WATER AND POVERTY LINKAGES IN AFRICA:

SENEGAL CASE STUDY

by

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SUMMARY

Water management holds the potential to address a multiple range of livelihood, poverty and development issues in Africa. However, despite commendable initiatives and steps to meet development agendas, there is slow progress in many areas. To disentangle some of the water-poverty complexities and identify new dimensions for progressive development in Africa, the African Development Bank commissioned Stockholm Environment Institute to conduct a study on water-poverty linkages. The study contains three country cases which focus on a limited range of issues in the main review. This report from Senegal provides more in-depth context relevant reflections on the large scale initiatives to meet Millennium Development Goals on water supply and sanitation, including the strong reliance on groundwater, the relevance of appropriately functioning Integrated Water Resource Management (IWRM) issues, the issue of water for food production and the value of wise ecosystem maintenance in wetlands. In view of climate change, water may seriously affect the development potential of Senegal, including decreased water availability, sea level rise and increased temperatures

Despite the progress made, especially in addressing the water supply and sanitation targets, certain aspects can still be improved. A generic feature is the issue of local participation in IWRM and development in general: how to effectively consult and engage local resource poor communities in development? Another aspect is the lack of critical mass of human capacity at different levels of water managing institutions to safeguard, account and enable sustainable water resources development. Accounting for rainfall water resources is largely an untapped potential, not in the least in rainfed agriculture and livestock. To address future food demand, potential climate change and poverty, especially in the rural setting, a more holistic approach linking land and water resources and including the rainfall in IWRM processes may provide alternative win-win development paths.

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1. INTRODUCTION

Water is increasingly recognized as a major component in economic development and poverty reduction. Several recent papers[1] considering the importance of water in meeting the Millennium Development Goals (MDGs) have highlighted water's direct and indirect contribution to all of the goals and a majority of the targets, rather than just focusing on its central role in achieving the goal on environmental sustainability and the accompanying target on water supply and sanitation. This analysis illustrates the fact that water's interaction in the lives of the poor is complex in character and operates through multiple dimensions: improved livelihoods security, reduced health risks, reduced vulnerability, and pro-poor economic growth. Further, as well as its significance in poverty alleviation, investment in water infrastructure and management has a major impact on national economies[2]. Finally, there is increasing attention to the multiple values of water for society, including not only its importance in terms of ecosystem sustainability but also its cultural and social components.

This case study of water-poverty linkages in Senegal aims to reflect current issues in water, poverty and development at the local, regional, and national scale. Along with an analysis of policies and strategies, programs and initiatives, and cross cutting issues, the report will present some on-going initiatives from a range of actors in water supply and sanitation, irrigation and agriculture, and ecosystems water management for development, among others. The Senegal case study represents one of three country analyses on water and poverty linkages; Tanzania and Ethiopia are the other two case studies. These country case studies seek to expand on themes and findings from a literature review on poverty and water with a geographic focus on Africa. Together, the country case studies and the literature review support an overall review on water and poverty linkages commissioned by the African Development Bank in December 2006.

2. COUNTRY BACKGROUND

Senegal has 11.7 million inhabitants in 196,700 km^2 [3]. Its current human development index is 0.46, ranking 156 out of 177 countries[4]. The annual GNI is at US$710 per capita, approximately US$50 lower than the Sub-Saharan Africa average.

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[1] SIWI/UN Millenium Task Force on Water and Sanitation (2005). **Health, Dignity, and Development: What Will It Take?** SIWI, Stockholm, pp. 19-20; ADB, CIDA, DANIDA, EC, GTZ, Irish Aid, IUCN, SEI, Sida, SIWI, SDC, UNDP, UNEP and WHO (2006). **Linking poverty reduction and water management**. Poverty-Environment Partnership. UNDP, New York, pp. 20-22.

[2] For example, Sadoff and Gray (2006) examine the impact of hydrological variability on growth in Ethiopia and find it currently costs Ethiopia over one-third of its growth potential.

[3] World Bank (2007). World Bank Country data and statistics for Senegal. Accessed March 2007.

[4] UNDP (2006). **Beyond scarcity: power, poverty and the global water crisis**. Human Development Report, UNDP, New York.

The population is almost reaching 50% in urban areas, with the extended area of Dakar having around 2 million inhabitants. Approximately 43% of the total population is below 15 years of age, and population growth is 2.4%. The agricultural sector is the largest employing sector, occupying 3.4 million Senegalese. On a national level, primary industries (agriculture, livestock, forestry, fisheries) contribute roughly 20% to GDP, but have of late been stagnant and are contributing little or nothing to GDP growth. Urbanisation and emigration are the two main drivers of demographic change. It is estimated that around 2 million Senegalese live abroad and contribute 6.5% of national GDP through remittances[5].

2.1 Senegal and MDGs current status

On a country level, Senegal has progressed toward achievement of the first MDG, decreasing the percentage of undernourished and poor (Table 1). However, due to the population increase, the number of affected individuals has increased. There has also been strong commitment to address MDGs 2-6, especially the health goals (Table 2).

Table 1: Trends toward meeting the MDG on poverty and hunger

	1990-1992	2002-2004	2015 target
Poverty			
% poor (<2 US$/day)		63%	
% very poor (<1US$/day	45.4% (3.6 million)	22% (2.4 million)	22.7% (est. 3.3 million)
Hunger			
(% undernourished less than 2500kcal/day)	23% (1.8 million)	20% (2.1 million)	11.5% (est. 1.7 million)

Sources: AfDB, 2006, World Bank, 2007; UN, 2006:

[5] FAO (2004). **Till to tiller: Linkages between international remittances and access to land in West Africa**. L. Cotula and C. Toulmin with H. van Vlaenderen, S. M.Tall, G. Gaye, J. Saunders, C. Ahiadeke, J. K. Anarfi. Livelihood support programme, Food and Agricultural Organization (FAO), Rome/ International Institute for Environment and Development (IIED), UK http://www.fao.org/docrep/007/j2815e/j2815e00.htm; P.D. Goldsmith et al. (2004). Rural-urban migration and agricultural productivity. Agricultural Economics 31:33-45.

Table 2: Progress toward MDGs 2-6

Goal and indicator	1990	1995	2000	2001	2002	2003	2005
Goal 2: Achieve universal primary education (*2015 target: net enrolment to 100)*							
Net primary enrollment ratio (% of relevant age group)	47.1			57.9	57.9		
Percentage of cohort reaching grade 5 (%)	84.5			80.0			
Youth literacy rate (% ages 15-24)					49.1		
Goal 3: Promote gender equality (*2005 target = education ratio to 100)*							
Ratio of girls to boys in primary and secondary education (%)	68.5			85.4	87.1		
Ratio of young literate females to males (% ages 15-24)					70.0		
Share of women employed in the nonagricultural sector (%)	25.7						
Proportion of seats held by women in national parliament (%)	13.0			12.0	17.0	19.0	
Goal 4: Reduce child mortality *(2015 target = reduce 1990 under 5 mortality by two-thirds)*							
Under 5 mortality rate (per 1,000)	148.0	143.0				137.0	
Infant mortality rate (per 1,000 live births)	90.0	84.0				78.0	
Immunization, measles (% of children under 12 months)	51.0	80.0		48.0	54.0	60.0	
Goal 5: Improve maternal health *(2015 target = reduce 1990 maternal mortality by three-fourths)*							
Maternal mortality ratio (modeled estimate, per 100,000 live births)			690				
Births attended by skilled health staff (% of total)							52
Goal 6: Combat HIV/AIDS, malaria and other diseases *(2015 target = halt, and begin to reverse, AIDS, etc.)*							
Prevalence of HIV, female (% ages 15-24)				0.5			
Number of children orphaned by HIV/AIDS				12,000.0		17,000.0	
Incidence of tuberculosis (per 100,000 people)	200.2	216.4		237.6	241.3	245.1	
Tuberculosis cases detected under DOTS (%)		67.2		59.7	54.6	59.6	

Source for Goals 1-4 and Goal 6: World Bank, 2007.
http://devdata.worldbank.org/idg/IDGProfile.asp?CCODE=SEN&CNAME=Senegal&SelectedCountry=SEN
Source for Goal 5: WHO, 2007
http://www.who.int/whosis

Senegal's MDG targets for water supply are 100% urban coverage and 82% rural coverage; its targets for sanitation are 78% urban coverage and 59% rural coverage. The latest data on improved drinking water and improved sanitation[6] from the WHO/UNICEF Joint Monitoring Project are given in Table 3 below. In terms of feasibility of the country meeting its targets, a December 2006 WSP-Africa report opined: *'based on analysis of strategy of implementation, Senegal appears to be on the right track to achieve the MDGs for water supply, with lesser prospects for sanitation*[7]. Although Table 3 clearly reflects significant progress made, large discrepancies still remain between urban and rural areas; the WSP-Africa report specifically flagged rural access to sanitation as an area requiring additional financial commitments for meeting that target.

[6] WHO's definition of improved drinking water is water drawn from the following sources: piped water into dwelling, plot or yard; public tap/standpipe; tubewell/borehole; protected dug well; protected spring; rainwater collection. Improved sanitation is: flush or pour–flush to a piped sewer system, septic tank, or pit latrine; ventilated improved pit latrine; pit latrine with slab; composting toilet.
[7] WSP (2006). **Getting Africa on track to meet the MDGs on water and sanitation. a status overview of sixteen African countries**. WSP-Africa, Nairobi.

Table 3: Senegal's progress on the drinking water and sanitation target

				IMPROVED DRINKING WATER COVERAGE						IMPROVED SANITATION COVERAGE		
	POPULATION			Total		Urban		Rural				
YR	Total (mill)	Urb (%)	Rur (%)	Total (%)	HH connects	Total (%)	HH connects	Total (%)	HH connects	Total (%)	Urban (%)	Rural (%)
1990	7.9	40	60	65	22	89	50	49	4	33	53	19
2004	11.4	50	50	76	46	92	75	60	17	57	79	34

Source: WHO (2006).

2.2 Water resources and demands

Senegal is situated between the 200 mm isohyets in the northeast, increasing to 1,500 mm per annum going to the south western coastal zone. Rainfall is uni-modal with large spatial and temporal variations affecting agriculture and water supply. Potential evapotranspiration ranges from around 3,000 mm/yr in the drier zones to 1,500 mm/yr in the more humid zones. The Republic of Senegal has a hydrographical network that covers almost the entire country (Figure 1). Three primary hydro-geographic regions can be distinguished: the southern rivers, the Gambia and the Senegal River. All major rivers originate from high rainfall areas, providing inter-zonal transfers of freshwater between humid top semi-arid areas. Another feature of the Senegalese rivers is that they are shared with neighbouring countries.

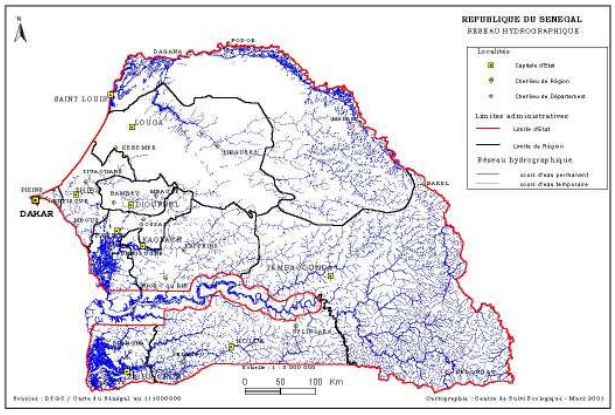

Figure 1: Surface water network in Senegal

The complex of southern rivers is mainly formed by the Kayanga and the Casamance. The Kayanga is located in the Casamance region and is vital for the region in terms of water resources availability. It flows towards Guinea Bissau, where it is called the Rio Geba. The Casamance occupies 20,150 km^2. It drains all the region of Zingunichor in its maritime basin and the Kolda region in its continental part. It suffers from the influence of the sea in terms of the increasing salinization..

The Senegalese part of the River Gambia covers 54,631 km², which represents 70.9 % of the total area of the river. It drains the centre-east and the eastern part of the country,

which is supplied by many tributaries with temporary flow. Its average annual flow is 254 m^3 s^{-1} (1953/81). The Organisation for the Development of the Gambia River (OMVG) is the trans-national river managing isntitution since 1978.

The Senegal River covers 290,000 km^2, only 9.5 % of which involve the Senegal. At Bakel, its characteristics include major floods and very long-term low water. The average annual flow is 702 m^3 s^{-1}. It varies between 0 and 7000 m^3 s-1 at Bakel. The Organisation for the Development of the River Basin (OMVS) has proceeded with its partial development through the construction of two major dams: Diama Dam (Senegal) and Manantali Dam (Mali).

All the main Senegalese watercourses have a tropical system alternating a short period of high water during the rainy season and a relatively long period of low water during the dry season. The temporal distribution of flows has strong implications for natural flora and fauna in the river systems, as well as for livelihoods depending on these river related ecosystem services and goods.

In addition to these principal river networks, *the Ferlo valley with the Sine and the Saloum* cover the centre of Senegal with respectively 6,120 km^2 and 6,500 km^2 basin areas. *The Ferlo basin* occupies the centre-north of Senegal and covers 22,330 km^2. This hydrographical network is formed by a stream of temporary pools during the rainy season. Lake Tamna and Guiers are the two major natural lakes in Senegal.

There is relatively limited large dam and reservoir capacity in Senegal. Of the existing dams, only Diama (250,000 m^3) on the Senegal river is fully contained in Senegal. The main purpose of this dam is to halt salt water intrusion and provide for irrigation of rice[8].

Total withdrawals of the renewable internal and external sources (i.e., of blue flows) are approximately 2.01 km^3 y^{-1}, representing 5% of total renewable water sources of 38.8 km^3 y^{-1} [9]. Agriculture is the largest water-consuming sector, using 92% of annual withdrawals for irrigation purposes. Domestic water supply and industry appropriate 4.4% and 2.6% respectively. The total renewable water resource has almost halved from 6,623 m^3 cap^{-1} y^{-1} in 1980 to 3,665 m^3 cap^{-1} y^{-1} in 2005 due to population growth[10].

Water for food is the largest consumer, both in rainfed agriculture and as total withdrawal of freshwater for agricultural purposes. Senegal is self-sufficient to almost 60% of its demand of agricultural vegetal and animal produce (Figure 2)[11]. In fisheries produce, national supply exceeds demand and is exported. Since 1990, reliance on food imports has increased slightly more for animal produce. The average diet is highly dependant on cereals, supplying 91% of daily per capita calorie intake, with 6% supplied by animal

[8] FAO (2007). **FAO Country Profile**. Accessed March 2007 http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=SEN&subj=3
[9] AQUASTAT (2007). **Geo-referenced database on African dams**. Accessed March 2007. http://www.fao.org/ag/agl/aglw/aquastat/damsafrica/index.stm
[10] Ibid.
[11] AQUASTAT (2007). **Geo-referenced database on African dams**. Accessed March 2007. http://www.fao.org/ag/agl/aglw/aquastat/damsafrica/index.stm

produce and 2% by fish. These data of dietary intake are similar for the period 1990 to 2005 (Figure 3)[12].

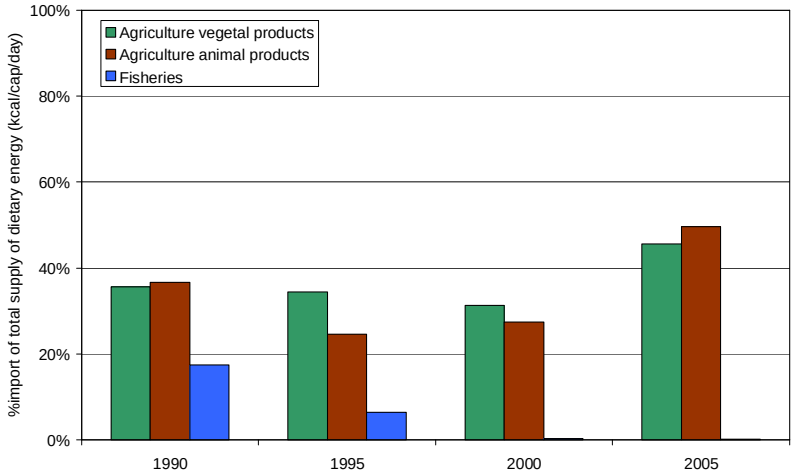

Figure 2: Reliance of food import 1990-2005 in Senegal for vegetal, animal and fishery produce as % of total supply (in kcal/cap/day)
Source: AQUASTAT, 2007

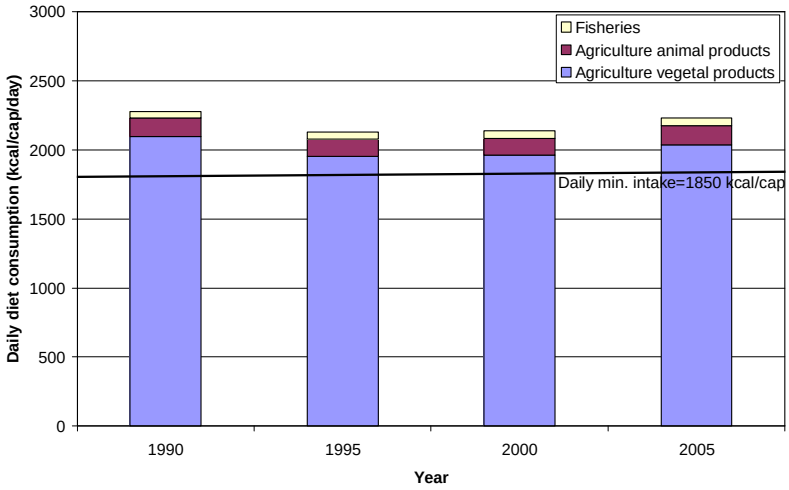

Figure 3: Daily average calorie intake 1990-2005 in Senegal for vegetal, animal and fisheries food supply
Source: AQUASTAT, 2007

Using average agricultural production data[13], water appropriation for current rainfed and livestock production can be estimated at approximately 5.1 km^3 per year. In addition, agriculture withdraws 2.1 km^3 per year for irrigation purposes, of which approximately

[12] Ibid.
[13] AQUASTAT (2007). **Geo-referenced database on African dams**. Accessed March 2007. http://www.fao.org/ag/agl/aglw/aquastat/damsafrica/index.stm

30% is return flow, and possibly utilised downstream and/or recharging groundwater. Significant imports of food contribute to the virtual water, so that actual average agricultural produce, including imports and excluding export, amounts to 3,900 kcal/cap/day , equivalent to 2.6 m^3/cap/day of water. This amounts to an annual 11.1 km^3 of water for total agricultural produce. Actual consumption of 2,200 kcal/cap/day corresponds to a water consumption of approximately 1.6 m^3/cap/day, equivalent to 6.8 km^3 water per year for the whole population.

Table 4: Freshwater resources and use in Senegal

	Freshwater (10^9 m^3 yr^{-1})	Freshwater Per capita m^3 cap^{-1} y^{-1}
Precipitation (10^9 m^3/yr)	135	
Internal renewable	25.8	
External renewable	13	
Total renewable	38.8	3665
Domestic	0.1	
Industrial	0.06	
Agriculture	2.07	
Total withdrawal	2.23	225
Groundwater abstraction	*No comprehensive information*	

Source: after AQUASTAT, 2007

Accounting for the full green and blue water balance of Senegal (Figure 4), including rainfall with internal and external (blue) flows, indicates that irrigation appropriation is a marginal water user when compared to other land use systems. Rainfed-dominated croplands currently use 2% of the total water resources on 18% of the country area. Large amounts of water are consumed in savannah and grasslands, which correspond to 65% of the area. Wetlands and water bodies take up 3% of land area but use more than 5% of the total water resource. Senegal receives approximately 13 km^3 of total annual water resource (including rainfall), equivalent to 9% of total water, from neighbouring countries.

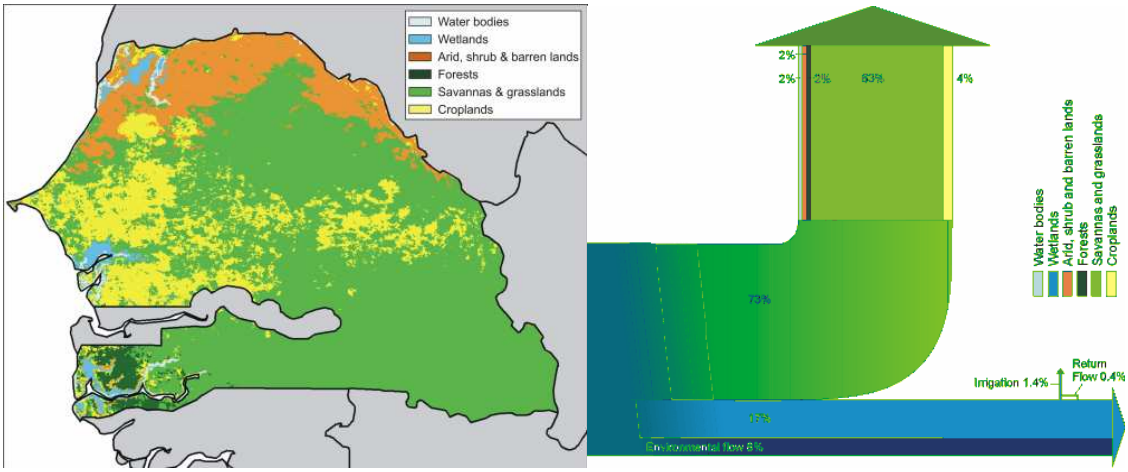

Figure 4: Land use (right hand) is governing the water resources of Senegal. Total rainfall and incoming external renewable water is divided into green flows and blue flows (left) depending on land use

Abstraction of groundwater is very important. Due to the high spatial and temporal variation in rainfall, groundwater is increasingly supplying water for the development of domestic supplies (Box 1).

Box 1: Groundwater to meet the MDGS and for sustainability

It is undisputable that every human being should have adequate access to water and food in order to lead a healthy life. To meet the Millennium Development Goals increasing efforts are being taken to deliver safe water and adequate sanitation to the currently un-served in Sub-Sahara Africa. In order to do so, groundwater - which was until recently a quite under-used resource - is being developed at escalating rates. At the same time, institutions and policies to monitor resources outtake and provide safeguards against over-abstraction and possibly degradation through pollution have been degrading. There are two main issues to consider with respect to groundwater from a hydrologic perspective:

- shallow groundwater (>50 m) is often connected to surface water, i.e., streams, lakes and wetlands. If these degrade, the groundwater level may decrease significantly, beyond restoration
- deep groundwater (100-400 m) is not easily recharged, and the deep aquifers are less well quantified.

Thus, the sustainability of heavy reliance on groundwater extraction should be undertaken with caution until sufficient information is available on actual resource quantities and recharge potentials. Climate change, changes in rainfall patterns and land use may seriously affect the groundwater recharge rates and subsequently the rates of sustainable outtake.

Sources: World Bank, 2006; Scanlon et al., 2006; Showers, 2002.

The resources of groundwater can be identified through the aquifer they belong to and can be categorized into four groups:

- The groundwater in the Tambacounda region of the southern part of the country is difficult to reach due to complex hydro-geological conditions, but may be reached through drilling at 40 m depth and beyond.
- The deep groundwater aquifers in sand and sandstone of *Maastrichtien*. These cover 4/5 of the territory with a potential abstraction of 500,000 m^3 /day. This is the most exploited table through drilling and can be reached at 400 m in depth. The potential renewable rate is 1 km^3/year according to ADB sources[14]
- The semi-deep tables with potential varying between 68,000 m^3 and 115,000 m^3
- The shallow aquifers linked with surface water. These are more accessible and therefore subjected to over exploitation, as is happening in, for example, Thiaroye. It has been suggested these have a potential annual renewable amount of 5 km^3/year[15]

Despite the numerous studies conducted, the actual groundwater potential remains poorly understood. Groundwater extractions are not without complications. The ground water sources in Senegal are suffering from over exploitation in the west along the coast, from hyper-salinization in the north and south, and from low recharge rates in the centre.

In Senegal, as well as in many other Sahelian countries, domestic and industrial waste water, as well as rainfall water originating from urban centres, are mostly left untreated before being discharged into the ocean. From Dakar city alone, 100,000 m^3 per day are being discharged into the sea. The minimal access to wastewater and sewage facilities constitutes a great constraint, and as a result a mere 6% of the wastewater leaving Dakar is treated.

Photo by Patrick J.W. Fox

Solid waste polluting water resources in village setting in Saloum Delta, Senegal

[14] ADF (2005b). **Senegal, Sub-programme for the launching of the rural water supply and sanitation initiative**. Appraisal Report. Department of Infrastructure, West and Central regions, African Development Fund.
[15] Ibid.

2.3 Water as priority in development strategies

According to the Poverty Reduction Strategy Paper (PRSP) for Senegal, four principal strategies have been defined to aid the fight against poverty and towards the achievements of the MDGs.

In the latest PRSP, two principal strategies on 'wealth creation' and 'strengthening of capacities' are well incorporated in action plans addressing the alleviation of poverty, whereas the 'support to vulnerable groups' was only addressed in 20% in the surveyed plans[16]. Of total resources mobilised (internal and external), for the Priority Action Plans (PAPs), 5.9% was directly aimed at improving drinking water and 2.8% at addressing sanitation. Other initiatives may indirectly also address water and poverty alleviation, such as activities in primary industries (agriculture, forestry, fisheries), health, education, and natural resource management initiatives[17]. The report concludes that on the whole, there is good progress toward meet the MDG target on drinking water, but less so on the sanitation target. Goal 1, on reducing incidence of poverty and hunger, will not be met unless increased national growth occurs, i.e. at greater than7% compared to the current 6.4%[18]. The PRSP recommendations that directly relate to water and poverty alleviation include:

- better incorporation and involvement of civil society participation in project planning and implementation[19]
- stronger commitment for cross-ministerial collaborative frameworks[20]
- re-balance allocated resources towards under financed initiatives such as sanitation[21]
- stronger monitoring on environmental impact of implemented PRSP activities[22]

The latest available report on PRSP follow-up with Joint Staff Advisory Notes (JSAN) states that growth acceleration needs to be increased if MDGs are to be met by 2015. However, overall poverty is estimated to have decreased to 54% in 2004[23]. There are large discrepancies between urban and rural populations. For example, current figures are 64% of population having access to clean drinking water in rural Senegal, whereas urban areas have 96% access in Dakar and 84% in other urban areas[24]. The figures for sanitation are similar: Dakar's population having 64% access to sanitation (25%

[16] World Bank (2005).
[17] Ibid, p.20.
[18] World Bank (2005): Poverty Reduction Strategy Paper (PRSP). Progress Report on Implementation of the Poverty reduction strategy 2004 (Final version). http://siteresources.worldbank.org/INTPRS1/Resources/Senegal_PRSP(May2005).pdf p. 63.
[19] Ibid, p. 67.
[20] Ibid, p. 66.
[21] Ibid, p. 67.
[22] Ibid.
[23] IMF,2006: Senegal: Poverty Reduction Strategy Paper- Second annual progress Report- Joint Staff Advisory Note. IMF Country report No. 06/69, International Monetary Fund (IMF) Washington D.C. http://www.imf.org/external/pubs/ft/scr/2006/cr0669.pdf
[24] M. Ndaw, pers comm.; ADF (2005b). **Senegal, Sub-programme for the launching of the rural water supply and sanitation initiative**. Appraisal Report. Department of Infrastructure, West and Central regions, African Development Fund.

community facilities), 39% in other urban areas (predominately private), and 17% in rural areas[25].

Despite well-known direct and indirect linkages between water management, poverty, and MDGs, the recent Country Strategy Paper 2005-2009[26] does not specifically mention water resource management as an important means towards poverty alleviation and development. despite:

- Noting that overall water access and sanitation is progressing but far from fulfilled
- Primary sectors, relying on rainfed production (agriculture, livestock) no longer contribute towards GDP growth. Also fisheries is mentioned as no longer generating wealth, due to over-fishing;
- Environmental concern is raised due to pollution from industries causing deteriorating water resources; and
- The need to develop electrical supplies country-wide as well as to reduce oil import dependencies, are indirectly water-related, as firstly expansion of hydropower affects current river systems, and secondly, an increase in biofuels may potentially address petroleum dependency but also be rainfall dependant and/or affect current land and water uses in agriculture

The current ADF/AfDB country strategy for Senegal 2005-2009 is focused on two strategic areas of intervention: improving the [economic] environment for accelerated growth, and improving access to basic infrastructure. The former addresses transparency and accountability in public finances, award of public contracts, anti-corruption, and the facilitation of private market developments and investments. The latter includes all types of infrastructure, such as roads and drinking water supply[27].

3. CASE STUDY TOPICS

3.1 National initiatives on water supply and sanitation

Since 1995, three large-scale water and sanitation initiatives driven by the government have been implemented in Senegal. These are the Water Sector Project ("Projet Secteur Eau" - PSE), Long Term Water Sector Project ("Projet Eau à Long Term - PLT) and the National Water Supply and Sanitation Programme for the Millennium (PEPAM) (Table 5).

[25] Ibid.
[26] ADF (2005a). **Republic of Senegal, Country strategy paper 2005-2009**. Country Operations Department, West Region, African Development Fund, p. 24.
[27] Ibid.

Table 5: Principal large scale initiatives to tackle MDG targets on water supply and sanitation in Senegal

	PSE	PLT	PEPAM
Financing Agency	IDA,AFD, KFW, BEI, BOAD, NDF, BADEA, SONES	IDA (US$ 125Millions)	AfDB
Total Project Cost	US$290 Millions	US$ 288,43 Million	33.54 Millions Euros
Time frame	1995-2003	2001-2007	2006 – 2009

In 1994, the Senegalese government embarked on a year-long process to design sector reforms that would allow expand water supply and sanitation coverage. The core of the reform plans was the establishment of three main sector institutions linked through a web of four contracts. The main actors were the "Ministère de l'Hydraulique", a state asset-holding company, and a private operator. In 1995, the World Bank provided a US$100 million IDA credit to the Government of Senegal to implement the reform plans.

The objective of **Water Sector Project/"Projet Secteur Eau"** (PSE) was the creation of an enabling government framework to attract the private sector, increase efficiency and improve service delivery for water supply and sanitation, while keeping water charges at an acceptable level for consumers. The law implementing the institutional reform was passed by the National Assembly in March 1995. The law authorized the creation of new asset-holding company, the "Société Nationale des Eaux du Sénégal (SONES). SONES was set up along with Office National d'Assainissement du Sénégal (ONAS), a small, professionally competent outfit with clear finance targets to manage liquid sanitation. Both SONES and ONAS were institutionally autonomous, governed by a 1990 law pertaining to para-statal sector enterprises.

To achieve poverty alleviation objectives, the design of the contract recognized the need to allocate sufficient, specific resources for financing increased access to piped water supply for the poor. As a result, a fund was created to allow the private operator to subsidize *social connections*. It aimed at providing improved services to the poor for a lower price. Social connections were free, while a connection fee aimed at wealthier households was charged for ordinary connections.

The company in charge of water supply and billing, "Sénégalaise des Eaux" (SDE), and SONES worked through a large NGO to identify the need for social connections. In addition, the SDE set up a decentralized computerized network of payment booths. This made payment by domestic clients easier, and improved customer services.

The PSE extended access to water supply services to approximately one million people. At the end of the project, a total of 81,000 water social connections, 400 water stand pipes and 13,000 new sewerage connections had been installed. Water production

increased 19%. Unaccounted water fell from 31.5% in 1996 to 20% in 2003, one of the lowest rates in Africa. Water quality also improved for domestic consumers[28].

The **Long Term Water Sector Project/"Projet Eau à Long Term**" (PLT) is a follow-up of the PSE. This project addresses the continuing need for an increase in production capacity, financing much-needed sanitation investments and supporting further institutional reforms. It aims to achieve sustainable improvements in the delivery of urban water and sanitation services in underserved and low-income areas of Dakar and secondary cities. There are seven project components. The first improves the reliability, quality, quantity, and coverage of water supply services by increasing production capacity to meet demand, increasing the number of connections, restructuring and balancing water distribution, and increasing storage capacity. The second component expands and reinforces drinking water networks. The third component increases the number of households connected to sewer networks, improves demand management and reduces wastewater and septic pollution, and limits severity and duration of flooding. The fourth component targets peri-urban and low-income settlements in order to improve sanitary conditions in households; this component includes an investment program and a capacity building and demand generation program. The fifth component improves the role of the executing agency in regulating water resources and develops an action plan for integrated management. The sixth component incorporates environmental concerns in the project to increase quality as well as to follow safeguard policies and national regulations. The seventh component increases the efficiency of public entities involved in the water and sewerage sector by strengthening their capacity and the capacity of small private and community enterprises.

The **Sanitation Programme for the Millennium** (PEPAM) was launched in 2006. It is an instrument through which the government expects to reach the Millennium Development Goals relating to drinking water and sanitation in urban areas as well as in rural areas. The PEPAM represents a global programmatic framework which will in the future include all interventions aimed at reaching the 2015 MGDs in water and saniation areas.. As mentioned above in Section 2.1, these are: (i) access to drinking water 100% in urban areas and 82% in rural areas; (ii) sanitation 78% in urban areas and 59% in rural areas. The funds needed to reach these goals are estimated at €418 million for the component on the rural areas and €367 million for the urban areas.

In the urban areas, the PEPAM strategy will pursue the achievements of the PSE and PLT and to improve continuously the quality of services for drinking water and sanitation. In rural areas, the PEPAM strategy will assure a deep evolution of the project's planning, the organisation of the water services management and the participation of the private sector.

[28] World Bank (2006). **Sustainable groundwater management: lessons from practice**. GW-Mate Case profile Collection No.15. World Bank, Washington, DC. www.worldbank.org/gwmate

3.2 Senegal River Basin Water and Environmental Management Programme

Plans to control the floods of the Senegal River have been in existence since the nineteenth century. The Sahelian drought of the 1970s led the governments of Mali, Senegal and Mauritania to create the 'Organisation pour la Mise en Valeur du Fleuve Sénégal' (OMVS) in 1972 and to proceed with the construction of two major dams on Senegal River in an attempt to develop irrigated agriculture, hydroelectric power and river navigation**.** The OMVS has the mandate to ensure food security and harmony among all the riparian users. To do so it works on the concept of 'optimal distribution among users' rather than volumetric water withdrawals[29]. The OMVS includes representatives from all three countries; further, Gambia signed the pre-treaty in 2005.

The first dam to be completed was Diama dam in 1986. It was built to stop the dry-season intrusion of seawater along the river, which could penetrate over 100 km inland. The second dam, completed in 1990, was a storage dam at Manantali in Mali on the Bafing, the main tributary of the river, which supplies approximately 50% of the annual flow. The reservoir is theoretically capable of storing 11 billion m^3 of the strongly seasonal rainfall on the Fouta Djalon Mountains in Guinea. The water can be gradually released over a longer period than the natural strongly seasonal flood.

The dam developments in the Senegal River have brought both benefits and costs to the countries and local communities. Despite the major ecological changes brought by the dams and associated dykes on the flood plain, including affecting groundwater quantities and qualities, some benefits have been realized. Thus far, the dams have primarily benefited irrigation, thereby playing a key role in stalling the late 1960s/early 1970s massive exodus of the valley's population in the face of severe drought and desertification. Flow regulation from the Manantali dam has ensured a year-round supply of irrigation water for farmers who pay a fixed land-based fee, while Diama dam prevents this supply from mixing with intruding sea water and reduces pumping costs by raising the upstream water level. The increased access to fresh water has also enabled the cleansing of soil contaminated by salt intrusions. The dam has hence made these sites habitable again, including providing domestic water as a result of the raised water table. The dam also provides water for Lake Guiers, which in turn supplies Dakar and Thies with 64,000 m^3/day, plus up to 135,000 m^3/day through newly-installed pumping. Meanwhile, it needs to be noted that the dam has also resulted in the presence of bilharzia and an increased incidence of malaria and diarrhoea. The hydropower stations at both dams have underperformed since their commissioning in the 1990s. Water pollution, mainly from agriculture, has increased, as has the proliferation of water weeds, clogging canals and outlets. River banks have been subjected to increased erosion, thus settling sediments downstream. Wetlands and ecosystem changes, loss of biodiversity and loss of agricultural and pastures have also been noted.

[29] WWAP (2003). **Case study on Senegal River Basin**. In "Water for people, water for life", World Water Development Report 1, UNESCO/Berghan Publishing.
http://www.unesco.org/water/wwap/wwdr1/table_contents/index.shtml

The delta and the valley flood plain have seen the development of both large-scale and community-based irrigation for several decades on the Mauritanian as well as on the Senegalese side. The irrigation schemes currently in place cover just over 100,000 ha, of which 60,000 ha are cropped (mostly with rice) in the wet season and some 20,000 ha in the dry season. Currently irrigated land represents only one third of the overall potential estimated at 375,000 ha.

Additional benefits are (i) the creation of a significant fisheries resource in the Manantali reservoir, which has led to the seasonal settlement of fishing communities; (ii) the maintenance of the Diawling, Djoudj and Trois Marigots/Ndinel national parks and protected areas, and (iii) year-round navigation of parts of the rivers' system.

In 1997, OMVS started collaborating with the World Bank to develop a GEF project for the Senegal River Basin. After a series of consultations, a technical programme was established to develop a viable integrated resource management strategy focusing on water, biodiversity and the environment (initiated in 2001, with a second phase, 2004-2008). The programme focuses on a series of activities at national levels which together forms a cohesive strategy for the river basin. The project's development objective was to establish a participative basin-wide framework for the integration of transboundary water resource activities and launch a basin-wide action program for the global environment. This objective will be accomplished through:

1. Capacity building: strengthening environmental and water resource management capacity in national institutions and in OMVS and support for the full involvement of Guinea and OMVS member states in a cooperative agreement for sustainable water resources management in the basin.

2. Data and knowledge management: supporting the improvement of the data and knowledge base for water resources management in the basin and the establishment of necessary monitoring and analysis on a sustainable basis, in close coordination with the *Observatoire de l'Environnement de l'OMVS (The Environmental observation unit of OMVS)*.

3. Transboundary diagnostic and action program: completing the basin-wide Transboundary Environmental Analysis and Action Program (TEAAP)

4. Priority actions: based on the preliminary transboundary diagnostic analysis, carrying out specific on-the-ground priority actions through pilot activities

5. Public participation and awareness: establishing a public participation and awareness program for broader community and civil society involvement in development actions in the Senegal River basin.

The project is intended to address the following identified needs: (i) land degradation (including deforestation, soil erosion, overgrazing and desertification); (ii) water resource management (including groundwater use, information data collection, water quality

needs, food security diseases); (iii) capacity building at all levels with special emphasis on transboundary aspects; (iv) participatory approaches to project planning, implementation and (v) awareness and outreach. The project is also intended to address root causes which act to undermine the cooperative and sustainable management of the shared water resource.

The contribution of the project to poverty alleviation is expected by the OMVS through the fourth component on priority actions. In fact, based on preliminary transboundary diagnostic analysis, priority actions have been identified for early implementation through pilot activities. The pilots specifically target improvements of transboundary water resource and environmental management which have a transboundary impact. The pilots are intended to assist the four countries involved in establishing best practice, in testing transboundary management approaches and in establishing networks across boundaries, thereby strengthening riparian cooperation and integration. The pilots are implemented through micro-grant activities. The small grant allocations have a ceiling of US$5,000 per grant.

Unfortunately, the total amount available for the four countries involved for four years is US$1.66 million (of US$17.695 million total cost of the project, thus 0.93%). Moreover the majority of activities eligible for funding don't procure benefits in the short term. These are, for example, tree planting, river bank protection, human capacity building etc. However, so far insufficient attention has been given to the need for a wider consultation and participation of all stakeholders for the implementation of a sustainable management of the Senegal River basin resources; in particular smallholder land users have been excluded from consultations. The lack of appropriate governance and policy for the consultation of all stakeholders seriously affects some aspects of the Senegal River water management[30]. One root cause is the lack of literacy and poverty, which hampers effective engagement of potential stakeholders. The complexity and multi-level character of stakeholder consultations is not easily achieved in practice and requires special attention and interventions.

3.3 Wetlands management in the Biosphere Reserve of Saloum Basin

The Biosphere Reserve of Saloum Basin (330,000 ha) is located mainly in Fatick administrative region; it covers the hydrographic basin of Saloum, Diomboss and Bandilala rivers. This region covers large and diverse habitats of wetlands, forests, and savannah in which birds, fishers, shrimps, mollusks, etc. find conditions meeting their biological and ecological needs. The population is estimated at 43,224 inhabitants, mostly smallholder artisan fishing communities relying on the biodiversity of the delta. Since 1981, IUCN has been working in the Saloum Delta to understand the multiple links of the reserve's fragile ecosystems and the diverse factors of their evolution with the local population. This population, among the poorest in Senegal, is mostly illiterate, secluded and have little awareness of conservation issues. Consequently, the sustainability of local

[30] GIWA (2005). Canary Current, GIWA Regional assessment 41. Eds. Tayaa, M., Saine, A., Ndiaye, G. and M. Deme, University of Kalmar on behalf of United Nations Environment Programme http://www.giwa.net/publications/r41.phtml

peoples' livelihoods is threatened, as well as the integrity and welfare of resources and ecosystems.

The local population uses large-scale mangrove ecosystems for supply of water and fishing for domestic and commercial purposes. The free access regime, loss of traditional resource management rules, lack of means of public institutions in charge of natural resource management increase the risk of a rapid degradation. The objective of IUCN is to ensure the sustainable management of the reserve, thus providing substantial benefits to local residents. Several activities are being implemented, such as conservation and reconstitution of the mangroves, tree planting, bee keeping in the mangroves, ecotourism, organic farming, the promotion of sustainable fishing and microfinance for income generation.

The main species caught by the fishers are shrimps. A total of approximately 3,757 fishermen have been recorded recently; these fishers mostly specialize in shrimp fishing. The 2003-2004 production was estimated at 1,600 tons; on average, annual income generated is estimated at US$1,970,584. Only 1.4% of produce is used for local consumption. Women in the community sell 5% of the total production.

Other activities which provide livelihood support and income to the local population are:

- Habitat restoration for oysters: the objective is to create favourable conditions for development of the mangroves while restoring the threatened oysters (Box 2)
- Traditional and improved smoking of fish: the aim is to reduce the overexploitation of the mangroves for firewood and at the same time to improve the quality of the products, thus increasing market value.
- Bee keeping: aims at protecting the mangroves and generating income for the local population. The average annual production is estimated at 33,600 litres costing US$134,400.
- Market gardening: involves 11 villages with 760 persons, each exploiting 30ha.
- Ecotourism: developed through the construction and exploitation of a camping and eco-museum.
- Rational exploitation of seafood: aims to improve the quality of finished products through a selective grading of quality of seafood. It provides an added value to the finished product, with a growth rate of the initial price of the kg product from 40% to 113.4%, thus improving income generation revenue for residents.

Photo by Patrick J.W. Fox

Women harvesting mussels and cockerels in the Delta of Saloum, Senegal

Photo by Patrick J.W. Fox

Help with packing and product design can help artisan fishery communities reach new markets, thus improving quality and gaining more for their products

To promote the above mentioned activities, IUCN developed microfinance through local credit banks. A total of 2,071 persons are involved, of which 1,178 women. From the total amount of US$369,290 provided in 2005, US$8,000 has been saved by the beneficiaries. Some social achievements (e.g. wells, schools, grinders etc.) have been realized. Ecotourism has become more attractive for local people, while agriculture, due to the decline in rainfall, is less practiced.

Box 2: The value of regenerating mangroves

The mangroves covering the shores of the Delta of Saloum are the habitat of many "fruits de mer", which are utilised and sold by local communities. However, the mangroves are also subject to declining stands as they are used for firewood, timber and building materials. The re-plantation of mangroves is crucial for continuing the Saloum's biodiversity and livelihood support, and plantation schemes are under way due to the initiative of local communities. Women are especially keen to re-plant, as they are the main beneficiaries of oysters harvested in the mangroves in the Saloum. It was found that 50 women had planted two hectares of land in one day, including the collection of seedlings. The plant density varied, but averaged on 50,000 plants per hectare. The complete regeneration of plants is estimated to take approximately 10 years before a full harvest of oysters can be obtained. Average yields of oysters have been measured previously at around 100 kg of fresh oysters per outing; the women consulted were able to conduct up to 100 outings per year. Approximately 2 hectares of land is required to regularly collect 100 kg of fresh oysters.

Yield fresh oysters	Yield dried oysters	Price for dried oyster (CFA/kg)	Income per outing (€)	Income per day (€)
100 kg	2.2 kg	6250 = 9.54 €	19.85	5.44

Oysters are only one of many seafood and fish harvested from the rich delta. Thus, by simple valuing of ecosystem produce, the value of maintaining the health of mangroves for poverty alleviation may emerge. Assuming that both the yields of oyster and the market remain stable, the intervention certainly merits some attention in line with poverty reduction projects, particularly since the income gained surpasses the minimum economic levels.

Source: interview with women in Delta of Saloum, IUCN representatives (Annex 1)

Photo by Patrick J.W. Fox

Mangroves under threat: used for drying fish to be exported to other markets and urban areas

Photo by Patrick J.W. Fox

Communities in delta of Saloum investing in their environment

3.4 Future demand on water resources to meet MDG targets on food

To meet the MDG targets on food, water and sanitation will require an increasing allocation of freshwater. Current reliance on internal agricultural production is approximately 47% of daily per capita calorie food supply. To meet the MDG goal on hunger in Senegal, more water must be allocated to agricultural production, either internally or as virtual water in imported food. Current average national diets at 2,200 kcal/cap/day[31] are above recommended minimum diets of 1,850 kcal/cap/day, but well below the recommended daily intake for a healthy and productive life at 2,700 kcal/cap/day. The national average dietary composition is currently at 90% vegetal and 10% animal of total energy consumption. The recommended rates are 80-20 for a balanced diet. Using these recommendations, Senegal faces a challenging future to meet the MDG on hunger. Three major dietary improvements are to be raised that affect overall water allocation for food production:

- the overall national consumption of energy needs to be raised from the current 2,200 to 2,700 kcal/cap/day
- the balance between energy from vegetal to animal energy needs to be adjusted towards 20% animal and 80% vegetal intake (currently 8% and 92% , respectively)
- the increase in population requiring diets raise with 2.4% annually

In Figure 5, the implication of water allocations are shown for these dietary improvements. Current national consumption (national produce and imports) corresponds to 7.1 km^3 water annually. The total annual agricultural supply (including imports but excluding exports) corresponds to 11.1 km^3 water appropriation. For a national consumption of a balanced diet (80-20 vegetal and animal energy intake for a total of 2,700 kcal/day/cap) is estimated at 13.8 km^3, projected to increase with population growth to year 2015 to 17.1 km^3. To meet the MDG goal of hunger, i.e., halve the proportion of hungry in 1990, will still put significant pressure on the water resources. With a balanced diet for non-hungry at 2,700 kcal/cap/day and an estimated 1.7 million still hungry, the required water allocation for food consumption is estimated at 16.9 km^3 annually.

These projections for 2010 and 2015 do not include water for additional agricultural produce, such as feeds, fodder, fibres or bio-energy. To meet the hunger goal and extend it to the full population still requires almost *tripling* water for agricultural direct food supply. However, the estimated totals can be reduced through targeting agricultural and livestock water productivity. Improved cropping, fertilizer and management all contribute to higher water productivity and improve yield per hectare.

[31] FAOSTAT. 2007. *FAOSTAT Online Statistical Service*. Rome: FAO. http://faostat.fao.org. Accessed March 2007.

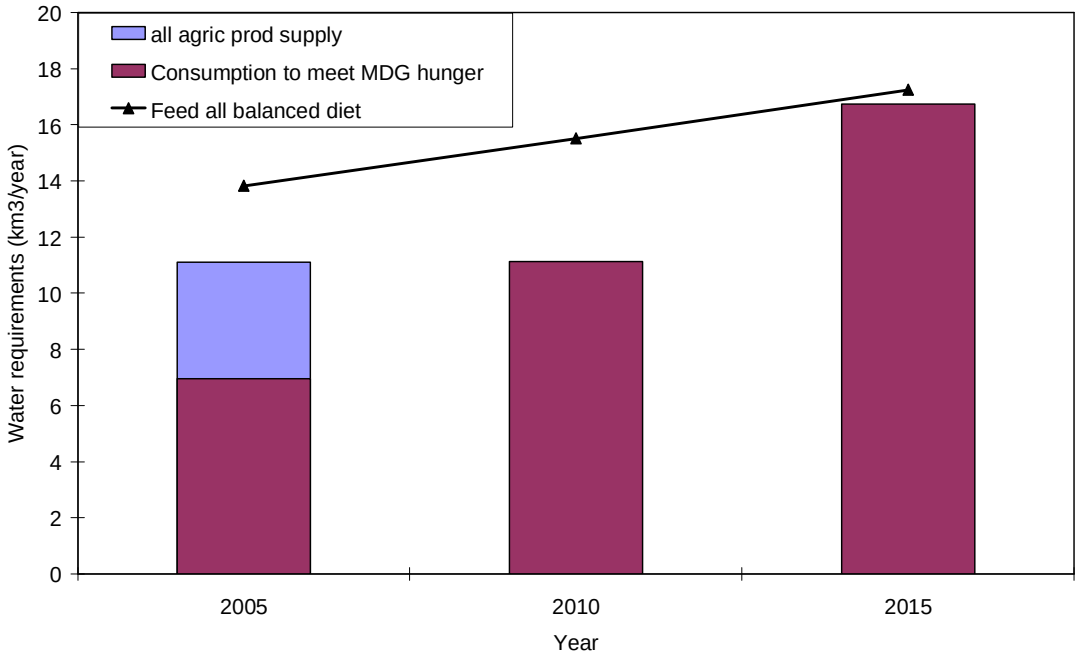

Figure 5: Water requirements for total dietary water requirements for Senegal 2005 to 2015 with projected improved dietary balance, increase in per capita daily energy intake and meeting the MDG on hunger (staples)
The water required to feed total population a balanced diet of 2 700 kcal/cap/d is shown as line.

3.5 Adaptation to climate change: water and preparedness

Senegal has experienced a continuous cycle of decrease in precipitation between 1970 and 2000, with significant changes in isohytes (Figure 6). Despite changes in rainfall, land-use changes in Senegal have been limited over time, with minimal increases in agricultural land and marginal decreases in woodland and forests[32]. However, the overall loss of agricultural productivity has also been ascribed to degradation of soils, especially in Casamence and the groundnut basin. This has serious consequences as it carries a direct effect on income as harvests are reduced in value.

[32] C.G. Tappan et al. (2004). **Ecoregions and land cover trends in Senegal**. Journal of Arid Environments 59: 427-462

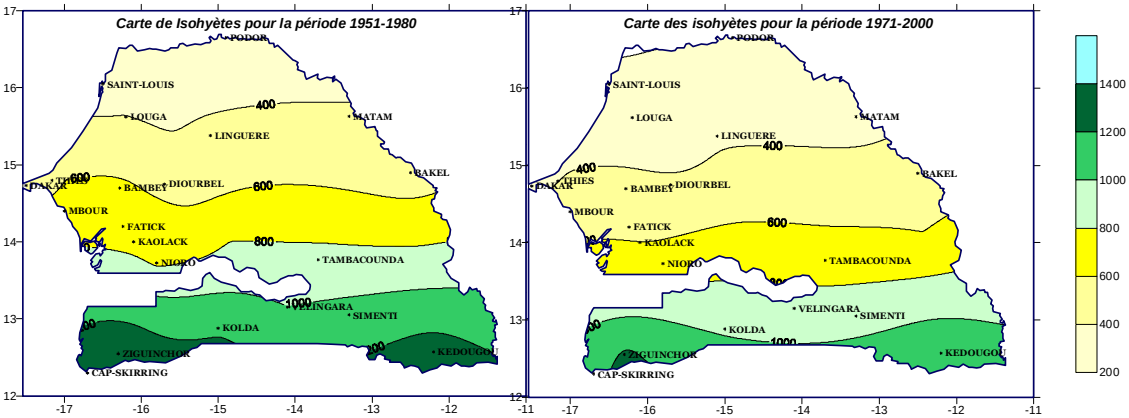

Figure 6: Shift in isohytes in Senegal from 1951-1980 (left) and 1971-2000 (right)
Source: National Direction of Meteorology, Senegal

Future climate change scenarios indicate increasing drying of the coastal zone of West Africa, including Senegal[33], despite the high uncertainties associated with the climate change modelling for the region. Senegal is also expected to experience relatively high temperature increases in 2080-2099, in the region of 3-5 ^{o}C compared to 1980-1999[34]. The expected changes will have significant effects on the Senegalese water resources, both in terms of rainfall an also increased potential evapotranspiration (due to increased temperatures). There may be significant effects on available blue water, in particular large river systems, which are also affected by climate changes and developments from upstream catchments.

One major effect of climate change is through the increased sea levels, which will hit Senegal severely. In recent estimates by the World Bank[35], a 2-4 m sea level rise would affect 5-10% of GDP, and up to 10% of the population. The total loss of land area would be around 10%, mainly in urban areas, and 35% of current wetlands may be lost. For Senegal, with much of its economic activity and capacity focused on Dakar and the coastal zone, follow-on effects may be increasingly severe for poverty alleviation goals and the projected 5-8% GDP growth needed to reach MDG targets.

Senegal has developed its "Plan d'action national pour l'adaption aux changements climatiques"[36], submitted to the United Nations Framework Convention on Climatic

[33] IPCC (2007). **Regional climate projections.** By J.H. Christensen et al. Chapter in *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the 4th assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge UK and NY, USA. http://ipcc-wg1.ucar.edu/wg1/wg1-report.html
http://hdr.undp.org/hdr2006/statistics/countries/data_sheets/cty_ds_SEN.html, p. 869.
[34] Ibid.
[35] S. Dasgupta et al. (2007). **The impact of sea level rise on developing countries: a comparative analysis**. WPS 4136. World Bank, Washington, DC.
[36] Ministere de l'environement et de la protection de nature (2006). **Plan d'action national pour l'adaption aux changements climatiques**. Strategy paper for UNFCC. http://unfccc.int/resource/docs/napa/sen01f.pdf

Change (UNFCCC). The report recognises the importance of water resources and the potential negative impacts which may occur due to climate change. It strongly advocates two main adaptation strategies; to collect fresh water before it reaches the sea, and to protect water reserves from pollution and degradation. In addition, the agricultural sector and coastal zones are discussed for adaptation strategies. However, it has been suggested that climate change adaptation, especially in view of poverty alleviation, needs better and more holistic approaches if smallholder farmers and the vulnerable poor are to adapt efficiently[37].

The capacity of farmers to adapt and cope with additional stresses such as climate change is often undermined by poverty, ill health, inadequate village infrastructure and poor social networks for support. A more water-focused adaptation strategy for West Africa was proposed by IUCN[38], to include a more holistic IWRM approach for water resources, including coastal and inland wetlands. The reason for a West Africa regional approach is partially based on the inter-dependence of water due to the trans-national river systems, as well as similarities in hydro-climate, development agendas and socio-economic settings. The report also highlights that Burkina Faso has developed over 1,500 dams over the last 30 years to cope with the long-term droughts experienced in the Sahel, 1980-2000. But, overall, it concludes that regionally West Africa utilises just 3% of its freshwater resources efficiently. To cope with future reductions in rainfall and increased temperatures, more proactive initiatives need to be undertaken, especially IWRM strategies to ensure sustainable water development in the region.

4. DISCUSSION AND REFLECTION

Despite Senegal being seen as a 'dry' country, water resources are abundant in terms of surface water and groundwater. But the outlook for poverty alleviation, meeting the MDGs and coping with projected climate change may ultimately prove difficult and hit hard at the already poor and vulnerable parts of the population.

4.1 Water supply and sanitation

The Senegalese authorities have taken serious the objectives of achieving the MDGs and are well on target to achieve commitments for supply of drinking water and improved sanitation (MDG target 10). However, it should be noted that the route to providing the water supply and sanitation solutions appear to be very top down in terms of choices of development, i.e. local stakeholders have marginal choices on the form of water supply and sanitation solutions will take. In some cases, in particular in the rural context, it

[37] P. Tschakert (2007). Views of the vulnerable: Understanding climatic and other stressors in the Sahel. Global Environmental Change. *In press.*

[38] M. Niasse et al. (2004). **Reducing West Africa's vulnerability to climate impacts on water resources, wetlands and desertification: elements for a regional strategy for preparedness and adaptation.** IUCN Regional Office for West Africa.
http://www.iucn.org/dbtw-wpd/edocs/2004-068/climate-impacts-Eng-prelims.pdf

appears that although water is supplied, through improved quality and quantity, the technology supplied may actually increase vulnerability, as the (relatively) high-tech pumping requires an external supply of energy (diesel and/or electricity).

In particular, these small-scale options can enable individual households to reduce water costs for part of the year in semi-arid areas, as well as reduce water supply network and infrastructure costs, especially in less densely-populated areas such as in rural Senegal. Equally, promoting sanitation solutions as an alternative to water closets (WC) should be a high priority in an emerging water-stressed country such as Senegal. There are numerous alternative solutions that can be investigated for both technical and social appropriateness. If the supply of energy is broken, or the maintenance of the pump fails, people face severe constraints as they now have few means to support clean water. Thus, there is a question mark as to why the focus is not put more strongly on so-called 'off-the-grid' solutions (i.e., rainwater harvesting, small-scale dams) that enable rural communities' independence and self-sufficient water systems, at least providing a choice.

Gutters and rainwater collecting tanks supply cheap water during dry spells and dry seasons while lessening demand on other fresh water sources in landscape

Another issue that emerges is the heavy reliance on groundwater for providing clean water supplies. The groundwater is, at this stage, abundant on a country level. However, a number of contacts (Annex 1) also raise the issue of declining water tables, decreased quality, and overall sustainability of groundwater at specific sites in Senegal. The data on actual resources and aquifer recharge times varied in a range of available sources. Until information on aquifer sizes and actual recharge rates (not only potential extraction rates) are available and well established, the issue of sustainability of groundwater-dependent systems are in question. For example, installation of pumps for wells of 200 m or more is expensive and requires a long lifetime for justification.

A third concern raised is that the technology for groundwater abstraction has far outpaced the development of institutions and legal frameworks for the monitoring and oversight of

abstraction of groundwater resources[39]. Thus, caution for over-abstraction (as can be seen in several North Africa countries) should be taken. Support for building institutional and human capacity for groundwater monitoring and data management is desirable. Similarly, institutional capacity and clear legal frameworks are necessary to maintain the quality and quantity of groundwater and surface water resources outtake for development, as well as in consideration of potential future increased demand.

4.2 Management of water resources

Senegal has a long experience in IWRM strategies to safeguard development of water resources, especially in the transboundary context. Water resources management involves complex processes with a multitude of goals to be served, and complexity increases with the size of basin and the size and diversity of the population. The OMVS has taken the initiative to address the issue of local stakeholder consultations and participation in its current IWRM work. However, it should be recognised that stakeholder participation and consultation is a difficult process, especially in involving local communities that struggle with everyday livelihoods and poverty issues. Learning and capacity support to enable stakeholder involvement is necessary to achieve a fair and equitable dialogue, not only for process owners (such as OMVS or external facilitators) but also for the communities. To have IWRM work towards poverty alleviation and sustainable water, ecosystem and economic development often requires strengthening of the involvement of local communities.

The full recognition of green and blue water for integrated management is not fully realised in current IWRM approaches. A more holistic approach considering rainwater as a manageable resource to meet development demands may offer new options for development in certain sectors. Already, the issue of self-sustained 'off-the-grid' solutions has been discussed. The second potential is in rainfed agriculture and livestock. Generally, a more strategic and active approach to water management in rainfed agriculture can return large local gains in water productivity, both for crops and livestock. Improved on-farm water management for crops and livestock also enable less demand for agricultural area expansion and less need for irrigation on a country level. Through active promotion, rainfed agriculture can provide win-win development opportunities for smallholder rural farming systems.

4.3 Water for food

In view of the estimated population growth, the emerging picture of the water-food-land use assessment indicates agricultural productivity needs to be increased substantially to meet food supply requirements, unless either more land is allocated to agriculture or reliance on food imports is increased. Despite the constraints of highly variable rainfall and the short length of growth periods, as is common in semi-arid environments, there is

[39] World Bank (2006). **Sustainable groundwater management: lessons from practice**. GW-Mate Case profile Collection No.15. World Bank, Washington, DC. http://www.worldbank.org/gwmate

ample research and development experience on methods to upgrade rainfed agriculture through incentives and development support. However, to achieve these needs requires active policies and support in multiple sectors to enable farmers to improve their agricultural systems. What is of further concern is that more fresh water needs to be allocated for increased food supply. The estimates here indicate a doubling of water for food alone. Additional water for fodder etc, will further add to the amounts if no active measures are taken to improve water productivity (m^3 water per produced yield of biomass).

Allowing for more entrepreneurs to diversify and invest is viewed as key for achieving the MDGs and linking to poverty reduction. Micro credit schemes are hence viewed as a democratic means for an individual to gain the ability to gain control over his/her future. This should be encouraged as it further empowers individuals affected by production declines or increased vulnerability as a result of limited livelihood options.

4.4 Climate change

Senegal has already experienced a successive period of drying, with declining rainfall over the whole country. Future climate change may severely affect both blue and green water resources. Again, the initiatives from Senegal to meet the climate change challenges are good, but more is needed to enable adaptation to less favourable water resources. The economic implications can be illustrated with sea level rise, which may cost 5-8% of GDP, when the Government of Senegal has estimated a 6-8% annual GDP growth is required to alleviate poverty. Already today, groundwater is locally being degraded due to pollution, salt water intrusion and over-abstraction. Surface waters and in particular wetlands and coastal zones suffer from degrading water quantity and quality[40].

One way forward is to put more effort and investment into less conventional resources, including desalinisation and re-cycling of wastewater, whenever possible. Awareness and capacity building is crucial to enabling successful adaptation measures, particularly with regard to the agriculture and livestock sectors.

[40] GIWA (2005). Canary Current, GIWA Regional assessment 41. Eds. Tayaa, M., Saine, A., Ndiaye, G. and M. Deme, University of Kalmar on behalf of United Nations Environment Programme http://www.giwa.net/publications/r41.phtml

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ANNEX: PERSONS CONSULTED IN SENEGAL

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