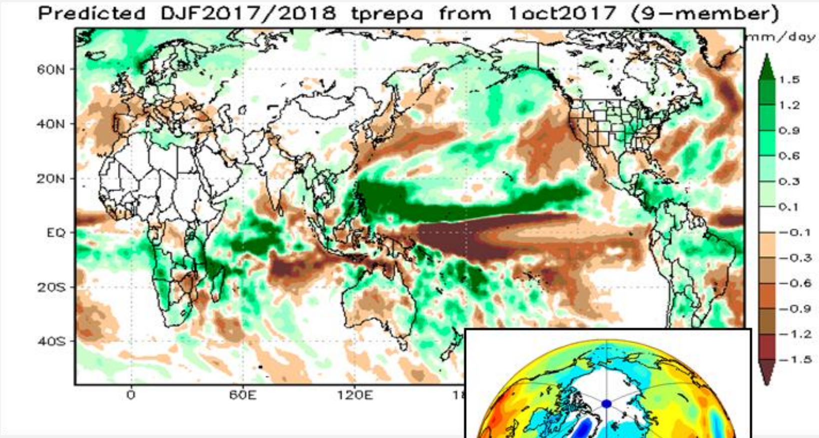
’Traditional’ model chain for flood forecasting

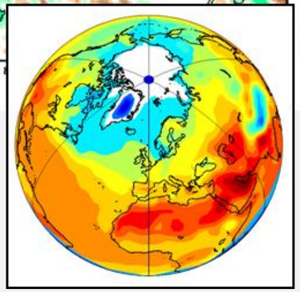


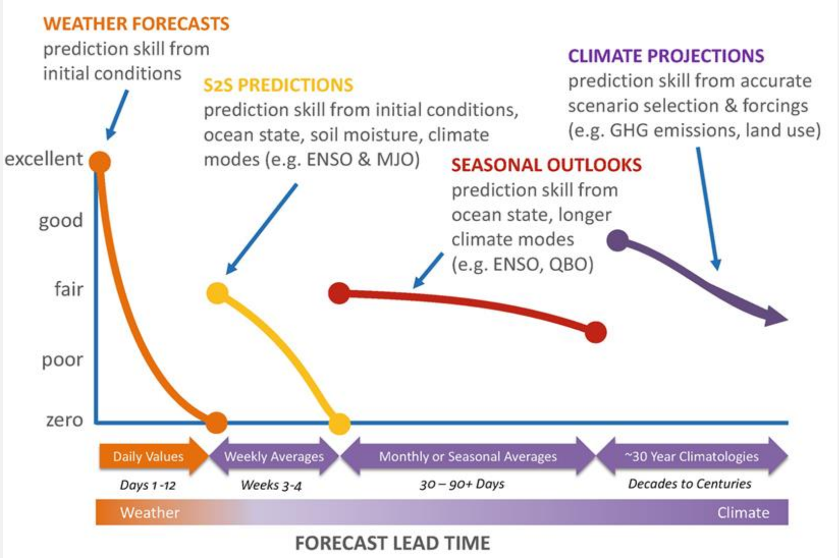
Initial conditions



Knowledge of weather during the forecast period







Initial-value driven

Boundary-condition driven

Different types of data for initialisation prior to predictions

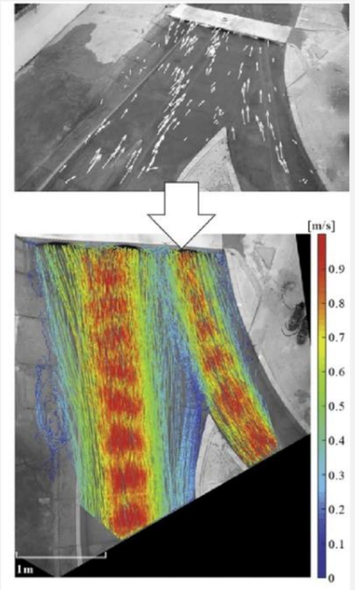
New systems for high-resolution real-time analysis and nowcasting of rainfall, based on AI-supported integration of data streams from different sensors, for example stations (incl. PWS), radar (C- and X-band) and microwave links.

Facilitate global collaboration in the exploitation of exa-scale Earth System observations (WMO, 2022)

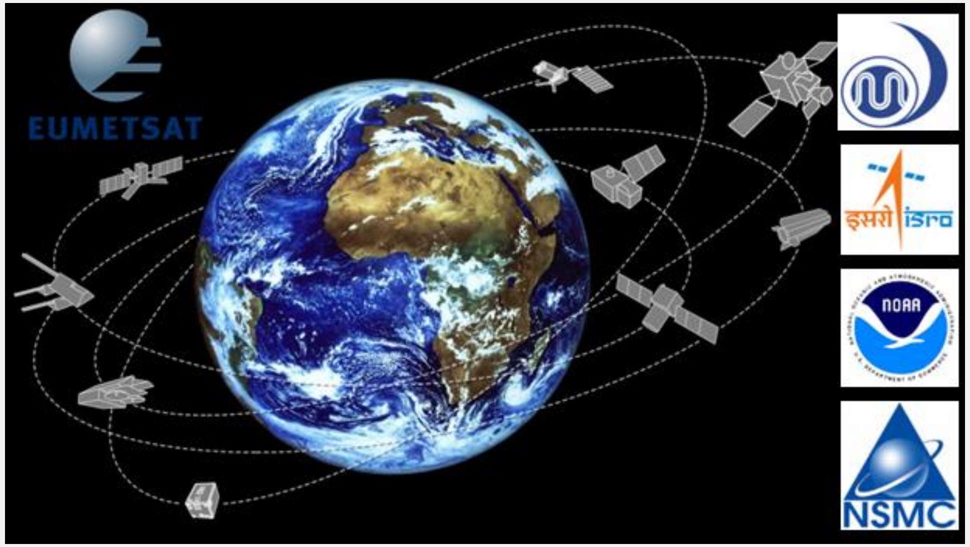
Telecommunication network (Microwave links)

UAV-based sensing

Image-based sensing



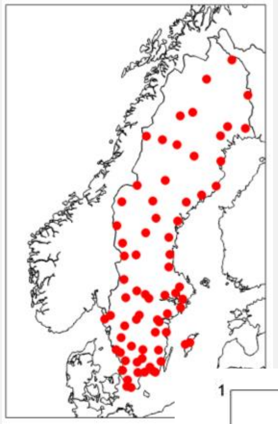
Space-based data

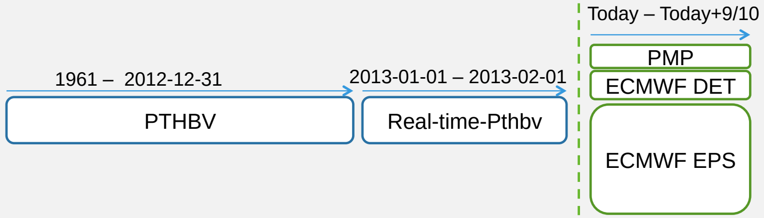


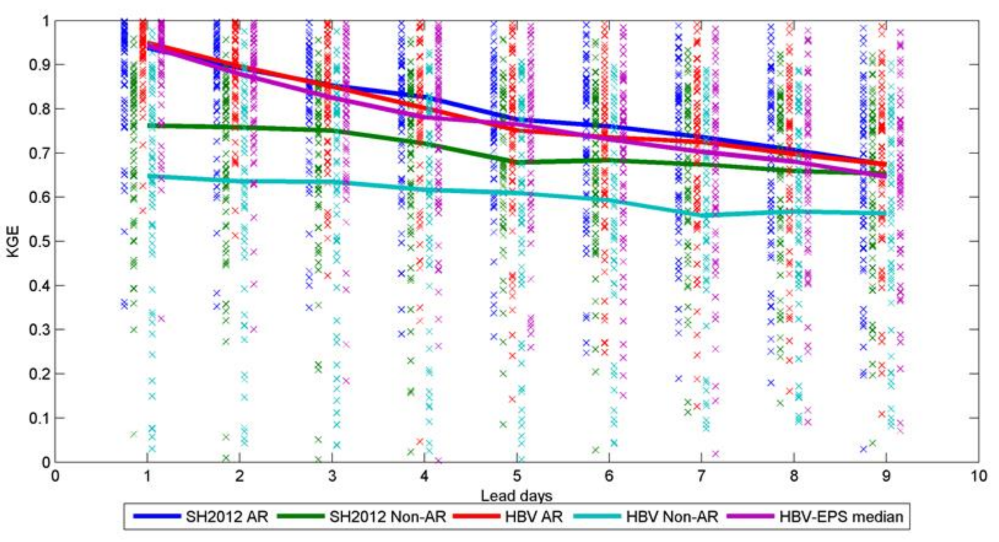
Crowdsourced data

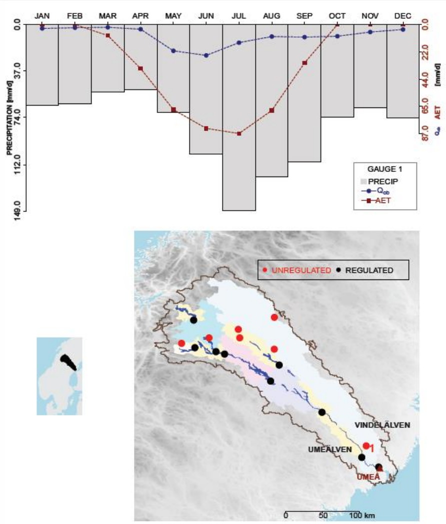
Data Assimilation & hydro predictions

What is the impact of (and relevant importance) in-situ and EO data assimilation on hydrological forecasting?

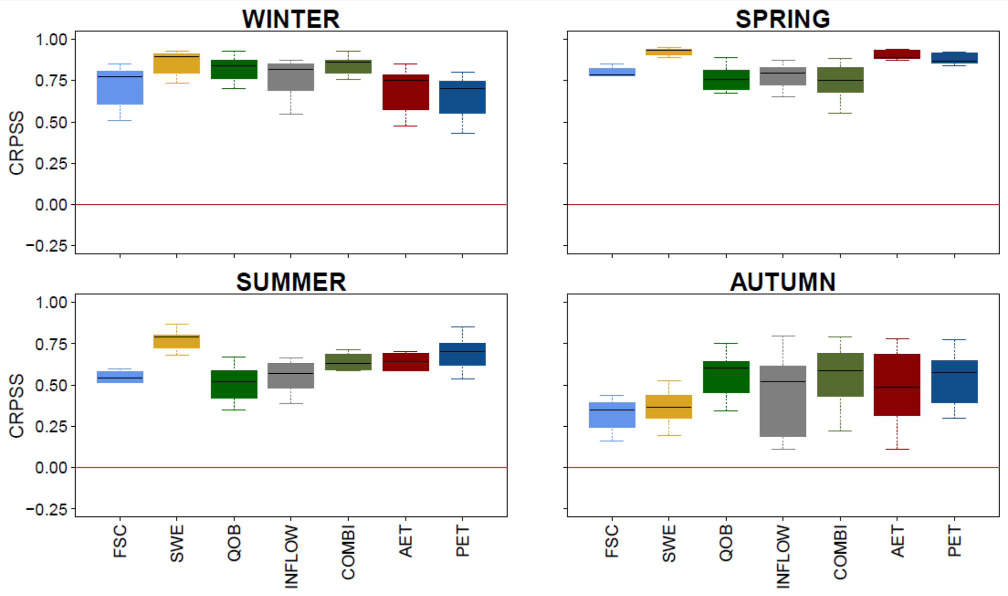


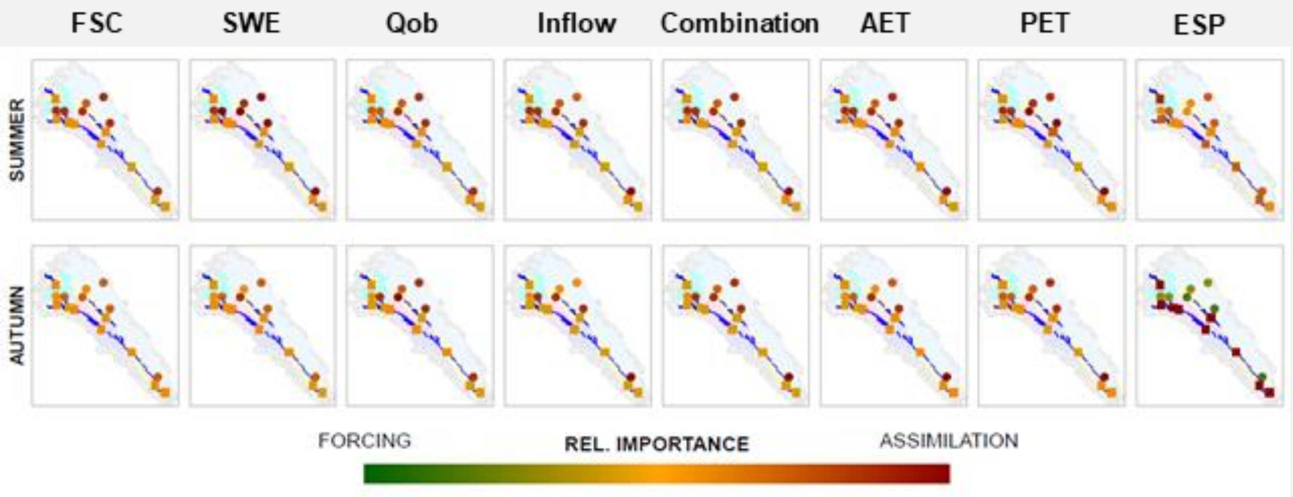






•Northern Sweden •26000km^2
•Snow-dominated • >1000MW capacity





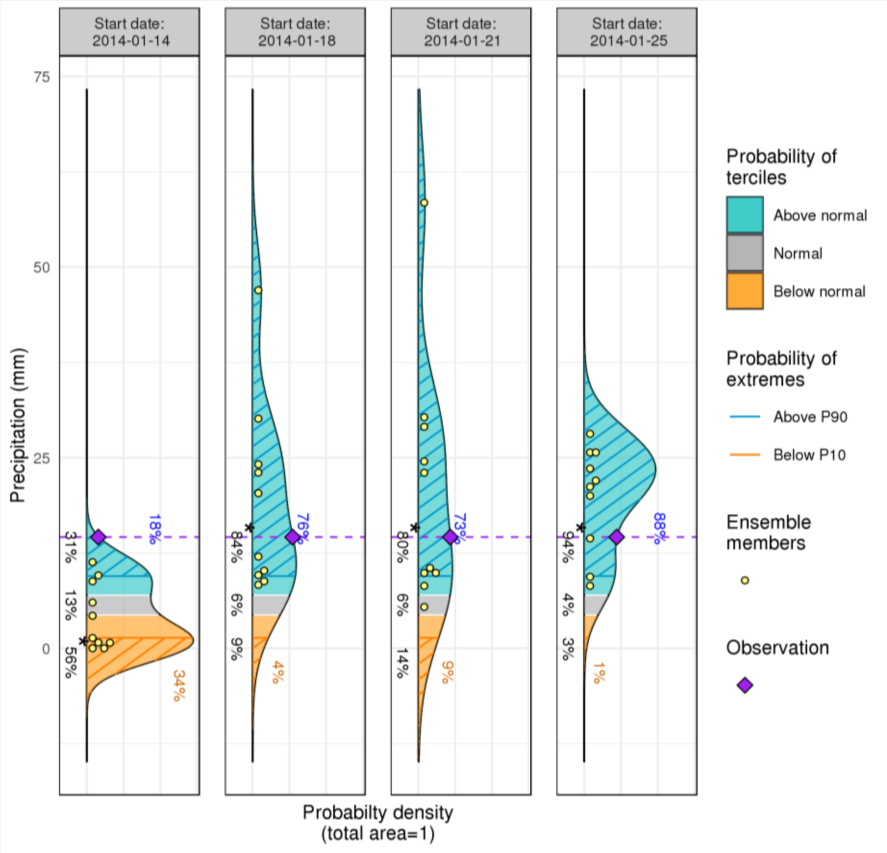
with credits to Jude Musuuza

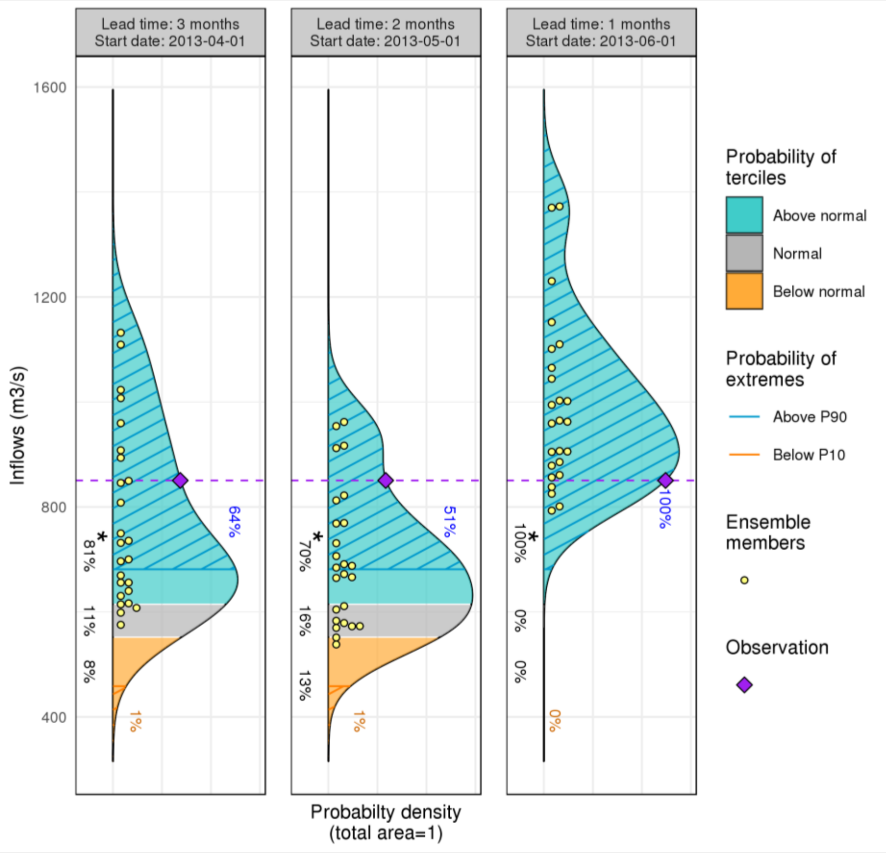
Information extraction from extended time horizons

Short range	Medium range	Sub-seasonal range	Seasonal range	Decadal range	Centennial range
Couple of days	< 10-15 days	< 1-2 months	< 6-12 months	Several years	Till end century

Currently fragmented services depending on the time horizons.

Need for a seamless prediction.



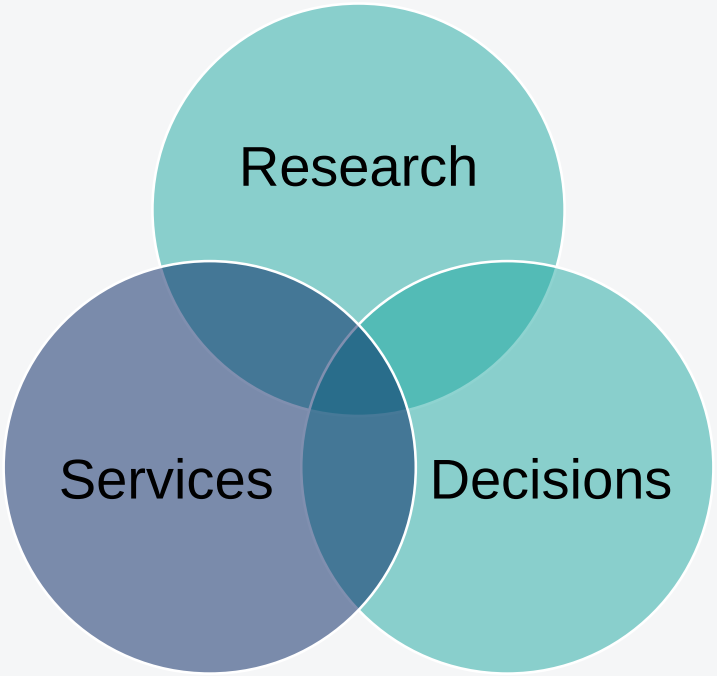


Left:
High precip. in Feb. 2014 in Romania

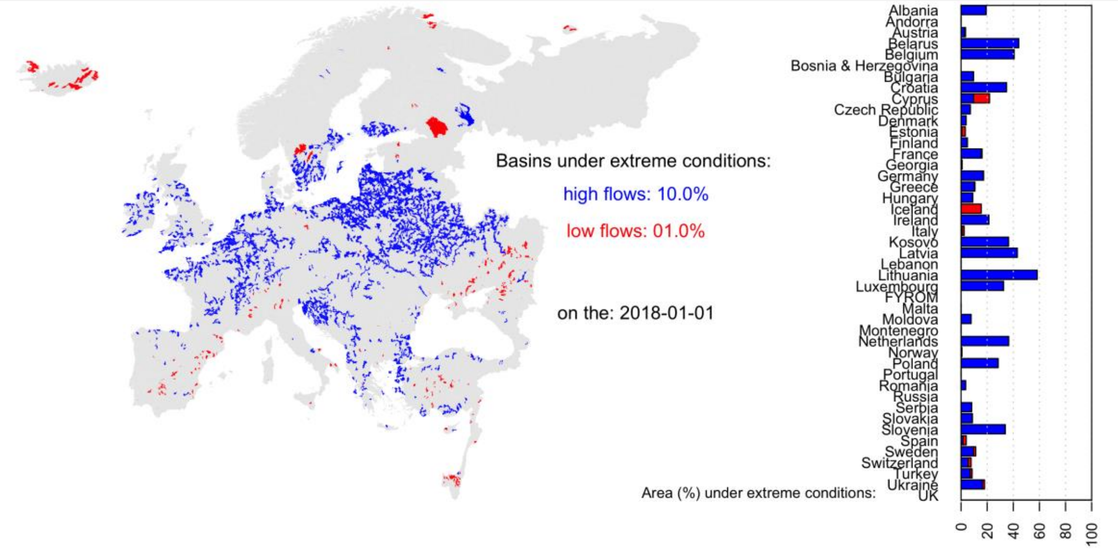
Right:
Flooding in Elbe in summer 2013

with credits to Louise Crochemore


Impact-based flood predictions
Rapid impact mapping
Persistency and consistency in predictions


Research
Services
Decisions

Towards impact-based flood forecasting



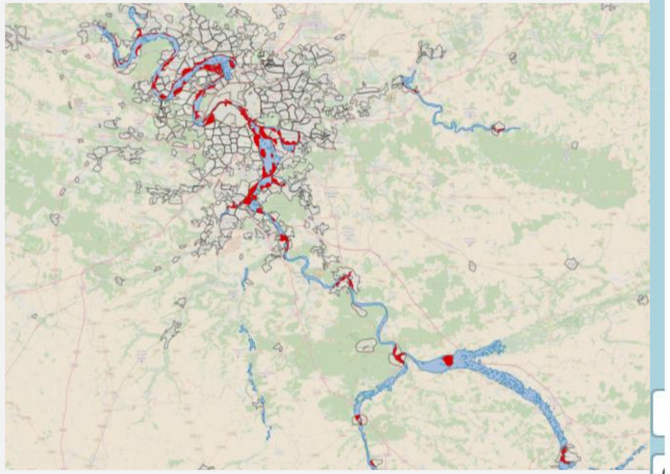
Population Affected

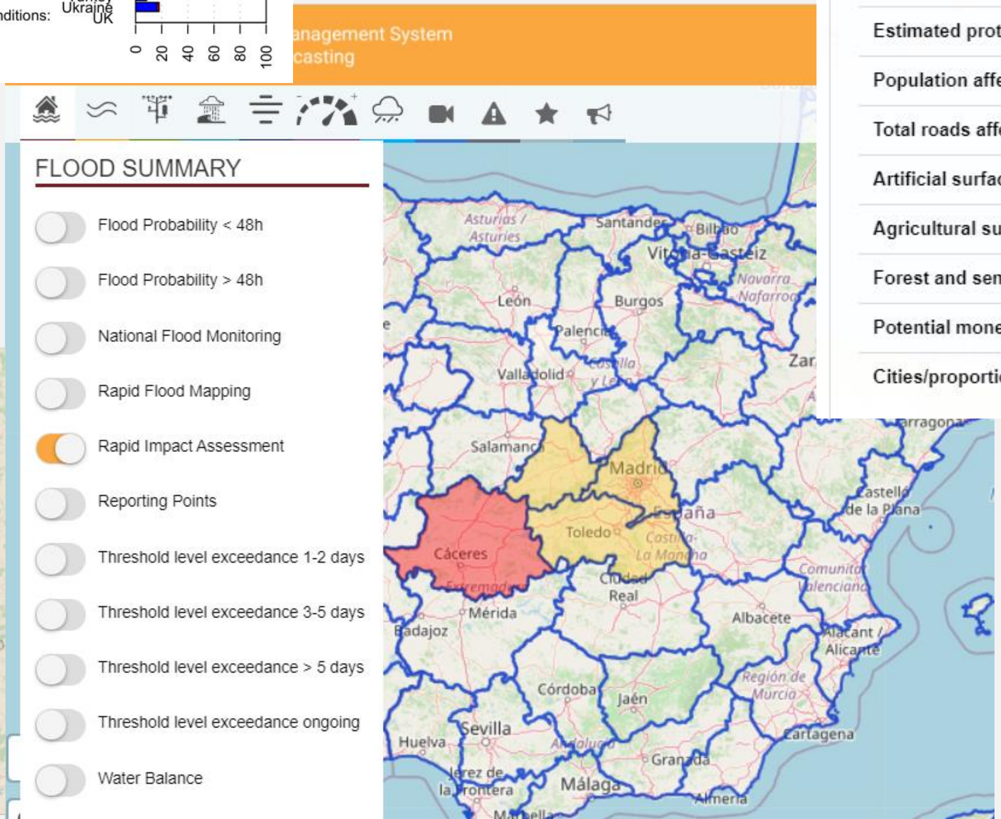
	Low impact <1K	Medium impact 1K-10K	High impact > 10K
High likelihood			
Medium likelihood			✔
Low likelihood			

Population Affected

	PROTECTED	UNPROTECTED
Estimated peak time	4	4
Estimated mean return period [yr]	49	49
Estimated protection levels [yr]		
Population affected [Nr. of people]	310100	310100
Total roads affected [km]	N/A	N/A
Artificial surfaces [ha]	N/A	N/A
Agricultural surfaces [ha]	5944	5944
Forest and seminatural [ha]	N/A	N/A
Potential monetary damage [M Euro]	N/A	N/A
Cities/proportion affected [%]	N/A	N/A

Coupling hydrological (Lisflood) and hydraulic (Lisflood-FP) models

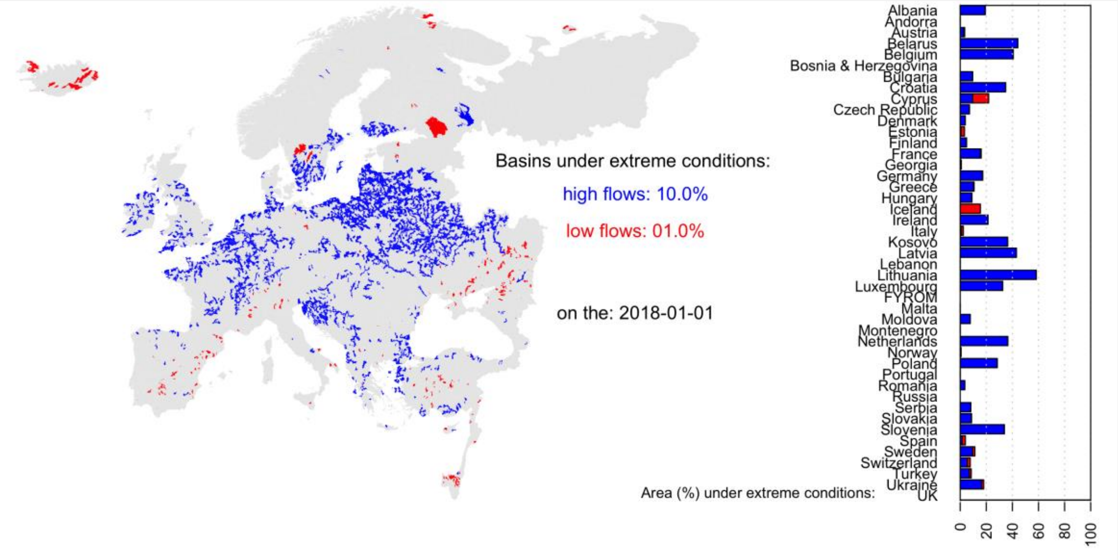


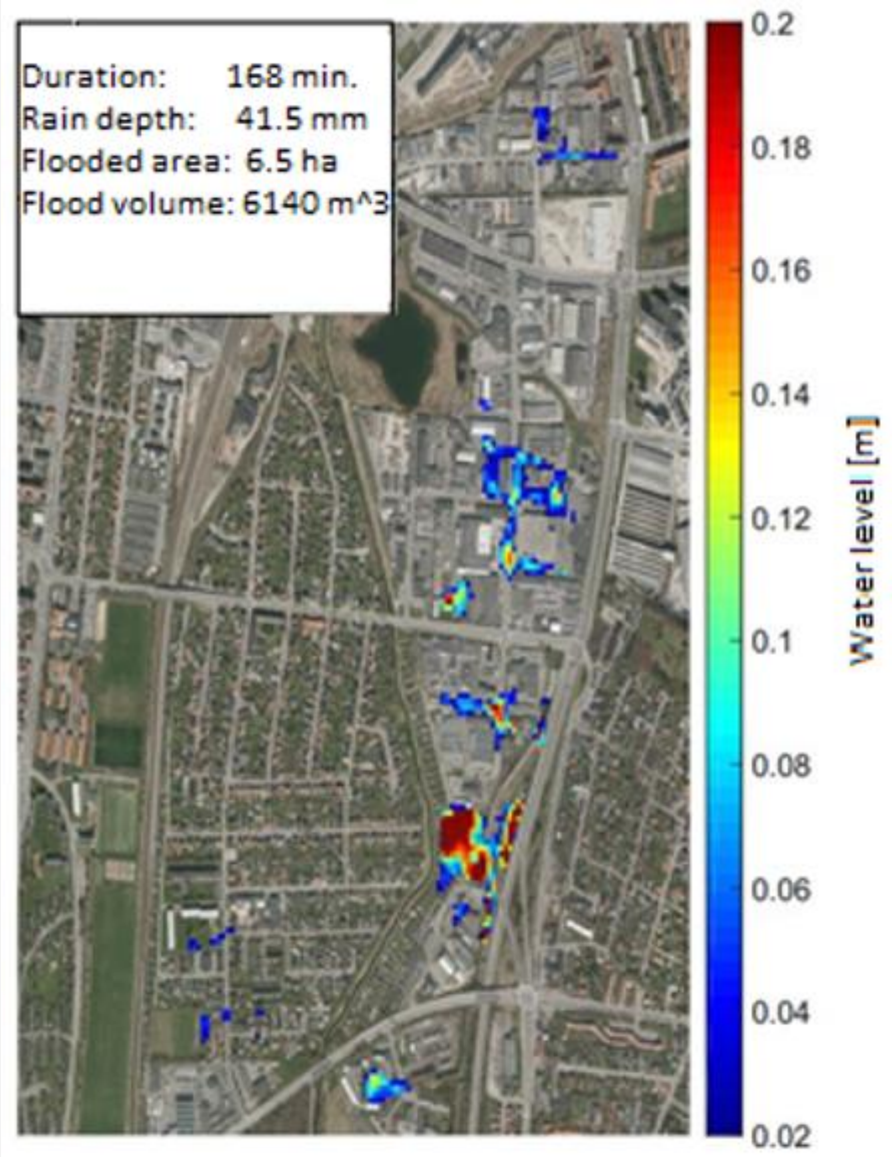


	HIGH	MEDIUM	LOW
Impact	>10k	1k-10k	<1k
Likelihood	<48hours	2-3 days	>3days

with credits to

Towards impact-based flood forecasting





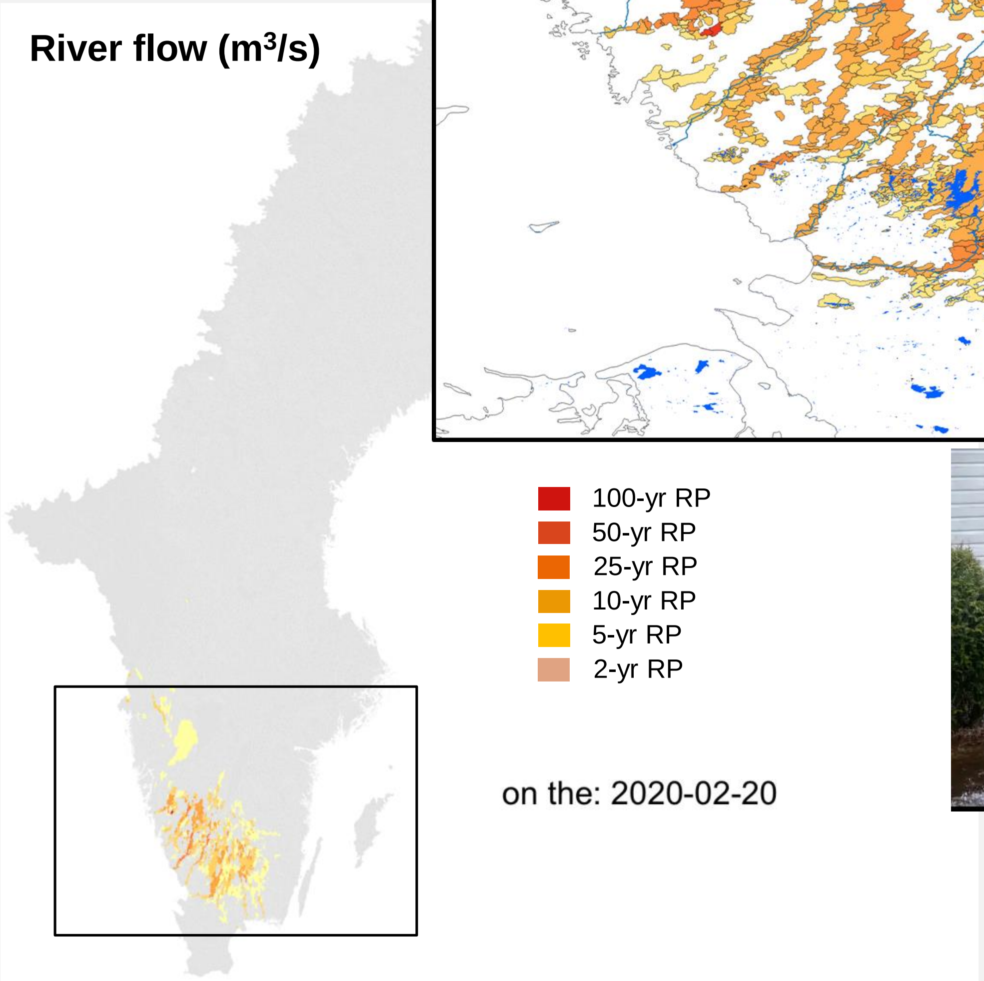
Extended use of improved pluvial and fast fluvial flood risk mapping for impact-based forecasting, by *dynamically coupling hydrological and hydraulic models at high resolutions in space and time*.

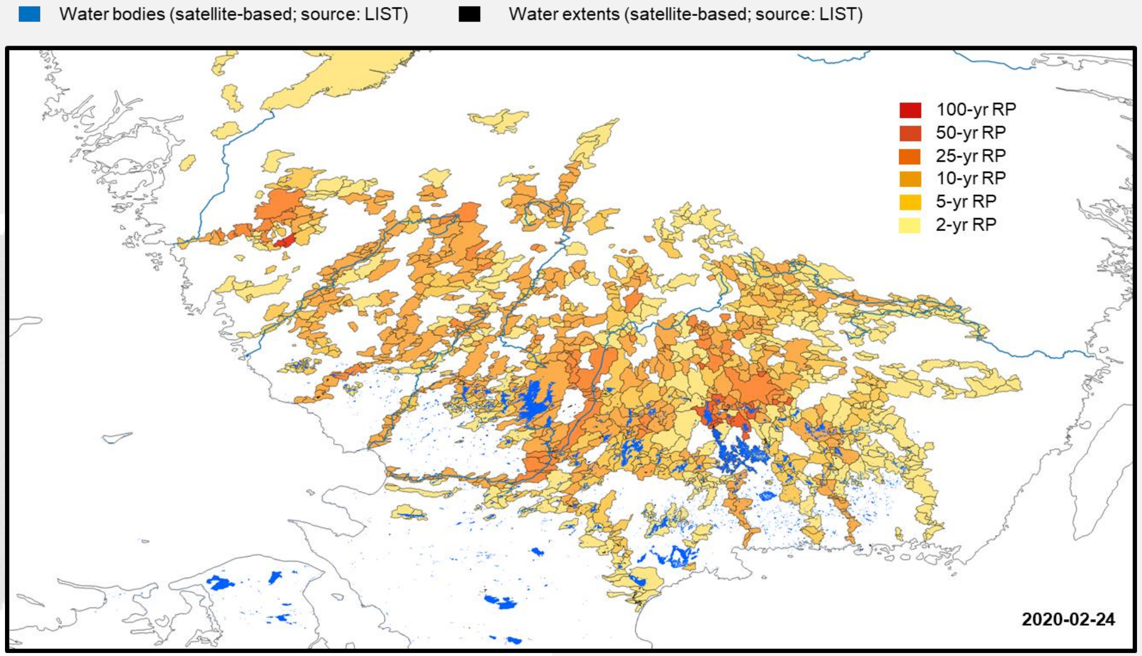
Positive message:
More and more national organisations are making the step towards impact-based flood warnings!

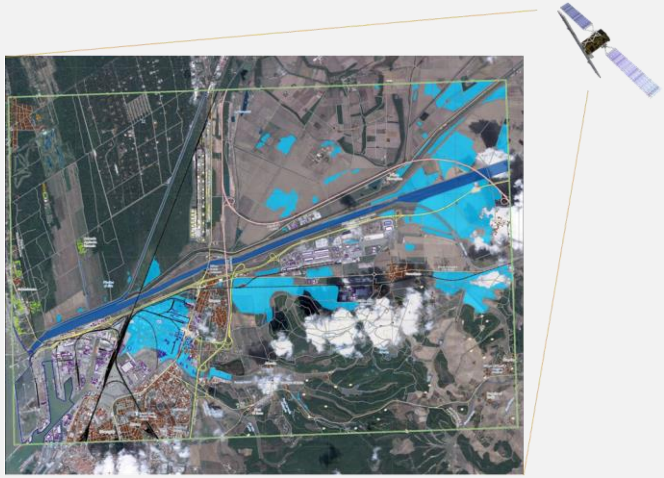
with credits to Jonas Olsson

Space-based data evolving flood services

The 2020-02-23 flooding in Lagan, Sweden







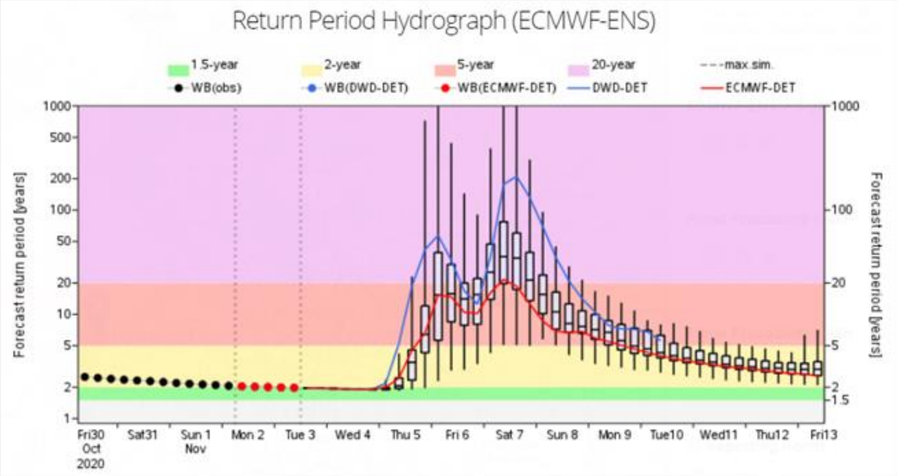
Floodwater map on a given day
(source: Copernicus EMS Rapid Mapping)

SMHI's class 3 warning for extremely high water flows in Lagan, including at Ljungby. 15,000 sandbags were used in the area.

The flows in the watercourses are at a level that arises on average every 50 years and causes serious flood problems.

with credits to

Persistency and consistency - Warnings beyond (only) threshold exceedance



Evaluation of **persistency** in time and **consistency** between forecasts are important and provide a concise picture of the forecasts.

Forecasts Overview

Forecast Type	03	03	04	04	04	04	05	05	05	05	06	06	06	06	07	07	07	07	08	08	08	08	09	09	09	09
DWD-DET		↑	↓	↓	↓	↑	↑	↑	↑	↑	↑	↓	↓	↓	↑	↑	*	↓	↓	↓	↓	↓	↓	↓	↓	↓
ECMWF-DET		↑	↓	↓	↓	↑	↑	↑	↑	↑	↑	↓	↓	↓	↑	*	↓	↓	↓	↓	↓	↑	↓	↓	↓	↓
ECMWF-ENS > 5 yr RP									22	69	84	88	88	88	96	100	100	98	100	100	92	86	78	75	67	49
ECMWF-ENS > 20 yr RP									2	20	41	47	25	29	61	75	73	53	35	12	4	2				
COSMO-LEPS > 5 yr RP							5	15	25	50	75	80	75	85	95	95	100	95	85	85	80	70				
COSMO-LEPS > 20 yr RP									10	20	45	45	40	30	45	70	60	35	25	5	5	5				

ECMWF-ENS > 5 yr RP

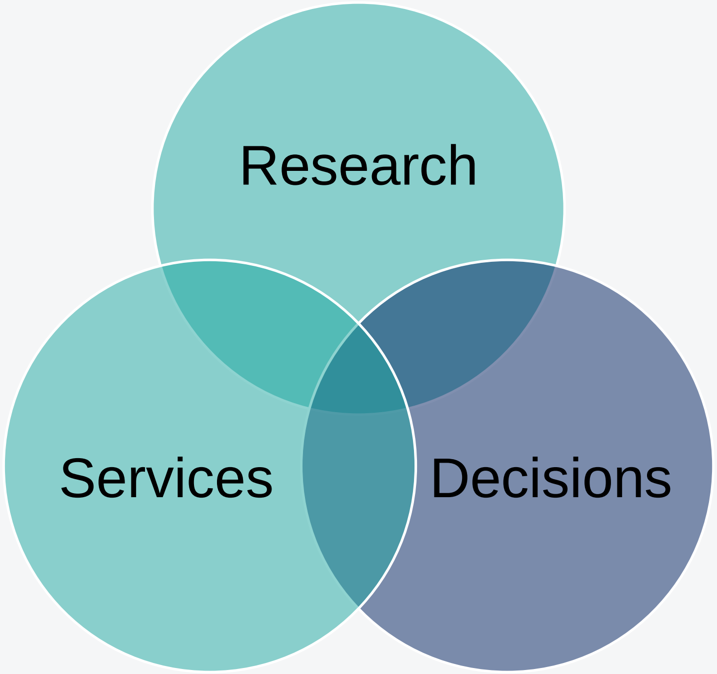
Forecast Day	31	31	01	01	01	01	02	02	02	02	03	03	03	03	04	04	04	04	05	05	05	05	06	06	06	06	07
2020-11-03 12:00																					22	69	84	88	88	88	96
2020-11-03 00:00																				2	31	65	82	90	90	96	96
2020-11-02 12:00																				8	31	53	69	80	73	75	90
2020-11-02 00:00																4	10	24	43	67	76	82	86	88	90	88	92
2020-11-01 12:00																	8	29	47	76	84	92	96	98	98	96	98
2020-11-01 00:00																	14	25	51	75	86	90	94	94	94	92	94
2020-10-31 12:00																2	6	8	25	39	61	76	75	73	71	65	67

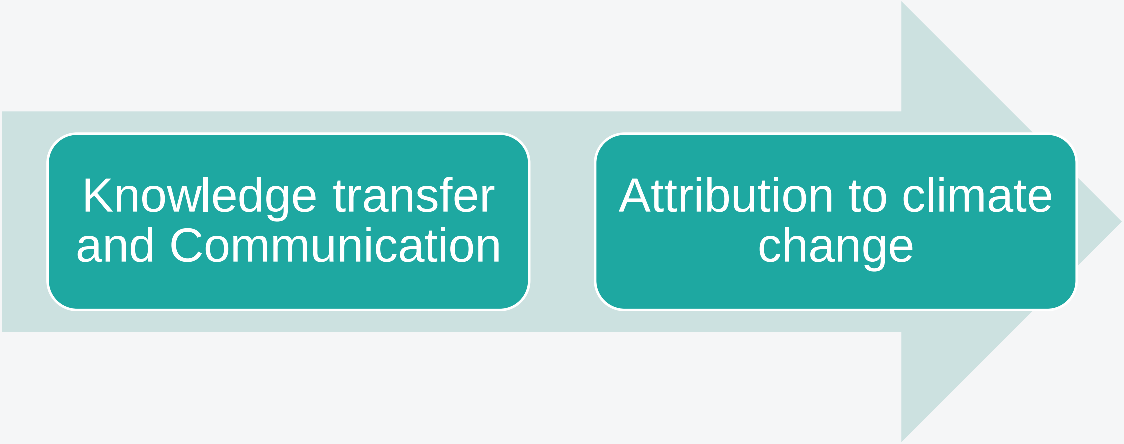
Consistency between forecasts

Persistency of results from forecast to forecast

Reduction of false alarms

with credits to


Research
Services
Decisions


Knowledge transfer and Communication
Attribution to climate change

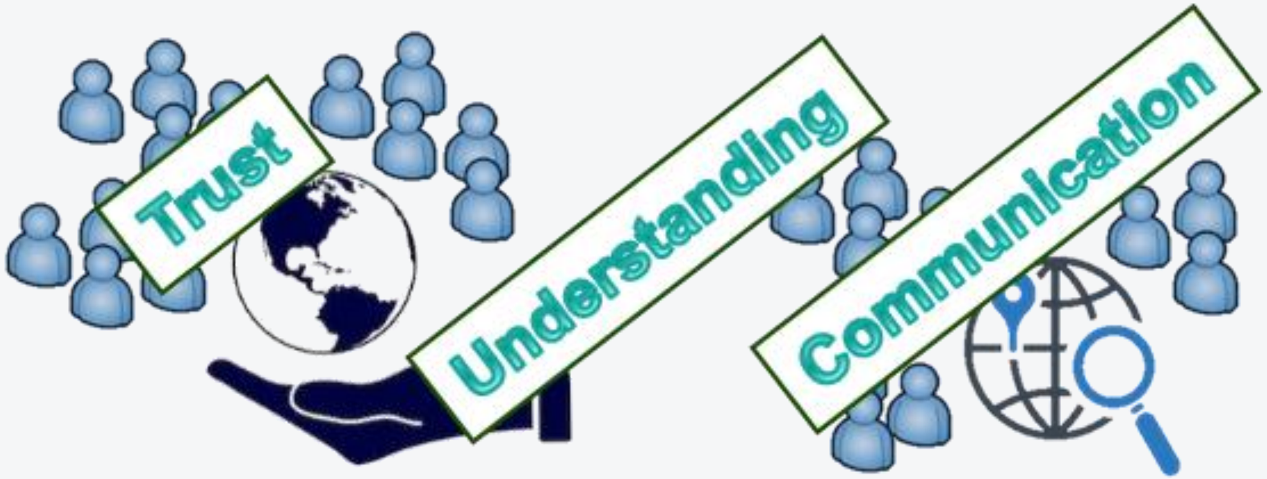
From reseach to flood services to decision-making

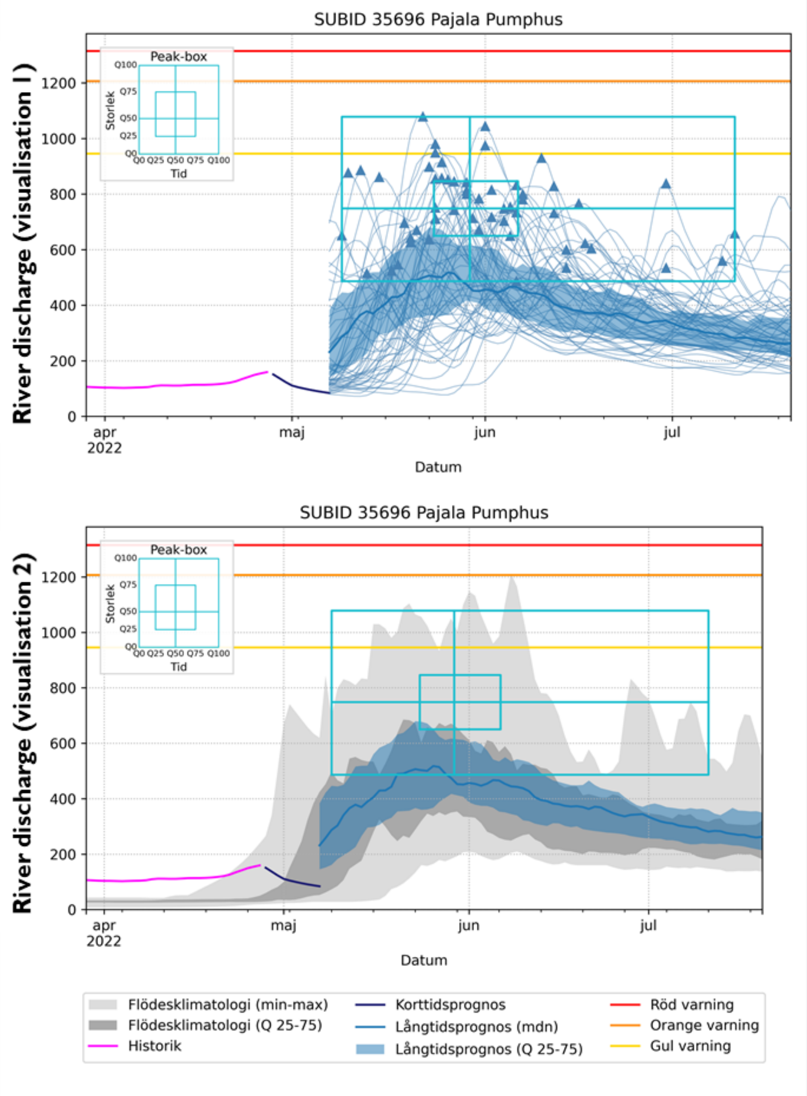
Challenge

- Science and services are developing fast and often users find difficulties to adapt to the use of new emerging methods or types of simulations.

Moving forward

- Knowledge transfer - Identify visualization methods that allow improved communication of flood information tailored to specific user needs





with credits to Marc Girons Lopez

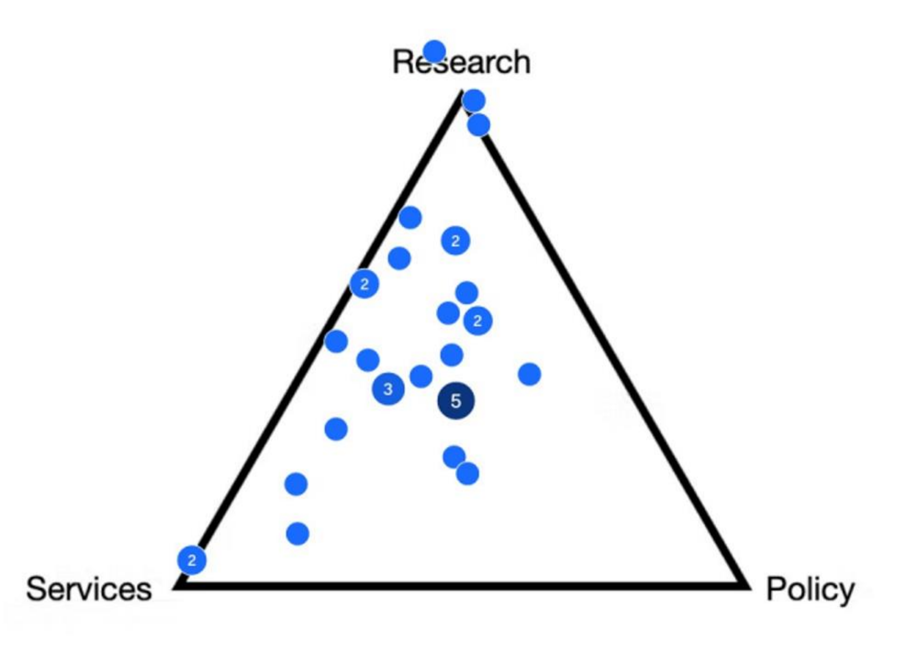
From reseach to flood services to decision-making

SMHI

UN Secretary General – António Guterres (23rd March 2022 – World Meteorological Day)

"Within the **next five years**, **everyone** on **Earth** should be **protected** by early warning systems against increasingly extreme weather and climate."

How to achieve this?



GDB5 EDI

Hydrology and Earth System Science: research, services or policy?

Co-sponsored by IAHS and WMO

Convener: Nilay Dogulu | Co-conveners: Louise Arnal[ECS], Johannes Cullmann, Ilias Pechlivanidis, Micha Werner

Thu, 26 May, 17:00–18:30 (CEST) Room E1

EGU European Geosciences Union IAHS AISH WMO

with credits to

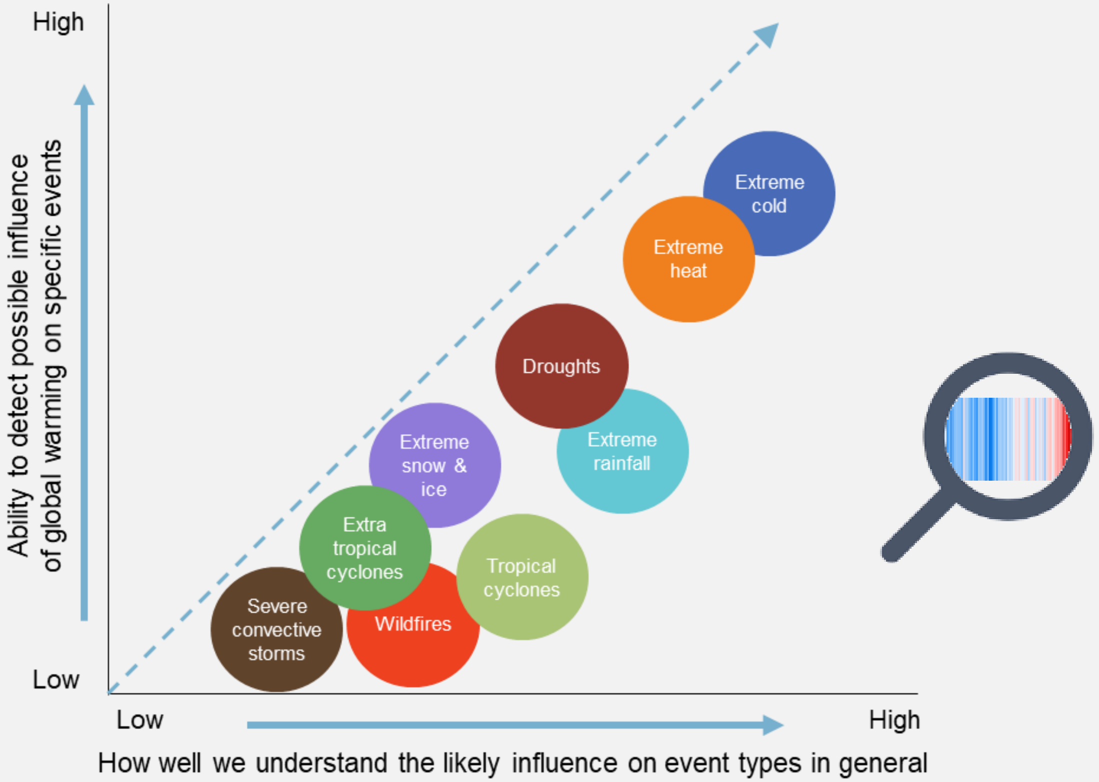




Accelerate the development of attribution science and techniques (WMO, 2022)

Potential for **AI frameworks** (composed of Machine Learning techniques and algorithms) to:

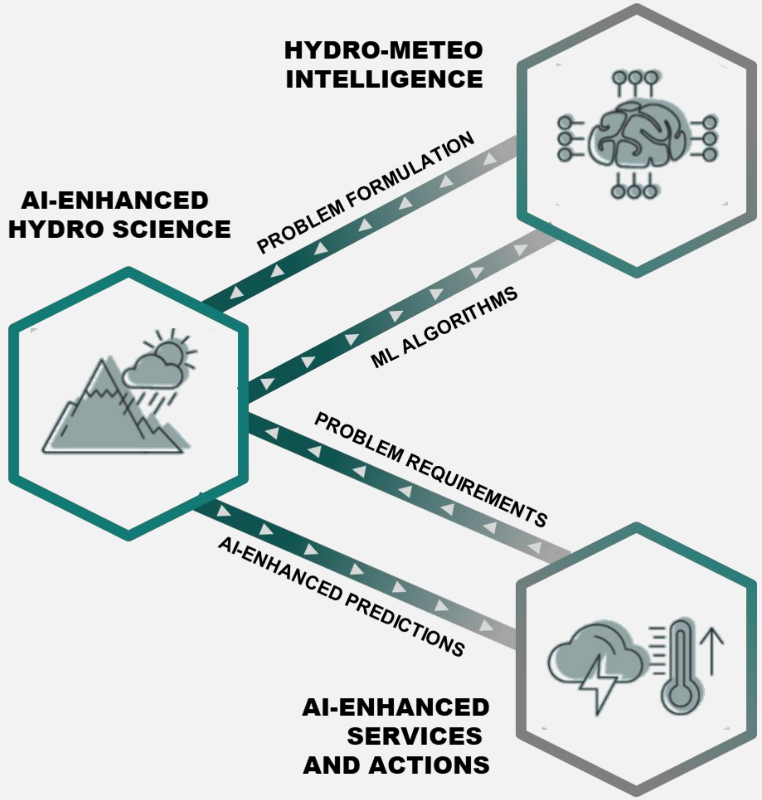
- "Learn from past weather records to predict the future"
- Post-processing to "regionalise" information
- Filling in cases of missing data



Source: NOAA Climate gov. NAS 2016

Process big datasets for improving hydrological science in the causation and attribution of **extreme impactful events, i.e. flooding**

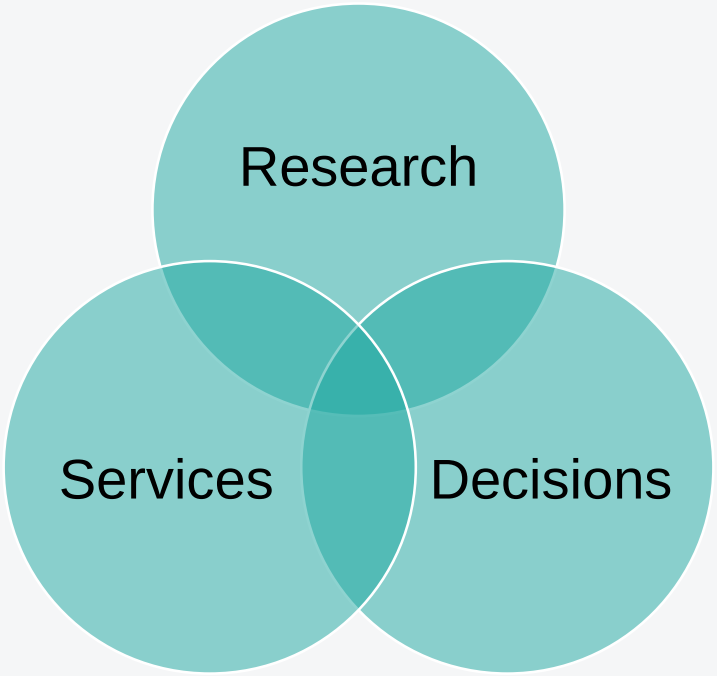
1. Validate the physically based nature of causality discovered;
2. Support the attribution of flooding and observed trends in extremes to man-made climate change and improve the quantification of future changes in extremes

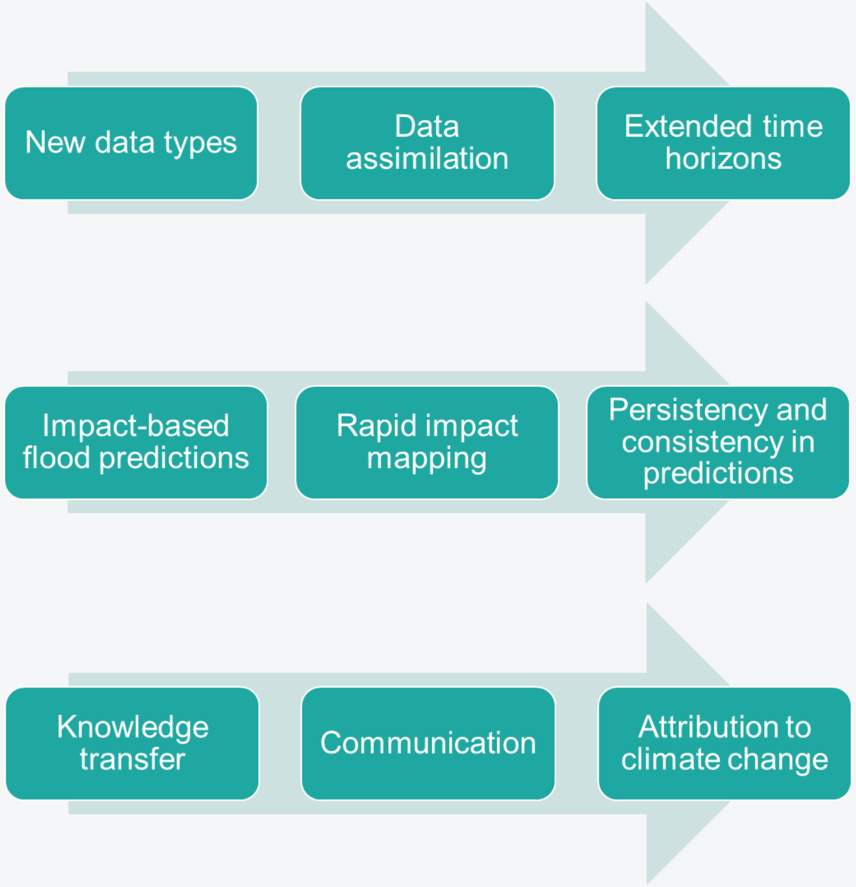


WMO

CLINT CLIMATE INTELLIGENCE

Take home messages

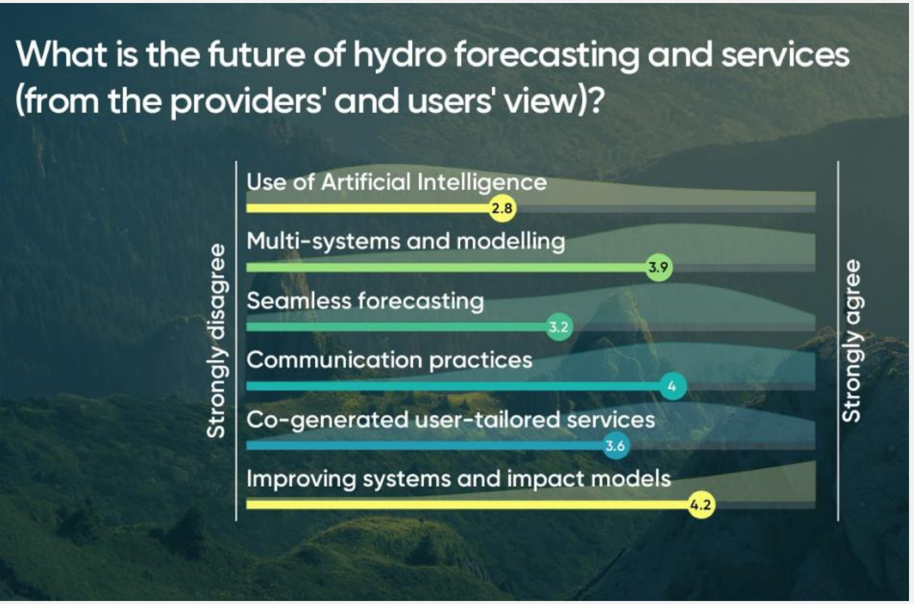


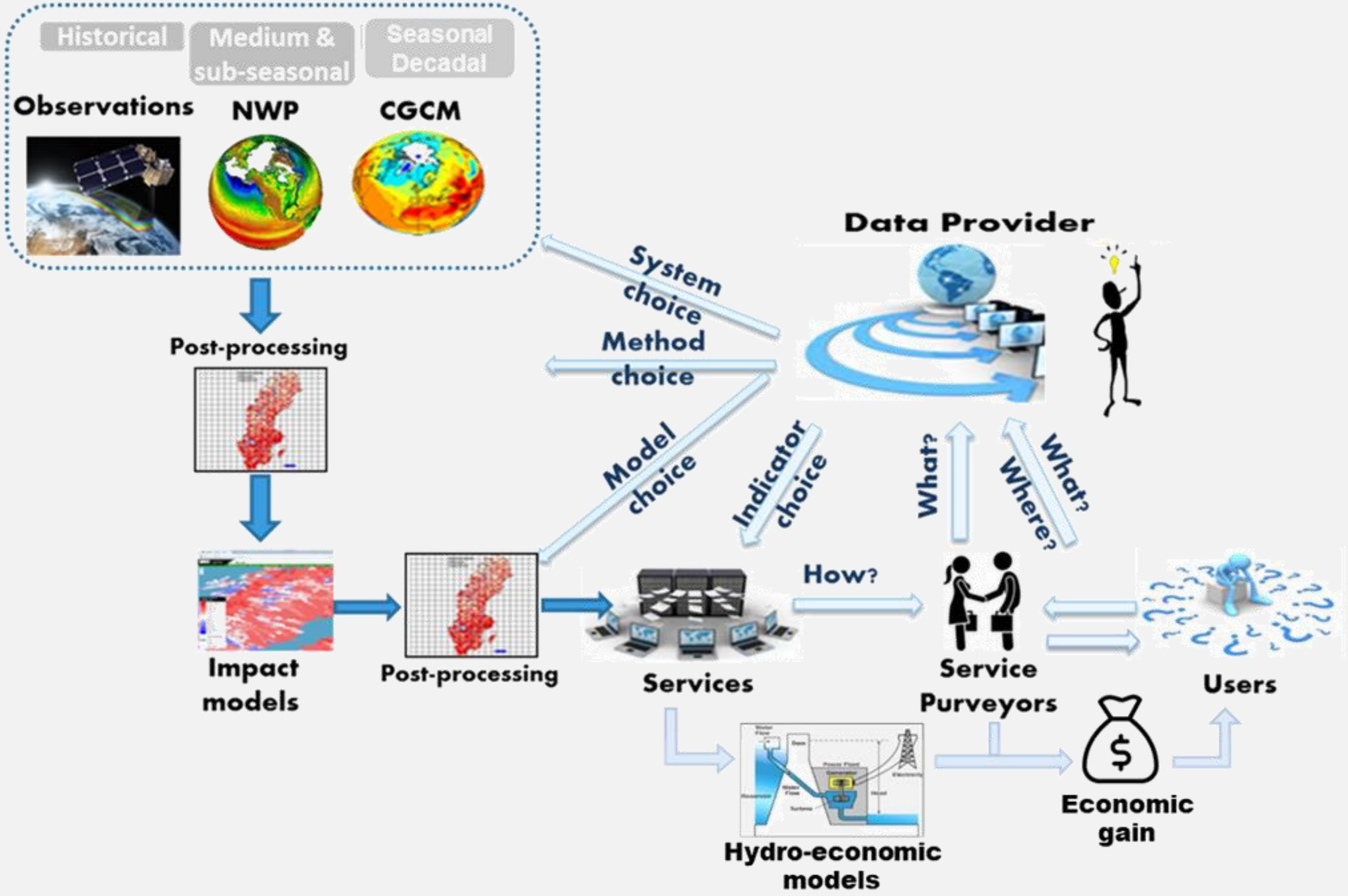


Flood predictions are not ready when they are issued. They are ready when they are understood!

All steps in the prediction chain are full of challenges.

Hence, research flooding, co-create, early warning services, co-evolve services and knowledge, and guide improved decision-making.





Thanks for your attention !

The SMHI Hydrology R&D unit

You are always welcome to share your views!