C4S Senegal

Hydrological evidence to guide climate resilient agricultural policies in Senegal

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Senegal
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This report presents the research activity "Hydrological evidence for more crop per drop" carried out in Senegal by the Institute of Geosciences (IGE), as part of the Climate Smart Systemic Solutions and Scaling (C4S) innovation package, under work package 3 Climate policy pathways of the CGIAR initiative on Climate Resilience, ClimBeR. The team leader is also coordinator of the long-term AMMA Catch hydroclimate observatory http://www.amma-catch.org/-Senegal-128-

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Background: hydrological evidence for more crop per drop

Climate adaptation agricultural and land restoration programmes such as the Great Green Wall often do not integrate enough hydrological evidence in their design, despite water scarcity being a key limiting factor for the agricultural sector.

As part of the inter and transdisciplinary research collaboration BRIDGE initiated by IRD in 2021, IGE hydrological expertise helps exploring/assessing how to better integrate hydrological scientific methodologies and tools in climate-smart agricultural decision-support systems. The objective here is to connect agricultural modeling expertise with IGE hydrological modeling and experimental framework to better evaluate effect of land use change (vegetation cover change or land/water conservation infrastructure) on water recharge and coping response of agricultural activities to droughts and other future climate stresses. Interdisciplinary climate-crop-water (surface and underground)modeling research could improve the understanding of interrelationships between land use change and the water cycle at different scales, providing evidence for better climate and water smart planning.

For instance, which, where water recharge/conservation options (eg crop diversification, water conservation technique like bench terracing or water harvesting infrastructure) are the best to improve drought resilience of farming sector in Senegal.

Methodology and site description

Terrain measurements for Senegal context: the research team benefits from the new installation of the long-term regional hydroclimatological observatory network AMMA-CATCH, which aims at better understand the changes of the West African Monsoon phenomenon. Cohard and his team has started installing in 2022 new sites in Senegal:

Niakhar site where AMMA CATCH is installing new equipment within/near IRD carbon flow experiment in Faidherbia parkland system (Roupsard).

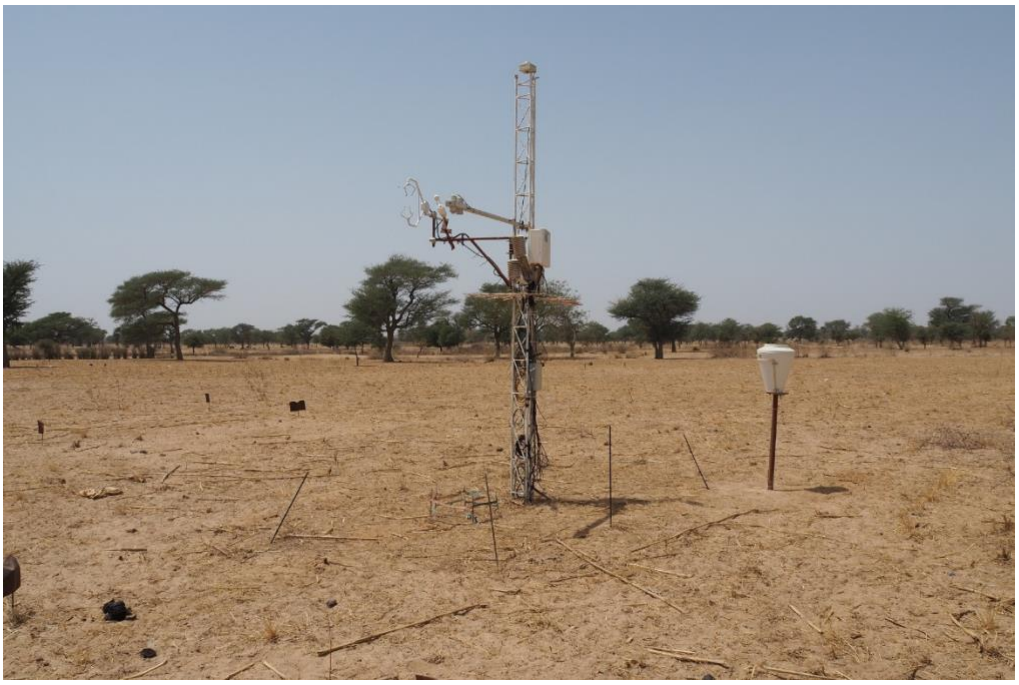

Fig 1. AMMA CATCH hydroclimate instruments in Niakhar site

Dahra is another possible site in the future (AMMA Catch starting equipment).

Fig2. Carbon flow experimental design in Faidherbia parkland, Niakhar site

Cross-learning with other AMMA Catch countries in the Sahel region, eg transfer learnings of bench terracing valuation for climate resilience in Niger.

Interdisciplinary modelling: the research team explores ways to better integrate vegetation dynamics in PARFLOW modelling and link with downscaled climate scenarios. Collaboration with Vincent Vadez (IRD).

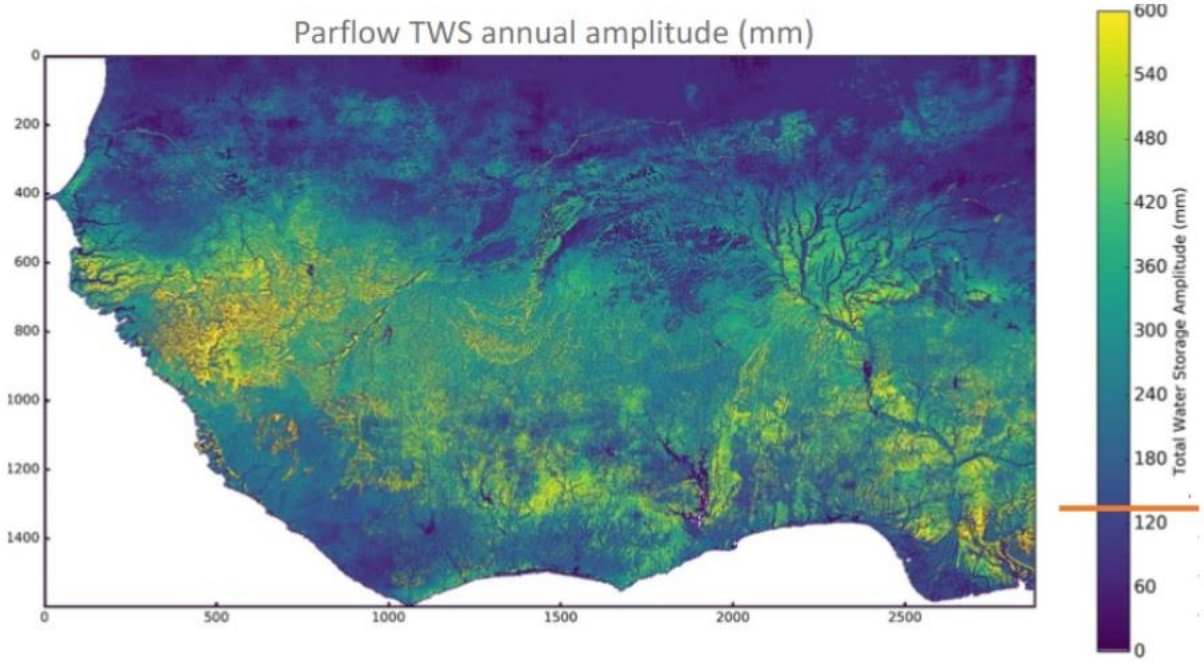

Fig3. Example of PARFLOW water storage map for West Africa

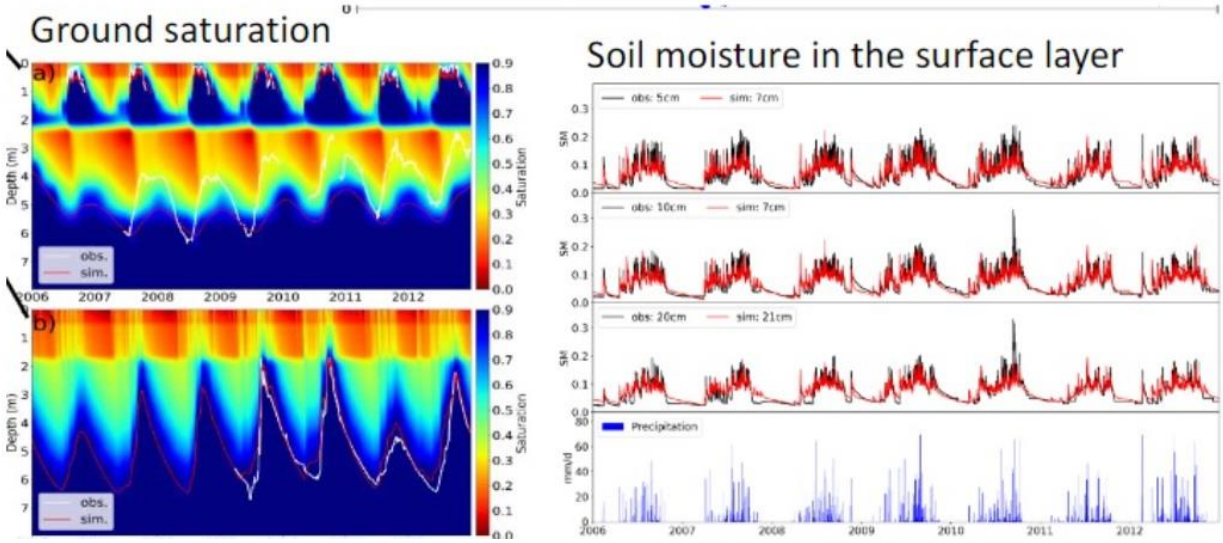

Fig4. Examples of PARFLOW outputs that are used to evaluate impact of land use change on key hydrological variables like surface soil moisture.

One reference study for methodology is PARFLOW hydrological modelling of a pilot watershed (Hector B et al, 2018)

Interaction with end users to better understand hydro evidence needs and interdisciplinary research gaps.

Planned pilot studies may include:

- impact of farming and land conservation practices (bench terracing “banquette”) on water budget in pilot watershed (Hector et al, 2018; Descroix et al, 2018)
- Faidherbia park modelling (tree crop competition for water)
- impact of irrigation scenarios for water resilience.

The team discussed in January 2022 with the Great Green Wall accelerator management team. There were various interactions with regional players like in Niger, under the AFD-funded Water Cycle and Climate Change and other collaboration programmes. The Great Green Wall is a good example where soil and land conservation investments like tree planting or landscaping operations eg bench terracing often do not use enough hydrological evidence to guide where to implement such nature-based infrastructures.
In March 2022 the team attended the World Water Forum. A field visit was organised with Vincent Vadez (BRIDGE coordinator) and Senegalese research partners to the Niakhar site.
Interactions with Senegal stakeholders in water sector involved through AFD CECC project, including ANACIM who is the main counterpart for the AMMA Catch observatory.

Capacity-Building

IGE / Grenoble University team (Jean-Pierre Vandervaere) is coordinating the **3EC-Sahel Water, Environment and Climate Change capacity building programme** with leading Universities in the Sahel

región including Senegal. This projects aims at improving high education curriculum (Master, Phd, vocational training) so that a new generation of water experts could emerge (theme youth, job creation).

First hydrological findings to guide C4S policy pathways

Bench terracing, example of land structure for drought resilient farming landscapes

A communication about the impact of bench terracing to reduce run-off in the Sahel. [Vandervaere JP, 2022. Personal communication in French presented in Annex 1] was given at the 2022 World Water Forum.] It shows what type of localized impact of land conservation structures could have on key hydrological variables, which should be integrated in planning more climate resilient agriculture (drought).

Vandervaere, 2022 says that land and water conservation practices widely adopted in Sahel region like demi-lunes, zai pits, bench terracing, against the effects of run-off have been scarcely evaluated in term of hydrological efficacy. Climate change is leading to more frequent intense rainfall events which makes this issue even more relevant. A recent experimental study quantified bench terracing impact on run-off reduction and water recharge to determine if/where this climate smart innovation could be relevant to increase water resilience for agriculture and a good flood management measure.

Bench terracing could increase water stockage (2 meters deep soil horizon) from 90 to 170mm.

Fig5. Bench terracing with impluvium (upstream), ditch and small land mound. Hydrological measures using neutron probe and water conductivity apparatus.

Pilot study using AMMA Catch remote sensing datasets

A pilot PARFLOW watershed methodological study using remote sensing data was completed in summer 2022 using Niger datasets: 34 sites of bench terracing covering 6600ha, data during the period 2018-2021. This NDVI analysis shows that bench terracing has positive impact on recharge and vegetation resilience: the NDVI vegetation cover index has increased by +11% over the period on average but there is a significant variability. Indeed, the impact range between +30% and -15% for a few sites.
The causes for variability need to be determined with further research to guide future land restoration implementation.

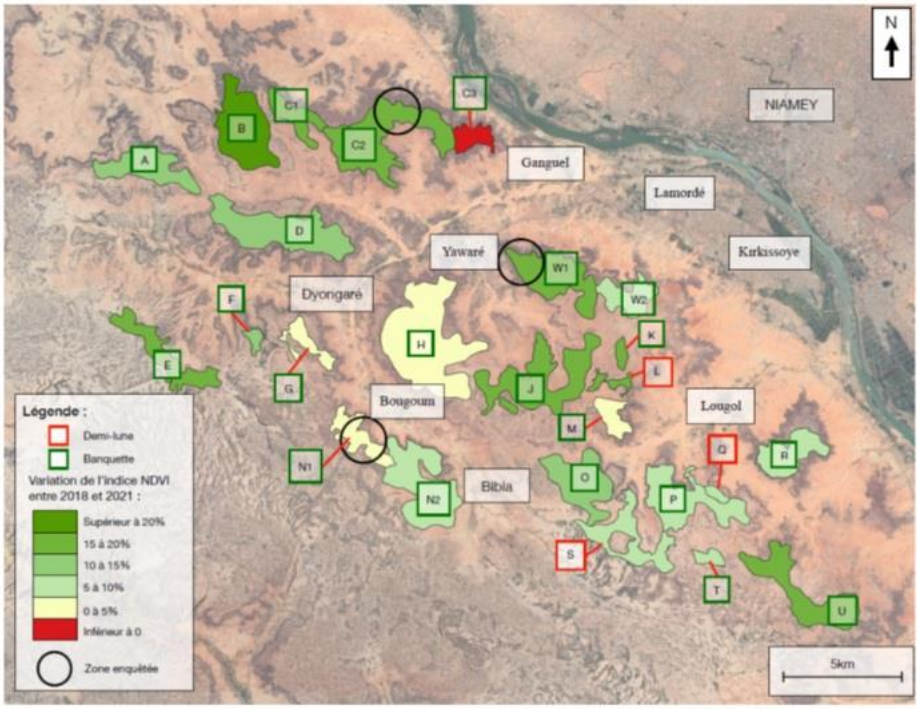

Fig6. NDVI impact variation across bench terracing sites

Findings from these studies will be presented during ClimBeR C4S Senegal stakeholder consultations in 2023. And will serve as template to adapt participatory hydrological modeling activity in Niakhar site, Senegal.

Interdisciplinary collaborations towards a more integrated assessment

Interdisciplinary hydro-crop PhD thesis supervised by IGE hydro, IRD CERAAS and Benin Institute . The PhD proposition to improve integration of hydrological measures to assess efficiency and climate resilience of sowing density options, has been successfully submitted. This was possible thanks to the collaboration initiated under ClimBeR programme. This will lead to new climate advisory key for dryland cereal farmers.

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