



***NEPAD CENTRES OF EXCELLENCE ON WATER
SCIENCES AND TECHNOLOGY - PHASE II***

***“Human Capacity Development Programme addressing
Junior Professional and Technician level capacity challenges”***

**DEVELOPMENT OF NATIONAL FRAMEWORK
FOR HUMAN CAPACITY DEVELOPMENT IN
SENEGAL WATER SECTOR**

Draft, 28 October 2018

TABLE OF CONTENT

TABLE OF CONTENT	2
ACRONYMS	4
EXECUTIVE SUMMARY	5
INTRODUCTION	6
1. GENERAL CONTEXT OF THE STUDY	7
1.1. SOCIO-ECONOMIC SITUATION	8
1.2. ENVIRONMENTAL PROFILE	10
1.3. SENEGAL'S WATER RESOURCES	11
1.3.1. SURFACE WATERS	13
1.3.2. GROUNDWATER	15
1.3.3. HYDRAULIC INFRASTRUCTURES	16
1.3.4. MOBILIZATION OF WATER RESOURCES	19
1.4. INSTITUTIONAL CONTEXT AND GOVERNANCE FRAMEWORK FOR WATER RESOURCES	21
NATIONAL STUDY ON HUMAN RESOURCE CAPACITY IN THE WATER SECTOR	25
2.1. RESULTS OF ACEWATER1 PROJECT ON HUMAN RESOURCES	26
2.2. METHODOLOGICAL APPROACH AND ANALYTICAL FRAMEWORK	28
2.2.1. METHOD FOR WATER SECTOR CHARACTERIZATION	29
2.2.2. STEPS OF SURVEY PROCESS	29

2.2.2.1. PRE-GROUND	29
2.2.2.2. FIELD WORK INVESTIGATION	30
2.2.3.3. DATA PROCESSING	30
2.3. IDENTIFICATION OF ACTORS AND INSTITUTIONS OF WASH SECTOR	30
2.3.1. INVENTORY OF WASH INSTITUTIONS	31
2.3.2. REPRESENTATION OF WATER AND SANITATION STRUCTURES	32
2.3.3. WATER AND SANITATION TRAINING OFFERS IN SENEGAL	33
2.4. SUMMARY OF NEEDS ANALYSIS	34
2.4.1. STATE OF HUMAN RESOURCES	34
2.4.1.1. SOCIO DEMOGRAPHIC PROFILE OF THE PERSONNEL OF THE WATER INSTITUTIONS	34
AGE GROUPS OF THE WATER AND SANITATION SECTOR	35
2.4.1.2. SOCIO-PROFESSIONAL PROFILE	36
STAFF EDUCATION LEVEL	36
PROBLEMS IN PERFORMING TASKS	37
2.4.2. TRAINING NEEDS IN THE WATER AND SANITATION SECTOR	37
2.5. TRAINING AND RESEARCH INSTITUTIONS	38
2.5.1. TYPES OF TRAINING INSTITUTIONS	38
REFERENCES	48
ANNEX	50

ACRONYMS

ZiE	:	International Institute for Water and Environment Engineering
AMCOW	:	African Ministry Council on Water
ANSD	:	Agence Nationale de la Statistique et de la Démographie
ASUFOR	:	Association d'Usagers de Forages
AUC	:	African Union Commission
CCRE	:	Centre de Coordination des Ressources en Eau
ECOWAS	:	Economic Community of West African States
FAO	:	Food Agricultural Organization
GIRE	:	Gestion Intégrée des Ressources en Eau
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HCD	:	Human Capacity Development
KNUST	:	Kwame Nkrumah University of Sciences and Technology
NEPAD	:	New Partnership for Africa's Development
NWRI	:	National Water Resources Institute of Kaduna (Nigeria)
ODD	:	Objectifs du Développement Durable
OLAC	:	Office des Lacs et Cours d'eau du Sénégal
OMD	:	Objectifs du Millénaire pour le Développement
OMVG	:	Organisation pour la Mise en Valeur du fleuve Gambie
OMVS	:	Organisation pour la Mise en Valeur du fleuve Sénégal
ONAS	:	Office National de l'Assainissement
PAGIRE	:	Plan d'Actions pour la Gestion Intégrée des Ressources en Eau
PNES	:	Partenariat National de l'Eau du Sénégal
PREFELAG	:	Projet de Restauration des Fonctions Écologiques et Économiques du Lac de Guiers
RWESCK	:	Regional Water and Sanitation Centre, Kumasi
SDE	:	Sénégalaise des Eaux
SONEES	:	Société Nationale d'Exploitation des Eaux du Sénégal
SONES	:	Société Nationale des Eaux du Sénégal
UCAD	:	Cheikh Anta Diop University
UGP	:	Unité de Gestion et de Planification
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
UNIBEN	:	University of Benin, Benin City (Nigeria)
WANWATCE	:	Western African Network of Centers of Excellence on Water Sciences and Technologies
PREFELAG	:	Projet de Restauration des Fonctions Écologiques et Économiques du Lac de Guiers

EXECUTIVE SUMMARY

The African Centres of Excellence in Water Sciences - PHASE II (ACE-WATER 2) project requested by the African Ministers of Water, aims at supporting the establishment of a Human Capacity Development Programme of the African Ministers' Council on Water (AMCOW) in the water sector in Africa through the NEPAD African Network of Centres of Excellence in Water Sciences and Technology (CoE) by scaling up the approach of the pilot phase. The main activities of the project consisted in:

- Strengthening of two existing NEPAD water Centres of Excellence networks in West and Southern Africa;
- Creating two NEPAD water Centres of Excellence networks in Central and Eastern Africa;
- Strengthening institutional networking and improving research support to policy making in the water sector:
 - a) Analysis of the Climate Variability in Africa;
 - b) Water Resources Security and SDGs – Online Atlas on Water Conflicts and Cooperation;
 - c) African Water-Energy-Food Security Nexus Assessment;
- Supporting the implementation of the African Water Ministers' declaration and NEPAD Centres of Excellence to develop a "Human Capacity Development Programme for junior professional and technician level capacity challenges in the water sector".

Concerning the geographical scope, in line with the available budget, the project has been implemented:

- **At regional level** in three regions: Southern Africa, Western Africa and Eastern/Central Africa;
- **At country level in:** 5 countries in Southern Africa, 4 countries in Western Africa, 5 countries in Eastern and Central Africa.

The project will be implemented in direct management by **JRC** and in indirect management with **UNESCO** (Delegation agreement) through a cross sub-delegation with JRC.

The Commission decision was signed in August 2015. The Administrative arrangement between the two main partners started in January 2016. The first advisory board took place in Ispra (Italy) at the JRC in March and the Kick-off meeting was foreseen at the end of May 2016.

INTRODUCTION

The first phase of the NEPAD Centers of Excellence for Water Science and Technology was subject of a pilot project funded by the European Union during the period 2010-2013. The signing of agreements with ECOWAS and the formulation of a Water Sector Monitoring and Evaluation Program with AMCOW and the African Union are, among others, the main achievements of this phase of the project.

In the first phase of the project, a sector-wide diagnosis was conducted in West Africa (Ghana, Nigeria and Senegal) through four of the five NEPAD Centres of Excellence: EDEQUE / UCAD (coordinator of the West African network); KNUST (Kumasi, Ghana); NWRI (Kaduna, Nigeria) and UNIBEN (Benin city, Nigeria).

These assessments in Senegal, Ghana and Nigeria revealed a significant human resource deficit in the water trades sector. There were also failings in the governance of the water sector. A joint course on Integrated Water Resources Management (IWRM) was designed to support universities in continuing education. Research on variability and climate change has mainly highlighted the shortcomings in hydro-climatic information in the West African sub region.

During the first year of implementation of the ACEWATER2 Project, the WANWATCE network with technical and financial support from UNESCO undertook an update of data on human resources in the water sector. The objective is to develop national capacity-building strategies in this sector for technicians and young professionals, in accordance with the mandate received from ECOWAS, AMCOW and the African Union. To ensure the buy-in of all stakeholders, the strategies developed will be validated in each country, in relation with the different components of the sector. The set of national strategies, once validated, should serve as a basis for the development of a sub-regional strategy and will concern the different areas of the network of Centers of Excellence (West, South and East and Central Africa).

During the second phase of the Project, the objectives are, inter alia, to support the development of national water-related capacity-building strategies, particularly for young professionals and technicians in the water sector. The aim will be to define and promote quality training able to steer programs and apply the results of research in the field of water and sanitation and to ensure the strengthening of technical capacities of the services water and sanitation in West Africa. In this perspective, an assessment of human resources in the field of water and sanitation has been carried out in the various centers of excellence of NEPAD. A restitution workshop was held at UCAD on February 16, 2018 to validate the results of the surveys with the various national institutions that were targeted.

This report presents the results of the update of data on human resources in Senegal's water sector and provides a first framework for capacity building in the sector. The presentation of the anthropogenic natural landscape and the legal and institutional framework provides the basis and justification for the national capacity building framework described in this report.

1. GENERAL CONTEXT OF THE STUDY

Senegal is located at the most westerly extremity of the African continent, between 12.5 ° and 16.5 ° N latitude and 12 ° and 17 ° W longitude. It is bordered on the east by Mali, on the north by Mauritania, on the west by the Atlantic Ocean, on the south by the Guinea-Bissau border and Guinea-Conakry (see figure 1). The Gambia, located between the natural regions of Sine Saloum and Casamance, constitutes inside Senegal an enclave of 300 kilometers long and 60 kilometers wide. Senegal covers an area of 196,712 km², bordered on the west by 700 km of coastline on the Atlantic Ocean.

In terms of administrative organization, Senegal has 14 regions, 45 departments, 123 districts for deconcentrated institutions; 126 Communes including 5 cities, 46 municipalities, 385 rural communities for decentralized structures. This situation made the administration organisation of the national territory quite complex and it was supported by the law 2008-14 of March 18, 2008 which modified the law 72-02 of February 1, 1972 related to the organization of the Territorial and local Administration and brought the number of regions to 14, including three new ones: Kaffrine, Kédougou and Sédhiou. However, the territory is not simplified with 602 local communities of unequal surface size, differently endowed with natural resources.

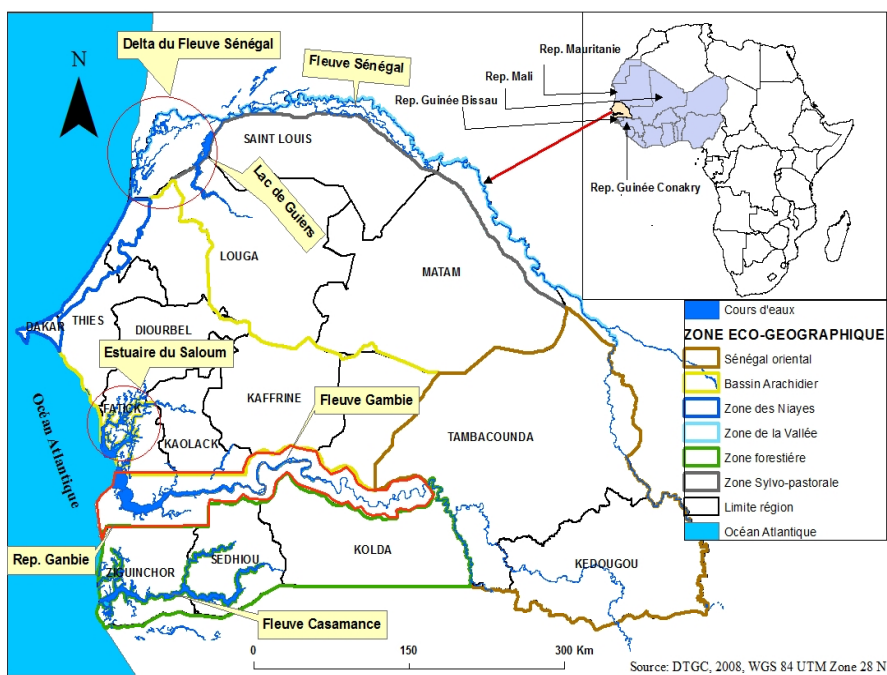


Figure 1: Situation map of Senegal

1.1. Socio-economic situation

Senegal has a population of 13,508,715, a density of 69hbt / km², according to the latest 2013 Census of Population and Housing, Agriculture and Livestock (RGPHAE). The population is quite young (42% are under 15), dynamic with a growth rate of 2.7% per year.

The Senegalese population is very unevenly distributed over the territory; Dakar has a population of more than 3,137,196 inhabitants, where $\frac{1}{4}$ of the total population (23.2%) lives in an area corresponding to 0.3% of the national territory. The average density is 5735 inhabitants per km² but conceals significant disparities: the average density in Kédougou is 9 inhabitants per km² and 16 inhabitants per km² for the region of Tambacounda which is the largest one in the country but with only 5% of Senegal's population (ANSD, 2016).

The evolution of the population shows an upward trend between 1976 and 2013 (Figure 2). The Senegalese population has thus increased from 4,958,085 inhabitants in 1976 to 11,841,123 inhabitants in 2008. According to ANSD projections, this population will reach 25.7 million inhabitants in 2035 and 38.9 by 2050. Given these projections, the Senegalese population will triple between 2013 and 2050.

This rapid growth of the population, linked to the high level of fertility, reveals a strong demographic dynamism which increases, therefore, the social demand. It should also be noted that most of this population is of rural type with significant needs for basic infrastructures.

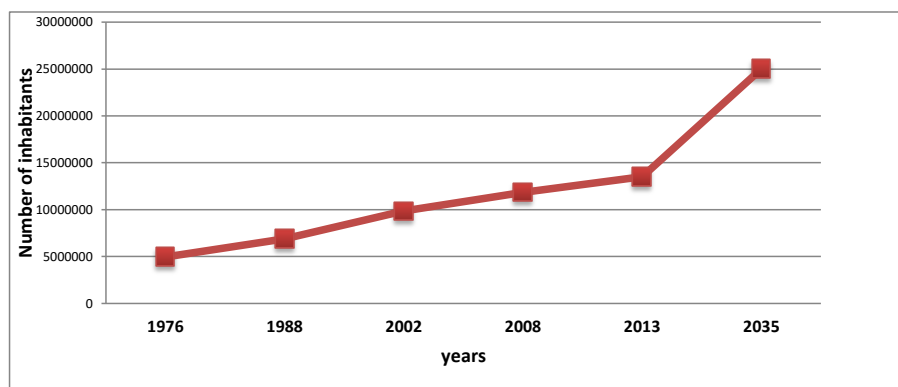


Figure 2: Evolution of the population of Senegal from 1976 to 2035 (source: Vidal et al., 2016)

At the economic level, most of Senegal's population is largely focused on agriculture, one of the pillars of the Senegalese national development strategy or plan known as '**Plan Sénégal Émergent**' (PSE). The latter occupies an essential place in the national economy. The agricultural sector employs more than 60% of the country's labor force; however, it is a subsistence, low-productivity agriculture that contributes very little to GDP (on average 8%). Senegal wants to rely on agriculture to achieve economic development by 2035. But it should be noted that agriculture is weakened by the climate variability that is recorded throughout the Sahelian zone.

With the Plan Sénégal Émergent (PSE), we note new orientations and a refocusing on the agricultural sector, particularly through the axis aimed at "a structural transformation of the economy through the

consolidation of the current drivers of growth and the development of new sectors that create wealth, jobs, social inclusion and strong export and investment attraction ". The National Agricultural Investment Program (NAIP), the Agro-Sylvo-Pastoral Orientation Law (LOASP) in addition to the implementation of the 'Plan Sengal Emergent(PSE) main axes have resulted in the new Programme of Acceleration of the Senegalese Agriculture (PRACAS) growth with three Strategic Objectives (SOs): (i) improve and secure the productive base, (ii) increase production and productivity and (iii) improve the efficiency of sector management (ANSD, 2015).

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Fishing is also an important economic sector, mainly because of the importance of sea fishing. Indeed, the Senegalese maritime area is rich in fishery resources which exploitation has made the fishing activities as a major sector in the Senegalese economy. Fishery production account for 12.3% of export earnings and 1.3% of GDP. In addition to foreign exchange and employment, the fishing sector plays a central role in the diet of Senegalese, with a contribution of 70% of nutritional intake of animal protein.

Senegal has significant mineral resources in the Senegal-Mauritanian sedimentary basin and the areas of eastern Senegal (Tambacounda and Kedougou regions). Off the coast of Dakar and at the Guinea-Bissau border, oil fields (offshore) are newly discovered . Off Saint-Louis, gas deposits have been also found. The Diamniadio area gas field, the production of which is used entirely to produce electric power, is presently in decline. Others sites have been revealed in the same sector, but their potential is very low.

The informal sector occupies an important place in the national economy for its high potential for job creation and income, particularly for young people and people without professional qualifications (ANSD, 2013). In 2003, the Dakar region had 281,600 informal production units employing 434,200 people, mainly in non-agricultural market sectors (www.commerce.gouv.sn). However, the participation of the informal sector in GDP is very difficult to measure, given the nature of the sector. However, it remains clear that the informal sector plays an important social role.

Tourism is one of the key sectors of the Senegalese economy. It is the country's second largest source of foreign exchange with a 4.6% contribution to GDP formation. The dynamism of the sector is especially visible on the 'Petite Côte' where it is the main base of economic growth. The Casamance, in the bottom south, has long been an area of attraction for tourism but this situation has been disrupted with the emergence of the MFDC (Mouvement des Forces Democratiques de Casamance) and the installation of insecurity. Despite significant results, Senegal's share of the African tourism market remains modest compared to other destinations in Africa (Morocco, Tunisia for example). It should also be noted that it is the sector that suffers the most from the negative impacts of climate change because of the seaside tourism that is predominant.

With the slowdown in growth linked to the difficult international economic situation since 2008, the Senegalese economy has not performed well in recent years. However, renewed activity has been observed since 2012, thanks to the improvement of the business environment_(boost of public and private investment) and the increase of the -external demand.

In general, Senegal presents a fragile and vulnerable economy, highly dependent on the primary sector. It is also linked to exogenous factors such as fluctuations in world prices, natural phenomena such as floods, droughts, etc.

1.2. Environmental profile

Senegal is a sub-Saharan country with a Sudano-Sahelian climate. The climate is characterized by the alternation of a dry season from November to mid-June and a wet and hot season from mid-June to October. Annual average rainfall follows a decreasing gradient from south to north of the country: it increases from 1200 mm to 300 mm, with large variations from one year to the next.

Various prospective studies have been carried out on climate change. These are rather favorable to an increase of the temperatures and a variability of the rainfall. On the basis of the projections made, the potential climate risks in Senegal can be summarized as follows:

- An Irregularity in rainfall from year-to-year
- A decrease in surface water resources and reduction of the potential of alluvial aquifers;
- A disruption of the agricultural seasons;
- A decline of wetlands and biodiversity.



Figure 3: Senegal's climate zonation (source: IRD)

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The Senegal country presents a series of wetlands that have a particular biological value. This is the case in the Senegal River Delta area where we have the **Diawling** and **Chat Boul** National Park on the right bank, the Djoudj Park, the Gueumbel Reserve and the Ndial Reserve on the left bank. The Saloum Delta is an important RAMSAR site and the Niokolo Koba National Park which is internationally well known.

Senegal has been marked in recent years by a gradual degradation of its marine and coastal environment. The Senegalese coastline experiences particularly significant coastal erosion phenomena, mainly related to the human footprint on the coast. Indeed, the coastal zone is under pressure from urbanization, industry, fishing, tourism, agriculture, etc. These economic activities contribute to pollution and degradation of the marine environment. Added to this, is the presence of oils residues rejected from tanker parked- in the Dakar harbor (CSE, 2015). Fishing, by trawlers dredging bottoms, and unreportable fishing practices contribute to the degradation of marine ecosystems. The occupation of the coast and the removal of sea sand contribute to intensify the erosive phenomenon. The urbanization of coastal areas and port infrastructures lead to a disruption of natural sediment transit. It should be noted that Senegal's coastline plays a major role in economic activity and tourist attractiveness.

1.3. Senegal's water resources

Located in one of the driest areas in the world, the Sahel, and despite the precarious weather conditions, Senegal has significant potential-water resources (Table 1) to secure the water supply for populations and socio-economic activities. Water resources are characterized by very strong interannual variability and unequal spatial distribution. The drought of the 1970s had a significant impact on the resource especially in rural areas. Saline water intrusions are noted in the lower valleys of Sine Saloum, in the deltas of the Casamance and Senegal rivers, as well as in the Grande Côte in the Niayes zone.

	Parameters	Value in 2014
Precipitation	Average height over the long term	686 mm / year
	Average volume of precipitation over the long term	134,9 10 ⁹ m ³ /year
	National precipitation index	576 mm / year
Ressources en eau renouvelables	Total Renewable water resources	25,8 10 ⁹ m ³ /y
	Domestic resources per capita	1773 m ³ / person / year
	Total renewable water resources from outside the country	13,17 10 ⁹ m ³ /year
	Total renewable water resources	38,97 10 ⁹ m ³ /year
	Total renewable water resources per capita	2679 m ³ / person / year
	Share of surface water and groundwater	1,5 10 ⁹ m ³ /year
Surface water	Water produced within the country	23,8 10 ⁹ m ³ /year
	total Inward flow in the country	2,17 10 ⁹ m ³ /year
	Total flow of frontier rivers	22 10 ⁹ m ³ /year
	Recorded flow of frontier watercourses	11 10 ⁹ m ³ /year
	Inflow flow in the country	13,17 10 ⁹ m ³ /year
	Total flow Leaving the country	5,4 10 ⁹ m ³ /year
	Total Renewable external flow 13,17 10 ⁹ m ³ / year	13,17 10 ⁹ m ³ /year
Groundwater	Produced inside the country	3,5 10 ⁹ m ³ /year
	Total renewable resources	3,5 10 ⁹ m ³ /year
Indices	Water Dependency Index	33,80%

Table 1: Senegal's water resources according to AQUASAT, 2014, Source: FAO, AQUASAT 2014

1.3.1. Surface waters

Senegal has several watersheds, including those of the Senegal and Gambia rivers (Figure 4), most of whose water comes from Fouta Djallon in the Republic of Guinea. In addition to these two large basins, intermittent streams such as Casamance, Kayanga with its main tributaries such as Anambé, Sine, Saloum and several coastal rivers such as Somone. Lake Guiers, the bolongs of the estuarine areas of Saloum and Casamance and the ponds of the Niayes region of the north coast and Ferlo complete this system. This national hydrographic network is the result of the geological and geomorphological configuration, as well as the regime and distribution of rainfall in the country. These rivers are home to a specific fauna and flora, and their development (dams, retention ponds, etc.) allows the development of diversified socio-economic activities.

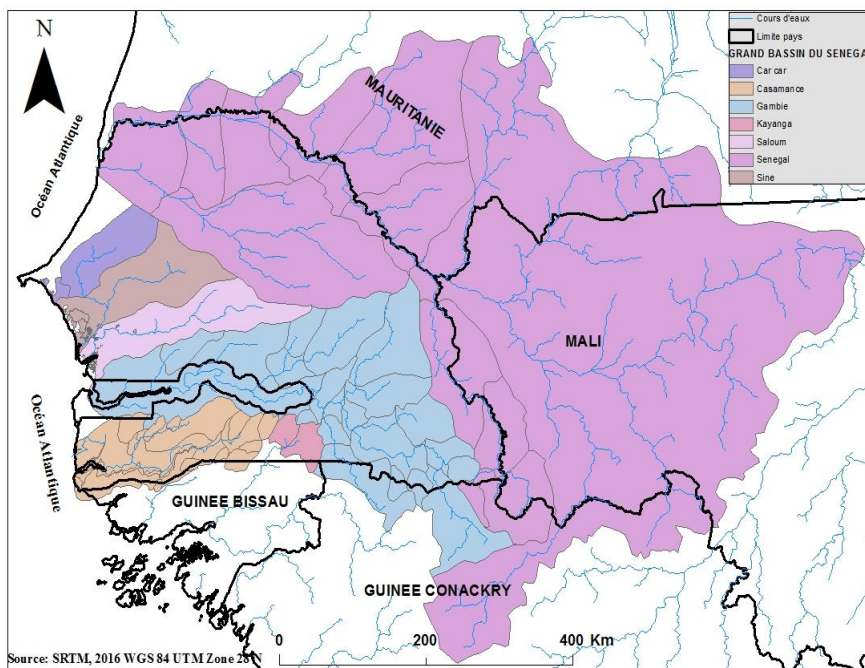


Figure 4: Watersheds (by Ngor Maurice Sarr, 2017)

Senegal's total water prices are estimated at 31 billion m³ in the average year (Table 2). The 1,800 km long of Senegal River drains a basin with a total area of 289,000 km². The hydrographic network is an essential component of the basin landscape; it participates in the formation and delimitation of major geographical, socio-economic and socio-cultural areas (Niang, 2014). Senegal is a transboundary basin managed by the OMVS (Organization for the Development of the Senegal River), created by the four riparian states of Senegal, Mauritania, Mali and Guinea. Lake Guiers, located in the delta of the Senegal River, constitutes the main surface water reserve of the country; its volume is estimated at 601 million cubic meters at -1.80 m IGN. It is fed by the Senegal River from the Taouey Canal. This lake Guiers

Lake occupies a strategic position in the water supply system of the city of Dakar, hence the importance of the Diama dam for Senegal. All the development policy developed in the Delta focused on making Lake Guiers a fresh water reserve for drinking water and crops (Chateau, 1986). The Gambia River is 1125 km long, bordering the Senegal River to the south and southwest. It takes its source in the heart of the Tamcué massif in the Fouta Djallon, and flows into a bay formed by the Atlantic Ocean in the city of Banjul. The Gambia River basin covers 77 000 km² and crosses three countries Guinea, Senegal and The Gambia. The river management is under the responsibility of OMVG (Organization for the Development of the Gambia River), to which Guinea-Bissau joined in 1985 when the competence of the organization was extended to the nearby Kayanga-Geba basin.

Table 2: Average volumes sold annually in the main

Hydrologic Unit	Average Annual Volume	Reference gauging Station
Senegal River	20.4 Billion m ³	Bakel
Gambia River	3.44 Billion m ³	Wassadou
Casamance River	46,4 Billions m ³	Kolda
Kayanga/Anambé	102 Billions m ³	Anambé Dam

Casamance is a small coastal river in southern Senegal, with a large estuary on the Atlantic coast. Its main tributary is Soungrougrou, also formed by the crossing of several small tributaries that originated from the vast region of Fouts, Pata and Guinara (Dacosta, 1989). The flow of Casamance is low compared to that of Senegal or The Gambia; it is 7.67 m³ / s at Kolda gauging station in the upper basin. This low flow explains the incursion of marine water upstream of Sedhiou, where a dam is currently blocking the marine water invasion. The Casamance River is composed of two distinct areas : the continental reach, which annual flows recorded at Kolda are around 46 billion m³, and the seabase, characterized by high salt concentrations, often greater than 100 g since the end of the 1970s. Kayanga has its source in Guinea Bissau. The contributions of the Anambé backwater are estimated at 25% of the Kayanga flows in Niapo (1993 Anagé Basin hydroagricultural development studies). The Kayanga basin is equipped with two dams: Anambé and Niandouba.

Sine and Saloum are inlets in their downstream part; the mainland of their watersheds experiences intermittent flows during heavy rains. Their flows are quite limited and can not stop the marine lift. In the Saloum Delta, near Fatick and Kaolack, salt is presently mined. In the area close to the Fatick region, two small permanent rivers flow, Nema and Djikoye (Mendy, 2010).

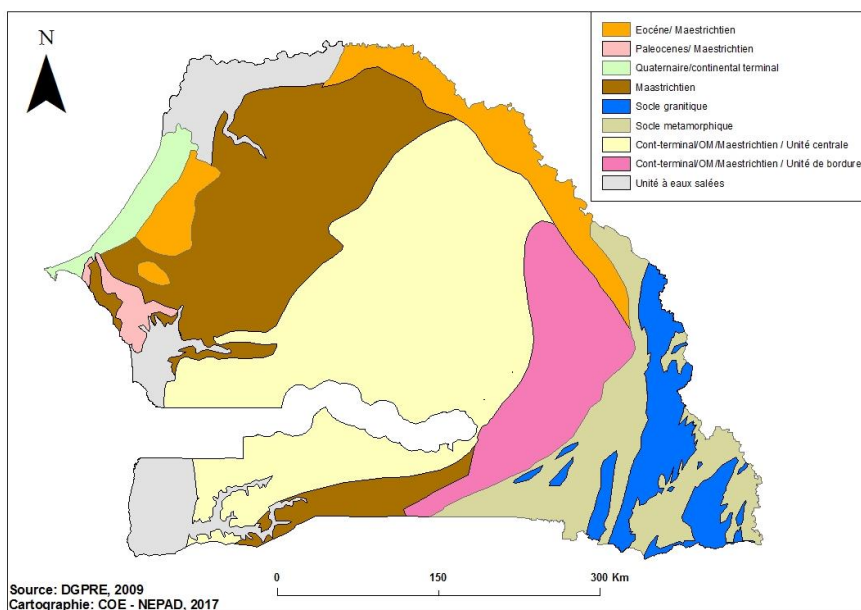
According to several projections, by 2025, all hydrographic organizations in West Africa are likely to end up in a situation of severe water scarcity (Sharma et al, 1996, IPCC, 2014; et al, 2016). Much more than the scarcity of fresh water, it is the extreme weather events (especially droughts and floods) that should cause serious economic and social dysfunctionning . In transboundary basins, this could cause conflicts of use and could install international tensions for water sharing. The consequences would then be a reduction in resources, a drying up of watercourses, a deterioration of the quality of water and associated ecosystems, a loss of biodiversity and above all a growth of poverty and food insecurity.

1.3.2. Groundwater

Senegal has significant groundwater resources that are contained in sedimentary basins, including the Senegal-Mauritanian basin; Groundwater is represented by four groups of aquifers: the superficial aquifer system, the intermediate system, the deep aquifer system and the hard rock aquifers. They enable the satisfaction of water needs where surface water is lacking (quality and quantity) (DGPRES, 2007). Two major geological and structural features stand out: the Senegal-Mauritanian sedimentary basin with its widespread generalized aquifers of the inter-granular type and the old metamorphic aquifer with its discontinuous to semi-continuous fissure aquifers (CSE, 2015). **Figure 5 shows the spatial distribution of different aquifers throughout Senegal.**

With the exception of the east and south-east of the country (Bakel, Tambacounda, Kédougou), groundwater resources are available in sufficient quantity, although in some places their mobilization requires deep drilling and their quality is a problem. (Fluorine concentration and high salinity levels throughout the central part of the country (EIS, 2009)). These water resources are also characterized by their vulnerability from the qualitative and quantitative point of view. In addition, anthropogenic actions such as over-exploitation for the production of drinking water or pollution contribute to the weakening of water resources.

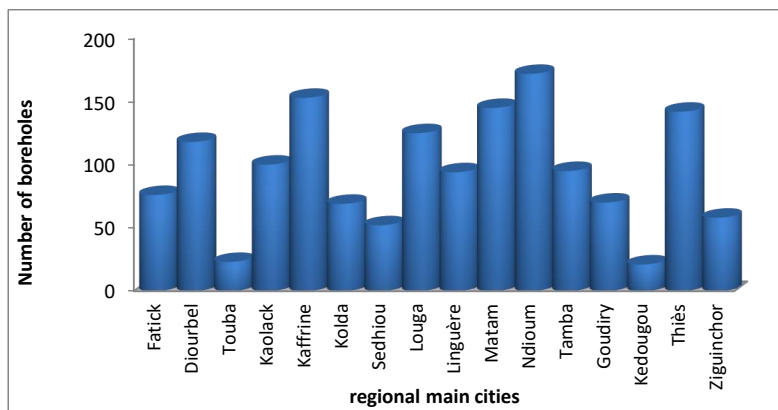
Figure 5: Senegal's aquifer systems



The superficial aquifer system consists of the Nouakchottien and Continental Terminal aquifer. The Nouakchottian aquifer is quite salted with a concentration of 60 g / l of salt, compared to 33 g / l for Atlantic water. The continental aquifer includes Quaternary, Miocene, Oligo-Miocene and alluvial deposits. Its thickness varies from a few meters to tens of meters. The intermediate aquifer system is represented by the Paleocene, Eocene and Pliocene aquifers. The thickness of the Paleocene aquifer is between 5 and 350 m, its potential is 50 to 100 billion cubic meters with flow rates ranging from 50 to 100 m³ per hour. It is actively exploited especially for Dakar water supply in the region of Sébikotane where it is located at shallow depths. The pliocene aquifer, 20 to 30 m deep, is exploited in the central-south of the country. Its water is of good agricultural quality but polluted with fluoride, so not suitable for drinking, especially for children. The Maestrichtian is the deepest and largest aquifer in the entire sedimentary basin (Kane and Niang, 2007). It is reached by drilling of depth between 100 and 350 m with flow rates that can reach 50 to 100 m³ per hour for a potential of 300 to 400 billion m³. Its water is quite warm and especially charged with ferrous oxides, causing pumping problems related to the corrosion of the strainers and drip irrigation due to obstruction by deposition of ferric oxides (Wade et al, 2007).

1.3.3. Hydraulic infrastructures

The building of hydraulic infrastructures allows to cover the water needs of populations from surface and / or underground water. These infrastructures are multiple and varied; they range from dam to water drilling through modern, traditional wells and man-made pumps. They make it possible to ensure the greatest part of the water needs of the various uses such as agriculture, cattle breeding, Drinking Water Adduction (AEP), etc. **Figure 6 shows the distribution of pumping boreholes in the various cities of Senegal.**



Based on the results of the last national inventory of access points to drinking water, the rural environment has a hydraulic heritage of 1513 boreholes distributed very disparately throughout the national territory (Figure 7). The analysis of the map reveals a large spatial disparity in the distribution of boreholes in rural areas. The North and Central zones concentrate 75% of the boreholes with respectively 35% in the North and 40% in the Center. The southern part hosts only

25% of the boreholes. This uneven distribution of boreholes is the result of the economic orientations of the Government but also of the difference in financial cost for the realization of hydraulic works from one area to another. The North and Central zones are agricultural geographical areas with a significant demand for groundwater, due to the scarcity of surface water suitable for agricultural and domestic use. The southern zone is abundantly endowed with atmospheric water (+1200 mm/year) and surface water with the presence of several perennial streams that satisfy most uses. Groundwater is only used for drinking. It should also be noted that in the southern zone, like Kédougou, the lack of hydraulic structures is also explained by the fact that this region is located in the non productive metamorphic hard rock region, which is known by the low productivity of groundwater and the difficulties of the exploitation requiring important financial resources.

As part of the Policy to improve access to drinking water in rural areas, the Senegalese State in collaboration with China, represented by a Chinese company, called CGCOC, will be constructing 180 multi-village boreholes systems and will rehabilitate other 70 in all regions of Senegal, excepted the two following regions : Dakar and Kédougou.

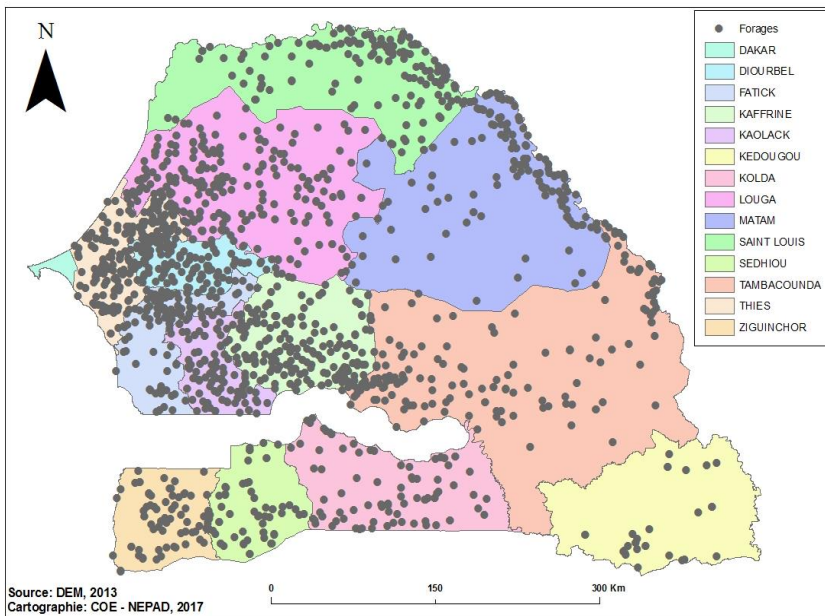


Figure 7: Distribution of drilling by brigade in rural areas, (source: DEM data, 2013)

Commented [KP3]: Definition of acronym ?

Human powered pumps (HMPs) play an important role in the water supply to populations, especially in rural areas. According to the PEPAM data, 2014, Senegal has nearly 3000 PMH (Figure 8), a significant part of which is down (16%) or abandoned (5%).

Hydraulic works face enormous problems related to water pollution and the management of structures. In the center of the country, many boreholes are no longer functional because of a growing chlorides and fluoride contamination of groundwater reserves, specifically the Maastrichtian aquifer. This is a limiting factor in the water supply for populations and other uses, requiring the introduction of new water treatment technologies. Several projects have been developed in this direction from 2009 to now; in particular by PARPEBA financed by the Belgian Cooperation and PEPAM AQUA (PEPAM, 2014).

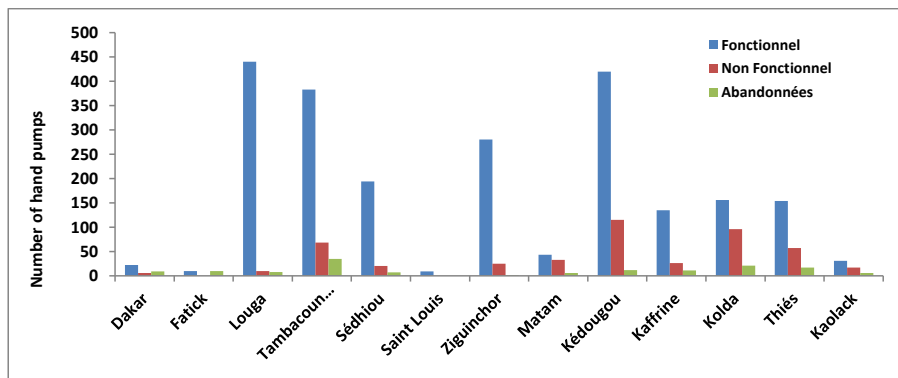


Figure 8: Distribution of Human Powered Wells (TMPs) by Region, (source: PEPAM, 2014)

In urban areas, the drinking water supply is under the responsibility of the national water utility SONES (Société Nationale des Eaux du Senegal) and SDE (Senegalese Des Eaux), which are linked by a performance contract. SONES ensures the implementation of hydraulic structures (boreholes, water towers and water supply networks), the quality control of the services offered by SDE which, in turn, ensures the production and distribution of drinking water in urban centers. The total production of water at 31 December 2013 was 154.8 million m3 for an annual forecast of 159.6 m3 with 97% of realization (PEPAM, 2014).

To face the water shortages in urban areas, linked to population growth, the State of Senegal, through SONES, has put in place an extensive investment programme in the water and sanitation sector. especially in urban hydraulics. In the 2017-2025 master plan, it is planned to set up in Dakar a seawater desalination plant in 2017 (capacity of 50000 m3.j-1) and a third water plant KMS3 in 2019 (capacity of 75000 m3per day for the Dakar region and increased production on the Mbour-Mbodiène axis in the Petite Côte. The emergency program of the Dakar region of 2014 sets a daily production of 345000 m3 and a de-ironization station (Point K) of 40000 m3.j-1 (PEPAM, 2014).

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1.3.4. Mobilization of water resources

The strategic plan for mobilizing water resources revolved around three main points: (1) urban water supply; (2) the achievement of food security objectives; (3) access to water and achieving the MDGs. This plan requires an increase in drilling of 74 million cubic meters per year or about 202 739 m³ / day. This requires a water transfer and treatment capacity of nearly ten million cubic meters per year, ie 11% of the volumes of water distributed, but up to 40% in some Planning and management unit, PMUs, (DGPPE, 2011).

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The main objectives of the Urban Hydraulics sub-sector are the improvement of consumption per capita in secondary cities and the reduction of individual consumption in large centres. Indeed, it is expected a consumption of 30 to 50 liters of water per person per day in secondary cities and 65 liters in large cities. This strategy will not only reduce disparities in access to water in urban centres, but will also contribute to create an enable a good environment for the expansion of other cities (DGPPE, 2011).

As part of the implementation of the post-MDG agenda for meeting the drinking water needs of urban and rural populations, the objectives of the State of Senegal are to:

- maintain the achievements of 2015 and to continue the investment to ensure a sustainable distribution of water;
- connect more than 300 inhabitants from a borehole by 2025, thanks to increased investment;
- to distribute water quality to the population through the construction of water treatment plants in localities where water quality is lacking (DGPPE, 2007).

The attainment of food security objectives is subject to the development of over 135,000 ha of irrigable land for production of about 1,100,000 tons of rice in 2025, in addition to 115,000 tons of rainfed rice. These two types of production (rain and off-season) are expected to achieve about 80% of the rice production target of 15,000,000 tonnes of paddy.

The notion of access to drinking water is an indicator representing the share of the population with reasonable access to an adequate amount. According to WHO, the adequate amount of drinking water is at least 20 liters of water per capita per day, while "reasonable access" is generally understood to mean drinking water within 15 minutes of walking. It has been recognized since July 2010 as a fundamental human right by the United Nations. On November 10, 1980, the United Nations General Assembly designated the period 1981-1990, the International Decade for Drinking Water and Sanitation (DIEPA). The main objective was then to guarantee access to water and sanitation for all inhabitants of developing countries before 1990. In this perspective, significant efforts were made by Senegal to be in line with the objectives of the Decade of Drinking Water and Sanitation. Between 1975 and 1980, 36% of the Senegalese population had access to drinking water. Between 1990 and 1995, this figure rose to 52%, with 28% in rural areas and 85% in urban areas (UNDP, 1996). During the period 1996-2000, the percentage of individuals with access to drinking water increased from 67 to 72%, an increase of 8.5% (CSE, 2015).

Presently, Senegal is the country of sub-Saharan Africa that has the highest rate of connection to running water in urban areas, 98%, according to the World Bank.

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In 2000, UN member states signed the Millennium Declaration to eradicate poverty, hunger, disease, environmental degradation and discrimination against women. Since 2005, Senegal has implemented the coordination unit PEPAM (Program for Drinking Water and Sanitation Millennium) to facilitate the achievement of the MDGs in the Water Sector. PEPAM coordinates the efforts of the State, civil society, local communities, NGOs, the private sector and development partners to effectively achieve the Millennium Development Goals. PEPAM is therefore not a project, but a national programmatic framework in which all actors are invited to register their interventions and investments

In 2010, the Millennium Development Goal on access to safe drinking water, measured through an indicator of access to improved drinking-water sources, was achieved at the global level, but much remains to be done to reach the sanitation target. Satisfactory results have been achieved by Senegal in the water sector; the country has officially reached the MDGs for the drinking water sub-sector. The target set by 2015 had already been reached in urban areas two years earlier; it was exceeded at the end of December 2013 for rural areas, thus confirming all initial forecasts of a possibility to cross the MDG curve before the 2015 deadline. For this, major operations have been deployed since 2005 with the support from development partners and exceptional mobilization of civil society to improve the living conditions of populations, especially those living in rural areas. The rural water supply sub-sector has an access rate of 84.1%, well above the target of 82% set for 2015. The implementation of projects and programs initiated by the subsector 69.85% of the rural population have satisfactory access to water through drinking water networks and 14.25% by manual or mechanized drawing from modern wells or boreholes equipped with hand pumps. In 2015, out of 15,992 localities, it shows that the overall improved access rate for drinking water in rural areas was 86.6% in 2015. Based on statistics on new achievements that were recorded in 2015, the global access rate for drinking water for December 2015 is estimated at 87.2% (PEPAM, 2016). In addition, the efforts to reduce regional disparities are reflected in a very satisfactory dispersion with a coefficient of variation that is decreasing by 13% at the end of 2013 compared to 18% in 2004, considering the overall access rate by region (PEPAM, 2014).

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In urban areas, the overall access rate has almost stabilized with 98% for the entire afforested area of the Senegalese Des Eaux (SDE). The other urban centres show a result of 91.2% for the same indicator. The fountain access rate stood at 8.5% overall at the perimeter level (a slight decrease of 1 point compared to December 2012) with 4.0% for urban Dakar, 11.2% for Dakar peri-urban and 12% for other urban centers. Disparities continue to be noticed between the cities in the contractual perimeter, but could be gradually reduced by the end of the programme with 68,000 social water connections. A new connection programme, however, would be useful to absorb the strong urban demographic growth (PEPAM, 2014).

According to the PEPAM (2016), at the national level, the rate of access by drinking water supply (people served through the standpipes and special connections from motorized boreholes or water treatment stations) was 74.0% against 69.85% in 2014; a good positive evolution of 4.15 points. On the other hand, access by modern wells (equipped or not with hand pumps) decreases significantly to 12.6% compared to 14.25% in 2014. It should be noted that the improvement in quality and the security of access to water has changed significantly over the period 2005-2015 through linear trends in the increase in access rate by water supply and the decline in the access rate per well.

However, even though Senegal had reached the MDG on access to drinking water, in the sanitation sector, especially urban, the progress remained very low. Similarly, MDG-Agenda 2063 / SDG (2016) states that the MDG target for sanitation globally has not been met, as only 68% of the world's population had access to improved sanitation facilities in 2015. The main challenges remain the rapid population growth, which will increase the demand for drinking water, which will be even more difficult to meet.

1.4. Institutional context and governance framework for water resources

In Africa, the issue of water is crucial because of the social and economic situation in most of the African countries. In sub-Saharan Africa, particularly in the Sahel, water is a vital issue (see climatic characteristics of the Sahelian zone).

In Senegal, the water context following the climate crisis of the 1970s, was accompanied by major institutional reforms to improve the governance of water resources, with a view to sustainability and preservation. The definition of a governance framework for water resources from the local to the international level is therefore necessary to ensure the sustainability of uses, reassure users and prevent conflicts.

The framework of water governance in Senegal can be analyzed first through legal and institutional policies and mechanisms. Senegal has experienced several reforms of the Hydraulic sector, especially urban, which resulted each time in the redefinition of the institutional and / or legislative landscape and the creation of new institutions and / or the reorientation of the vocation of those already existing

. **Figure 9 below summarizes the links between the various players in the water sector.**

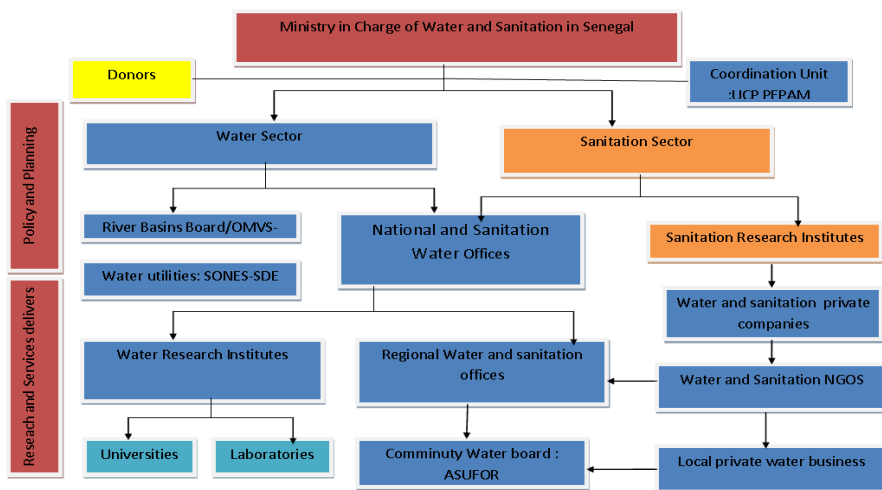


Figure 9: Main actors in the water and sanitation sector in Senegal

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The management of water resources now rhymes with the implementation of large-scale programmes such as the Potable Water and Sanitation Program (PEPAM) or the Action Plan for Integrated Water Resources Management (PAGIRE), both aiming to the achievement of Senegal's social and economic objectives with regard to water.

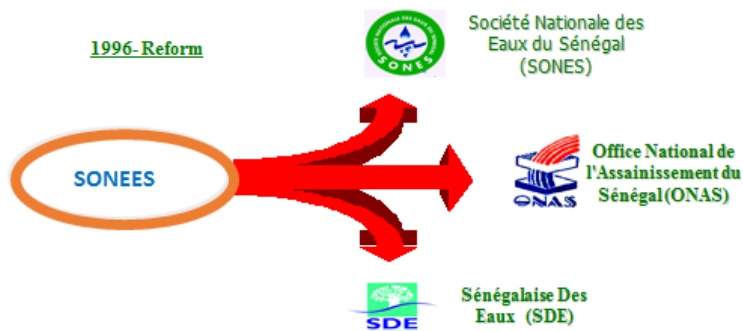
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In 1996, the Government of Senegal developed an ambitious water program valued at \$ 450 million to support water infrastructure projects in rural and urban areas. The institutional reform of the urban water supply and sanitation sector, in 1996, resulted in the creation of the Senegal National Water Company (SONES), the Senegalese Water utilities (SDE) and the National Office of Sanitation (ONAS). These three institutions were created in replacement of the SONEES (National Company of Water Exploitation of Senegal).

SONES is a public body responsible for the management of the urban water heritage and the control of the quality of the operation and the public service of the water supply. SONES is a signatory, with the State of Senegal, of a 30-year concession contract doubled recently with a performance contract.

The SDE is a private company, exclusively responsible for the operation of drinking water installations located within the scope of its contract. This perimeter covers the urban and peri-urban areas of Senegal, concession areas of SONES. The SDE is linked to the State of Senegal by a leasing contract and to SONES by a performance contract for a period of ten years, extended for five years, in 2006 (Touré, 2017). This contract between the SDE and the State of Senegal, extended in January 2013 for a period of five years, expires on December 31, 2018.

First generation of urban water and sanitation reform in Senegal



ONAS is a public industrial and commercial institution (EPIC) responsible for asset management, remediation work and the maintenance and operation of sanitation facilities. ONAS is responsible for the collection, recovery, treatment and disposal of wastewater and rainwater in urban and peri-urban areas.

From 2005, the Public Service of Drinking Water and Sanitation (SPEPA) and the Potable Water and Sanitation Program (PEPAM), under the supervision of the Ministry of Hydraulics and Sanitation. PEPAM is a unified framework of interventions put in place by the Government of Senegal to achieve the Millennium Development Goals in the sector of drinking water and sanitation. It was launched in January 2005 following a planning process that took into account all the concerns of all stakeholders in the sector.

Thanks to these reforms in the water sector, the institutional landscape has seen the creation and / or reorientation of several institutions in the water sector. For example, in 2002, the Water Resources Management and Planning Service (SGPRE) was restructured and became the Directorate of Water Resources Planning Management (DGPRES). The DGPRES is in charge of monitoring, management and planning of all water resources under the national authority (surface water and groundwater). It relies on its technical services consisting of the regional divisions of hydraulics: Maintenance Services, Well and Drilling Brigades, maintenance units.

Since 2007, Senegal through the DGPRES has embarked on the definition of its Action Plan for the Integrated Management of Water Resources (PAGIRE). PAGIRE materializes through a strategic management plan whose objective is to "Strengthen the management resources and reform the institutional, legal and organizational frameworks with a view to improving the protection, technical, economic and financial management of water resources by involving all actors (DGPRES, 2007). Through this plan, the State of Senegal wants to achieve the following objectives:

- 10% increase in the satisfaction of the demand for water, following better control of water needs and availability.
- Improved participatory management of water resources through the participation of at least 20% of key stakeholders in decision-making processes at different scales through appropriate and applied legislation and their adherence to principles IWRM.
- Reduction to 20% of the degradation of water resources, lands and related resources by controlling the impacts of climate change, pollution and other risks (DGPRES, 2007).

In 2010, the Directorate of Management and Planning of Water Resources (DGPRES) developed a "Water Resources Mobilization Strategic Plan". It identifies five (5) management and planning units (MPUs) spread over Senegalese territory (Figure 10); these MPUs are subdivided into 28 sub-PMUs that make it possible to analyze the resources mobilized to respond to the major strategic issues of national development, the risks to which they are subjected and the resilience of these strategies to a prolonged drought episode (DGPRES, PEPAM, 2014). The delimitation of watersheds is based on a number of criteria: topography; the level of precipitation; the direction of drainage of watercourses; the characteristic of groundwater; the contours of the communes. Five (05) major hydrological groups have been identified: the Senegal River Basin, the Sine-Saloum Basin, the Casamance Basin, the Gambia Basin and the Eastern Senegal Basin.

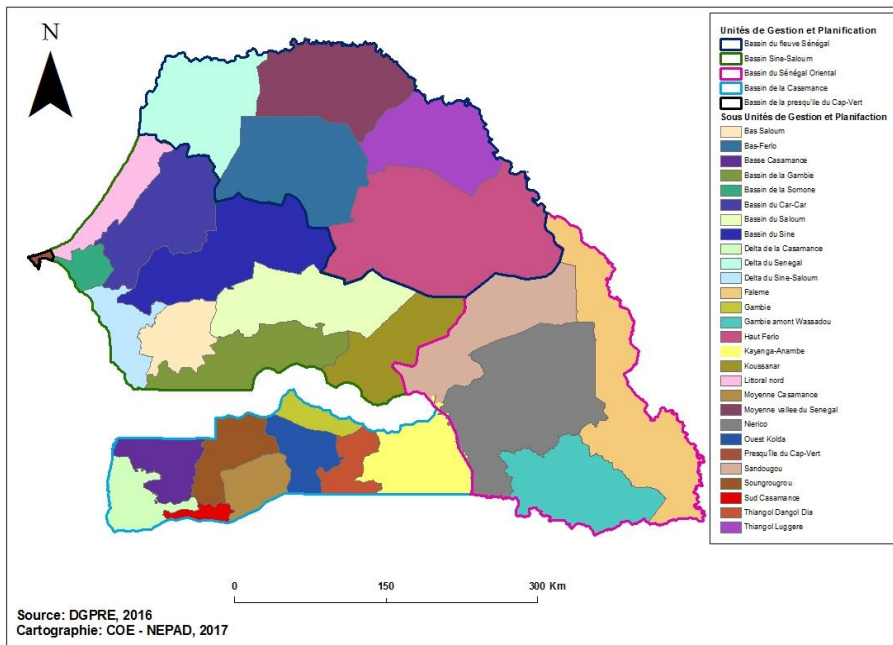


Figure 10 : Management and Planning Geographic unit and distribution of sub units

The management of water resources is a priority for the State of Senegal, in this perspective Senegal had created the Office of Lake Guiers (OLAG), a public institution of an industrial and commercial nature. The creation of OLAG firstly responded to the need to set up and guarantee sustainable management of Lake Guiers, whose importance for the urban water sector (mainly Dakar) is vital. The 4-year (2014-2018) ecological and economic restoration project of Lake Guiers (PREFELAG) was implemented for the restoration of the ecosystem functions of Lake Guiers in order to guarantee in a sustainable way the performance of production systems and their resilience to climate change. The project has among other objectives, the ~~the~~ watering of the Ndiel Bird Sanctuary catchment

In 2017, OLAG's field of competence was expanded with the creation of the OLAC (Office of Lakes and Rivers), which replaced it. OLAC aims at mastering the integrated management of water resources, in a perspective of sustainable development and optimization of the territory's water resources, with the following missions:

- the planning and rationalization of the management of the waters of all the lakes and inland waterways, throughout the national territory, excluding watercourses subject to international conventions;
- the programming of related investments;
- delegated project management and public investment related to the management and planning of water resources, lakes and inland waterways;

- the maintenance of the equipment and works of management of the water bodies;
- the control and management of all protection areas of lakes and inland waterways;
- the qualitative and quantitative monitoring of the resources of inland lakes and rivers;
- The management and exploitation of invasive aquatic plants on inland lakes and streams.

The institutional landscape of Senegal's water sector requires the mobilization of qualified human resources, well trained to take on the technical challenges (Water quality is going to be a big challenge for the coming years) Surface management and management of sustainable infrastructure, capacity development in project design and management, and promotion of IWRM and gender issues in water management, particularly in the clear vision of the Emerging Senegal Plan. Human capital is indeed one of the bases of development of this plan which encourages any action or initiative to endow the country with human resources able to design and conduct water and sanitation policies and strategies.

NATIONAL STUDY ON HUMAN RESOURCE CAPACITY IN THE WATER SECTOR

The 2000s were marked by the resurgence of the problem of water shortages throughout the Sahelian space. In Senegal, several projects and programmes have been implemented in the context of water management.

For the achievement of the Millennium Development Goals (MDGs), Senegal had established the PEPAM (Program for Drinking Water and Sanitation Millennium) which is a unified framework of national interventions in the field of water and sanitation. The major efforts made by Senegal have made it possible, the achievement of the MDGs in the water sector as early as May 2014 (Table 3), and significant efforts will have to be made in the field of sanitation.

Today, in the context of the implementation of the Emerging Senegal Plan(PSE) and the perspective of the SDGs, the need for qualified human resources able to take up Senegal's development issues and priorities is more urgent than ever before.

Table 3: PEPAM data on Senegal's achievement of the MDGs (May 2014)

	Drinking water	Sanitation
Urban	98%	61,7%
Rural	84,1%	38,7%
Total	90,4%	49,1%

As a result of the MDGs, the United Nations, together with all member countries, has defined other goals confined on Sustainable Development Goals (SDGs). These 17 goals are intended to strengthen MDG achievements. Water development is supported by SDG6, which aims to "ensure by 2030 universal and equitable access to safe and affordable drinking water". To achieve the objectives and reduce the gap between rural and urban areas, the State has integrated a "rural water" component into the Community Emergency Development Programme (PUDC). Also, for a better quality of the services and **an efficient and effective management, the State initiated a reform of the sector with**

the creation of the Office of the Rural boreholes (OFOR) which is in charge of the management of the inheritance of the rural boreholes and the implementation of a more efficient management system based on the delegation of public services (Regional Report, 2015).

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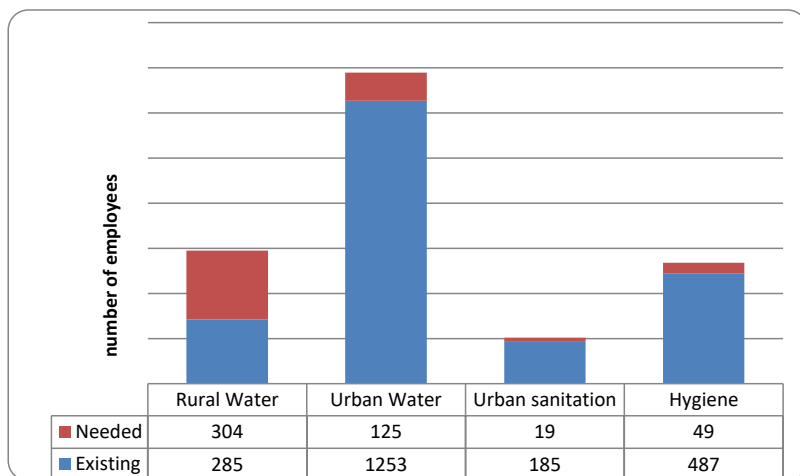
2.1. Results of ACEWATER1 Project on Human Resources

During the first phase of ACEWATER (2009-2013), a study was conducted based on the objectives of the project and agreed with all involved institutions partners. These were as follows:

1. To carry out a survey in the water sector.
2. To carry out a study on the subject of expertise in the field of research and development.

In 2013, the population of Senegal was estimated at 13 million inhabitants and around 70% living in the rural area; a rapid urbanization was observed and a strong migration movement of the population to cities. This situation causes an increasing demand for water in cities and a need for heaving investments in water infrastructures to improve the water access and to reduce poverty and health problems.

A questionnaire was sent to about 33 institutions working in the water and sanitation sector. Online interviews on water and sanitation issues have been developed. Existing official databases (PEPAM etc.) were investigated to have an exact situation of the water supply and sanitation sectors in Senegal.



The main constraints met are:

- Important delays were recorded before we agree on the final questionnaire format to share;
- Not enough resources were available to support the administration of the questionnaire
- Some organizations did not have time to respond to the questionnaire and that led to some estimations;
- A precise estimation of capacities, needs and shortage in the WASH sector either in public or private organizations is a difficult exercise and needs time and expertise.

The main findings were:

- a real need in human resources both at central and local level;
- a bad distribution of the workforce in the water and sanitation sector: it has been noticed a real concentration of engineers and technicians in the Capital City of Dakar;
- a lack of replacement of retiring officers and ageing work force in the water and sanitation sectors;
- Inexistence of appropriate skills in the fields of specified areas such as: water resources engineering and planning, Computer systems managers and operators, hydrologists and hydrogeologist, sanitation engineers.

Regarding training and career development, it exists in Senegal training institutions but not focusing in specific courses on water resources development or management; the existing universities trained students to the intermediate or high level (Masters and PhDs programs) in areas of environments, geography with some courses related to water. It has been discovered that many professional institutions (water utilities and water companies) provide internally training for their workers; but there is still a need for training in some very specific areas such as climates changes impacts management, flooding management.

The national institutions suffered from this lack of financial and human resources; there was an important gap for engineers and technicians and also higher educated and experimented people to conduct efficiently water and sanitation projects. That situation is worsening because of the aging civil servant agents that are to retired.

Government and non-governmental organisations did not develop strong connections with research and universities institutions to use either their results or the existing capacities to design and accelerate projects and programmes implementation.

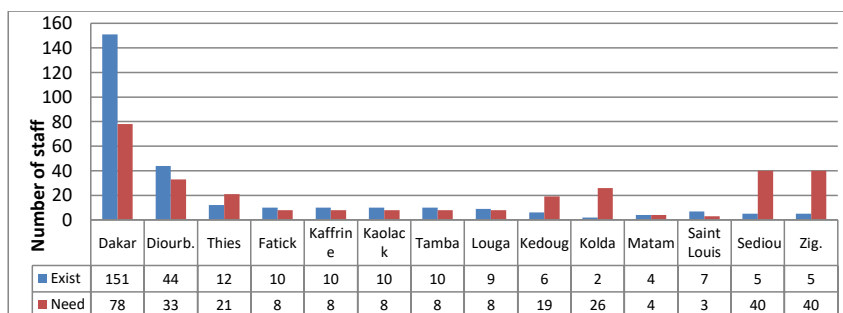


Figure 1 : Situation of existent and needed staff at regional level

A clear need for capacity building in the following fields have been expressed:

- Water productions infrastructures: borehole Maintenance and Rehabilitation, Geophysical Investigation Techniques, Drilling Technology, Drilling Equipment Maintenance, pumps installations or maintenance;
- Water Treatment Techniques: Water Treatment Facilities;
- Remote Sensing and Geographic Information System, Integrated Water Resources Management;
- Sanitation and Hygiene: sanitation construction facilities, mobilization and sensitizing techniques;
- Project Management, Project Monitoring and Evaluation, Environmental Impact Assessment (EIA).

The formulated recommendations were:

- to fill up important gaps recorded in the water and sanitation sectors in terms of skills and human resources
- rehabilitating training centres in water and hygiene that were closed for budget restrictions;
- developing short and professional courses in water and sanitation with an accent in areas related to urban water and funding managements systems and hygiene promotion;
- optimizing training strategies and programmes allocated by donors through cooperation agencies.

Large discrepancies still remain between urban and rural areas. Urban access of population to water in 2006 was estimated to be at 93% compared to 65% in the rural area. The percentage of population that had access to water services grew from 80.3 % in 1995 to 96% in 2004 in Dakar. The main stakeholders are:

- Publics sectors / Governmental Institutions (Ministries etc.)
- Research Institutions/laboratories
- Water utilities
- Water companies
- Water agencies
- Water user Associations
- Sanitations institutions
- Donors: Many bilateral agreements exist between countries and Institutions and friends developed countries
- Civil society, local and international NGOs: are important actors both in the rural and the urban water sector.
- Shared catchment organisations
- Local communities

2.2. Methodological approach and analytical Framework

Capacity is commonly defined as "the ability of individuals, organizations, and the community as a whole to successfully manage their business." It is about the ability to create, understand, analyze, develop, plan, achieve goals, reflect on the results of actions, toward a vision, change and transformation.

The Food and Agriculture Organisation (FAO)'s Capacity Building Strategy defines capacity building as "a process by which individuals, organizations and the community as a whole liberate, create, reinforce, adapt and maintain capacity over time".

Capacity building therefore addresses political and social aspects, in addition to technical aspects, and must take into account the individual, organizational and systemic dimensions that require a deep diagnosis of the targeted organizations.

2.2.1. Method for Water Sector characterization

The approach for the characterization of the water sector of Senegal was also based on a thematic division allowing to take into account all the dimensions of the water resource but also all the themes allowing an optimal coverage of the subject matter. The idea was also to take into account the major innovations recently made in Senegal's water sector. Each theme is entrusted to a manager responsible for conveying all the information relating to the theme for which he is responsible, emphasizing recent innovations, current and future programs and projects. These data will also feed into and enrich the national capacity building strategy being defined.

Table 4: Thematic organisation of the Study

THEMATIC	RESOURCE PERSON
Waste and water treatment	Seydou NIANG
Groundwater management	Samba BA
Surface water management	Niokhor NDOUR
Water for agriculture	Mor Talla SALL
Water technology and innovations	Awa NIANG FALL

2.2.2. Steps of survey process

The collection and updating of data on human resources in the water sector is based on a simple methodology that broadly reflects that of the first phase of the project.

After the inventory of structures involved in the water and sanitation sector, the field investigation work was organised into two phases: a pre-field phase and a field phase.

2.2.2.1. Pre-ground

First, a pre-field was carried out, in which an identification of the structures working in the sector of water and sanitation was conducted. This work is made possible thanks to the use of the internet, which allowed us to have all water and sanitation institutions; this allow to collect the physical and electronic contacts of the identified institutions.

This task is followed by sending letters to all structures targeted by the field survey. The list of respondents to the survey is given in the appendix (Annex 2 List of recipients of the survey of human resources in the water sector - Dakar and regions)

2.2.2.2. FIELD WORK INVESTIGATION

Regarding the field investigations, individual interviews were conducted with those responsible for water and sanitation structures. These interviews are accompanied by a questionnaire on the assessment of human resources in the water and sanitation sector. These are structured around two essential points:

- an inventory of human resources in the water and sanitation sector
- identification of training needs in the water and sanitation sector

To do this, the study area (the entire national territory) has been divided into three parts:

- Dakar city area
- Dakar Area Suburbs
- Other regions of Senegal (mainly Thiès and Saint-Louis), each corresponding to a field phase.

In the first phase of the field that took place in the city of Dakar and its suburbs, five zones were identified (Fann, Ngor, Plateau, Sacré Coeur-Liberté, Hann and Banlieue). These zones include a total of eighty (82) institutions across all domains (see table above). Five investigators were deployed per zone, making a total of twenty five (25) investigators.

The second phase of the investigations concerns mainly the structures located inside Senegal, more precisely in the regions of Thiès and Saint Louis where twelve (12) structures were targeted and visited by the team investigators.

Questionnaires were administered in two forms (online or physical) that take into account the availability and choice of the respondent. A physical questionnaire has been drawn up for the focal points who are present on the national territory and who wish a direct interview with the investigating officer. Multimedia support has also been set up for focal points who do not have a lot of time or who are outside the national territory at the time of the survey.

2.2.3.3. Data processing

The data collected in the field were processed and analyzed using Sphinx and Excel software. Indeed, the statistical tables generated by Sphinx (software used for the questionnaire design and the collection of field data) are transferred into Excel for the processing and editing of result graphs. The choice of Excel for the treatment is mainly justified by its greater ease of handling but also by a greater clarity of the results which can therefore be easily exported in the report and / or on a map.

2.3. Identification of actors and institutions of WASH Sector

The assessment of human resources in the water and sanitation sector in Senegal focused on structures working in the field of water and sanitation or those with activities related to water and sanitation.

2.3.1. Inventory of WASH institutions

Thus, the study focused on four (04) categories of institutions:

- public institutions,
- private institutions,
- non-governmental organizations,
- and Associations.

The study carried out among these water and sanitation institutions shows that these structures operate in different areas and zones. They all intervene in the same areas of competence but to different degrees, the public sector is more present in the support for development, supervision, research, monitoring of the resource, exploitation, management and planning and support advice. Non-governmental organizations are more active in supporting project ownership in addition to research, development support and mentoring.

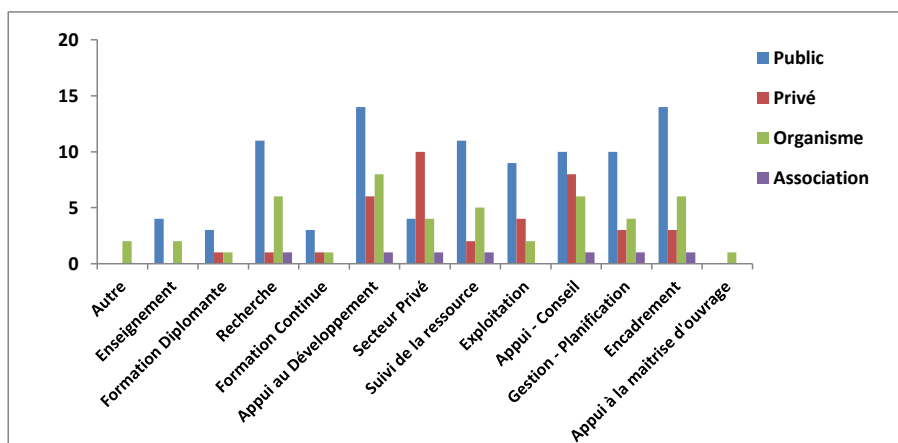


Figure 13: Areas of Intervention by Business Line

They intervene on several scales. Indeed 60% of them work throughout the national territory, 16% only in rural areas and 2% specifically in urban areas. In addition, some NGOs and private companies are present at the sub-regional level.

These structures are mainly involved in research topics related to:

- development of water resources management and planning strategies;
- mobilization of water resources;
- water governance;

- the management of border basins.

Other research topics are also explored by some structures such as, among others,

- Urban / Rural sanitation
- water drainage
- sanitation of household solid waste in medium-sized cities
- the study on sanitation systems and the management of domestic wastewater
- agricultural sanitation
- improving the quality of water in rural areas
- the relationship between water and health
- environment and agriculture (irrigation and agricultural water management)
- coastal erosion and hydrogeology
- the control of runoff and the fight against salt
- the Water Police
- national wetland management policy
- etc.

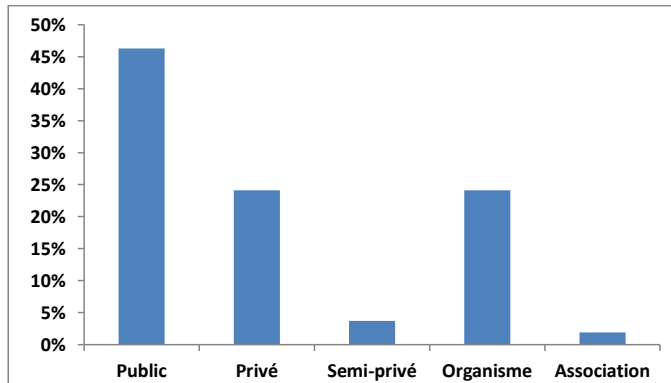
About 72% of the structures use different tools and methods to popularize the results of their research. Annual reports (41%) and websites (36%) and newsletters (23%) are the most commonly used by them. Research is also popularized through the publication of scientific articles, sharing and information workshops, television programs and social networks. Scientific articles are generally published in research programs and / or in connection with research and training institutions.

2.3.2. Representation of water and sanitation structures

In Senegal, 50% of the water and sanitation structures are public and mainly consist of departments, services, agencies and offices. This can be justified by the fact that water and sanitation competences are not transferred to local institutions in Senegal. The private sector accounts for 24.1% followed by user organizations and associations representing 24% and 1.9% respectively. In recent years, the private sector has begun to take an important place in the field of water thanks to the new state policy which aims to better involve the private sector through public-private partnerships, especially in the field of water. Today, Urban Hydraulics is managed by SONES (National Water Company of Senegal) which is a public structure with a commercial vocation. The latter works in close collaboration with SDE (Société Des Eaux), which is a private institution. These two structures are linked by a leasing contract. With regard to rural hydraulics, the State, through the OFOR, is moving towards full privatization of the sector through the establishment of the Delegation of Public Services (DSP) in rural

areas. These CSPs will be responsible for ensuring, among other things, the provision of drinking water for the population, livestock and agriculture.

Non-governmental organizations bring support the State of Senegal in its water and sanitation policy through the construction of hydraulic infrastructure and sanitation, especially in rural areas.



2.3.3. Water and sanitation training offers in Senegal

In this part it will be discussed the questions on the adaptation or not of the academic and professional offers to meet the needs of the business world and secondly we will analyze the current training needs in the field of water and sanitation.

According to the field investigations, 50% of the structures targeted by the study consider the training offers provided by the public and private academic institutions in terms of water and sanitation to be satisfactory. On the other hand, for some (42.6%), there is an inadequacy of training offers compared to the real needs of the structures. According to them this fact is more felt in the university world where the learning techniques are still classic and unsuited to the realities of the companies. There is a lack of collaboration between the operational world and the academic community. Operational structures are not well involved in identifying training offers.

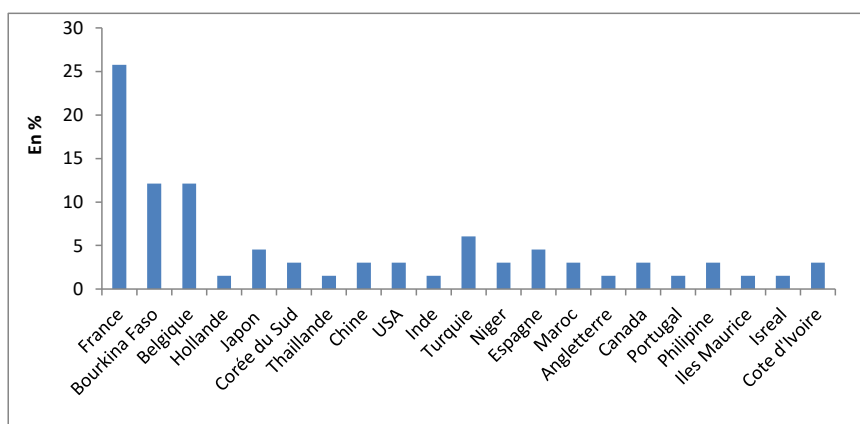
In order to make their agents more operational, companies carry out capacity building for their staff through seminars, short-term internships or in-service training in foreign countries in the following areas:

- Water, Sanitation and Health,
- Sanitation
- Water and hygiene,
- Water, Environment and Sanitation,
- Water and Sanitation, Project Management,
- Environment and waste management,
- Management of classified installations,
- Environmental legislation
- Irrigation, flood management

- Drilling, network and water tower construction in rural areas
- Mobilization of water resources
- Water resources for agriculture and irrigation
- Water sciences

The Training is largely provided by countries such as France, Belgium, Burkina Faso, Holland etc. France, Belgium and Burkina Faso are the main host countries for Fellows who are trained at the Engineering (35%), Master (33%), PhD (16%), Bachelor (9%) and BTS (7%) levels. %).

Figure 15: Distribution of host countries of staff working in the water and sanitation sector



2.4. Summary of needs analysis

2.4.1. State of human resources

In this section, it will be presented the current state of human resources in the water and sanitation sector by highlighting their composition, their level of study and the limits related to the execution of their tasks. .

2.4.1.1. Socio demographic profile of the personnel of the water institutions

Gender distribution of human resources in the water and sanitation sector

The question of gender is a fundamental element that deserves to be studied; indeed, in Senegal, women are increasingly present in the structures and occupy strategic positions at both the administrative and technical levels. However, their numbers are limited compared to men.

In the water and sanitation sector, at the level of public structures, men are more represented with 70% compared to 30% of women. The same observations are made on the non-governmental organizations which have a female human resource equal to 39% which remains lower than that of men (61%). The situation is more alarming in the private sector where **there is a very low representation of women (3%)**. This weak presence of women's expertise in public and private structures and NGOs can be explained by the low rate of schooling of girls inherited since independence, which is now being reversed with the new policies of the Government towards women. the State of Senegal objectives is to fulfill the integral schooling of the children and especially girls.

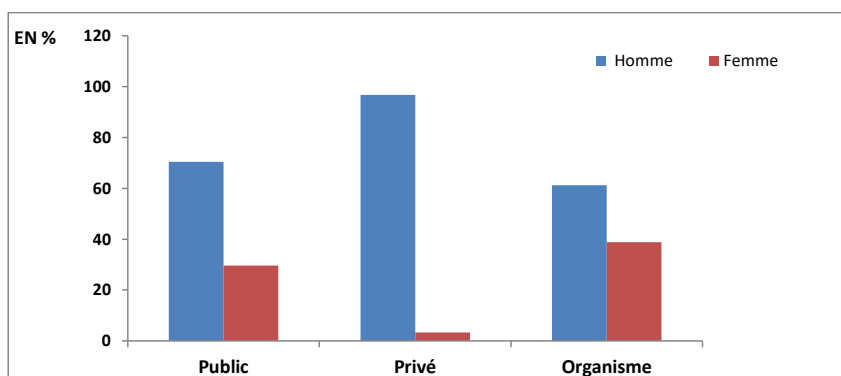


figure 16: Distribution of HR by gender

Age groups of the water and sanitation sector

55% of the staff working in the water sector is between 25 and 60, 22% between 25 and 65, 13% between 25 and 55 and 9% between 25 and over 70 years old. 70% of the public sector staff is in the age range 25 to 60. This is because the majority of the staff in this sector are affiliated with the public service, whose retirement age is 60 years for civil servants and 55 years for contractors. Some public servants, in the academics, retire at age 65. The same observations are made for staff working in development (NGOs). The private sector, unlike other sectors, has employees who can be 70 years old.

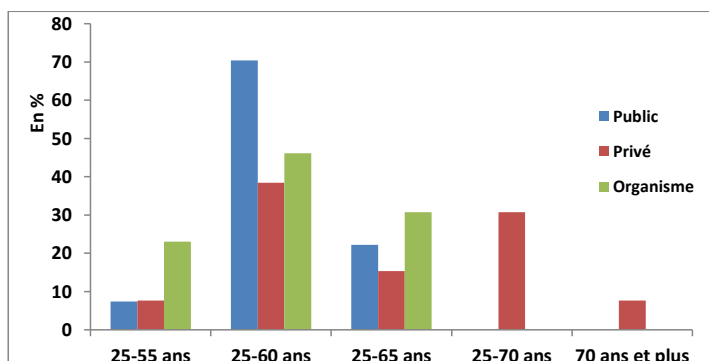


Figure 17: Age distribution of staff working in the water and sanitation sector.

2.4.1.2. Socio-professional profile

Staff education level

According to our field surveys, 45% of the staff working in the water and sanitation sector are senior technicians and 33% are volunteers. The Bachelor, Master and PhD levels are less represented in the sector with 13, 2 and 1% of the workforce, respectively. Engineers represent 7% of the total workforce.

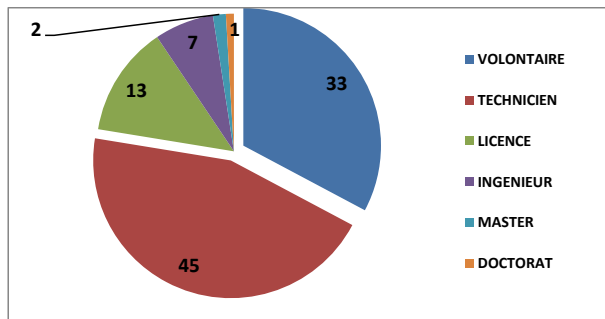


Figure 18: Distribution of resources by level of study

However, there is some complexity, if one looks at the level of education by category of sector:

- In the public sector, 42% of the staff are engineers, 26% are volunteers and 17% are technicians. Staff with Bachelor, Master and PhD levels are lower at 8, 4 and 3% respectively.
- In the private sector, unlike in the previous sector, it is the technician level that is most represented with 50% of the workforce, followed by volunteers (30%), licensees (12%) and engineers who represent only a tiny part (16%). In this sector strength is found that the Master and PhD levels are almost absent from the device.
- In non-governmental organizations, unlike the public and private sectors, homogeneous representativeness of the levels of study is observed. The Masters represent 24%, the licensees 23%, the technicians 21% and the engineers 16%. Volunteers and doctors are the most under-represented staff in these organizations.

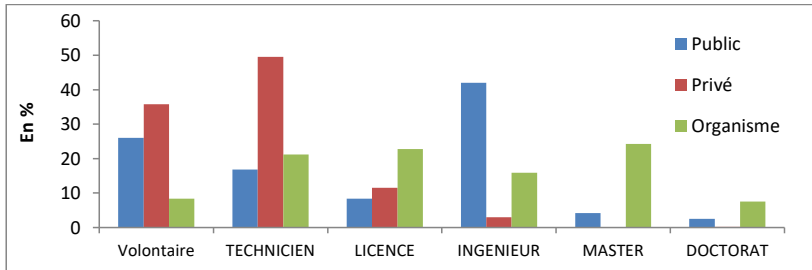


Figure 19: Distribution of HR by Business Line

Problems in performing tasks

In Senegal, most of the structures working in the water and sanitation sector (81.5%) face enormous problems in the execution of their tasks, largely related to a lack of quality human resources. (63%) and insufficient equipment (52%) and financial (16%) resources.

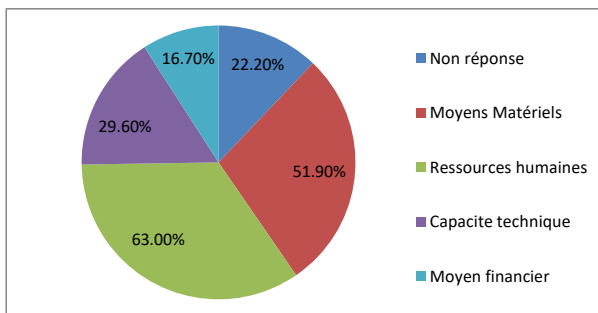


Figure 20: Constraints of water and sanitation structures

To these problems are added constraints related to:

- the difficulty of accessing data and quality information,
- lack of enforcement agents and failure to comply with donor implementation manuals,
- problems of coordination with state institutions,
- organizational problems of State structures (change of project coordinators in the full exercise of their mission),
- lack of production infrastructure
- the inadequacy of the legal and institutional framework to meet the needs of the water and sanitation sector.

2.4.2. Training needs in the water and sanitation sector

For efficient and effective management of projects and programs, different fields of study are required by the staffs working in the field of water and sanitation.

Table 5: Areas of study or capacity building solicited

Areas of study or capacity building demanded	Fréquences en %
Project planning, management and monitoring	21
Project design	17
Financing research	16
The development of institutional and regulatory frameworks	15
Water mobilization techniques	11
New techniques of treatment and purification of water	10
Negotiation and awareness-raising techniques of partners	10
TOTAL	100

Apart from the training mentioned above, other areas of competence have been identified by the structures namely:

- Sanitation, coastal erosion and hydrological modeling
- Hydropower project design, irrigation, drainage
- Delegation of public services
- Renewable energy and climate change
- Hydrological expertise and operational hydrology
- Training in communication and in international languages (English, Chinese, Arabic)
- Water management at the plot level
- Installation and monitoring of hydrological measurement equipment
- Punctual Awareness and early warning systems
- Monitoring the quality of the water
- Monitoring and evaluation of projects
- Wastewater.

2.5. Training and research institutions

2.5.1. Types of training institutions

In Senegal, three types of institutions and people in water and sanitation are recorded

- Polytechnic institutions mainly train to become technicians (2 years after the A level) or Engineers (4 to 5 years after the A level)
- Academic institutions with universities where are located BSc, masters and PhDs programs; those who graduate are prepared for research or program coordination. These Universities offer courses in Water Sciences, Civil Engineering, Geography, Sociology, Environmental Sciences, Economy / Management .
- and Professionals and Private Schools, colleges where social development, management / finance, administration are trained. For the management and finance, it exists a good number of schools,

colleges and high schools dedicated to train students in management, finance, marketing etc. But few of them are working in the WATSAN sector.

Recently, few private schools offer course in Civil Engineering and mechanical engineering. Professional and Private schools they are used to manage budgets, human resources and planning.

By 2022, Senegal will turn over a new universities- map with three new universities: University Amadou Makhtar Mbow (UAM), the 2nd University of Dakar and two other universities in Tambacounda and Kedougou.

Table 1 : Types of training institutions in Senegal

Polytechnic institutions	Academic institutions	Professionals and Private Schools
<ul style="list-style-type: none"> ▪ École Supérieure Polytechnique (ESP) ▪ École Polytechnique de Thiès (EPT) ▪ École Nationale Supérieure d'Agriculture de Thiès (ENSA) ▪ Institut Polytechnique de Saint-Louis (IPSL) ▪ Institut Universitaire de Technologie de Ziguinchor (IUTZ) ▪ Réseau des Instituts Supérieur d'Enseignement Professionnel (RISEP) 	<ul style="list-style-type: none"> ▪ University Cheikh Anta Diop (UCAD) ▪ University of Thiès (UT) ▪ University Gaston Berger of Saint Louis (UGB) ▪ University Assane Seck of Ziguinchor (UASZ) ▪ University Alioune Diop of Bambey (UADB) ▪ University of Sine Salou Elhadji Ibrahima Niass (USSEIN) ▪ Virtual University of Senegal (UVS) 	<ul style="list-style-type: none"> ▪ École Nationale de Développement Social (ENDS) ▪ Institut Africain de Management (IAM) ▪ École Supérieure d'Économie Appliquée (ESEA) ▪ École Nationale d'Administration (ENA) ▪ Institut Supérieur de Management (ISM) ▪ Centre Africain d'Études Supérieures en Gestion (CESAG)

The Virtual University of Senegal (UVS) is presently an excellent alternative to the overpopulated of the existing universities. The UVS is reinforced by a network of open digital spaces (ENO) which by 2022 will mesh the entire national territory with an average of one ENO per department, then a total of fifty ENOs will cover the entire national territory . The interest of these NWE is that they have significant computer equipment, equipped with the latest technology and allowing the delivery of distance courses for audiences of up to a thousand people.

In this respect, the UVS constitutes a real revolution because it is capable of reaching a wider and more diversified public, in the most remote corners of Senegal, hence its slogan "fo nekk, fofou la"("where you is the right place"); With a student population of 20,000, it has even become the second largest university in the country, behind UCAD, in less than five years.

The Network of Higher Institutes of Professional Education (RISEP) has been set up by the Ministry of Higher Education, Research and Innovation as part of its objective of professionalizing training courses. For example, the ISEP training of Richard-Toll and Matam is totally geared towards the agricultural professions, including the issue of agricultural water management, water quality issues and pollution by pesticides, irrigation techniques, etc. The training provided in these ISEPs are BTS (technician) level and intended for direct employability.

New universities and private polytechnic schools have also emerged very recently and have contributed to the diversification of training offerings in different fields of STEM and other sectors mainly related to management. We can mention among others, the most known and / or recognized,

- the African Polytechnic Institute,
- Cours Saint-Michel
- **University of the Sahel**
- Amadou Hampathé Ba University
- Tamaro Toure University of Science and Technology
- BEM (Bordeau Management School)
- Higher School of Engineering
- CFDT (Center for Entrepreneurship and Technical Development) G15

It should be noted that, in favor of the latest reforms of higher education, the procedures for opening up sectors and training schools are subject to the prior authorization of ANAQ-Sup, which is the National Authority of quality assurance in higher education. The accreditation procedures of the ANAQ-Sup allowed to regulate private vocational training courses and schools which must now comply with both the requirements of the LMD (License-Master-Doctorate) and CAMES (Conseil Africain) reforms. and Malagasy for Higher Education.

The existence in Senegal of a thematic doctoral school focusing on the different dimensions of water is a major innovation in the West African sub-region. EDEQUE (Doctoral School Water, Quality and Uses of Water) officially launched in 2008 in favor of the LMD reform, is one of the seven (07) doctoral schools of the University Cheikh Anta Diop of Dakar. It hosts eleven doctoral programs grouped into four major themes: Water Resources; Uses and Demands in Water; Water, Environment and Societies; Coastal Management. This is an excellent example of integration between the hard sciences and social sciences, around a common question that of water in all its forms. However, EDEQUE only trains for Top Management, which is a limit for the sector as the most important training needs are in the bachelor's, master's and engineering programs.

Nevertheless, since its creation, the EDEQUE has participated in the training of many national and sub-regional senior executives of institutions in charge of the water sector and related fields with numerous academic theses supported (see appendix). In many cases, graduates from EDEQUE, when are not professionally integrated, find opportunities in universities, national programs and projects and / or in the subregion to contribute to fame of the school.

Table 2: EDEQUE doctoral training

Mention 1 : Water Resources	Mention 2 : Usages et Demandes en Eau	Mention 3 : Eau, Environnement et Sociétés	Mention 4 : Gestion du Littoral
Continental Hydrology Hydrogeology Hydraulic Chimie, Microbiology and Water Treatment Climate et Climatic Impacts	Eau et Stratégies Spatiales Traditionnelles et Modernes Économie de l'Eau	Integrated Water Resources Management Gestion durable des ressources en eau Water, Environment and Health Politique de l'eau	Gouvernance du littoral Environnement littoral Génie du littoral

2.5.2. Analysis of the capacity of national training institutions

Resulting from our survey, there is a great lack of professional dedicated school in the WASH sector either in water supply (Hydraulic Engineer, technician, electromechanical), and sanitation work. Most of the engineers in visited companies, are from Civil or Mechanical Engineering School. Data show that Management/Finance and Social Development institutions put in the job market sufficient human resources, in opposition to WATSAN and Engineer.

The total annual training capacity for WATSAN related to engineering courses in higher education institutions to meet demand in the water sector is quite low. To improve the situation or overcome this fact, higher percentage of trainees should be attracted to this sector.

To meet objectives of PSE and SDG's in the WASH sector, training institutions should adapt their curricula to the real needs of the sector. For that, a real incitation to WASH jobs should be promoted as well as increase number of trainees in the WATSAN and other engineers.

However, one major concern is also to create vocational professional institute in the WASH sector which can train from plumber, hand craft, technicians, specialized technicians to hydraulic and sanitation engineers as expressed by most of the private companies.

Thus, in 2017, the Ministry in charge of Hydraulics and Sanitation launched its project to set up a Training Center for Water and Sanitation. This is a project based on PAEX-SEN030 funded by the Grand Duchy of Luxembourg. The objectives set in the project framework are similar to those outlined in this component of the ACEWATER2 Project. It is essentially:

- to list existing human resources in the water and sanitation sector and to identify gaps;
- produce technical documentation enabling the construction of the Center;
- to propose training courses in line with the needs of the sector;
- and ensure the participation and involvement of all actors at all levels (apparent and dormant).

From a methodological point of view, there are similarities with the ACEWATER2 project, particularly in the diagnostic approach of the water and sanitation sector. The actors in this project, however, favor interviews in the form of focus groups. In the long term, the establishment of this Training Center for the water and sanitation professions should allow the support and the reinforcement of the national

technical capacities of the sector. Nevertheless, this center will not provide initial training, which is devolved by universities.

2.6. Priorities and Strategic Actions

National priorities in the water and sanitation sector in Senegal are defined by the Sectoral Development Policy Letter (SPSD), the latest dates from November 2017 and covers the period 2016-2025. This new LPSD is anchored globally in the new agenda for achieving the Sustainable Development Goals in 2030 and at the regional level, the African vision of water defined by AMCOW by 2025 and the Ngor Declaration on Hygiene and Sanitation adopted on 27 May 2015 at the Regional Conference on in Africa (AfricaSan 4). The 2025 Investment Plan for the implementation of this LPSD is based on a budget of more than \$ 1 trillion, or approximately \$ 3 billion, representing more than four times the budget of the previous Sector Policy Letter 2005 for the same period (2005-2015). But it should be noted that this budget remains essentially dedicated to investment in equipment and the implementation of programs and projects. Very little is left to training, which is usually provided through public or private or through international training provided by institutions such as SIDA or DANIDA or JICA, etc.

Since 2012, the Senegal Emerging Plan has been a national reference for the strategic plan since its implementation should, by 2035, lead Senegal towards economic and social development. One of the SEP focuses precisely on improving human capital through, inter alia, "the development of a diversified and quality higher education offer with specialized programs taking into account the reinforcement of short vocational training centered on the potential of the economic poles and the demand of the private sector".

Despite significant progress made through academic training and research conducted in higher education and research institutions, all Senegal's water sector specialists and stakeholders recognize that knowledge and good management Water resources remain relevant. It therefore requires researchers to invest in this issue to mark a strong presence in the field of water.

The first project start-up workshop in April 2017, which brought together key stakeholders, identified the following strategic priorities and actions for research and training for the water and sanitation sector :

- Improvement of the knowledge of water resources (surface water and groundwater), notably by updating the mapping of resources taking into account the infrastructures and developments realized during the last decades;
- Knowledge and mastery of new water treatment technologies, more specifically those used in the desalination of seawater (in view of the first plant currently being set up in Mamelles-Dakar with the support of the Japanese Cooperation);
- The implementation of scientific research programs and environmental and social impact studies in the field of seawater desalination;
- The development of modules and training courses on water treatment technologies, within universities and vocational training institutions;
- The need to reduce the lack of intermediate training in the field of water (technicians), especially with a view to supporting the implementation of the PSE (Plan Sénégal Émergent) which has a strong component of "irrigated agriculture". This sector will have

to be more and more efficient in the coming years in order to reconcile the decline in water resources, the growth of the population and the increase in production.

The disconnection between research and development projects has also emerged as an imperative to avoid any conflict of interest in the implementation of development programs. But the need for collaboration between academics and professionals in the water and sanitation sector is recognized by all stakeholders. This should underpin the role of universities and enable them to anticipate the needs of the sector. To this end, it was recommended to EDEQUE to establish more relations with the Ministry in charge of Hydraulics and Sanitation, particularly to assist it in the establishment of its center of trades of the water.

Based on feedback from regional or even departmental level, it appears necessary to set up a single consultation framework for the water and sanitation sector in order to concentrate all the energies for a better coverage of needs sector.

3. NATIONAL FRAMEWORK FOR HUMAN CAPACITY DEVELOPMENT

Key Concepts

Capacity is commonly defined as "the ability of individuals, organizations, and the community as a whole to successfully manage their business." It is about the ability to create, understand, analyze, develop, plan, achieve goals, reflect on the results of actions, move toward a vision, change and transform.

The FAO Capacity Building Strategy Paper (2013) defines capacity building as "a process by which individuals, organizations and the community as a whole liberate, create, reinforce, adapt and maintain their capacities over the course of time. time ". Capacity building therefore addresses political and social aspects, in addition to technical aspects, and must take into account individual, organizational and environmental dimensions.

In recent years, the trend has been to replace the English term "capacity building" with "capacity development". This change in terminology reflects the abandonment of an initial concept involving a process driven primarily from the outside and in which there is no pre-existing capacity, in favor of a new concept strongly emphasizing national accountability and processes of change. endogenous.

The concept as well as the approach used here is that of "capacity development", since it is above all a question of reinforcing the capacities and competences of the actors in order to allow them to take in an adequate and sustainable way, the question of water and sanitation. Of course, this development will be done according to the priorities defined by the stakeholders themselves.

Senegal National Framework for HR Capacity Development

As part of the ACEWATER2 Project, the capacity building component of human resources in the water sector in West Africa is aimed primarily at enabling States to develop skills in line with the real needs of the sector and articulated around major orientations of development.

For Senegal, the references are the LPSD and the PSE, themselves articulated around the AMCOW Declaration on Young Water Professionals and Technicians, in accordance with the African Union Agenda 2063 which sets with a particular focus on the development of Human Capital. It is about making the breakthroughs that will place Senegal on a new trajectory of sustainable development in

order to further stimulate its potential for growth, creativity and productivity to satisfy people's strong desire for better living.

The definition of the National Capacity Building Framework for the Water and Sanitation Sector will be articulated around the following strategic objectives:

1. Strengthen the technical, technological and scientific skills of those involved in the planning, implementation, **monitoring and evaluation** of programs, projects and infrastructure of the water and sanitation sector in Senegal;
2. Improving multisectoral and multi-stakeholder coordination and cooperation at local, national and regional levels for effective implementation of the strategy;
3. Assist in the reform and adaptation of the political, legislative and water resource mobilization framework by providing an improved and optimized knowledge base for all stakeholders concerned and / or impacted by the management of water resources and sanitation.

Commented [BMW11]: You are also expected to submit a Monitoring and Evaluation Framework with this report

In an operational way, it will essentially be:

- Strengthen the technical, technological, scientific and organizational skills of the actors and structures in charge of water and sanitation issues for the effective implementation and achievement of the objectives set in the reference documents Agenda 2063 of the African Union, the 2013 AMCOW Declaration of Cairo, the Senegal Emerging Plan, the Sectoral Development Policy Letter, the SDG6, etc. ;
- Help improve knowledge of the biophysical, social, economic and cultural environment of water resources and sanitation in Senegal;
- Encourage the development of innovative practices in the mobilization and management of water resources;
- Support the development of one or more institutes of water sciences and trades at the most appropriate spatial scale, preferably by relying on existing educational institutions (public or private);
- Encourage and promote water and sanitation education for a better understanding of the issues and the protection of resources, especially by the youngest.

Implementation framework for Human Capacity Development

The development of Senegal's national capacity building framework for the water sector will be based on the following schema, and in accordance with the terms of reference of the ACEWATER2 Project.

Commented [BMW12]: A National HCD Framework is supposed to be developed and validated in a National Validation Workshop in THIS phase of the project, not later. These are my comments as per earlier drafts.

Process steps Main activities / actions

Step 1 Identification of Institutional, Technical and Financial Partners for the Implementation and Sustainability of the Capacity Building Program - Training, Modules and Pathways in Water Management Training and Hosting Institutions (Local Scales) national and sub-regional)

Commented [BMW13]: These Partners are supposed to have been identified during the consultation process, which I suspect you have already identified ? and were present at a first consultation meeting?

- Research and training laboratories, focus on those oriented towards the five (5) major identified priority training and research needs (see priorities)
- Identification of skills available for the provision of training in the water sector
- Technical and financial partners cooperation

Step 2 Popularization and Dissemination of the HCD Strategy - Publication of the Strategy and Translation to the General Public

- Soliciting expressions of interest from institutions and actors in the sector as well as donors

Step 3 Development of courses and modules, materials and course materials - Identification of existing courses, courses and course modules related to identified priorities

- Development of course modules and tailor-made training programs for professionals
- Reflection on the creation of new sectors, innovative and oriented towards the needs expressed by the sector, in particular for the young professionals of water and sanitation
- Strengthen collaboration with national research and training institutions through the formulation of cooperation agreements for training in the water and sanitation professions

Step 4 Development of a pole and mechanisms of sub-regional exchanges between the institutions of the West African network for the training of technicians and professionals of water and sanitation

- Foster the development of institutional protocols of collaboration between the institutions network
- Go towards the development of a sub-regional federation of training and research institutions in the field of water
- Develop diploma and professional training, and alternating (school / company and inter-campus) in the field of water
- Capitalize on local experiences and projects in progress (water trades center) and / or existing at the national and sub-regional levels (Agrhyment Center, 2ie, etc.)

In accordance with the objectives, orientations and priorities defined in collaboration with the actors of the water sector as well as researchers and trainers, the following five (5) training areas are proposed, including potential partners / managers and laboratories.

Wastewater and sanitation Groundwater Sectoral water policies Agricultural water Water technologies, research and training

- Wastewater treatment
- Management of sludge
- Knowledge of ERs
- Modern drilling techniques
- Groundwater quality
- Groundwater protection and pollution management
- Modeling ☐ Project Management
- Negotiations and financing of the water sector
- Water security and sustainability of AEP systems
- Standardization and application of charters ☐ Modern irrigation techniques
- Water saving and protection of resources
- Drainage water management

Commented [BMW14]: This is for the next cycle of activities, but you cannot disseminate and HCD Strategy until you have developed one and had it validated at a Validation Workshop with the key partners and stakeholders. Course priorities would reflect the sector needs and would normally have been identified during the building of your draft HCD Strategy and approved during the validation exercise.

- Management of pollutants and pollution of agricultural origin ☒ Technological innovations
- Modeling
- Geomatics applied to the management of water resources

CONCLUSION

The inadequacy of human resources is a huge constraint to good governance of the water and sanitation sector in Africa in general. In Senegal, the existence of highly qualified human resources is proven according to sectorial surveys. However, one of the major limitations of the sector since 2013 is the lack of qualified technicians and senior technicians for the implementation of operational work in the water sector. While top management is well-staffed, the operational sector is struggling to find skilled workers. Thus, among the commitments that have been made, in agreement with those responsible for the structures, we can mention:

- The establishment of a single consultation framework for the water sector, based on the observation of the lethargy of bodies such as the Superior Council of Water or the non-involvement of structures such as the Economic and Social Council and Environmental,
- The implementation of a water capacity development strategy for upgrading water sector staff, based on an assessment of real human resource needs,
- The annual organization of water days extended to all stakeholders, communities and research and training institutions,
- Strengthening and deepening knowledge on water resources (surface and groundwater), including the publication of a national water atlas of Senegal and regular hydrological bulletins,
- Initiate a deep reflection on seawater desalination techniques and technologies, extended to all stakeholders concerned and / or impacted in order to consider benefits as well as risks,
- The valuation of the water business, especially small trades, particularly requested but difficult to fill

Commented [BMW15]: Can you expand on this point ? are you referring to commitments of stakeholders, including govt? is this a Validation process?

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ANNEX

Annexe 1 : Questionnaire

Annexe 2 Liste des destinataires de l'enquête sur les ressources humaines du secteur de l'eau - Dakar et régions

N°	Structures	Téléphone	Email	Adresse
1	Direction de l'Administration et de l'Équipement Général (DAGE)	33 889 21 00	infos@minfinances.sn	Rue René Ndiaye x Avenue Carde, 4017 Dakar
2	Direction de la Gestion et de la Planification des Ressources en Eau (DGPPE)	33 822 21 54	niokhorndour@gmail.com	Ex Camp Lat Dior Dakar (Sénégal)
3	Direction de l'Hydraulique (DH)	77 306 50 81	sanemoust@gmail.com	Route des pères Mariste
4	Direction de l'Assainissement (DA)	33 864 63 12	dirass@sentoo.sn	5, Route du Front de Terre
5	Agence de Promotion du Réseau Hydrographique National (APRHN)	33 821 01 52	aprhn@yahoo.fr	Cité Keur Gorgui ex ministère de l'Hydraulique 3 ^e étage à côté de la muraille verte
6	Office du Lac de Giers (OLAG)	33 938 20 11	olag@olag.sn	Avenue des Grand Hommes Ndioufène St Louis
7	Société Nationale des Eaux du Sénégal (SONES)	33 839 78 00	sones@sones.sn	Route du Front de Terre Hann
8	Sénégalaise Des Eaux (SDE)	33 839 37 37	eau[at]sde.sn	Siège social : Centre de Hann, Route du Front de Terre
9	Office des Forages Ruraux (OFOR)	33 827 57 38	forages@forages-ruraux.sn	63 Immeuble Aïda, rond point VDN x Ouest-Foire
10	Office National d'Assainissement du Sénégal (ONAS)	33 859 35 35	onas@onas.sn	Cité TP SOM n°4 Hann
11	Ecole Doctorale Eau, Qualité et Usage de l'Eau (EDEQUE/UCAD)	33 864 01 04	edeque@gmail.com	UCAD 3 rue Eucalyptus
12	Agence Nationale de la Recherche Scientifique Appliquée (ANSRA)	33 864 43 49	info@anrsa.sn	Cplx Sicap-Point E 2 ^e me étage Immeuble D
13	Centre de Suivi Écologique (CSE)	33 825 80 66	dt@cse.sn	Fann résidence, Rue Léon Gontran Damas
14	Association des Jeunes Professionnels de l'Eau et de l'Assainissement Sénégal (AJPEAS)	77 353 31 22 77 353 31 22 77 273 30 02	ajpeas@gmail.com	

N°	Structures	Téléphone	Email	Adresse
15	Direction de l'Environnement et des Établissements Classes (DEEC)	33 826 01 17 33 822 62 11	denv@orange.sn	Parc Forestier de Hann- Route des Pères Maristes 1 ^e étage
16	Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM)	33 865 60 00	anacim@anacim.sn	Aéroport Léopold Sédar SENGHOR BP : 8184 Dakar-Yoff
17	Programme d'Urgence et de Développement Communautaire (PUD)	33 859 67 67 77 569-96 338592710	ngone.sow @undp.org	Immeuble HCR King Fahd
18	Société Nationale d'Aménagement et d'Exploitation des Terres du Delta (SAED)	33 832 59 57	saed@orange.sn	Hann Maristes-Routes des Maristes
19	Société de Développement Agricole et Industriel (SODAGRI)	33 821 04 26	soterco@orange.sn	2 stv immeuble Fahdd 9 ^e Secrétariat de la SODAGRI
20	Compagnie Sucrière Sénégalaise (CSS)	33 938 23 23	direction.generale@c ss.sn	Richatoll BP 49
21	OMVS		omvssphc@omvs.org	
22	OMVG			
	ARD Saint-Louis			
23	Agence Nationale de la statistique et de la Démographie (ANSD)	33 869 21 39	statsenegal@ansd.sn	Colobane à côté de la maison du parti Socialiste Mme Sagna Directrice des ressources humaines
24	Direction de la Protection Civile (DPC)	33 889 39 00	dpksen@hotmail.com	75 Passage le blanc AV Nelson Mandela
25	Agence de Développement Municipal (ADM)	33 849 27 10	contact@adm.gouv.sn pacadem@orange.sn	En face du Ministère des finances à côté de l'ancien bureau des passeports - 2 ^e étage
26	Direction de la Restructuration et de l'aménagement des Zones d'Inondation (DARZI)	33 879 34 34 33 879 34 00	support@adie.fr	Pikine Technopole
27	Direction des Bassins de Rétention et Lacs Artificiels (DBRLA)		youssou57@gmail.com	Hann route des pères Mariste
28	Bassins de Rétention et de Valorisation des Forages (BARVAFOR)	33 864 64 69 33 864 64 70	contact@sakss.sn	Hann route des pères Mariste
29	Service National d'Hygiène (Ministère de la Santé)	33 820 96 49	snh@sante.gouv.sn	Nord foire Derrière Terminus 34
30	Direction des Parcs Nationaux (DPN)	33 859 14 39	dpn@sentoo.sn	Hann/ ministère de l'environnement

N°	Structures	Téléphone	Email	Adresse
31	Agence National de l'Aménagement du territoire	33 832 15 06	contact@anat.sn	Hann Mariste Derrière Bat le « Soleil »
32	Grande Cote Opération (GCO)	33 869 31 81		Mboro, village de Diogo
33	Direction de l'agriculture (DA)			
34	Direction de l'Investissement (DI)	33 889 26 88		Rue Docteur Guillet
35	ASCOTEN	77 635 07 07	ascosen@gmail.com	Rue ZGM 02, à côté de l'École élémentaire de l'unité 26, immeuble AAD, 2 ^e étage
36	Union Nationale des Consommateurs du Sénégal	33 824-01-18	uncs2007@hotmail.com	UCAD en face du canal 4
37	Agence nationale de l'intégration et du développement Agricole (ANIDA)	33 859 06 60		VDN Mermoz en face de la passerelle
38	Union régionale des coopératives de construction et d'habitat de Thiès (URCCHT)	33 979 70 00	urccht@gmail.com	Zac de Thiès à côté du rondpoint
39	APTE Sénégal	33 821 44 44		Cité Gorgui Villa Num 17
40	Cabinet EDE	33 820 87 06	ede@cabinetede.com	Route de l'Aéroport, Sunugal NG 28, Dakar, Sénégal
41	Biotech Sénégal	33 877 95 08 77 201 63 10 77 313 34 22	biotechsenegal@gmail.com	Fith Mith n° 651 Golf Sud
42	Cabinet IDEV-IC	33 855.95.90	idev-ic@idev-ic.sn	Patte d'Oie Builders villa n° B11 & D11 jumelées Dakar, Sénégal
43	SETICO	33 869 21 11 33 864 08 97	setico@sentoo.sn	Sacré Cœur III VDN Extension Villa n°157 Lots B-D
44	Eau vive	33 951 35 24	evthies@eau-vive.org	cité Malick Sy n 54 A thiés
45	ACRA	33.827.6413	acradk@orange.sn	Villa N°8613E, Quartier Sacré Cœur II
46	EAA ex CREPA	33 832 29 97		Route Ecobank Mariste Villa N 32 D
47	ENDA/RUP	77 285 58 53	dif-enda@endatiersmonde.org	Rue Félix Eboué
48	ENDA GRAF	33 827 20 25	endagrafsahel@endagrafsahel.org	Cité Millionnaire Grand yoff
49	ENDA ECOPOP	33 859 64 11	ecopop@endatiersmonde.org	Avenue Cheikh Anta DIOP Complexe Administratif Sicap Point E, Bâtiment B-2ème étage

N°	Structures	Téléphone	Email	Adresse
50	CARITAS Dakar	33 834 00 20	Caritas@orange.sn	Km 11, route de Rufisque
51	WORLD VISION	33 865 17 17	worldvision_senegal@wvi.org	Sacré coeur 3 VDN Villa 145 M/S, Malick Sy
52	ADEMAS	33 865 01 88	ademas@ademas.sn	Sacré Coeur Pyrotechnique à côté de la Pharmacie Mame Oumy Gueye
53	SOTRACOM	33 869 07 67	sotracomsa@sotracomsa.sn	82, VDN Sacré Coeur III Dakar/SENEGAL
54	CONGAD	33 827 54 94 77 538 25 71	congad@orange.sn congad@congad.org	2 voies Liberté 6 vers Samu Municipal
55	PLAN INTERNATIONAL	33 865 35 50	senegal.co@plan-international.org	91- Sotrac Mermoz Ancienne Piste
56	SCIEPS	33 832 26 80	scieps@orange.sn	3444 Immeuble Orange espace Residence Hann Maristes Dakar
57	RC CONSTRUCOES	33 961 00 66	gersenegal@rodriguecamacho.com	91, Qrt. Route de Khor/ ST. LOUIS
58	SONED AFRIQUE	33 825 88 02	sonedaf@orange.sn	Immeuble Ndiaga DIOP, Parc à Mazout Colobane
59	École Supérieure Polytechnique de Dakar	33 824 05 40	esp@esp.sn	Université Cheikh Anta Diop de Dakar, Corniche Ouest
60	École Polytechnique de Thiès	33 951 15 48	ept@ept.sn	A10, Thiès Nones, Thiès, Sénégal
61	Université de Thiès	33 939 76 00 33 939 76 07	unithies@orange.sn	Thiès
62	ENSA (Thiès)	33.939.59.26	ensath@orange.sn papndiaye10@hotmail.com	Thiès route de Khombole
63	GRET	33 849 35 38	gret@gret.org	s/c IRD Hann Maristes Route des Pères Maristes, Dakar
64	ENDA Eau Populaire	77 638 49 04	se@endatiersmonde.org	Mermoz en face de la SONATEL
65	DELGAS	33 939 71 70	contact@delgas-assainissements.com	247, Saly station, route de Saly
66	DELTA	33 867 23 76	lenatall@orange.sn	Liberté VI Extension VDN
67	HYDROCONSEIL	+ 33 (0)4 90 22 57 80	hydroconseil@hydroconseil.com	
68	HYDROPLAN	+49 6241 9103-0	info@hydroplan.de	
69	AGERROUTE	33 869 07 51	ageroute@ageroute.sn	Rue F x David Diop – Fann Résidence
70	APIX	33 823 94 89	contact@apix.sn	52 - 54 Rue Mohamed V
71	EIFFAGE	33 839 73 39	eiffage.senegal@eiffage.com	Avenue Félix Éboué x Route des Brasseries
72	Compagnie Sahélienne d'Entreprises (CSE)	33 859 03 00	csesn@groupepcse.com	Rocade Fann Bel-Air
73	Consortium d'Entreprises (CDE)	33 839 59 59	cde@orange.sn	Avenue Félix Eboué X Bld Mariste Bel Air

N°	Structures	Téléphone	Email	Adresse
74	HENAN-CHINE	33 820-03-29	henanchine@henanchine.com	Almadie zone 10 lot C
75	SVTP	33 832 33 77	svtp@orange.sn	Km 8 Boulevard du Centenaire
76	VICAS	33 867 16 95	ibrasow65@yahoo.fr	02 Cité Assane Diop Grand Yoff Dakar
77	GEAUR	33 865 30 00	geaur@geaur.sn	Rue 14 prolongée x Bourguiba, Bâtiment N° 32
78	AGETIP	33 864 98 88	agetip@agetip.sn	Route de l'aéroport derrière Hôtel Onomo
79	Syndicat des BTP/CNES			
80	Syndicat Professionnel des Industries du Sénégal (SPIDS)	33 823 43 24		Gibraltar 2 Villa N° 333
81	Conseil National de Patronat	33 889 65 65	cnp@orange.sn	7, Rue Jean Mermoz
82	Association des Maires du Sénégal	33 889 16 11		31, Rue Carnot – Place de l'Indépendance
83	Hydro-Consult	33 867 57 95		Sicap Liberté Vi Extension
84	VERITAS	33 865 12 20		VDN x Ancienne Piste Mermoz Pyrotechnie
85	Water Aid	33 859 08 30	westafricaregionaloffice@wateraid.org	Ouest Foire cite Sonatel Prestige villa 22
86	MSA	33 865 1180	contact@msasenegal.com	VDN 3 bande verte lot 58
87	AFID	33 825 52 02		29, rue E x Aimé Césaire Dakar Fann Résidence
88	Direction des Collectivités Locales	33 839 20 70	contact@adl.sn	Liberté VI VDN Lot N°23 Immeuble Nolvin
89	Banque Mondiale (BM)	33-859-41 40	mademba@worldbank.org	Corniche Ouest X Rue Léon Gontran Damas
90	Coopération Technique Belge (CTB)	338 60 01 25	representation.sen@btccctb.org	121, Sotrac Mermoz Route de Ouakam
91	Coopération Luxembourgeoise (LUX-Dév)	33 869 64 44	rof.dak@luxdev.lu	Yoff Toundoup Riya Cité des Jeunes Cadres Lot 43-Route de l'Aéroport
92	Coopération Allemande (GIZ)	33 822 93 15	giz-senegal@giz.de	109 Rue Carnot x Mass Diokhane Dakar
93	Banque Africaine de développement (BAD)	33 820 08 88		Immeuble Coumba, 2eme étage Route de Ngor, Zone 12 Les Almadies
94	Agence Française de Développement (AFD)	33 849 19 99	afddakar@afd.fr	15, avenue Nelson Mandela
95	Délégation de l'Union Européenne (UE)	33 889 11 00 33 889 10 71	delegation-senegal@eeas.europa.eu	12, Avenue Hassan II
96	Banque Islamique de Développement (BID)	33 889 11 44	contact@bis-bank.sn	18 Boulevard de la république

N°	Structures	Téléphone	Email	Adresse
97	Institut de Recherche pour le Développement (IRD)	33 849 35 35		Hann route des Pères Mariste
98	USAID	33 879 4000	mcopson@usaid.gov	SAID/Senegal c/o U.S. Embassy
99	KOICA	33 865 07 80	koica.sn@gmail.com	Aytryum Center ,4 éme Etage, Route de Ouakam
101	JICA	33 859 72 72	sn_oso_rep@jica.go.jp	3e Etage, Atryum Center, Route de Ouakam.
102	ISRA			

Annexe 3 : Liste des thèses soutenues à l'EDEQUE de 2008 à 2018

N°	Year	Name	These Title	Speciality
1	2009	Samo DIATTA	<i>Profils verticaux de précipitations sur l'Afrique de l'Ouest et bilan des processus atmosphériques dans les basses couches à partir des données de radar spatial (TRMM/PR)</i>	Climat et Impacts climatiques
2		Mouhamadou Bamba SYLLA	<i>Modélisation haute résolution du climat de l'Afrique de l'Ouest pour l'élaboration de scénario changements climatiques jusqu'à l'horizon 2100</i>	Climat et Impacts climatiques
3	2010	Saïdou Nourou DIOP	<i>Élimination partielle du fluor et de la salinité des eaux souterraines du bassin arachidier par nanofiltration et par adsorption sur argile</i>	Chimie
4		Coura KANE	<i>Vulnérabilité du système socio-environnemental en domaine sahélien : l'exemple de l'estuaire du fleuve Sénégal. De la perception à la gestion des risques naturels</i>	Hydrologie Continentale
5	2011	Koly BEAVOGUI	<i>Variabilité spatio-temporelle des pluies et des orages en Guinée</i>	Climat et Impacts climatiques
6		Ansoumana BODIAN	<i>Approche par modélisation pluie-débit de la connaissance régionale de la ressource en eau : Application au haut bassin du fleuve Sénégal</i>	Hydrologie Continentale

7		Mathias DIEDHIOU	<i>Approche multi-traceur géochimique et isotopique à l'identification des sources de la pollution nitratée et des processus de nitrification/dénitrification dans la nappe de Thiaroye*</i>	Hydrogéologie
8	2012	Sidia Diaouma BADIANE	<i>Espaces forestiers de la Casamance amphibie (Sénégal). Déterminisme territorial, biodiversité et stratégies de conservation</i>	Environnement littoral
9		Aminata MBENGUE	<i>Savoirs et innovations dans le développement des productions localisées : cas de la sardinelle braisée-séchée ou keccax de Cayar (Grande Côte du Sénégal)</i>	Gouvernance du littoral
10		Amy GUEYE	<i>Précarité et services d'eau potable et d'assainissement : les quartiers pauvres de Dakar (Sénégal) à l'épreuve des projets communautaires</i>	Gestion Intégrée des Ressources en Eau
11		Ousmane Coly DIOUF	<i>Apport des outils cartographiques et géochimiques à la validation des paramètres d'entrée du modèle hydrogéologique de la nappe des sables quaternaires de Dakar : implication sur les inondations en zone péri-urbaine</i>	Hydrogéologie
12		Diakher Hélène MADIOUNE	<i>Étude hydrogéologique du système aquifère du horst de Diass en condition d'exploitation intensive (bassin sédimentaire sénégalais) : apport des techniques de télédétection, modélisation, géochimie et isotopie</i>	Hydrogéologie

13	2013	Seyni SALACK	<i>Analyse des pauses pluviométriques et évaluation des incertitudes de la pluie des modèles régionaux de climat à l'aide d'un modèle de culture</i>	Climat et Impacts climatiques
14		Cheikh FAYE	<i>Évaluation et gestion des ressources en eau dans un contexte de variabilité hydro-climatique. Le cas du bassin versant de la Falémé</i>	Hydrologie Continentale
15	2014	Diaba BA	<i>Analyse et modélisation de la dynamique spatiale du port de Dakar de sa création en 1964 à 2012</i>	Gouvernance du littoral
16		Awa NIANG	<i>Vulnérabilité de l'environnement et des ressources en eau dans l'estuaire du Sénégal. Dynamique et impacts de la brèche de la Langue de Barbarie de entre 2003 et 2013</i>	Hydrologie Continentale
17		Marième MBOUP	<i>Changements socio-environnementaux et dynamique de la végétation aquatique envahissante dans le delta du fleuve Sénégal</i>	Environnement littoral
18		Bamol Ali SOW	<i>État moyen, variabilité saisonnière de l'upwelling sénégal-mauritanien : approche modélisation</i>	Climat et Impacts climatiques
19		Yangane DIONE	<i>Participation du public et politiques d'accès à l'eau potable en milieu rural sénégalais. Les Associations d'Usagers des Réseaux d'Eau Potable dans la région de Saint Louis."</i>	Gestion Intégrée des Ressources en Eau

20		Aïchetou SECK	Les pêcheurs migrants de Guet-Ndar (Saint-Louis du Sénégal) : analyse d'une territorialité diverse entre espaces de conflits et espaces de gestion	Gouvernance du littoral
21		Ndickou GAYE	<i>Les dynamiques socio-économiques autour de l'aire marine protégée communautaire de Bamboung : entre conservation et développement territorial.</i>	Gouvernance du littoral
22	2015	Moussa DIAKHATE	<i>Couplage océan-atmosphère en Atlantique tropical</i>	Climat et Impacts climatiques
23		Moussa GUEYE	<i>Modélisation des couplages entre les aérosols désertiques et le climat ouest-africain</i>	Climat et Impacts climatiques
24		Badara DIAGNE	<i>Les dynamiques climatique et sédimentaire : impacts sur l'évolution des littoraux sableux des localités de Palmarin à Djiffère, de Dionewar et de Sangomar</i>	Génie du Littoral
25		Olivier Maurice Aly MBAYE	<i>Détermination par la méthode de fluorescence photo-induite des pesticides propanil, monalide et carboxide dans les échantillons d'eaux naturelles – Étude de leur dégradation par les procédés électro-Fenton d'oxydation avancée</i>	Chimie, Microbiologie et Traitement de l'Eau
26		Ismâïla DIALLO	<i>Caractérisation du cycle de l'eau dans le système de mousson de l'Afrique de l'Ouest et son évolution dans un contexte de changement climatique</i>	Climat et Impacts climatiques

27		Abdoul Aziz NGUINGUE	<i>Étude et modélisation hydrogéologique des interactions eaux de surface-eaux souterraines dans un contexte d'agriculture irriguée dans le delta du fleuve Sénégal</i>	Hydrogéologie
28		Mouhamed Cherif Bassirou Cisse DIATTA	<i>L'eau dans le développement : approche géographique des incidences de la réforme du secteur de l'eau en milieu rural sénégalais</i>	Gestion Intégrée des Ressources en Eau
29		Abdou Lahat DIENG	<i>Étude de la cyclogenèse au large des côtes ouest-africaines aux échelles synoptiques et saisonnières</i>	Climat et Impacts climatiques
30		Ramatoulaye MBENGUE	<i>Stratégies de gestion locale des déchets solides urbains de Ngor (Dakar/Sénégal). Formes d'organisation de l'assainissement et problèmes</i>	Environnement littoral
31	2016	Diatou THIAW	<i>Vulnérabilité et adaptation des territoires aux effets du changement climatique. Incitations globales, stratégies locales. Perspectives pour un développement territorial axé sur un suivi de l'utilisation de l'espace et des ressources dans les communes de Mbour, Saly et Malicounda (Sénégal)</i>	Gouvernance du littoral
32		Guilgane FAYE	<i>Impacts des modifications récentes des conditions climatiques et océanographiques dans l'estuaire du Saloum et ses régions de bordures (Sénégal)</i>	Environnement littoral
33		Aïssata Delphine NATI BAMA	<i>Impact de la variation pluviométrique sur la salinisation des bas-fonds côtiers et processus de leur récupération pour la riziculture : cas des bas-fonds du Sine Saloum au Sénégal</i>	Hydrogéologie

34		Moustapha SEYE	<i>Gouvernance des pêcheries artisanales et des aires marines protégées dans un contexte de changement climatique sur la grande côte maritime du Sénégal</i>	Gouvernance du littoral
35		Vieux Boukhaly TRAORE	<i>Contribution à la modélisation intégrée des écoulements d'un bassin versant pour une utilisation rationnelle des ressources en eau : renforcement de la Kayanga à partir de la Koulountou</i>	Hydraulique
36		Souleymane SY	<i>Impact du changement d'occupation des sols passé et à venir sur la dynamique de la circulation de la mousson ouest-africaine</i>	Climat et Impacts climatiques
37		Doulo TRAORE	<i>Eau, environnement et santé dans un écosystème côtier urbain : approche géographique à Nouakchott (Mauritanie)</i>	Eau, Environnement et Santé
38		Ibrahima DIOUF	<i>Climat-santé : Observations et modélisation de l'incidence saisonnière du paludisme pour sa prévision au Sénégal et au Sahel</i>	Climat et Impacts climatiques
39		Ibrahima MALL	<i>Évaluation des ressources en eau dans le socle birimien du Sénégal oriental : Apports des outils Géochimiques, Géostatistiques, de la Télédétection et des SIG</i>	Hydrogéologie
40	2017	Birane CISSE	<i>Facteurs de risque du paludisme dans la banlieue de Dakar : quels déterminants pour une meilleure prise de décision dans la lutte contre paludisme ?</i>	Eau, Environnement et Santé
41		Tidiane SANE	<i>Vulnérabilité et adaptabilité des systèmes agraires à la variabilité climatique et aux changements sociaux en Basse-Casamance (Sud-Ouest du Sénégal)</i>	Environnement littoral

42		Penda DIOP	<i>Vers une stratégie de gestion participative multi-usages de la ressource en eau dans le Delta du Fleuve Sénégal : processus de décision et outils de régulation autour du lac de Guiers</i>	Gestion Intégrée des Ressources en Eau
43		Ndèye Maguette DIENG	<i>Étude de la relation eaux de surface-eaux souterraines dans un contexte de changements climatiques dans la zone de Sud du bassin du Saloum (Sénégal). Apport des outils géochimiques, isotopiques, de la télédétection, des SIG et de la modélisation</i>	Hydrogéologie
44		Mamadou SADIO	<i>Morphodynamique et aménagement des flèches littorales du Sénégal</i>	Hydrologie Continentale
45		Mariama KABA	<i>Étude des transferts hydriques et géochimiques dans les zones humides du littoral Nord au Sénégal</i>	Hydrogéologie
46		Néné Makoya TOURE	<i>Approche géographique de l'étude de l'accès à l'eau potable sur la Petite Côte : exemple de la zone d'intervention de la Sénégalaise Des Eaux de Mbour</i>	Gestion Intégrée des Ressources en Eau
47	2018	Ousmane DIANKHA	<i>Dynamique des populations de Sardinella aurita et Sardinella madarensis dans les eaux sénégalaises : aperçu des effets des variations climatiques et non climatiques</i>	Climat et Impacts climatiques
48		Yves Birame DIADHIOU	<i>Littoral Sénégalais : dynamique actuelle du milieu, modélisation et approche de la gestion des risques liés au changement climatique (de Joal à Palmarin, Petite Côte, Sénégal)</i>	Environnement littoral

49	Moumouny TRAORE	<i>Caractérisation microbiologique et développement d'une nouvelle méthode d'analyse du taux de cadavérine par voie spectrofluorimétrique : application sur trois espèces de poissons (Cyprinus carpio, Arius sp. et Cybium tritor)</i>	Chimie, Microbiologie et Traitement de l'Eau
50	Seyni NDOYE	<i>Étude et modélisation numérique de l'intrusion saline dans la nappe côtière du Continental Terminal du Saloum (Sénégal)</i>	Hydrogéologie
51	Mouhamed SECK	<i>Actualisation des connaissances sur la nappe du Littoral nord et évaluation des impacts potentiels de l'exploitation des sables minéralisés par Grande Côte Opérations : approche hydrochimique, isotopique et hydrodynamique par modèle-Sénégal</i>	Hydrogéologie
52	Huguette Christianne EMVOUTOU	<i>Fonctionnement hydrodynamique du système aquifère du bassin sédimentaire côtier dans la ville de douala/Cameroun : apport des outils géochimiques, géostatistiques et isotopiques</i>	Hydrogéologie
53	Mame Diarra Bousso DIENG	<i>Représentation à haute résolution des changements climatiques en Afrique de l'Ouest par le modèle COSMO-CLM : Adaptation, Évaluation et Application</i>	Climat et Impacts climatiques