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Sustainable Water Management: What Are the Challenges for the Great Green Wall?

The Great Green Wall (GGW) initiative aims to create a green strip through the Sahel, some 8,000 km long and 15 km wide, to restore degraded land. Launched in 2021, the GGW Accelerator focuses on five pillars, but does not directly address water resources. This paper is based on several Agence Française de Développement (AFD) studies and a review of the literature. It examines the role of water resources in the acceleration of the GGW.

The Great Green Wall under the watchful eye of hydrological sciences in the Sahel

The Great Green Wall (GGW) initiative was launched in 2007, under the leadership of the African Union (AU), and is coordinated by the Pan Africa Agency for the Great Green Wall (PAAGGW). The GGW is today a program focused on integrated ecosystem management in 11 countries, along a corridor in the southern Sahara connecting Senegal to Djibouti. The objective is to tackle land degradation, the effects of climate change, biodiversity loss and, *de facto*, food insecurity in Sahel countries. The GGW is supported by many actors, including the World Bank, the European Union and AFD,[1] which finance projects that contribute to the objective of the GGW.

The aim of the GGW is to curb further land degradation and restore, by 2030, 100 million ha of degraded land, sequester 250 Mt of carbon, and create 10 million green jobs.[2] The latest Global Sustainable Development Report[3] (GSDR) points to a delay in the implementation of the Sustainable Development Goals (SDGs) and failures in the achievement of certain targets, especially in the arid and poor parts of the world. The success of the objectives of the GGW should contribute to the achievement of the SDGs, in particular SDG 6 on sustainable water resources management and sanitation. This will be achieved by building infrastructure for drinking water supply and sanitation around this initiative, and increasing groundwater recharge by planting millions of trees. In addition, the achievement of SDG 6 can facilitate the achievement of the other SDGs, as water offers the greatest potential synergy for achieving other objectives (Taka *et al.*, 2021). Figure 2 shows the indicative route of the GGW, the hot and dry steppe and desert climates it crosses through the 11 countries concerned, and the main perennial rivers that can provide a water source for the vegetation around the wall in certain places.

[1] https://www.afd.fr/fr/ressources/groupe-afd-et-grande-muraille-verte

[2] https://www.afd.fr/en/actualites/africas-great-green-wall-restoring-land-food-security

[3] https://sdgs.un.org/gsdr

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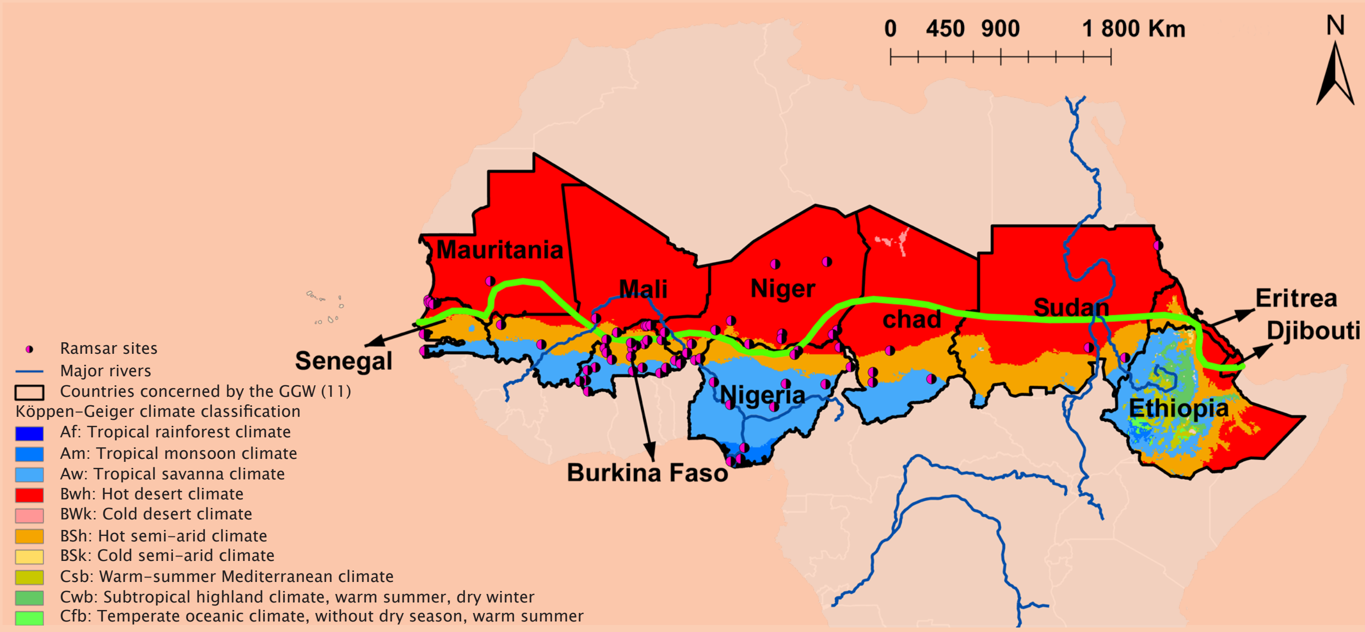
Figure 1 - Indicative route of the Great Green Wall (GGW) across the 11 countries concerned showing the environmental characteristics.



Source: Authors.

Launched during the One Planet Summit in Paris in January 2021, the GGW Accelerator aims to monitor the GGW and provide more coordinated support for its member countries and institutions. Its implementation is based on five pillars for action: (i) investment in small and medium-sized enterprises, (ii) land restoration, (iii) climate-resilient infrastructure and access to renewable energies, (iv) a favorable economic and institutional framework for effective governance, (v) capacity building.

However, these pillars do not directly address the "Water" dimension, despite the reality of the Sahel region, which is characterized by a water shortage as a result of a long dry season (8-9 months) and a short wet season (3-4 months), with an annual rainfall of between 100 and 400 mm. In response, university and civil society actors, along with members of the Regional Steering Committee of the GGW initiative in the Sahel, have been considering a crosscutting Water-GGW strategy since September 2021, including at the Africa-France Summit (Montpellier, October 2021). They have all emphasized the importance of highlighting the "Water" dimension in the current dynamics of the GGW, in particular by improving knowledge about available water resources and taking nexus approaches.

To achieve this, in the absence of pluviometric, hydrometric and field data, it is crucial to refine regional climate and hydro(geo)logical models through satellite observations to assess the water resources and guide countries towards an integrated management (Nkiaka *et al.*, 2022). Each country needs to make efforts to establish consistent piezometric, pluviometric and hydrometric networks in order to better inform the combined climate-hydro(geo)ological models. Collaboration between the countries concerned is essential for collectively analyzing the resources and capitalizing on the knowledge required to plan their use in the context of the GGW.

A major challenge for the GGW: growing and diversified water use

Rapid population growth in the Sahel, with a forecasted increase of more than 141 million people by 2045,[4] poses a major challenge for the GGW, in particular due to the increase in competing and varied water uses. This pressure will especially affect agriculture, livestock farming and fishing, which currently employ 60 to 80% of the population of the Sahel.[5] The need to feed a constantly growing population will require adopting innovative irrigation strategies (modern techniques and technologies used to optimize the use of water in agriculture, in order to maximize agricultural production, while minimizing water consumption and the environmental impacts), such as drip irrigation. Indeed, conventional irrigation methods often fail to adapt to the actual spatial and temporal dynamics of soil, plants and the meteorological environment. This results in either overirrigation or underirrigation. Innovative approaches to irrigation, combined with dynamic soil moisture models, offer an alternative. They should allow water savings of more than 29% and improve the efficiency of water use compared to conventional irrigation methods.[6]

The GGW is located in an arid/semi-arid area and surface water alone cannot meet the maintenance requirements of the project. The acceleration of the GGW will require a substantial use of groundwater, which is already essential for agriculture, livestock farming, industry, and the needs of local communities (Figure 2), thus creating risks of conflicts of use. According to the UN Water Report (2022), the Sahelian zone of the GGW has a number of aquifers (estimated at 720 billion m^3), mainly inherited from the wetter climate periods of the past.[7] They offer a sustainable solution,

[4] https://sahel-intelligence.com/8229-sahel-les-defis-demographiques-au-coeur-des-preoccupations-de-lonu.html

[5] https://www.alliance-sahel.org/en/presse/the-great-green-wall-fighting-global-warming-in-the-sahel/

[6] https://ace-partner.org/res-eau/en/boursier/erion-bwambale/

[7] https://www.csf-desertification.eu/dossier-csfd/deep-groundwater-resources-in-the-sahara-desert-and-arid-and-semiarid-fringe-areas/

provided that they are used appropriately. However, there are disparities in groundwater storage between countries, with larger stocks in Chad, Niger and Sudan (MacDonald *et al.*, 2012), which requires a utilization adapted to local conditions.

The Sahel region has been faced with a mining boom in recent years, involving valuable resources such as gold and bauxite. This attracts a growing number of people, leading to a local overexploitation of groundwater. A study on the modeling of the piezometric evolution of aquifers over the last 50 years in the Tim Mersoï Basin (northern Niger) has shown a significant disturbance in the direction of the flow and a sharp decline in the water level. This evidences that pumping for mining has had a significant impact on water availability.[8] In addition to its considerable water demand, mining accounts for 7% of global deforestation, meaning that close monitoring is required in the implementation of the GGW. Furthermore, it is now essential to promote solar energy and clean cooking technologies to replace fuelwood, the main source of energy in the region. Finally, an integrated approach to water resources management is essential to the success of the GGW, reconciling the objectives of land restoration and the growing water needs of local people and economic activities.

[8] https://ace-partner.org/ramr2d/en/boursier/boube-dobi-farida/

The GGW to mitigate the impact of climate change

In the context of climate change, among the most affected parts of the world, the Sahel is of particular importance. Indeed, global warming may reach +3 °C by 2050[9] and +4.3 °C by 2080 in the Sahel. This is 1.5 times above the global average, with an increasing frequency of extreme weather events, such as droughts, floods, and high rainfall variability,[10] which directly reduces agricultural yields. Recent studies show that climate change poses an increased risk of floods in the future for Sahelian cities, including Niamey and Ouagadougou.[11] The GGW initiative is a key solution for mitigating these effects of climate change in the Sahel. By increasing forest cover, the GGW initiative contributes to sequestering more carbon, which thus helps reduce greenhouse gases in the atmosphere.[12] It acts as a natural barrier against the expansion of the desert, stabilizes the soil, and prevents desertification. It thereby mitigates the effects of climate change in the Sahel region.

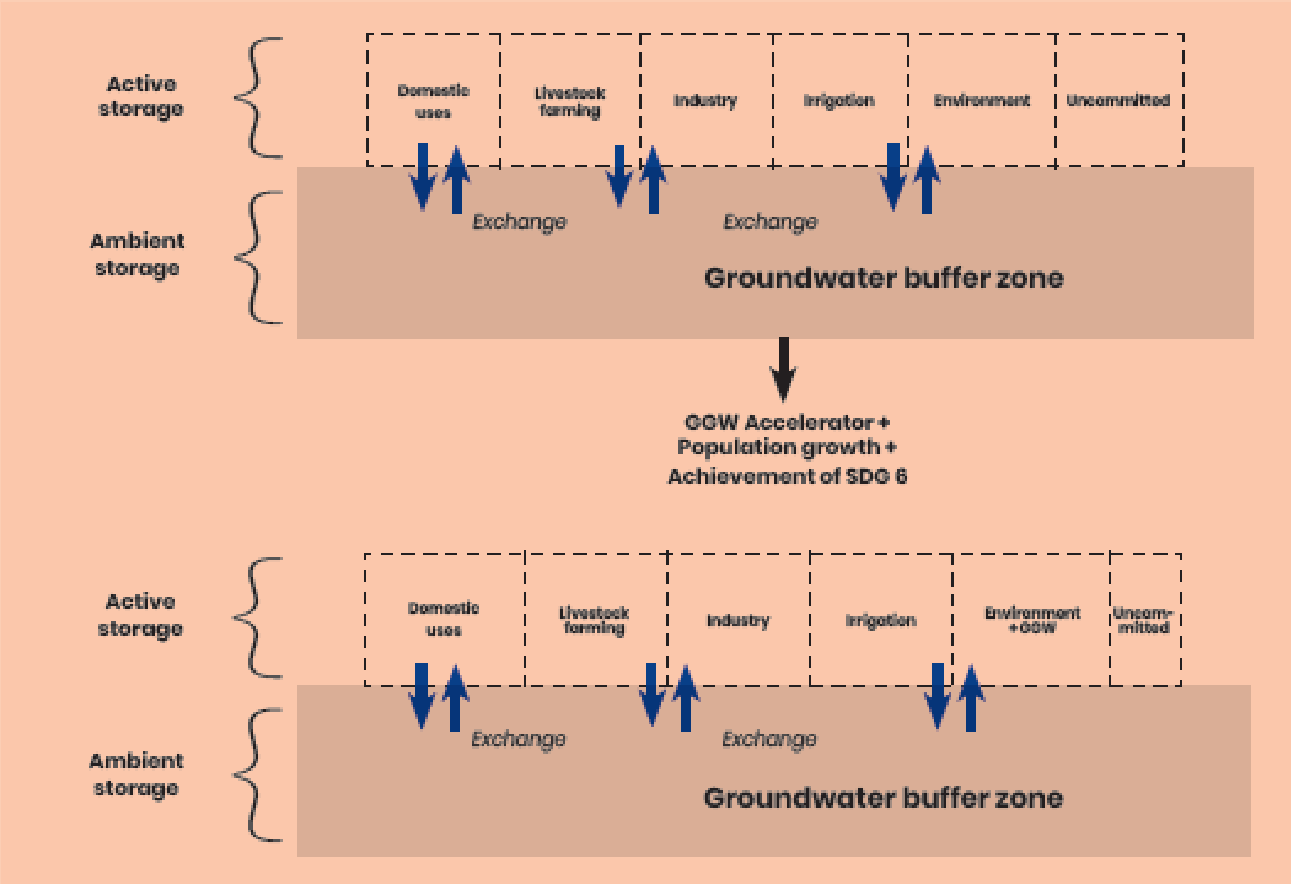
[9] Intergovernmental Panel on Climate Change (IPCC).

[10] https://www.alliance-sahel.org/en/presse/the-great-green-wall-fighting-global-warming-in-the-sahel/

[11] https://www.gdn.int/afd-video-contest

[12] https://www.undp.org/africa/stories/great-green-wall-homegrown-solutions-accelerate-climate-action-and-development

Figure 2 - Total groundwater storage distributed between ambient and active reserves.



Source: Based on Pavelic *et al.* (2012).

N.B.: Active groundwater reserves are allocated to five main beneficial uses and to an uncommitted reserve which varies depending on the demand from the GGW and population growth.

Sustainable Nature-based Solutions in the Sahel

The choice of species (flora and vegetation) is an important stage in the mechanism to create the GGW. In addition, it is planned to create a strip of stormwater collection and retention ponds, or a network of boreholes, in appropriate areas along the route. The objective is to mitigate the rainfall deficit and make water available for the GGW, domestic activities, and other income-generating activities.[13]

Nature-based Solutions are sought in the context of the GGW initiative. Consequently, in the choices made, particular attention is paid to indigenous species and their usefulness for local people. Local cultivation techniques, such as stone bunds, Zaï and half-moons, are keys to the success of the GGW (Figure 3). Indeed, these techniques reduce stormwater runoff by more than 25% at ground level. This limits erosion by increasing water storage and infiltration. More specifically, it has been demonstrated that Zaï and half-moon techniques can reduce the effects of pockets of drought by maintaining water availability for crops and plants over a relatively long period of three weeks (Zouré *et al.*, 2019). These traditional cultivation practices have already enabled the restoration of between 200,000 and 300,000 hectares of degraded land in Burkina Faso. They also show that while nature-based approaches take time,[14] they offer sustainable solutions to environmental challenges. The financing required must therefore be implemented over a reasonable period to ensure that the GGW initiative is a lasting success.

[13] https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers11-06/010050326.pdf

[14] https://www.unep.org/championsofearth/laureates/2020/yacouba-sawadogo

Figure 3 - Illustration of the "half-moon" technique.

Source: https://green-got.com/articles/rapport-impact-t4-2022

Conclusion

The success of the GGW depends partly on an efficient implementation of transboundary and integrated water resources management, as water offers the greatest potential for synergies for the achievement of the other objectives of the initiative. To this end, it will be necessary to: (i) refine the regional climate and hydro(geo)logical models to assess the water resources and guide countries towards integrated management, (ii) adopt innovative irrigation strategies to save water and improve the efficiency of its use, in order to cope with the rapid population growth in the Sahel region, (iii) conduct close monitoring to mitigate the impact of mining activities on the availability and quality of water, (iv) implement endogenous cultivation techniques, which are key to the success of the GGW by providing sustainable solutions to the environmental challenges.

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