ADB WATER AND DELTARES SEMINAR SERIES

# Collaborating on Innovative and Sustainable Solutions for Integrated Water Management

Deltares ADB

EVENT SNAPSHOT

## Part 4 – Yellow River, A Hydrological Basin Approach

### Event Details

**Date and Time**
22 September, 3:00–4:00 p.m. (Manila time)

**Venue**
Zoom

Related water subthemes

| | | | |
|---|---|---|---|
| | Water supply, sanitation, and wastewater | x | Flood/drought risk management and disaster resilience |
| | Irrigation and productivity | | Water governance and finance |
| x | IWRM, storage, water-food-energy nexus | | Water and health |

Water managers are continuously making decisions to guarantee water safety. These decisions relate to the short term; for example, ongoing droughts or when there is a risk of flooding. But these decisions can also affect the long term given the more extreme weather events caused by climate change. All these decisions have one thing in common: they are often grounded on results from hydrological models.

During the webinar, Albrecht Weerts of Deltares shared the challenges of setting up a conceptual hydrological model for the Yellow River Basin. He particularly focused on the open-source platform Blue Earth tool and computational framework as a means to assess river basin scenarios and improve water management decisions.

Various examples of its applications for modeling hydrological extremes under present and future climate, modeling effects of reservoirs, and/or sediment in large river basins were also shown.

This fourth session of the series, which had a total of 158 participants, was supported by the IWRM, Storage, and Water-Food-Energy Nexus advisory of the ADB Water Sector Group. Silvia Cardascia from the East Asia Environment, Natural Resources and Agriculture Division moderated the session.

## Key Takeaways

**Developing a conceptual hydrological model for a large basin should be evidence-based, flexible, and integrate different modeling.** The process toward such a model for a decision support system to be used for investment programs should consider measurements, share information with stakeholders, combine global and local data to become grounded in evidence. As for integrated modeling, this can link rainfall-runoff, groundwater, water demand management, reservoir management, water quality, and river hydro-morphodynamics. Lastly, to be flexible, rapid, multi-resolution, and open-source tools should be considered.

**The Blue Earth tools enable informed and interactive decision-making through a structured analytical planning framework.** The tools combine stakeholder engagement with the best available data to identify scenarios and strategies that can help build, run, and analyze hydro models. The tools also include state-of-the-art processing methods to apply the models on various scales and resolutions.

**Reservoir management is key for the Yellow River.** The Yellow River system face numerous challenges, from water resources, water quality, and sediment problems to coastal erosion and salt intrusion, which all need to be considered together. To improve the river's conditions, water management decisions should examine mitigation of drought hazards and risks, water resources management strategies (e.g., water quality, environmental flows), and climate change adaptation (e.g., shift from rain-fed to irrigated agriculture) and other drivers (such as urbanization, population growth).

## Questions from the Audience

**Which institution in India is handling the Ganga River basin model?**
This is the Modelling Unit of the Central Water Commission (CWC), Ministry of Jal Shakti.

**How does the Water Demand model work? What is the basis for making demand projections?**
Historic water demand is based on country statistics from AQUASTAT (EUROSTAT), UN, and the World Bank. This country level data is downscaled to the catchment or even more local scale using population, nightlight, and land use maps. The datasets provide water demand actual use and is calculated based on the water availability simulated with the hydrological model.

For irrigation water demand, the estimates are based on FAO crop pattern maps, crop factors, and the growing calendar. This is integrated in the hydrological model to assess at each time-step how much water is required depending on the natural water availability.

For the future projections, we base ourselves on UN projections for GDP and Technological Development. The framework is flexible and can be supplemented or improved using local data for the specific country / basin we are working.

**Can you share an example of a dashboard with the audience?**
Water, Peace and Security – the Inner Niger Delta, Mali:
*https://storymaps.arcgis.com/stories/fe8d45e9138a474c98cdce714a22ea59*
Our dashboard with policy dashboards is continuously updated and expanded:
bit.ly/deltares-dashboard

**Do these models require any instrumentation to be set up in the river basin?**
The models do not require any instrumentation to be setup. It starts from available global data sources that can be supplemented with local data. Ideally, there are in-situ measurements available from stakeholders for

validation (e.g., discharges, water use, reservoir levels, groundwater level, etc.) and if needed, fine tuning of the models. Here we also make use of global data sources like satellite imagery (e.g., reservoir area) which is available for the past 30 years or so.

**For water demand, allocation, priorities: (i) does the model include information about the legal status of various demands, and (ii) can alternative demand priority scenarios be modeled and is this part of the exercise?**
The model does not include information on the legal status of various demands. However, water allocation modeling is all about studying alternative demand (priority) scenarios. The model is well suited to support this kind of analysis. Changing priorities can also provide valuable insight in the system behavior and sensitivity of the system for certain changes.

**How does this model synchronize with other variables like land use land changes in different parts of the river basin?**
Land use, land use change, and LAI (leaf-area-index) information are available from global satellite imagery at high resolution. The land use and LAI are import sources for the hydrological model. For instance, we derived and use a global monthly climatology of LAI from MODIS at ~300m in the hydrological model setup. An example for land use can be found here: https://lcviewer.vito.be/.

**How does the model predict or calculate sediment loss?**
We use the wflow_sediment (https://wflow.readthedocs.io/en/latest/wflow_sediment.html) library, an add-on to the hydrological model used. This module allows for basin-scale soil erosion and sediment transport modeling. Again, the underlying data sources are globally available; for instance, Soilgrids (https://soilgrids.org/). The sediment module can be used to calculate inflow of sediments into lakes and reservoirs. The sediment dynamics are also important to consider in relation to ecological health of rivers and deltas.

**Could you please explain about the limitations when using Blue Earth? How can we learn about this modeling system and is there any training available to learn about Blue Earth?**
Blue Earth is an integrated open platform with information and tools to support water-related planning processes. Backed up by stakeholder engagement, results from the past can signpost opportunities for the future and guide you on the road to informed and interactive decision-making. Please check: http://blueearth.deltares.org/

Some limitations include:

- It's complex (covers many aspects) but provides the necessary detail to solve complex water related issue.
- Blue Earth builds on top of available global datasets. The data itself, however, cannot always be shared (license issue); the derived data (e.g. models) can be shared.

Previous experiences: https://blueearth.deltares.org/previousexperience/
For data: https://blueearth.deltares.org/blueearth-data/.

**How do you select scenarios for evidence-based decision-making?**

The selection is done in close collaboration with stakeholders through workshops and (virtual) interactions (including digital twins).

**How do you address the El Niño and La Niña phenomena and the effects of climate change?**
We make use of historic forcing datasets that contain effects of El Niño and La Niña like the reanalysis forcing data ERA5. Rainfall datasets like CHIRPS also contain the effects of these phenomena. And these phenomena are also present in future climate simulations like CMIP6 used for developing and analyzing future scenarios.

**What is the ideal size/scale of river basin for using this model?**
We often use different models to be able to deal with specific questions in different parts of the river basin and at various temporal scales. As shown during the presentation, the system can be setup and developed for large rivers basins like the Ganga (India) or the Yellow River. This modeling approach can also be used for small basins and islands. The level of detail and selection of models often depend on the issues to be tackled and how intertwined they are. The multi-resolution approach allows for a flexible, tailor-made solution for the problem at hand.

**There are many integrated models, all with their range of errors. Did you compare simulations with real world events? And how well do the simulations compare to measured data from best case to worst case? What options do you have to compensate for lack of data?**
The model components are tested continuously in ongoing projects and research. As mentioned in the presentation we make use of the best globally available data sources. One of the main sources of uncertainty is good and representative rainfall. While products like ERA5 are good on mid and higher latitudes, they are less adequate in the tropics. Here we often make use of merged products like CHIRPS, FEWSNET RFE (Africa, parts of Asia) and or TAMSAT (only Africa) or use local gridded rainfall datasets like the one provided by Indian MetService for the Ganga project.

Another source of uncertainty is reliable soil data. Although global soil databases do exist, the quality of the soil data differs from region to region, resulting in better and worse model performance. The option to include local knowledge and data sources can partly solve these issues.

Example of recent applications of wflow_sbm:

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019WR026807

https://www.sciencedirect.com/science/article/pii/S2590061720300132

Daily flow simulation in Thailand Part I: Testing a distributed hydrological model with seamless parameter maps based on global data. Wannasin et al, J. of Hydrology Regional Studies. 2020a (under review).

Daily flow simulation in Thailand Part II: Unraveling effects of reservoir operation. Wannasin et al, J. of Hydrology Regional Studies. 2020b (under review).

**River basins elsewhere in the world are confronted with huge sedimentation problem. Does Deltares have some solutions for some selected river basins?**
Deltares has knowledge, experience, and experts regarding river sediment transport, river hydrodynamics and

morphology, and river basin management. There are numerous examples where Deltares tools, knowledge, and expertise regarding sedimentation was successfully used or implemented. Please check our website (www.deltares.nl) for various publications on river sedimentation problems.

Deltares is also working on many water quality related projects, in which also sediment transport is included to model the transport of contaminants that are attached to the sediments.

See for example: https://www.deltares.nl/en/news/modelling-tyre-particles-aquatic-environment/

**Is linking these models problematic, i.e. different time-steps, different response times, two-way feedback linkage, stability issues, etc.?**
Sequential coupling is relatively straightforward in the Blue Earth approach. Two-way coupling is technically more complex, and this is also an area where developments are ongoing. However, we have enough examples where we successfully applied such an approach for instance in the integrated water management system developed for the Dutch Government.

Other examples are available in peer reviewed journals like GMD (e.g https://gmd.copernicus.org/preprints/gmd-2017-140/gmd-2017-140.pdf). The development of the hydrological model WFlow (https://wflow.readthedocs.io/) also has a basic model interface (https://wflow.readthedocs.io/en/latest/index_bmi.html) to enable coupling with MOFDLOW, D-WAQ and other model packages. A project example where the sequential coupling setup for the Ganga River Basin is shown in Van der Vat et al. (2019).

**Eastern India is having excess water availability whereas the western part is generally devoid of it. How effective is this model in helping to plan holistically river linkages and judicious use of equitable water availability across India?**
We have set up large water allocation models in which various water distribution strategies were studied. See e.g. https://www.deltares.nl/en/software/ribasim/. These kind of trans basin links were also part of the project done for the Ganga River Basin, using the tools available in Blue Earth (see again Van der Vat et al. (2019)).

**The stakeholder engagement seems to follow an iterative process. When are these made and don't they limit the scenarios?**
The interaction with the stakeholders (often in consecutive workshops) is especially important to see and understand clearly what possible and realistic scenarios are. Physical constraints to water availability and effects of certain measures for instance under climate change and other non-climatic drivers are being calculated to feed this stakeholder dialogue and support decision making incorporating all aspects that are important.

Stakeholder engagement can also focus on the output that the model should generate. Co-design of the model and the indicators can improve the dialogues between different stakeholders and improve understanding and acceptance of the outcomes of the models.

## About the Speaker

**Albrecht Weerts**
Data Model Integration Expert, Deltares
albrecht.weerts@deltares.nl

Dr. Albrecht Weerts is an expert on data model integration and hydrological forecasting at Deltares. Albrecht investigates the predictability of the hydrological system, which is driven by weather and climate. The aim of the research is to improve predictions of hydrological processes at different spatial and temporal scales. Improved prediction can help water managers, crisis managers, and policymakers to make informed decisions about reducing risks and impacts of future floods and droughts.