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Forest-Water Relations in Central Africa

Jean Lagarde Betti

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Acronyms and Abbreviations

AMESD	African Monitoring of Environment for Sustainable Development program
CICOS	Commission internationale pour le bassin du Congo-Oubangui-Sangha
CPWF	Challenge Program on Water and Food
DRC	Democratic Republic of Congo
ECCAS	Economic Community of Central African States
GEF	Global Environmental Facility
GWP-CAf	Global Water Partnership, Central Africa
HDI	Human development index
IRWR	Internal renewable water resource
IWRM	Integrated water resources management
LCBC	Lake Chad Basin Commission
MDGs	Millennium Development Goals
NBA	Niger Basin Authority
NWRMP	National water resources master plan
PES	Payment for environmental services
PWS	Payment for watershed services
RWSSI	Rural Water Supply and Sanitation Initiative
SAP	Strategic priority Piloting an operational approach to adaptation
UNDP	United Nations Development Program
UNEP	United Nations for Environment Program
UNOPS	United Nations Office for Project Services

Foreword

Central Africa sub-region is much endowed with natural water resources. The region is watered by the four largest watersheds of the continent. These include the Congo River basin, the Nile River basin, the Niger River basin, and Lake Chad basin. However, the overall utilisation rate of these resources is low and this, coupled with effects of climate fluctuations, unsustainable water projects, conflicts, lack of regulation and mismanagement, has increased food insecurity and worsened the livelihoods of the people. Besides, very few studies have reported on the relationship between forests and water resources in this region, but it is acknowledged that watershed forests play important role in the regulation of the stream flows, by absorbing water from high rainfalls and releasing it slowly through drier periods. Overall, there is a need to understand the interactions between forests and water in watersheds, to raise awareness and build capacity in forest hydrology, to develop institutional mechanisms to enhance synergies in forests and water issues, and to implement and enforce national and regional action programs. 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 the Sahelian region. The issues addressed in this study include: the extent of shared commitment to 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.

This report provides a modest initial step in this direction, by highlighting key aspects related to the link between these two resources, as well as some issues that could be addressed by various stakeholders including researchers, local communities and policy makers. It has been made possible through collaborative efforts of the African Forest Forum and Dr. Jean Lagarde Betti was responsible for writing this report.

Prof. Godwin Kowero

Executive Secretary, African Forest Forum

Executive Summary

Central Africa sub-region, including Cameroon, Central African Republic, Republic of Congo, Democratic Republic of Congo, Equatorial Guinea and Gabon, represents about 14% of African continent. The sub-region is well-endowed with water resources, including the Congo River basin, the Nile river basin, the Niger River basin and Lake Chad basin, the four largest watersheds of the continent. However, the overall utilisation rate of these resources is low. The total annual water withdrawal for the six countries is less than 1% of their total renewable water resources. The three main sectors consuming the water resources are agriculture, water supply, and industry. Sectors such as hydroelectricity, navigation, fishing, mining, environment and leisure activities have a low rate of net water consumption. The capacity of storing water resources for a better distribution, utilisation and regulation of water floods, through construction of large dams is still weak. The average irrigation potential of all six countries is only 5% of the total agricultural land, leading to a weak food crops production in several countries. This situation coupled with effects of climate fluctuations, unsustainable water projects, conflicts, lack of regulation and mismanagement, has increased food insecurity and worsened the livelihoods of the people. Besides water resources, several major basins in Central Africa sub-region hold large forested areas. Very few studies have reported on the relationship between forests and water resources in this region, but it is acknowledged that watershed forests play important role in the regulation of the stream flows, by absorbing water from high rainfalls and releasing it slowly through drier periods. A key challenge in land, forest and water management around watershed areas is to maximize the wide range of forest benefits without detriment to water resources and ecosystem functions. To address this challenge, there is a need to understand the interactions between forests and water in watersheds, to raise awareness and build capacity in forest hydrology, to develop institutional mechanisms to enhance synergies in forests and water issues, and to implement and enforce national and regional action programs. In the past a piecemeal approach to water management focusing only on satisfying immediate demands for energy, agriculture or urban water supply has been set up, failing though to take into account the potential environmental, social or long-term financial impacts. With the integrated management of water resources approach, many stakeholders are involved particularly in policy, supply, use, trade and management. At the sub-regional level, major players like UNDP, UNEP, UNOPS, Africa Development Bank, Global Water Partnership, Africa Water Facility and the Economic Community of Central African States substantially contribute to the promotion of water resources management through the development of regional approaches and coordination of efforts to sustain the management of water resource. At national and basin levels, stakeholders like the ministries in charge of water resources, the national and private companies, the local institutions such as municipalities, the NGO, the local communities, and association of consumers play the main roles of providing suitable legal and institutional

environment for the development of water sector, distribution, regulation and trade of water, advocacy and the implementation of rural projects for water access. At both regional and national level, regional bodies such as the Lake Chad Basin Commission, the Niger Basin Authority, and the International Commission for the Congo-Oubangui-Sangha Basin are also involved in watersheds management. Their overall objective is to promote cooperation and the efficient and effective coordination of the activities of the national institutions, to ensure an integrated development of the resources of the river basin, notably in energy, water, agriculture, livestock, fishing, aquaculture, forestry, wood, transport, communication and industry. The African Monitoring of Environment for Sustainable Development program in Central Africa is also a recent program implemented by CICOS for Central Africa aiming at developing a monitoring system for water resources in the Congo Basin. For these approaches to be effective and efficient, key issues such as cross-sectorial integration between forest, water and others sectors, and better governance practices need to be adequately addressed.

CHAPTER 1 Background Information on Countries

Central Africa sub-region, made up of six countries including Cameroon, Central African Republic (CAR), Republic of Congo, Democratic Republic of Congo (DRC), Equatorial Guinea and Gabon, and cover a total land area of 4.08 million km^2, or 13.9%of the continent (FAO, 2005e). The DRC is the largest country of the region (44%of the area of the region), the smallest being Equatorial Guinea. The total population of the six countries is 79 million inhabitants with 68.8%of them living in DRC. An average 48% of the population of the six countries leaves in rural areas (UNDP, 2005; AfDB, 2007). DRC has the greatest share of rural population (68%) while Gabon has the lowest (15%). The average population density is 16 inhabitants per km^2 with Cameroon having the highest (34 inhabitants per km^2) and Gabon the lowest (5 inhabitants per km^2). The annual population growth rate ranges from 1.5% in CAR to 3.3% in DRC, for a regional average of 2.7% between 1994 and 2004, significantly lower than in the previous period (3.6%) (FAO, 2005e; CEEAC, 2006).

The average human development index (HDI) is 0.512 (CEEAC, 2006; 2009; 2010) with Equatorial Guinea having the highest (0.703) while CAR and DRC have the lowest, 0.361 and 0.365 respectively (Table 1).

The estimated cultivated area in 2002 was about 10 million ha, or 5.7% of the 173 million ha of cultivable land (FAO, 2005d; 2005e). CAR is the only landlocked country of the region. The climate varies from tropical dry or wet to equatorial, depending on countries. Average precipitation (1,425 mm/year) reaches both extremes in coastal countries, ranging from 900 mm/year in the northeast to 6,000 mm/year in the southwest. At the regional level, the averages range from 1,010 mm/year from the South to 3,200 mm/year in West of the six countries and the evapotranspiration in this region varies from 1,200 mm/year to 2,200 mm/year (adapted from FAO, 2005e; CEEAC, 2006).

Table 1: Socio-economic characteristics of central Africa countries and Human Development Index (HDI)

Country	Population (2004)		Population density (inhabitants per km²)	HDI (2002)	HIV/AIDS prevalence as % of population age 15-49 (late 2003)	Part of economically active population in agriculture (%)
	Inhabitants	% rural				
Cameroon	16,296,000	48	34	0.501	6.9	55
CAR	3,912,000	57	6	0.361	13.5	69
Congo	3,818,000	46	11	0.494	4.9	37
DRC	54,417,000	68	23	0.365	4.2	61
Gabon	135,100	15	5	0.648	8.1	33
Equatorial Guinea	507,000	51	18	0.703	0.0	68
Total	79,085,100	48	16			54

Source: (FAO, 2005d; 2005e; CEEAC, 2006)

Table 2: Renewable water resources in the six countries of Central Africa sub-Region

Country	Average annual precipitation		Annual renewable water resources				
			Internal resources		Total resources		Dependency ratio (%)
	Height (mm)	Volume (10^6 m^3)	Volume (10^6 m^3)	per inhabitant (2004)(m^3/inhab)	volume (10^6 m^3)	per inhabitant (2004) (m^3/inhab)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=100× ((5)-(3))/(5)
Cameroon	1,604	762,463	273,000	16,753	285,500	17,520	4.4
CAR	1,343	836,662	141,000	36,043	144,400	36,912	2.4
Congo	1,646	562,932	222,000	58,146	832,000	217,915	73.3
DRC	1,543	3,618,120	900,000	16,539	1,283,000	23,577	29.8
Equatorial Guinea	2,156	60,481	26,000	51,282	26,000	51,282	0.0
Gabon	1,831	489,997	164,000	121,392	164,000	121,392	0.0
Total	1,687	1,055,109	1,726,000	50,026	455,817	78,100	18.0

Source: (FAO, 2005d; 2005e)

CHAPTER 2 Management of Water Resources in Central Africa

The hydrographical network of the Congo basin is particularly dense. The rainforest area and water availability per inhabitant are very high (FAO, 2005d; 2005e). The Congo river is the second largest in the world in terms of volume flow rate but water resources are unevenly distributed and poorly managed (Gleick, 2004; FAO, 2005c). While the Sahelian zone experiences persistent water stress and long periods of droughts, water resources appear abundant in the southern parts (FAO, 2005a; 2005b).

WATER DISTRIBUTION, AVAILABILITY AND SUFFICIENCY

The six countries are well-endowed in water resources compared to the other African regions (FAO, 2005e). The average annual height of precipitation is 1,687 mm, which is far above the average within Africa with Equatorial Guinea having the highest (2,156 mm) and CAR having the lowest (1,343 mm). The average annual volume precipitation is the highest in the Africa continent equivalent to 1,055,109 million m^3 with DRC having the highest in Africa (3,618,120 million m^3) and Equatorial Guinea having the lowest (60,481 million m^3). The total annual volume of internal renewable water resource (IRWR) for the six countries represents 45% of the total annual volume of IRWR in Africa with the annual volume of IRWR of DRC having the highest in Africa and Cameroon and Congo being also among the 10 highest in Africa (FAO, 2005d; 2005e). The annual volume of IRWR per inhabitant is very high (50,026 m^3) compared to the rest of Africa and the average dependency ratio is generally low except for Congo that has one of the highest dependency ratio of the Africa continent (Table 2).

CHARACTERISTICS OF KEY INTERNATIONAL RIVER BASINS

Thirteen out of the sixteen main international river basins of the central Africa sub-region (WRI, 1994; 2003; GWP-CAF, 2009) are included in the six countries concerned in this review. Four countries including DR Congo, CAR and Cameroon share the Congo River basin, which is the largest basin in the central Africa sub-region, representing 82.3% of its total size (FAO, 2005e; CEEAC, 2006; 2009; 2010) as shown in table 3.

Table 3: Key international river basins

River basin	Total size (1000 km²)	Countries sharing Basin	% of Central Africa in the total size
Congo	369,000	DRC, Congo, CAR, Cameroon	82.30
Nile	3,031,700	DRC, Chad	0.75
Niger/Benoue	2,113,200	Cameroon, Chad	4.95
Lake Chad	2,388,700	Cameroon, CAR, Chad	56.29
Zambezi	1,385,300	DRC, Angola	18.46
Ogoué	223,000	Gabon, Congo, Cameroon, Equatorial Guinea	100.00
Cross	52,800	Cameroon	23.66
Benito/Ntem	45,100	Cameroon, Equatorial Guinea, Gabon	100.00
Nyanga	12,300	Gabon, Congo	100.00
Chiloango	11,600	DRC, Congo	67.29
Utamboni	7,700	Gabon, Equatorial Guinea	100.00
Mbé	7,000	Gabon, Equatorial Guinea	100.00
Akpa	4,900	Cameroon	61.65

Source: World Report on the valorization of water resources (2003), CEEAC (2006; 2009; 2010)

The Congo River Basin

The Congo River Basin is the largest river in the Western Central Africa and the second longest in Africa. It is about 4, 374 in length and average discharge of 41,800 m^3/s (FAO, 1997; 2005e). Its width depends on the location and time of the year but ranges from 0.8 to 16 km. This river outflows into the Atlantic Ocean. It flows through the following drainage basins, "DRC, Congo, CAR and partially through Zambia, Angola, Cameron and Tanzania". Congo River discharges about 34 litres of water per second into the sea. Congo River has four sections: the headwaters, Upper Congo, the Middle Congo and the Lower Congo. The Congo River and flooded forests contain a wide diversity of freshwater habitats, including swamps, lateral lakes, and floodplains, in addition to the main channel habitats of the Congo River (Brummett et al., 2008). They are known to have the most diverse and distinctive large river faunas in tropical Africa. The Congo River and Flooded Forests ecoregion (known as the Congo Basin) contains the most diverse and distinctive group of animal species adapted to a large-river environment in tropical Africa. An exceptional group of endemic species is adapted to large rapids in the lower Congo (FAO, 2004b; 2005e).

With the Congo River and its tributaries, the basin is a huge freshwater reserve, and freshwater fishes from the Congo River are an important protein source for much of the population of Central Africa (Brummett et al., 2008). And yet, in the future, this biodiversity could be in danger of overfishing in areas near urban centres. Probably the greatest threat to the freshwater biodiversity of the Congo basin comes from the potential for hydropower development, particularly in the region of the lower Congo rapids. As human population increases, the river will become even more susceptible to large dam development.

The Congo River basin spreads out from both sides of the equator. Every day the weather is hot, and the basin receives up to 90 inches (230 cm) of rainfall a year. Tropical rain forests cover much of the land. The lowest branches of many trees are 60 feet (18 m) above the ground. Smaller trees and plants grow close together under the tall trees. One of the entomologically richest, yet least studied, regions of Africa is the interior Congo River basin (FAO, 1997; 2004b; 2005e). Forests of this region have been called Earth's "second lung" (after the Amazon Basin forests) and harbour an immense diversity of invertebrates. In these tropical rainforests live people of several cultures whose lives and livelihoods are intimately tied to invertebrates, which, in turn, help keep their forest ecosystems healthy.

As forests seem to shrink, wildlife disappears and economies sputter, one business keeps booming in the Congo River Basin forests: logging (FAO, 2004b; 2005e; Brummett et al., 2008). Along with pressures caused by population growth over the last decades, more or less unregulated and often illegal extraction of timber puts wildlife, local people and economies at risk. That draws attention to the study of the hydrologic regime and the climatic conditions of the Congo River Basin. In general, the hydrologic regime and the discharge of streams depend on the influence of stable and variable parameters: Today, environmental issues are just one of the items on the 'to-do' list of several Congo River Basin countries. Better education and infrastructure, employment opportunities, improved public services, more foreign investments are some of the many priorities vying for support (FAO, 2004b; 2005e).

The Nile River Basin

The Nile river basin, with an estimated length of over 6,800 km, is the longest river flowing from south to north over 35° of latitude. It is fed by two main river systems: the White Nile, with its sources on the Equatorial Lake Plateau (Burundi, Rwanda, Tanzania, Kenya, Zaire and Uganda), and the Blue Nile, with its sources in the Ethiopian highlands (FAO, 2004b; 2005e). The sources are located in humid regions, with an average rainfall of over 1,000 mm per year. The arid region starts in Sudan, the largest country of Africa, which can be divided into three rainfall zones: the extreme south of the country where rainfall ranges from 1,200 to 1,500 mm per year; the fertile clay-plains where 400 to 800 mm of rain falls annually; and the desert northern third of the country where rainfall averages only 20 mm per year. Further north, in Egypt, precipitation falls to less than 20 mm per year (FAO, 2004b; 2005e).

The total area of the Nile basin represents 10.3% of the area of the continent and spreads over ten countries (Table 4). For some countries, like DRC, the Nile Basin forms only a very small part of their territory.

Table 4: Nile Basin: areas and rainfall by country

Country	Total area of the country (km²)	Area of the country within the basin(km²)	% of total area of basin	% of total area of country	Average annual rainfall in the basin area (mm)		
					min.	max.	average
Burundi	27,834	13,260	0.4	47.6	895	1,570	1,110
Rwanda	26,340	19,876	0.6	75.5	840	1,935	1,105
Tanzania	945,090	84,200	2.7	8.9	625	1,630	1,015
Kenya	580,370	46,229	1.5	8.0	505	1,790	1,260
DRC	2,344,860	22,143	0.7	0.9	875	1,915	1,245
Uganda	235,880	231,366	7.4	98.1	395	2,060	1,140
Ethiopia	1,100,010	365,117	11.7	33.2	205	2,010	1,125
Eritrea	121,890	24,921	0.8	20.4	240	665	520
Sudan	2,505,810	1, 978,506	63.6	79.0	0	1,610	500
Egypt	1,001,450	326,751	10.5	32.6	0	120	15
For Nile basin		3 112 369	100		0	2,060	615

Source: FAO, 2005e

Rivers and discharges

The most remarkable topographic feature of the Sudd area is its flatness: for 400 km, from south to north, the slope is a mere 0.01 % and much of it is even flatter. The soils of the whole area are generally clayish and poor in nutrients. Rain falls in a single season, lasting from April to November and varying in the Sudd area from about 900 mm in the south to 800 mm in the north (FAO, 2004b; 2005e). As the rainy season coincides with, though is slightly shorter than, the flood seasons of the rivers, there is land of water and mud for half of the year and, away from the rivers, land of desert-like dryness for the other half (FAO, 2004b; 2005e). The main natural channels flow through a swampy area, waterlogged throughout the year, and are then flanked by grasslands flooded at high river levels but exposed when the river level drops. Because of the high rainfall in the Equatorial Lake Plateau during the 1960s and 1970s the permanent swamp area increased from 2,700 km^2 in 1952 to 16,200 km^2 in 1980.

Less than half of the water entering the Sudd region flows out of it into the White Nile. The rest disappears through evaporation and evapotranspiration. The quantity entering the Sudd region varies greatly over the years, mainly depending on the rainfall in the upper catchment area, and hydrological measurements have shown that the greater the flow of water into the Sudd, the greater the percentage of water 'lost' in evaporation. In order to bypass the Sudd region and to direct downstream a proportion of the water considered lost each year by spill from the river and evaporation in the swamps, the construction of the Jonglei Canal had been planned (FAO, 1986; 1995; 1997; 2004b; 2005e). This water could then have become available for irrigation and other uses downstream in Sudan and Egypt. Construction of the canal began in 1978 for a planned total length of 360 km, but work stopped in November 1983 after 240 km because of the civil war. By that time it had also become clear that these 'losses' create resources in pasture and fisheries and that the canal causes enormous human and environmental problems in the area (FAO, 1986; 1995; 1997; FAO, 2004b; 2005a). The issue is now how much water can be drained from the Sudd through the construction of the Jonglei Canal without serious and irreparable damage to the local environment and economy and its potential expansion.

As already mentioned, variations in rainfall over the years can cause quite considerable variations in discharges and lake levels. This seems to be more explicitly the case for the White Nile River system. For this reason, average discharge figures might vary greatly depending on the period under consideration. In addition to variations due to rainfall, the discharges might vary also due to water abstractions, mainly for irrigation purposes.

Irrigation potential and water requirements

The Nile Basin in DRC covers less than 1% of the area of the country. The area is hilly and does not really lend itself to irrigation. This area is rather densely populated with most people engaged in cattle rearing and fishery activities around Lake Albert (FAO, 2004b; 2005e). It is considered that about 10,000 ha could be developed for irrigation. Taking into consideration water saving and possibilities of re-use, the water balance of the Nile Basin in Egypt in 1993 and 2000 is shown in Table 5 (FAO, 1997; FAO, 2004b; 2005e). This deficit corresponds to an area of almost 2.2 million hectares, considering an average water requirement in the region of 12,000 m^3/ha per year. This leads to an irrigation potential for the basin as a whole of 8 million hectares instead of the nearly 10.2 million hectares. However, even these 8 million hectares are still a very optimistic estimate and should be considered as a maximum value, requiring very important storage works and optimum water use.

The transboundary nature of the Nile Basin presents many obstacles to sustainable resource use and national economic development. Unilateral management and control of each country's individual territory cannot, over the long term, benefit the region as a whole (FAO, 2004b; 2005e). Equitable and effective water allocation and environmental protection depend on institutionalized regional cooperation. The Challenge Program on Water and Food (CPWF) offers a multidisciplinary research framework for the design of transboundary solutions to the Nile Basin's many challenges. The program, led by Egypt's National Water Research Centre, is complementing ongoing activities and cooperating with national and other stakeholder organizations in the region. Results of this work will be particularly valuable in other regions where water sharing and basin management require joint action by several countries (FAO, 1997).

Table 5: Nile Basin: irrigation potential, water requirements, water availability and areas under irrigation*

Country area within the Nile basin	Irrigation potential (ha)	Gross irrigation water requirement		Actual flows (km3/year)		Flows after deduction for irrigation and losses(km3/year)		Area already under irrigation (ha)
		per ha (m3/ year)	Total (km3/ year)	inflow	outflow	inflow	outflow	
Burundi	80,000	13,000	1.04	0	1.50	0	0.46	0
Rwanda	150,000	12,500	1.88	1.5	7.00	0.46	4.09	2,000
Tanzania	30,000	11,000	0.33	7.0	10.70	4.09	7.46	10,000
Kenya	180,000	8,500	1.53	0	8.40	0	6.87	6,000
DRC	10,000	10,000	0.1	0	1.50	0	1.40	0
Uganda	202,000	8,000	1.62	28.70	37.0	23.83	30.51	9,120
Ethiopia	2,220,000	9,000	19.98	0	80.1	0	60.12	23,160
Eritrea	150,000	11,000	1.65	0	2.20	0	0.55	15 ,124
Sudan	2,750,000	14,000	38.5	117.1	55.5	90.63	31.13	1, 935,200
Egypt	4,420,000	13,000	57.46	55.50	rest to sea	31.13	minus 26.33	3,078,000
Total for countries	10,192,000		124.08					5,078,604
Total for Nile basin	<8,000,000							

Source: FAO, 2005e. *For the sake of simplicity it was supposed that if a certain quantity of water is abstracted upstream, this same quantity is subtracted from the resource downstream, except in cases where more information was available.

The Niger/Benue River Basin

The Niger/Benue River Basin, located in western Africa, covers 7.5% of the continent and spreads over ten countries. The Niger River, with a total length of about 4,100 km, is the third-longest river in Africa, after the Nile and the Congo/Zaire rivers, and the longest and largest river in West Africa (FAO, 1997; 2004b; 2005e). The Niger River Basin is divided into four systems: The upper Niger River system, the inner delta, the middle Niger River system and the lower Niger River system to which belongs Cameroon. Leaving the border between Niger and Benin the river enters Nigeria, where it is joined by numerous tributaries. Table 6 summarizes the areas and rainfall by country in the Niger River basin.

Table 6: Niger River Basin: areas and rainfall by country

Country	Area of the country within the basin (km^2)	% of total area of basin	% of total area of country	Average annual rainfall in the basin area (mm)		
				min.	max.	mean
Guinea	96,880	4.3	39.4	1,240	2,180	1,635
Côte d'Ivoire	23,770	1.0	7.4	1,316	1,615	1,466
Mali	578,850	25.5	46.7	45	1,500	440
Burkina Faso	76,621	3.4	28.0	370	1,280	655
Algeria	193,449	8.5	8.1	0	140	20
Benin	46,384	2.0	41.2	735	1,255	1,055
Niger	564,211	24.8	44.5	0	880	280
Chad	20,339	0.9	1.6	865	1,195	975
Cameroon	89,249	3.9	18.8	830	2,365	1,330
Nigeria	584,193	25.7	63.2	535	2,845	1,185
Total for Niger basin	2273946	100.0		0	2,845	690

Source: adapted from (FAO, 2004b; 2005e).

Rivers and discharges

The most important tributary of the Niger is the Benue, which merges with the river at Lokoja in Nigeria. The Benue itself rises in Chad although there are almost no surface water resources in its uppermost part. In Cameroon it receives water from several tributaries. The slope in Cameroon is considerable and the discharge there has important seasonal variations (FAO, 2004b; 2005e). The quantity of water entering Nigeria was estimated at 25 km^3/year before the 1980s and at 13.5 km^3/year during the 1980s. In Nigeria itself the Benue is joined by several tributaries, of which the ones at the left side originate mainly in Cameroon. The Benue reaches its flood level in September. It begins to fall in October and falls rapidly in November, continuing slowly over the next three months to reach its lowest level in March and April. From the confluence with the Benue, the Niger heads southwards and empties in the Gulf of Guinea through a network of outlets that constitute its maritime delta (FAO, 1995; 1997; 2004b; 2005e).

Irrigation potential and water requirements

The rainfall and hydrological conditions in Guinea make it possible to exploit, with good chances of success for an annual rainfed crop, the alluvial plains of the Niger River and its tributaries. However, to be able to cultivate all year round, irrigation is necessary. The irrigation potential in this region is estimated at 185,000 ha, of which 100,000 ha are relatively easy to develop, though the construction of dams is necessary for the storage of the water (FAO, 2004b; 2005e). To date only about 6,000 ha of rice are irrigated. In the National Water Resources Master Plan (NWRMP) there are also two proposals for water transfer schemes from the Niger to the Lake Chad basin and two for water transfer between different tributaries within the Niger basin. Table 7 summarizes the irrigation potential of the Niger basin, per country and for the basin as a whole.

Water problems may arise in the Niger Basin if the whole potential is developed. The effect of water abstraction upstream of the inner delta on the quantities that disappear within this delta has not been studied (FAO, 2004b; 2005e). Probably, as is the case with the South swamps in the Nile basin, the lower the quantity of water entering the swamp area the lower the quantity of water disappearing in absolute as well as relative terms. In all cases, important storage works for the development of irrigation are necessary throughout the whole basin. Probable navigation and hydropower problems may arise if more water is abstracted for agricultural purposes.

Table 7: Niger River basin: irrigation potential, water requirements, water availability and areas under irrigation*

Country area within the Niger basin	Irrigation potential (ha)	Gross irrigation water requirement		Actual flows (km³/yr)		Flows after deduction for irrigation and losses (km³/yr)		Area already under irrigation (ha)
		per ha m3/year)	Total (km3/yr)	inflow	outflow	inflow	outflow	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Guinea	185,000	23,500	4.35	0	40.4	0	36.05	6,000
Cote d'Ivoire	50,000	23,500	1.18	0	5.0	0	3.83	0
Mali	556,000	40,000	22.24	45.4	29.2	39.88	6.96	187,500
Burkina Faso	5,000	7,000	0.04	0	1.40	0	1.37	850
Benin	100,000	18,500	1.85	0	3.1	0	1.25	740
Niger	222,000	37,000	8.21	33.7	36.3	9.58	3.96	67,520
Cameroon	20,000	18,500	0.37	0	13.5	0	13.13	2,000
Nigeria	1,678,510	10,000	16.79	49.8	177	17.09	rest to sea	670,000
Sum for countries	2,816,510		55.02					924,610

Source: FAO, 2005e. *For the sake of simplicity it was supposed that if a certain quantity of water is abstracted upstream, this same quantity is subtracted from the resource downstream, except in cases where more information was available. For Nigeria, (4) Equal to inflow from Niger (36.30%) plus inflow from Cameroon (13.50%).

The Lake Chad Basin

The Lake Chad basin is located in Northern Central Africa, covers almost 8% of the continent and spreads over seven countries. About 20% of the total area of the Lake Chad Basin, or 427,500 km^2, is called the Conventional Basin (42% in Chad, 28% in Niger, 21% in Nigeria and 9% in Cameroon), which is under the mandate of the Lake Chad Basin Commission (LTBC) (FAO, 2004b; 2005e). This commission was created in 1964 by the four member states with the objective of ensuring the most rational use of water, land and other natural resources and to coordinate regional development. Table 8 summarizes the areas and the rainfall by country in the Lake Chad Basin.

Table 8: Lake Chad Basin: areas and rainfall by country

Country	Total area of the country (km^2)	Area of the country within the basin (km^2)	% of total area of basin	% of total area of country	Average annual rainfall in the basin area (mm)		
					min.	max.	mean
Nigeria	923,770	179,282	7.5	19.4	285	1,330	670
Niger	1,267,000	691,473	29.0	54.6	0	635	105
Algeria	2,381,740	93,451	3.9	3.9	0	135	20
Sudan	2,505,810	101,048	4.2	4.0	70	1,155	585
CRA	622,980	219,410	9.2	35.2	760	1,535	1,215
Chad	1,284,000	1,046,196	43.9	81.5	0	1,350	400
Cameroon	475,440	50,775	2.1	10.7	365	1,590	1,010
For Lake Chad basin		2,381,635	100		0	1,590	415

Source: FAO, 2005e

Rivers and discharges

Lake Chad is a terminal depression with the seven basin countries grouped around it, of which four are in direct contact with the lake: Nigeria, Niger, Chad and Cameroon. To the south is the CAR, a humid country with enormous water resources. The sources of the Chari-Logone Rivers are located in the CAR and the quantity of water leaving the country to Chad was about 33 km^3/year in the period before the 1970s, but fell to 17 km^3/year during the 1980s(FAO, 1986; 1995;1997;2004b;2005e).

The amount of water crossing the border from Cameroon to Chad varies between 3 and 7 km^3/year. More to the north, the Logone River forms the border between Cameroon and Chad until N'Djamena where it flows together with the Chari River which then continues north to the lake. These rivers have a tropical regime with a single flood occurring at the end of the rainy season, which lasts from August to November (FAO, 2004b; 2005e). They are characterized by irregular inter-annual flows and by their large water 'losses', estimated at about 5 km^3/year, due to flooding of the adjacent Yaéré lowlands in Chad and Cameroon. The largest area flooded covers about 8,000 km^2 and is used for pasture, fishing, flooded rice production and flood recession cropping. In order to expand the Yaéré area, two sites for regulatory dams have been identified on upstream branches of the Logone in Cameroon and Chad. However, this would be to the detriment of water uses for hydro-electric power generation and for irrigation outside these Yaéré lowlands.

The rivers outside the Chari-Logone basin in Chad have flash floods during heavy rains and negligible flows the rest of the time, like the Batha River. This regime seriously limits irrigation development. The Chari-Logone Rivers, with 38.5 km^3/year, contribute for about 95% of the total inflow into Lake Chad. In recent history the area of Lake Chad has varied between 3,000 and 25,000 km^2, with a variation in its level of over 8 m and a variation in volume of between 20 and 100 km^3 (FAO, 2005e). The total inflow in recent times has varied between 7 km^3/year (1984/85) and 54 km^3/year (1955/56). Due to the lowering of the lake level, ideas have been put forward to replenish the lake with water from the Congo/Zaire basin through the construction of a 2,400 km-long canal, but for the time being this is impractical on technical, economic and political grounds (FAO, 2004b; 2005e).

Irrigation potential and water requirements

The irrigation potential for the whole of the CAR is estimated at 1.9 million ha, but no details are available on location. About one-third of the country is situated in the Lake Chad basin, the remaining two-thirds being in the Congo/Zaire basin (FAO, 2004b; 2005e). A first approximation of the part of the potential in the Lake Chad basin is estimated at 500,000 ha. This would require 8.25 km^3/year of water, which is about one-quarter to a half of the total quantity of water leaving the country to Chad, depending on the period of reference (FAO, 2005e). In addition, there are an estimated 90,000 ha of oases in the Saharian zone, but most probably to be irrigated by non-renewable groundwater. The irrigation potential for Cameroon is estimated at about 100,000 ha in the Lake Chad basin. Table 9 summarizes the figures for the whole of the Lake Chad basin and for the Conventional Basin.

Table 9: Lake Chad basin: irrigation potential and water requirements, result of the country studies

Country	Irrigation potential in whole Lake Chad basin (ha)	Irrigation water requirement (km^3/year)	Irrigation potential in the Conventional Lake Chad basin (ha)	Irrigation water requirement (km^3/year)
Nigeria	502,000	5.020	300,000	3.000
Niger	48,000	0.936	40,000	0.780
Algeria				
Sudan	4,000	0.030		
CAR	500,000	8.250		
Chad	835,000	12.525	700,000	10.500
Cameroon	100,000	1.250	80,000	1.000
Total	1,989,000	28.011	1,120,000	15.280

Source: FAO, 2005e

At present, out of a potential of over 1.1 million ha in the Conventional Basin fewer than 100,000 ha are actually irrigated. However, due to the lowering of the level of Lake Chad in recent history, every new irrigation development has to be studied very carefully. Already in 1980, the maximum development was estimated at fewer than 400,000 ha by a UNDP-financed study. The recently prepared master plan for the Conventional Basin proposes to concentrate future developments on small-scale projects. Taking into consideration the above aspects, the total potential for the whole of the Lake Chad basin is summarized in Table 10.

Table 10: Lake Chad basin: irrigation potential, water requirements and areas under irrigation

Country	Irrigation potential			Gross irrigation water requirement		Area under irrigation (ha)
	within conventional basin (ha)	outside conventional basin (ha)	within the whole basin (ha)	per ha (m3/year)	total (km3/year)	
Nigeria	204,000	100,000	304,000	10,000	3.040	82,821
Niger	3,000	8,000	11,000	0.215	2,000	2,000
Algeria	-	0	18,000	0.000	0	0
Sudan	-	4,000	4,000	7,500	0.030	500
CAR	-	500,000	16,500	16,500	8.250	135
Chad	142,500	135,000	277,500	15,000	4.163	14,020
Cameroon	46,700	20,000	66,700	12,500	0.834	13,820
Total	396,200	767,000	1,163,200		16.531	113,296

Source: FAO, 2005e

The Global Environmental Facility (GEF) Project titled **‘**Reversal of Land and Water Degradation Trends In the Lake Chad Basin Ecosystem: Establishment of Mechanisms for Land and Water Management’ that ended in 2008, has been one of the biggest opportunity to achieve global environmental benefits through concerted management of the naturally integrated land and water resources of the Lake Chad Basin through overcoming barriers to the concerted management of the basin through well-orchestrated and enhancing collaboration and capacity building among riparians and stakeholders. This project set-up the bases for the long term management of water resources in the Lake Chad as it established mechanisms and Program Co-ordination Unit and country lead agencies as well as regional policy and institutional mechanisms. It has provided for the participation and education of institutionalized stakeholder, their involvement through development of local initiatives combined to the test of methodologies, implementation modalities, developed measurements, and synthetic basin framework. It built a financial capital via donor support mobilized for GEF-SAP and LCBC Plan implementation. These assets can be used for the implementation of future actions and intervention within the Lake Chad Basin.

The Zambezi Basin

The basin is the fourth-largest river basin of Africa, after the Congo/Zaire, Nile and Niger basins. Its total area represents about 4.5% of the area of the continent and spreads over eight countries. The Zambezi River flows eastwards for about 3,000 km from its sources to the Indian Ocean (FAO, 2004b, 2005e).The Zambezi basin in DRC in terms of areas and rainfall is not well documented as well as the irrigation potential and water requirements and areas under irrigation. Further downstream, no particular problems are expected in terms of water resources. However, water regulation would be necessary for full development of the potential.

The Ogooué (or Ogowe) River Basin

The Basin cover an area of 223,856 km^2 (86,431 sq mi), that 173,000 (73%) are part of the Gabon area, some 1,200 km long, is the principal river of Gabon (FAO, 2004b; 2005e). Its watershed drains nearly the entire country of Gabon, with some tributaries reaching into the Republic of the Congo, Cameroon, and Equatorial Guinea. It average discharge is 4,706 m^3/s (166,200 cu ft/s). The Ogoue River rises in the northwest of the Bateke Plateaux near Kengue, Congo-Brazzaville. It runs northwest, and enters Gabon near Boumango. Poubara Falls are near Maulongo. From Lastoursville until Ndjole, the Ogooue is non-navigable due to rapids. From the latter city, it runs west, and enters the Gulf of Guinea south of Port Gentil. The Ogowe Delta is quite large, about 100 km long and 100 km wide (FAO, 2004b; 2005e).

The catchment area has an average population density of 4 people per km^2. It mostly consists of undisturbed rainforest with some grassland. It is home to a high biodiversity. All three species of crocodile, for instance, occur in the river: the Nile crocodile (*Crocodylus niloticus*), the dwarf crocodile (*Osteolaemus tetraspis)*, and the slender-snouted crocodile (*Mecistops cataphractus*).

The main economy importance of the Ogooué is its navigability from Ndjole to the ***sea***. This river is used to bring wood to the Port Gentil Harbour. The Ogowe Basin includes several parks such as the Lope National Park.

The Cross River Basin

The Cross River basin encompasses an area of 70,000 km^2, of which 50,000 km^2 is in Cross River State, Nigeria, and the remaining 20,000 km^2 is in Cameroon. The entire Cross River basin is located within the evergreen rain-forest belt, except for a small savanna belt located at 7°N and drained by a principal tributary, the Anyim River(FAO, 2004b; 2005e).

There are two different climatic seasons in the area, the rainy season from March to October and the dry season from November to February. Year round rainfall of approximately 2,942–3,424 mm occurs, with maximum precipitation occurring from July to

September. Based on physiogeographic, ecologic, and zoogeographic considerations, the Cameroon section of the Cross River basin is referred to as the Upper Cross River, while the Nigerian section is termed the Lower Cross River. The Cross River isformed from the numerous headwaters of the western slopes of the Cameroon highlands, which has two extensions in Nigeria, namely the Oban hills in the south and Obudu Plateau that is further north. The main channel of the Cross River is 6,000 km from its source to its mouth. The Cross River enters Nigeria at Ekok (a town on the border with Cameroon). Downstream of Ikom, the Cross River is joined by the Afi River, a northern tributary that drains the Oshie Ridge of the Sankwala Mountains (FAO, 2004b; 2005e). The basin is characterized by the absence of any well-developed flood plains and the presence of numerous ecologic and zoogeographically important high-gradient streams, rapids, and waterfalls, one of which is the Agbokim Waterfalls, another study site. The swifter upper reaches of the river basin often have a rocky or stony substratum. All these topographic features are conducive for the breeding of black-flies, especially in the rainy season (FAO, 2004b; 2005e).

Little information is available in the human activities around the cross river basin and future studies should explore this more deeply.

The Benito/Ntem, Nyanga, Chiloango, Utamboni, Mbé, Akpa rivers basins

These basins are shared between few countries and their size appears small compared to the aforementioned basins rivers. In addition, very little information is available on them despite their strategic and economic importance.

CHARACTERISTICS OF MAJOR LAKES IN CENTRAL AFRICA SUB-REGION

Central Africa sub-region holds many important lakes, which are mainly located in the east of the sub-region as presented in Table 11.The Lake Chad is the largest of the sub-region, although due to the successive hard dry seasons, its depth has significantly decreased over the past decades (UN, 1988; UNICEF, 2005; World Bank, 2005; CEEAC, 2006; 2009; 2010).

Table 11: Major lakes in central Africa

Lake	Size (1000 km²)	Depth (m)	Countries of Central Africa sharing the Lake
Chad	2,388,700	-	Cameroon, CAR and Chad
Kivu	2,700	1,460	DRC, Rwanda
Tanganyika	140,000	1,453	DRC, Burundi
Albert	5,270	618	DRC, Uganda
Edouard	5,600	927	DRC, Uganda
Moero	5,100	927	DRC, Zambia

Source: CEEAC (2006; 2009; 2010)

LARGE DAMS BY MAJOR RIVER BASIN IN THE SIX STUDY COUNTRIES

In Central Africa sub-region, the capacities on mobilization of water resources are still weak. For instance, Central Africa sub-region holds a total of 44 dams while Burkina Faso and South Africa have respectively 78 and 517 dams respectively as shown in Table 12 (PNUE, 2002; FAO, 2005c; 2005e; World Bank, 2005). The total dam capacity of the six countries is 300.5 km^3, representing 65% of the total dam capacity of Central Africa, relates to the capacity of 18 large dams built in 7 river and lake basins (FAO, 2005e; CEEAC, 2006; 2009). These dams are mainly used for hydroelectricity production (Cameroon, Congo, DRC, and Gabon) and irrigation and livestock watering (Cameroon and DRC), water supply for population (Cameroon), navigation (DRC, Congo, and Cameroun), regulation of flooding and recreational activities (Cameroon) (Table 12).

Table 12: Large dams by major river basin in central Africa

River basin	Countries in basin	Number of existing large dams (> 1 km³)	Height of dams (m)	Reservoir capacity (km³)	Total reservoir capacity (km³)	*Main purpose
Niger	Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria,	6	23 -79	2.2 – 15.0	31.4	I, H
Lake Chad	Algeria, Cameroon, Central African Republic, Chad, Niger, Nigeria, Sudan	4	14 -48	1.9 – 6.5	16.6	I
Nile	Burundi, Egypt, Eritrea, Ethiopia, Kenya, Democratic Republic of the Congo, Rwanda, Sudan, United Republic of Tanzania, Uganda	6	22 -111	0.9 – 162.0	174.9	I, H
Congo	Angola, Burundi, Cameroon, Congo, Central African Republic, Democratic Republic of the Congo, Rwanda, United Republic of Tanzania, Zambia	2	50 -58			H
Djerem, Mape, Noun	Cameroon	3	17 -34	1.8 – 3.2	7.6	H
Total		18	25-66	1.7-46.7	300.5	I,H

Source: CEEAC (2009; 2010). * I = Irrigation, H = Hydropower, 1 km^3= 109 m^3 = 1 billion m^3 = 1 000 million m^3

WATER WITHDRAWALS BY END USE SECTOR: RENEWABLE VERSUS NON-RENEWABLE RESOURCES

The data on water withdrawal refer to the gross quantity of water withdrawn annually for a given use (FAO, 2005d; e). Table 13 summarizes the distribution of water withdrawal by country for the three large water-consuming sectors: agriculture (irrigation and livestock watering), water supply (domestic/municipal use), and industry. Although able to mobilize a significant portion of water, requirements for energy purposes (hydroelectricity), navigation, fishing, mining, environment and leisure activities have a low rate of net water consumption. For this reason, they are not included in the calculation of the country withdrawals but they do appear in the country profiles where information is available (FAO, 2005e).

Referring to the gross quantity of water withdrawn annually, the water withdrawal rate (as a function of internal renewable water resources) is the lowest in the Central Region of Africa (0.1%), the Northern region showing the highest rate (200%).The domestic water withdrawal per inhabitant is 25 m^3/year for the entire continent, which is low, with rather small regional and national variations as compared to agricultural water withdrawals (from 7 m3/inhabitant/year in the Central Region to 58 m^3/inhabitant/year in the Northern Region).

The total annual water withdrawal for the six countries included in the study is 1,634 million m^3, or barely 0.15% of the total renewable water resources on these countries (Table 13) (FAO, 2005e). On a regional scale, an average of 58 % inventoried withdrawals is used by municipalities, which is higher than the average of 10% for the African continent, 27% for agriculture (far below the average of 86% for the African Continent) because the annual precipitation in this region allows rainfed agriculture. Only an average of 15% is used for industries, but higher compared to the average of Africa (4%). Cameroon allocates 74% of its withdrawals water to agriculture. The amount of water withdrawn appears very high in Equatorial Guinea (233 m^3/year) while CAR and DRC have the lowest (6 m^3 and 7 m^3/inhabitant/year respectively). At regional scale, the average annual volumes of water withdrawn per inhabitant are 21 m^3 in the Central Region and 76 m^3 for the six countries involved.

Table 13: Water withdrawals in the six countries

Country	Year	Annual water withdrawal									
		Agriculture		Municipalities		Industries		Total			
		Volume (10^6 m^3)	% of total	Volume (10^6 m^3)	% of total	Volume (10^6 m^3)	% of total	Volume (10^6 m^3)	in % of IRWR	in % of TRWR	per inhab (m^3)
		(1)	(2) = 100 x (1)/(7)	(3)	(4) = 100 x (3)/(7)	(5)	(6) = 100 x (5)/(7)	(7) = (1)+(3)+(5)	(8)	(9)	(10)
Cameroon	2000	728	74	178	18	79	8	985	0.4	0.3	65
CAR	2000	1	5	17	77	4	18	22	0	0	6
Congo	2002	4	9	32	70	10	21	46	0	0	13
DRC	2000	112	31	186	52	58	16	356	0	0	7
Equatorial Guinea	2000	1	1	88	83	17	17	106	0.4	0.4	232
Gabon	2000	52	41	62	48	14	11	128	0.1	0.1	102
Total		898	27	563	58	182	15	1,643	0.15	0.1	71
Africa	-	184,349.1	86	21,462.3	10	9 003	4	21, 814.4	5.5	-	247

Source: (CEEAC, 2006; 2009; FAO, 2005e).

LAND USE AND IRRIGATION POTENTIAL

The total area covered by the six countries is 408 million ha, representing 10% of the total area of Africa and the total cultivated area is 18 million ha, representing 8.5% of the total cultivated area in Africa (FAO, 2005d; e). The irrigation potential of the six countries of central Africa sub-region is estimated at more than 10 million ha, considering irrigation potential by basin and renewable water resources (FAO, 1986; 1995; 1997; FAO, 2004b; 2005a). Cameroon and DRC account for 80% of the total cultivated area of the six countries in 2002 (Table 14) and the same percentage this potential is concentrated in the DRC. For this country, the irrigation potential is less than the area under water management (ICID, 2005). The average irrigation potential of the six countries is 5.35% of cultivable area, which is far below the average of other African regions with the CAR having the highest irrigation potential (12.7%) and Cameroon with the lowest (1.9%). This situation resulted into the weak increment of food production in several countries such as DRC and CAR. At the current rhythm, if drastic measures are not taken, the food consumption per habitant in Sub-Saharan Africa will not reach the level of 2,700 kcal/inhab/day, that is an indicator of the level of satisfaction of needs in food security, which Gabon is likely to achieve with energy availability of 2,610 kcal/inhab/day since 2002 (CEEAC, 2009; 2010).

CHAPTER 3 Key Water Issues

WATER STRESS

In Central Africa and particularly in the 6 countries, the flow of below ground water is very important and it was estimated at 1922.5 km^3/year. However, the rainfall regimes between the beginning of 1900 and the 1980s showed an overall decrease of the average rainfall since 1968 (WHO, 2005; UNICEF/WHO, 2005; CEEAC, 2006; 2009). In fact, the curves of the rate of water flow measured at the two water metric stations located in the Congo River and the Lake Chad reveals a negative trend that confirms the deficit observed since the 1980s. Since the last 20 years, the rainfall deficit has been observed within the whole inter-tropical Africa and this has an influence on the hydraulicity of rivers in the humid equatorial Africa and on the level of water in the large lakes (GWP-CAf, 2010). Based on the data available, it has been remarked that this decrease continues despite the normal re-establishment of rainfalls regime that has taken place.

Although, there are basic documents adopted by key stakeholders in Lake Chad, there are still no significant improvements in river basins management. The main factors to that include a combination of effects of climate fluctuations and unsustainable water projects that led to significant reductions in the flows of the rivers that drain into Lake Chad. In turn, this situation has resulted in the shrinkage of the lake.

Table 14: Land use and irrigation potential

Country	Total area (ha)		Cultivable area (ha)		Cultivated area (ha) (2002)		Irrigation potential	
	Area 10^3	per inhab	Area	per inhab	area	per inhab	Area (ha)	% of (3)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=100 x (7)/(3)
Cameroon	47,544	2.92			7,160,000	0.44	290,000	1.9
CAR	62,298	15.92	15,000,000	3.83	2,024,000	0.52	1,900,000	12.7
Congo	34,200	8.96			240,000	0.06	340,000	2.3
DRC	234,486	4.31	80,000,000	1.47	7,800,000	0.14	7,000,000	8.8
Equatorial Guinea	2,805	5.53	850,000	1.68	230,000	0.45	30,000	3.5
Gabon	26,767	19.81	15,155,000	11.22	495,000	0.37	440,000	2.9
Total	408,100	9.575	111,005,000	3.03	17,949,000	0.33	10,000,000	5.35

Source: adapted from FAO (2005d; 2005e)

CONFLICTS OVER WATER

There are not too many conflicts over water in the region except for Lake Chad, where there is a very high potential for having conflicts. However, there is a competition for water access in many towns within the regions because of the lack of urban planning and the proliferation of slum towns. The intensity of competition between different land and water users has been exacerbated by the failure of traditional rules governing peaceful relationships (GWP-CAf, 2010). In the absence of new guiding rules and regulations that are equitable and properly enforced, the breakdown of law and order is inevitable in many countries (Commission for Africa, 2005).

SUB-REGIONAL COOPERATION IN WATER AND CONSTRAINTS TO THIS, CLIMATE CHANGE INDUCED ISSUES

The main international river basins are, in decreasing order of area: Congo (Zaire), Nile and Lake Chad (CEEAC, 2006; 2009). These basins cover nearly half of the total area of the continent. The water in these river basins, shared between several countries, is managed through basin organizations that group together all or some of the countries included in one basin (FAO, 2005e; UNECA, 2006). Of the basins mentioned, only the Congo River Basin, which is the largest African river basin, does not have any organization to coordinate actions related to the water resources.

The Economic Community of Central African States (ECCAS) promotes water resources management. It recently adopted a regional water policy, which will be implemented through the following five strategic principles:

- creation of an enabling environment for good water governance at national, basin and regional levels;
- definition of the principles of integrated water resources management (IWRM);
- stakeholder participation and gender mainstreaming;
- implementation of programmes for water resources development, in areas such as water supply, sanitation, water for agriculture and livestock, hydro-electricity, fisheries, navigation and tourism;
- capacity building through training, education and research (CEEAC, 2009; 2010).

Global Water Partnership, Central Africa (GWP-CAf), the youngest of the 14 GWP Regional Water Partnerships, was instrumental in assisting ECCAS develop the regional water policy. As a neutral stakeholders' platform for dialogue, GWP-CAf will contribute to implementing the policy by supporting the establishment of a coordination unit for water resources management within ECCAS, providing strategic and technical support, and helping in mobilizing resources.

GWP-CAf closely works with one of the two major basin organisations in the region, the International Commission for the Congo-Oubangui-Sangha Basin (CICOS). It was instrumental in shifting CICOS' focus from navigation to a fully integrated basin management approach. GWP-CAf is now assisting CICOS in developing its Basin Strategic Action Plan involving all basin stakeholders, at regional and national levels.

STAKEHOLDERS IN WATER SUPPLY, USE, TRADE AND MANAGEMENT

Water sector is full of stakeholders in policy, supply, use, trade and management areas in all the six countries (CEAC, 2010) who are described in the following paragraphs.

Regional bodies

Most of them are in-charge of the formulation of regional approaches and coordination of efforts to sustain the management of water resource. For this purpose, the role of Global Water Partnership and Africa Water Facility and global actors such as UNDP, UNEP, UNOPS, Africa Development Bank and ECCAS has made a substantial contribution in the development of these regional and to translate MDGs and Africa Water Vision 2025 into a regional perspective.

Ministries in-charge of water

They are in-charge for the development of national water policy by internalizing regional policies. They play a key role in providing the suitable legal and institutional environment for the development of water sector.

National companies

Most of them are in-charge of technical dimensions i.e. for the translation of water policy into practices. They are responsible for the distribution and regulation of water resource market.

Private sector

Most of private actors are involved in the distribution and trade of water resource management, sometimes as sub-contractors and in some countries as major contractor to implement water policy.

Local institutions such as municipalities

Municipalities are key stakeholders in the development of urbanization and this requires from their side an anticipation of the master of water access and distribution within the urbanization taken as a long-term plan process.

NGO and local communities with their multiple uses

NGO plays also a key role in the advocacy and the implementation of rural projects targeting water access and even in urban areas where they are involved with municipalities to support the development of water projects.

Association of consumers

These associations have emerged over the past two decades with the move of democratization and liberalization that took place in many African countries. They are important actors in the advocacy and lobby for a better regulation on price and access to water quantity and quality to urban and rural populations.

THE REGIONAL BODIES MANAGING WATER RESOURCES

Three major sub-regional bodies on water management that seem to be the most important are presented in the following paragraphs.

The Lake Chad Basin Commission

The Lake Chad Basin Commission (LCBC) was created in May 1964 by the leaders of the states that share Lake Chad (Cameroon, Chad, Niger and Nigeria). The CAR became the fifth member in 1994. Algeria and Sudan, also included in the lake basin, are not part of the "conventional basin". The main objectives of the LCBC are: (i) to conserve the limited water resources; (ii) to restore the water level in Lake Chad, which is one of the largest wet zones in Africa; (iii) to combat desertification through dune fixation; (iv) to combat erosion and to initiate programmes of plant regeneration; and (v) to collect data on the resources for an effective management of the river basin (FAO, 2004; FAO, 2005d; 2005e; CEEAC, 2006).

The Niger Basin Authority

Created in 1980, the Niger Basin Authority (NBA) is the successor to the Niger River Commission, created in 1964. Of the ten countries included in the basin (Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria), only Algeria is not part of the NBA. The objective of the NBA is: "to promote cooperation between member countries and to ensure an integrated development of the resources of the river basin, notably in energy, water, agriculture, livestock, fishing, aquaculture, forestry, wood, transport and communication, and industry". To achieve this, it is necessary to accomplish the following three objectives: (i) harmonize and coordinate the national policies on the development of the resources in the basin; (ii) plan river basin development by developing and implementing an "integrated river basin development plan"; and (iii) conceive, develop, undertake and maintain common works and projects (FAO, 2005a; PNUD, 2005; CEEAC, 2006; 2009; 2010; NBA, 2010).

The International Commission for the Congo-Oubangui-Sangha Basin

The International Commission for the Congo-Oubangui Sangha Basin (CICOS) has the mandate and competency to assume the efficient and effective coordination of the activities of the national institutions directly related to the interior navigation of international interest (CEEAC, 2006; 2009; 2010; CICOS, 2010). However, it should be mentioned that the agreement already mentioned as Legal Framework governing the Commission did not adequately take into account the integrated water resource management, notably the water cycle and its multiple uses. These problems linked to the governance and the uses of water form the challenges that could not be addressed again in a sectorial or local perspective, neither separately nor otherwise. The challenges are:

- the request for water transfer ;
- the pollution of river Basin ;
- the spreading of invaded plants;
- the disappearance of forest cover and water erosion,
- the dropping of water draught required for navigation.

To address these challenges, an additive to the agreement on institutionalizing a Uniform River Regime and creating the *Commission Internationale du Bassin Congo-Oubangui-Sangha* (CICOS) has been elaborated by the water experts, approved by the Ministers Council of the CICOS in order to adopt the principles of IWRM. This complementary Legal Framework confers to the CICOS, the competencies of the Basin Authority in full exercise (CICOS, 2010).

FOREST AND WATER SUPPLY IN THE SUB-REGION: KEY WATERSHEDS/RIVER BASINS IN RELATION TO FOREST ECOSYSTEMS

Relationship between forests and hydrological goods and services: forest cover and watersheds

Goods and services linked to water resources are numerous and vital, but often underappreciated. The Congo Basin forested region forms part of the Congo Basin watershed that provides its inhabitants with multiple water-related benefits, including water supply, flow regulation and water quality (State of Forest Report, 2008). The watershed is characterized by a dense river network that serves as an important navigation system for Central Africa, plays a large role in food supply and local livelihoods, acts as habitat for a range of plants and animals and has significant hydropower potential (Brummett et al., 2008). Some of the goods and services provided by the hydrological system in the Congo Basin and the relationship between forest ecosystems and the water resources that provide these benefits have been already examined and explored (Brummett et al., 2008). A flexible spatial definition will be applied; the primary focus is on the Congo Basin forested region, but some consideration is given to the entire Congo River Basin and to major coastal cities on rivers outside the hydrological basin that benefit from hydrological goods and services. The section starts with a picture of the water system in the Congo Basin, followed by a rundown of select hydrological goods and services, a description of the relationship between forests and water resources in large river systems and with analysis of the challenges and opportunities with a sub-section on the state of knowledge and water resource management in Central Africa.

The forests of Central Africa sub-region overlap with several major basins: the Congo, the Ogooué, the Sanaga, the Cross, and the lower Niger. There are also many smaller basins that drain into the Gulf of Guinea. The Congo River basin, with annual renewable water resources of about 1.3 billion cubic meters, is the largest of these basins and accounts for about 30 % of the water resources in Africa and was estimated to contain a population of approximately 77 million inhabitants in 2005. Known as the largest basin in Africa covering an area in an order of 4 million km^2; the Congo River has an annual average discharge at Brazzaville of about 41,000 m3/s. The Basin includes portions of ten different countries, but 85.3 % of the Congo River basin falls within the largely forested regions of four countries: Cameroon, CAR, the Democratic Republic of Congo and the Republic of Congo. Within the Basin the hydrological network is very dense and includes a complex river network, vast flooded forests and lakes.

Several studies have been conducted to understand the biodiversity and resources used dynamics. As an example, in the lower Congo, it has been documented the presence of over 300 fish species and of these upward of 80 appear to be endemic, with its unique hydrological regime, represents a model system for exploring the interplay of complex hydraulic conditions, channel features of extreme depth, and patterns of species richness and drivers of local endemism. Water resources are regional services that are strongly influenced by their ecosystem. Vegetation is often the primary influence of these ecosystem effects on hydrological services. In a forest ecosystem, forests influence the hydrological cycle by regulating the quantity and timing of water and nutrients being added to the system. The extent to which ecosystems are affected is dependent on the size and distribution of different ecosystems within a catchment system as well as the frequency, duration and intensity of climatic events. Larger forests, such as the Amazon or Congo Basin play a critical role in both controlling the quantity and quality of water circulating in a watershed or river basin as well as influencing climate at the global level.

The Role of Forests in the Congo Basin Water Balance

Forest Cover and Watersheds

Relative to other comparable forested regions, far less research has gone into understanding the relationship between forests and water in the Congo Basin (Box 1). However, studies from other areas can provide insight into how forest cover may affect water systems. The common perception is that “forests are good for water,” acting like sponges to absorb high rainfalls and releasing water slowly through drier periods (Brummett et al., 2008). While it is generally accepted that forests improve water quality, moderate peak flows and sequester carbon dioxide, trees can also use more water than other vegetation types and so the net water balance may mean that less water is provided to downstream areas than for other land covers. This increased water use is due to the larger rooting depth of trees (compared with grassland or agricultural crops) allowing them to access water from a greater portion of the soil profile, and sometimes even from the sub-soil. Forest also presents a rougher surface than shorter crops, thus increasing the efficiency of gas exchanges with the atmosphere.

Evidence of the greater water use of forests has been accumulated mainly from studies, almost exclusively for montane forests, where these later have been cleared and net water supply has increased, albeit in a much more irregular flow distribution pattern. No declines in annual streamflow totals following lowland tropical forest removal have been reported from literature. In the Congo, the effects of deforestation on rates of evapotranspiration are expected to be particularly significant because a large portion of rainfall, (between 75-95 %), comes from recycling moisture from the region’s forests. A recent study mapping forest clearing over the last decade for the entire Congo Basin, at a spatial resolution that allows forest clearing to be examined on a per watershed basis, will provide important data for future studies.

Forests and water quantity

According to Brummett et al. (2008), the conversion of precipitation to groundwater and streamflow is reduced by the interception of forests and by evaporation from the tree canopy. It is reduced further through transpiration of soil moisture from foliage. These can be described as losses to the useful water system, but it is through this water use and photosynthesis that trees produce wood, leaves, flowers, fruit and seeds. The shortage of water can then has a significant influence on bio-ecological processes. With its flora and fauna, the forest ecosystem is a major user of water, but also provides enormous benefits for humanity: from birds to boards to bears, from fuelwood to medicines, from carbon fixation to orchids and chestnuts, there is a treasury of products from forest biodiversity. Recreation and landscape aesthetics can be added to these, as well as a high degree of soil erosion control, and – in the right circumstances – avalanche hazard reduction.

Human society is concerned about the beneficial and limiting impacts of forests on water quantity, because sometimes there is too much water (flooding) and sometimes not enough. This concern involves many myths and misunderstandings and much misinterpretation and misinformation (Hamilton, 1985). It has been claimed, for instance, that logging and land clearing in the Nepalese Himalayas have been responsible for devastating flooding of the lower Ganges in India, and that restoring forests can cause dry rivers to flow again, relieving drought. Such misinterpretations of hydrological science persist.

Increased erosion and sedimentation can reduce the capacity of stream channels at both upstream and downstream locations. Flows that would previously have remained within the streambanks may now flood. For precipitation events that are not extreme in amount and duration, these impacts can have a noticeable effect on stormflow volume and on peak magnitude and timing. As the amount and duration of precipitation increase, the influence of the soil-plant system on stormflow diminishes. The influence of vegetative cover is therefore minimal for the extremely large precipitation events that are usually associated with major floods.

In saline-prone areas, it would bring salts closer to the soil surface. In cloud forest, it would reduce water input into the catchment. A major dilemma is that although water quantity can be increased by forest removal, the land uses replacing forest are more intensive in human and/or animal activity. It has been shown that tree harvesting through partial cutting or forest regeneration retains the site in tree cover (rather than converting it) and temporarily increases water yields throughout the year, but the use of skid trails, haul roads, winching channels and landings for the removal of wood tends to impair water quality, owing to accelerated erosion until recovery is complete. The greatest yield increases will occur on the deeper soils, where deep root systems exploit more soil moisture. The effects of reforestation or afforestation on water yields are usually the reverse of those for forest removal (Hamilton and Pearce, 1987).

Box 1: Effects of forest manipulation on water yield

- Carefully executed, light selective harvesting will have little if any effect on streamflow, which increases with the amount of timber removed. The data set for the humid tropics supports the general finding of Bosch and Hewlett (1982) that removal of natural forest cover may result in a considerable initial increase in water yield (up to 800 mm per year); possibly more in high rainfall regions, depending mainly on the amount of rain received after treatment.
- Depending on rainfall patterns, there is a rather irregular decline in streamflow gain, with time, associated with the establishment of the new cover. No data have been published regarding the number of years needed for a return to pre-cut streamflow totals in the case of natural regrowth, but it may take more than eight years.
- Water yield after maturation of the new vegetation may: remain above original streamflow totals in the case of conversion to annual cropping, grassland or tea plantations; return to original levels (*Pinus* plantation after full canopy closure); or remain below previous values (reforestation of grassland with *Pinus* or *Eucalyptus*). Coppicing of *Eucalyptus* after ten years caused even stronger reductions for two years.

Source: Extracted from Bruijnzeel (1990).

They vary depending on whether the land is still in reasonable hydrological health or has been severely degraded from long-term, non-conservative use. Locally, for frequent short, low-intensity storm events, flash flooding should be reduced where soils are deep. On the other hand, low flows are usually diminished as well, especially where fast-growing, heavy water-using species are employed.

Box 2: State of Knowledge

Compared to other vast river systems in the world, little information and research is available for the Congo Basin. Quantitative data on water resources within the Congo Basin has always been limited. The collection and management of information on water resources are difficult for numerous reasons, including:

- the dilapidated state, and low density, of data collection sites for hydrological, limnimetric or meteorological information;
- few stations are operational, most are manual and they are usually limited to large freshwater areas.

- the discontinuity in the hydroclimatological data series in the vast majority of hydroclimatological stations across the Basin; very few continuous data sets, where continuous refers to constant data collection since pre-1960, exist; even rarer are meteorological or hydrological stations with a continuous series of data for the past 100 years; the data that is most frequently presented have been collected through remote sensing;
- the lack of coordination between different sectors concerned with water resource management in all the riparian countries.

However, some historic data are available for: the Congo from 1902 (station in Kinshasa), 1907 (station in Kisangani), and 1912 (station in Kindu); from 1911 for the Oubangui (station in Bangui) and from 1948 on the Sangha river (at Ouesso). Daily water levels are measured at Bangui, Ouesso, Brazzaville and Kinshasa. The three organizations charged with monitoring flow in the Congo Basin are:

- the River waterways authority [*Régie des Voies fluviales* (RVF)] in DRC for the middle and upper portions of the river;
- the Sea waterways authority [*Régie des Voies maritimes* (RVM)] in DRC for the lower Congo;
- the waterways maintenance shared service [*Service commun d'Entretien des Voies navigables* (SCEVN)] in CAR and RDC for the Congolese section of the river and Oubangui.

Furthermore, the African Monitoring of Environment for Sustainable Development program (AMESD) in Central Africa aims to develop a monitoring system for water resources in the Congo Basin. Implemented by CICOS for Central Africa, AMESD will utilize existing meteorological satellite data receiving stations in seven Central African countries, install additional environmental receiving stations in key organizations and built the capacities of regional experts with the aim of providing regular information on water levels and the water cycle (rainfall, runoff and evapotranspiration will be measured). Two operational services will be developed: one to alert on low waters for navigation, and one to monitor the impact of deforestation and climate change, initially on the Oubangui sub-basin water resources.

Source: Extracted from Brummett et al., 2008.

IMPLICATION OF FOREST MANAGEMENT ON WATER BUDGETS: POLICIES, REGULATIONS, CHALLENGES AND OPPORTUNITIES

The forest plays an important role in maintaining the quality and quantity of water in the Congo basin. The relationship between forest and water resources has been already acknowledged in various scientific literature and study reports (AWF, 2003; AfDB, 2007); particularly, regarding the role of forest gallery on the regulation of river course and/or water source. But the major problem remains the lack of sectoral integration in the different countries, and the lack of water code, which can better create the conditions for this to take place (CEEAC, 2009; 2010). The preservation of natural aquatic ecosystems represents a major challenge because the development and conservation of water resources strongly depend on it. The importance of deforestation and land degradation in Central Africa constitute the two main threats having a high incidence on the development of water resources but very studies have been conducted to capture the real impacts of these threats on the water quantity and quality. In addition to these threats, others non-neglected impending factors include:

- the lack of legal frameworks for the control of water quality and management of industrial wastes (except in Cameroon);
- the excessive proliferation of invasive aquatic plants within water plans (e.g. water jacinth, water lettuce);
- the importance of land degradation, this affects the transport of important solids in the water course (case of Congo River) (CEEAC, 2010).

It is increasingly recognized that both the availability and quality of water are strongly influenced by forests and that water resources in many regions are under growing threat from overuse, misuse and pollution (FAO, 2005d; 2005e; Brummett et al., 2008). The relationship between forests and water is therefore a critical issue that must be accorded high priority. A key challenge for land, forest and water managers is maximizing the wide range of forest benefits without detriment to water resources and ecosystem functions. To address this challenge, there is urgent need for better understanding of the interactions between forests/trees and water (particularly in watersheds), for awareness raising and capacity building in forest hydrology, and for embedding this knowledge and research findings in policies. There is also need to develop institutional mechanisms to enhance synergies in forests and water issues, and to implement and enforce national and regional action programmes.

Box 3: Payment for Watershed Services

The ecosystem services delivered by a particular geographical location and habitat will provide benefit both to the location itself and to others at a distance. In current market conditions and governance structures, the costs of protecting these ecosystem services, in terms of proactive management or lost opportunities to carry out other activities, falls predominantly on those in the provider location. It is thus important when considering the ecosystem service of an area to identify the flows of benefits, so that the full value, in ecological terms, can be assessed. So, for example, forests provide services at the global level (regulating climate, sequestering and storing carbon dioxide, biodiversity, as a source of medicinal plants), at the national/regional level (e.g., timber resources, opportunities for eco-tourism), at the river basin level [e.g. clean water, regulated river flows (less floods, higher dry season flows), reduced sediment supply] and at the local level (e.g. timber, firewood, water, non-timber forest products).

Forests in many areas of the world are under pressure primarily due to the clearance of land for food production or timber extraction. There is much evidence that such activities cause the loss of a whole range of ecosystem services at all levels from global to local. Therefore, it is argued that those who would benefit from the protection of such services should contribute financially to their protection.

This is one of the underlying principles of the global carbon market (although this also allows swapping of damaging behavior in one location for carbon storing actions in another). The idea of ecosystem service beneficiaries paying managers of the land elsewhere to protect those services either proactively, or through not taking some action (such as forest clearance for agriculture) is the concept behind payment for Environmental services (PES).

At the watershed, or river basin level, this is often called payment for watershed services (PWS), although it can be argued that this is only a partial picture of the services delivered predominantly through transfers of water and mass (sediment, nutrients, contaminants). It is now recognized globally that with ever increasing population and standards of living, the environmental resources of the planet are becoming stretched to, and sometimes, beyond, their limit; climate change is the obvious pressing example. Many governments, NGOs and scientists are now starting to advocate ecosystem approaches and PES schemes to protect and restore the environment to address such concerns.

Source: Brummett et al., 2008.

With funds from GTZ and the African Development Bank, CICOS has been tasked with the preparation of a strategic action plan for integrated management of the Basin's water resources. As part of this plan activities are likely to include the rehabilitation of an *in situ* hydrological network within the Basin (complementary with the AMESD satellite monitoring system), the creation of an information management system within the CICOS Secretariat and capacity building to implement activities in accordance with the principles and strategies agreed with the riparian countries. It is hoped that this approach will promote well-coordinated policies at the national, regional and transnational scales that seek to balance long-term water needs, essential ecological processes and economic gains.

CICOS recognizes that the management of vast river basins is dependant on many factors, including: the ecological nature of the basin, demographic and socioeconomic conditions, the historical context of the Basin, partnerships, regulating texts and laws, the engagement of governments, financial factors and planning. Given all of these different variables it is difficult to provide a comprehensive strategy of resource management for water resources in the Congo Basin; however, CICOS has identified some underlying principles that are necessary to implement effective resource Management***.***

CHAPTER 4 Lessons Learnt and Experiences that can be Shared

The lessons learned and experiences to be shared are based on the implementation of several local, national and transboundary projects and seem to concern pure water management than forest-water management such as: (i) Cameroon: Planning for sustainable water resources development and management ; (ii) Transboundary: Reversal of land and water degradation in Lake Chad ; (iii) Transboundary: Capacity Building Actions in Groundwater Management Issues as an aspect of IWRM for the Nile Region; (iv) Cameroon: Local initiative to protect Lake Ossa ; (v) Cameroon: Challenges in Kumbo community to improve water supply management; (vi) Transboundary: Lake Chad Commission wants to save the lake and mitigate conflicts (GWP-CAf, 2005; 2010). The following lessons are drawn:

- independent organizations, such as international NGOs, can play a unique role as a catalyst, facilitator, technical adviser and 'honest broker';
- relatively small financial investments can generate significant conservation results ;
- Transboundary protected area designations can help to 'unlock' international financial cooperation on forest-water relations ;
- hydrogeological capability makes groundwater allocation more effective, but the issues remain to ensure the institutional and regulatory frameworks as well as management instruments for the sustainable management of this precious resource;
- local NGOs can be vehicles for the mobilisation and enhancement of the skills of different stakeholders, organising and formalising users associations, building capacity and facilitating dialogue and concerted action through participatory action processes;
- deteriorating drinking water supply service delivery can trigger community mobilisation leading to a complete take-over and management of the system by local communities; furthermore, the participatory management is important in resolving water catchment conflicts and improves cost recovery; command and control decision-making paradigm and deteriorating drinking water supply services can be triggered for social and political instability, as well as sources of water related conflict; community based organisations can be suitable platforms to enhance participatory governance for efficient and effective management of water resources and conflict resolution;
- the absence of an integrated drainage basin management strategy is partly responsible for the conflicts regarding Lake Chad; although feasible technical solutions are known, water authorities in charge have lacked the will to implement them;

Very few initiatives have been taken to address water management from forest management perspective in the entire Congo basin in terms of research and development.

CHAPTER 5 Way Forward With Forest-Water Relations in the Sub-Region

The way forward is related to the gaps to fill in terms of policy, science and forest-water management in the short term perspective to create the conditions for the sustainable management of water resources. Among this, we have:

- the biggest issue remains the cross-sectoral integration between forest and water but also with others sectors such as energy, agriculture, transport, fisheries, lands, domestic used;
- the development of water code in various countries can enable the integration of the two key sectors (forests and water);
- the internalization of the IWRM both at the national and regional levels;
- the challenge of water governance that could improve equitable access, avoid conflicts, improve quality and distribution, and attract more investments in the sector;
- the need in meeting the Millennium Development Goals (MDG), drinking water and sanitation target and by taking advantage of the International decade for action, African Water Vision and Water for life, 2000-2015;
- taking advantages of the existence of the African Water Facility around its three foci of intervention;
- actively conduct activities aligned with the Rural Water Supply and Sanitation Initiative (RWSSI);
- as the lack of funding for water management structures remain a gap in most donor funding policies, developing a water financing mechanism that aims at stimulating more internally generated funds as well as external funds to cover this gap;
- ensuring the right policies are adopted, putting in place the right institutional structures, building capacities and applying integrated water resources management tools is the only guarantee to an effective development of the water sector in order to contribute to social and economic growth and improved welfare;
- the payment of watershed services appears to be an opportunity to mobilize from the global processes.

CONCLUSION

The six countries are endowed with water resources but these resources are weakly valorized and poorly distributed. This has resulted to the weak level of water resource use in satisfying agricultural, human and industrial needs and explains the weak pressure of economics activities on water resources. This lack of commitment has resulted also to the weak level of cover in water supply and sanitation. Rapid and uncontrolled urbanization have led to the development of shanty towns and peri-urban marginalized areas, where inappropriate and precarious modes of water supply and sanitation are predominant, weak operational capacity of water management institutions at all levels (sub-regional, basins and countries) and of course to manage water resources information. To overcome these weaknesses, it would require to strengthen water governance capacity, to address the lack of appropriate tools to implement IWRM in most of the countries, accelerate sub-regional cooperation actions between countries and at the level of river and lake basins, to operationalise of development funds for water sector indicated in the different laws, to increase the contribution of State budget to the development of water sector related to the engagements and declaration of Head of States and Governments, and capacity of States to mobilize funding from the development partners, to optimize investments through inefficient used of financial resources as well as capacity in the absorption of mobilized funding, to strengthen coordination between stakeholders of the sector and between countries of ECCAS and to create institutional and legal environment in order to attract private sector in the large projects of water sector.

RECOMMENDATIONS ON WATER AND WATERSHED MANAGEMENT STRATEGIES

The following recommendations can be suggestions to both regional and national policy and implementation processes; this includes:

- to promote water and irrigation management as a key factor to improving their food security and to ensuring access to drinking-water for their populations;
- to initiate trans-sectoral projects including forest and water, plus other sectors using water;
- to conduct water transfer flowing towards Lake Chad in order to compensate for the decrease in water levels (from the Niger Basin in Nigeria, or from the Congo Basin);
- to implement the regional water policy that may also include a more integrative cross-sectoral perspective with water-forest-agriculture-energy, etc.;
- to create the institutional and legal environment for the development of the regional water sector including trans-sectoral issues such as forests-water;

- to create an enabling environment for good water governance at national, basin and regional levels;
- to operationalize and institutionalize the principles of integrated water resources management;
- to promote stakeholder participation and gender mainstreaming in the development and implementation of national water strategy;
- to increase the number of programs for water resources development, in areas such as water supply, sanitation, water for agriculture and livestock, hydro-electricity, fisheries, navigation and tourism; capacity building through training, education and research;
- to promote permanent dialogue between ministries in-charge of water, forests and finances to increase budget allocations and to facilitate the consumption of funding;
- to develop tools for programming the financing of water in State members of ECCAS;
- to mobilize funds for water sector in the sub-region in order to achieve MDGs;
- to accelerate the adoption of a regional strategy for financing the water sector;
- to support the process of finalization of regional fund for water by Central Africa Development Bank under the coordination of ECCAS;
- to invest of research to understand the interactions between forest and water in order to inform decision-making with consistency.

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