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Forest-Water Relations in sub-humid West Africa

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Acronyms and Abbreviations

AQUASTAT	FAO's Information System on Water and Agriculture
DGIS	The Netherlands Directorate General for International Development Cooperation
DGWR	Directorate General for Water Resources
ECOWAS	Economic Community of West African States
ET	EvapoTranspiration
FAO	Food and Agriculture Organization
GWP	Global Water Partnership
GWP-WA	West African Water Partnership
ICOLD	International Commission on Large Dams
IUCN	International Union for the Conservation of Nature
IUCN PACO	IUCN Regional Programme for Central and West Africa
IWRM	Integrated Water Resources Management
MW	MegaWatt
NAPA	National Adaptation Plans of Action
NGO	Non Governmental Organisation
PAGEV	Projet d'Amélioration de la Gouvernance de l'Eau dans le Bassin de la Volta
SIDA	Swedish International Development Cooperation Agency
UEMOA	Union Economique et Monétaire Ouest Africaine
VAT	Value Added Tax
WANI	Water and Nature Initiative
WFD	Water Framework Directive
WRC	Water Resources Commission

Foreword

With 28 shared river basins covering 71% of the region, sub-humid West Africa would appear to have considerable water resources. This also makes the countries in the region very much water interdependent. However, evidence abounds that for the last one century many parts of the region have faced severe water stress. This has been traced in part to the varying climate in the sub-region. Most of the southern part of the region enjoys relatively adequate and bi-modal rainfall between March and October, while the drier northern part has a uni-modal regime of rainfall lasting barely four months in a year. In addition to climatic variations, the situation is complicated further due to the fact that the region's major watercourses have their sources in high rainfall areas and flow through the Sahelian zone. Several interventions have been made to harness and optimize the benefits from this resource, including the construction of large dams as water receptacles and for the regulation of flows. Even with these efforts the water stress in many parts of the sub-region remains a big problem.

As part of its contribution to managing the African forests sustainably, as well as generating and sharing knowledge and information for sustainable forest management, the African Forest Forum commissioned a study on the broad area of forest–water relations, covering eight sub-humid West African countries of Benin, Ghana, Guinea Conakry, Ivory Coast, Liberia, Nigeria, Sierra Leone and Togo. The issues addressed in this study include: the extent of shared commitment and desire to promote synergy and strengthen cooperation of the member states on water, water issues in the sub-region, water supply in the region as related to forest ecosystems, learning and sharing of experiences and best practices, potential for collaboration in managing and using water resources and related forest ecosystems in the sub-region. This was essentially a desk study primarily aimed at identifying the major water resources in the sub-region, how they are linked to various forest ecosystems that serve as water catchment forests, and challenges and opportunities in managing these forests to improve supply of quality water to the sub-region.

The report therefore addresses issues relating to forest and water supply, and more specifically the key water sheds and river basins as they relate to supporting forest ecosystems, issues in management of forests in water catchment areas including aspects related to policies, regulations, challenges and opportunities. The report identifies stakeholders in water resources and recommends ways for harmonising their interests with respect to water supply, use, trade and management. It also proposes improvements in knowledge and information sharing. Also some ideas are given on the way forward with water resources, including sub-region-wide coordinated policy and legislative actions and incentives that will enhance forest management for sustainable water supply and protection

of water catchment areas. It proffers the use of adaptive technologies to enhance water yield and use in the sub-region.

This report has been made possible through collaborative efforts of the African Forest Forum and the Centre for Sustainable Development at the University of Ibadan in Nigeria under the guidance of its Director, Prof. Labode Popoola, who was responsible for writing this report and to whom credit should be attributed to for this work.

Prof. Godwin Kowero

Executive Secretary, African Forest Forum

Executive Summary

Water stress results from lack of quality water supply and seriously jeopardises human development in sub-humid West Africa. In addition, climate changes, water interdependency of countries in the region and human activities are other important factors increasing the pressure on water resources.

Water interdependency is a key issue related to water stress, a major constraint facing sub-humid West Africa communities. Many important transborder river basins are shared by at least four to eleven countries, ensuring an interzonal distribution of freshwater across wet and arid areas. However, the rapid increase of the population, and industrial and urban development during the last decades intensified the pressure on the water courses, exacerbating risks of water conflicts. In addition to political disturbances and poverty, water conflicts are important obstacles to potential collaboration for water resources management in West Africa.

Large water infrastructures have been constructed in response to the unpredictable climate changes in the sub-region. They significantly contribute to the increase of water storage capacities, the regulation of water flows, and the economic development of the region. However, this contributed to increase unsustainable water withdrawals for different human needs, basically modified the natural water distribution patterns among riparian, and led to environmental disorders like loss of habitat, deforestation, and loss of fisheries, field and forest resources.

Forests in sub-humid West Africa contribute in many ways to maintaining environmental conditions and natural water flows, while providing habitat, food and breeding areas for many species. Historically, forests have been the preferred land for drinking water supply catchment. However many countries in West Africa have inadequate or inexistent policies for watershed and forests management, added to improper implementation strategies and inadequate governance arrangements.

International water management policies and agreements are undergoing dynamic changes and there is an urgent need for West African countries to develop collaborative coping strategies for water resources management taking into account the great impact of the forests. The Global Water Partnership has defined Integrated Water Resources Management (IWRM) as **"***a process which promotes the coordinated development and management of water, land and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems***."** There is a great potential to set up concrete ways to adopt the IWRM in West Africa, while developing cross-sectional synergies in land

management, innovative measures and incentive mechanisms to build and strengthen local, national and sub-regional capacities to adapt to land-water/forest-water resource systems to climate variability.

This paper reviews various water scenarios in some West African countries, the stress, challenges and the opportunities in the management of water resources and the strategic roles of forests in the sustainable management of water resources in sub-humid West Africa.

CHAPTER 1 Introduction

OVERVIEW

A number of socio-economic and environmental factors have created conditions which bring a high level of vulnerability to Africa. The climate and hydrology are problematic as extremes abound, often coexisting in the same areas (Oyebande et al., 2002). In Africa, the accumulation of water and ecological deficits over nearly four decades of droughts has predisposed the environment to a high level of desiccation and vulnerability (Falkenmark, 1989). Widespread poverty is another basic factor in Africa's water problems. Poverty is debilitating and represents lack of access not only to financial and other material resources, but also to knowledge, information and technical know-how, such as in tackling water problems.

For many reasons, water conflict risks are particularly serious in West Africa (Niasse, 2000; Niasse et al., 2004). First, West African countries are highly water interdependent; with the exception of the Cape Verde islands, each of the West Africa countries shares at least one of the region’s 25 transboundary river basins. Second, climate change and variability have resulted in severe decline in average annual rainfall and discharge in major river systems. Third, many countries have plans for increasing investments in large water infrastructure, like dams, with the anticipated result of not only increasing water withdrawals but also radically changing natural water allocation patterns between riparian countries.

History is replete with water shortages in different parts of the planet earth at one time or the other. This has always led to competition and often times conflicts leading to protracted internecine wars. In the final analysis, humans have always learned to adapt or cope, sometimes by moving. At first people followed the water, settling near rivers, lakes, and springs, and moving to others if these dried up because of climate variability. With evolution of technologies, humans moved water to their locations by building reservoirs, aqueducts and pumping stations. However, in the past hundred years the human population has mushroomed and large cities and megacities have developed. Water consumption has risen to feed humans, their livestock, water our crops, quench our insatiable thirst and supply the industries that feed our economic growth. Pollution loads have outstripped the capacity of our ecosystems to respond. Locally and regionally, competition for water is increasing. To this must be added the threats to regional and global ecosystems caused by anthropogenic and incidence of climate variability and change. This paper reviews various water scenarios in some West African Countries, the stress, challenges and the opportunities in the management of water resources and the strategic roles of forests in the sustainable management of water resources in sub-humid West Africa.

EXTENT OF SHARED WATER RESOURCES

West Africa has 28 cross-border river basins that cover 71% of the region (Figure 1). The most important ones are the Niger (shared by 11 countries, if one takes into account the non active part of the basin), the Senegal (4 countries), the Volta (6 countries), Lake Chad (8 countries), and the Comoé (4 countries). The sub-region also has fresh water reserves, approximating several billions of m3, stored in deep water tables. Paradoxically, this part of the world is often prone to shortages of water whenever it is needed. The unavailability of fresh water in West Africa is all the more acute as it is compounded by sharp variations in rainfall and climatic conditions. In the absence of adequate infrastructure to control those vagaries, national economies have been buffeted by flooding and droughts at the same time. To face up to the deteriorating hydro-climatic context, the construction of dams is a logical solution in order to increase the water storage capacities and the regulation of water flows to contribute significantly to the economic development of the countries of the sub region.

In West Africa, the transformation of rivers has a long history (the 1929 Kurra dam in Nigeria, the 1950 Tougouri dam of Upper Volta now Burkina Faso). However, the emergence of large dams goes back to the early independence years when they were first constructed to generate energy: the 1964 Akossombo in Ghana and the 1970 Kossou in Ivory Coast. According to information from FAO's AQUASTAT data base and on the basis of the definition of big dams by the International Commission on Large Dam (ICOLD), West Africa has more than 150 big dams out of 1,300 throughout the continent and 45,000 throughout the world. The distribution of large dams in West Africa clearly shows their limited number in comparison with the rest of the world. Two factors account for this situation. On the one hand, the weakness of the economies of the countries of the sub region reduce the funds for such infrastructure development; on the other hand, vocal opposition against these works throughout the world has made national and international public opinion, as well as the international institutions, reconsider their support for big dam projects.

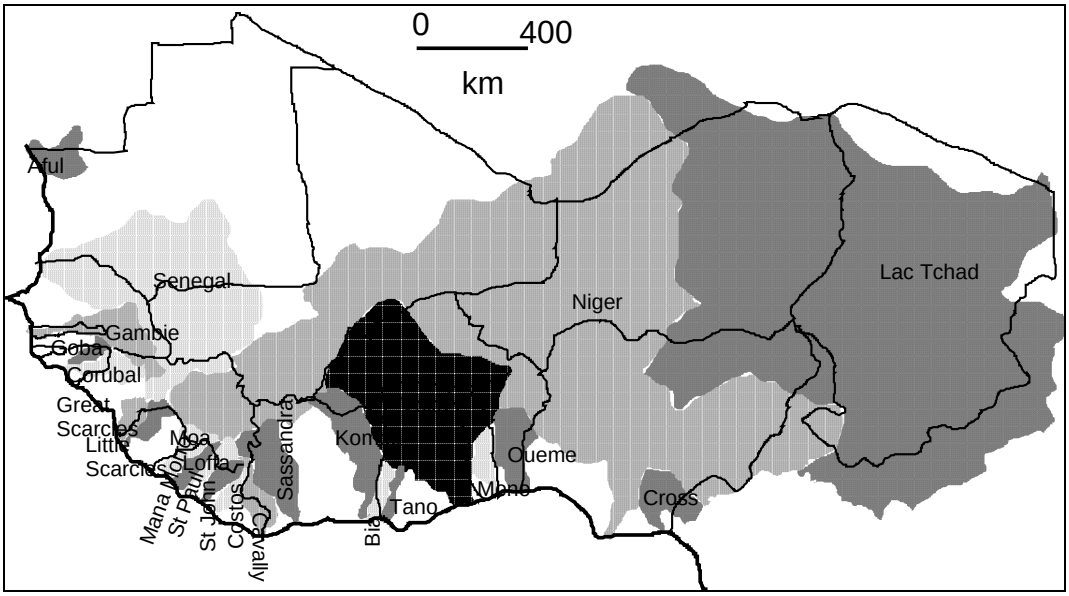

Figure 1: River basins in sub-humid West Africa sub-region.

The two biggest dams of West Africa are the Akossombo dam on the Volta River in Ghana with a height of 134 m (4th in Africa) and 150 billion m3 capacity (3rd in Africa) and the dam of Kossou on the Bandama stream in Ivory Coast with a capacity of 28 billion m3 (6th in Africa). More than 50% of the large dams constructed in West Africa are intended for hydroelectric production. The Niger basin is currently the most exploited in West Africa with more than 2,004 MW of hydroelectric capacity. The dams also allow for the regulation of natural flows, variable according to the seasons and the climate changes, by adapting them to demand for irrigation water, hydroelectricity, drinking water, industrial use and for navigation. With the construction of these dams, the existing potential for irrigated agriculture constitutes a major asset for the achievement of food self-sufficiency, and to a larger extent, for enhancing development in West Africa. In addition to the agricultural production recorded in the rainy season, the dams allow for off-season farming all year round because of the permanent availability of water through flood gate operations. At the local level, these second crops are instrumental in improving the livelihoods of local people while assuring them year long production. The dams also encourage leisure, tourism, fishing and fish farming, and can sometimes improve environmental conditions.

LEARNING AND SHARING EXPERIENCES AND BEST PRACTICES

Water resources in sub-humid West Africa appear abundant, going by the number of sources (rivers, lakes, streams, dams and other artificial sources). The question however, is how sustainable will water resources and use be in the next two decades, given the rates of population growth and urbanization in the sub-region. Added to these challenges, is the issue of global change, particularly, climate change. Risks of water conflicts are therefore high and likely to increase. Fortunately, these risks have so far not resulted in open armed confrontation. How long this can be avoided is a matter for conjecture. The lessons therefore are that deliberate efforts need to be made to mitigate all predisposing factors, such as deforestation and other climate risks and impacts which may upset livelihoods. The need to remove the risks of perturbation of the peaceful relations between and among countries sharing the same watercourses therefore becomes urgent.

POTENTIAL FOR COLLABORATION IN MANAGING AND USING WATER RESOURCES

The fact that countries sharing same water courses have co-existed without major conflict portends the potential for collaboration if water resources in the sub-region are to be properly and equitably harnessed. The Economic Community of West African States (ECOWAS) has a key role to play to sustainably develop protocols for the management of water bodies to ensure equitable involvement in investment (governance, research and development, resource management) and benefit sharing. There is the potential to put in place concrete ways to adopt Integrated Water Resources Management (IWRM) as well as cross-sectional synergies in land management, innovative measures and incentive mechanisms that build and strengthen local, national and sub-regional capacities to adapt to land-water/forest-water resource systems to climate variability. These inclusive and sustainable solutions hold the key to collaborative management and the use of water resources in the sub-region. Application of some economic instruments as outlined below will also go a long way in the management of water resources in the sub-region.

Economic instruments and financial flows for management of water resources

Economic instruments that could be used for the implementation of the national policies in the area of water resources management comprise the following:

- Water fees, tariffs and charges that are gradually set at a level that covers the cost of the resource, water intake, wastewater collection and treatment to induce private and public

water users to adopt water-saving technologies, including water recycling and reuse systems, and to minimise or eliminate waste products that would otherwise be discharged into the effluent stream or soil and watershed management.

- Fines for misuse of water resources, among others for illegal water intake and for exceeding the permissible intake as well as for transgression of the limit values specified for wastewater disposal. Here the Polluter Pays Principle should apply.
- Subsidies in the form of government and budgetary grants and preferential credits from National Funds for Environmental Protection and Foundations supporting environmental investments.
- Tax incentives. Pro-ecological fiscal preferences that are mainly aimed at reducing some investment expenses intended for the protection of water resources and the application of reduced value-added tax (VAT) rates for manufacturers of certain goods and those rendering some water protection services.

Water inter-dependency in sub-humid West Africa

One of the West Africa region's most striking features is the stark contrast between wet and arid zones. This contrast is, however, attenuated by the configuration of the region's hydrographical network. Indeed, the region's major watercourses (Niger, Senegal, Gambia, Lake Chad hydrographical network) have their sources in high rainfall areas, before flowing through the Sahelian zone, which experiences chronic rainfall deficits. Thus, these watercourses ensure an interzonal transfer of freshwater from wet to arid areas. These transfers create a high level of water interdependency among West African countries. The 17 countries of the sub-region share 25 transboundary rivers. The Niger River basin is shared by 11 countries against 8, 6 and 4 for the Lake Chad Basin, the Volta River and Senegal River, respectively. The majority of West African countries have a dependency ratio of more than 40% (Niasse, 2002).

In response to the unpredictability of hydro-climatic conditions and as one of the manifestations of the increasing pressure on water resources, West Africa has experienced a significant increase in the construction of large dams. Although the number of large dams in West Africa is currently low (compared to other regions in Africa and other continents), there is a relatively large number of projects at various levels of planning and execution which illustrates the deliberate move toward structural responses to climate change in West Africa which experiences a growing competition for water. On the Niger River alone, there are no less than 20 plans for building new large dams. Among the most advanced projects are Fomi and Kamarato in Guinea, Kenie, Tossaye and Labezanga in Mali, Mekrou in Benin and Niger, Kandadji for Niger, Lokoja, Makurdi and Onistha in Nigeria. Countries such as Guinea or Benin each have plans for four to five large dams that they expect to build in the coming years.

By storing freshwater during seasons and years of abundance and making it available when needed, dams are a means to address scarcity and unreliability of water and achieve a dependable water supply. By doing so, they often affect significantly the patterns and modalities of access to water and to other resources depending on it. Therefore, the multiplication of dams increases the pressure on water resources –which translates into increased withdrawals and the alteration of flow regimes as a result of the fragmentation of river courses (Niasse, 2000).

Successful transboundary water laws have historically been multilateral and focus on joint management and development of resources. Allocation is a process of dividing water supplies as opposed to developing and maintaining sustainable water resources for future use (Niasse, 2000). Historically, multilateral agreements have enhanced the development of sustainable water resources. Such laws govern Lake Chad, Niger, Senegal and Volta basins and include most or all riparian States with the intention of promoting economic development through investment to reduce economic water scarcity (Tatlock, 2006). Experts say that regardless of a country's water abundance or scarcity, development is the only means to ease future water stress. Improving water and sanitation programs is therefore crucial to spurring growth and sustaining economic development (Tatlock, 2006). Because it takes time to develop these programs, a paradox emerges. Poor economies are unable to develop because of water stress and economic instability prohibits the development of programs to abate water stress.

CHAPTER 2 Management of water resources in sub-humid West Africa

CURRENT KNOWLEDGE ON WATER DISTRIBUTION, AVAILABILITY AND SUFFICIENCY

By some measures, renewable water resources in the sub-region appear relatively abundant. One measure, the use-to-resource ratio (given by total water withdrawals divided by the available renewable resources), provides an overall gauge of the average pressure on available resources. A value as low as 0.10 for this measure may indicate the onset of stress (Raskin et al., 1997). As shown in Table 1, values for this measure range from 0.01 to 0.03 for the UEMOA countries, indicating no generalized stress for the region.

However, looking beyond the picture painted by this measure, the situation appears less favourable. As shown in Table 1, an important issue for some countries, especially Niger, is their dependency on outside water resources, as measured by the dependency ratio, the ratio of outside flows to total resources (Heaps, et al., 1999). In Niger, nearly all of the total renewable resources originate outside of the country. Most of the external resources are supplied by the Niger River (FAO, 1995), which crosses the extreme south-western part of the country. This high degree of dependency makes Niger vulnerable to future reductions in crossborder flows should other countries increase their consumption, with implications for future conflicts over water resources (Heaps et al., 1999). Such conflicts are already a familiar concern in other parts of the world such as North Africa, the Middle East and Central Asia.

In addition, the low values for the use-to-resource ratio shown in Table 1 may be more a reflection of low levels of access to water than of abundance, since annual withdrawals for domestic uses are small, between 4 and 17 m3 per capita, compared to the estimated minimal requirements for basic needs of 18 m3 per capita annually (Gleick, 1996). Furthermore, the use-to-resource ratio does not reflect the strong variation in the availability of water in the region, both in time and in space. Water supplies in both Mali and Niger are concentrated in the south-western parts of the country, thereby limiting the availability of water in large parts of these countries (Heaps et al., 1999). In the Sahelian countries, most of the rivers are temporary and rainfall is erratic and very localized (FAO, 1995). When the rains do come, they are hard and brief, leading to the irregular supply of water for crops and which can compact the soil surface and lead to soil loss from runoff.

Table 1: Annual renewable water resources in some West Africa countries in 1995

Country	Internal Resources (m3)			Cross-border flows (km3) Total	Dependence	Coefficient of variation of Precipitation	Use / resource	Use / internal resource
	Ground	Surface	Total					
Benin	2	9	11	16	0.60	0.06	0.01	0.01
Burkina Faso	10	8	18	0	0.00	0.06	0.02	0.02
Cote d'Ivoire	38	39	77	1	0.01	0.05	0.01	0.01
Mali	20	40	60	40	0.40	0.13	0.03	0.04
Niger	3	0	4	29	0.89	0.14	0.02	0.20
Senegal	8	19	26	13	0.33	0.12	0.03	0.05
Togo	6	6	12	1	0.04	0.07	0.01	0.01

Sources: FAO (1995) and Raskin et al. (1997).

The tasks of using the available water efficiently, retaining the soil, and reducing the risk of crop failure from insufficient rainfall, are challenges faced annually by the region's farmers (Heaps et al., 1999). There is strong inter-annual variation as well, as measured by the coefficient of variation of precipitation (Table 1). A value for this indicator above 0.06 may reveal a stress condition (Raskin et al., 1997). The values for all of the UEMOA countries except Côte d'Ivoire meet or exceed this threshold.

Likely effect of future increases in industrial and urban development and the expansion of irrigated agriculture are expected in the sub-region. For example, irrigated agriculture currently accounts for 87% of water withdrawals in the region (Table 2), even though only about 2% of the cropland in the region is irrigated (Heaps et al., 1999). This information (see Table 2) excludes the huge sudano-sahelian agro-climatic zone of Nigeria which also depends largely on irrigated agriculture. This illustrates the potentially huge increases in withdrawals that may occur as irrigated agriculture expands. These scenarios call for careful planning, failing which the increased competition for scarce water resources caused by these effects may increase the level of water stress faced by subsistence households.

Table 2: Annual water withdrawals in 1995 for seven West African countries.

Country	Contribution to withdrawals (%)			Total (km^3 / yr)
	Agriculture	Domestic	Industrial	
Benin	64	22	14	0.2
Burkina Faso	80	20	0	0.2
Cote d'Ivoire	67	24	9	0.9
Mali	98	1	1	2.5
Niger	84	14	1	0.7
Senegal	91	6	3	1.4
Togo	26	63	11	0.1
Total	87	10	3	6.1

Source: FAO (1995)

KEY ISSUES AND ACTIONS AND MEASURES TO ADDRESS THEM

The sub-humid West Africa sub-region suffers from chronically overburdened water systems under increasing stress from fast-growing urban areas, weak governments, corruption, mismanagement of resources, poor long-term investment and a lack of environmental research and urban infrastructure only exacerbate the problem (Oyebanji, 2001). In some cases, the disruption or contamination of water supply in urban infrastructures and rural areas has incited domestic and cross-border violence. The incorporation of water improvements into economic development is necessary to end the severe problems caused by water stress and to improve public health and advance the economic stability of the region.

The increasing stress on Africa's freshwater resources is the result of natural and human causes (Falkenmark, 1989). Rapid population growth, pollution from pesticides and fertilizers, and industrial effluent all contribute to Africa's water stress. Another cause of stress is environmental degradation. Forests, which serve as important water catchment areas, are being cleared for fuel wood, lumber, and agriculture. Existing agricultural land is being degraded by soil erosion and 'devegetation'. Perhaps the most important threat facing freshwater systems in the sub-region, apart from climatic change, are the numerous hydro-development projects that have been constructed in the area. These projects range from small farm dams to multimillion dollar constructions, such as the Akossombo Dam on the Volta River, which formed the world's largest man-made lake. According to Gordon (1998), the effects of such schemes include but are not limited to:

- loss of habitats;
- obstruction of fish and wildlife migration;
- deforestation;
- salinisation and acidification of soils;
- obstruction of nomadic pathways;
- loss of local control over natural resources;
- loss of fisheries, crop and pasture land, and forest resources.

Several issues are central to water and ecosystem management in the sub-region.

1) Integrated water resources management and use (water laws; water rights; institutional structures; planning, management, and decision making processes; access to drinking

water and sanitary services, especially in urban areas; natural hazards; and transboundary conflicts).

2) Economic and legal policies to support sustainable development (management of water demands through pricing and incentives for conservation; valuation of water and water-related services and economic impacts of pollution and resource over-exploitation).

3) Access to technology and participation in decision making (legal and administrative instruments that enable direct involvement of water users, government, and other stakeholders in water planning, development, and management).

4) Strategies for financing and investing in water resources (water resources development projects; non-structural measures; and improvements in water resources management).

5) Access to information and technology to improve the management of water resources (mechanisms for sharing information, water technology, and management experiences between organizations and countries; promotion of appropriate technologies that support sustainable development and public education and training).

Water stress refers to economic, social, or environmental problems caused by unmet water needs. Lack of supply is often caused by contamination, drought, or a disruption in distribution. In an extreme instance, during the years of political crisis when Côte d'Ivoire split between the rebel-led north and government-ruled south, the conflict led to unpaid water bills, which precipitated a dangerous health threat in the region, increasing the risk of water-borne diseases such as cholera. Nigeria, in addition to other countries in the sub-region, is having trouble meeting the UN's Millennium Development Goals because numerous water projects in the country have been abandoned due in the main to corruption and policy summersaults as well as non-inclusive development planning processes; high levels of pollution are contaminating available surface water that is abundant but undrinkable.

Sources of water conflict in sub-humid West Africa

Problems in the water sphere are mainly caused by various human and natural factors. These problems can normally be grouped into three major kinds: water quality, water quantity, and ecosystem problems. Increasing populations impose increasing demands for water supplies, often leading to unsustainable withdrawals. Human consumption and activities of humans in industry and agriculture generate wastes that are usually discharged into water bodies. Environment and supporting ecosystems require water, and meeting those requirements often conflicts with meeting other demands. Land Use/Land Use Changes also play significant roles in water stress. The natural factors include the erratic natural distribution, extreme climatic events (such as floods, droughts, and cyclones), arid

and semi-arid climates and local natural conditions. While human intervention may minimize the impact of these natural factors, lack of consideration and ignorance of the important roles of ecosystem functions, together with lack of consultation with stakeholders, may aggravate water conflicts.

Obstacles to Cooperation in sub-humid West Africa

Very often the source of water conflict is itself an obstacle to cooperation. Greater upstream use, for example, may be difficult to reduce when it is due to a rise in population. Water-quality-related conflicts due to pollution resulting from extensive agricultural development upstream might have implications for food security in the downstream countries. In a large river basin, water may be managed for multiple uses, such as power generation, food production, industrial development, municipal water supply, recreation, or a combination of these. Different user groups having different objectives will have difficulty in arriving at a common schedule of quantity and time of water distribution.

Political decisions driven by other factors may also impact on water resources management. For example, shifting political boundaries may demarcate new riparian areas in the international river basins. Political power, or the lack of it, may also make cooperation more difficult. Thus a group occupying the upstream area of a basin or having more political power has more control over the others in implementing development projects. Differences in the levels of economic development may also be hindrances. More developed nations may have better options for alternate sources of water and may be less demanding over a conflict with a less developed neighbour. Water conflicts resulting from human-initiated developments such as dams and diversions are more likely to be severe than those resulting from natural events, such as floods and droughts.

Among other obstacles to cooperation there are the potential for socioeconomic political disturbances and poverty and socioeconomic underdevelopment. Individuals preoccupied with their daily survival will definitely lack interest in cooperative measures that will bring benefits in the future. Other challenges are lack of information, inequalities in existing water allocation procedures, knowledge, geographic advantages and the weakness of globally ratified laws and conventions, especially enforcement mechanisms. Countries in many international basins also suffer from weak institutions (including lack of democracy and good governance, lack of political will, and lack of financing and other support for development of institutions).

Climate-induced tensions and conflicts over shared water courses

Natural factors, such as climate, are generally overlooked when analysing the underlying causes of water conflicts because current efforts to assessing and addressing climate

impacts –including on water– are centred at the country level. This is the case for current National Adaptation Plans of Actions (NAPAs) prepared by Less Developed Countries in order to enhance their coping strategies and capacity to adapt to climate change) that are developed at the national level, with no complementary regional dimension. In these cases, climate-induced tensions and risks of conflicts between countries are not given due attention in current adaptation efforts. This may take time to happen, but it just has to happen.

CHAPTER 3 Forests and water supply in sub-humid West Africa

KEY WATERSHEDS AND RIVER BASINS

Forests contribute in a number of ways to maintaining local and downstream environmental conditions. They physically stabilize the upper reaches of watersheds where rainfall is heavy and land steeply sloped and prone to earth movements (Revenga et al., 1998). Tree roots “pump” water, thereby reducing soil moisture content and the likelihood of mud slides, while root structures increase the shear-strength of soil and help prevent landslides. Forests and other vegetation are also crucial in moderating water flows by soaking up precipitation and releasing it in a controlled, regular supply. For example, they reduce runoff during high-water periods and maintain flow during dry periods. Deforestation, for instance, can cause the relatively steady, year-round water flows in downstream areas to change to destructive flood and drought regimes (Matthews et al., 2000). In addition, forests provide habitat for many terrestrial species. In many floodplain areas, forests also provide much of the food and breeding grounds on which fish and other species depend. Forests have historically been the preferred land use for drinking water supply catchment areas. Water is filtered and purified to some extent by its passage through foliage and forest soils. Perhaps more importantly, forested land is relatively free of water pollutants associated with livestock rearing, agriculture, or industrial activity.

Unlike in the developed countries with proper legal provisions dealing with different watershed management, and water uses and the protection against detrimental effects of water extreme situations (floods and droughts), the West Africa sub-region has inadequate (if any) policy on watershed and water management. Where documents exist, they are faced with another challenge of inadequate or improper implementation strategy.

The Draft Water Policy of Ghana presents a good model which other countries in the sub-region may adapt. The Ghana policy is targeted at the availability and ease of access to water in sufficient quantities for cultivation of food crops, watering of livestock, and sustainable freshwater fisheries as a major precondition for the achievement of food security and self-sufficiency in food production to meet the nutritional needs of the population. Towards achieving this, the Government promises to:

- support the establishment of micro-irrigation and valley bottom irrigation schemes among rural communities;

- strengthen district assemblies to assume a central role in supporting community operation and maintenance of small-scale irrigation and other food production facilities;
- promote partnerships between the public and private sector in the provision of large commercial irrigation infrastructure;
- encourage the efficient use of fertilizer to reduce pollution of water bodies, as well as high-yielding crop species and agricultural extension services to ensure conservation of water;
- promote and encourage water use efficiency techniques in agriculture and reduce transmission losses of irrigation water in irrigation schemes;
- manage land use and control land degradation, including bush fires, to reduce soil loss and siltation of water bodies;
- develop a pricing system and a mechanism for delivering irrigation water that is affordable to farmers and also ensure cost recovery on investments made in infrastructure;
- utilise data and information on water cycles, land cover/use, soils and socio-economic elements for the planning, design, and development of agricultural schemes.

The Senegal River basin

Senegal River is a 1,800 km long lifeline in the Sahel shared by four nations: Guinea, Mali, Mauritania, and Senegal. The high rainfall uplands of Guinea are the source of a major part of the river water (Varis et al., 2006). It is then conveyed through the lowlands, which become increasingly arid towards the mouth of the river. The river and the surrounding valley have supported its population variably through the centuries in the harsh and highly variable climatic conditions. The traditional livelihood methods and ways of using the river in cyclical manner has been the only possible way until the introduction of modern agriculture to the valley in 1950s. Throughout history, there has been a high frequency of dry climatic periods which has forced people to leave the valley, causing mass starvation and conflict. The last few decades have seen an augmentation of various problems in this fragile valley. Severe droughts have hit the region, the population growth rate has been very high, the economy has declined, food security has been unstable, and consequently, there have been numerous mass migrations, mainly to the mushrooming cities, such as Dakar, Bamako, Conakry and Nouakchott (Varis et al., 2006).

Since the last five decades, the river has been seen as a means of enhancing the national economies of its member States. An attempt at food self-sufficiency, boosted by the problem of feeding the growing urban population and the possibility of future droughts, are the major driving forces of some national and international organisations. Large-scale

schemes for modernizing agriculture, hydropower generation, and enabling navigation are listed as the major means of supporting such attempts. So far the success of these has been flimsy and mostly negative (Varis and Fraboulet-Jussila, 2002; Varis and Lahtela, 2002; Niasse et al., 2004).

The entire Senegal River represents strong contrasts in several axes (Varis and Fraboulet-Jussila 2002). The rapidly expanding city of Dakar is thirsty for water. The city has merits due to its developed water services, but the water is simply not enough for the present needs, and the future needs blur due to rapidly growing population. A growing share of the water is transferred from the remote Lac de Guiers. The water withdrawal enhances the need to restrict local, irrigated agriculture and is the key driver behind the destruction of the Ferlo valley. Modest restrictions to water uses are necessary for the local population in human waste management, hygienic pollution control, leakage of nutrients from agriculture, improper sanitation and some other aspects. The benefits from such restrictions benefit the communities themselves, as well as the city water supply alike.

Intensive, modern cash-crop agriculture, which does not nourish the local population but generates income to a narrow stratum of the population, has been previously backed by the government. The loser is local agriculture which cannot apply traditional methods any longer, that has been largely neglected in national development priorities, but still must provide the livelihood for a large share of local population, particularly the rural poor. The intensive agriculture must be subjected to limitations concerning its discharge to the vulnerable Lac de Guiers. This causes marked benefits to the local population and urban water supply.

The contrasts between the semi-nomadic communities and permanent villages on the shores of the lake are notable. They all stand, however, in the same boat if the water quality and accessibility of the lake are further deteriorated. The carrying capacity of nature is very much under pressure by the excessive herds of the semi-nomads and less by local farmers and fishermen. Traditionally wealthy and prestigious nomadic families with large zebu cattle gradually lose their respect and dignity and find themselves among the poorest of the poor.

The Volta basin

The Volta Basin in West Africa is a complex ecosystem with varied water resources management challenges, including the absence of framework for managing information and data sharing; risks of conflicts resulting from increasing competition among various water users and uses; soil and land degradation leading to silting of river channels and reservoirs, increase in the growth of aquatic weeds, especially in the lower reaches of the basin. The basin is the ninth largest basin in Africa and until recently remained one of the few transboundary river basins without formal legal and institutional arrangements for the management of its water and other natural resources.

In 2004, the Water and Nature Initiative (WANI) of the International Union for the Conservation of Nature (IUCN) initiated the "Volta Water Governance Project", commonly known by its French acronym PAGEV (Projet d'Amélioration de la Gouvernance de l'Eau dans le Bassin de la Volta), in response to the need for transboundary coordination and cooperation regarding the management of the Volta Basin waters and to demonstrate how to apply the ecosystem approach into river basin management. The project is being implemented in the Volta River Basin which is shared by six countries (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo). Burkina Faso and Ghana were selected as experimental States because they are the two among the six riparian countries which share the largest proportion of Volta Basin's area (nearly 85%). It is developed and implemented by IUCN Regional Programme for Central and West Africa (IUCN-PACO) in partnership with the West African Water Partnership (GWP-WA), Ghana's Water Resources Commission (WRC) and Burkina Faso's Directorate General for Water Resources (DGRE) and it is receiving financial support from the Swedish International Development Cooperation Agency (Sida) and The Netherlands Directorate General for International Development Cooperation (DGIS). The PAGEV approach is based on three key components: water resources information base improvement component, pilot IWRM component and institutional and legislative improvement component.

MANAGEMENT OF FORESTS IN WATER CATCHMENT AREAS

Falkenmark (1997) introduced a useful terminology of "green and blue water". Green water is the return of water to the atmosphere as evapotranspiration (ET, including transpiration by vegetation, evaporation from soil, lakes, and water intercepted and evaporated from (mainly tree) canopy surfaces), i.e. to a large part water that is used to produce food and environmental services by forests and agricultural crops. Blue water is on the other hand what is left for deeper groundwater and stream runoff, i.e. water available for animal and human consumption for example in downstream urban areas. Critical processes are the partitioning of rainfall between green and blue water (Malmer and Nyberg, 2008) which is

1) infiltration of water into the soil or surface runoff and

2) uptake of soil water by plants or recharge of groundwater.

Typically, regenerating forests and afforestation are shown to partition more of the rainfall to green water, reducing availability of blue water (Scott et al., 2005). The role of forests for partitioning between green and blue water in tropical semi-arid regions is under long term scientific and policy debate (Rockström, 2003; Bruijnzeel, 2004). Forests have been shown to maintain high infiltrability by superior litterfall and soil protection (e.g. Bosch and Hewlett, 1982; Bruijnzeel, 1990). Increasing surface runoff after deforestation and possible soil deterioration leads to more "blue water" in streams momentarily. In the semi-arid situation this means that less water during the wet season in the second partitioning to contribute to

long term ground water recharge and subsequently to maintain dry season streamflows. This is often observed by rural people, but physically this is elaborate and time consuming (expensive) to investigate in environments of low infrastructure. Consequently, only a few studies have reported the expected long term decline in dry season flows (Bruijnzeel, 1989; Sandström, 1998). However, there is some evidence that a “sponge effect” can be lost by deforestation and subsequent soil degradation but the conclusion can hardly be made general for all semi-arid ecosystems.

STAKEHOLDERS IN WATER UTILISATION AND MANAGEMENT

The identified water stakeholders in the sub-region include the following:

- Decision-makers, politicians in federal/state Governments, policy-makers in Departments of Water (Management) and the Environment (pollution control), and industrial leaders.
- Water managers (municipal engineers, irrigation engineers, water supply and sanitation specialists, and wastewater treatment specialists).
- Scientists (hydrologists, ecologists, social scientists, and legal scientists).
- General (consumer groups; farmer associations; in-stream interests, NGOs; industry, mining, forestry; medical profession, municipalities, tourism and journalists)

Adequate governance arrangements are of key importance for efficient watershed management. It includes improving consultation and co-operation within the water sector and with other sectors and stakeholders. Integrating water and land-use planning becomes imperative. Effort and resources should not be wasted in trying to develop extremely detailed plans for a very large watercourse. Instead, the planning work should be carried out at the most practical level – generally the sub-basin level. A parallel synthesis process, with continuous co-ordination and integration of “top-down” and “bottom-up” approaches will be required to be sure that the aggregated plans can satisfy the Water Framework Directive (WFD)’s objectives.

In the context of water and watershed management, the monitoring needs to be extended as it should not be limited to measurement of physical and chemical water quality parameters but should include the entire ecosystem. The West Africa sub-region has many valuable river, lake and terrestrial ecosystems that deserve better knowledge and protection. Importance of bio-monitoring that is almost non-existent in the region should be given special attention. But most importantly monitoring must be viewed and organised as a

necessary tool to control and manage water bodies appropriately and the watershed sustainably.

An increase of the number of monitoring stations and measured parameters, as well as of the sampling frequency, should be a priority in order to gradually achieve parity according to standard procedures. Financing of monitoring activities must be considerably improved in all basin countries.

Lack of legal provisions is a problem in the sub-region. In the face of current global water crisis, there is need for formulation of proper and adequate policies in the members' countries on water and watershed management. This should be backed-up with good implementation strategies and plans for evaluation.

More awareness raising and education is needed on water and watershed management and provision should be made for the general public and individual citizens to respect these requirements and exercise their rights. For example, for preparation of river basin management plans specific knowledge is needed on how to involve the general public and stakeholders in this process and local NGOs and the Country Water Partnerships could show more initiative in this respect.

MONITORING OF WATER FLOWS

Forestry must develop with understanding of use and conservation of water

In agriculture, much of expected increase in food production is expected from semi-arid areas and rain fed agriculture. Falkenmark and Rockström (2008) stress the importance of increasing efficiency in cultivation systems to shift losses in evaporation to productive transpiration. Makurira et al. (2007) give a good example from Tanzania. In the same manner there is need for fundamental process knowledge about rainfall partitioning in forest ecosystems to be able to elaborate on effects of forestry applications. Specific fields of study include:

1) study of not only infiltrability but actual groundwater recharge,
2) links between groundwater recharge and macropore flow, top soil carbon and aggregation and tree species,
3) tree root development and symbiosis, deep roots and water uptake by trees,
4) tree species transpiration in relation to productivity,
5) interception (evaporation from tree canopies) by various forest structures and species.

For better efficiency of biomass productivity also forestry itself needs to develop in the understanding of multispecies systems like miombo or intensively managed wooded areas. Multi-species plantations in general are shown by meta-analysis to be more productive than monospecies plantations (Piotto, 2008).

Long term environmental monitoring

Long term monitoring programs and qualified analysis have been the basis for much of the success in development of northern forestry (Malmer and Nyberg, 2008). There is an urgent need for such monitoring programs and trials (e.g. long term stream and rainfall monitoring and long term forestry trials) and academic capacity building in the sub-region.

CHAPTER 4 Way forward with forest-water relations in sub-humid West Africa

Water facilities, watercourses, and their sources in the environment are protected to some extent under law, both domestic and international (Mohrmann, 1992). International water law and international water-related cooperation are undergoing changes in a very dynamic way with the introduction and/or adaptation of various water-related agreements: global, regional, basin-related, and bilateral. These are not just the result of legal and professional expertise in the field, but are determined by the outcomes of negotiations, which form the tool and the forum for reconciling the interests of various sectors, disciplines, and countries (Cosgrove, 2003). The law governing international watercourses has evolved through both custom (practice of States) and international treaties, and has been influenced by other "sources" of law: general principles of law, judicial decisions, and resolutions and recommendations of international organizations (Opoku-Agyeman, 2001; Odame-Ababio, 2002; Cosgrove, 2003).

INTEGRATED WATER RESOURCE MANAGEMENT (IWRM)

The Global Water Partnership (GWP) has defined IWRM as "a process which promotes the coordinated development and management of water, land and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

The concept of IWRM in contrast to "traditional," fragmented water resources management is its focus on the management of water demand and supply. Thus, integration can be considered in two basic categories (Cosgrove, 2003):

- the natural system, with its critical importance for resource availability and quality, and the wide range of environmental services that it provides; and
- the human system, which fundamentally determines the resource use, waste production, and pollution of the resource, and which must also set the development priorities.

Integration has to occur both within and between these categories, taking into account variability in time and space.

To ensure their sustainability, water resources must be viewed holistically, both in their natural state and in balancing competing demands on water, such as domestic, agricultural, industrial (including energy), and environmental (Ackerman, 1997; WRC, 1999, 2000).

Sustainable management of water resources requires systemic, integrated decision making that recognizes the interdependence of three areas (Cosgrove, 2003). First, decisions on land use also affect water, and decisions on water affect the environment and land use. Second, decisions on our economic and social future, currently organized by socioeconomic sectors and fragmented, affect the hydrology and ecosystems in which humans live. Third, decisions at the international, national, and local levels are interrelated. At the operational level, the challenge is to translate agreed principles into concrete action. The response to this is often referred to as IWRM. The concept of IWRM is widely debated. Hence, regional and national institutions must develop their own IWRM practices using the collaborative framework emerging globally and regionally.

NATIONAL POLICY IS A PREREQUISITE

All national (and international) policies must recognize that water can only be managed holistically, taking into account its natural state, the impacts of the socioeconomic activities of humans, and other variables such as climate change. Clearly, no single model of institutional arrangement can suit all countries on all continents. But there is growing agreement on the essential characteristics that will create the conditions for improved water management. All countries need to work toward a statement of water management principles either through a water law or a national policy declaration, from which all subsequent actions are derived. The top priorities should be both the qualities of human existence and ecological protection. All other concerns must be incorporated, but remain subsidiary to these two priorities.

It is the responsibility of States to create an information system that depicts the trade-offs being made in decision making. Transparency includes information related to risk of droughts on the one hand and floods on the other. Since the balance between water as an economic good and water as a social good must change constantly to reflect environmental, income, and usage shifts, the institutional system that governs these changes also needs to be capable of change. Legislation should require periodic reviews of national policy based on an assessment of changes that have occurred in the intervening period.

ORGANIZATION

National management accountability needs to be vested in the ministry that will give it the broadest cooperative framework to mitigate the fragmentation of water management. Governments should establish apex bodies, such as national environmental or water resources councils, to coordinate and negotiate between sector, regional, and local concerns through systemic management agencies at the basin and aquifer levels. Governments should also encourage the establishment of such management agencies at the basin and aquifer levels. As the World Commission on Water has pointed out, to make

this operational, it is necessary to recognize a hierarchy in space of catchments, sub-basins and basins. At the water services delivery level, it will very often work best if there is a conversion of water management organizations to service business, responsive to a multi-sector clientele.

THE ROLE OF THE PRIVATE SECTOR

Private–public partnerships are emerging in a number of countries and there is a growing separation of policy-making bodies and administrative entities. A major issue is how to encourage private sector profit-motivated organizations to respond to environmental and social needs. The environmental movement is increasingly organized with resources to make sure that it is represented whenever true participatory processes make it possible. But this so for appears to exclude the poor.

EMPOWERING THE POOR

The State can play a vital role in helping the poor gain access to places where decisions are made concerning water that have a direct impact on them. First, governments should frame their policies and legislative and administrative systems so that no citizen is excluded. Second, services should be provided using client-centred, problem solving approaches. This should apply to all government services but also be a requirement of the regulatory framework and contractual arrangements with private sector suppliers of public services. Finally, to the extent that it is necessary, affirmative action programs may be used, requiring service providers to meet targets or quotas for the poor and disadvantaged.

RESOURCE AVAILABILITY

The requirement for capital is enormous, especially if the needs of the under-served and unserved are to be met. However, traditional capital sources from public funding are in ever shorter supply as globalization pushes public spending down and competition for public funding increases. Current users, not taxpayers, should pay the full costs of delivery as consumers, with a compensation system for poor people. For conservation and demand reduction, as well as to raise revenue, everybody should pay something, with the ultimate goal being full cost payment in water supply and sanitation. These funds must be made available to the water system managers together with a clear understanding of the equity and efficiency goals expected in the delivery systems.

SUSTAINABLE FOREST MANAGEMENT OPTIONS

Some forest management options for sustainable management of watershed include:

1. **Afforestation and reforestation**. These are forestry practices in which selected tree species are planted. They are widely acknowledged as potential means of offsetting or reducing a part of anthropogenic GHG emissions. Afforestation and reforestation of no-forested lands can increase, and prevention of deforestation can maintain, the amount of carbon held in forests. Their relatively low cost, compared with non-forest offset options, may make them economically attractive. Two of the most commonly adopted tree species of afforestation and reforestation in West Africa are *Gmelina arborea* and *Tectona grandis*.

2. **Sustainable harvesting methods**. Humans can also vary the way they manage existing forests to increase the carbon storage on site through adoption of sustainable harvesting methods. For example, selective cutting schemes, lengthened rotations, reduced-impact logging, and species choice may achieve a higher average level sequestered carbon.

3. **Agroforestry**. Agroforestry is a collective name for land-use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land. Common forms of agroforestry in the sub-region are Taungya system, non-timber tree farms, and inter-cropping of leguminous trees with food crops.

4. **Forest Protection**. This is a forestry management strategy that emphasises protection of the forest, especially prevention of fire outbreak and promotion of fire suppression practices in the event of increased fire risk and prevention of forest land degradation.

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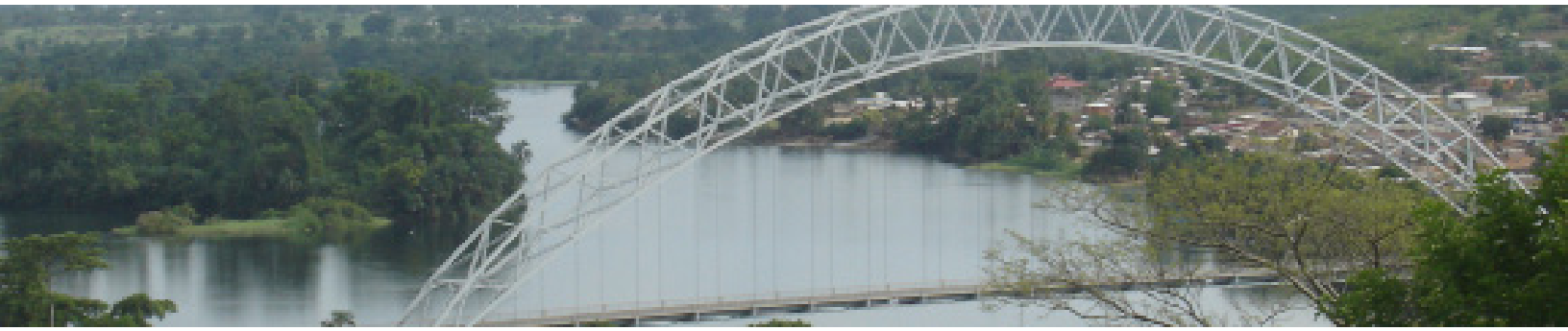

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