

Water resources on the Guiana Shield: sensitivity and evolution

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Objectives

Contribute to the assessment of the water resource on the Guiana Shield and its sensitivity to ongoing climate and anthropogenic changes

Compile a **database** (surface water) by integrating available satellite and in situ data and a **documentary database** (including grey literature)

Build an **integrated system of observation and forecasting of flows**, water levels and water bodies in the main rivers of the region



Assess the sensitivity of surface water resources to anthropogenic and climatic pressures and determine possible changes



Basemap: OpenStreetMap, made with QGIS 3.16 , Mp.Bonnet

Geographical context: Guiana Shield



Amazonian context

Institutional background:

- OTCA IRD MOU (Amazonian Cooperation Treaty Organization)
- Bilateral agreements (ANA, CPRM, SENAMHI Peru, Bolivia, INAMHI Ecuador, Several universities in the basin countries

MOU OTCA IRD signed in September 2020 Since then a joint work plan has been decided.



1. Support for compatibility and complementarity of hydrological and biodiversity information for the Amazon Regional Observatory (ORA).

2. Mercury in water bodies: information on the involvement of mercury in physical and biological processes, the presence of mercury in the atrophic chain from sediments, phytoplankton, to human health effects.

- 3. Environmental DNA
- 4. Calculation of ecological flow in the most representative sub-basins to determine ecosystem services





To fulfill the main purpose of the PROGYSAT project : to be the symbol of transboundary cooperation around SEAS-Guiana, establishing a link with the OPHYSE and Bio-Plateaux projects as well as the ongoing exchange between IRD and OTCA (Amazon Cooperation Treaty Organization) has been the baseline for our actions.

Un territoire commun BIO-BIO-BIO-BIO-BIO-BIO-PLATEAUX, pour l'Articulation Transfrontalière de l'Eau et de la Biodiversité, est cofinancé par l'Union Européenne au travers du Programme de Coopération Interreg Amazonie. Il vise à développer le partage de données, informations et expériences sur l'eau et la biodiversité en milieu aquatique entre la Guyane Française, le Brésil et le Suriname, en particulier dans les deux bassins transfrontaliers des fleuves Oyapock et Maroni.

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MINISTÈRE E LA TRANSITE ÉCOLOGIQUE ET SOLIDAIRE

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The OpHySE project (*Operational Hydrology from Space and modEls*) (CNES/SCO)

Set up of a real-time state checking of rivers using navigability on the French Guiana territory









Collect, process, organize and disseminate comprehensive and internationally comparable official information among the Member Countries, providing information services agreed with the competent national public institutions through their foreign ministries, for the study and development of the Amazon region in the defined topics previously.

1. Support for compatibility and complementarity of hydrological and biodiversity information for the Amazon Regional Observatory (ORA).

Transfer of HYBAM observatory data and Amazonfish database

2. Mercury in water bodies: information on the involvement of mercury in physical and biological processes, the presence of mercury in the atrophic chain from sediments, phytoplankton, to human health effects.

Beginning of a joint work UnB-IRD to collect available informations on mercury in the Amazon basin and create an atlas of vulnerability to mercury exposure. Capacity building is central in collaboration with ANA





3. Environmental DNA

4. Calculation of ecological flow in the most representative sub-basins to determine ecosystem services









MINISTÈRE DE LA TRANSITIE ÉCOLOGIQUE ET SOLIDAIRE

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Guiana shield context

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<u>Two projects "Hydrology spatial and operational" carried by Hydro Matters in</u> <u>strong synergy with the Hydrological axis of the PROGYSAT project's activities:</u>



OpHySE (**Op**erational **Hy**drology from **S**pace and mod**E**ls)

SAGUI (Sig d'Alerte pour la Guyane sur l'eaU et l'alr)

Setting up an operational alert plateform (using open source data) on all French Guiana's drainage basins with :

- Hydrological modeling
- Spatial data (e.g. Remote Sensing)
- Local public actors's expertise partners (e.g. DGTM, OEG).



Publics Partners:





Planned API for interface with the PROGYSAT project, export format : type XML SANDRE or WaterML



Operationalize automatic detection of floodable areas

- Creation of an automatic Sentinel-1 based classification chain
- Developed initially for floodplains in the Amazonian basin and **operationalized** within the PROGYSAT project

S1 processing workflow



Src: https://github.com/BiodivBONDS/





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S1-Flode , Detection of open water in the city of Paramaribo



Basemap: Open streetmap made on QGIS 3.16





Setting up a hydrological model

MGB was already applied for tropical regions including the Amazon basin. It is being operationalized for the Guiana shield.

Focus on instrumented basins (Oyapock) to calibrate the model parameters and prepare extrapolation for other basins

Semi-conceptual and spatialized model



ESQUISAS HIDRÁULICAS UFRGS





Setting up a hydrological model

Compiling in situ and satellite products and prepare the MGB input data for the Guiana shield

DATA	PRODUCT	Source	
Climate	ERA-5	ECMWF(1)	
Daily water level and discharge	In situ data	Shapi / Hydroportail ANA/hidroweb(2)	
Monthly water level	Altimetric data	Theia/Hydroweb(3)	
Elevation and river width	DEM MERIT Hydro	Yamazaki et al, 2019 (4)	
Soil type	SOTER	ISRIC/FAO/UNEP(5)	
Land cover	Global cover 2019	Copernicus(6)	
Hydrography	Stream network	BD Carthage(7)	
River depth	A simple global river bankfull width and depth database	Andrealis et al, 2013 (8)	
Precipitation	IMERG (0.01 degree) MSWEP GSMAP In situ daily data	GPM NASA(9,10,11)	
Institut on Recherche Bour to Développement			



Setting up a hydrological model for the Oyapock basin

Compiling in situ data and remote sensing data in order to prepare the MGB input data:

- Automated watershed delineation from DEM (90 m) ٠
- 30 km² threshold for stream definition (a stream network ٠ compatible with BD Carthage data)
- Subbasin division in order to separate large contributing areas and the areas upstream of discharge/water level measuring stations
- Unit-catchments division with 5 and 10 km stream segmentation in order to compare model performance
- HRU based on land cover, slope and soil types ٠
 - 7 classes were defined



HRU classes map





Selecting remote sensed rainfall product







Selecting remote sensed rainfall product







Calibration



METRIC FOR C3	FULL SIMULATION PERIOD	NOV-DEC- JAN	FEB-MAR- APR	MAY-JUN- JUL	AUG-SEP- OCT
NSE	0,65	0,04	0,17	0,22	0,17
KGE	0,79	0,14	0,55	0,59	0,75
PBIAS	-12,55	-40,50	-37,09	+1,92	+19,35
ΔVolume	-2,2E+10	-8,3E+09	-2,0E+10	+1,6E+09	+4,2E+09



We are a setting up a hydrological model for the other basins

Compiling in situ and satellite products and prepare the MGB input data

Espace DEV

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Suriname HRU map







OPHYSE & SAGUI





Oyapock simulation and regionalization

- Calibration at the sub-basin scale and validation for the Oyapock
- Apply the model in the other Guiana shield basins and evaluate using the few altimetric stations

Medium and long term forecasting

- Build the rating curves using simulated discharge and altimetric water level (Paris et al, 2016) and automatization
- Create scenarios based on climate changes scenarios (CMIP6)





Webography

(1) https://www.ecmwf.int/

(2) https://www.data.gouv.fr/

(3) https://www.snirh.gov.br/hidroweb/

(4) http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_Hydro/

(5) https://data.isric.org/

(6) https://land.copernicus.eu/global/products/lc

(7) https://geo.data.gouv.fr/

(8) https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/wrcr.20440

(9) https://gpm.nasa.gov/data/imerg

(10) http://www.gloh2o.org/mswep/

(11) https://smap.jpl.nasa.gov/





Discussion about the methodological aspect

- The MGB Plugin
- Chuvabin interpolation

Usage of the possible Sentinel-1 Datacube

• Up to date MGB model fed with daily precipitation data

