

Global Dryland Ecosystem Programme (G-DEP): Africa consultative meeting report post-print

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Abstract

To enhance and restore natural capital ecosystems in African arid regions, the Global Dryland Ecosystem Programme (G-DEP) consultative meeting was convened in Dakar, Senegal, from 23 to 25 September 2019. This paper provides a detailed account of the inaugural African meeting of G-DEP. The consultative meeting reviewed preceding dryland ecosystem case studies, identified vulnerable arid and semi-arid regions, and proposed sustainable solutions to existing challenges. It also assessed the successes and failures of previous initiatives aimed at improving vulnerable ecosystems, ultimately formulating an action plan to enhance future efforts. Three additional focal areas of the meeting included: climate, ecosystems, and livelihoods in the context of Sustainable Development Goals (SDGs); the Great Green Wall Initiative (GGWI) for the Sahara and Sahel; and China-Africa cooperation in science, technology, and innovation. Additionally, more specific topics such as the complex relationships between these natural processes and human activities, including pastoralism, soil restoration, and vegetation regeneration techniques, were thoroughly discussed. The consultative meeting also recognized the positive impacts of international collaboration on dryland regions, particularly through sharing information, technology, and innovation to develop joint proposals for long-term research programs in African arid and semi-arid areas. Furthermore, strategic recommendations were proposed to strengthen the global partnership for sustainable development, including convening meetings to review progress on ecosystem management for sustainable livelihoods in Africa, identifying priority areas, and developing and implementing ecosystem programs to facilitate appropriate research and collaboration in African arid and semi-arid zones. Additionally, as workshop outcomes,

three steps were proposed to address climate change in African drylands, several aspects were suggested to resolve current challenges facing the GGWI, and a series of actions were recommended for G-DEP-related activities in Africa.

Full Text

Preamble

Global Dryland Ecosystem Programme (G-DEP): Africa Consultative Meeting Report

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Abstract: To enhance and restore natural capital ecosystems in African arid regions, the Global Dryland Ecosystem Programme (G-DEP) consultative meeting was convened in Dakar, Senegal, from September 23-25, 2019. This paper provides a comprehensive report on the first African meeting of the G-DEP. The consultative meeting reviewed previous dryland ecosystem case studies, identified vulnerable arid and semi-arid regions, and proposed sustainable solutions to pressing challenges. It also examined the successes and failures of prior ecosystem improvement initiatives and ultimately formulated an action plan to enhance future efforts. Three additional focal areas emerged during the meeting: climate, ecosystems, and livelihoods in relation to the Sustainable Development Goals (SDGs); the Great Green Wall Initiative (GGWI) for the Sahara and Sahel; and China-Africa cooperation on science, technology, and innovation. More specific topics—including the complex relationships between natural processes and human activities such as pastoralism, soil restoration, and vegetation regeneration techniques—were thoroughly discussed. The meeting also highlighted the positive impacts of international collaboration on dryland regions, particularly through sharing information, technology, and innovation to develop joint proposals for long-term research programs in African arid and semi-arid areas. Strategic recommendations proposed include: regular meetings to review progress on ecosystem management for sustainable livelihoods

in Africa; identification of priority areas; and development and implementation of ecosystem programs to facilitate appropriate research and collaboration in African arid and semi-arid zones, thereby strengthening the global partnership for sustainable development. As concrete outcomes, the workshop proposed a three-step approach to address African dryland climate change, suggested several measures to resolve current GGWI dilemmas, and recommended a series of actions for G-DEP activities in Africa.

Keywords: Africa; Global Dryland Ecosystem Programme (G-DEP); dryland; ecosystem; consultation; Sustainable Development Goals; Great Green Wall Initiative (GGWI)

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1 Introduction

Land cover reflects both natural processes and human activities. Drylands cover over 45% of Earth's surface [?] and support more than 38% of the global population—approximately 2 billion inhabitants. These regions are particularly vulnerable to aridity and climate change [?]. Although arid lands harbor diverse and innovative populations that have adapted to challenging environments, they remain highly sensitive to rapid social and physical transformations [?]. Environmental and socio-demographic impacts increasingly jeopardize local livelihoods, especially in Africa, where rapidly growing pressures include global environmental changes, shifting demographics, degradation of arid and semi-arid areas [?], and challenges related to water access, energy, land use, sustainable agriculture, and human and livestock health [?, ?]. These factors constitute root causes of escalating unrest and economic instability at regional and global scales. Addressing these challenges requires innovation from local communities, institutions, and global political systems. Supported by research, semi-arid and arid areas could be transformed to enhance resilience and avert increasingly unpredictable and catastrophic disruptions.

Africa hosts the world's most extensive dryland system, spanning nearly 23 million km² or approximately 15% of global land area [?]. However, significant environmental perturbations—particularly desertification and other ecological and climatic disturbances—threaten these regions, leading to anthropogenic consequences such as escalating poverty, food insecurity, inadequate infrastructure, regional conflicts, and political instability. Ensuring ecosystem sustainability and improving local livelihoods in drylands are therefore essential for Africa's sustainable development. This consultative meeting aimed to establish a permanent partnership system for dryland sustainability by providing practical information to the Global Dryland Ecosystem Programme (G-DEP) during its initial African implementation phase. Additionally, the meeting sought to iden-

tify approaches for sustainable agriculture and renewable energy in the Sahel region' s arid and semi-arid countries.

The United Nations Environment Programme-International Ecosystem Management Partnership (UNEP-IEMP) and Senegal' s National Academy of Sciences and Technology (ANSTS) jointly organized the first G-DEP consultative meeting in Africa. The workshop aimed to develop a joint proposal for long-term research programs in arid and semi-arid areas, addressing two key questions: (1) How can the Sahel region address research gaps in African dryland ecosystems under a joint framework? (2) What actions are critical for sustainable development in Senegal' s arid and semi-arid regions, and in Africa more broadly?

The G-DEP consultative meeting attracted over 100 participants from China, Africa, the United States, the Netherlands, France, and other regions worldwide, convening in Dakar, Senegal, from September 23-25, 2019.

2 Arid and Semi-Arid Ecosystems in Africa

Africa is experiencing severe shifts toward drier conditions, a trend that contrasts with other continents. The northern, eastern, and southern regions of Africa represent the three primary epicenters of dryland transformation [?]. Influenced by local natural conditions and global environmental changes, these areas are increasingly prone to land degradation, natural hazards, and water and food shortages [?, ?]. Researchers presented their latest work from Africa' s arid and semi-arid regions during the meeting.

A South African case study demonstrated that new land cover classification approaches based on Landsat 8 OLI, Sentinel-1, and SRTM (Shuttle Radar Topography Mission) data exhibit excellent adaptability and practicality in the Nzhelele and Levuvhu catchments. Land cover composition in these areas includes tree cover (16.47%), shrub cover (35.55%), grassland (15.63%), cropland (13.07%), aquatic vegetation (0.11%), sparse vegetation (12.50%), bare areas (1.42%), built-up land (4.06%), open water (0.48%), and plantation cover (1.25%) [?]. Currently, nearly 60% of South Africa' s land has experienced degradation, with soil erosion representing a major concern [?]. Land cover products from arid and semi-arid areas are critical for improving ecosystem, hydrology, and climate change studies, serving as fundamental requirements for understanding complex interactions between human activities and global environmental change [?]. Landscape changes in the Nzhelele and Levuvhu catchments hold considerable agricultural and economic significance. Located in a semi-arid region where precipitation is the primary limiting factor, these catchments feature mixed land cover including shrubland, grassland, cropland, and settlements, with substantial changes resulting from intensive human activities.

Beyond landscape alteration, policy represents another key to ecosystem solutions. Research in Senegal' s Ferlo Desert revealed that government decentraliza-

tion policies enable regional communities to share specific responsibilities with the state, particularly in land use planning and natural resource management. Public decentralization policies also unlock potential values such as pastoral hydraulics. In the Ferlo Desert, studies of diversity, equitability, and similarity—conducted under variable climate conditions—revealed that buffer and transition zones, which experience multiple human uses, exhibit greater variety and higher levels of woodland organization than central locations [?]. The woody flora inventoried in the Sahelian Ferlo region is species-rich, comprising 35 species across 27 genera and 19 families, with Combretaceae, Mimosaceae, and Caesalpiniaceae as dominant taxa. Woody stands of *Balanites aegyptiaca* and *Sclerocarya birrea*—two wild edible fruit trees—constitute valuable local food sources. Other advances relate to non-communicable diseases resulting from dryland ecosystem degradation. Chronic non-communicable diseases (CNTDs) claim nearly 41 million lives annually—seven out of ten deaths globally—and pose a major health threat, particularly in sub-Saharan Africa, where CNTDs tend to be long-lasting and result from combinations of genetic, physiological, environmental, and behavioral factors.

To address these concerns, international cooperation through the G-DEP was proposed. The program’s overall objectives are to understand dryland ecosystem responses to global environmental change and to identify methods for fostering pathways that support socio-ecological system resilience and sustainable development in dryland ecosystems [?]. Specifically, G-DEP aims to quantify the magnitude and direction of change and associated ecosystem responses to land system and social processes, identify factors controlling dryland ecosystem vulnerability and resilience, and understand global environmental change impacts on ecosystem services. To accomplish these goals, G-DEP conducts targeted regional studies in arid regions worldwide, with recent research in Australia serving as the latest example [?]. In African arid and semi-arid ecosystems, four additional research themes require focus: (1) climate change impacts on dryland regions; (2) social-ecological system interactions; (3) ecosystem service improvement and poverty eradication; and (4) dryland degradation prevention and ecosystem restoration.

3 Climate, Ecosystems, and Livelihoods for Sustainable Development Goals (SDGs) in Africa

Insufficient research on climate and livelihoods in arid and semi-arid ecosystems remains an ongoing challenge in Africa [?]. Without effective and sustainable ecosystem management, impacts on ecosystems, biodiversity, and human well-being can be enormous [?].

In the Sahel region, increased rainfall has positively affected vegetation cover, with general trends indicating changes in vegetation index variation. This “re-greening” phenomenon has been accompanied by improved land quality in the

region [?]. In Zimbabwe, a perception survey examining Indigenous Knowledge Systems was conducted among 3,000 farmers across eight districts over a two-year period, assessing observations of rising air temperatures, shorter winters, reduced rainfall, extended dry seasons, and increasing drought frequency. Results demonstrated that climate change caused temperature increases across all districts with climate variability [?]. In Rwanda, despite declining rainfall, recent decades have witnessed a surge in flooding, indicating climatic regime variability [?]. In semi-arid zones, pastoralism is also becoming increasingly vulnerable. Research in Senegal, Benin, and Mali identified water as the primary constraint, while other challenges include governance barriers, public policy vulnerabilities, and weak collective action dynamics that hinder pastoralism improvement.

In Africa's context of demographic growth and rising temperatures, climate change amplifies the development of extreme events. Currently, a three-step framework exists to address this situation: (1) calculation of gross risk; (2) determination of gradual risk; and (3) classification to understand potential deviations.

Determining at-risk areas and assessing future affected zones has proven effective in China [?]. Water represents a particularly critical factor, requiring integration of water research with human-nature system sustainability [?]. China possesses experience in applying integrated water analyses, where understanding the relationship between downstream water use and upstream water supply proves essential. This analysis must account for water transfer and changes among rainwater consumption by natural ecosystems, rainwater consumption by cropland, and irrigated water consumption from irrigated cropland. Given that African countries face similar dryland conditions, if research findings from Ethiopia's agro-ecosystems prove conclusive [?], these approaches could potentially be replicated in other countries such as Senegal [?].

4 Great Green Wall Initiative (GGWI) in the Sahara-Sahel Region

The Great Green Wall is an African-led initiative aiming to rehabilitate an 8,000 km natural wonder across Africa's entire width through vegetation restoration. Located in the Sahel region at the southern edge of the Sahara Desert, the GGWI operates based on a clear vision with four phases: start-up, operation, consolidation, and sustainability of achievements, under the slogan "made by and for the people." Despite financial constraints, this vision—adapted to differentiated local strengths—has produced concrete achievements, including Sustainable Land Management (SLM), socio-economic development in target regions, and capacity building for local populations.

Niger serves as a case study where Natural Assisted Regeneration (NAS) achieved rapid vegetation replenishment at lower cost, demonstrating NAS as an effective GGWI implementation option in the Sahara-Sahel region [?].

GGWI implementation is driving dietary changes among local populations as the initiative provides employment, increasing purchasing power and enabling food diversification. Previously, pastoralists in the area consumed frugal diets of milk, millet, curd, cowpeas, balance oil, tea, and sugar. Currently, rice has replaced millet, while vegetables and dried fish have been introduced. These dietary changes will ultimately impact population health.

The Sahel region hosts a rich diversity of long-distance migratory bird species. Over the past 40 years, bird populations have declined due to habitat loss, with land degradation in the Sahel playing an essential role in this reduction. While the GGWI and other initiatives work to restore Sahelian ecosystems and their services, positive environmental changes may be reflected by the return of Palearctic migratory birds and other local species.

Based on these case studies, current GGWI dilemmas requiring resolution focus on eleven key aspects: (1) how to share GGWI experiences with other countries; (2) the initiative's primary agroforestry approach tends to neglect other socio-ecological system dimensions; (3) whether integrating other Lake Chad countries would improve coherence; (4) improving reforestation and afforestation success rates; (5) serious acceptance by GGWI of pastoralism value assessments; (6) mobilization of financial resources and existence of fundraising strategies; (7) water resource availability and biodiversity profiling with utility assessment; (8) existence of monitoring and evaluation systems; (9) need for technology transfer systems from China; (10) governance bodies; and (11) governance systems (both local and regional).

5 China-Africa Cooperation on Science, Technology, and Innovation

Since the 1st Conference on Climate, Ecosystems, and Livelihoods in Nairobi, Kenya, in 2017, significant progress has strengthened the China-Africa partnership and South-South and multilateral cooperation on Africa's sustainable development issues. Fundamental research in China envisions long-term programs with policy and spatial coherence, making operational cooperation with China an adequate pathway to consolidate achievements in sustainable dryland ecosystem and resource management. China-Africa collaborations on science, technology, and innovation in dryland ecosystems are expected to yield significant benefits for both G-DEP and GGWI.

Collaboration can occur at two levels: at the individual level, where researchers identify and propose opportunities with Chinese partners; and at the institutional level, where research is conducted by national or regional institutions.

Priority collaboration opportunities between China and Africa exist notably in livestock sectors and pastoralism, soil restoration techniques, vegetation regen-

eration techniques, water resources, renewable energies, and bushfire management.

Recommended actions for G-DEP-related activities in Africa include: (1) collecting and sharing environmental, socio-economic, and land information and data for drylands programs; (2) disseminating diverse satellite imagery solutions in Africa; (3) collecting data and improving models for ecosystem and ecosystem service monitoring; (4) developing joint socio-economic case studies with China; (5) transferring innovations and technologies developed in China's Xinjiang Uygur Autonomous Region to the GGWI; (6) establishing long-term observation, monitoring, and ecosystem management mechanisms; (7) developing predictive models for natural disaster and risk management; (8) rewarding research results that jointly contribute globally to sustainable dryland management; (9) creating an African Institute of Arid Areas (affiliated with African research networks); and (10) integrating ecological, socio-economic, legal, and governance aspects to address poverty in local communities.

6 Conclusions

Based on the current status of African dryland ecosystems, restoration and enhancement of natural capital through the GGWI for the Sahel region should be grounded in reliable scientific knowledge and information. Given similarities with some Chinese arid areas, particularly Xinjiang, sharing innovations and technologies developed by G-DEP for sustainable management, long-term ecosystem monitoring and evaluation enhancement, and protection of agro-sylvapastoral systems adapted to drylands is recommended.

Strategic recommendations include: regular consultative meetings to review progress on ecosystem management for sustainable livelihoods in Africa; identification of priority areas; and development and implementation of ecosystem programs to facilitate appropriate research and collaboration in African arid and semi-arid zones, thereby enhancing the global partnership for sustainable development.

Furthermore, meetings and workshops aimed at developing joint proposals for long-term research programs on African arid and semi-arid areas with clear goals, objectives, and outputs have been identified as successful cooperation opportunities. During G-DEP program launch, participants should prioritize creating a permanent China-Africa partnership mechanism as an active international collaborative program.

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