SPLASH : Small Ponds and Lakes in semi-Arid regions by SWOT and High resolution satellite sensors

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Small water bodies (SWBs) play a pivotal role in semi-arid regions, and particularly in the Sahel. They are widely spread all over the landscape, which makes them a primary source of water for people and livestock. Also, in a region where water borne diseases are the first cause of mortality among young children, water quality is a major issue. This is due to an important pollution of surface waters and to bio-physical and chemical conditions that favor bacteria development and survival. In addition, small water bodies have been shown to be a major source of greenhouse gases and they strongly impact biogeochemical and carbon cycles.
However, given their small size and their important temporal variability, their hydrological dynamics remains poorly known and difficult to model. Water quality is usually unknown in rural areas. Processes of carbon emission and stock by Sahelian SWBs still need to be addressed and understood. Also SBWs are very reactive to climate and human forcing with a complex and sometimes unexpected dynamics which questions their future evolution in a context of environmental changes and demographic increase.

Recent and forthcoming satellites provide unprecedented vision of small water bodies at the large scale, combining high resolution, high frequency (Sentinel2, Sentinel3) and new observations of water height and volume (SWOT). This proposal aims at monitoring at the same time water amount and water quality of small hydrological objects in semiarid regions. Methodological development is necessary to address a large variety of water bodies in order to switch from case studies on specific areas or pre-launch simulations (SWOT) to the regional scale. It will be conducted in four main tasks focused on Sahelian water bodies and a fifth task aiming at extending the approach to all semi-arid regions worldwide.

Objective 1: Estimation of volumes in small water bodies across the Sahelian region

The development of algorithms for water volume estimation will rely on the coupling of water areas and water heights. Before SWOT launch, water levels will be estimated from altimeters data (as Sentinel3, Fig. 1), for the lakes below the orbit, and from high resolution DEM and bathymetry acquired when water levels are at minimum. Once available, SWOT data will be employed to improve SWBs volume estimation (Grippa et al. 2019) and generalize the approach to the regional scale. SWOT data will also be evaluated using dedicated Calval Tier2 sites below the 1-day calval orbit (Agoufou lake in Mali and reservoirs in Burkina Faso), and the nominal orbit (lakes in Niger).

Objective 2: Small water bodies hydrology and surface-groundwater interactions

The knowledge of water volumes and areas will provide extremely precious information to better understand hydrological processes. We will develop a lake water balance approach (Gal et al. 2016) to quantify water fluxes and derive information on surface –ground water fluxes, a term that is very poorly known at the regional scale.

Objective 3: Water quality indicators: turbidity, suspended particulate matter and temperature.

Water turbidity and suspended particulate matter will be estimated from optical high resolution sensors (Robert et al. 2016, 2017) as Sentinel2 (Fig. 1) Sentinel3-OLCI, and Landsat and water temperature from the thermal bands on Landsat8 as well as, for larger objects, those on Sentinel 3-SLSTR and MODIS.

Objective 4: Cross-analysis of hydrological characteristics and water quality indicators

Combined estimates of water amount and quality will provide a global inventory of SWBs characteristics with their seasonal variability and their hydrological behaviors. This will allow to investigate for each watersheds the relationships between water bodies dynamics and environmental variables such as precipitation, vegetation amount and soil characteristics as well as anthropogenic activities impacting for example land cover (Abdourhamane Touré 2011).

Expected outcome

This work is a contribution to an integrated approach of small water bodies, that can be applied to other regions worldwide, particularly those in semi-arid climates.
Combined estimates of water amount and quality will provide a global and dynamic inventory of SWBs characteristics, improving knowledge on: 1- SWBs current spatial distribution of water storage and their seasonal dynamics which is at the moment unknown at the regional scale; 2- the relationships between water bodies dynamics and environmental variables such as precipitation, vegetation cover and soil characteristics as well as anthropogenic forcing. This is important to understand past changes and anticipate future changes in SWBs under climate and anthropogenic constraints.
In addition, results from SPLASH will be employed for large range of applications including health issues (particularly diarrheal diseases, Rochelle-Newall et al. 2015) and SWBs climate impacts related to the carbon cycle and to greenhouses gases emissions.

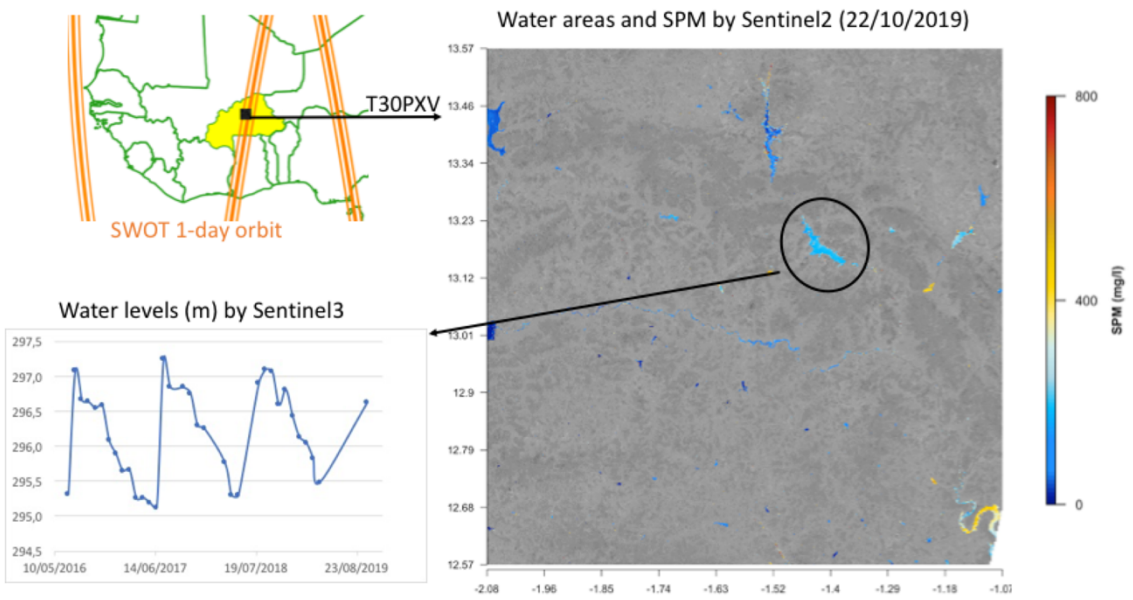

Fig. 1 Example of water area and SPM derived by Sentinel2 over north east Burkina for the 22nd of October 2019 (THEIA level2 products, tile T30PXV) . and seasonal variability of water levels estimated by Sentinel3 over the Namissiguia lake (situated within the SWOT 1 day calval orbit.)

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