

SPATIAL HYDROLOGY WORKING GROUP

SWOT programme

Managing water levels and river flows requires detailed knowledge, in particular in the context of climate change. Yet in situ hydrologic stations are increasingly rare and financing their maintenance can be problematic. Calculations of “water elevation” (the altitude of rivers and lakes) based on data from Earth observation satellites provide a promising new source of information. Combined with other hydrological information from satellites, these altimetry data open up multiple perspectives for both scientific research and the operational management of water resources, in particular for large transboundary rivers.

OBJECTIVES

In 2014, a working group was created to **bring together technical and scientific visions and user needs** concerning satellite altimetry (estimation of river levels and discharges), and more generally, “multi-sensor” data (imagery, radars) useful for water management.

The spatial hydrology working group gathers French research, institutional, technical and operational stakeholders. It also works closely with potential users, like transboundary basin organisations, especially in Africa. **The group members pool their research and champion the implementation of innovative technologies and knowhow.**

The group works in particular on the **SWOT satellite programme** (Surface Water and Ocean Topography). By 2021, this Franco-American project featuring Earth observation satellites will provide spatio-temporal variations of the water levels of large rivers, lakes and streams, of the discharges of major rivers, and of sea levels.



Group members

The working group on spatial hydrology, coordinated by IOWater, involves the CNES, IRD, AFD, IRSTEA, BRLI, CNR and CLS.



The National Centre for Spatial Studies has a twofold industrial and commercial purpose. It proposes national spatial policy to the government and implements it in 5 strategic areas: Ariane, Sciences, Observation, Telecommunications and Defence.



The French Development Agency is a public financial institution acting on four continents to combat poverty and foster sustainable development.



The Research Institute for Development is a French state body with a scientific and technological focus that promotes research, expertise, training and knowledge sharing. It works mainly in partnership with Mediterranean and inter-tropical countries.



The International Office for Water is a French non-profit-making organisation in the public interest. Its action involves developing skills to improve water management in France, Europe and around the world.



This French public research institute conducts research into science and technologies with a focus on the environment and agriculture.



This engineering firm specialises in areas related to water, the environment and land management.



The National Company of the Rhône is the leading producer of exclusively renewable energy in France and the contract supplier for hydroelectricity, river transport and agricultural usage in the Rhône region.



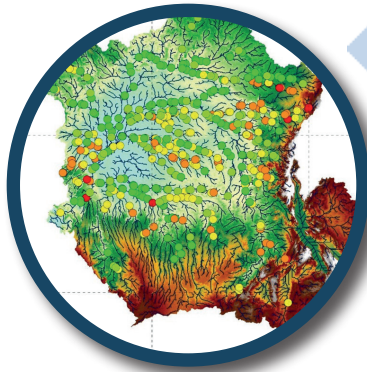
This pioneering worldwide company has been providing monitoring and surveillance solutions for the Earth.

The group's activities



Overview of knowledge and requirements

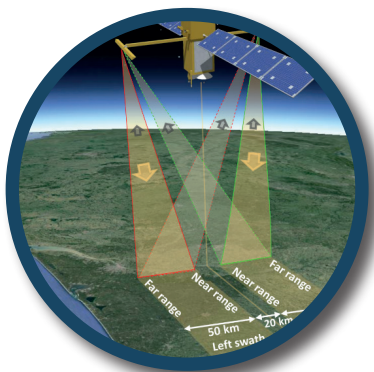
- Overview of the state-of-the-art on the use of spatial data in hydrology
- Continuous monitoring of progress in the field
- Analysis of the needs of transboundary basin organisations



Creation of models using data from virtual stations

- These models are used to calculate:
- Water elevations in lakes and rivers
 - Flows of watercourses
 - Forecasts of future levels of water elevations and discharges

Virtual stations occur at the intersection between altimetry satellite ground tracks and the river network. They indicate the elevation of the water in relation to a reference: the ellipsoid.



Determination of virtual stations operating on pilot basins

- Collection and processing of spatial altimetry data received from different satellites (Saral, Envisat, Jason series, Sentinel 3)
- Comparison with data measured by stations on the field to estimate their precision
- Selection of pertinent virtual stations



Operational transfer

- Application for use: navigation, hydroelectricity, flood forecasting, ecosystem maintenance, etc.
- Set up of an information system for users to collect, store, process, disseminate and exchange data
- Training of beneficiaries to ensure successful adoption of tools

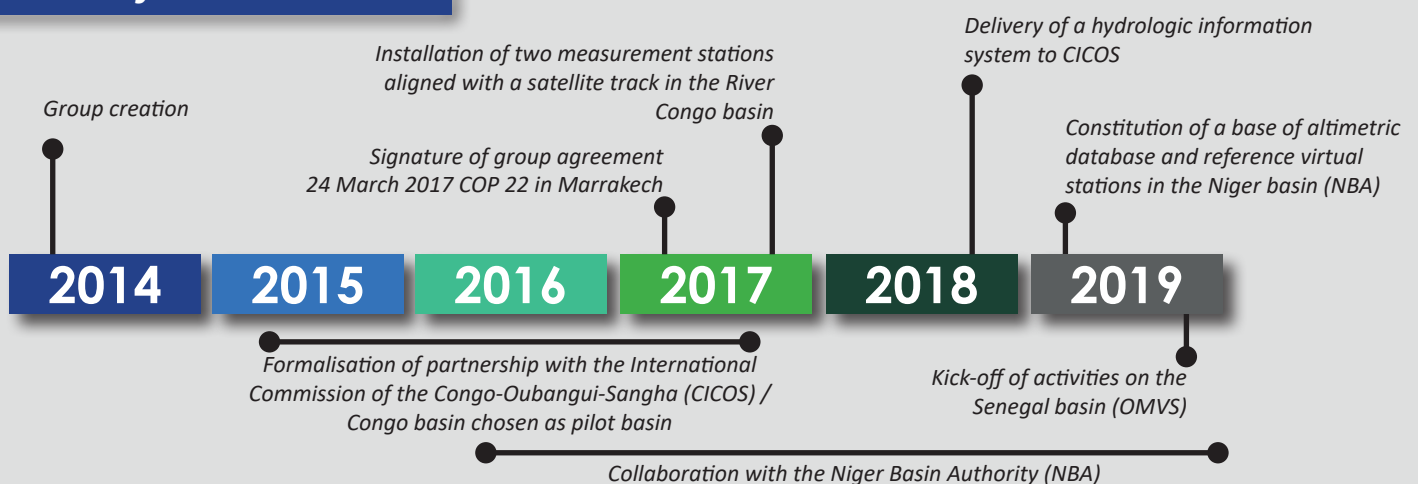


Availability of data

Time series of the water levels of rivers and lakes are available on the Hydroweb platform. These time series are continuous and cover a long period. They are produced from data supplied by different altimetry satellites. Cartographic visualisation and filters make it easier to access the available series.

<http://hydroweb.theia-land.fr/>

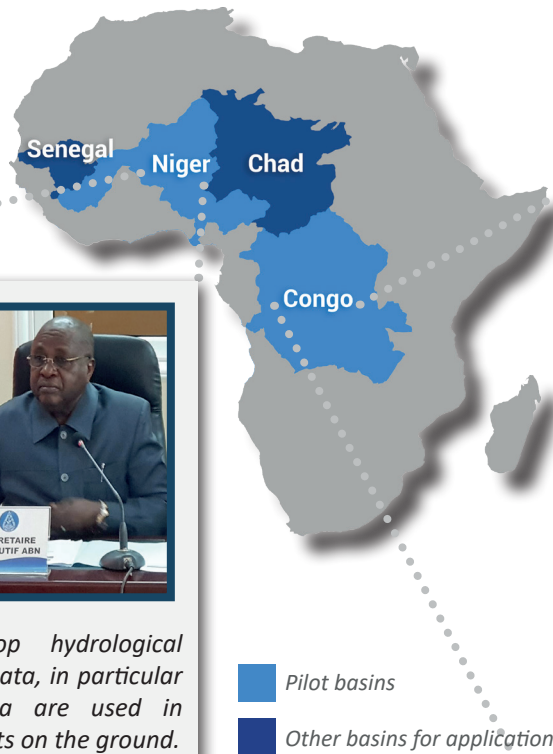
Key dates



The pilot basins: Congo & Niger rivers

In the words of Mr **ABDERAHIM Bireme Hamid**, Executive Secretary of the Niger Basin Authority

In the words of Ms **ENAW, born Judith Efundem Agbor**, Secretary General of the CICOS

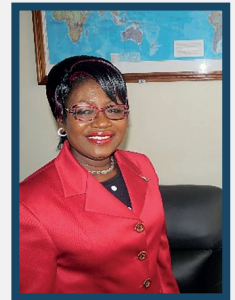


«For over fifteen years, the French Development Agency (AFD) has accompanied the NBA in hydrological monitoring of the Niger Basin. During the current phase, a highly innovative contract has been signed between the NBA and the



IRD-CNES group to develop hydrological applications based on spatial data, in particular spatial altimetry. These data are used in combination with measurements on the ground. We're proud of our progress in this domain and hope that upcoming support from AFD will strengthen, complete and consolidate these achievements, leading to improved knowledge of water resources, which is so vital for the harmonious development of the Niger basin which is home to 160 million people.»

«The spatial hydrology group, created by French research and implementation institutions, chose the Congo River basin as its pilot basin. Following my signature at COP 22 of a Declaration of Intention with the French Minister for the Environment, numerous activities have been developed with the spatial hydrology group financed by AFD.



Thanks to this cooperation, CICOS now has a hydrologic information system combining in situ and spatial data, which is extremely useful to its member states. Applications have also been devised based on these data for the development of both hydropower and river navigation.»

Focus on...

The Congo basin's hydrological information system

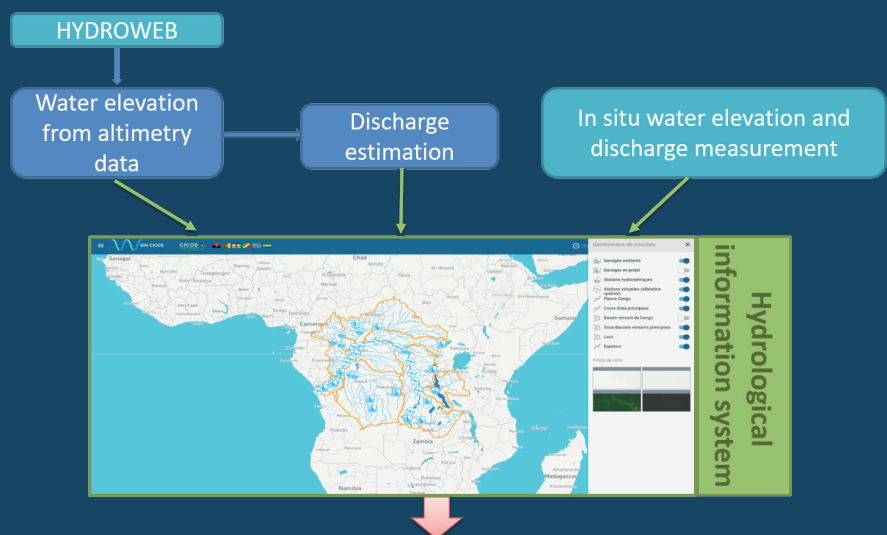
The hydrological information system (HIS) developed for CICOS features:

- In situ measurements (water levels, discharges and rating curves)
- Water elevation from spatial altimetry.

The development of HIS is based on the WIMES platform produced by BRILI.

It is operated through services and applications used for navigation (water level forecasts) and for developing hydropower potential.

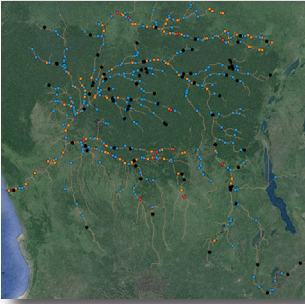
CICOS teams have been trained to use the tool.



Applications and services:
navigation, integrated water resources management, hydropower

Examples of achievement

Availability of virtual stations



Virtual stations on the Congo basin

- 544 time series of water levels produced by virtual stations on the Congo basin are freely available on Hydroweb. In addition, 163 time series from ENVISAT and 33 from Jason 2 are available from CICOS, IRD and on Hydroweb.
- The data from these stations are used to feed into models and hydrological information systems in addition to in situ data.

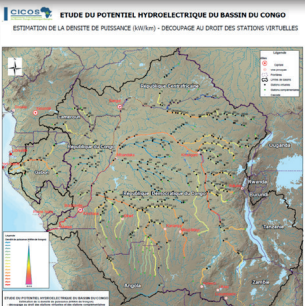
Installation of measurement stations on the field



Installation of the station in Kollo

- M'Bata in Central African Republic, Maluku-Tréchet in Congo and Kollo in Niger
- Measurements of pluviometry and water elevations
- Maintenance of stations carried out by national hydrological services
- Data used for comparison with data from virtual stations

Cartography of the Congo basin's hydropower potential



Source: CICOS

CNR mapped an indicator of hydropower potential on the Congo and Ogooué basins, crossing flood and slope information useful for identifying hydropower projects. It is built from satellite altimetry, in situ discharges, precipitation data and a digital elevation model.

The second part of the project, relating to navigation, resulted in a forecasting service of water levels on the Sangha, a tributary of the Congo.

Cartography of an indicator of hydropower potential on the Congo and Ogooué basins

Flood forecasting in the Niger basin



Photo of Niamey during a red flood

A new approach has been developed to forecast discharges, and in particular "red floods" (right-bank tributaries from Burkina), which can be devastating in Niamey. It integrates complementary tools i.e. satellite estimation of rains flowing into the river and the sometimes highly reactive lateral basins, a hydrological model to propagate the run-off and discharge, and satellite altimetry based on operational satellites (Jason, Sentinel 3) to monitor flood levels.

Key figures

2021

Launch year of SWOT satellite

100 m

SWOT will be able to measure water levels of rivers wider than 100 m and water bodies of minimum 200*200m

10 cm

The future SWOT mission will provide water levels with decimeter accuracy

544

Number of virtual stations in the Congo basin

PERSPECTIVES

➔ Continued activities on pilot transboundary basins of the Congo and Niger rivers:

- Extension of operational series to other satellites in orbit

- Operationalisation of other hydrological variables from spatial sources (water quality, soil moisture, water surfaces, land use, etc.)

- Spatial and temporal densification of the virtual station network, state of water resources on the entire basin, and forecast of floods and low waters

- Establishment of relations with the Space Climate Observatory piloted by the CNES

➔ Activities are underway on rivers shared by Guiana. The group could extend its activities to other transboundary basins, e.g. Senegal, Lake Chad, Mekong and Nile rivers.

➔ Training of final users and local experts along with citizens' initiatives are vital to ensure the sustainability of action.

Contact - More information



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CNES - <https://swot.cnes.fr/fr>
Hydroweb - <http://hydroweb.theia-land.fr>

NBA - <http://www.abn.ne/>
CICOS - <https://www.cicos.int>