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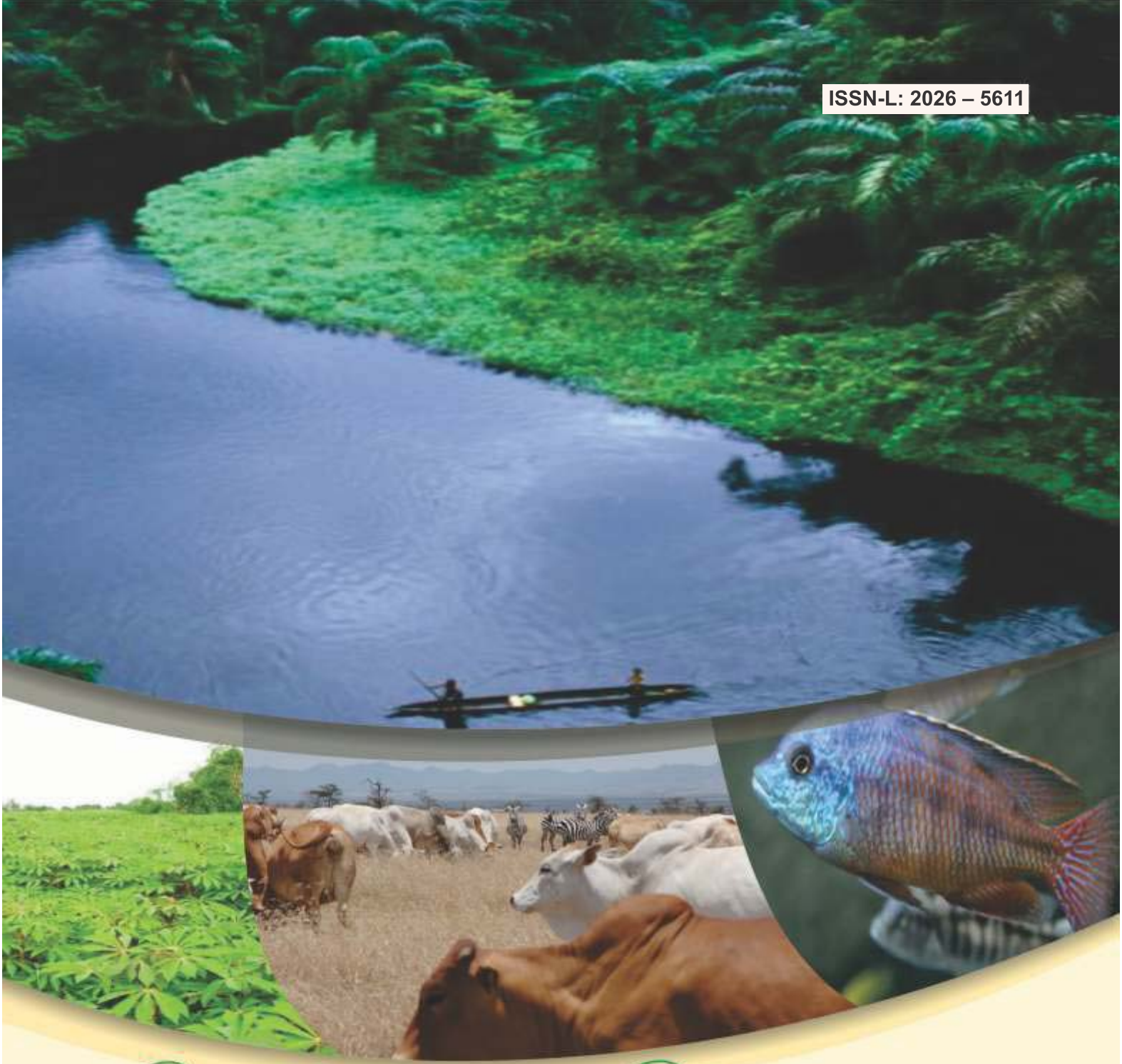

Nature & Faune

Volume 27, Issue 1

Managing Africa's water resources: integrating sustainable use of land, forest and fisheries.

FAO Regional Office for Africa

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Front Cover Photos:
Top: Waterway in the depths of the Congo rain forest, Photo credit: Michael K. Nichols.
Bottom (From left to right): A plantation of healthy cassava in Kenya, Photo credit: Catherine Riungu; Cattle grazing with zebra at Ol Pejeta wildlife conservancy in Kenya, Photo credit: Marisa De Bruyn; African cichlid image, Photo credit: Earl Robbins.

Back Cover Photos:
Top: Waterway in the depths of the Congo rain forest, Photo credit: Michael K. Nichols.
Bottom (From left to right): Land cultivated historically in Zambia returns to trees, Photo credit: Jeffrey Barbee; A plantation of healthy cassava in Kenya, Photo credit: Catherine Riungu.

FAO REGIONAL OFFICE FOR AFRICA

Nature & Faune

Enhancing natural resources management for food security in Africa

Volume 27, Issue 1

Managing Africa's water resources:
integrating sustainable use of land, forests and fisheries

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Accra, Ghana
2012

FAO REGIONAL OFFICE FOR AFRICA

Contents

Message to Readers

Maria Helena Semedo[1]

Throughout the past six months, *Nature & Faune* magazine has been shinning a light on managing Africa's water and other natural resources. A lynch pin in water resources conservation in Africa is the integration of sustainable use of land, forests and fisheries. Twenty articles from contributors working in and outside the African continent explore the different facets of the over-arching theme: "Managing Africa's water resources: integrating sustainable use of land, forests and fisheries". The articles reflect the interface between water resources and land, forestry and in-land fisheries management in the continent. Content and subject matter of articles featured contribute to the assessment of best practices, and offer applicable measures to ensure a secured access to abundant and good quality water, land, forests and fisheries in Africa.

In the editorial, Bai-Mass Taal, Executive Secretary of African Ministers' Council on Water (AMCOW) reminds stakeholders at all levels to act on a wide range of fronts, with particular emphasis on integrated — as opposed to piecemeal — approaches to managing water in Africa. Integrated management and better coordination are obviously important. However, too little water is managed in Africa, resulting in overwhelming need for more management effort at all levels. If current levels of water management are maintained, the region will likely not register significant progress towards sustainable development. Mr. Taal mentions many challenges that face the sector, including institutional failures, with institutional underdevelopment posing the greatest challenge. Faced with the fact that too many people in the continent have little access to managed water, Africa's water-related institutional arrangements are currently too feeble to accelerate the implementation of the water agenda in the continent.

The special feature in this issue includes three articles on: (1) Okavango river basin; (2) Opportunities for expanding the benefits from cooperative transboundary water governance in the Nile basin; and (3) Volta basin. The Cubango-Okavango river basin, shared by Angola, Botswana and Namibia, remains one of the least human-impacted river basins on the continent. Due to the uniqueness of the basin and its resources, and therefore the need to protect its integrity, Botswana has given up the right to mining one of its most prominent coal beds because it exist right under the Okavango inland delta. Everisto Mapedza and Tesfaye Tafesse, drawing from experiences in the Nile basin, concur that the Okavango case is another outstanding illustration of joint management and multiple-benefit sharing beyond the water resource itself, for riparian countries in Africa that share a common river basin. The third featured article highlights some aspects of integrated water resources management practices in West Africa with a focus on the Volta river basin. It reviews progress made during the past several decades in the management of Africa's transboundary surface and ground water resources, especially in relation to established institutional arrangements such as river and lake basin organizations.

The Opinion Piece on the World Commission on Dams' report makes the case for creation of more dams in Africa. Also featured is the experience of sharing the benefits of large dams in West Africa.

On the whole, eight articles emphasize the importance of designing and implementing integrated and transboundary water resource management strategies to ensure sustainable access to water for all within Africa. Included in this set is an article on managing the Komati's water resources through integrating sustainable use of land, forests and fisheries. Swaziland has been put under the spotlight in this issue of the magazine, given its peculiar water situation and unique cooperation with other countries (South Africa and Mozambique) with which it shares its five major

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rivers. In addition, four articles call attention to the merits of integrated water resources management within individual countries (Cameroon, Ghana, Nigeria, and Somalia). An article from Côte d'Ivoire investigates the practice of planting Australian acacias in the vicinity of Abidjan as a water resources conservation tool.

The piece on complementarity between the sectorial water management approach and integrated management of water resources underlines the merits of both integrated and sectorial approach. The message is that it is not an "either or" situation; rather the sectorial approach could be used as a complementary tool at a given stage to lay a firm foundation for a successful integrated water resource management in Africa.

The subject of partnership is briefly discussed with focus on agricultural water development and management in Africa. Partnership assumes inclusiveness and calls for bringing on board the active participation of small-scale producers. To this end, Randall Brummett shares his insights on certifying sustainable aquaculture for Africa and on leveling the playing field for smaller-scale producers while ensuring ecosystem health.

It is widely acknowledged that climate change and variability impact on water resources. The article by Benjamin De Ridder and Jean Ruhiza Boroto presents some details of this in the case of Africa. In the same vein Sonwa Denis and his colleagues assess the linkages between forest, water and people in a context of climate change in Central Africa providing a balanced review of the challenges faced and the efforts that are being made to better manage water resources of the Congo River Basin.

The largest reservoir and man-made lake (by surface area) in the world is the Volta Lake in Ghana, West Africa. However, this artificial lake, which was created following the construction of the hydroelectric dam in Akosombo in 1964 is not without its challenges. The dam, which is managed by the Volta River Authority (VRA), supplies hydroelectricity to Ghana and neighbouring Togo, Benin and Burkina Faso. Construction of the dam resulted in the submergence of tracts of forest, and forced the relocation of some 80,000 people to 52 newly created townships on the Lake's higher banks. For years, the Government of Ghana and VRA have sought ways to remove the submerged tree stumps, which, in recent times, have become the major cause of fatal accidents on the lake. In this issue of *Nature & Faune*, Godfred Asare and Sean Helmus examine underwater logging in Ghana's Lake Volta, to harvest the submerged wood under the lake.

Gandiwa and his colleagues at Gonarezhou National Park (GNP) in Zimbabwe present the importance of water resources in wildlife conservation using GNP, a state protected area, as a case study. They call for integrated river basin management for the three catchment rivers covering GNP and adjacent areas in the Great Limpopo Transfrontier Conservation Area.

Under the regular feature of *FAO Activities and Results*, this edition presents Somalia Water and Land Information Management (SWALIM) Project, an FAO initiative set up with the purpose of supplying reliable information to decision makers on both water and land resources. A wealth of information and reports are available from: http://www.faoswalim.org. Also featured under this section is the Water and Food Security Initiative implemented in West Africa by FAO Sub-regional Office for West Africa. It focuses on small-scale irrigation technologies, and its contribution to securing political commitments at sub-regional level.

Finally, I invite you to take a look at our announcement and news sections to learn about some developments in the thematic area under review. To give you a glimpse of what they have to offer, permit me to share with you the welcomed news that the United Nations General Assembly has proclaimed 21 March each year as International Day of Forests!

Editorial

Managing Africa's water resources: integrating sustainable use of land, forests and fisheries

Bai-Mass Taal[1]

The overarching theme of this edition of *Nature & Faune – Managing Africa's water resources: integrating sustainable use of land, forests and fisheries* – is at the very heart of the work of the African Ministers' Council on Water (AMCOW), especially as regards the pursuit of the African Union's Vision of:

An integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the global arena and the Africa Water Vision 2025 of:

An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation and the environment

To put those aspirations into context, let us be reminded that the environment and natural resources, particularly freshwater, are critical to the productivity of such sectors as agriculture, industry and fisheries and – therefore – the release of Africa's development potential. as well as sustaining growth and development. Specifically:

- Access to clean water is essential for healthy human communities. Freshwater availability is a key determining factor in efforts to ensure food and energy security as well as for increasing industrial production. The quality particularly of freshwater ecosystems has a direct impact on the wellbeing and productivity of the population and, therefore, on the sustainability of economic growth and development at national level. The benefits of investing to improve water resources management and access to clean water and sanitation therefore remain clear and germane.
- Land constitutes the most important factor of production and survival for the peoples of Africa. About 70% of Africa's labour force is involved in agriculture, which in turn contributes to over 25% of the GDP; a percentage that is substantially in some countries.
- Forests, woodlands and wetlands are valued for the services they provide, particularly as important catchments for Africa's freshwater resource systems; regulating climatic conditions; as well as sustaining ecosystems and biodiversity. They also provide fuelwood, which is the principal source of energy for the majority of the population on the continent.

However:

- Africa's population is growing at a rate that is much higher than the global average, while at the same time rapid urbanisation is observed across the continent.
- Africa's environmental and natural resources are faced with severe degradation in part due to fragmented sectoral approaches to their governance. Almost universally, the responsibility for various aspects of their development, utilisation and management is shared by numerous government ministries, private sector actors and local administrations that do not necessarily have coordination mechanisms in place. The outcome is often inefficient use and inadequate protection of these valuable natural assets.
- The agricultural sector and the rural economy on which the majority of Africa's populations depend for their livelihoods are under threat from negative impacts of climate change and increasing climate variability. Projections which show a general increase in average temperatures for Africa are predicted to result in increased rainfall variability and incidences of extreme weather conditions. Changing rainfall patterns will negatively affect cropping systems and will increase the occurrence of such diseases as malaria. Growing uncertainty as regards rainfall and shifting crop water requirements threaten Africa's largely rain-fed agricultural sector; while risks and uncertainties to economic productivity and political stability are growing with the increasing evidence of water-borne diseases, droughts, floods and landslides. Looking back over the past two years, Africa has endured devastating flooding in Southern Africa; severe drought and famine in the Horn of Africa; and social unrest in part due to

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soaring food and commodity prices in all countries on the continent.

The above, in turn, have direct implications for the fight against poverty, and the extent to which the targets of the Millennium Development Goals (MDGs) can be achieved – not to mention aspirations for water, food and energy security. As many of the negative impacts are anticipated to operate through water, making fundamental changes in the way Africa's water and related resources such as land, forests and wetlands are utilised and managed is an important step towards climate change adaptability and mitigation; disaster risk reduction and management; and sustainable environment and natural resources management.

Governments thus need a more closely integrated approach to planning for and management of the Environment and Natural Resources (ENR) sector. Communication, coordination and cohesion must overcome the inadvertent competition, conflict and confusion between government bodies over the authority and responsibility for the various sub-sectors.

Indeed, there are positive signs of progress towards this goal. At the 4th Africa Water Week in May 2012, AMCOW released the findings of the *"2012 Status Report on the Application of Integrated Approaches to Water Resources Management in Africa"* which found that nearly half (18 of 40) of the member countries of AMCOW that responded to a detailed survey conducted by UN-Water as part of a global study on progress in implementing Chapter 18[2] of Agenda 21, are executing national plans for integrated water resources management (IWRM). A similar study conducted in 2008 found that 5 countries, out of the 16 that responded to the survey, had IWRM plans or were in the process of developing them. The survey also demonstrated that there is already a lot of good experience in Africa that could be shared more effectively to speed up progress. For example, country-to-country knowledge sharing on disaster preparedness and early warning systems can be promoted to increase resilience to climate change.

The progress reported is not without challenges. A great deal more, in terms of commitment to funding; implementation of programmes; and minimising institutional underdevelopment and failures, is required to assure water, food and energy security in Africa. As AMCOW consolidates the gains of the past decade of its stewardship of policy interventions relating to the management of water resources and provision of water services in Africa; and also builds on the strong foundation of political commitment to deliver tangible benefits of water management to the peoples of Africa, there is need to develop more regular, objective, evidence-based and consolidated reporting on the ENR sector in Africa in order to create a benchmark for measuring progress, and to strengthen the awareness of the political leadership and other stakeholders.

Developing appropriate tools and indicators for measuring the contribution of the productive use of water and related resources to development is particularly important to provide a basis for highlighting their pivotal role as essential ingredients in the advent of a green economy in Africa. This makes it imperative to mobilise the resources needed to build on the findings of the *2012 Status Report on Integrated Approaches to Water Resources Management in Africa,* to finalise on-going activities to establish a permanent pan-African monitoring, evaluation, and reporting mechanism on both the status of water resources management as a basis for informed decision making within AMCOW member countries, and the implementation of relevant political commitments.

It is crucial then that as all African states intensify efforts to achieve the Africa Water Vision by 2025, close linkages are established in the formulation and implementation of policies and activities in the ENR sector. Such an approach will enhance integration and coherence in the pursuit of a wide range of linked thematic priorities; leveraging resources for accelerated progress; and providing a mechanism for coordination, mutual support and deepening the impact of interventions. This is key, not only to achieving sustainable use of land; forests; wetlands; and fisheries, but also – in more general terms – to advancing the well-being of Africa's people, environment and economy.

[2] *Protection of the quality and supply of freshwater resources: application of integrated approaches to the development, management and use of water resources*

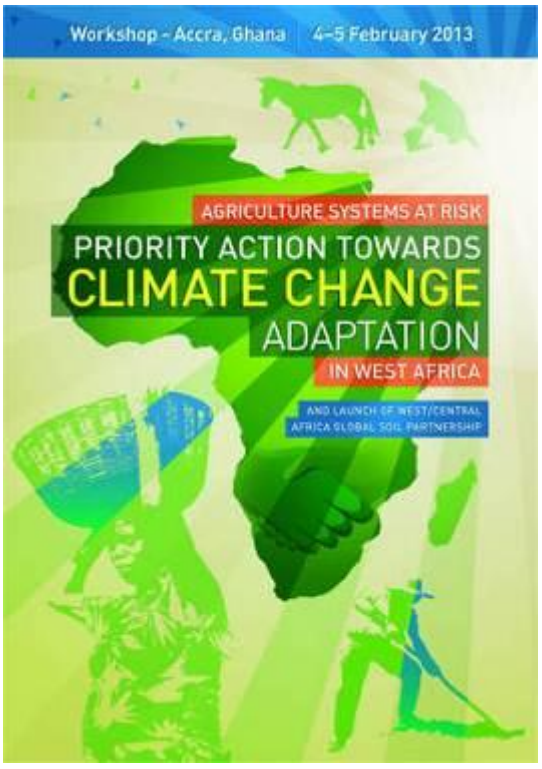
Announcements

International Conferences

Regional workshop on Agriculture Systems at Risk: priority Action towards Climate Change Adaptation. Accra, GHANA, 4 to 5 February 2013

FAO in collaboration with the Economic Community for West Africa States (ECOWAS), CILSS/AGRHY MET, and Research Program on Climate Change, Agriculture and Food Security (CCAFS), will host a regional workshop on **"Agriculture Systems at Risk; priority Action towards Climate Change Adaptation"** from 4 to 5 February 2013. The workshop will additionally see the launch of the Global Soil Partnership for West Africa.

This workshop will bring together Senior level professionals from ECOWAS member states and aims to place climate change adaptation firmly on the governance agenda of regional and national governments.



The workshop aims to discuss:

- Status and trends in land and water resources in West Africa with identified agriculture systems at risk. Focus is laid on anticipated impacts of climate change.
- An appraised Agriculture Investment Plan taking into consideration climate change variability. National Adaptation Programmes of Actions will be compared against investment plans.
- Thematic areas and collaboration within the Global Soil Partnership (GSP).

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Date: 4 to 5 February 2013
Venue: Labadi Beach Hotel, Accra, Ghana

International Conference on Forests for Food Security and Nutrition; Rome 13 – 15 May 2013

Worldwide, nearly a billion people go hungry every day. With the world population projected to exceed nine billion people by 2050, global agricultural output must expand by an estimated 60 percent to meet global food needs.

Yet, in many places, deforestation triggered by escalating demand for food, fibre and fuel is degrading ecosystems, diminishing water availability and limiting the collection of fuelwood - all of which reduce food security, especially for the poor.

Natural forests are critical for the survival of forest-dwellers, including many indigenous peoples, and they help deliver clean water to agricultural lands by protecting catchments.

Farmers increase food security by retaining trees on agricultural land, by encouraging natural regeneration and by planting trees and other forest plants. For most of the year, herders in arid and semi-arid lands depend on trees as a source of fodder for their livestock.

Forests, trees and agroforestry systems contribute to food security and nutrition in many ways, but such contributions are usually poorly reflected in national development and food security strategies. Coupled with poor coordination between sectors, the net result is that forests are mostly left out of policy decisions related to food security and nutrition.

The **International Conference on Forests for Food Security and Nutrition** will increase understanding of the crucial role that forests, trees on farms and agroforestry systems can play in improving the food security and nutrition of rural people, especially in developing countries. It will propose ways to integrate this knowledge in policy decisions at the national and international levels.

Specifically, the conference objectives are to:

- highlight the ways in which forests, trees on farms and agroforestry systems contribute to food security and nutrition
- explore policy options and innovative approaches for increasing the role of forests, trees on farms and agroforestry systems in food security and nutrition
- identify key challenges and bottlenecks hindering that contribution

Event date: 13 May 2013 - 15 May 2013
Venue: FAO Headquarters
City: Rome
Country: Italy
Contact: forests-foodsecurity@fao.org / Fax +39 0657055514
Website: http://www.fao.org/forestry/food-security/en/

Forum for Wetlands for Livelihoods: Kigali, Rwanda. 8-12 July 2013

The UNESCO-IHE Institute for Water Education and the Rwandan Environmental Management Authority (REMA), will host, with international and regional partners, a Forum on Wetlands for Livelihoods, linking policy makers, regional stakeholders and researchers. The Forum will provide an important and strategic opportunity for stimulating research, capacity building and policy for wetland management across the Nile Basin and further afield. Building on the Ramsar Convention's Wise Use of Wetlands, there is a need for more inclusive and ambitious policies and actions to support wetlands and the livelihoods that depend on them. The Wetlands for Livelihoods Forum is more than a meeting or a conference because it sets out to stimulate a longer lasting and global view for supporting the wise use of wetlands through bringing together the spectrum of regional and international social, economic and ecological interests that can effect a difference.

More information at: http://www.ramsar.org/pdf/FORUM_Wetlands_for_Livelihoods_2013.pdf

New Publications

Guidelines for Institutionalizing and Implementing Community-Based Forest Management in Sub-Saharan Africa

The Food and Agriculture Organization of the United Nations, Regional Office for Africa, has released a new publication: "**Guidelines for Institutionalizing and Implementing Community-Based Forest Management in Sub-Saharan Africa"** ISBN 978-92-5-107268-4

To access online, click on: http://www.fao.org/docrep/016/i2786e/i2786e00.htm

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FAO REGIONAL OFFICE FOR AFRICA

Guidelines for the sustainable development of inland wetlands management in Africa

Guidelines for the sustainable development of inland wetlands in Africa were developed in 2012 by the Food and Agriculture Organization of the United Nations, Regional Office for Africa, in partnership with the Ramsar Convention Secretariat and with the financial contribution from IFAD. They are meant to facilitate increasing agriculture investments in these sensitive natural systems, especially for the cultivation of rice. The guidelines have subsequently been presented to government officials, investment partners and other stakeholders in Cote d'Ivoire and in Rwanda. In both countries, all parties have welcomed the opportunity to pilot the guidelines as they are considered as an innovative and timely contribution by the FAO to maximize economic, social and environmental benefits from the countries' inland wetlands. Wider dissemination to other countries will follow.

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News

Establishment of 21st of March as the International Day of Forests (IDF)

Nature & Faune has the pleasure to inform its readership that the 2nd Committee of the General Assembly of the UN has approved the Resolution establishing the International Day of Forests on 21st of March.

It has been a long haul from the first recommendation for such a day in 1971 to the FAO Conference in 2011, UNFF and finally the UN General Assembly. The Resolution provides a unique opportunity for each country "to celebrate and raise awareness of the importance of all types of forests and of trees outside forests". As requested by the Resolution, FAO, together with the UNFF Secretariat, members of the CPF and other international partners, stand ready to facilitate the implementation of this Resolution.

The forest community can draw deep satisfaction from this development since, further to the success of the International Year of Forests in 2011, the IDF will ensure that forests are highlighted positively at least once a year in the media. Everyone is invited to take active part in the ensuing annual event at organizational, national, sub-regional and regional levels.

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Fighting to save Africa's richest rainforest

Protests continue against a controversial palm oil plantation in the Korup National Park, Africa's oldest and richest rainforest in terms of floral and faunal diversity, in Mundemba, southwest **Cameroon**.
Read more at: http://www.ipsnews.net/2012/12/qa-fighting-to-save-africas-richest-rainforest/
Source: Inter Press Service 20 December 2012

Rwanda's national forestation at 24.5 per cent

Forests cover 24.5 per cent of the **Rwanda**'s land surface, the Minister of Natural Resources, Stanislas Kamanzi said yesterday. The government has a target of 30 per cent by 2017.
For the whole article, visit: http://www.newtimes.co.rw/news/index.php?a=61958&i=15211
Source: The New Times, 19 December 2012

China launches African agriculture and forestry research center

China's first research institution on **African** agriculture and forestry was launched in east China's Zhejiang Province on Sunday. For the whole article, visit: http://www.coastweek.com/3551_agriculture_05.htm
Source: Coastweek, 22 December 2012

New species (126 of them) discovered in Greater Mekong.

The Greater Mekong region consists of Thailand, Cambodia, Myanmar, Vietnam, Laos and the southwestern Chinese province of Yunnan. From a devilish-looking bat to a frog that sings like a bird, scientists have identified 126 new species in the Greater Mekong area, the WWF says in a new report detailing discoveries in 2011.
For the whole article, visit: http://www.theage.com.au/environment/animals/heres-the-good-news-126-new-species-discovered-in-greater-mekong-20121219-2bmeh.html
Source: The Age 19 December 2012

Special Feature

Transboundary Approaches to River Basin Management – The Okavango Case Study

Ebenizario Chonguica, PhD[1]

The Cubango-Okavango river basin, which is shared by Angola, Botswana and Namibia, remains one of the least human impacted river basins on the African continent. The basin supports predominantly rural communities, which in each country are remote from the countries' capital cities and main centres of economic activity. As a result, the people of the basin are in general poorer, less healthy, and less well educated than other groups in their respective countries, underscoring the need

Figure 1: *Geographical scope of OKACOM work*

for economic development in the basin. At the same time, in its present near-pristine status, the river basin provides significant ecosystem benefits and will continue to do so if managed appropriately (TDA Report, 2011).

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Through the 1994 agreement that established the Permanent Okavango River Basin Water Commission (OKACOM) the three basin States of Angola, Botswana and Namibia expressed their bold commitment to developing a joint, co-operative management regime for the economically, socially and environmentally sustainable development and management of the basin.

The objective of the Commission is to act as the technical advisor to the Contracting Parties on matters relating to the conservation, development and utilization of water resources of common interest in the Okavango River Basin. This entails promoting coordinated and sustainable water resources management of the basin, while addressing the legitimate social and economic needs of the riparian states.
The Commission mandate emerges from a shared vision of the three States that envisages *anticipating and reducing unintended, unacceptable and often unnecessary impacts to the resources* of the Okavango basin system. The vision is supported by operational principles of: i/ equitable allocation; ii/ sustainable utilisation; iii/ sound environmental management and iv/ sharing of beneficial uses (OKACOM Agreement, 1994).

Approach to transboundary basin planning and management
To effectively transform the bold policy statement into practical joint interventions on the ground, the OKACOM commissioned a Transboundary.

Diagnostic Analysis (TDA) and a Strategic Action Programme (SAP) under the Global Environment Facility (GEF) - funded Environmental Protection and Sustainable Management of the Okavango (EPSMO) project. These recently concluded studies constitute the very first project requested by OKACOM, designed to assist in the mapping of its intervention strategy for the sound management of the Cubango-Okavango river basin.

While the TDA is an in-depth environmental and socio-economic assessment of the basin, resulting from a joint fact finding exercise carried out under the auspices of OKACOM, the SAP is a cooperative management response to the key challenges for the Cubango-Okavango basin, as identified and described in the TDA, which forms the scientific-technical basis for the SAP. The SAP is a basin-

wide mid-term planning document that lays down key principles for the development of the basin and, provides a framework for its joint management. The SAP has been developed over three years (2008-2010) through a consultative process with a wide range of stakeholders from government departments, academic and scientific institutions, civil society, the private sector and community representatives (TDA project document, 2004).

A series of national consultation workshops were held in each country, complemented by basin-wide consultation meetings under the umbrella of the Okavango Basin Steering Committee (OBSC). At country level, the process resulted in the formulation of National Action Plans (NAPs) in the three countries.

Central to the SAP, is improvement of livelihoods of the basin's people (as one of the main four thematic areas of priority) through the cooperative management of the basin and its shared natural resources. The remaining three thematic areas include, water resources management, land management and environment and biodiversity.

***Photo 1**: Cuebe/Cubango Confluence in Angola*

As part of the key component of Basin Development Management Framework (BDMF) that will generate the necessary conditions for provision of effective responses to the four thematic areas, the SAP identifies TWO fundamental and overarching goals:

- The livelihoods of basin people are improved.
- The sustainable management of shared waters and living natural resources is secured

To achieve these objectives, the following areas of supportive intervention (SI) are identified:

- SI1: Basin development planning and management based on shared vision;
- SI2: Decisions based on solid scientific knowledge;
- SI3: Focused environmental and socio economic monitoring programmes to support management decisions and tracking of long term trends established and strengthened
- SI4: Integrated planning criteria and objectives for sustainable development of water resources in the Cubango-Okavango basin agreed and established
- SI5: Technical capacity in the basin and involvement of stakeholders in SAP and NAP implementation is improved.

Uniqueness of the adopted approach

The TDA process has created a solid opportunity to craft the science based approach for planning, management and decision making, a working framework that OKACOM believes should be the basis for its operations. Through the TDA process, OKACOM has established solid action research links with critical centers of knowledge and information within the three riparian states. The process developed unprecedented trans-country and trans-disciplinary research activities among researchers from Angola (Agostinho Neto University); Botswana (the University of Botswana's Harry Oppenheimer Okavango Research Centre) and Namibia (Namibia Nature foundation - NNF and Namibia Polytechnic).

Building from the Integrated-flows assessment methodology, the TDA process has provided a mechanism to improve understanding of the implications that changes in flow regime may have on basin ecological systems (broken down into various disciplines – e.g. freshwater biology, hydrology, hydraulics, geomorphology, socio-economic conditions (livelihood strategies – e.g. natural resource economics, anthropology, demography) and the Okavango River Basin's overall macro-economic system. A specially developed decision support system is being used to support the integrated basin flow assessment and to evaluate the "*triple bottom line*" impacts (ecological, socio-economic and macro-economic) of possible water-use development scenarios in the basin. The water-use development scenarios are viewed as

ways of exploring possible management options, noting however, that we cannot assume that they will necessarily take place. They are simply meant to be used to inform negotiations for cooperative basin development. Ultimately, this analytical/thinking tool (responding to the *"what if"* type of questions) can be used to guide the OKACOM in how best to define the "*acceptable development space*" in the basin that can sustain fundamental development needs without undermining the stability and functionality of the river system (*cf.* King J. and Brown C. 2009; King, J. et al.: in prep).

Addressing the challenges to transboundary basin management

Transbounday river basin management is a relatively new concept to planning, management and decision making. The approach, therefore, is faced with a number of challenges requiring careful thinking, tenacity and high levels of commitment by those involved in the process.

In one hand, it might be easy to understand that the logic of transbounday river basin management is routed in the principles of trans-national connectivity of natural river systems, socio-cultural realities and economic dynamics that do not recognise political boundaries. The prevailing policy and institutional construct, however, might still be grounded on *"business as usual models"* of country specific, sectoral and fragmented approaches, crippling the principles of trans-national connectivity. This can only be overcome when riparian states can perceive that there are challenges and opportunities that need to be addressed creatively with an understanding that there is more to gain from joint management as compared to country specific and fragmented approaches. A holistic approach to basin management is, therefore, required to facilitate the building of a basin wide common vision amongst the riparian states based on common understanding of the best return on investment from the uses and exploration of the basin resources.

To a certain extent, in the context of the Okavango, the move towards the development of joint shared vision has been initiated with technical and scientific joint fact finding driven by the TDA process. Technocrats from the riparian states were exposed to similar data sets as well as to similar realities on ground through conducted joint field expeditions and application of similar methods of analysis.

This was, however, a first step towards the required up-scaling for a much broader changes in mind sets and the need to also think laterally/transboundary, in planning, management and decision making, using of the best available knowledge and information. It calls for the ability to manage trade-offs in between countries and understand the big picture emanating from basin wide management of investment opportunities framing the agreed tri-country concept of "*the acceptable development space*" for the basin. To facilitate this, tri-countries trade-offs negations in an informed manner, robust decision support systems supplied with appropriate data and information are required to adequately facilitate evidence based policy formulation, planning and decision making. One of the key challenges to transboundary management, rests on the required institutional and policy frameworks to think and operate laterally and across sectoral scales. Since countries have different national priorities governed by country specific planning frameworks and development visions, this institutional and policy challenge cannot be under-estimated.

Addressing this particular challenge will certainly require a quantum leap in the establishment and consolidation of highly functional institutions of transboundary water governance.

Ultimately, it is in relation with this particular policy challenge that the revised SADC Protocol on Shared Water Courses Systems is of critical importance in guiding transboudanry water governance in the context of the SADC regional integration strategy. In its article 3, it articulates principles of equitable and reasonable utilisation, unity and coherence, close cooperation and exchange of information. Implementation of the protocol is driven by the SADC Regional Strategic Action Plan (RSAP) for

the Implementation of Integrated Water Resources, through which River basin Organisations have been recognised as a critical instrument for the process. In this respect, it is important to note that OKACOM is increasingly being considered a leading example in implementing the SADC protocol.

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Opportunities for expanding the benefits from cooperative Transboundary water governance in the Nile Basin: benefits beyond physical water quantities

Everisto Mapedza[1] and Tesfaye Tafesse[2]

Summary

Water can be a key driver in economic growth in Sub-Saharan Africa and help meet the Millennium Development Goals (MDGs). In Sub-Saharan Africa, both physical and economic water scarcity are negatively affecting the economies of the countries with the latter considered a major challenge for the region. The International Panel on Climate Change (IPCC) projections of 2007 generally paint a gloomy picture for the region, since most of the Sub-Saharan countries will negatively be affected by climate change. Currently, most of the Sub-Saharan countries are failing to cope with climate variability. This paper briefly outlines opportunities for transboundary cooperation along transboundary river basins using Sadoff and Grey's Benefit Sharing Framework or Model. The major objective of the study is to assess how the fluid benefits from water could be enhanced across political boundaries in the Nile Basin. Benefit sharing is a mechanism that can enable riparian countries to share diverse benefits derived from water rather than physical water per se. This approach transforms transboundary water governance from a Zero Sum Scenario to Positive Sum Outcomes, where all stakeholders can benefit from cooperation.

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Introduction

The study aims to augment ongoing benefit sharing discussions in the broader Nile River Basin region through focused consideration of some key issues within the Eastern Nile Sub-basin countries of Ethiopia, Sudan and Egypt. The study is pertinent and exemplary for other river basins in Africa that are attempting different ways to increase cooperation for transboundary river basins. Cooperation becomes even much more pertinent and important in the context of the IPCC's largely projected reduction in rainfall in Sub-Saharan Africa, affecting all the major transboundary river basins (IPCC 2007). The study also attempts to draw on transboundary examples across the world to see how benefit sharing framework can be relevant for Africa's water governance. Benefit sharing attempts to avoid what Scheumann *et al* (2008) refer to as a 'race to the pump house' in the context of transboundary river basins in Africa. However, benefit sharing is a much more comprehensive concept that also includes basin-wide cooperation to address the 'tragedy of the commons' (Ostrom 1990; Agrawal and Ribot 2000), i.e. shared use of transboundary water resources, forests, grazing lands, bio-regions and responses to climate change. For instance, during the 2003 World Parks Congress, the transboundary approach was promoted as 'benefits beyond boundaries' (Wolmer 2003). Zbicz (1999) suggests that 'nature rarely notices political boundaries and hence there is a need to have integrated resource management that might stride across national boundaries.' Benefit sharing demands cooperation in areas such as communication and joint investment (Sadoff and Grey 2005).

This study considers the operationalization of the benefit sharing concept bearing in mind experiences in promoting the concept of equity as defined in the 1966 Helsinki Rules and the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Water Courses. Neither the Helsinki Rules nor the UN Convention have helped in overcoming ambivalence in the application of the concept of 'equity' in African river basins (Klaphake

2006; Lautze and Giordano 2008). It is in this context that Sadoff, Grey and Whittington (2002) underline the importance of transboundary river basin cooperation. The major challenge facing 'benefit sharing' is how to put theory into practice, taking stock of the power and interest asymmetries that exist among riparian states within the river basins, such as the Nile (Waterbury 2002; Conway 2005).

Methods

We used the Benefit Sharing Framework as depicted by Sadoff and Grey (2002 and 2008) along with the review of the literature on benefit sharing and interviewed key informants, especially those working at the Nile Basin Secretariat and the Subsidiary Action Program Offices, such as the Eastern Nile Subsidiary Action Program (ENSAP).

The Benefit Sharing Framework

Better management of ecosystems provides 'benefits to the river'; with cooperative management of shared rivers, benefits can be accrued 'from the river' (e.g. increased food production and power); easing of tensions among riparian states reduces costs 'because of the river'; and cooperation between riparian states leads to economic integration, resulting in 'benefits beyond the river' (Sadoff and Grey 2002). Attempts have been made to cite some global experiences with highlights from African initiatives within the context of this benefit sharing typology. One of the key attributes of benefit sharing is that it avoids the 'zero sum scenario' where each individual country pursues its egocentric interest, resulting in water resource destruction which will in the end sees all countries losing out. This situation can be rectified through cooperation which can bring or result in 'positive sum outcomes'.

There are numerous challenges and opportunities associated with cooperative management of international river basins (refer to Table 1). Transboundary cooperation could enable basin states to rehabilitate degraded watersheds, meet increased demand for water, overcome tense regional relations and promote soil and water conservation, agricultural and power production, integrated regional markets and cross border trade. In what follows, a brief description of each of the typologies will be made.

Table1: Types of cooperation and benefits on international rivers

Types of cooperation	The challenges	The opportunities
Type 1: increasing benefits *to the river*	Degraded water quality, watersheds, wetlands, and biodiversity	Improved water quality, river flow characteristics, soil conservation, biodiversity and overall sustainability
Type 2: increasing benefits *from the river*	Increasing demands for water, sub-optimal water resources management and development	Improved water resources management for hydropower and agricultural production, flood-drought management, environmental conservation and water quality
Type 3: reducing costs *because of the river*	Tense regional relations and political economy impacts	Policy shift to cooperation and development
Type 4: increasing benefits *beyond the river*	Regional fragmentation	Integration of regional infrastructure, markets and trade
Source: Sadoff and Grey 2002: 393		

(a) *'Benefits to the river' ('Ecological River):* Cooperative efforts to restore and protect shared river basins have been exemplified by Rhine River (Sadoff and Grey 2002). Due to the pollution of the Rhine, Salmon fish disappeared from the river in the 1920s. In due cognizant of the problem, the Ministers of the eight Rhine riparian states met in 1987 and came up with a plan to repopulate the river with Salmon under the motto 'Salmon 2000.' As a result of the concerted efforts made by the basin states and the allocation of enough funds, Salmon fish resurfaced in Rhine as planned in 2000. Within Africa, the Komati Basin Water Authority (KOBWA) which has two members, namely South Africa and

Swaziland, is a company formed in 1993 through the treaty on the development and utilization of the water resources of the Komati River. The treaty ensures, among others, that ecosystem water is available through set/enforced minimum cross-border flows thus protecting the environment in the context of increasing pressure on the resource. The lessons one can draw from this example is how cooperation on shared water resources can yield ecological benefits to the river.

(b) *'Benefits from the river' (Economic River[1]):* in this context, four examples can be cited. The first one refers to the Senegal River where Mali, Mauritania, Guinea and Senegal are cooperating to regulate river flows and generate hydropower using common resources and designing fair benefit sharing mechanisms. The Senegal River Basin Organization's (OMVS) achievements to date include: (i) the construction of two dams and hydropower plants, (ii) implementation of environmental management projects, (iii) creation of an observatory for the environment and (iv) adoption of a Water Charter (ENTRO 2007). Benefits have accrued to the three member countries in terms of irrigation, hydro-power and river navigation. Over 1 Billion US Dollars have been raised to fund dam construction and irrigation and to boost institutional support.

The second example is the Lesotho Highlands Water Project (LHWP) that has been designed to harness the Orange River for the benefit of both Lesotho and South Africa. As noted by Vincent (2002: 50), LHWP had dual purposes: (i) to control and redirect a portion of the water of the Orange River from the Lesotho mountains to the Vaal River Basin through a series of dams and canals for utilization in the Gauteng Province of South Africa, (ii) to take advantage of the head differential between the highlands and lowlands of Lesotho to generate hydropower in Lesotho to meet its own needs. In order to attain both purposes, the two parties agreed to share the cost of construction in rough proportion to the share of their anticipated benefits (Sadoff and Grey 2002).

The third one takes us to the Eastern Nile Subsidiary Action Program (ENSAP). The Nile Basin Initiative (NBI) is now looking at joint investments in irrigation, hydro-power generation and trade, river basin and watershed management and flood mitigation, bringing tangible benefits to the peoples of the basin. Despite the inherent difficulties of multi-country cooperation, serious efforts are being made to identify optimal solutions – with regional assessments 'removing borders' to identify best options scenario - and benefit sharing mechanisms to ensure good social and environmental practice (Sneddon and Fox 2008). The way things are moving now, it seems the Initiative might offer tangible benefits for improved Transboundary River Basin Cooperation in the Eastern Nile Sub-basin. In August 2007, a Regional Parliamentary Review further called for increasing further cooperation by calling for the 'acceleration of cooperation and a scaling-up of coordination and joint action' (NBI 2001).

The last example revolves around the Okavango River Basin Commission (OKACOM) whose members include Botswana, Namibia and Angola. The OKACOM Agreement of 1994 commits all member states to promote coordinated and environmentally sustainable regional water resources development, while addressing the legitimate social and economic needs of each of the riparian states. All the three riparian states of the Okavango appreciate the fact that upstream activities will also have downstream impacts that need a joint plan through OKACOM. The Okavango also attracts tourism amongst the member countries and beyond (OKACOM 2013).

(c) *'Because of the river' (Political River):* the costs incurred due to the presence of shared water resources have remained higher in rivers flowing through arid and semi-arid environments, such as the Jordan, Nile and the Euphrates-Tigris. Tensions and disputes, which have long remained the norms than exceptions in these river basins, inhibited regional integration and facilitated fragmentation. As noted by Sadoff *et al* (2002a: 398) with reference to the above-mentioned rivers, "little flows between the basin countries except the river itself – no labor, power, transport or trade". Cooperation might come as a result of the river.

(d) *'Benefits beyond the river' (Catalytic River):* it envisages other flows than the river itself, such as improved communication and trade (ibid). The same authors (2002a: 399) stated that "cooperation on shared river management can enable and catalyze benefits 'beyond the river', more directly through

[1] *The word 'economic' is applied here in its literal sense denoting the utilization of rivers for irrigation, power etc.*

forward linkages in the economy and less directly through diminished tensions and improved relationships". A good example for such a benefit is the Mekong River Basin. During years of conflicts in the region, Laos always provided hydropower to Thailand. Similarly, Thailand has always purchased gas from Myanmar and Malaysia and hydropower from Laos and China. In effect, the riparian transactions brought about mutual inter-dependency.

Conclusion

Zero sum outcomes are likely to occur when riparian countries act in a unilateral manner. It is hence incumbent upon co-basin countries to go beyond that and apply a positive sum outcome if they opt to share the benefits coming from the water. The first step in this direction would be to establish transboundary river basin institutions which will offer a platform for such an engagement. However, the establishment of such an institutional architecture is necessary but not sufficient to guarantee the success of cooperative action. Benefits, costs and information have to be continuously shared amongst the different stakeholders in order to build trust and confidence. The latter is not an event but rather a process which should be continuous and built on in an iterative process. Whilst benefit sharing as it appears is a noble conceptual framework, the question may always arise on its operationalization. The political economy of transboundary water institutions also needs to be understood so that they do not perpetuate inequities across the boundaries.

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Integrated water resources management for sustainable use: the case of the Volta Basin in West Africa

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Summary

This paper presents some aspects of integrated water resources management practices in West Africa with a focus on the Volta basin. It highlights some progress made during the past several decades in the management of Africa's many transboundary surface and ground water resources, especially in establishing institutional arrangements such as river and lake basin organizations. It also discusses the negative impacts observed during the same period from poorly managed development of these water and related resources and how mitigation action is being taken. In the Volta basin, these impacts include those of dam construction for hydropower generation, clearing of forests for agriculture, use of inappropriate fishing gear and increasing transfer and spread of genetic material through unregulated aquaculture practices. To address these concerns, the Volta Basin Authority and its partners are implementing a Strategic Plan, which initially covers the period 2010 to 2014, and aims to harmonize water resources management policies of the riparian countries, increase the knowledge base on the basin and expand involvement to all interested parties to improve coordination and management.

Introduction

The Integrated Water Resources Management (IWRM) approach recognizes the many different and competing interest sectors that use and abuse water, as well as the needs of the environment. It also co-ordinates water resources management across different scales, from local to international (GWP/INBO, 2009). This paper presents some aspects of IWRM practice in West Africa with a focus on forestry and fisheries in the Volta basin. It highlights some of the progress made during the past several decades in water governance as well as some of the major negative impacts of poorly managed development activities and gives an example of how mitigation action is being taken.

Africa has 63 international transboundary river basins that cover about 64 per cent of the continent's land area and contain 93 per cent of its total surface water resources (UNEP, 2010). These international basins harbour 77 per cent of Africa's population. Fifteen principal lakes and 24 main watersheds also cross the boundaries of two or more countries in Africa. In West Africa, there are three large river basins, the Niger, Senegal and Volta. Nine countries share the Niger, the longest and largest of these while the Senegal and Volta are shared by five and six countries respectively. Many countries in Africa also share groundwater resources although knowledge on aquifer occurrence and boundaries is not always comprehensive. In West Africa, shared aquifers include the Iullimeden, Taoudeni and Liptako-Gourma (UNESCO, 2009).

Transboundary Water Governance in West Africa

The past 50 years have seen some progress made in transboundary water governance in Africa. In West Africa, this period marked the establishment of such organizations as Lake Chad Basin Commission (1964), Organization pour la Mise en Valeur du Flueve Senegal (1972) and Niger Basin Authority (1980). Further developments led in 2000 to the Economic Community of West Africa States Regional Action Plan for IWRM and establishment of the Water Resource Coordination Centre in 2001 to coordinate and implement the Action Plan. The Volta Basin Authority (VBA) was created in 2007 with the signing of the Convention on the Status of the Volta River and Establishment of the VBA with a mandate to "*promote permanent consultation and sustainable development of the water and related resources of the basin for equitable distribution of benefits towards better socio-economic integration".*

Impacts of Development

In spite of progress made in water governance, the last 50 years have also witnessed development of water and related resources which have resulted in significant negative socio-economic and environmental impacts. The adverse impacts of construction of dams for hydropower generation in

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the Volta basin, for example, are well catalogued (Gordon and Amatekpor, 1999; Biney, 2012). Upstream negative impacts include loss of arable lands and forests and displacement of local populations following inundation. The loss of forest cover and land disturbances on steep slopes has increased sediment deposition in the reservoirs, which could shorten their useful life. Negative impacts downstream include disappearance of fish stocks due to physical blockage by the dam structure or as a result of restricted saline intrusion, reduced floodplain agriculture and increases in water related diseases in humans. In spite of this, all the riparian countries intend to increase hydropower generation for rapid socio-economic development (IUCN/PAGEV, 2005).

In addition to the above, increases in agricultural production in the Volta basin have largely been due to expansion of agricultural land since most of the cultivation is still mainly rain-fed. This has led to land degradation especially forests have been cleared in the southern areas, loss of topsoil and soil salinisation.

Fishing is another widespread activity, especially in large reservoirs such as the Volta Lake, and the Bagre and Kompienga reservoirs. In Ghana, the Volta Lake produced 87,500 tonnes of fish in 2000, about 98% of the inland fish production in the country (Braimah, 2001). Since the mid 1990s there has been increasing deployment of more active gear, such as winch nets, with unapproved mesh sizes leading to the lake's potential annual fish yield of about 40,000 tonnes being exceeded (Braimah, 2001). In the face of such unsustainable practices and with marine fisheries declining, all the riparian governments now recognize the need and potential of aquaculture for increasing food security and for providing other economic opportunities.

Thus, over the past two decades, fish farming has increased in popularity with the rapid expansion of cage fish culture in the Volta Lake and Kpong Headpond in Ghana, where aquaculture production tripled over the last five years to almost 4,000 tonnes annually. The major problems associated with aquaculture include natural habitat modification resulting from construction of facilities (Gordon and Amatekpor, 1999) and localised pollution (Biney, 1990). Another concern is the increasing transfer and spread of fish seed within the basin and from sources outside the basin in a generally unregulated manner.

Strategic Plan of the VBA

The above negative impacts from poorly managed development of water and related resources, coupled with predicted impacts of climate change in the Volta basin (Lemoalle and de Condappa, 2009) require joint efforts from all interested parties to reverse the trend and maintain a healthy ecosystem in the basin. Thus, VBA and its partners have developed a Strategic Plan (VBA, 2009), which initially covers the period 2010 to 2014, with the following five Strategic Objectives:

- Strengthening policies, legislation and institutional framework;
- Strengthening knowledge base of the basin;
- Coordination, planning and management;
- Communication and capacity building for all stakeholders;
- Effective and sustainable operations.

To date, progress in implementing the Strategic Plan has been achieved mainly on strengthening of the knowledge base in the basin through establishment of the VBA Observatory for Water Resources with support from Fonds français pour l'environnement mondial and implementation of the Volta Hydrological Observing System Project with support from African Water Facility (VBA, 2009) as well as through establishment of partnerships with various stakeholders. With support from FAO, VBA is hosting the Tilapia Volta Project that aims to assist the countries with key elements for development of aquaculture, focusing on strengthening capacity for sustainable access to quality fish seed in a sustainable manner, based on informed environmental decisions. In collaboration with VBA, other partners have also made considerable efforts towards IWRM of the basin. These include UNEP GEF Volta River Project, Challenge Program for Water and Food and IUCN Project for Improving Governance in the Volta Basin.

The implementation of the Strategic Plan is however yet to have a major positive impact on livelihoods in the basin because the tools and mechanisms required for harmonization of policies and improved coordination and management, such as the Water Charter, Communication Plan and Master Plan have not yet been developed. Achievement of major positive impacts in IWRM is understandably slow

and expensive, and for a young institution such as the VBA, this requires overcoming financial challenges and strengthening institutional capacity as well as gaining the trust of the riparian countries and key partners. Also, to make its implementation more effective, there will be a mid-term evaluation of the Strategic Plan in 2013, which will take into account problems encountered and concerns raised by various partners.

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Opinion Piece

If Africa is to develop its agriculture, should it follow the recommendations of the World Commission on Dams?[1]

Mafa E. Chipeta[2]

Every so often, the international community takes up a matter of global significance for sustainable development. Towards the end of the 1990s, having observed that dependence on water for energy generation and for agriculture was leading to massive investment in dams and that best practice was not being followed in constructing these structures, the IUCN and the World Bank promoted the launch of the 1998 World Commission on Dams (WCD) to review large dams and their impacts. The Commission delivered its report "*Dams and Development: a New Framework for Decision-Making*" in November 2000. In its authors' views, the report was not prescriptive but instead set out some principles, the application of which would need adaptation to specific circumstances.

What did the WCD report mean for Africa, are we acting on it, and have we put in place capacities to cope with its core recommendations? Although Africa accounts for only about 3 percent of the world's large dams, the matter is of interest to this highly agriculture-dependent region because irrigation is the main reason for building both large and small dams. According to a review of Asian Development Bank engagement with dams,[i] some 63 percent of large dams in Asia were for irrigation, with electric power generation a distant second at 7 percent and water supply/flood control at 2 percent each. Perhaps more important – given Africa's massive agricultural shortfalls and instability of farm output (largely due to reliance on unreliable rains) can Africa afford to follow the extremely cautious guidelines of the WCD on dams or should it follow its own immediate self-interest by accelerating building of dams to boost farm output? Some personal thoughts on this follow:

What did the World Commission on Dams (WCD) report say?

1. According to a 2010 World Water Week document,[ii] the WCD report assembled considerable new information based on over 100 dams and nearly 80 countries; thematic and case studies; country studies ; individual submissions; and consultations of all kinds. The WCD recorded the contributions of dams, noting that dams support 35-40 percent of irrigated areas which give 12-16 percent of global food, apart from 19 percent contribution to electricity and roles in household water supply and flood control. In addition to recognising their benefits, the WCD did not condemn dams wholesale, even large ones. Wikipedia reports that by end 2025, 80 percent of additional food production will come from irrigated land.[iii]

2. Of the WCD's few strong positive statements about dams, Nelson Mandela's keynote remarks when launching the report[iv] were probably among the best when he reminded everyone that the picture is not all bleak and that dams had brought great benefits too; that although millions had suffered, millions more had made great gains in terms of water and electricity not available before - "*The problem is not the dams*," he said, "*It is the hunger. It is the thirst. It is the darkness of a township. It is the townships and rural huts without running water, lights or sanitation*."

3. Potential benefits notwithstanding, the WCD report chose to emphasize instead and in great detail the weaknesses of dam projects in the past. The WCD report's call for caution in building dams was so emphatic and elaborate that some considered the document to be an overall condemnation of large dams: the report stressed that many dams had caused economic havoc due to massive cost overruns - 75 percent had cost overruns, some severe; had needlessly displaced rural communities and destroyed their livelihoods without offering

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[1] In 2010, Stockholm hosted a Water Week dedicated to reviewing what has transpired since the report was released; this opinion piece draws a lot on material from that meeting.

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effective alternatives - some 40 – 80 million people were displaced as dams inundated land; many had failed to yield the anticipated scale of either power or other collateral benefits - over half did not supply as much power as expected and almost half of irrigation schemes underperformed; most had destroyed irreplaceable habitats so undermining the survival of species and ecosystems. Although the Commission did not call for a stop to dam construction (instead it developed principles to follow in responsibly doing so), the weight of its message was discouraging. As a result, dams that would before not have called for comment became controversial.

4. The Commission made clear recommendations for principles to follow in future. The real question is whether the five "Core Values" – *Equity, Efficiency, Participatory Decision-making, Sustainability and Accountability* – and seven "*strategic priorities (with 26 guidelines) for an equitable and sustainable development of water and energy resources*" are not too numerous to be practical. Acting on all of them would almost without doubt stretch and delay operations – perhaps even deter investment interest for both the recipient countries (especially institutionally weak ones in Africa) and the lenders. Despite WCD denials, some readers felt that the report was not exhortatory but prescriptive; countries like China and India reportedly rejected the report "for fear that it could bring dam construction to a halt."[v]

5. A surprise is that despite rosy projections by planners, dams rarely deliver what is promised by the planners and their construction costs are almost inevitably much more than projected. Yet the WCD report did not apportion significant blame to engineers and planning economists whose irrepressible optimism gives the exaggerated expectations upon which investment decisions are based.

Did the WCD report affect dam construction?

6. The effect of the WCD report on investment and operational practice has not been subsequently systematically tracked but is thought to have been considerable: for developing countries which depended on international financial institution loans, lending windows appear to have narrowed. Some ten years later, in the UNEP-coordinated World Water Week (Stockholm 2010) a diversity of views regarding what had transpired was large. In one paper, "**WCD+10: uptake, impact & perspectives – a snapshot survey**. James Ramsay (presenter Thomas Chiramba, the point was made that opinion remained polarised but had become more negative; some commentators believed that the WCD report was not implementable because it was too complex.[vi] Naturally, other believed that things had improved – certainly the tempo of dam construction appeared to be coming up again.

7. The Report of the WCD[1] initially effectively tied society up in knots as to how best to continue with dams. So much was the uproar from the civic society environmental and social lobbies that their campaigns were practically interpreted as being calls for funding bodies to boycott dam projects – the lobbyists pressured international (especially multilateral) financial institutions to strictly and with extreme diligence apply "precautionary principles" – build no dam unless it does absolutely no harm. In its review of the WCD report, the World Bank reported that (a) some developing country governments feared a reduction in bank support to dam projects and felt that the WCD report's 26 guidelines would result in more lending conditionality; (b) the International Hydropower Association considered the overall tone of the report negative and feared that hasty adoption of its elaborate guidelines would make dam planning and approval impossibly lengthy, costly, uncertain and prone to unrealistic financial conditionality that could unduly impede approval of urgently needed projects.[vii]

8. The WCD report created a partial paralysis not because its message was impossible to follow but perhaps was too thorough, too intellectually perfect, so well imbued with doubts and so comprehensive that compliance with what it recommended alone was enough to freeze or delay action. The limited weight and emphasis

[1] "***Dams and Development: A new Framework for Decision-Making***", *The Report of the World Commission on Dams. Earthscan Publications Ltd, November, 2000. ISBN 1-853-798-9 Paperback; 1-853-797-0 Hardback. The Commission arose out of an IUCN/World Bank Workshop held in April 1997 in Gland, Switzerland.*

given to benefits of dams compared to their disadvantages; the implied "Murphy's Law" message – i.e. that in a dam project anything that could possibly go wrong would go wrong; and the other implied message that dams are wrong until proved otherwise made a mark. Reports suggest that there was a "chilling effect" on international lending for large dams, which meant that only countries with their own money, such as China, India, Thailand, Malaysia etc. continued to build new dams on any major scale.

9. There are two other concerns: (a) *the WCD report did not attach relative weights to its core principles or its strategic priorities* – would failure to comply with any single one of them be a potential "deal-breaker"? If only some were met, could one go ahead and invest? If there was some doubt and the environmentalists or pro-indigene lobbies protested, would the lenders have the courage to go ahead anyway? For African countries, which are already generally perceived as investment risks, these can be real hurdles to securing credit to finance dam construction whether for irrigation, for power, or for multiple purposes; (b) *the apparent desire for perfection in dam investments* – whereas there is pragmatism in almost all investments in other sectors, the WCD report was so detailed in its picking on faults for dams that it appeared that only perfection would do. No dam should be built until all faults are removed from its design, prior informed consent and other requirements are fulfilled for the consultative processes with all stakeholders – everyone should say "yes it is good" before proceeding. This is application of the precautionary principle at its most extreme.

How should African agriculture obey?

10. Africa is hungry: for decades, it has been a net agricultural importer – annual import figures of US$33 billion are routine but by now even US$50 billion per year is mentioned. Africa accounts for less than 2percent of global agricultural trade; it also consumes more international food aid than any other continent. In basic cereals, its productivity is only around 1 ton/hectare against a developing country average closer to 3.5 tons/ha. The signals are not positive and despite some patchy improvements, Africa needs to produce much more. With only about 4 percent of its available arable land irrigated (compared to about 40 percent in Asia) and fertiliser use somewhere below 10 kg/ha (compared to a 120kg/ha OECD average and up to over 400kg/ha in East Asia) Africa will not make it if it does not drastically change.

11. Expanding irrigation is among the most effective ways to boost farm production and building dams must come in, including large and very large ones. *In the end, for Africa the core question is to choose between continuing starvation and agricultural underproduction or investment in more dams (including many large ones) so as to exit from the food shortages and unstable food supplies.* Orders of magnitude may help here: the ADB NGO Forum[viii] reports that in 1998 Africa (a region with about 15 percent of global land area) had only 1 269 large dams (2.7% of global total). In the same year, Asia, with not much more than double Africa's land share, had 31 340 large dams (65.8% of global total); North and Central America – far smaller than Africa in land area – had 16.8% of the world's large dams.

12. One appreciates that since the WCD conditions for dams have become more stringent. *Unfortunately this has happened just when Africa needs to sprint ahead in agricultural production – others who invested when the so-labelled economically inefficient and environmentally/socially negative dams could be constructed without qualms have benefited economically from their folly. But should Africa conform with WCD ideals so faithfully when this locks it into continuing starvation?* Should it so slavishly fit new global norms when this curtails its reasonable development and food security aspirations? Would it not be better for Africa to not aim for perfection but instead to select only some of the WCD criteria and principles so as to develop faster? *Africa has to make clear choices on WCD compliance, all of which are political – to obey in full; to not obey at all; or to be pragmatic by going for part-compliance:* why not uplift the lives of the poor people of Africa sooner rather than later by being selective in compliance so allowing significant dam construction?

13. Africa would do well to remember Nelson Mandela's observation that "*The problem is not the dams, it is the hunger. . . . .* " To address this very hunger, Africa should choose the pragmatic pathway. But it should demonstrate its sense of responsibility by ensuring at least the following:

    a. *Have ambition based on self-interest*: achieving compliance with global ideals is fine but this should not be at the cost of own people's starvation and economic penury;

    b. *Ensure that its planning figures of costs and benefits for large dams are realistic* – it makes no sense to pretend that at little cost, one can build dams that yield miraculous abundance of irrigation water, hydropower and flood protection/sanitary water benefits;

    c. *Take seriously the question of stakeholder consultation but do not pretend that absolutely everyone will be happy*: development is never painless and the regions with most large dams have never themselves consulted to this degree of achieving total agreement;

    d. *Pay attention to community impacts* – after all they tend to be among the most powerless and government must stand up for them - *but do not adopt the view that only community interests matter* – national goals and ambitions are also necessary, provided the returns are not grossly ill-distributed among interest groups;

    e. *Seek balance between environment and development but do not value environment so high that all environmental values are protected fully before development can be allowed* - even environment has limits to its value; and

    f. *Avoid the following excesses and thereby respect the concerns that led to the launch of the WCD*: exaggerated claims of achievable agricultural irrigation and power supply that never materialise and so give the whole industry a bad name; construction-cost overruns of several times the initial budgets, which risk bankrupting the borrowing countries; wanton displacement of communities with little or no compensation; and irresponsible and sometimes needless inundation of precious ecosystems.

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Articles

Sharing the benefits of large dams in West Africa

Jamie Skinner[1] and Jérôme Koundouno[2]

Summary

More than 60 large dams are under construction or planned in Africa, including at least 39 in West Africa. Through the Global Water Initiative (GWI), the International Institute for Environment and Development (IIED) and the International Union for Conservation of Nature (IUCN) aim at improving the dissemination of information on the social impacts of large dams on local development and at strengthening the required capacity so that managers can ensure inclusive, participatory and accountable decision-making. Financed by the Howard G. Buffett Foundation, GWI seeks to meet the challenge of supporting actors to develop new mechanisms for benefit-sharing and innovative ways to rethink these large water infrastructure projects through:

- *An improved sharing of benefits derived from dams is in the interest of everyone: public authorities, local communities, private sector and donors. It is neither expensive nor complicated to support local development in parallel with national objectives and thus avoiding protracted conflicts that drain public resources in the long term.*
- *The transition from a traditional system of resource development to a land management under modern law is the main source of tension, combined with the challenge of managing internal migration tied to opportunities provided by the reservoirs.*
- *The rights of local populations affected by dams should be codified and protected by written agreements to avoid accusations of broken promises and conflicts within host, resettled and immigrant communities, and disputes over the compensation received.*

Introduction

Fifty years ago, the iconic Akosombo dam was built in Ghana (1965), submerging the lands and homes of 80,000 people to create the largest artificial lake in the world and to secure electricity supply for Ghana. Since then, West African countries have built more than 150 large dams as defined by the International Commission of Large Dams[3]. Like Akosombo, many dams have stimulated national development while bringing in their wake considerable social and environmental challenges.

Overall, after 1990, the construction of large dams was no longer a priority for major donors, while global concerns were growing about their local impacts. However, over the last decade the World Bank and other major multilateral banks have renewed their support to large dams in a bid to meet a growing demand for energy and foodstuffs. However, can these projects avoid repeating past experiences? As part of the Global Water Initiative (GWI), the International Institute for Environment and Development (IIED) and the International Union for Conservation of Nature (IUCN) encourage communities and public authorities to learn from past experiences in order to improve dam planning, benefits-sharing and

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[3] A dam with a dike height of 15 m or more from the foundation, or a height of 5-10 m with a reservoir with a capacity of over 3 million m³. Based on this definition, there are currently more than 45,000 large dams in the world.

resettlement practices in West Africa. This programme builds on the recommendations of the World Commission on Dams (2000) that brought a new vision on large dam projects and fostered new dialogue initiatives in the world, supported by the *Dams and development project* of the United Nations Environment Programme (2002-2007)[1], inviting policy-makers among others, to consider the local communities as full partners.

The economic and political environment new dams are faced with is entirely different from what it used to be prior to 1990. Thus, the Sélingué dam built in 1980 in Mali was born under a military dictatorship, while the latest Malian dam project in Taoussa operates in a context of decentralization and democratization. The policies of donors have also evolved to give much more attention and funding to the protection of the environment and local populations.

However, poor planning can still cause tragedies and mega projects financed by donors such as dams, do not have the financial flexibility to respond to unexpected social consequences. The lessons learned from past projects could dramatically improve the impacts of planned dams, the construction of which could start within five years for buildings that are supposed to last a century. While some *governments sometimes seem to resist learning lessons from the processes* implemented 20 years earlier, many other public authorities are more receptive to exploring best practices for moving forward.

Methods, results and discussions

Revisiting the objectives

GWI and local researchers have reviewed the documentation associated with six dams in West Africa and have met people who have experienced resettlement in Burkina Faso, Mali and Senegal, to discuss the effects of relocation, the benefits received from the dam and to identify those who have benefited[2] from it. Could these benefits be shared more equitably and effectively in order to promote development for all involved, and to provide the affected populations with a reason to be interested in the project and accept it throughout its lifecycle? How to protect existing ecosystems which benefit local communities and ensure their well-being, and which will be transformed by the construction works?

National workshops that brought together local stakeholders and government officials, have focused on stories told by affected people and communities and have learned from them lessons that could influence national policies.

One of the messages that have emerged is that governments and donors should equate the local development objectives of a dam with national objectives. Indeed, these large structures were built primarily to provide electricity or irrigation, and people who live near the reservoirs were often treated as obstacles
that simply needed to be removed and compensated for their losses. Experience shows that conflicts related to the compensation and resettlement land dragged on and sometimes became violent. Thus, to this day, claims about the Akosombo dam are still being lodged before land tribunals, whereas in Bagré, Burkina Faso, local leaders are trying to protect what they consider as their customary land by driving away immigrants attracted by new jobs and markets near the dam.

[1] See *Dams and Development: Relevant Practices for Improved Decision-making: A Compendium of Relevant Practices for Improved Decision-making on Dams and Their Alternatives.* Nairobi: UNEP-DDP Secretariat, 2007. Print.

[2] Bazin, Frédéric, Jamie Skinner, and Jérôme Koundouno. Share the water Share the benefits*: Lessons from six large dams in West Africa*. London: International Institute for Environment and Development, 2011. Also available (FR/ENG) at the following addresses http://pubs.iied.org/pdfs/17510FIIED.pdf / http://pubs.iied.org/pdfs/17510IIED.pdf

Photo: The Bagré hydroelectric dam in Burkina Faso, an important potential resource for agriculture, livestock and fishing at the local level (photo credit: Jean-Claude Frisque/IUCN)

Instead of bearing the cost of conflict –both in financial terms and in lost development opportunities– the government could channel a portion of the resources created by dams towards displaced communities, ensuring that the local people actually benefit from the projects. Thus, based on the sentiment that emerges from the case studies, GWI currently supports the authorities in Niger to develop a Local Development Fund receiving two to three percent of the hydropower revenues of a new dam. Over the hundred years of a dam's life, this fund can meet the changing needs of local populations – e.g. increased schooling, investment in the agricultural sector or improved water resources – and provide flexible support that reduces

dependence on the government to resolve conflicts related to resettlement. In addition to the hydropower financial revenues, shared benefits may include secure access to irrigated land, a portion of utilities or a structured fishery system.

Signing written agreements

Research shows that another crucial step is to codify the legal rights to land, housing and other resources redistributed by the dams. In many cases, such as in Sélingué, immigration exacerbated the pressures on resources and the transition from a customary tenure to a modern legal system was thus complicated. Decades after the construction of the dam, traditional chiefs who allocated land to immigrants or who had witnessed the government doing same, may come to believe that their own communities were ultimately forgotten in the resettlement process.

In oral cultures, the sometimes arbitrary promises of government spokesmen can also

generate tensions. The chief of a village resettled in Sélingué recalls: «We were promised that there would be so much rice, that we would have enough to eat and sell and buy millet whenever we needed to. » In fact, the plots of irrigated rice proved difficult to grow and more expensive than rainfed millet. To ensure that expectations in terms of land rights, compensation and benefit-sharing are clear and binding, governments must safeguard the commitments through written agreements.

Conclusion and way forward

GWI is liaising with dams' development authorities, the civil society and local communities to incorporate these lessons in dam projects announced in Guinea, Mali and Niger. This also feeds into the reflection of international agencies in charge of managing river basins and the 15 countries of the Economic Community of West African States (ECOWAS) on good practices for the management of major water infrastructures in West Africa[1]. And while the new dynamics of dam construction in Africa continues to build up, the GWI should have more opportunities to promote a constructive dialogue and encourage future projects to learn from the past.

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[1] See (ECOWAS, 2012) Guidelines for the development of water infrastructure in West Africa, Water Resources Coordination Center (WRCC).

Managing the Komati's water resources: integrating sustainable use of land, forests and fisheries in a basin shared by South Africa and Swaziland

Sipho V. Nkambule[1]

Summary

Sustainable use and conservation of resources is crucial for Africa in general and the Komati Basin in particular. The article explores the water, land, forests and fisheries resources use in the basin which is shared by two countries (South Africa and Swaziland) but is part of a bigger basin (Incomati River Basin) which includes Mozambique. Successes and threats are interrogated. For purposes of discussion the river basin is dissected into 3 sections based on land use types and biophysical features. The critical role of political will and an autonomous trans-boundary water resource development and management institution are highlighted.

Introduction

The Komati is a trans-boundary sub-catchment being part of the bigger Incomati River Basin. It starts in South Africa, enters Swaziland then exit back to South Africa. It joins the Crocodile River before exiting into Mozambique. Therefore South Africa and Swaziland are both upstream and downstream of each other. There are five dams along the river (Figure 1) being Nooitgedatch Dam (78-million m^3), Vygeboom (79-million m^3) and Driekoppies (251-million m^3) all in South Africa and Maguga(332-million m^3) and Sand River (49-million m^3) Dams in Swaziland (Keevy et al, 2009).

The Komati River is of interest to three countries (South Africa, Swaziland and Mozambique) hence subject to international law. There are several bi-national and tripartite Treaties and agreements governing the Basin. In August 2002, on the sidelines of the World Summit on Sustainable Development in Johannesburg, the much acclaimed "Tripartite Interim Agreement on Water Sharing of the Maputo and Incomati Rivers" (the Interim IncoMaputo Agreement-IIMA) was signed as an example of trans-boundary Cooperation. Notable in this context is also the earlier 1992 Treaty (KOBWA 1992) through which South Africa and Swaziland, with Mozambique's assent, agreed to jointly develop two water reservoirs in the Komati Basin and formed the trans-boundary and autonomous Komati Basin Water Authority (KOBWA) to design, construct, operate and maintain Maguga and Driekoppies Dams and manage the water harvested by them .

Furthermore the South African National Water Act (NWA, 1998) and Swaziland Water Act (2003) have been put in place for national administration purposes. This article concisely highlights the integrated use of water, land, forestry and fishery/wildlife in the Komati Basin.

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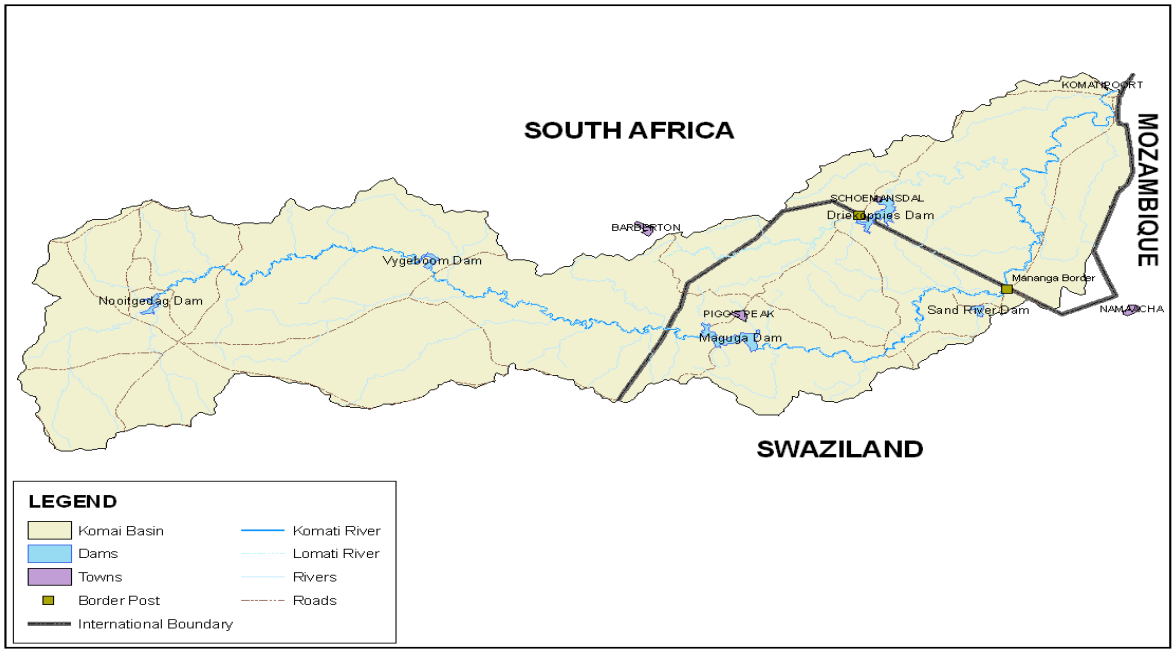

Figure 1: Komati River Basin between South Africa and Swaziland (Adapted from KOBWA, 1992)

Water and land use in the Komati basin

Conceptually the Komati Basin can be divided into three (3) sections being (i) the wet and arable upstream, (ii) the rugged/mountainous middle section and (iii) the flat arable but arid downstream.

Wet and Arable Upper Section

This section is dominated by rain fed crop (mainly maize) farming and animal grazing on poorer soils presumably taking advantage of fodder from maize. The water is also used for inter- and intra-basin cooling of thermal power stations (KOBWA 2007). There are several wetlands and coal mines in this section; the wetlands are threatened by acid mine drainage and fertilizer/chemical pollution from farming (Afridev Consultants, 2005)

The Rugged/Mountainous Section

The mid-section is dominated by 123 000 hectares of forestry (KOBWA 2007), wildlife game reserves and communal settlements and grazing. It is noteworthy that water was allocated for the forestry (KOBWA, 1992). Any increase on the area under forestry would affect the water allocation for other uses such as agriculture for the country concerned.

One of the challenges in this section is alien invader species which does not only displace indigenous terrestrial and aquatic plant species but severely reduce the amount of water in the catchment. A recent study estimated that the alien invader species consume about 62-million m^3 of the water resources in the basin per annum (Nepid Consultants, 2010), about 8% of system yield. The governments have programmes in place but success is limited. The grassroots buy in is infantile, perhaps bottlenecked by the communal land tenure systems in both countries. Success in a downstream country is undermined by failure in an upstream country.

The Maguga and Driekoppies Dams are found in this section. Maguga Dam water intended for irrigation downstream passes through generators which produce about 20-megawats of electricity equivalent to 10% of Swaziland's requirements. This is another synergistic use of the land and water resources in that the power gets used for irrigation among other things.

The dams in the Komati Basin currently do not have capacity to sustain commercial net fishing. The Governments of Swaziland and South Africa have taken keen interest in development of fisheries projects in the dams/river. The Maguga and Driekoppies Dams have become famous sport fishing destinations in the region. Cognizant that both dams are situated in the midst of impoverished

communities line fishing permits are availed free of charge. The size of the dams permits access to the fishery resources to both impoverished communities for subsistence purposes and tourists for leisure.

The Flat Arable but Arid Downstream

The section is dominated by irrigated sugar plantations and orchards in the Lowvelds of Swaziland and Mpumalanga Province in South Africa. Irrigation accounts for about 80% of the allocation of water in the Basin. The largest dams (Maguga and Driekoppies) were built primarily to increase assurance of supply on then 33 500 hectares existing irrigated lands and to provide for an additional 16 000 hectares in both countries (KOBWA 1992).

The riparian states are cognizant of the need to maximize water productivity by this sector. In the past 20 years significant shifts from relatively inefficient (surface, impact sprinklers) to water/electricity efficient (drip and centre pivot) irrigation systems has been observed. For instances in Swaziland the farmers using the Komati river have converted approximately 10 600 hectares of irrigated fields from mainly dragline sprinkler (70% efficiency) into drip irrigation (95%) and centre pivot (85%) (L.S Ndlovu, personal communication in December 2012). Assuming a consumptive water use of approximately 10000-m^3/hectares and average new efficiency of 90% it is conservatively estimated that the changes have made available 33 650 793 m^3 per annum. By World Health Organization (WHO) standards (www.un.org.waterforlifedecade/human_right_to_water.shtml) the amount saved can supply water for basic human needs to between 1-million (100-litres/person/day) and 2-million people (50-litres/person/day) per annum.

The benefit from the water used for irrigation is increased by the maximization of outputs from the crops produced. For instance irrigated sugarcane is no longer used for sugar production only. The major users in the basin are increasingly using previously wasted plant components for the production of fuels (ethanol) and electricity (biomass) thus saving coal and other fossil fuels.

The principle of water as "an economic good" is not yet universally implemented in the basin. Commercial uses do not always attract the requisite tariffs besides cost recovery, in some cases, due mainly to lack of human and measurement of infrastructural capacity to enforce existing legislative provisions. Where the tariffs are collected they are not "ring fenced" to support further development of the resource in the Komati Basin.

The concept of water as "a social good" is guaranteed by the provisions for "water reserve" in South Africa and "primary water" in Swaziland.

Sustainable Use of Natural resources

During development of the two large dams KOBWA ensured that affected communities were left better off than they were before. The amenities provided included *inter alia* modern houses, community clinics, schools, roads, commercial agricultural projects and water purification plants.

About 20% of the Komati water resources are reserved for industrial use and basic human needs. International and national legislations pronounce safe water for human needs as top priority/right. However, the riparian states are still challenged by either unsatisfactory quantity or quality of the resource. The acid mine drainage around the town of Carolina and the water service delivery protests in the Nkomazi Municipalities (both in South Africa) are manifestations of this challenge. Data is not readily available specifically for the Komati Basin in Swaziland but observations are that that stretch is also challenged with respect to availability of clean water for impoverished communities. For both countries, the problem seems to be more of inadequate capacity (human, material and financial) rather than shortage of the resource. The use of mobile Total Package Water Purification Plants has proved very effective and cheaper than standard purification plants and perhaps other African countries need to explore the technology.

The major dams in the Komati are zoned according to environmental sensitivity. The surrounding land use is governed by the gazetted zonings. A river basin approach is employed in monitoring water quality, aquatic and terrestrial ecosystems. Trends are reported to the countries for mitigation (negative) or enhancement (positive). Over the years the water quality monitoring data has been showing that the water is generally in a fair condition for use with exception of areas affected by acid mine drainage upstream.

The Treaties ensure that ecosystem water is available through set/enforced minimum cross-border flows thus protecting the environment in the context of increasing pressure on the resource.

Conclusion

The trans-boundary Komati Sub-Catchment has many actual and potentially synergistic and sustainable natural resource uses. The existence of an autonomous bi-national entity (KOBWA) enables greater efficiency and equity in water management through conjunctive use of dams, located in two countries, as a single system. The benefit extends to assurance of environmental flows and environmental monitoring. KOBWA owes its existence and success to the political will among the countries to cooperate at a technical level thus circumventing potentially stifling political differences. Land resources are generally allocated according to suitability maps. The threats posed by acid mine drainage and invasive alien species remain and require urgent research and redress at a trans-boundary level. A capacitated trans-boundary coordinating institution with focus on the control and elimination of alien invasive species would probably achieve better results than individual country efforts.

The use of forestry by-products and alien invasive species to generate power in timber and sugar mills is one area requiring further research in the basin. The mobile total plant package technology has been effective for rapid redress of clean water needs and is worth further exploration by African States.

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Irrigated Sugarcane in the Komati

Certifying sustainable aquaculture for Africa: leveling the playing field for smaller-scale producers while ensuring ecosystem health

Randall Brummett[1]

Aquaculture, as with any form of food production or human activity, has an ecological footprint (Boyd et al. 2007; Lorenzen et al. 2012). Competition for land and water are driving intensification that sometimes pushes the limits of ecosystems to absorb impacts.

A number of environmental experts and government regulators have expressed concern about the sustainability of aquaculture. It is in no one's interest that aquaculture grows beyond the carrying capacity of the environment and consumers are right to insist on seafood[2] produced in a manner that maintains ecosystem functionality. Of equal importance to producers, gaining access to international markets increasingly depends upon the ability of the farm to demonstrate that it is acting responsibly in respect of the environment.

After years in the doldrums, aquaculture in sub-Saharan Africa is finally taking off. The clariid catfish (*Clarias* and *Heterobranchus spp.*) industry in Nigeria and the Nile Tilapia (*Oreochromis niloticus*) industry in Ghana have grown exponentially over the last decade (Figure 1) and are now worth an estimated $420 million and $26 million, respectively (FishStat 2012). In 2010, 35 sub-Saharan countries reported an estimated 150 thousand metric tons in production, up from less than 8,500 MT 25 years earlier (FishStat 2012). ***Certifying Sustainability***

To guide consumers about sustainability, seafood certification and seafood guides seek to create market incentives designed to encourage producers to reduce environmental impacts. In effect, to get into the international market, farmers will increasingly need to be certified sustainable. There are currently some 200 guides and 50 environmental standard-setting bodies, ranging from environmental lobbies, to supermarket chains, to private third-party oversight companies to national governments.

Feedback from key stakeholders in the seafood trade and governance indicates that the multiplicity of these well-intentioned efforts may be counterproductive, confusing buyers, retailers and consumers, while raising the cost of production. Lack of baseline criteria that can link responsible farm-level practice to changes in the larger surrounding ecosystem has opened standard setters to criticisms of 'green-washing', the certification of products produced in systems that may not be as 'sustainable' as advertised (Roheim, 2009). The impact these programs have in terms of ensuring that responsible aquaculture equates to sustainability is also being called into question.

One tool used in the sustainable seafood movement is "watch-cards", which caution consumers on a species-by-species basis. Another tool, aquaculture certification schemes, certify individual farms or, in a few cases, collectives of small farms. Certification is based on farm practices such as nutrient loading, number of escapes, use of antibiotics, *inter alia*. However, the most significant negative ecological impacts of aquaculture, loss of biodiversity and eutrophication, do not occur at the farm level, but rather reflect the collective impacts of all farms, certified or otherwise, again which are not explicitly and thoroughly assessed by current standards. While some of the existing tools for ensuring seafood sustainability raise the issue of cumulative impacts, they do not explicitly indicate metrics to assess them. Any determination of environmental sustainability needs to move beyond the farm level to that of the larger aquatic ecosystem of which aquaculture forms only a part.

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[2] *Seafood, as per the global norm in regulation and marketing, is taken in this article to include both capture and culture, freshwater and marine species.*

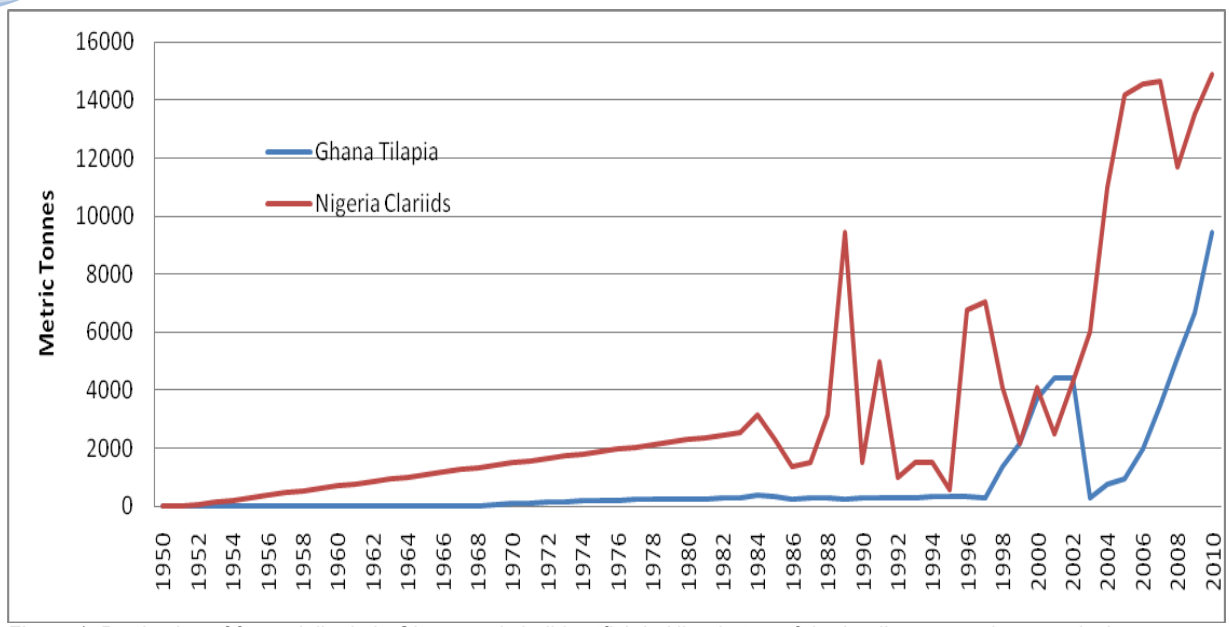

Figure 1. Production of farmed tilapia in Ghana and clariid catfish in Nigeria two of the leading aquaculture producing countries in sub-Saharan Africa

Systems to ensure ecosystem-level sustainability of aquaculture should aim to sustain indigenous species abundance at levels prevailing prior to the introduction of aquaculture and will require: 1) spatially explicit regulatory/zoning instruments to define the boundaries over which aquaculture sustainability should be assessed and, 2) sustainability indicators and monitoring systems in respect to the local ecological carrying capacities of these zones.

Planning at the ecosystem level will simplify permitting and ensure that farms occupy less environmentally sensitive areas. Within zones, collective action among farms and with veterinary services to control diseases would be made easier. Once established, zoned aquaculture areas could be certified collectively so that all farms have access to markets. Norway and Scotland (salmon) and Ireland (bivalves) have pioneered user-friendly approaches to ecosystem-level management based on extensive, heuristic carrying capacity datasets that could inform initiatives elsewhere.

With increasing wealth, health consciousness and global population, demand for seafood is increasing and great new marketing opportunities are opening for aquaculturists. At the same time, scarcities of water, arable land and power, combined with unstable climates, will make growing food increasingly difficult and costly. Governments may be tempted to compromise long-term sustainability to meet short-term food security targets. Long-term sustainability should be defined in a way that the public understands so that policy makers can communicate the process and the results of aquaculture's impacts while maintaining their essential roles in maintaining their public trust responsibilities for safe seafood supplies, healthy ecosystems and biodiversity.

Investing in Sustainability

Unfortunately for farmers, the existing certification systems are expensive and return little if anything to the bottom line. While essential for getting into some markets, certification of the typical fish farm costs about $3000 per year in 2008, plus the cost of whatever modifications to the production system that might be needed to comply with standards (Washington & Ababouch 2011), only increases the likelihood that a consumer will purchase a seafood product by about 5% (Roheim (2008) and the marginal price paid by consumers in the US and Europe for certified seafood is generally nil (Washington & Ababouch 2011). For large-scale farmers, certification can be a good deal, but for most African farmers, investing $3000 per year for no additional profits is out of the question. What can a smaller-scale farmer do to get into the certification game?

The generally small scale and organic growth of the aquaculture industry has made it difficult to regulate and contributes importantly to the high levels of risk perceived by potential new investors. Some of the

larger certifying bodies are trying to help smaller-scale farmers by giving training and advising producer associations on how they can become collectively certified. While this is a step in the right direction, it does not address the fundamental disconnect between certifying 'responsible practice' and true sustainability.

Useful sustainability indicators should reflect an understanding of how ecosystems function and the services that the public expects functional ecosystems to generate. They should also be robust and easy to monitor, and would necessarily be determined by the ecosystem and informed by local priorities rather than by farmed species or culture system. A definition of aquaculture sustainability that rings true with the larger society will capture complexity in a relatively simple index comprised of a limited number of iconic indicators.

The development of sustainable aquaculture zones might be a better approach. Because disease and negative environmental impacts (including those resulting from the use of non-indigenous strains) are the major exogenous risk factors in aquaculture and are determined primarily by water management, production intensity and proximity of fish farms to one another, there are clear incentives for responsible aquaculturists to welcome zoning and ecosystem monitoring to ensure sustainability and protect their investments.

Working together, African public regulatory, research and veterinary services and private sector investors could agree a set of credible indicators of sustainability for application within a designated aquaculture zone that take global environmental and local socioeconomic concerns into consideration while reducing the cost of certification and market access for smaller-scale producers. Reliability and practicality (including cost-effectiveness) of measurements should be considered in the selection of indicators.

Ecosystems in which aquaculture and other human activities occur will change, but not all change is bad. Well-managed aquaculture generates modest (relative to the goods and services it generates), often unnoticeable changes that do not upset the natural balance of the ecosystem. In many cases, impacts of aquaculture will be positive in terms of ecosystem services. Indicators of sustainability should capture these changes to enable sound management.

Summary and Conclusions

To improve the climate for aquaculture investment so as to meet food security and economic development targets without causing environmental degradation, a new approach to managing growth and certifying sustainable practice is needed. This could open new markets for smaller-scale producers, while making sure they do not exceed the carrying capacity of the ecosystem. Spatial planning can identify best sites that are good for production, away from environmentally sensitive areas. As indicators of sustainability, existing certification systems are not adequate. Needed are objective indicators that take into account the collective impacts of aquaculture at the ecosystem level. The first step should be to identify the key environmental parameters, biological and/or physicochemical, impinging upon ecological integrity deemed most likely to be affected by aquaculture activities. Opportunities exist to learn from existing initiatives in Norway and the UK. These should then be assessed for robustness and applicability across a range of likely ecosystems where aquaculture is practiced (e.g., tropical lagoons, floodplain rivers, coastal bays, estuaries, coral reefs, etc.). The level of impacts from aquaculture that is tolerable should be assessed for a range of ecosystem services considered indicative of ecosystem health and the wishes of informed local communities. Based on agreed levels of impact, verified by a simple and robust set of indicators, all farmers operating within an aquaculture zone could be certified, gaining access to new markets while assuring that our aquatic environments are protected for future generations.

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Complementarity between the sectorial water management approach and integrated management of water resources: concept and implementation mechanisms.

Lebdi Fethi[1]

Introduction

Integrated water resources management (IWRM) as defined in the «Global Water Partnership, 2000» document is «a process which promotes the development and coordinated management of water, of land and related resources in order to maximize the resulting economic and social well-being in an equitable manner without compromising the sustainability of vital ecosystems».

It is thus important to understand from this definition that the implementation of IWRM refers to a process which is a series of continuous and dynamic logical actions that lead to the rationalization of water resources management. The context is generally one of scarce resources. In Africa, the physical scarcity of resources is found at local and regional levels, though there are also very humid countries or regions that constitute the water reserve of Africa. However, the scarcity in Africa also has two dimensions: scarcity due to low investments in the water sector and to financial constraints, which translate into an obvious lack of water infrastructure, but also scarcity due to institutional and legal weaknesses. The basic principles of IWRM defined at the 1992 Dublin International Conference on Water and Environment are the following:

- Fresh water is a limited and vulnerable resource, essential for life, development and the environment.
- Water development and management should be based on a participatory approach involving users, planners and policymakers at all levels.
- Women are at the heart of water supply, management and conservation processes.
- For all its different and often competing uses, water has an economic dimension. That is why it should be regarded as an economic asset, taking into account human, social and environmental realities.

In the following paragraphs, the principles and mechanisms to establish a process of integrated water resources management are detailed in the African context.

1.Sectoral approach and Integrated Water Resources Management (IWRM)

A number of foundations are constitutive of IWRM, including governance, institutional, legal, technical and financial aspects.

From the onset, and particularly in Africa, countries emerging from the colonial era used to, and continue to face problems in accessing water, sanitation and food security, through the mobilization of the available conventional water resources. Sectoral programs have been put in place. The water sector has been one of the most important in national economic plans. In reality, the sectoral programme is being conducted as follows:

1.1. The water policy: the vision is sector-based following a long-term water policy (generally beyond a decade), where the objectives are defined and institutional aspects are fixed. The latter clearly establish the roles of actors in the water sector, their responsibilities and the financing of missions assigned to that sector. The water policy document also includes the management principles of water provision:

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public, private operators, public operators with financial autonomy, etc. In this water policy document, intervention priorities are clearly stated, either for the geographical area of intervention or the sub-sector of intervention: urban freshwater, rural freshwater, irrigation, urban sanitation, rural sanitation, etc. Finally, to regulate the whole operation, a legal framework is established, stating the laws and rules and conditions of their enforcement.

1.2. From the strategy to budgeting the actions: it is in fact an action plan or master plan, which takes place over a limited period (5 years for example). It describes, in terms of financial and physical implementation, by shorter time step as compared to the period applied to the water policy, the actions that enable to reach the objectives set in the water policy. A policy or administrative coordination framework ensures the implementation of the action plan and budget monitoring.

2. Complementarity between the sectoral policy and IWRM

It is important to note in this process, its independence from other sectoral policies and the lack of integration met in the field. The water sector is actually closely linked to the policy of the following related sectors:

2.1. Social sectors. They particularly include access to safe drinking water and sanitation as well as peri-urban agriculture, primarily composed of home gardens established on small plots. In Africa where the population pressure is increasing and climate events are sometimes harsh (drought, flooding), disorderly or emergency land occupation due to rural exodus, creates peri-urban areas that require the provision of unplanned water and sanitation services.

2.2 Economic sectors: Water management is multi-objectives by nature, when economic sectors require water and in case of limited resources, are competing for quantity and quality. In addition to meeting the environmental and portable water needs in priority, there are industrial, mining, energy production and irrigation needs to be satisfied. Agricultural, industrial and mining, environmental and sanitary policies should be clear and coherent. In the case of agriculture in Africa, a policy for the use of water for agriculture (inclusive of livestock) should take into account the opportunities, constraints and needs in the range of choices between irrigation and agriculture that do not rely on rainwater.

2.3. Environmental sectors: Each time a water consumption sector's needs are satisfied, it has a direct effect on the ecosystem and on the maintenance of a sustainable environment. This is true everywhere but especially in Africa where the future expansion of irrigated land, of industry and of mining, should be commensurate with the development needs expressed by the countries and the continent. This will have an impact on ecosystems. Environmental needs as well as the services created around ecosystems, such as tourism or agroforestry, fishery and aquaculture or livestock, might be reassessed to accommodate conventional economic sectors.

2.4. Transboundary resources: Africa is characterized by the multiplicity of cases where natural resources do not respect administrative borders. Transboundary basins are the majority in Africa. Among them, there is the Niger Basin, the Lake Chad Basin, the Senegal Basin, the Nile Basin, the Congo Basin, the Zambezi Basin, the Orange Basin in addition to the non-renewable transboundary sedimentary (fossil) basins and renewable aquifers. At that level, the IWRM approach supports the water sector with a broader integration with related sectors, on several spatial scales (local, national or particularly regional) regrouping several neighboring countries that share the resource and that will benefit from sharing the resources, their use, the profits derived from these activities as well as the costs, in an equitable, sustainable and efficient manner, and enabling access to water for underprivileged categories of populations. Integration at regional level

contributes to an improved harmonization of policies and governance, through the establishment of legal and institutional tools and through the development of a shared vision, reinforced by the Water Vision for Africa by 2025. Thus, several initiatives are ongoing in Africa, either through ECOWAS (Economic Community of West African States), ECCAS (Economic Community of Central African States) or COMESA (Common Market for Eastern and Southern Africa) but also CILSS (Permanent Interstate Committee for Drought Control in the Sahel), IGAD (Intergovernmental Authority for Development) operating in Eastern Africa and the Horn of Africa and SADC (Southern Africa Development Community).

3. IWRM implementation hypotheses

3.1. Equity: This is all the more important because it can involve vulnerable entities, gender and transboundary minorities such as pastoral communities.

3.2. Subsidiarity which highlights the separation of roles at national or local level or at transboundary level. The communities can only deal with the issues regarding the transboundary basin at regional level only if these issues cannot be addressed efficiently at national level and concern the same transboundary basin.

3.3. Participation: It involves a mechanism that should be put in place each time a water management issue is raised at IWRM or sector level, to ensure a common understanding of the issue by the various stakeholders in all the phases of the water management process.

3.4. Sustainability of the ecosystem: All the facets of IWRM that are technical, social, economic, institutional and legal, should coherently contribute to ensuring the sustainability of the established management rules and of all the potential resources that form the material system, their functions and the relations that govern their interaction.

3.5. Complementarity: At regional level, this involves the shared water resources, surface or groundwater. Partnership initiatives are able to create synergies between the actors of the water sector. The example of the Sahara and Sahel Observatory and its intervention on aquifers shared by Algeria, Tunisia and Libya is a real life example.

3.6. Progressiveness: IWRM being a process, the implementation of measures should be progressive to take into account the specific interests of each actor and the need to make required adjustments in a gradual but timely manner.

3.7. Caution: Water management is conducted in a stochastic context, with various types of uncertainties. The absence of scientific certainties should not delay the decision making process or the measures aiming at preventing a sanitary or environmental risk.

3.8. Monitoring: Beyond responding to emergencies in most parts of Africa, monitoring and management through early warning systems is imperative. This is more so for drought and floods incidences in view of the increase in the frequency and severity of these climate change related events. IWRM intrinsically facilitates preparedness for effective management of the crisis when it occurs and together with early warning systems alleviates the negative impacts on all stakeholders in water resources.

3.9. Responsibility: This is also the principle of the 'user pays' and also the 'polluter pays'.

In conclusion, the sectoral approach and IWRM are two approaches required at regional, national or local level, and are also complementary. Water management in Africa requires an integration of growth sectors, such as energy, mining, livestock, fisheries and aquaculture or tourism and agro-forestry. Development needs in African countries are growing and depend on natural resources which are abundant albeit limited in a context of a

growing demand. This state of affairs requires integrative solutions that consider water-related development sectors. The adoption of this approach requires that the institutional and legal capacities and training of the actors be put in place to develop a framework for integrated water management which can achieve the objectives of corporate development (food security, accessible freshwater and sanitation services, hydropower production, industrial and mining production) through a solid implementation of IWRM, adapted to the local African context and adopted by users and decision makers. This should be achieved while keeping in mind the objectives of the water sector itself which, in some risk areas (recurrent droughts for example in the Horn of Africa) must be associated with the issue of emergency response, in parallel with development issues.

In Africa, the dissemination of the context-specific IWRM approach, needs to translate into this multidisciplinarity which should lead, not only to the multiplication of infrastructures, but also to the realization that the ultimate objective has been achieved, that is, improved food security, less poverty and a protected environment.

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Agricultural water development and management in Africa: the role of AgWA partnership

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Introduction

The Africa Water Vision for 2025 underlines that Africa faces many issues of Agricultural Water Development and Management (ref: www.uneca,org). The need to produce more food to feed in a sustainable way a growing population; end hunger and malnutrition and to reduce poverty, calls for a strong development in Agricultural Water and Management, on a nexus including land and energy. Water scarcity and drought are the main constraints in some parts of Africa, whereas in other parts abundant water resources are not yet explored nor exploited, from the large rivers, big lakes, aquifer systems and wetlands. Africa has a high potential for the development of Agricultural Water Management (AWM) in its sub-regions and countries, by increasing regional integration and political will and by improving socio-economic and environmental performance of irrigated and rainfed production systems. Affordability of water, efficiency in the use, equitable access, in particular for smallholders, pastoralists and agro-pastoralists and sustainability of the water systems, are the main objectives for optimal Agricultural Water management.

The focus and purpose of this paper is to introduce AgWA partnership mission, objectives and its role to advocate Agricultural Water Management (AWM), in African water resources contexts.

Main challenges

Agricultural Water Management faces many challenges in Africa, and its development has to address the following key issues in a context of rain variability, water scarcity, extreme events (drought and flooding) exacerbated by climate change context. AWM development objectives are to contribute to ensuring food security, reducing poverty and conserving ecosystems.

AWM is a multi-objectives system but it has also multi uses, as livestock and fisheries are related to water management and integrated in an ecosystem management framework. This requires building strategies for investments in infrastructure, for water storage and delivery. To make management of water and production feasible affordable and profitable especially at farm level, institutional and legal frameworks need to be enhanced where already present, and established where there are none. Smallholders constitute the largest sector of farmers in Africa and their farming activities are mainly oriented towards subsistence. Promoting small-scale community-based both for irrigation and for water harvesting in the rainfed area, is a major challenge. For that, social rules should be embedded and public investment (roads, hydraulic infrastructures, energy), targeted subsidies and adapted financial packages should secure access of smallholders to water, land and markets and ensure the sustainability of the farming system.

African water resources system is characterized by existence of many transboundary rivers basins and aquifer systems, on which depend population from riparian countries, with communities living around these resources and crossing eventually countries' borders. More than water availability and hydrological characteristics, transboundary water resources create economic, and social interdependencies between communities. Despite the potential of conflict over their sharing, these resources also offer an opportunity for cooperation, for enhancing dialogue, institutional and legal frameworks for possible shared regional programmes and projects and for sharing the resulting benefits and related costs and for the protection of the resources.

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Partnership for Agricultural Water Management in Africa (AgWA)

The Africa Water Vision for 2025 was designed to stimulate the region's economic development and social well-being and to sustain growth. The shared vision is for "An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment".

CAADP is a strategic framework for investment in agriculture in Africa. Its goal is to: 'help African countries to reach and maintain a higher path of economic growth through agriculturally led development that reduces mass poverty, food insecurity and hunger'. CAADP has set out its approach based
on four 'pillars' of which the first is 'Extending the area under sustainable land management and reliable water control systems'.

The Partnership for Agricultural Water for Africa (AgWA) was created to help achieve the objectives of the Africa Water Vision for 2025, to implement the CAADP Pillar 1 at regional and country levels, to advocate Agricultural Water Management and to boost the investment, that is 'socially equitable, profitable at the farm level, economically viable, environmentally sound and sustainable. AgWA is operating in this context.

Conclusion

AgWA's mission is to contribute to building partnership to meet challenges and generate synergies between stakeholders, in particular for Agricultural Water management in Africa (AWM). The way to achieve this objective is that AgWA is constituted as an expert pool, involving organizations and networks (NEPAD and CADDP, IFAD, AfDB, IWMI, ICID and ARID, USDS, FAO, WB, GWP, CILSS). Such organization of AgWA enables providing support to expanding AWM and improving the quality of intervention in the field. AWM is linked to the institutional, legal, social, economical, technical, financial and environmental aspects of the Integrated Water Approach. All of which will result in increased investment in sound, sustainable agricultural water development that contributes to CAADP Pillar 1's objective of increasing the area under reliable agricultural water control and the achievement of the Millennium Development Goals

For more information on The Partnership for Agricultural Water for Africa (AgWA), visit: www.agwa-africa.org

Impacts of climate change and variability on Africa's water resources

Benjamin De Ridder[1] and Ruhiza Jean Boroto[2]

Summary

Water plays a crucial role in achieving socio-economic development. It is the primary medium through which people, ecosystems and economies will most likely experience the impacts of climate change. Although water is abundant in Africa on a regional scale, it is unevenly distributed by nature. Therefore, the impact of climate change and variability on water resources and their availability will also not be uniform across the continent. 'Climate smart' water infrastructure development must be prioritized to meet the needs of the continent. Most of Africa's water resources are shared between two or more countries, therefore to secure a future sustainable access to water we also need to scale up transboundary cooperation and integrated water resources management across the continent.

Introduction

'Water is life'. It is indeed a critical resource for sustaining life and society. The crucial role of water in achieving socio-economic development is widely recognized (UNECA and Others, 2002). With regard to agriculture and food security, Africa has large untapped potential for irrigation. According to UNEP (2010) only 3.8 percent of 185 million ha of area under cultivation in Africa is irrigated. In this context, land deals with foreign investors are likely to involve large-scale, industrial agriculture operations consuming massive amounts of water.

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Water is also the primary medium through which people, ecosystems and economies will experience the impacts of climate change. Water stress or water scarcity is a threat not only to food security, it also affects socio economic growth, including energy production. As temperatures rise, people and animals need more water to maintain their health. More frequent and intensified floods are occurring because of climate change causing damages to infrastructure and losses of life and, sometimes, of crops, affecting food production. The intrusion of salt water, because of sea level rise, threatens the delicate ecosystem balance of estuaries which are habitats to a variety of marine species; it might also affect the supply of safe drinking water to the rapidly increasing coastal population.

As a response to these threats, this paper emphasizes the importance of immediate and full-scale implementation of integrated and transboundary water resource management strategies to ensure sustainable access to water for all within the African continent, in the future.

Impacts

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (IPCC, 2007), states that Sub-Saharan Africa is one of the most vulnerable continents to climate change and climate variability, but large uncertainty exists with respect to predictions and impacts. Although water is abundant in Africa on a regional scale, it is unevenly distributed by nature. Therefore, the impact of climate change and variability on water resources and their availability will also not be uniform across the continent.

The major effects of climate change on African water systems will be through changes in the hydrological cycle, the balance of temperature, and rainfall. Projections of increased temperature and reduced precipitation could initiate or exacerbate desertification, particularly in the arid, semi-arid and dry sub-humid areas which occupy 43% of the African land area while hosting 40% of the continent's population (Ramsar, 2002). It has been estimated that by 2080, there will be an increase of 5-8% in the proportion of arid and semi-arid lands in Africa compared to the situation in 2000 (Boko, Niang et al. 2007). This, in turn, means that the African population projected to be exposed to increased water stress by 2020 will be between 75 to 250 million people and this will increase to

between 350 and 600 million people by 2050's (Boko, Niang et al. 2007).

Different climate change models and the Special Report on Emissions Scenarios (Arnell, 2004) show differences according to the sub regions: a likely increase of people who could experience water stress by 2050 in northern and southern Africa while in contrast, more people in eastern and central Africa will be likely to experience a reduction rather than an increase in water stress (Arnell, 2006) because of an estimated increase in rainfall by approximately 7% compared to 2000 (Meehl et al., 2007). Changes in runoff and hydrology are strongly associated with climate through complex interactions. Due to a lack of information, the interaction between climate change and groundwater is not clear, however, there is no doubt that it affects water fluxes, including groundwater recharge. Consequently, it is a great concern for Africa as over 400 million people in rural areas depend on groundwater with the majority of demand being for domestic use rather than agriculture or livestock (Giordano, 2006 and Morris et al., 2003). This dependence is likely to increase as river run-off will decrease due to the projected higher temperatures and more frequent and more severe droughts while demands for reliable water from domestic, agricultural and industrial users increase. Existing data on groundwater conditions and trends is extremely limited, and present quantities and patterns of recharge are uncertain.

In addition to quantitative impacts, climate change will also have water quality implications. Higher temperatures are likely to affect water quality in lakes through increased thermal stability, which inhibits water circulation and results in reduced oxygen concentrations. The projected increase in rainfall intensity is expected to lead to increased erosion because of unsustainable land management practices and also to increased transport of pollutants. This is expected to have consequences for inland fisheries and aquaculture. It could also increase the cost of treating water for domestic consumption. In semi-arid and arid areas climate change is likely to increase salinisation of shallow groundwater due to increased evaporation and water uptake from the vegetation. In coastal areas rising sea levels may have negative impacts on groundwater resources through saltwater intrusion into coastal freshwater aquifers and estuaries.

Climate change and variability will impose additional pressures on water availability, water accessibility and water demand in Africa. Projected population increase, urbanisation, land use change and rising demand for food will also have a major impact on both patterns and levels of water demand. Climate change poses further disaster risks of loss of investments (infrastructure, damage to crops, loss of livestock, etc) and loss of lives.

This stresses the importance of moving away from a focus on issues and events towards a more holistic approach. Water cannot be dealt with in isolation, it requires a high degree of collaboration and engagement between and among the water ministries and the ministries responsible for driving social and economic development, such as ministries od economic planning, environmental management, agriculture, energy and infrastructure planning.

Importance of sustainable water management strategies

Africa's water resources present many challenges such as the development to meet the needs of the continent for agriculture, domestic, industrial, energy and environmental requirements. These are all affected by climate change in a context of transboundary shared water resources and integrated water resources management. The challenge is exacerbated by population growth – and urbanization - which will increase pressure on the quantity (from the development imperatives above) and quality of water (mostly as a result of pollution from the same activities).

In the face of these challenges, investing in water management is therefore necessary in order to protect the resources for future generations

One set of responses are interventions such as the promotion of 'climate smart' water infrastructure development to harness water resources and at the same time contribute to resilience to climate change. Complementary interventions include conjunctive use of surface and groundwater and efficient use of existing water (water conservation and water demand management and its array of options).

Another set of responses needs to consider that most of Africa's water resources (watersheds, river basins, lakes and aquifers) are shared between two or more countries. These water resources are

lifelines for local farmers, pastoralists and other rural communities in these shared transboundary watercourses. Therefore it is very important to involve all stakeholders in decision-making in order to prevent water conflicts as climate change mounts the stresses on water systems. Such transboundary responses – with the concept of sharing of a common destiny through a shared resource and shared benefits – are already under way as illustrated by the several river basin organizations that exist in different stage of development such as the Komati (Nkambule NV 2012), the Okavango (Chonguica, E, 2012) and other river basins such as the Senegal, the Nile, the Niger and several others on the continent. Cooperation in transboundary water resources management increases resilience to climate change: the Limpopo River shared between Botswana, Mozambique, South Africa and Zimbabwe demonstrates this: flooding that affects downstream Mozambique is often announced by early warning systems that are in place in upper stream South Africa, allowing time for action such as displacement of riparian communities at risk in the lower Limpopo in Mozambique.

Another strategy is capacity development and empowerment of stakeholders. As a practical example, peer to peer learning should be developed and promoted to build upon existing good examples of climate change adaptation actions such as the Integrated Water Resources Management (IWRM) Strategy for the Kafue Flats in Zambia (UN, 2008). This project illustrates the role that technological innovation and cooperation play in reconciling water and hydropower management with the natural water cycle and the fragile ecosystems relying on it. Through an interactive dialogue among the Zambian Government, the Zambia Electricity Supply Corporation, local people and commercial farmers a more natural flow pattern to water release from the Dam was restored.

Finally, an encompassing strategy which covers some of the above is the IWRM approach which consist of three steps: (1) *enabling environment* (policies and laws), (2) *institutional framework* (such as the river basin organizations or disaster management institutions at country level, and/ or regional bodies such as the Comité Inter-Etat de Lutte Contre la Sécheresse au Sahel (CILSS), l'Observatoire du Sahara et du Sahel (OSS) which deal indirectly with issues related to climate change and (3) *management instruments* such as data collection (including for groundwater) and information management, hydrological modeling, capacity building, stakeholder participation, water demand management, etc… With regard to this IWRM response, it can be said that Africa is evolving like a bottle that is slowly filling up: laws and policies are in place (AMCOW, 2012) in most countries and even at regional economic communities level such as ECOWAS and SADC. Water management institutions are gradually becoming functional and finally, the investments required to have management instruments in place are slowly being mobilized as institutions become stronger and take up the challenges of their mandates as illustrated by the Komati Water Basin Authority and the Okavango Commission as presented respectively by Nkambule SV and Chonguica E in this issue. It can be surmised however that both institutions (as other similar institutions on the continent) are becoming increasingly equipped to deal with the challenges of climate change in their business.

Conclusion

The water 'crisis' is primarily one of governance and access, not of absolute shortage. For this reason, extending access to affordable, reliable supplies remains key to building climate resilience. Therefore, providing climate smart water infrastructure, understanding the potential of groundwater as a critical response and other soft and technical management options, are all required for a sustainable response to the climate change threat on a continent that still has to meet its development challenges and opportunities. . This issue of Nature and Faune and the recent AMCOW report demonstrate the increased strengthening of the institutional framework and several transboundary water management and IWRM initiatives are under way within the region and these will increase the resilience of communities and ecosystems to climate change and ensure a sustainable water supply across the continent.

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FAO REGIONAL OFFICE FOR AFRICA

The link between forest, water and people: an agenda to promote in the context of climate change in Central Africa

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Summary

Central Africa is known for its substantial reserve of clean water. This reserve is unfortunately declining with climate changes. While forests, another natural resource of the zone has up to now been the focus of most efforts, mainly for biodiversity conservation, this is not yet the case for water resources on which plants are however dependent. In the context of this paper, we revisit (1) climate changes, (2), their impact on the water system, (3) the incidence of disturbances on the water system, (4) the current responses and the way these responses should be oriented for a good synergy between the water, forestry and development sectors in a context of adaptation to climate change.

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Introduction

Central Africa arouses particular interest from the international community due to the importance of its biodiversity. Considerable efforts are gradually made to maintain forest habitat in the Congo Basin. Similar efforts emerge to improve the management of water resources of the Basin. However, in spite of the potential link between vegetation and water cycle at the level of a Basin such as the Congo Basin, very few efforts have been initiated to understand and manage the relation between forest and water resources in Central Africa. The agenda to manage natural resources in the region has strongly focused on forests and does not yet seem to give significant priority to water. In a context of climate change marked by disturbances in temperature and rainfall, it is necessary to revisit the evolution of the water rhythm, the implication on forest and the populations in forest zones. The Congo Basin mainly comprises of the following countries: Cameroon, Congo, CAR (Central African Republic), DRC (Democratic Republic of Congo), Gabon and Equatorial Guinea.

Climate changes in Central Africa

Studies on West and Central Africa (Cameroon and CAR) generally show a decrease in rainfall around the 1970s as has been observed in the Sahel (Paturel *et al*., 1997). The decrease would be around 20%. For the future climate, the fourth report of the IPCC (Intergovernmental Panel on Climate Change) mentions a temperature and rainfall increase in Central Africa.

The climate in Central Africa is influenced by conditions at the surface of oceans (Balas *et al*., 2007), the low altitude masses of air from the Sahara, from the Atlantic Ocean (Pokam *et al*., 2012) and from Eastern Africa at an average altitude (Pokam *et al*., 2012). It is only recently that connections between these various parameters and the climate in the sub-region have begun to be examined (Nicholson *et al.,* 2012; Amin and Nicholson, 2012). It is important to note that studies on the atmospheric modelling sensitivity will be necessary to understand these connections. It is at that level that the modeling of atmospheric phenomenon should play a key role. In the meantime, only two laboratories (University of Yaoundé 1 in Cameroon and University Marien

Ngouabi in Congo) and a consultant based in the CIFOR Regional Office for Central Africa address the modeling aspects of the climate in Central Africa. The laboratories of western countries (mainly in Europe) have up to now mainly worked on West and Southern Africa. One of the rare initiatives on Central Africa is the support that the German Government recently granted to the "Climate Service Center" of Hamburg (Germany) and the Wageningen University (Holland) to work on 'Scenari of climate change in the Congo Basin'.

Climate change and Hydrology

The Congo River has over 50% of water supplies in the Atlantic and contributed to more than one third of losses (i.e. decrease of water resources) of the past decade (Olivry *et al*. 1993). Central Africa covers 20% of the total area of the continent and receives 37% of the rainfall (CCPA, 2011). The Congo Basin holds 30% of the water resources of the continent (Brummet *et al*. 2009) and the rainfall simply represents between 40 and 70% of the flows (Conway *et al*. 2009). This suggests that other factors such as vegetation, aquifers, etc. briefly account for the flows. Of the 10 ECCAS (Economic Community of Central African States) countries, Sauveplane (2012) identifies approximately 17 aquifer systems responsible for groundwater resources which are said to contribute to 49% of the runoff. Paturel *et al*. (1997) record flow deficits reaching 45% since the 1970s in West and Central Africa (Cameroun and CAR). From 1993, Olivry *et al*., began to emphasize the long-term depletion of water resources in humid Africa, as a result of climate change and the cumulative effects of rainfall deficits. Some authors even speak of a *sahelization* and *kalaharization* of the outskirts of the Congo Basin.

Hydric disturbance, Forests and Populations

Pokam *et al.,* (2012) have showed that evapotranspiration contributes to up to 70% of the rainfall in some areas of Central Africa. At the ground level, it is often stated that 85.3% of the watershed is under forest cover. Brummet *et al*., (2008) identify the products and services provided by forests through wetlands. These range from animal protein to the water cycle. Most of the services offered in the form of biodiversity and fresh water is now preserved in Ramsar sites. About fifteen sites covering 37,242,058 hectares of reserved sites represent 7% of the surface area of the countries who have signed the Ramsar Convention (Sauveplane, 2012). According to Brook *et al*., (2011), the Congo River is the richest African environment in freshwater species and the second in the world after the Amazon. Half of the species are endemic and 15% of all species are endangered (Brook *et al*., 2011). Some threatened species may also be « sensitive » to climate change which would increase the pressure on them, and some taxa/habitat may become threatened with climate disturbances. Thus, the choice of species/areas to protect in humid forest areas can no longer ignore climate disturbances.

According to a report by the CICOS (International Commission of the Congo-Oubangui-Sanga Bassin), 77 million people live in the Congo Basin, with approximately 59% of them being rural populations whose lifestyles are linked to the exploitation of natural resources. More than half the population (54.6 to 71%) does not have access to safe drinking water in Burundi, in Central African Republic, in DRC and in Rwanda; the situation is similar for nearly 37.7% in Equatorial Guinea, and between 17.2 – 19.4% in Congo and Gabon (UNDP, 2011). As paradoxical as it may seem, in the wettest part of the continent, people do not have access to safe drinking water. Forest cities in Central Africa such as Yaoundé, Bangui, Ouésso, etc. experience large water shortages, especially during the dry seasons. This lack of safe drinking water and floods have led to consequences including waterborne diseases (Bomba, 1999). In a forestry context where opening roads is difficult, the river system complements the deficiency of the road network. Despite the potential relevance of hydro-electricity, woody sources are a significant portion of the energy used by populations in Central Africa. The Inga hydro-electric Dam in DRC is known as having a potential that can serve several countries in sub-Saharan Africa. The hydrographic network of Central Africa has other potential areas for the production of clean energy. In the absence of development of that energy by the States and/or the private sector, populations use forest resources, thereby putting a strong pressure on forests. The transfer of water from the forest Congo Basin (which is gradually drying up) through drainage is an option presented to increase the pool of the Lake Chad which is also drying up. No impact study has been conducted as yet to assess the effect of this transfer on the Congo and Chad Basins.

In the forest area of Central Africa, the potential provided by water resources has not yet been fully used in areas such as drinking water supply, energy, agricultural irrigation, navigation, etc. These resources constitute a pool of investment, mainly in the green economy of Central Africa.

Organizational response

COMIFAC is perceived in the tropical basins as a model of Transboundary management. Donors have established the CBFP (Congo Basin Forest Partnership), which helped define a vision for biodiversity conservation in Central Africa (Kamdem *et al*., 2006), materializing later in the existence of 12 landscapes which constitute the backbone of conservation in the Congo Basin. These landscapes are regularly monitored and this monitoring is reported in the EDF i.e. Etat Des Forêts (State of Forests) of the Congo Basin. With the growing importance of the climate change theme, the actors of biodiversity conservation easily integrate their objectives in the one that already exists, mainly the reduction of forest habitat deforestation. REDD+ is said to enable the conservation of biodiversity. And when it could cause its destruction, safeguards on biodiversity reframe the initiatives that can potentially be negative for diversity.

Water supports the forests of Central Africa and plays an important role in sub-regional economies. The equivalent of the COMIFAC for the water sector is CICOS (International Commission of the Congo-Oubangui-Sanga Basin) which includes Cameroon, Congo, Central African Republic and DRC. Founded in 1999, it is today an international Basin organization that can handle not only inland waterways, IWRM (Integrated Water Resources Management), but also issues of pollution, invasive weeds, loss of vegetation cover and water erosion (Sauveplane, 2012). CICOS sets up a SAP (Strategic Action Plan) to be realized by 2025 and gradually attracts some donors, such as GIZ ("*Deutsche Gesellschaft für Internationale Zusammenarbeit*"), the EU (European Union), the AU (African Union) and AfDB (African Development Bank). The development of the SAP 2025 did not take into account the beneficiaries (Sauveplane 2012).

Despite the existence of CICOS, water does not yet mobilize as much attention as do forests. For the moment, in the CGIAR (Consultative Group on International Agricultural Research), the two centers that are primarily involved in water resources at global level are not present in Central Africa: the International Water Management Institute (IWMI) and the World Fish Center (see CGIAR 2012, for the current CGIAR programme on aquatic environment). The IRD (Institute of Research for Development, France) which has in the past (when it was still called ORSTOM: French Office of Overseas Scientific and technical Research) carried out several research projects in the field of Hydrology, no longer has the same intensity of work and collaboration. National research centers in hydrology are facing the problems inherent to the research sector. The number of hydrological and meteorological stations has declined significantly since the 1990s. In cases of water disturbance, the region has to deal with extreme situations of lack, or abundance of water. Unfortunately there is no sub-regional hydrological observation platform as resourced and structured as OFAC (Observatory for Central African Forests). PES (payment for environmental services) in the field of water and/or energy could potentially refinance watershed management, data collection and their analysis. The partnership of public sector - private sector – forest watershed populations is yet to be built. Many models for re-investment of funds into the basins exist in the forest sector and could serve as a springboard for enhanced ideas and inspiration for water and/or energy.

Up to now, research activities had been few and far between in the field of forestry, hydrology and climate change. In 2008, during the science policy dialogue in the context of the CoFCCA project (Congo Basin Forests and Climate Change Adaptation), it was determined that water was part of the 4 priority forestry-related sectors, that are the most sensitive to climate change (Sonwa *et al*. 2012). A link exists between water and the other priority sectors (food security, energy and health) identified during the dialogue. This underlines the need for multidisciplinarity and multi-institutionality in which teams from Central Africa truly network with teams from developed countries.

Conclusion

Although forests play an important role in the water cycle, we are still far from an integrated management of the forestry and hydrology sectors in Central Africa. Even though water is useful not only for the survival of forests, but also for populations and the private sector, it has not yet

benefited from the same attention that has been granted forests in Central Africa. It would be unrealistic to think that we will successfully preserve carbon stocks without considering the water on which forest formations and populations depend. Responses to climate change should be coordinated between both sectors. This requires planning at regional level with national level plans that are translated into a more integrated management at watershed level. Building the capacity of communities, policymakers and other stakeholders in the region is necessary to achieve integrated management. The agenda that includes water, forestry and development is yet to be built in Central Africa.

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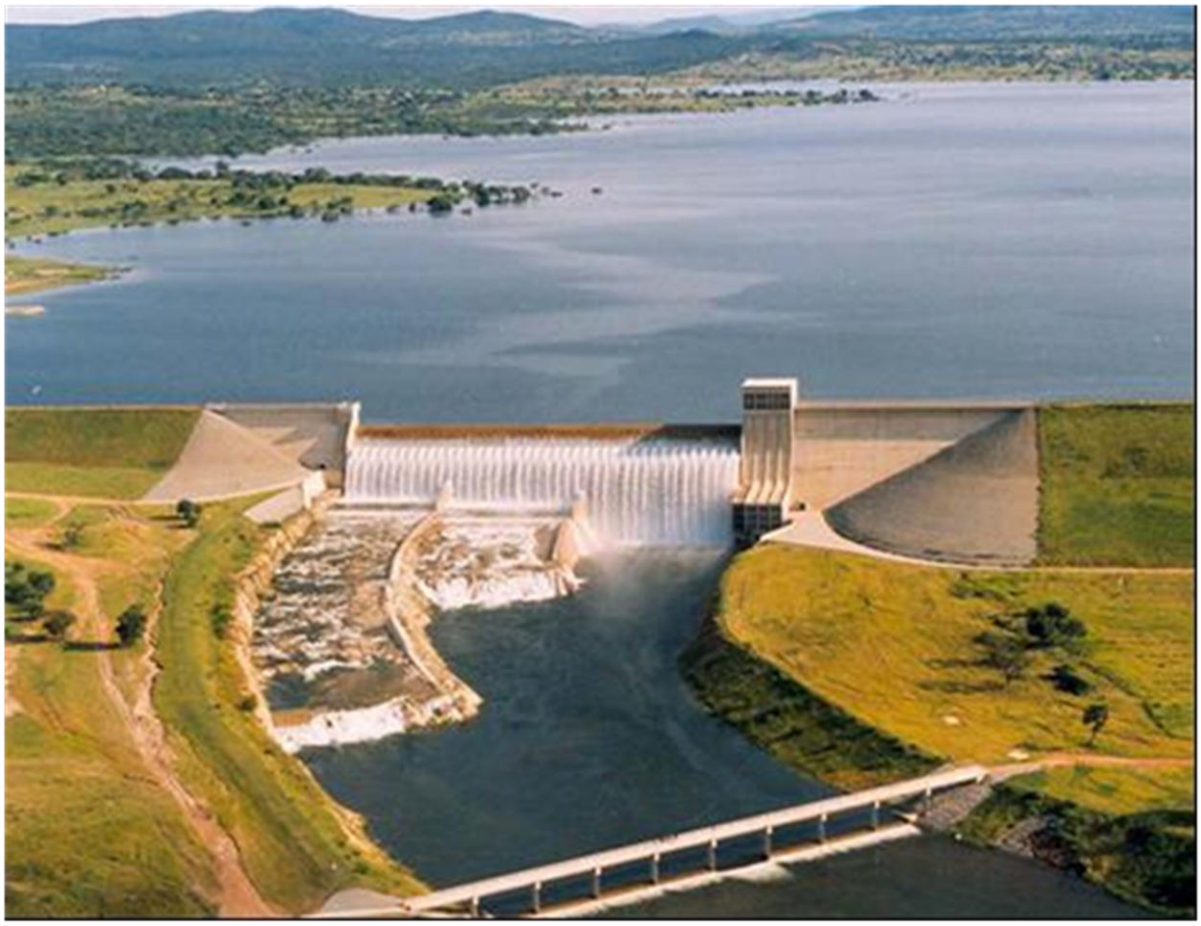

Integrated management of land and water: agricultural and land use practices to enhance water security in Cameroon

Mathias Fru Fonteh[1]

Summary

Sustainable socio-economic development is only possible when there is water security. To ensure water security, water needs to be managed in an integrated manner, considering both the physical and human systems. Within the physical system, two areas which require integrated management are land and water resources. Water resources are greatly affected by the agricultural sector which consumes the lion's share of fresh water abstracted. The objectives of this paper are to highlight the need for the integrated management of land and water resources to ensure water and food security, and to propose some sustainable agricultural and land use practices that should be promoted to minimize the negative impacts of agriculture on water resources with a focus on Cameroon.

Introduction

Water security is a pre-requisite for sustainable socio-economic development. This implies the availability of water in sufficient quantity and quality for the protection and promotion of human health; for food, agriculture & rural livelihoods; for industrial development; energy production; and for managing water-related risks. Despite the key role of water, and the abundant water resources available, estimated at about 17 000 m^3/capita/year, Cameroon is far from achieving water security (Fonteh, 2008). The main problem is that of poor sectoral management.

To ensure water security in Cameroon, water needs to be managed in an integrated manner rather than the conventional sectoral approach prevailing to date. Integrated water resources management (IWRM) is now widely accepted within the international community as the starting point for developing water policies that will enhance sustainable development. Cameroon embarked on the elaboration of a national IWRM Plan in 2005 and completed the diagnostic analysis of the water sector in 2009 (MINEE & GWP, 2009). The basic principle of IWRM is that the various uses of water are interrelated through their effect on the hydrologic cycle and hence their management should be integrated. According to GWP-TEC (2000), integration needs to be implemented both within and between the natural and human systems. Examples of some areas that should be managed in an integrated manner in the physical system are: fresh water and coastal water; upstream-downstream users; surface water and groundwater; land and water resources and the quantity and quality of water. In the human system, water resources policy should be integrated with national economic policies as well as with national sectoral policies. In Cameroon, because of sectoral management, there is very little or no integration between the areas identified above.

This paper addresses only the integration of land and water management within the physical system. Land use is greatly affected by the agricultural sector which consumes the lion's share of fresh water extracted. In 2009, the total estimated withdrawal of water for consumptive use in Cameroon was about 0.46 % of the internal renewable water resources (MINEE & GWP, 2009). In Cameroon, agriculture is the predominant water user accounting for about 72 % of all the water withdrawn. Unfortunately agricultural water resources are often overused and misused, especially in irrigated agriculture. A study by UN-Water (2006), estimated that the average application efficiency of irrigation in developing countries was 38 %. In Cameroon, this was estimated at about 30 %. This implies that in Cameroon, about 70 % of the water mobilized for irrigation is wasted through

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deep percolation or as runoff. Poor agricultural water management can result in water-logging, salinity and overexploitation of groundwater resources, depriving downstream users of water and polluting fresh water resources with deep percolation losses and contaminated return flows. In addition, despite the highly variable rainfall, and incidences of droughts, food production in Cameroon is almost entirely rainfed, with little investment in managing soil moisture. MINEE & GWP, (2009) estimated that only about 0.44 % of cultivated land in Cameroon is irrigated.

Agriculture also affects other sectors indirectly through the impacts of land-use change on water resources. Conversion of grassland and forests to pasture and arable land alters the hydrological regime of a catchment by modifying infiltration and evaporation rates, and hence the amount of runoff. Increased sediment loads in rivers arising from erosion from agricultural lands have a negative impact on downstream aquatic ecosystems and result in increased siltation in downstream channels, reservoirs and other hydraulic infrastructures, thereby shortening their economic life.

The objectives of the paper are to: a) highlight the need for the integrated management of land and water resources to ensure water and food security, and b) to propose some sustainable agricultural and land use practices that should be promoted in Cameroon to minimize the negative impacts of agriculture on water resources and hence ensure water security. The emphasis of the actions is on field level interventions which reduce damage to soil structure from rainfall and reduce the runoff from agricultural land. The result is reduced soil erosion and reduced pollution of water resources.

Water resources problems in Cameroon

MINEE & GWP (2009), concluded that the main water resources problems in Cameroon in order of decreasing importance were: a) reduction in surface water flow especially in the dry season due to reduced soil cover, climate change, increased evaporation and sedimentation; b) reduction in ground water recharge due to climate change and increased evaporation; c) increase in the turbidity of water resulting from erosion; d) water borne diseases; e) pollution of surface water resulting from spills during the transportation of petroleum products and from used engine oil dumped in water courses. In river basins with intense agricultural activities; eutrophication of surface water, partly as a result of soil erosion and fertilizer use; and surface water pollution by pesticides from runoff from agricultural lands are also important problems.

Most of the above problems can be attributed to poor agricultural and land management practices, including deforestation to provide land for agriculture, and land use practices which result in erosion and increased surface runoff. Soil erosion is a major problem since most adverse impacts cited previously are related to erosion which is an indication of soil degradation. Soil erosion greatly impacts on the productivity of the land and negatively affects food security in Cameroon. Agricultural and land use practices that minimize soil erosion and degradation will therefore contribute not only to improving food security but also to protecting water from pollution, regulating the flow rates of rivers; reduced sedimentation of dams etc.

A study carried out by Sigha-Nkamdjou *et al*., (2002) compared the amount of erosion in various river basins in Cameroon in various ecological zones. The study concluded that erosion is low in the closed forest region, varying between 5 - 14 tons/km^2 per year. Erosion was highest in the Sudano Sahelian regions, where an average value of 213 tons/km^2 per year was recorded. This highlights the importance of vegetation cover in the reduction of erosion. Erosion is more severe in the Sudano-Sahelian region due to; the long dry seasons during which most of the vegetation dries up, the nature of the soils and the high intensity of the rainfall. In some parts of the Sudano-Sahelian region of Cameroon like the Mandara Mountains, erosion of up to 1,000 tons/km^2/year has been reported (Liénou *et al*., 2002).

Agricultural and land use practices that can enhance water security

FAO (2006) discusses the intrinsic links between water resources, climate change and forests. Forests play a very important role in the hydrological cycle as their presence or absence affects the amount of runoff and the amount of water infiltrating into the soil. When forests are destroyed or degraded, the environmental services which they provided is lost. This has resulted in increasing global concerns and support to efforts to stop deforestation and reduce the degradation of forests. FAO (ND) estimates that nearly 2 billion ha of land worldwide are already seriously degraded, some

irreversibly. Land degradation results in increased erosion, reduced productivity, disruption of vital ecosystem functions, negatively affects biodiversity and water resources, and increases vulnerability to climate change.

Agroforestry

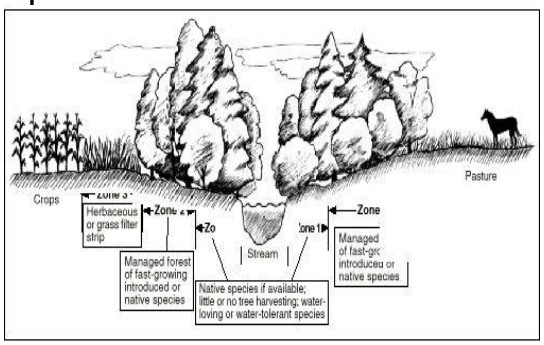
FAO (2010) defines agroforestry as the use of trees and shrubs in agricultural crop and/or animal production and land management systems. Trees are used in many traditional and modern farming and rangeland systems. Agroforestry systems and practices come in many forms, including improved fallows, growing annual agricultural crops during the establishment of a forest plantation, growing multipurpose trees and shrubs, farm woodlots, orchards, plantation/crop combinations, windbreaks, conservation hedges, fodder banks, live fences, trees on pasture and tree apiculture. The use of trees and shrubs in agricultural systems help to diminish the effects of extreme weather events, such as heavy rains, droughts and storms. Trees help reduce erosion, stabilize soils, increase infiltration rates and minimize land degradation. They can enrich biodiversity in the landscape and increase ecosystem stability. Trees can improve soil fertility and increase soil moisture through enhancing soil organic matter. Agroforestry systems should therefore be promoted as part of the integration of land and water management to help reduce the negative impacts of land use changes from agriculture on water resources.

Conservation agriculture

According to FAO (2010) conservation agriculture (CA) is a term encompassing farming practices which have three key characteristics: minimal mechanical soil disturbance (i.e. no tillage and direct seeding); permanent soil cover (e.g. use of straw and/or other crop residues including cover crops); and rotations or sequences and associations of crops including trees which could include nitrogen-fixing legumes. CA can be practiced in all agro ecological zones on small to large farms.

As concerns water resources, the maintenance of a mulch layer provides a substrate for soil-inhabiting beneficial micro- organisms, which helps to improve and maintain water and nutrients in the soil. The protective soil cover of leaves, stems and stalks from the previous crop shields the soil surface from heat, wind and rain, keeps the soil cooler and reduces moisture losses by evaporation. In drier conditions, it reduces crop water requirements, supports better use of soil water and facilitates deeper rooting of crops. In extremely wet conditions, CA facilitates rainwater infiltration, thus reducing soil erosion and the risk of flooding. Conservation agriculture also helps protect crops from extreme temperatures. CA thus offers opportunities for improving food security through sustainable production, and intensification leading to enhanced productivity, while at the same time leading to reduced soil and land degradation. This reduces the negative impacts of agriculture on water resources.

Riparian forest buffer



Source: USDA (2010)
Figure 1: Riparian forest buffer

The USDA (2010) defines a riparian or riverside forest buffer as an area of trees and shrubs located adjacent to streams, lakes, ponds and other wetlands. They could be natural or re-established. Figure 1 illustrates a re-established riparian forest buffer zone. If sufficiently large the buffer protects the watershed by: intercepting sediments, nutrients, pesticides and other materials in surface runoff and hence reduces the amount of pollution from adjacent land. At the same time, the buffer zone provides food and cover for wildlife, provides corridors for the movement of wildlife, helps lower water temperatures, increases the resistance of the banks to erosion, and provides litter fall and large woody debris which are important for many aquatic organisms. Buffer zones also contribute to conserving biodiversity.

Destruction of riparian forests generally has negative impacts on the health and well-being of rural communities who rely on related aquatic resources. In degraded landscapes, buffer zones should be re-established, while in secondary and

primary forests, the buffer should be left intact during land clearing.

Conclusions

Land use changes resulting from agriculture and agricultural practices can have a profound negative impact on water resources and hence adversely affect water security and livelihoods. For sustainability, the management of water resources should be at the scale of a basin or a watershed, and should integrate land and water management practices. There are a number of sustainable agricultural and land use practices which can help minimize the negative effects of agriculture on the environment and which should be promoted. These include: agroforestry; conservation agriculture; and the establishment or maintenance and management of riparian forest buffers to protect watersheds.

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Sustainable Water Management tips for Sahel Savannah ecoregion of Nigeria

Temitope Israel Borokini[1]

Summary

The majority of the cereals and legumes consumed in Nigeria are produced in the Sahel Savannah ecoregion of the country. However, this region is faced with frequent water-related challenges and imbalances. This study reports such problems in 26 settlements in 5 selected states in Nigeria's Sahel Savannah ecoregion: Bauchi, Borno, Jigawa, Katsina and Yobe states. The findings reveal drought, drying of wells, rivers and oases, flood and irregular rainfall as some of the water-related stress faced in the regions. The respondents claimed that these have led to a decrease in yields from agriculture and fisheries, and to conflicts and migrations, in addition to death of livestock and people from water-related diseases. Changes in climate were noted among the major causes of these water-related pressures. Several measures are suggested in this paper for the sustainable management of water resources for domestic and agricultural purposes in the region.

Introduction

The Sahel savannah ecoregion is located in the uppermost region of Nigeria, occupying greater parts or the whole of Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe, and Zamfara States. It is estimated that over 43 million people live in these 10 states, which is about 31% of the total Nigerian population (NBS, 2007). The delineation of the Sahel Savannah ecoregion is based on 50cm rainfall isohyets or less (Obioha, 2009). The ethnic groups within this ecoregion are mainly Hausa and Kanuri, the latter occupying Borno state and part of Yobe state. Other tribes found within the Sahelian ecoregion of Nigeria include Manga, Barde, Shuwa Arabs, Mbororo, Mobeur, Fulfulde and Fulani. The major occupations in these areas are pastoral farming, farming and fishing (Lake Chad Basin Commission, 1972), as well as potash production, arts and crafts. The ecoregion has also played a dominant role in promotion and production of export crops such as cotton, groundnuts and gum arabic and of food crops, most especially the production of import substitution crops such as rice and wheat (Federal Ministry of Environment, 2001). The present study was conducted to provide a comprehensive overview on the water-related challenges faced in the Sahel Savannah ecoregion and to advocate sustainable management of water resources.

Methodology

The study involves an on-site descriptive assessment of water-related disasters and the administration of questionnaires to respondents in five selected states in Northern Nigeria that fall within the Sahel ecoregion. They are Bauchi, Borno, Jigawa, Katsina and Yobe States. The on-site assessment involved critical observations of the water sources as well as visits to the Lake Chad southern pool. The Hadejia-Nguru wetland and Komadugu-Yobe river basin were also visited to observe environmental issues such as invasive plant species on the waterways, siltation, pollution and other water quality observations. Considering that most of the targeted respondents were illiterate, informal interviews were conducted on 90 selected persons in the study areas, to obtain information on water availability and how related challenges had affected their livelihood. In addition, relevant Government officials in each of the states were also interviewed. A total of 26 towns and villages were visited during the study.

Results and Discussions

The results from the on-site assessment of the water-related challenges and water availability in the areas visited are listed in Table 1.

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Table 1. Summary of water-related challenges faced in the selected states of the Sahel Savannah ecoregion of Nigeria

S/N	Water-related challenges	Bauchi	Borno	Jigawa	Katsina	Yobe
1	Flood	√		√		√
2	Drought	√	√	√	√	√
3	Wells dried up	√	√	√	√	√
4	Irregular rainfall	√	√	√	√	√
5	Oases dried up		√			√
6	Rivers dried up			√	√	

Floods were also experienced in Bauchi state in years back, as reported by Government officials and people in some of the settlements visited, during which over 11,000 people were displaced, a number of persons died and farmlands were washed off. Similar situations of floods were recorded in Jigawa state, where Government officials responded that in 1988 and 2001, an average of 270,000 people were displaced in the state in addition to animal deaths and flooding of farmlands; while in Yobe state, Government officials reported that over 100,000 people were negatively affected by flooding in 2001. The majority of the farmers reported that there had been a pattern of 3 to 4 years of drought, followed by 1 year of heavy rains, causing floods. Furthermore, Government officials in Katsina state confirmed what the majority of the respondents had reported that there was inadequate rainfall – only about 35 rainy days in the year, yet there were floods in the state. "Few rainy days, but destructive rains" was the summary of their travails.

Water scarcity bordering on drought was pronounced in most areas visited in Katsina state and the complaints were the same as above: i.e. "Wells have dried up". In many rural areas in Yobe state, many of the oases had reportedly dried up permanently. Many respondents noted that they had settled around these oases in the past because of availability of water. In addition, there were reports of dried up wells and rivers in many parts visited in Jigawa and Katsina states. Hundreds of boreholes per unit area are an indication of drought in Borno state, and worse still, many of them had dried up. In Jigawa state, irregular rainfall was also reported to be prevalent, making it difficult for farmers to determine the right time to sow.

Drought and drying up of wells appear to be the most frequently encountered water-related challenges faced in Sahel savannah eco-region of Nigeria, which many of the respondents thought were caused by changing weather patterns and desert encroachment. The respondents noted that the effects of water scarcity in the ecoregion was responsible for 86% reduction in agricultural yields, 57% reduction in fish yields, 51% of livestock deaths, 94% of human deaths and 76% of migration of local people to urban areas and to the Southern parts of Nigeria. In addition, violent conflicts among farmers, between farmers and pastoralists were also reported.

During the visit to the southern pool side in Borno state, shallow waters were observed in Lake Chad, with a proliferation of abundant water weeds identified as *Eichhornia crassipes*, *Aeschynomene elaphroxylon, Phragmites karka* and *Cyperus papyrus,* as well as thickets of Typha grass and *Prosopis* spp, all in the lake, all hindering easy navigation and fishing. A visit to the Komadugu-Yobe River system and their tributaries revealed a heavy invasion of the floodplain and river channels by invasive species, especially, *Typha australis* (cattails). This of course, had been enhanced by the dams that were constructed in the 1960s and 1970s that were highly unsustainable and poorly managed, leading to the accumulation of silt in the water ways and making them ideal habitats for invasive species. The dams, silt and typha grass have all contributed to altering of the river courses, greatly reducing the water entering Lake Chad. Worse still, these "blockages" have caused flooding in neighbouring villages and farmlands during heavy rains, and rendered the water unfit for domestic use and furthermore, had provided breeding sites for mosquitoes and tse-tse flies. In addition, many of the farmlands and communities for which the dams were built do not have access to the irrigation water. Though three major dams have been closed down, the adverse ecological effects they caused have remained permanent in areas affected.

Akeh *et al.* (2004) reported several drought cases in 10 northern states between 1960 and 1999, indicating that Bauchi had a total of 12 cases; Borno, 16; Yobe, 12; Kano; 9, Katsina, 18; Sokoto, 17; and Zamfara, 9. Between 1960 and 2004, Obioha (2009) reported that there have been more drought years than years of adequate rainfall in the Sahel Savannah of Nigeria. For

example in Katsina, the number of years with drought is 29 while those with rains are just 16. The implication of this is that Katsina has experienced more drought years compared to normal years of rainfall, which could be the chief factor responsible for the drying up of some rivers and the shortage of water supply in many parts of Katsina state (Obioha, 2009).

The average area of the Hadejia-Nguru floodplain (on the Komadugu-Yobe river system) has shrunk from 2,350km^2 in 1969 to less than 1,000km^2 in 1995, suggesting that the groundwater table has lowered (though this is yet to be confirmed scientifically), causing streams, ponds, ox-bows and village wells to have less water for a shorter period during the year. The customary five to six-month flow of Yobe River now lasts only three to four months (Bdliya and Bloxom, 2003).

It has been previously reported that Lake Chad has shrunk from 25,000km^2 in 1963 to 1,350km^2 today (Coe and Foley, 2001; UNDP/DEWA, 2003; Bdliya and Bloxom, 2003). Since 1973, the Lake has been divided into northern and southern pools by a stretch of islands of sand dunes that are now permanent; causing the pools to remain separated (Bdliya and Bloxom, 2003). The root causes of this environmental challenge on Lake Chad have been attributed to: overgrazing and deforestation, which has resulted in the loss of vegetation cover; the construction of large and unsustainable irrigation projects in the Lake as well as on its feeder rivers.

Suggestions for water management in the Sahel Savannah ecoregion

Based on experiences in other Sahelian countries, it seems that small-scale and farmer managed irrigation systems are more sustainable than large dams. Farmers should be trained and allowed to organize themselves into farmer groups to build small irrigation systems for their farms. In addition, creation of small reservoirs, promotion of water recycling and re-use of especially irrigation water, protection of watersheds and water reservoir sites through the establishment of vegetation cover to minimise evaporation and maximise water harvesting through capturing water in depressions, stream flood plains, catchments, and the construction of storage tanks and containers, are viable ways by which water availability can be managed in the drought-hit Sahelian states of Nigeria.

Since water is a major cause of conflict in the ecoregion, there is a need to establish a formal "water allocation process" in order to regulate existing water use rights and manage water demands within drainage basins. Urgent action is required for the sustainable management of water in this region, as water scarcity will lead to food insecurity.

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Integrating sustainable use of land, forests and fisheries: the case of Bui dam's water resources management on the Black Volta River in Ghana

Ofori-Danson Kwabena[1] *and S. Abenney-Mickson* [2]

Background

On June 8, 2011, an impressive ceremony to commence the impoundment (or blocking of the normal flow) of the Black Volta River in Ghana was performed. The impoundment is expected to create a reservoir area of 444 km^2 at full supply level of 183.0 m, from which water will be extracted for the power generation at the Bui dam (Fig. 1 below).

The Bui reservoir supports important small-scale fisheries and therefore provides important major source of animal protein, income and employment (Abban *et al.*, 1994). This implies that the fisheries, the surrounding land constitute a unique source of livelihood for fisher folks of the resettled communities in particular, and contributes to food security and nutritional balance in the area. The employment potential includes rural aquaculture and fisheries-related activities such as fish processing, marketing, boat building and sale of netting, and irrigation for crop farming (Ofori-Danson *et al.*, 2012).

Unfortunately, the development of the land, savanna and fisheries continues to be severely hampered by the lack of infrastructure such as roads and communication facilities. Furthermore, it is exposed to natural occurrences like seasonal floods, inundation and like most water impoundments, the fishermen are prone to water-related parasitic diseases particularly bilharziasis, river blindness (onchocerciasis) (Abban *et al.,* 1989, 1994) This could lead to depressed livelihoods of these fish dependent communities and threaten food security in the area.

The operator uses pre-harvest inventory and sonar data as well as on-board sonar and instrumentation to target trees for harvesting. The boom is lowered, the tree grappled, cut and raised to the surface where it is placed on a proprietary modular log transport bunk. When the bunks are full they are loaded onto a nearby barge, which is periodically offloaded at CSRD's sawmill on shore. Logs are then dewatered, sorted, bucked and transferred to a site mill to be sawn into lumber of various specifications.

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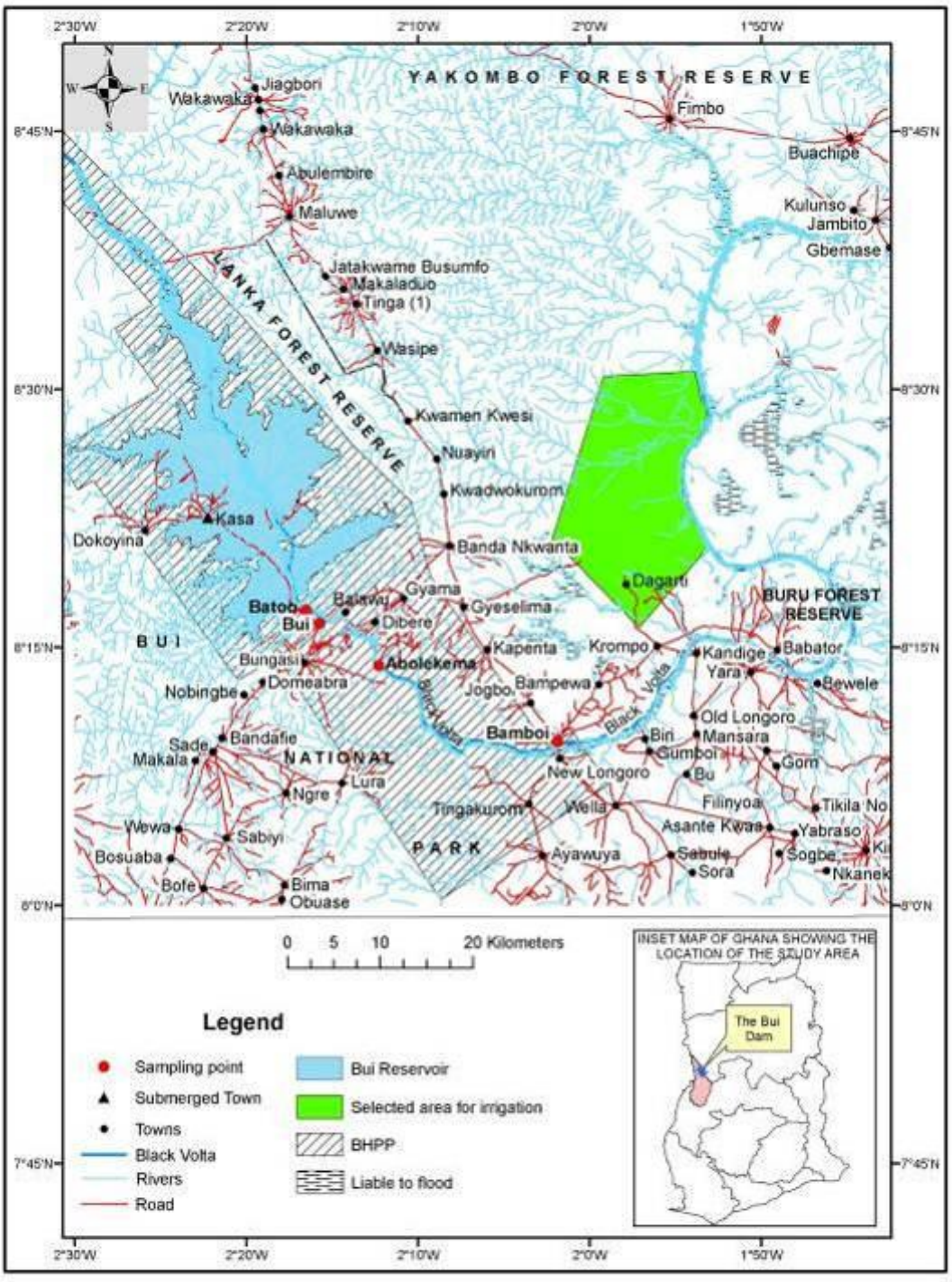

Fig.1. The Bui reservoir on the Black Volta River in Ghana

In recognition of the above mentioned potential and drawbacks of the Bui reservoir, there is need to integrate sustainable us of the land and fisheries for the development and utilization of the dam's water resources as an added benefit to hydro-power generation for the nation. The objective of this paper is primarily to present management interventions for fisheries and irrigation management from the Bui reservoir towards food and nutrition security and sustainable development in general.

Sustainable use of fisheries

In principle, fishery resources are open and available to anyone ready to fish. Therefore, if no control is imposed on fisheries, people will continue to enter into fisheries and overfishing becomes inevitable. This is the challenge for sustainable use of the fisheries resources. The apparent key approach to preserve the fisheries resource in the national interest is by limiting access. In this regard, Ofori-Danson *et al.*, (2012) have proposed for the implementation of an initial 5-year Fisheries Management Plan (FMP) consisting 5 key strategic areas as follows:

(i) Conservation of the fisheries resources by prevention of over-fishing through fishing effort control measures.

(ii) Livelihood/welfare enhancement programme particularly for resettled fishers and those affected by the inundation through introduction of floating cage fish culture technology in the reservoir.

(iii) Protection of the aquatic environment from adverse effects of anthropogenic activities such as pollution and contact with the water with particular need for construction of a permanent fish landing ramp and continued monitoring of water quality

(iv) Promotion of value addition to the quality of fish on sale.

(v) Enhancement of stakeholder participation in the management process including the establishment of a Board for the Implementation of the Fisheries Management Plan to be composed of stakeholders, identifiable NGOs, relevant ministries and research institutions.

The vast area of water expected to be generated by the reservoir (444 km^2) offers the possibility of placing a good number of floating cages conveniently for productive fish farming. For instance, the average annual temperature is 26 ^{0} C (about 79 ^{0} F), and pH levels of the water ranging between 7.3 to 7.7 suggest suitable for all year round culture of fish with good growth rate (Ofori-Danson *et al.*, 2012). Apart from the typical cichlids *Tilapia zillii* and *Oreochromis niloticus,* there are a number of potentially suitable fish species for culture practices in the Bui dam area such as *Clarias spp.* and, *Heterobranchus* (Clariidae), *Heterotis niloticus* (Osteoglossidae), the nile perch, Lates niloticus (Centropomidae) and *Chrysichthys* sp. (Claroteidae) (Ofori-Danson *et al.*, 2012). The report also indicates that the resettled communities are aware of the positive role aquaculture can play in fish production. These communities would therefore embrace community fish farming concept as means to enhance their livelihood and generation of funds for community activities.

Sustainable use of the land and forests

There are two fundamental problems in Ghana's development that has been accentuated over the past decade: the one problem increasing food production and limiting natural resource conversion from agricultural activities. Almost all of the Bui Dam catchment has successively been deforested for agriculture, extending into less suitable areas prone to soil degradation. To counteract this development, current agriculture needs to be intensified and to protect soil fertility; otherwise serious food shortages and migration to the cities will continue unabated.

Irrigation is probably the most important way to intensify agriculture and increase crop production with 1-2 extra seasons per year of farming, but Ghana is lacking behind in irrigation development. In Sub-Saharan Africa only 3-4% of agricultural land is irrigated compared to 37% in Asia and 15% in Latin America (AQUASTAT 2005; FAO, 2008a,b; IAASTD, 2009). These reports indicate that long-term food production growth is highly dependent on rates of growth in investment in irrigation and water infrastructure and improvements in water use efficiency.

To address the problems described above, a multi-disciplinary research approach is on-going for the area, which include rural sociologists, agronomists, geologists, food quality and safety experts, medical doctors, economists and engineers from technology providers, and which integrates policies on development, agriculture, food security, and land and water resources management.

The main driving force behind the approach is research and innovation results, which indicate that small-scale decentralized irrigation systems (less than 2 ha) can be co-managed together with organic manures, various compost and biochar (biosolids) to enhance crop nutrition, soil fertility and water use

efficiency and collectively increase the use of local resources and productivity of vegetable and stable crop, onion, hot pepper, tomato, okra, and maize for nearby city markets. Use of organic manures, biosolids and wastewater for irrigation has merits, as it is a good source of nutrients for crops. Proper management can prevent waste products from reaching the aquatic environment and thereby avoid eutrophication and degradation. Irrigation methods and strategies need to be coupled to the use of organic by-products in order to optimize crop production via a balanced plant nutrition focusing on the supply of phosphorus and nitrogen.

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Underwater logging: Ghana's experience with the Volta lake project

Godfred Asare[1] and Sean Helmus[2]

Summary

Flooded following the construction of the Akosombo hydroelectric dam 49 years ago, submerged forests from the Volta Lake are currently being salvaged by Clark Sustainable Resource Developments (GH) Limited (CSRD), a subsidiary of Triton Logging Inc. This project is intended to bring environmentally certified timber products from Ghana to the global market and establish Ghana as a world leader in underwater timber harvesting. By accessing a previously inaccessible resource, CSRD is partnering with Ghana in taking what was perceived as a negative value and turning it into a sustainable industry of much benefit for all stakeholders. This article examines underwater logging on the Volta Lake in more detail.

Introduction

Ghana's Volta Lake is among the world's largest reservoirs with a surface area of 8,515 km^2 (3,861 miles^2). It was created following the construction of the hydroelectric dam in Akosombo in 1964. The dam, which is managed by the Volta River Authority (VRA), supplies hydroelectricity to Ghana and neighbouring Togo, Benin and Burkina Faso. Construction of the dam resulted in the submergence of tracts of forest, and forced the relocation of some 80,000 people to 52 newly created townships on the Lake's higher banks For years, the Government of Ghana and VRA have sought ways to remove these submerged tree stumps, which, in recent times have become the major cause of fatal accidents on the lake.

In November 2010, *Clark Sustainable Resource Developments (GH) Limited (CSRD)* was granted an exclusive 25-year harvest agreement by the Government of Ghana to harvest the timber submerged in Volta Lake, through a concession comprising 350,000 hectares. Using video cameras, sonar technology and a dynamic positioning system, Triton's patented SHARC harvester manoeuvres its way to find, cut and retrieve trees using a powerful telescoping arm and cutting head. Compared to other underwater logging operations, the SHARC is quicker, safer, more environmentally friendly and able to reach greater depths.

Harvesting Process Description

The first process in this undertaking is locating submerged stands of timber. Forest cover maps are used to demarcate large scale planning cells in appropriate depth bands for deep or shallow water harvesting. CSRD's Imagenex multi-beam sonar is then deployed to identify and target underwater forests suitable for harvesting. Sonar surveys are conducted by running parallel transects, ensuring 100% coverage of a planning cell. The area the sonar covers in a single swath makes it an ideal tool for this broad scale type of surveying. Exporting this data into ARC/GIS enables planners to interpret and produce digital bathymetric maps for the SHARC.

Fitted with a 91,000lb caterpillar 330D FM forestry excavator the SHARC is a barge-based harvester capable of cutting and collecting timber up to 25 meters beneath the lake's surface. It is operated by a single operator and controlled by a Dynamic

Positioning System, which is a satellite guided, computer driven propulsion system that enables the barge to remain stationary in currents and winds.

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Figure 1: A pictorial description of the SHARC harvesting a tree

Project Benefits

With declining total rainfall, increasing human population, overfishing and the extensive use of illegal fishing methods all contributing to declining fish populations on the lake, it is important to not exacerbate the problem through damaging harvesting methods.

Although there have been earlier efforts to harvest underwater forests, these have depended upon divers using underwater chainsaws, or devices that crawled along the bottom of the lake. Some harvesting has been accomplished by simply pulling the trees to the surface, roots and all, by using barges, cables and winches. In the case of divers, there is a limit to the depth that can be endured, plus the danger inherent in trying to cut large diameter trees underwater. Simply pulling the trees up or using a crawler raises concerns about disturbing the lake bottom, thereby increasing

turbidity and stirring up pollutants and interfering with the ecology of the lake. However, when submerged trees are cut using the SHARC technology, the root wad is left intact and the lake floor is not disturbed, meaning no silt, which can threaten the surrounding ecosystems, is created.

While there is no proof that removing the submerged trees will negatively affect fish catch, CSRD is ensuring that fisheries are protected by returning canopies and buttresses to the bottom of the lake to serve as artificial reefs for fish habitat and to discourage drag-netting. CSRD is also working with local fishermen to educate them on legally approved fishing methods and raising awareness of the impacts of overfishing. Also, the majority of trees rooted in depths of less than 3m below the average low water mark of the past 20 years (75m) are left *in situ*, except within pre-agreed navigation channels, to protect biodiversity.

Another benefit of the project is the clearing of defined, navigable channels. The SHARC can cut up to 25 meters beneath the lake's surface, a depth sufficient for current and future lake-going vessels. Already CSRD has completed hydrographic studies and proceeded to clear the ferry crossing between Adawso and Ekye Amanfrom - an intervention that has improved lake transport between Kwahu North and Kwahu South Districts respectively in the Eastern Region of Ghana.

CSRD is also currently in the process of completing an audit by the Rainforest Alliance for certification under its SmartWood Rediscovered Wood program. This process provides third-party support that the procedures used by CSRD preserve the integrity of the environment as well as the health and welfare of its workers and community.

Conclusion

With the world's increasing focus on tropical deforestation and climate change, submerged forests offer a unique value proposition, with tremendous environmental benefits. Consequently, the emerging underwater timber salvaging industry has great potential to improve the environmental footprint of the forest industry. If well developed, it can provide a critical buffer period to help governments and responsible companies establish and enforce regulations and market mechanisms for sustainable tropical rainforest management in natural and manmade forests.

The direct and indirect social and economic benefits derived from the project including improvement in lake transportation safety; development of the lake transportation system to serve northern Ghana and neighbouring landlocked countries; recovery of the fibre value of an otherwise lost resource; creation of jobs and training opportunities for rural communities along the lake; and enhancement of the current and long term economic value of the reservoir for VRA, the Government of Ghana, local communities and stakeholders, provide proof that Ghana's experience with the Volta Lake underwater logging project is a positive one.

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Conservation of water resources by planting Australian acacias in the vicinity of Abidjan, Côte d'Ivoire

Bakayoko Oumar[1] and Saley Bachir[2]

Summary

This study is reviewed in the context of the conservation of water resources through the rehabilitation of the watersheds' plant cover. In the region of Abidjan (South-East of Côte d'Ivoire) the issue of water resources conservation also emerges in terms of plant cover degradation in the Banco National Park (BNP). The aim here is to assess the plant cover capacity of the soil at the BNP through a stand of Acacia crassicarpa as a method to conserve water resources in the park. Based on the measurement of circumferences and leaf surfaces of trees, the basal area and the leaf area index of the stand were determined. After 15 years, the leaf area index found is 6.5 m^2m^{-2} while the basal area is 29.16 $m^2.ha^1$. The results obtained show that the Acacia crassicarpa stand ensures an adequate ground vegetation and could thus contribute to the conservation of water resources in the region.

Introduction

As the main hydraulic reservoir in the district of Abidjan, the Banco National Park (BNP) plays a key role in the conservation of water resources in the area. In fact, forests absorb rain water and then gradually release it to the ground beneath. The water reappears much later in the sources that flow into streams. By enabling water infiltration through their roots and evapotranspiration through their foliage, trees help retain water and reduce erosion (Hamilton, 2008). According to FAO (1981), one way to preserve the hydrological function of degraded forests is to restore their plant cover. To do this, one option is to create forest plantations (Michaelsen, 1997). Unfortunately, due to fraudulent cropping and urbanization, BNP has lost a significant part of its plant cover (Environment and Development Group, 2000). In addition, given the slow natural regeneration of forests and the low growth rate of local tree species, the controlled use of fast-growing exotic species may be considered. Of these, the Australian Acacias are considered promising (De Taffin *et al.* 1991).

The overall objective of this study is to analyze the plant cover capacity of the soil in an *Acacia crassicarpa* stand to assess its ability to conserve water resources.

The specific objectives are threefold: (i) determine the basal area of the stand; (ii) assess the leaf area index of the stand; and (iii) compare the results obtained to the characteristics of the original vegetation.

The expected outcomes aim at contributing to the conservation of water resources of the BNP watershed.

Material and Methodology

Site of the study

The present study was conducted on the land owned by National Agronomic Research Centre (CNRA) in Anguédédou which is adjacent to the BNP and has the same edapho-climatic conditions. The climate of the region is sub-equatorial. The annual rainfall is 1,626 mm (average of 1994-2004) with a rainfall deficit which appears to have been increasing over the past years (Environment and Development Group, 2000). The average monthly temperatures range

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between 25.2°C and 28.2°C. Soils are of the highly desaturated ferralitic type, poor in clay. The terrain consists of deep thalwegs and low plateaus (Bernhard-Reversat, 1975).

Biological material

Native to Australia and Papua-New-Guinea, *Acacia crassicarpa* is a fast-growing tree species from the Mimosaceae family. It is said to be able to produce large amounts of biomass and litter (Dupuy and N'guessan, 1991). Moreover, unlike other fast-growing species such as the Eucalyptus, Australian Acacias are not reportedly water consuming (Hamilton, 2008). The stand studied is 15 years old.

Data Collection

The variables measured are the circumference at 1.30 m above ground, the leaf area and stand density. The first variable is obtained using a dendrometric tape. The leaf area is measured by removing leaves directly from a sample of trees of the stand studied and by measuring their surface using a planimeter. The stand density is obtained through manual counting. Based on these variables, the following parameters of the stand are deducted: the basal area and leaf area index. The basal area of a stand is the sum of the cross sections of the trees of that stand. According to CTFT (1989), it is related to the volume of woody matter expressed in square meter per hectare ($m^2.ha^{-1}$). The leaf area index is the percentage of soil covered by the projection of leaf area of a stand on the area covered by that stand and is expressed in square meter per square meter ($m^2.m^{-2}$). The leaf area intervenes in the photosynthesis and evapotranspiration processes (Chen and Black, 1992).

Findings and Discussion

Basal area

The basal area obtained can be considered as high (Table 1). Indeed, despite a relatively low survival rate the causes of which are yet to be investigated, the value obtained is higher than that of natural forests in Côte d'Ivoire which are 16 to 20 m^2 according to FAO (1981).

Table 1: Dendrometric characteristics of the stand of Acacias crassicarpa in the Banco National Parc

Average circumference (cm)	**Stand density** (number of trees per ha)	**Survival rate** (%)	**Leaf Area Index** ($m^2.m^{-2}$)	**Basal Area** ($m^2.ha^{-1}$)
102.32	350	31.5	6.5	29.16

Leaf Area Index

The leaf Area Index of the stand studied is 6.3 $m^2.m^{-2}$ (Table 1). This is a relatively high value. Indeed, according to Ramade (1981), the leaf area index ranges from 3 $m^2.m^{-2}$ for sparse stands to 8 $m^{-2}.m^{-2}$ for closed stands. Moreover, Alexandre (1981) estimated that the average leaf area index for tropical forests in Côte d'Ivoire ranged between 7.5 to 9.5 $m^2.m^{-2}$. We note that the values obtained for two measured parameters are higher than those of natural vegetation. However, the survival rate is quite low.

Conclusion

These results indicate that forest plantations of *Acacia crassicarpa* could contribute to plant cover restoration at the BNP and therefore to the conservation of its water resources. However, the fact remains that this work should be completed with studies on larger plantations to analyze the causes of the high mortality of *Acacia crassicarpa* and its impacts on the water resources and biodiversity of the BNP in order to take appropriate control measures.

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Towards integrated river basin management: a case study of Gonarezhou national park, Zimbabwe

Edson Gandiwa[1], Patience Gandiwa[2], Simba Sandram[3] and Evious Mpofu[4]

Summary

Globally, water is important in the conservation of wildlife. In this present study, we focus on the surface water systems and their role in wildlife conservation in Gonarezhou National Park (GNP), Zimbabwe. Specifically, water from natural perennial rivers, i.e. Mwenezi, Runde and Save rivers, seasonal pans and artificial weirs play a key role in the survival of wildlife in GNP. Moreover, groundwater provides an important source of water, although in GNP, its use is presently very limited. However, over the past years increasing pressure on water resources has led to, for example, upstream damming of some major rivers. These changes have implications on the water available for wildlife inside GNP and communities downstream. This therefore, calls for integrated river basin management (IRBM) for the three catchment rivers covering GNP and adjacent areas in the Great Limpopo Transfrontier Conservation Area.

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Introduction

Water may be everywhere, but its use has always been constrained in terms of availability, quantity and quality (Biswas, 2004). Services provided by naturally functioning freshwater ecosystems include flood control, fresh water storage, protein production, moderation and stabilization of natural microclimates, pest control, pollination, purification of wastes, soil retention, seasonal enrichment of floodplain soils, maintenance of genetic diversity, provision of aesthetics, and service as a global carbon sink (Gilman et al., 2004). However, at the end of the 20th century, freshwater resources and its management have drawn much attention of Africa and the international community and are considered one of the major environmental issues of the 21st century (Sivakumar, 2011). Water can be a critical factor in determining the abundance and distribution of wildlife, especially in arid and semi-arid ecosystems, although the impact varies by species, habitat and season (Simpson et al., 2011). The loss of natural water resources threatens wildlife. For instance, the growing elephant (*Loxodonta africana*) population in Gonarezhou National Park (GNP), Zimbabwe, led to the implementation of animal culling programs following severe droughts in the past, in particular the 1991-92 drought. Moreover, in the past, artificial water provision for wildlife in GNP was carried out as a way to expand the natural range of animals (Department of National Parks and Wildlife Management, 1998). However, with the exception of Benji weir and Massasanya dam which act as artificial water points (Gandiwa et al., 2012), current management in GNP aims at managing the park with limited artifial water provision to animals. Therefore, the general objective of the present study was to illuminate the importance of water resources in wildlife conservation using a state protected area in Zimbabwe, namely GNP as a case study.

Overview of water resources and their importance in Gonarezhou National Park

GNP is the second largest state protected area in Zimbabwe, covering 5,053 km^2 and is part of the Great Limpopo Transfrontier Conservation Area (GLTFCA) which includes Mozambique, South

Africa and Zimbabwe. GNP was established in 1975 and comprises of diverse animal and plant species (Gandiwa and Zisadza, 2010). GNP is generally viewed as a water-stressed protected area with an average seasonal rainfall of 541 mm (Fig. 1). The park is endowed with three major rivers which constitute three major catchments in Zimbabwe as well as neighbouring countries; several seasonal pans, and two artificial weirs, namely Benji Weir and Masasanya Dam (Fig. 2). The Save, Runde and Mwenezi catchments lies in the dry parts of Zimbabwe and serve major districts and towns. Zimbabwe has seven catchments or hydrological units namely, Gwayi, Manyame, Mazowe, Mzingwane, Sanyati, Save and Runde based on the country's major river systems. Mwenezi River falls under the Mzingwane catchment (Svubure et al., 2011). Major economic activities in these catchments include agriculture, with the lowveld sugar industry being a major user of water in the Runde and Mwenezi catchments, livestock production and wildlife conservation.

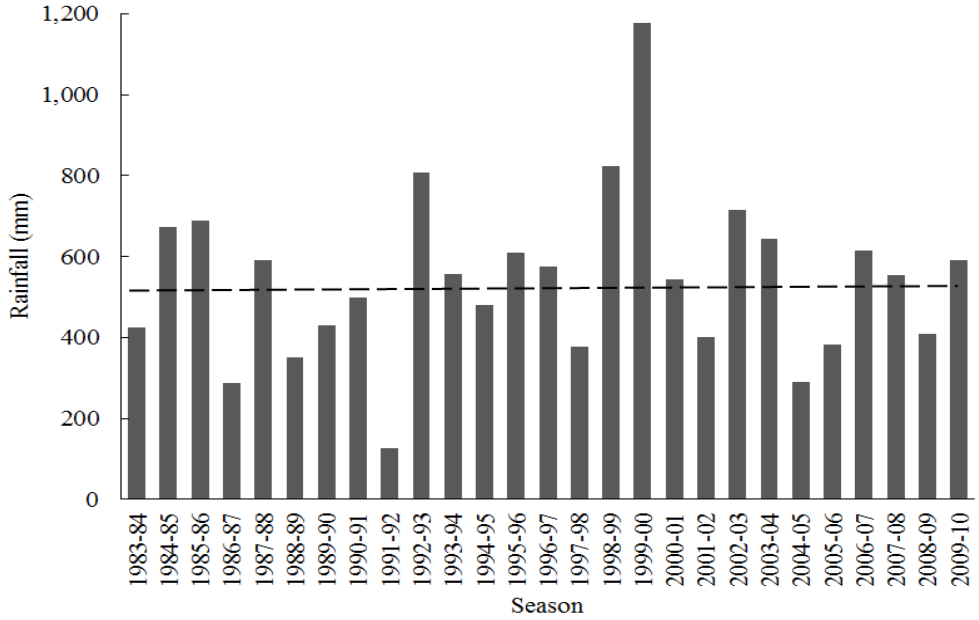

Figure 1: Seasonal rainfall for Gonarezhou National Park, Zimbabwe between 1983 and 2010. Dashed line represents the long-term average

Groundwater is likely to be the key resource in improving the water supply coverage GNP in times where extreme droughts occur in the park. In the past management attempted to resolve the water problem by drilling a significant number of boreholes and pumping water into selected pans (ZPWMA, 2011). Current thinking, based on the experiences in other areas, for example Kruger National Park, South Africa and Hwange National Park, Zimbabwe (Owen-Smith, 1996; Chamaillé-Jammes et al., 2007), is not to allow supplemented water, except for the two weirs namely Benji and Masasanya dam (ZPWMA, 2011).

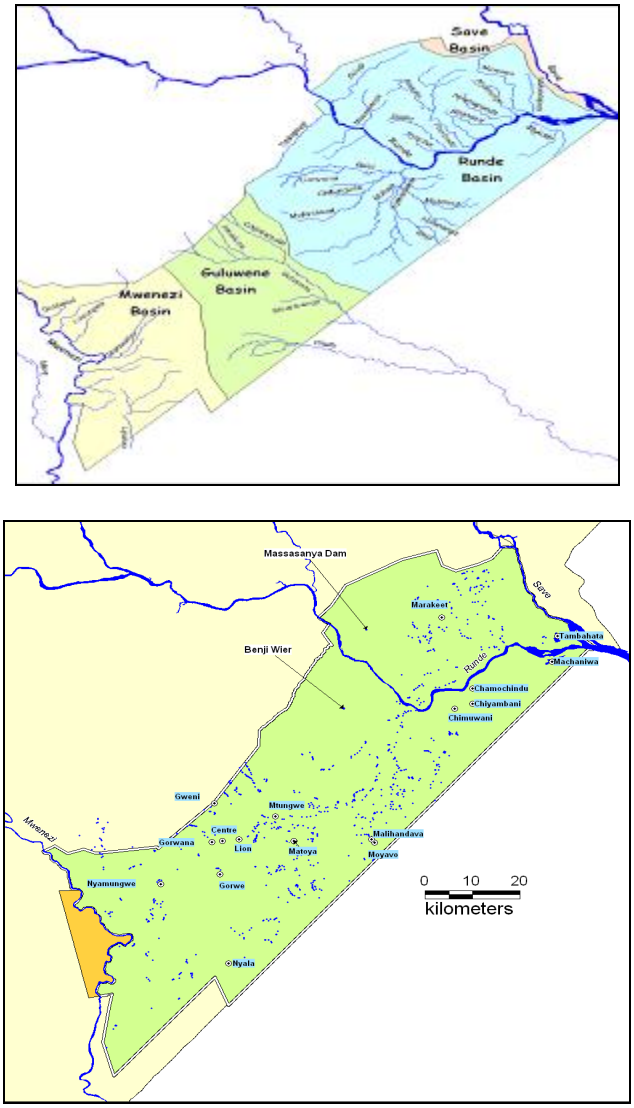

Figure 2: Major water basins (left), seasonal water pans and artificial weirs (right) in Gonarezhou National Park, southeastern Zimbabwe. Source:

ZPWMA (2011).Water is an important resource in wildlife conservation in GNP as it supports all the wildlife, ecosystem function and services, and associated tourism activities. However, changes in water flow in GNP's major rivers as a result of upstream damming, for example Mwenezi River; siltation; increased water usage by industries and local communities, and also rainfall variations as a result of climate change is likely to affect aquatic species such as hippopotamus (*Hippopotamus amphibius*), Nile crocodiles (*Crocodylus niloticus*), fish species, amphibians, aquatic birds and riverine vegetation. Pollution of rivers from agricultural activities will negatively affect the aquatic life and also promote the proliferation of invasive species in GNP. Furthermore, droughts are likely to negatively affect seasonal water pans and artificial weirs resulting in the disappearance of fish species such as the turquoise *killifish* (*Nothobranchius furzeri*) and southern lungfish (*Protopterus annectens* sub-species *brieni*).

Overall, negative changes in water resources quantity and quality in major river catchments would affect both the aquatic and terrestrial species in GNP. For the terrestrial animal species, reduced surface water supply would result in animal distribution being negatively altered resulting in the concentration of animals near permanent water sources, hence leading to negative effects on the environment, such as localised tree destruction by elephants (e.g., Owen-Smith, 1996; Valeix et al.,

2007; Chamaillé-Jammes et al., 2008; Gandiwa et al., 2011; Mukwashi et al., 2012), and increased predation of sensitive large herbivore species. This will create bottlenecks for some sensitive species populations as a result of water limitation and predation. All these changes would negatively affect the ecosystem function and services of GNP. Major changes in the spatial distribution of water would have implications for wildlife viewing opportunities since most attractive tourist sites in GNP are located near scenic water points.

Towards integrated river basin management in Gonarezhou National Park, and adjacent areas

In comparison to the rest of the world, the distribution of water resources in Africa is extremely variable and water supplies are unequally distributed in both geographical extent and time (Ashton, 2002). Therefore, there is strong rationale for the need for formal management of transboundary resources, based on the theory of common property and the so-called "tragedy of the commons." The theory was proposed by Hardin (1968) and holds that resources such as rivers that are not privately owned or controlled are susceptible to overexploitation because individual resource users gain the full benefits of using the resource but only bear a portion of the costs of overuse. Individual users acting rationally will continue to use the resource even if the collective rate of resource use is unsustainable. Furthermore, natural resources which are shared across international borders, such as water, can also be characterized as commons because users cannot control use or impacts caused by actors on the opposite side of a border (Katerere et al., 2001).

Increasing human populations and uncertain climatic changes will pose heavy demands on water resources in GNP and adjacent areas in the future (Gandiwa and Zisadza, 2010). Also, more water will be required for environmental concerns such as aquatic life, wildlife, recreation, scenic values, and riparian habitats (Bouwer, 2000). Moreover, in the southeast lowveld of Zimbabwe, water will continuously be needed in the commercial and small-scale sugar plantations which also rely on the Runde and Mzingwane catchments. Thus, increased needs for water for wildlife, human livelihoods, livestock, recreation and agricultural irrigation can be expected. Therefore, this will require implementation of appropriate national and regional water legislation, intensive management and international cooperation. Zimbabwe has a forward-looking Water Act and undertook significant reforms in the 1990s to create a Zimbabwe National Water Authority (ZINWA) to manage the national water resources (Government of Zimbabwe, 2002). The Water Act of 1998 together with the ZINWA Act provided the legal framework that led to the birth of new institutions of water resources management in Zimbabwe. The Water Act of 1998 reformed the water sector to ensure a more equitable distribution of water and a stakeholder involvement in the management of water resources (Svubure et al., 2011). Each of the seven catchments is administered by an elected catchments council, with technical support from ZINWA. Furthermore, transboundary natural resource management attempts to address the challenge of managing resources that are shared across international borders (Katerere et al., 2001), such as water and wildlife. For instance, integrated river basin management (IRBM) has gained wide acceptance as the most appropriate tool for the sustainable management of freshwater ecosystems and services in both developed and developing countries (Gilman et al., 2004).

It has been suggested that support for transboundary water management in Africa must be seen in the context of two interlinked task areas. First, water management should be seen as a means of promoting sustainable (ecological) development; i.e. as a means of coming closer to the objective of achieving the water related international development goals. Second, water management should be seen as a means of crisis prevention, i.e., transboundary cooperation serves to stabilize peace, and this is a central precondition for achieving the international development goals (Waltina and Neubert, 2006). Therefore, regional networks, dialogues, and/or collaborative management will be essential mechanisms for sharing of information and expertise on IRBM in GNP and GLTFCA. For GNP, this is important for the following river systems, Save and Runde rivers, which join to form the Save River which extends into Mozambique, the Mwenezi River which forms part of the Limpopo River basin extending into South Africa, and lastly the Chefu-Guluene river system which extends into Mozambique (see Fig. 2). IRBM will therefore, allow for the continued and sustainable conservation of water and wildlife resources in GNP and GLTFCA.

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COUNTRY FOCUS: Swaziland

Towards sustainable and integrated water resources management in Swaziland

Leonard Ndlovu[1] and Trevor Shongwe[2]

Country Background

Swaziland is a small country, some 17 400 km^2 in area mostly surrounded by South Africa except along the eastern border which is shared with Mozambique. The recently published census results of 2007 indicates a population of 1 018 499 people that live in the Kingdom of Swaziland, with just over 20% living in urban areas.

The Kingdom has four topographical and climatic areas varying from 200 to more than 1500 meters above sea level (masl), each with its own unique characteristics. The mountainous western part of the country called the Highveld (900 – 1100 masl) receives the highest amount of rainfall and has a temperate climate of warm wet summers and dry winters. The Highveld average rainfall is 1000 mm. To the east of the Highveld is the subtropical Middleveld at a lower altitude (ranging between 400 – 800 masl) with an average rainfall of 800 mm. Further east is the Lowveld, which is the largest region covering about 40% of the country and also experiences a subtropical type of climate but drier than the Middleveld with a mean rainfall of about 400 mm. The Lowveld experiences higher incidences of drought because of being on the rain shadow side of the Lubombo Plateau. The smallest and eastern most region is Lubombo Plateau which is characterized by a similar climate to that of the Middleveld yet it is also affected by its proximity to the Indian Ocean. The mean annual rainfall in the Lubombo is 800 mm per year. The country is divided into four administrative regions with Mbabane and Manzini being the capitals. The figure below depicts the four administrative regions of the country.

Figure1: Administrative Regions of Swaziland

Water Resources Development and Management

Swaziland is drained by five major river systems which flow from the west to the east. The main rivers, Lomati, Komati and Lusuthu, have their sources in South Africa. The next two largest rivers (Mbuluzi and Ngwavuma) have their headstreams entirely in Swaziland. All these rivers flow into the Indian Ocean through Mozambique, either, directly in the case of the Mbuluzi or indirectly in the case of the others which go through South Africa before returning to Mozambique.

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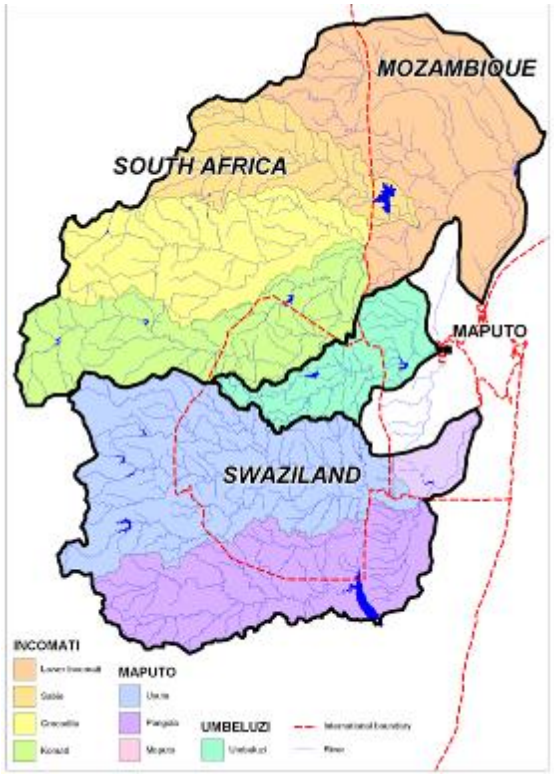

Fig. 2: The five major River Basins in Swaziland

It follows therefore that water management in Swaziland must be undertaken in collaboration with the other basin States, i.e. Mozambique and South Africa, highlighting the importance of the water sharing agreements between these States. Over the years the three countries have ensured that water resources of common interest are jointly managed to ensure their sustainable utilization.

Water Sharing Agreements

In 1983, Swaziland was a signatory to the Tripartite water sharing Agreement. This Agreement saw the establishment of the Tripartite Permanent Technical Committee (TPTC) with equal representation from the three riparian States of South Africa, Mozambique and Swaziland. This committee is led by senior government officials within the different water ministries and meets regularly to discuss water issues common to all the three States. In 1999 the country also signed two Agreements on the establishment of Joint Water Commissions (JWCs) between its two riparian States, South Africa and Mozambique. These agreements ensure that bilateral water issues are easily addressed in these platforms.

The country's collaboration with the other riparian States has seen the emergence of joint water projects like the Maguga dam. This dam is located on the Komati River in Swaziland with a water allocation to South Africa and is jointly managed by the two States through the Komati Basin Water Authority (KOBWA), a bilateral Basin Water Authority established by the two States. This project was realized through the Pigg's Peak Agreement signed by the Republic of South Africa and the Kingdom of Swaziland in the year 1992.

At the World Summit on Sustainable Development held in Johannesburg, South Africa in the year 2002, a ground breaking water sharing agreement was signed by Swaziland and her two riparian States. This agreement termed the Tripartite Agreement between South Africa, Mozambique and Swaziland for the Cooperation on the Protection and Sustainable Utilization of the water resources of the Incomati and Maputo Watercourses (IncoMaputo) spells out the conditions to be observed in the management and utilization of the water resources of the Incomati and the Maputo river systems. It also indicates water resources projects which could still be undertaken by the States in these river systems. For Swaziland this agreement provided the much needed clearance for the Lower Usuthu Smallholder Irrigation Project (LUSIP). This project entails the irrigation of 11,500 hectares of land through a 155 million cubic meters off channel storage fed from the Great Usuthu River.

Water Legislation and Policies

In Swaziland, water resources development and management is governed by the Water Act of 2003. This Act ensures that cooperation is not only achieved within the country but is also aligned to the international instruments including those from Southern African Development Community (SADC). The Act stipulates that the National Water Authority should develop a Water Resources Master Plan, a document which provide strategic guidance to decision/policy makers, water managers and water users on how best to manage and develop the country's water resources within the national and regional frameworks. The Integrated Water Resources Master Plan developed with the assistance of Global Water Partnership was able to meet this requirement. This document provides an inventory of water resources projects and strategies to be employed in the management and

development of the country's water resources for a period of three years from the year 2011.

The Water Services Act of 1992 governs the operations of the Swaziland Water Services Corporation the sole potable water supply utility in the country. The utility is responsible for the provision of potable water and the collection of sewerage in 32 scheduled urban centers of the country.

In the year 2010, the country concluded the drafting of the National Water Policy which currently awaits government approval. The policy has been harmonized with the SADC Regional Water Policy and Strategy and has encapsulated aspects of Integrated Water Resources Management.

Stakeholder Participation

In Swaziland participation of stakeholders on issues of water resources development and management is achieved through representation in the National Water Authority by all the RBAs. The National Water Authority is a body established through the Water Act of 2003 whose responsibility includes advising the Minister responsible for water even on trans-boundary water issues.

The Act advocates that water management powers shall be delegated to the users through catchment management units which are called River Basin Authorities (RBA). These Basin institutions (RBAs) were launched in 2009 and since then the government has provided seed funding for their operations. It must be noted, however, that some irrigation districts within Swaziland have been in existence for a long time with the oldest one being over 50 years old. This indicates that the concept of decentralized water management is not necessarily new in the country.

Efforts are now underway to strengthen these institutions and encourage more stakeholder participation in such an exercise. However, integrated water resources management techniques are new to Swaziland and are seen as a way of sustainably managing the country's water resources because of the role that water plays in Swaziland's economy.

In the year 2008, the government introduced the concept of Sector Wide Approach (SWAp) in budgeting. The water sector was one of the four sectors piloted under this new initiative. This approach ensures that all water sector stakeholders actively take part in the development and management of the country's water resources. The initiative is still at its infancy stages and sector stakeholders are still getting accustomed to its provisions. It is envisaged that at full implementation the sector will be guided by a sector development plan owned and developed by all the stakeholders.

Water Using Sectors

Agriculture forms the backbone of the economy of Swaziland with 70% of the population relying on this sector for their incomes. Agriculture uses 95% of the country's surface water resources through irrigation. The diverse activities that take place include the production of sugarcane, citrus fruit, and maize and other cereal crops, cotton, forestry and livestock.

About 70% of the land in Swaziland is Swazi Nation Land with the remaining 30% falling in the hands of title deed land holders. Nearly 80% of the population lives in rural areas and their main source of livelihood is crop and livestock production. By virtue of her dependence on agriculture Swaziland deems it prudent that natural resources such as land, forestry, water and fisheries/ aquaculture are properly managed in order to ensure sustainable food security in Swaziland.

An integrated approach to management of natural resources is crucial and the article presented here will have a slant to water mainly because of the need for irrigated agriculture in Swaziland because it has been evident over the years that rain-fed agriculture is not sustainable. Swaziland, as it is with the rest of the world has been affected by the impacts of climate change resulting in higher incidences of frequent and prolonged droughts, increased variability in stream and river flows, and higher incidences of floods. These impacts have tended to adversely affect the natural resources thus impacting on sustainability of food production. This happened at a time when Swaziland was establishing a strategy informed by her past to cope with the present. The strategy has, however, shown the lack of resilience in that the impacts of climate change are introducing a new dimension into the equation of life that will need to be considered in planning efforts.

As irrigated agriculture, in the broader context, becomes important going into the future, natural

resource management will be crucial in order to ensure water availability. The sharing of water between Swaziland and her neighbors will have to be guided by protocols and agreement that ensure environmental sustainability. The water sharing agreements ensure that the natural environment is not adversely impacted and thus reducing the role that it plays in food production These bilateral and trilateral agreements are also based on accepted international principles.

All river basins/catchments in Swaziland provide a habitat for a wide variety of species of flora and fauna that are either listed as endangered, rare, or vulnerable. The conservation status of the main rivers in Swaziland has been described as primarily natural for most stretches. Conservation efforts are continuing although challenged mostly by fuel requirements for cooking. Legislation exists in the country to deal with endangered species; however, its enforcement is difficult in that the area to be covered is wide, making the exercise costly.

The enforcement of legislation in relation to protecting riverine flora has been successful through the Swaziland Environmental Authority for large projects such as those in the sugarcane producing areas. Picture 1 below shows a typical section of a sugarcane farm in Swaziland with the riverine flora and the demarcated zone from the edge of the river.

The major challenge faced by Swaziland recently includes the proliferation of invasive alien plants in all the river basins of the country. These plants consume significant quantities of water in the basins and early estimates point to losses in the order of 5 to 10 percent of water generated in the watersheds. The Swaziland National Trust Commission has mapped Chromolaena odorata shrubs and created a Swaziland's alien plants database to be used in dealing with the elimination of these in an effort to reduce their impact on water thus affecting flora (www.sntc.org.sz/alienplants/species). The Swaziland Government through the Ministry of Agriculture in collaboration with that of Natural Resources and Energy as well that of Environment and Tourism embarked on an effort to eradicate the alien weeds infestation. Some of these weeds are also present upon close inspection of the Mbuluzi river picture shown in picture 1 below, yet the sugarcane growing community is also involved in efforts to eliminate these, through their own programs.

Picture 1. Typical river reserve at a sugarcane farm along the Mbuluzi (Umbeluzi) river.

The other challenges that are faced by Swaziland include wood harvested for firewood. While there is legislation against harvesting and selling of indigenous tree spices, the practice of that is at times difficult to police because most rural dwellers rely on this trade for survival.

Conclusion

In conclusion it is worth mentioning that with the enactment of the Water Act of 2003 the country has seen some improvement in the way water resources are managed. The Act provided for the creation of a Department of Water Affairs which has ensured proper coordination of the sector and has provided strategic direction on water matters.

The National Water Authority has also been very pivotal on the development of water resources policies. The country continues to push for the active involvement/participation of stakeholders. The new River Basin Authorities are a means to take water issues to the people.

Lastly the country continues to actively take part on regional water fora where issues of transboundary nature are discussed. The country continues to mobilize resources for infrastructure development to harness its surface water resources to improve its water storage capacity. A number of water infrastructure projects are provided in the Masterplan and efforts are made to even attract regional support for their implementation.

FAO Activities

Managing Somali land and water resources

Gadain Hussein[1], Ciacciarelli Palmira[2], Giasi Francesco[3] and Alinovi Luca[4]

Summary

Most Somalis depend on natural resources for their livelihoods: land for grazing and crops, water for irrigation, human and livestock, riparian and coastal zones for fisheries, and forests for wood, gums and resins. In a complex context like the Somali one, there are many challenges and opportunities related to land and water resources that can be managed only with an accurate monitoring and regular information collection and dissemination to decision makers. FAO Somalia, through its technical unit, the Somalia Water and Land Information Management (SWALIM) programme, is leading the quest to restore the missing monitoring and information system in Somalia. It provides information on water and land resources management, early warning, preparedness, response and resilience building, allowing informed decision making in sustainable natural resources management, planning and interventions.

Focus on Somalia's land and water resources

One of the most exciting challenges in a post conflict area is the protection of livelihoods and the sustainable use of natural resources. As a fundamental right, the access to and use of one's land and water is a crucial step for the reconstruction of an identity. This consideration applies very well to the complex Somali context, where not only livestock plays a central part in the local culture and farmers constantly cope with poor rainfall and droughts, but also, as Professor Lewis says "[…] the pastoral nomadism constitutes the economic base of the vast bulk of the Somali population […] and pervades almost all aspects of Somali life"[5]. Compounded by the absence of a functioning national state, systematic climatic and human-made disasters, degraded natural resources and a dwindling skilled human resource base, Somalia urgently needs more protection and safeguard of its natural resources to push its people out from this protracted crisis.

The total ***land*** area of Somalia is 637,657 km^2. About 45% of it is pastoral land, 14% is forest and woodland and 13% is arable. The climate is generally arid in the north-eastern and central regions to semiarid in the northwest and south. Rainfall is sparse with great spatial and temporal variability. The mean annual rainfall distribution in the county varies from less than 100 mm in the north-east, 200 to 300 mm in the central plateaus and 500 to 600 mm in the north-western and south-western parts on the country (Figure 1).

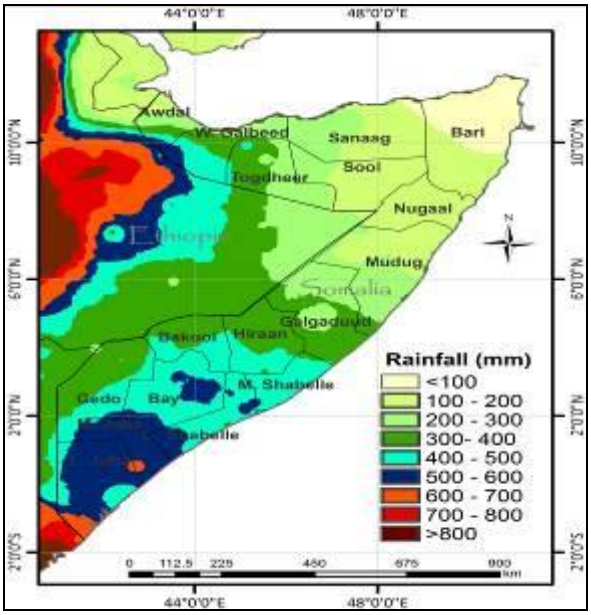

Figure 1: Spatial distribution of mean annual rainfall

Exceptional areas that receive over 800 mm are the lower parts of the Juba river. In many instances annual evaporation far exceeds rainfall. Despite the dominant arid and semi arid climate, most Somalis; maybe 80 percent, depend on natural resources for

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[5] R. Burton, *First Footsteps in East Africa*, Dover, New York, 1987

their livelihoods: land for grazing and crops, water for irrigation, human and livestock, riparian and coastal zones for fisheries, and forests for wood, gums and resins. The land use is limited by soil quality, low rainfall and limited water availability over much of Somalia. Viable alternatives to current production systems are limited or non-existent in the drier grass and woodland areas. This is clearly the case on most of the pastoral land where limited water availability is a major constraint along with low rainfall and poor soils. Added to this arid environment, the uncontrolled charcoal production due to absence of policy making institutions and militia, has lead to serious and irreversible environmental degradations. Given these environmental degradations and ecological changes that have happened overtime due to misuse of the country's fragile natural resources, the country is highly vulnerable to climate change and variability.

Somalia has scarce ***water resources*** with the type of water resource depending on location within the country. Water use is mainly for agriculture, livestock and domestic/municipal purposes. In general, the water resources are characterised by nine river basins (Figure 2), but only the Juba and Shabelle Rivers in the southern part of the country are the dominant perennial rivers.

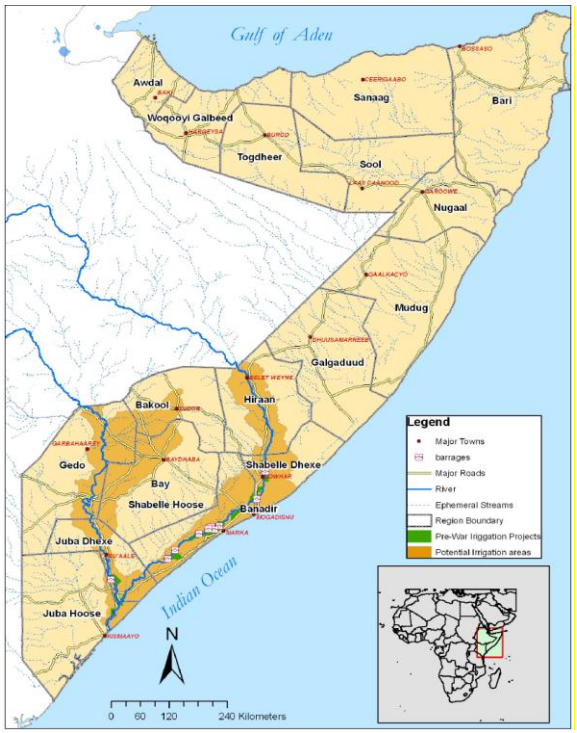

Figure 2: Major drainage basins, potential and irrigated areas

Other rivers and streams have surface water only after high rainfall events with high potential for rainwater harvesting but normally drain into either the Indian Ocean, or the gulf of Eden due to their flashy nature. Most of the surface water resources come from the Ethiopian highlands through the Juba and Shabelle rivers where only 10% of the surface runoff is generated within the Somali territory. Two third of this basin lies in Ethiopia and Kenya making it difficult for Somalia to exercise control over usage. Groundwater resources are limited and fragmented because of the limited recharge due to the hot and arid climate and highly variable rainfall. In the northern regions, some subsurface flows in the *wadis* are tapped for domestic and small irrigation use. Despite its limitation, groundwater is the main source of domestic water supply for almost 80 percent of the population. The main groundwater sources are boreholes, shallow wells and springs. The rate of failure of these sources is however high throughout the country due to lack of capacity to develop these sources. During the wet season there is usually enough water to meet the demand; however, during the dry season there is water stress in many areas of the country. Despite these painful facts, knowledge of ground water resources is limited with boreholes sunk without studies. The situation is even worse in the north. Due to the political stability, many people have settled prompting water agencies and NGOs to over exploit the groundwater aquifers leading to serious decline of the groundwater table.

Somali land and water resources: challenges and opportunities

Somalia, as one of the most food insecure countries in the world, has experienced several periods of famine and frequent food crises (mainly in 1991-1992, 2006, 2008 & 2011). Many years of conflict have created a situation of protracted and complex emergency which has eroded livelihoods, nutrition and food security. The 2011 crisis, officially declared as 'famine' through the international community on 20th July 2011, extended across all regions of the south and was driven by a combination of factors including the failure of the 2010 October-December dry season and the poor performance of the 2011 April to June rains, resulting in reduced labour demand, poor livestock body conditions and excess animal mortality.

In order to plan prompt interventions in this challenging Somali context, it is crucial to identify

the major challenges and opportunities for *a)* land and *b)* water resources:

a) The most available production factor in Somalia is ***land***. Continuous cropping cycles on the same plot increase land erosion and desertification processes:

   1. Adequate *agricultural technologies, innovations and practices* (crop rotation, best irrigation practices, etc) can guarantee high level of production maintaining same labour demand capacity in an environmental sustainable way;
   2. For *livestock training on animal nutrition* for sustainable grazing and browsing plans as well as time-extended milk production and collection schemes, animal fattening and finishing for better market terms will be encouraged as they would beneficial;
   3. For agriculture, *irrigable land* is a scarce resource though with highest production potential. This potential cannot be fully exploited if agriculture does not capitalize on adequate technology and improved quality of agricultural inputs.
   4. *Sustainable land resources management*, without capacity building and technology transfer might not be feasible in the current Somali setup and might take longer to achieve. Restoring land resources specially fertile soils, flora and fauna, will require many years of focused and coordinated work.

b) Due to unfavourable climatic conditions; with most of the country receives less than 500 mm of rainfall annually, water is scarce and does not satisfy all water requirements. There is high temporal and spatial variability in terms of water availability. Groundwater development requires high capital to be tapped to support surface water resources. In light of this, other challenges are the following:

   1. *A regular sustainable monitoring network* needs to be put in place and appropriate mitigation measures taken to improve on *water quantity and quality*. Sedimentation in surface runoff, high salinity levels in groundwater, and other water quality problems pose a big challenge to the development of water resources in Somalia.
   2. *Excessive runoff of rainwater have in the past damaged/destroyed water sources.* Rainwater harvesting technologies and institutional capacity are essential. There are no water storage facilities in the form of storage dams despite adequate amount of surface runoff generated in some of the dry rivers. Developing such facilities requires huge resources in terms of capital and data collection. Also construction of such facilities and their cost benefit compared to their environmental impacts is another factor to be determined.
   3. *Flooding* events have led to eroding riverbanks and protection walls for intakes and pumps. A significant portion of conveyance canals are located at risk area of flooding plains which can cause loss of equipment and damage the irrigation systems in general. Consequently, most of the irrigation infrastructure is highly at risk.
   4. The *water infrastructure* rehabilitation and management of access to water for livestock and humans are therefore crucial elements in enhancing productivity as well as building peace. Developing such facilities requires huge resources in terms of capital and data collection. Also construction of such facilities and their cost benefit compared to their environmental impacts is another factor to be determined.
   5. *Weak institutional capacity and absence of regulatory framework:* the authority responsible for water resources in Somalia lacks the capacity (technical and professional) to develop and manage water resources in the country. Water abstraction and development of new water sources is done without a regulatory framework. Licensing for drilling is absent and in some cases, boreholes are drilled at wrong locations.

All these challenges and opportunities can be managed only with an accurate monitoring and regular information system on land and water resources. Unfortunately data and other information required for the development of natural resources in Somalia is sometimes missing, or where available may be scattered and outdated. Many of the data collection networks collapsed with the central

government and it took time to restore them by SWALIM and are not yet at full operational status. Moreover there is lack in capacity to develop and manage natural resources in the country. Due to this complex framework, FAO Somalia is leading in restoring this missing monitoring and information system. FAO, through its technical bodies, provides all the necessary tools to take action against the above challenges and constraints.

FAO Somalia's best practice: monitoring and information systems

Considering the protracted crisis in Somalia, FAO Somalia is currently reviewing its strategic thinking and its programmatic approach. With a broad spectrum of vulnerabilities to food and nutrition insecurity, the overall objective of the FAO Somalia Strategy 2012-2015 is to *improve livelihoods and food security in Somalia*. Within this new programmatic framework, and in particular under the Information System sub-programme, FAO Somalia monitors, protects and manages natural resources for recovery and development and addresses the effects of climate change on natural resource-based production systems. With a particular focus on land and water, the monitoring of natural resources and the consequent provision of timely and accurate information represent, thanks to its long experience on the field, one of FAO Somalia's best practices.

The prolonged effects of civil war in Somalia for nearly twenty years have resulted in the loss or damage of most of the water and land-related information collected in the previous half century. Data and information have not been collected and analyzed in South Central Somalia since 1991. In order to provide a better understanding of natural resources management in Somalia and to ensure that communities, international partners and authorities adequately respond to emergency and/or plan development, FAO includes in its new strategy the *Information System sub programme*. Within this information system framework, FAO Somalia manages the Somalia Water and Land Information Management (SWALIM).

SWALIM is a long term land and water information management programme that consists of several consecutive project phases. Its impact is to contribute to sustainable private sector-led economic rural development, and support the food security of populations affected by disasters, mainly droughts, floods and resource based conflicts. The outcome of SWALIM project is increased availability and use of information in water and land resources management, early warning, preparedness, response and resilience building, allowing informed decision making in sustainable natural resources management, planning and interventions. To achieve the project objective, SWALIM maintains and develops the Water and Land Information System, provides information services to UN agencies, donors, NGOs and international community, helps Somali public institutions and other stakeholders involved in management of water, land and other natural resources and finally develops and implements a comprehensive Information and Communication Management (ICM). FAO Somalia, through SWALIM, conducts many activities in order to produce and manage relevant information: it achieves the recovery of lost archives; the establishment of a hydrometric and meteorological monitoring network; baseline water and land resources studies; preparation of several atlases including an aerial photographic survey and rehabilitation monitoring by remote sensing; a comprehensive hydro-geological survey of Somaliland and Puntland; the development of a data and document repository offering easy access to all clients to all available data, reports and maps.

As clearly appears from this brief activities' explanation, FAO Somalia has a comparative advantage in natural resources management. In addition, the idea to monitor land and water resources and provide accurate and timely information is fundamental to strengthen the ability of Somalis to anticipate, absorb and recover from external pressures and natural shocks. Through the development of this best practice, FAO Somalia creates the appropriate environment to adequately respond to land and water constraints, offering another substantial contribution to the great challenge of increasing food security and enhancing resilience in Somalia.

Conclusions

Somalia has reasonable potential water and land resources to be developed to increase food security. However, it requires focused attention because of its spatial and temporal limitations. Careful planning should be undertaken before exploitation of the resources, to consider best locations and best practice for use. The natural environment in Somalia is fragile and a proper balance should be found

between preventing environmental degradation and promoting sustainable development.

Sustainable food security requires proper management of water and land resources. Best management practices assume evidence based decisions. Evidence based decisions can only be established on objective assessments, which require reliable information. Reliable information can be best obtained from adequately processed data generated from a well designed monitoring system. Instinctive or emotional decisions can lead to wrong solutions. FAO has elaborated methods and a practical framework for monitoring land and water resources in Somalia including their degradation.

Managing land and water resources requires structured information system on water and land resources, which should be analyzed and managed hand in hand. SWALIM as an FAO project was set up with this purpose, to supply reliable information to decision makers on both water and land resources. A wealth of information and reports are available from: http://www.faoswalim.org. This system can easily be replicated in other countries with similar political and environmental conditions.

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FAO REGIONAL OFFICE FOR AFRICA

FAO engages in small-scale irrigation technologies in West Africa through the Water and Food Security Initiative

Nadia Nsabimbona[1], Gregorio Velasco Gil[2] and Abdourahmane Ba[3]

Introduction

Despite the availability of groundwater and surface water, Sahelian and West African countries have been experiencing recurrent food and nutritional crises for over thirty years. Factors related to climate change (soil aridity, drought, production constraints/water scarcity, etc.) in these countries have exacerbated the strong dependence of agricultural production on rainfall despite the random nature of rainy seasons. An analysis of the situation in West Africa produces the following observations:

- The persistence of poverty.
- An imbalance between food needs in appropriate quantity and quality and the level of production in the region, particularly in the sub-Sahelian region where food insecurity prevails.
- Inadequate policies for vulnerable populations particularly regarding agricultural infrastructure for farms and cooperative associations.

The causes of these three situations are both structural and conjunctural, the effects of climate change negatively impact on productions; the current pressure on natural resources is very strong. The main problem remains the difficulty in accessing inputs, technical innovation and production facilities, including hydro-agricultural developments and equipment. This is especially true for small producers, particularly women and the youth for whom access to land and water remains a challenge. This situation results in real issues in the areas of land tenure security, investment security and security in the duration of access to these investments. This article aims at highlighting the achievements of the FAO Water and Food Security Initiative (IESA) and its prospects.

With regard to the implementation and development of hydro-agricultural developments, several constraints result from the low purchasing power and vulnerability of populations in the face of food insecurity. However, several other issues relate to:

(i) access to land, which is considered extremely important in the context of investments such as developments, and more generally the difficult access to factors of production (land, inputs, services);
(ii) the low level of technical support and the lack of technical and organizational capacities of FOs (Farmers' Organizations);
(iii) a limited control over marketing channels;
(iv) high illiteracy rate.

Generally speaking, studies on agricultural production systems in the countries of the Economic Community of West African States (ECOWAS), have demonstrated that all the sectors are faced with challenges in the areas of production, marketing, storage and processing which limit their performance.

In addition, since the virtual disappearance of public extension systems, technical services lack human resources and logistics and are no longer able to provide all the necessary support and advice, which is a barrier to the dissemination of some technological innovations or technical packages.

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What is FAO Sub-regional Office for West Africa doing in terms of water control and food insecurity?

In response to the situation described above, and in the context of devising appropriate solutions and implementing them to ensure food security in Africa, the Government of Spain through the Spanish Agency for International Development Cooperation (AECID) and the United Nations Organization for Food and Agriculture (FAO), have launched the Water and Food Security Initiative for Africa (IESA).

One of the sustainable and least expensive solutions could be the choice of investments oriented towards small-scale irrigation technologies and/or local irrigation. In this context, the Water and Food Security Initiative (IESA) funded by the Spanish Agency for International Development Cooperation (AECID), empowers producers by providing them with funds (agricultural developments, wells, working funds for agricultural tools, agricultural kits, small livestock, etc.), and organizational support etc. to use water and land for the purpose of increasing production for food security.

The Water and Food Security Initiative in West Africa project aims, among other objectives, at improving food security by reducing hunger, increasing incomes and food availability for the most vulnerable producers in rural and peri-urban areas in West Africa through water control and technical and organizational capacity strengthening. The impact of IESA projects contributes to the achievement of the Millennium Development Goal 1 (MDG1) by reducing hunger.

These projects have been launched since 2007 and involve five (5) countries: Burkina Faso, Guinea, Mali, Niger and Senegal. Projects in Senegal and Niger were strengthened in March 2011 by an additional funding from South Africa to improve the achievements with regards to water control and access to financing of Income Generating Activities (IGAs) for the poorest and most vulnerable populations.

Five years after its launch, and based on the results of evaluations conducted by the beneficiaries, real changes have taken place, including:

- Increased diversified food availability through increased production for beneficiary households;
- Improved household resilience to food shortages due to increased income from market gardening;
- Improved access to water and land, enabling agricultural producers to achieve up to three cropping seasons a year.
- Strengthened organizational and technical capacities of beneficiaries after they formed associations.

Main results of Water and Food Security Initiative for Africa (IESA) 1

The results of the IESA have shown that on several national projects sites, populations have observed changes at socio-economic and food security levels. The most relevant changes are a more diversified diet through increased production and use of certain food groups, and a slight improvement in the resilience of households during lean periods primarily due to the increase in income through the sale of market garden produce.

The various results and good practices achieved with respect to water control and food security in the target countries have been capitalized (transformed into capital that can be used in future) through the following areas:

- Irrigation (construction of small dams, drip system, California irrigation, fish ponds, small irrigation schemes, etc.);
- Socio-economic considerations (access to land, gender and irrigation, vulnerability and access to irrigation, impact on health, education and employment);
- Advisory support, producers' organization and management (inputs and resources management, servicing and maintenance of facilities and equipment)
- Livestock activities and fish farming, petty trading and other IGAs (Income Generating Activities);
- Access to necessary financial resources for the sustainability of development activities and IGAs;
- Agricultural sectors, marketing and prices;
- Mitigation of environmental and social risks.

Towards a new strategic vision for IESA

During the IESA Regional workshop held in Bamako in December 2011, a special session focused on the development of a new strategic vision for IESA and the operationalization of its strategic priorities. This new vision will focus on strategies and policies within the ECOWAS in terms of agricultural development, taking into account the following elements: i) national and regional agricultural development policies and strategies, ii) national and regional programmes to improve food and nutritional security, iii) the Comprehensive African Agriculture Development Programme (CAADP).

IESA new strategic areas

- Area 1: Improving agricultural production through water control, intensification and diversification;
- Area 2: Developing agricultural products by strengthening value chains;
- Area 3: Nutrition and food hygiene. Enhancing food production: value chains (storage, processing, marketing, infrastructure);
- Area 4: Strengthening food security governance.

The operationalization of the new strategic vision of the IESA will be based on six guiding principles:

- Sustainability: have a lasting positive impact that promotes food security and poverty alleviation and contributes to environmental protection and sustainable rural development.
- Ownership by government and/or by beneficiaries: promoting accountability and ownership of the project results by the Government ;
- Capitalization and dissemination of best practices;
- Gender and equity and inclusion of the most vulnerable groups: promoting gender equality by systematically taking into account FAO's formal commitment and policy aiming at incorporating these into both its normative and field activities;
- Synergy and partnership development: ensure proper interaction between activities so that they combine their contributions; promote and expand partnerships, alliances, and participation as well as complementarity.
- Integration: integrate actions in priority regional and national development programmes.

Way forward

The second phase of FAO's Water and Food Security Initiative in West Africa is being prepared and will be submitted to various donors for financial support. FAO is already seeking technical and financial partnerships for the implementation of that second phase. Before completing the first phase of IESA scheduled for mid-2013, and based on the achievements and lessons learned, a new strategic vision and a five-year program will be formulated.

For more information and follow-up, please visit our website: www.fao-iesa.org

Links

Sahara and Sahel Observatory, Publications on water:

- Iullemeden Aquifer System: Concerted management…
- The North-Western Sahara Aquifer System...

Web page: http://www.oss-online.org/

Source : Observatoire du Sahara et du Sahel (Sahara and Sahel Observatory), Tunis, Tunisia © OSS 2011

Guidelines for Institutionalizing and Implementing Community-Based Forest Management in Sub-Saharan Africa (ISBN 978-92-5-107268-4) Produced by Food and Agriculture Organization of the United Nations, Regional office for Africa Accra, Ghana

Web page: http://www.fao.org/africa/

Source: Food and Agriculture Organization of the United Nations, Regional office for Africa. Accra, Ghana

Water and Agriculture

Report from the international conference in Falkenberg, Sweden, 14-16 May 2006. Chairman was professor Piotr Kowalik (Poland) Bertebos Prize Winner 2005. The Royal Swedish Academy of Agriculture and Forestry -

in cooperation with the Bertebos Foundation. Tidskrift Vol.146, No.1, 2007

http://www.ksla.se/wp-content/uploads/2011/01/KSLAT-2007-1-Water-and-Agriculture.pdf

Source: Royal Swedish Academy of Agriculture and Forestry

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Report: Mangroves protect our coasts against wind and swell waves

A new report by The Nature Conservancy and Wetlands International proves that mangrove forests protect coastal populations and infrastructure against wind and swell waves. Preventing damage to coastal infrastructure and flooding, mangroves reduce wave height by as much as 66% over 100 metres of forest. With coastal populations vulnerable to the impacts of extreme events such as storms and hurricanes, these organisations say mangrove management needs to be included in climate change adaptation and disaster risk reduction efforts in coastal areas worldwide.

McIvor, A.L., Möller, I., Spencer, T. and Spalding. M. (2012) Reduction of wind and swell waves by mangroves. Natural Coastal Protection Series: Report 1. Cambridge Coastal Research Unit Working Paper 40. Published by The Nature Conservancy and Wetlands International. 27 pages. ISSN 2050-7941.

http://www.wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/ArticleView/articleId/3353/Default.aspx

Source: Copyright Wetlands International 2012

Theme and Deadline for Next Issue

The next edition of Nature & Faune magazine will feature short articles that link to the general theme of **"promoting good governance in natural resource management in Africa"**. This is consistent with the magazine's mission of enhancing natural resource management for food security. The natural resources prioritized include land and soils, water, forests/woodlands, fisheries, wildlife and biological riches. The roll out date for the upcoming edition of the magazine is set for 30 June 2013.

In the preface to its "Voluntary Guidelines on the Responsible Governance of Tenure of Land Fisheries and Forests in the Context of National Food Security"[1], FAO points out that the eradication of hunger and poverty, and the sustainable use of the environment, depend in large measure on how people, communities and others gain access to land, fisheries and forests. It further noted that many tenure problems arise because of weak governance, and attempts to address tenure problems are affected by the quality of governance. The same idea was reiterated in the Rio+20 declaration, enshrined under the banner "The future we want".[2]

FRR (a division of The IDL Group Ltd.) elucidates and characterizes natural resource governance in this statement: "*Natural resources are not just valuable economic resources; they're also political and social resources. At all levels: local, national and international, actors compete to gain access, control and benefits from natural resources. How these competitions are played out and resolved, and who ultimately benefits from them, lies at the heart of natural resource governance.* " [3] There are a handful of tangible actions that the many and varied stakeholders in natural resource management can take besides reforming policies and plugging loopholes that allow malpractices. The next issue thus strives to publish articles that contribute to tangible innovations, and that make clear proposals. Additionally, the June 2013 issue of the magazine will be seeking answers to the questions: "What are the ultimate goals of natural resources governance at local, national and global levels?; What frameworks exist for natural resources governance?".

Sayer and Collins (2012)[4] observed that "society's requirements for forest goods and services are constantly changing and governance arrangements have to set the framework within which those changes may occur in an equitable and considered way." Cognizant of this prevailing school of thought, the editorial board is inviting authors to contribute articles that explore what needs to be done and the different roles that good governance could play in: optimizing the sustainable use of land/water/fisheries/forest; capturing Africa's biodiversity to spur development; leveraging investment in African fisheries, water, wildlife and forestry; strengthening natural resource monitoring and accounting; and building the ethical and legal aspects of forests/woodlands, wildlife, land and soils, water and/or fisheries management.

Deadline for submitting manuscript(s) and other contributions for the next issue of Nature & Faune is 1st May 2013.

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[1] http://www.fao.org/fileadmin/user_upload/nr/land_tenure/pdf/VG_en_Final_March_2012.pdf
http://www.fao.org/fileadmin/user_upload/nr/land_tenure/images/VG_Informal_aid.pdf

[2] *http://www.slideshare.net/uncsd2012/the-future-we-want-rio20-outcome-document*

[3] http://www.theidlgroup.com/FRR/NaturalResourceGovernance.htm . *FRR provides consulting services in natural resource management which tackle the challenges of poverty, governance, growth and sustainability.*

[4] *Jeffrey A. Sayer and Mark Collins (2012), Forest Governance in a Changing World: Reconciling Local and Global Values. The Round Table, Vol. 101, No. 02, 137–146, April 2012 ISSN 0035-8533 Print/1474-029X Online/12/020137-10 2012 The Round Table Ltd*
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