Deltares

Digital twin developments in DTC Hydrology Next

reservoirs *and flooding*

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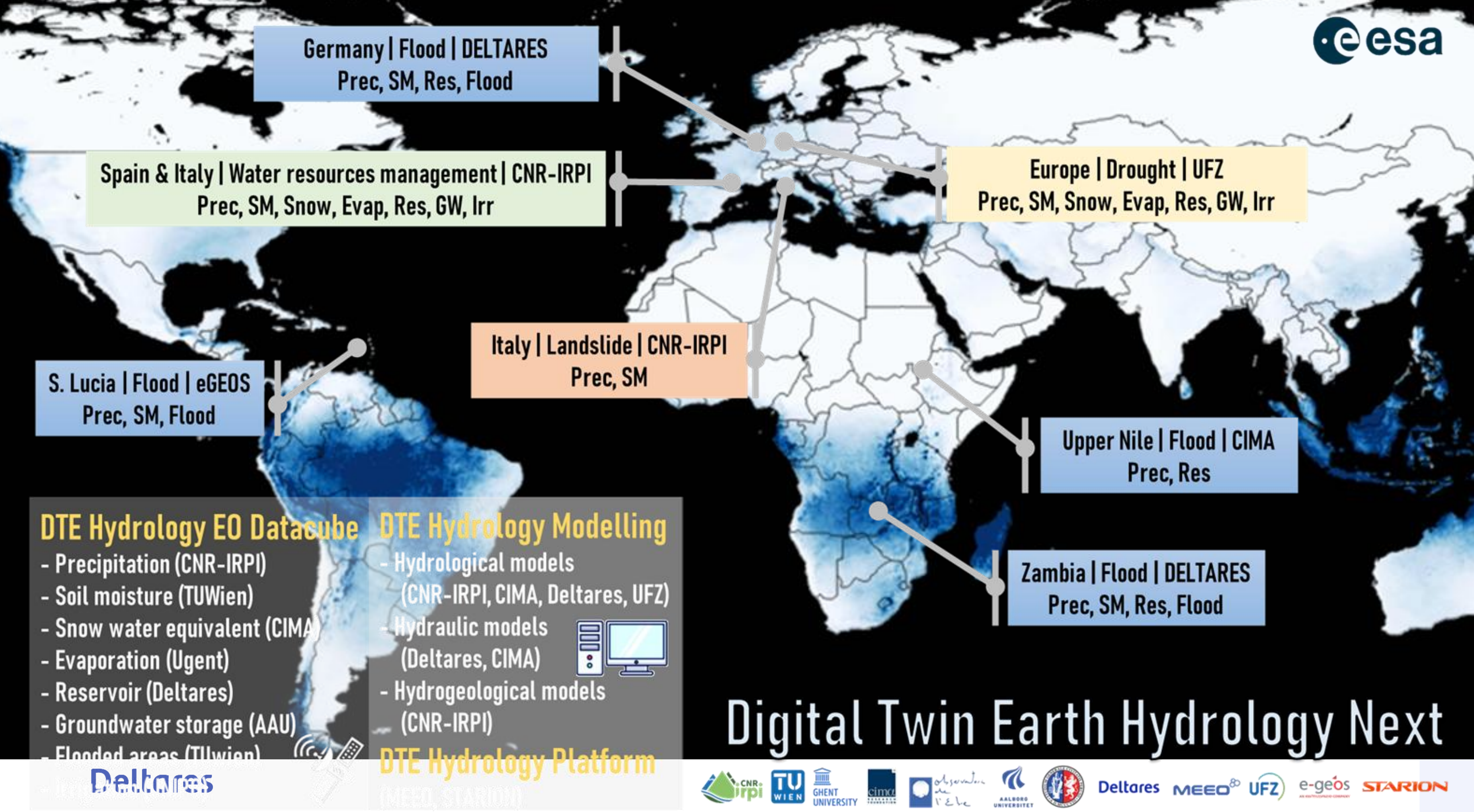
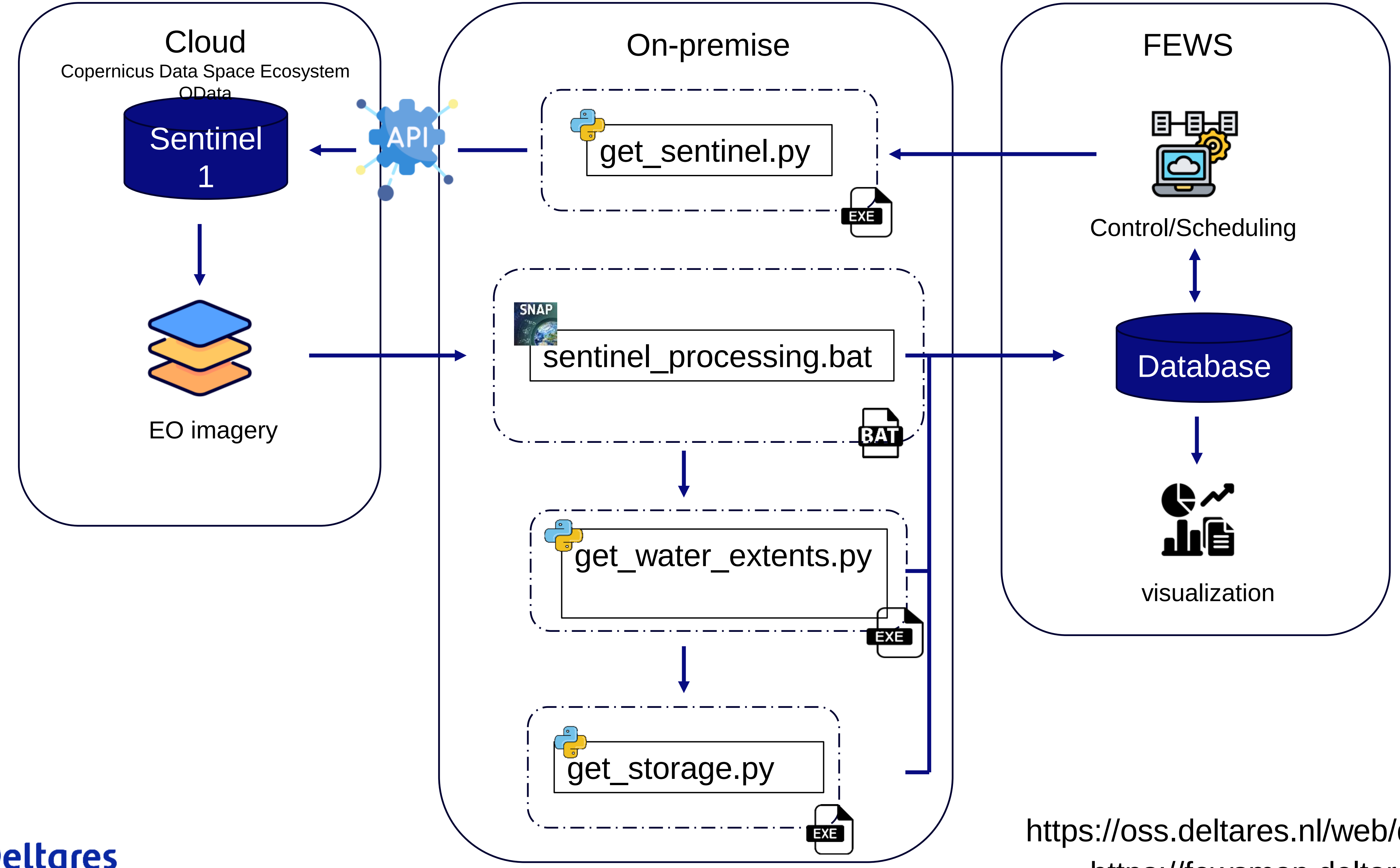
EGU 2025 30/4/2025


Germany | Flood | DELTARES
Prec, SM, Res, Flood
Spain & Italy | Water resources management | CNR-IRPI
Prec, SM, Snow, Evap, Res, GW, Irr
Europe | Drought | UFZ
Prec, SM, Snow, Evap, Res, GW, Irr
Italy | Landslide | CNR-IRPI
Prec, SM
S. Lucia | Flood | eGEOS
Prec, SM, Flood
Upper Nile | Flood | CIMA
Prec, Res
Zambia | Flood | DELTARES
Prec, SM, Res, Flood
DTE Hydrology EO Datacube
- Precipitation (CNR-IRPI)
- Soil moisture (TUWien)
- Snow water equivalent (CIMA)
- Evaporation (Ugent)
- Reservoir (Deltares)
- Groundwater storage (AAU)
- Flooded areas (TUwien)
DTE Hydrology Modelling
- Hydrological models
(CNR-IRPI, CIMA, Deltares, UFZ)
- Hydraulic models
(Deltares, CIMA)
- Hydrogeological models
(CNR-IRPI)
DTE Hydrology Platform
(MEEO, STARION)
Digital Twin Earth Hydrology Next

In a nutshell, the expected outcomes of the DTE Hydrology Next project are:

1. **High-resolution EO-based products (EU+Africa) for addressing hydrology and hydro-hazards**
   → DTE Hydrology Datacube 2.0
2. **Large scale assessment of EO-based products and high-resolution modelling systems** to characterise their **uncertainty** and reliability, and their **maturity for operational production**.
3. **Six Use Cases** demonstrating the unique role of EO for developing pre-operational systems addressing the hydrology and hydro-hazard challenges: **flood, drought, landslides, and water resources management**.
4. **A web public platform** allowing multiple users (scientists, policy makers, stakeholders, citizens) to interact with the developed Use Cases and thus using it for decision making at high-resolution
   → DTE Hydrology Platform 2.0



https://oss.deltares.nl/web/delft-fews/
https://fewsmap.deltares.nl

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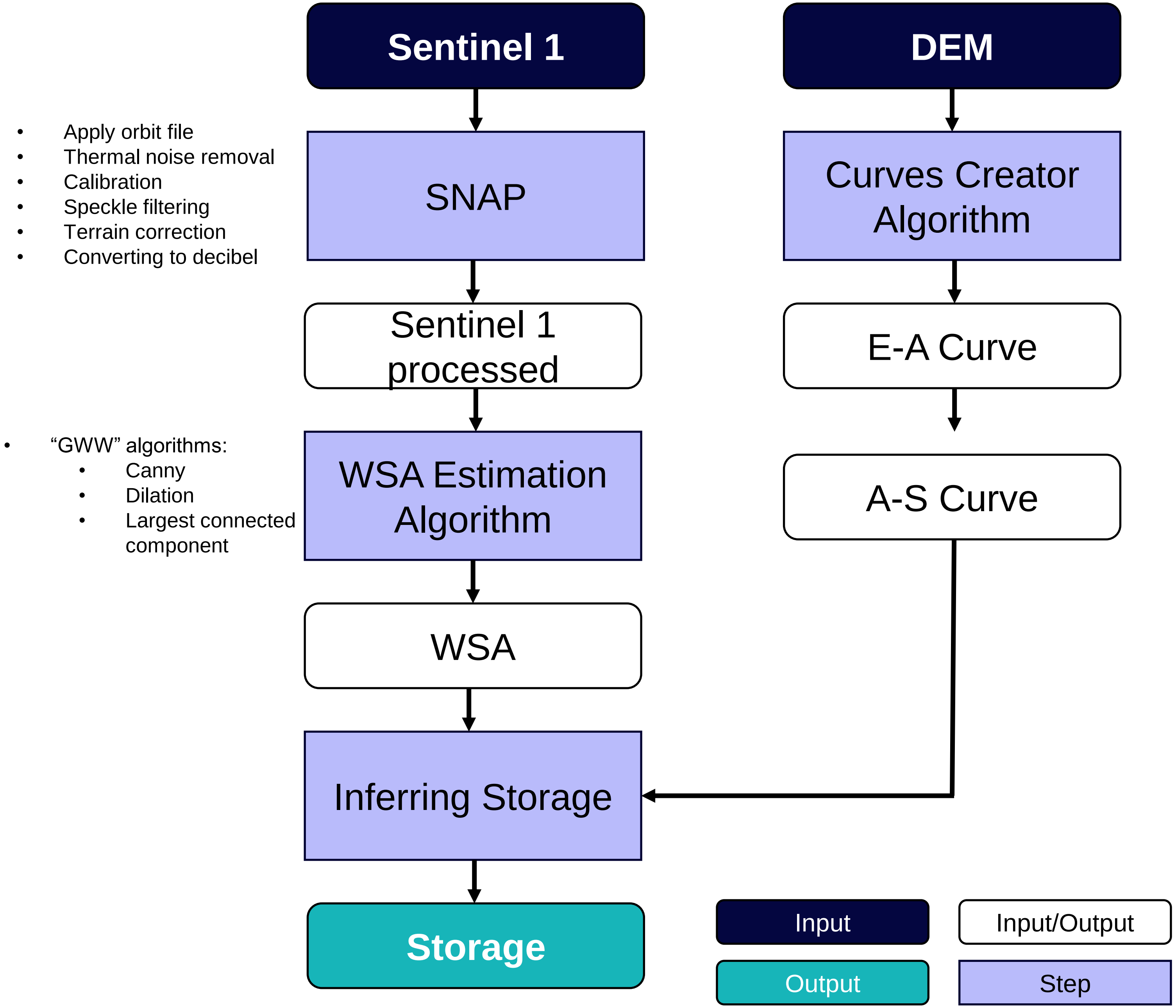

DEM: Digital Elevation Model
WSA: Water Surface Area

E-A: Water level – Water surface area
A-S: Water surface area –Storage volume

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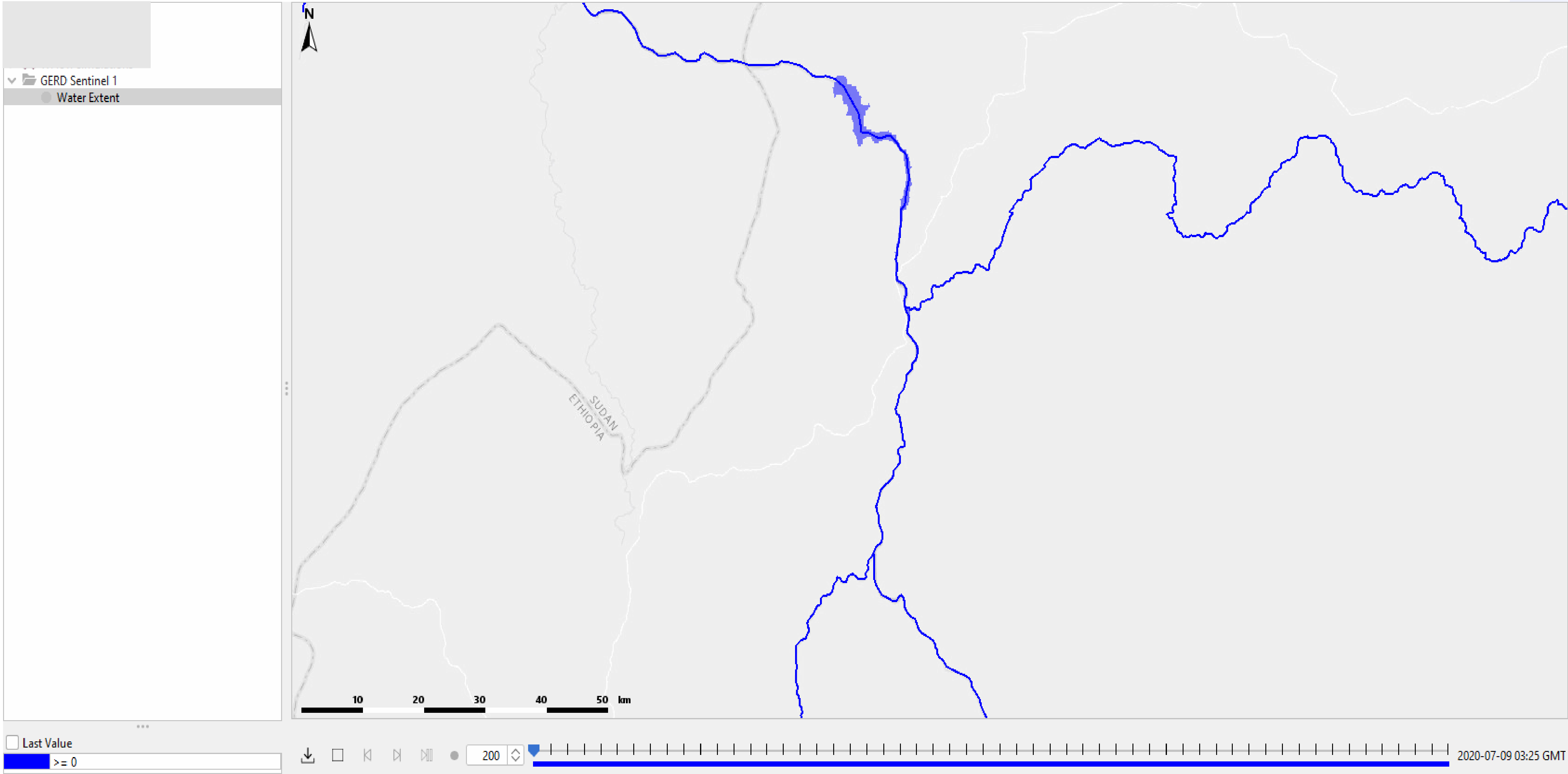
Proof of concept

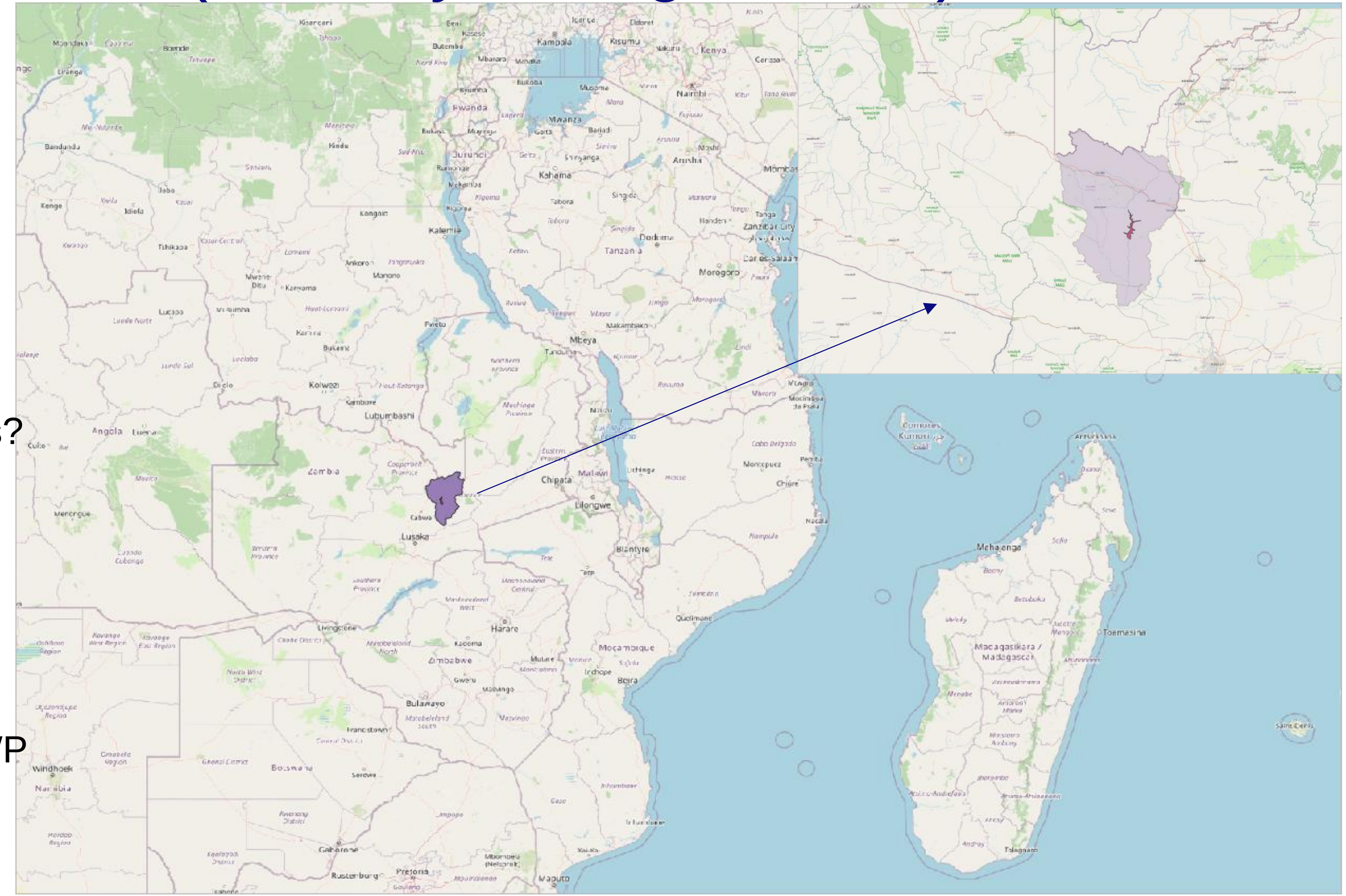


Use cases Zambia (& Rhine): Mita Hills Dam, Lunsemfwa River (tributary Luangwa river)

Stakeholders:
- WARMA (Zambia)
- RC510?
- Lunsemfwa Hydro Power?

Can we improve flood forecasts using surface area derived reservoir volume and provide impact forecasts? Whatifscenarios?

Goal: to make better decisions based on hydrological model initialized With measurements and NWP



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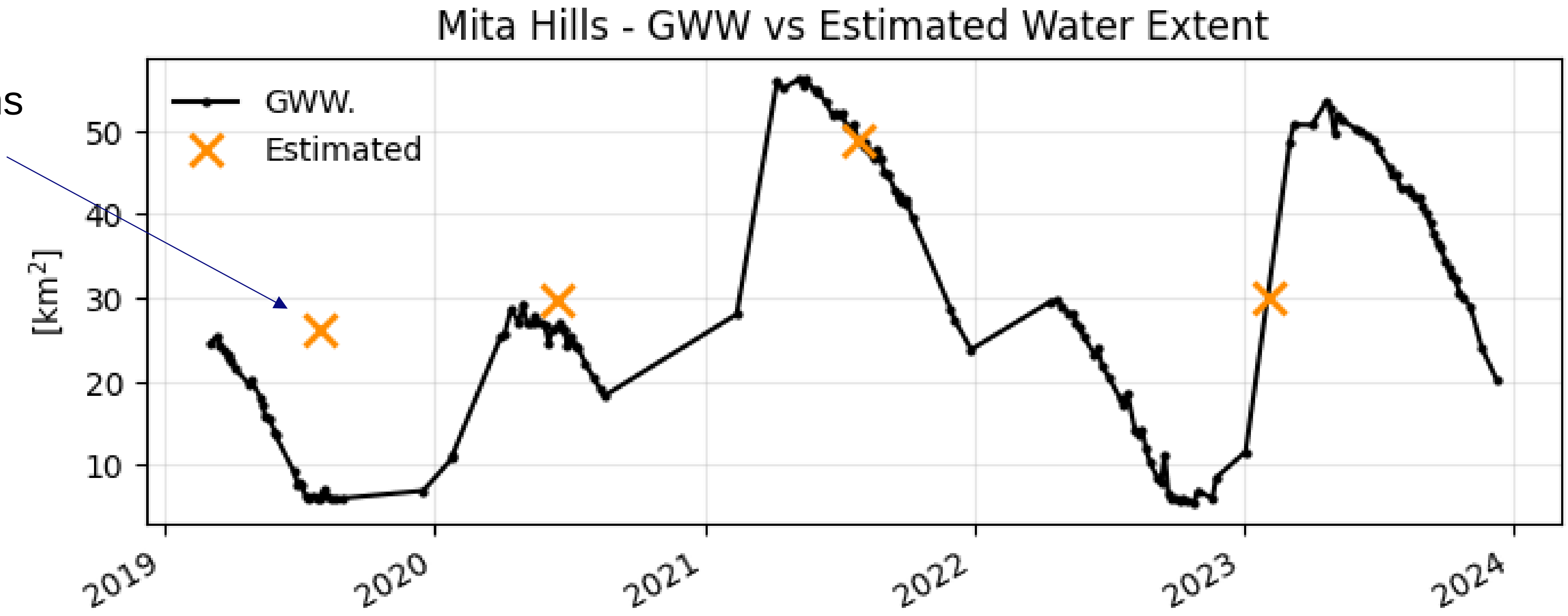
PoC with few images

Improved processing needed for dry conditions (in progress)



GWW = Global Water Watch, based on optical Landsat and Sentinel-2
Estimated = Sentinel-1 testing, to enable monitoring during (cloudy) wet season

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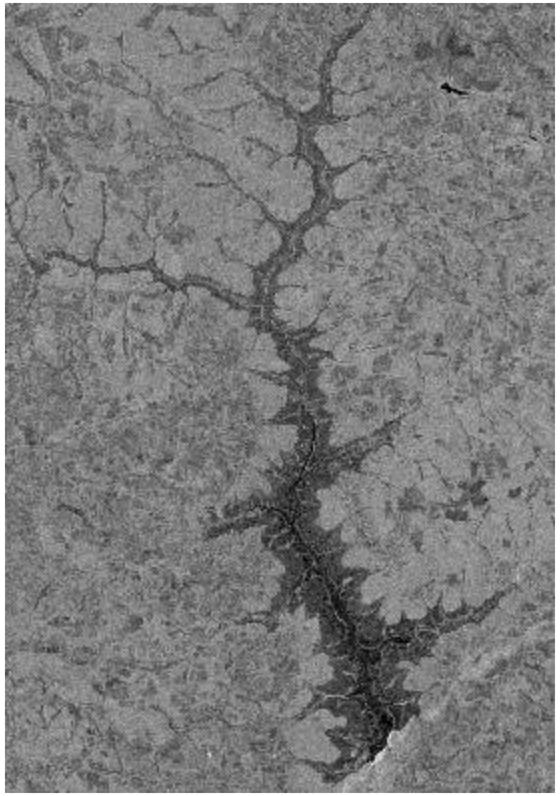
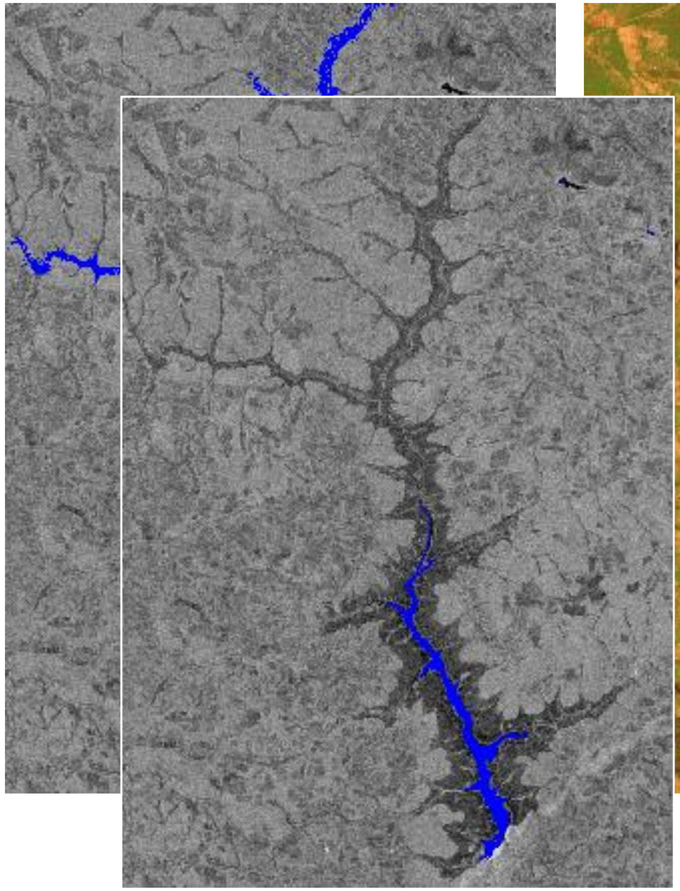
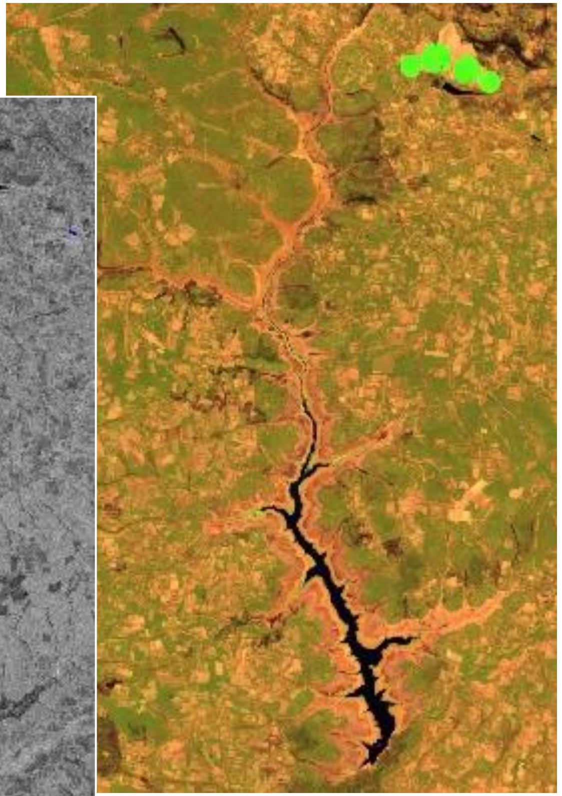
https://www.globalwaterwatch.earth/

Dry conditions example



S1 2019-07-27





S2 2019-07-29

*Dry soil causes SAR signal
to be similar to water
(i.e. low backscatter)*

*Solution (in progress, two options):
1) sample dry areas, match with historical series (GWW, JRC)
2) data fusion with optical (S2)*

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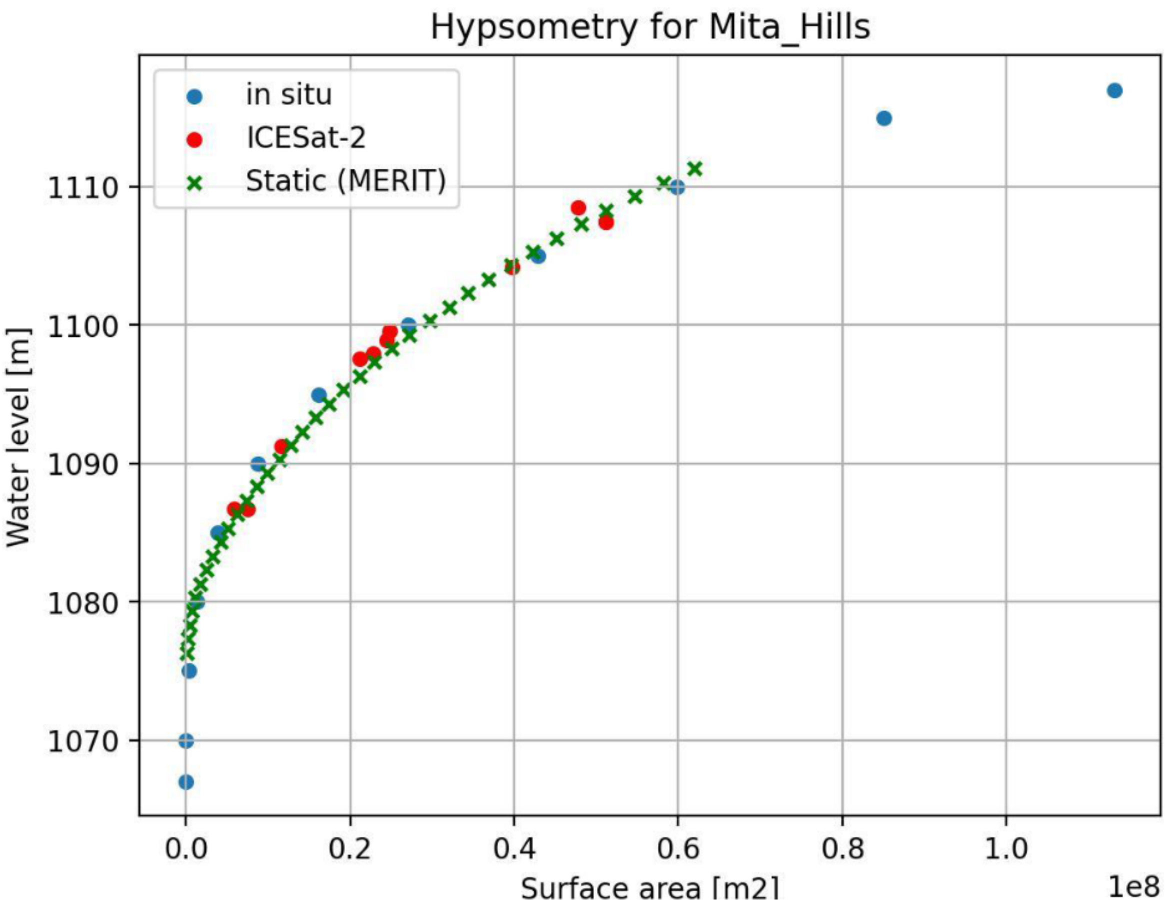
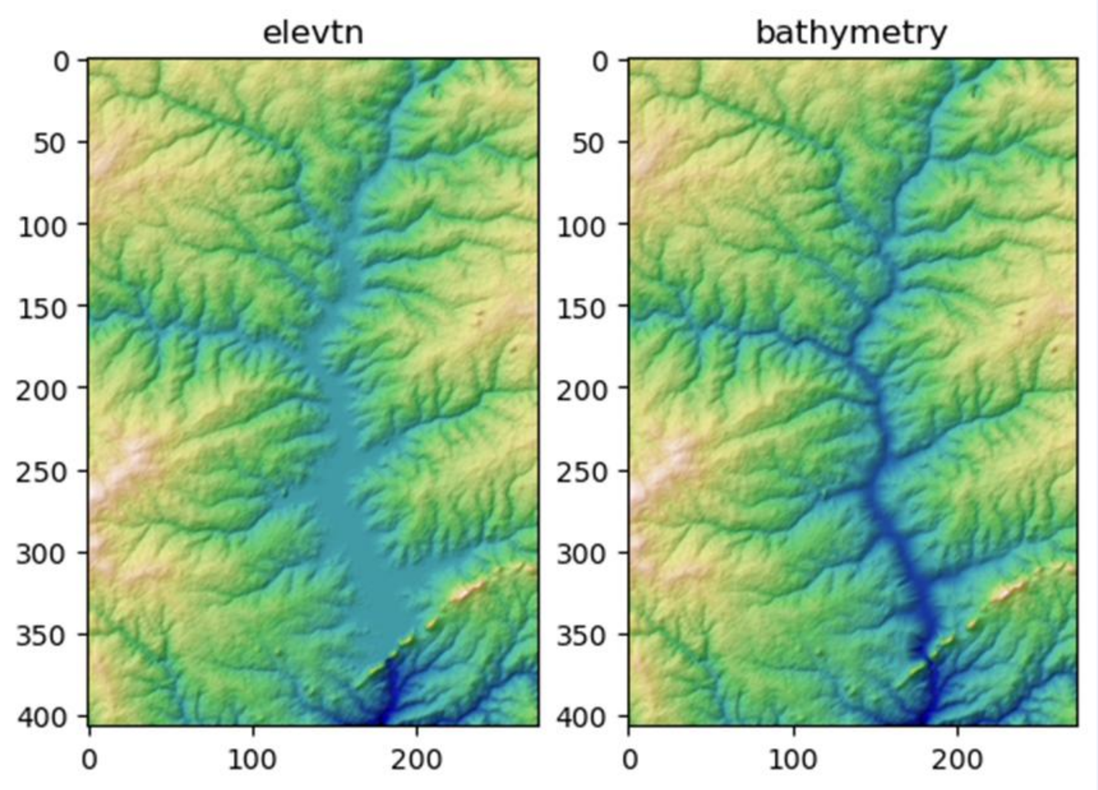
Derive hypsometry to go from Surface-2-Storage (or level)





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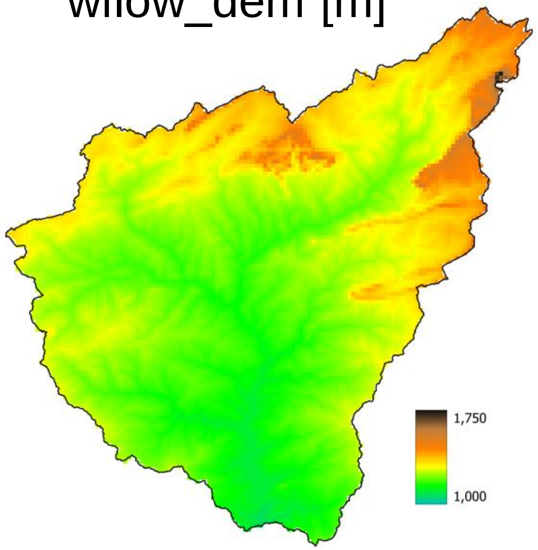
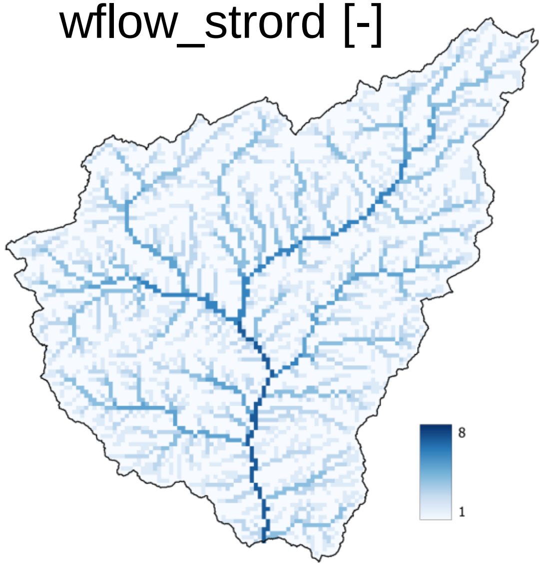
Winsemius and Moreno Rodenas, 2024

Hydrological modelling using wflow_sbm

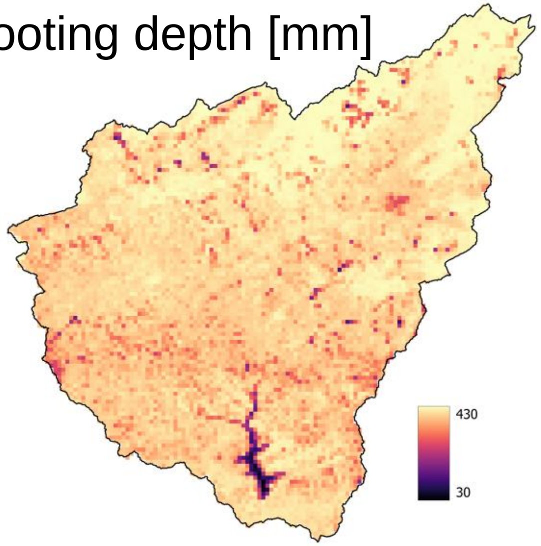
wflow_dem [m]



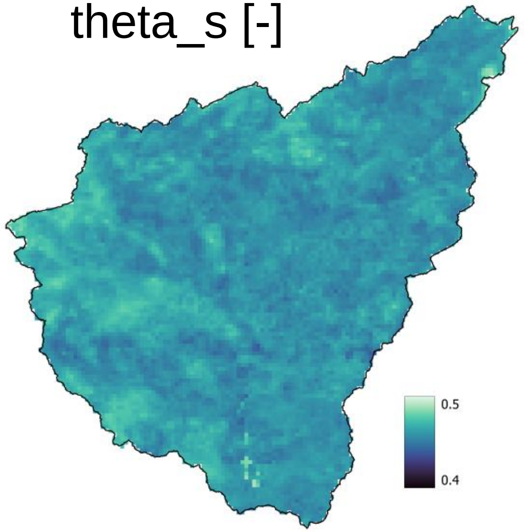
wflow_strord [-]



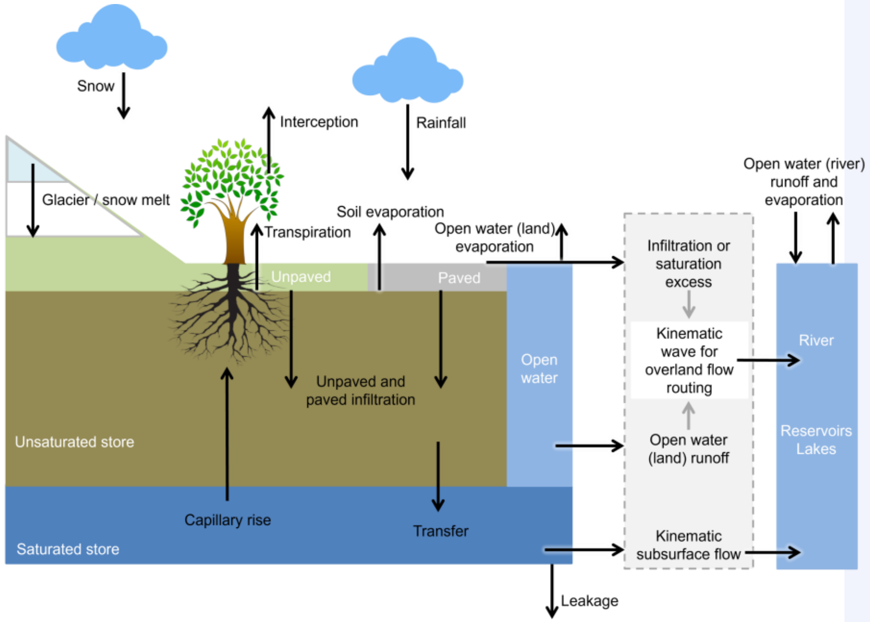
Rooting depth [mm]



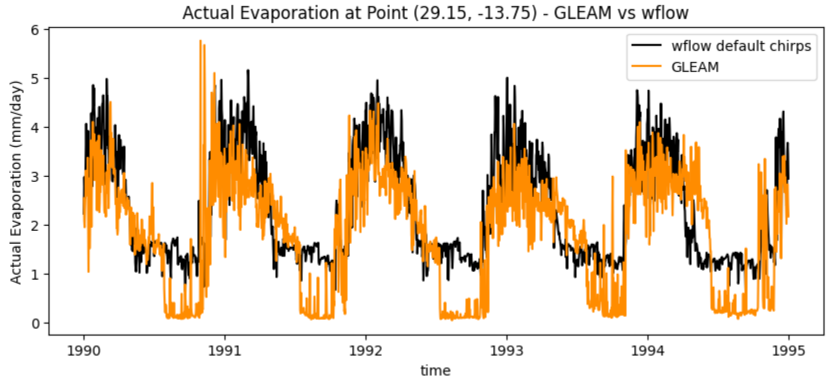
theta_s [-]



wflow_sbm



Van Verseveld et al., 2024;
Imhoff et al., 2020;
Eilander et al, 2021;
Imhof et al., 2024



Conclusions

- In DTC Hydrology Next, we aim to demonstrate the unique role of EO for developing pre-operational systems addressing the hydrology and hydro-hazard challenges in Europe and Africa

- We focus on getting reservoir volumes derived from reservoir surface area satellite options and assimilate those volume estimates to initialize hydrological models and provide better flow forecasts

- Deriving reservoir surface area works well compared to GWW (although some corrections will be made to deal with dry conditions)

- We developed automated workflow under Delft-FEWS

- Hydrological model validation for Mita Hills is ongoing using sparse insitu data and other (satellite based) products

- Assimilation experiments to be conducted

- What-if options through Delft-FEWS or DTE Hydrology Platform 2.0

References

Eilander, D., van Verseveld, W., Yamazaki, D., Weerts, A., Winsemius, H. C., and Ward, P. J, 2021. A hydrography upscaling method for scale invariant parametrization of distributed hydrological models, HESS, 10.5194/hess-25-5287-2021. https://doi.org/10.5194/hess-25-5287-2021

Imhoff, R.O., W. J. van Verseveld, B. van Osnabrugge, A. H. Weerts, 2020. Scaling Point-Scale (Pedo)transfer Functions to Seamless Large-Domain Parameter Estimates for High-Resolution Distributed Hydrologic Modeling: An Example for the Rhine River, An example for the Rhine River. Water Resources Research, 56, e2019WR026807. https://doi.org/10.1029/2019WR026807.

Imhoff, R.O., J. Buitink, W. van Verseveld, A.H. Weerts, 2024. A fast high resolution distributed hydrological model for forecasting, climate scenarios and digital twin applications using wflow_sbm. Environmental Modelling & Software, 10.1016/j.envsoft.2024. https://doi.org/10.1016/j.envsoft.2024.106099

van Verseveld, W. J., Weerts, A. H., Visser, M., Buitink, J., Imhoff, R. O., Boisgontier, H., Bouaziz, L., Eilander, D., Hegnauer, M., ten Velden, C., and Russell, B. Wflow_sbm v0. 7.3 a spatially distributed hydrological model: from global data to local applications, 2024, Geoscientific Model Development 17, 3199–3234, 10.5194/gmd-17-3199-2024.106099. https://doi.org/10.5194/gmd-17-3199-2024

Winsemius, H.C. and A. Moreno Rodenas, 2024. Surface-2-Storage - Final Report, 11207650-002-ZWS-0020, Deltares. https://www.deltares.nl/en/expertise/publications/surface-2-storage-final-report

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