I. MAN AND BIOSPHERE

CURRENT SITUATION AND SUSTAINABLE DEVELOPMENT OF WATER RESOURCES IN SENEGAL

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Abstract: Water is essential for human life, the socio-economic improvement of the state and the protection of its natural environment. Senegal has a rich and diversified hydrological potential, most of whose surface water reserves are located in the basins of the Senegal and Gambia rivers and in groundwater. Unfortunately, water resources can be threatened by anthropogenic actions of various origins and by the adverse effects of climate change. This article aims to analyze the current state of water resources, water problems and prospects for the sustainable development of water resources in Senegal. Information is collected from secondary sources and available statistics (books and the Internet). The results show the importance of Senegal's water resources potential (in terms of surface and groundwater), water resources that are often severely deteriorated due to pollution, agricultural activities and the rised water demand from the population. This degradation is likely to worsen with population growth, development and climate change. For example, the Senegalese government has been conducting a water control policy for several decades aimed at providing the various sectors with water in sufficient quantity and of appropriate quality according to custom to accelerate development balanced. There are several policies and actions for the formulation of rules and regulations on the general use of water. To be in line with the sustainable development goals (SDG), including SDG 6, Senegal is committed to the sustainable management of water resources to ensure universal and equitable access to safe and affordable drinking water for all population by 2030.

Keywords: integrated management, water resources, sustainable development, socio-economic development, Senegal

INTRODUCTION

Freshwater is a vital resource for life. It is essential for the survival of natural ecosystems and the development of human activities. Until the mid-twentieth century, water was considered inexhaustible wealth that each user could own and exploit according to their needs (Honegger and Tabarly, 2011). Men, to satisfy their vital needs, use water for their different economic activities. This situation has led to a sectoral and competitive use of the resource, a management that is at the root of many problems such as conflict, deterioration of water quality and environmental problems, uneven distribution and the decline in water resources (Batcho, 2008).

The combined effects of population growth, rising incomes and expanding cities will lead to an exponential increase in water demand, while the supply of the resource will become more erratic and uncertain (Camara and Bangoura, 2017). Without immediate action, water will become a scarce resource in areas where it is abundant today. The impact of water scarcity will be felt on all socio-economic activities, including agriculture, health, energy and income (Olivier, 2016). In the face of these multiple problems that do not guarantee the sustainability of water resources and the environment, water resources are increasingly limited and vulnerable (Sinarinzi, 2010). They are limited by various factors such as climatic conditions, the unequal distribution of rainfall, the shared nature of the resource between states with often different policies, the strong demographic pressure, the low water control. In order to cope with them and establish a rational management of water resources, the assessment of water availability is a fundamental step.

In Africa, water is the leading vector of children's diseases, with over 70-80% of diseases on the continent linked to poor water quality. Also, the resource is unequally distributed geographically. For the World Bank, water scarcity exacerbated by climate change could lead some regions of the world to experience a Gross domestic product (GDP) decline of around 6%, cause migration and trigger conflict (Camara and Bangoura, 2017). In addition, there are imperfections in water management, focusing on developing new sources rather than better managing existing ones, and sectoral approaches to water management that result in uncoordinated management and unsustainable resource (CAP-Net, 2005).

In Senegal, the potential for water resources (surface and groundwater) is significant and the availability of renewable water is currently estimated at around 4747 m^3 / inhabitant / year, (CONGAD, 2009). However, the issue of water has become a national concern given the series of issues facing the sector: scarcity, randomness of rainfall, vulnerability of water resources, unevenness in their spatial distribution, current or emerging potential

conflicts of their exploitation and overexploitation, degradation of their quality, inequity in access to water resources between zones, social groups, different socio-economic activities, etc. (Ministry of Hydraulics / DGPRE, 2007). The water crisis can be explained both by the absolute lack of physical availability, poverty and inadequate water management policies. In general, Senegal has a large potential for water resources, but their uneven distribution, their overabundance in the rainy season often causes catastrophic floods and shortage in the dry season causes severe drought conditions resulting in crop losses, livestock, public health problems and environmental degradation.

Faced with the urgency of moving to new forms of water management, Senegal has been keen to comply with the recommendations of the World Summits (Rio-Dublin in January 1992 and Johannesburg in August 2002). In Senegal, the management and monitoring of water resources throughout the territory is covered by the Directorate of Water Resources Management and Planning (DGPRE). As part of the management of water resources for achieving the Sustainable Development Goals (SDGs), this article examines the current state of water resources, water issues and prospects for sustainable development of water resources in Senegal.

PHYSICAL CHARACTERISTICS OF SENEGAL

The Republic of Senegal, located on the extreme western tip of the African continent, covers an area of 196 722 km². Its population is 13 508 715 inhabitants (ANSD, 2013). Coastal country with 700 km of Atlantic coastline, Senegal is located between 12.5° and 16.5° north latitude and 12° and 17° west longitude. Given the variations in rainfall in space and time, in Senegal, from south to north, there are three climatic domains, namely the southern Sudanian, northern Sudanian and Sahelian domains, each domain having two variants (a coastal and a continental) (Faye et al., 2017).

Located in the tropical zone, Senegal has Sudano-Sahelian climate with an annual rainfall varying between about 1250 mm in the South to just over 200 mm in the North. This climate is marked by an alternation between, the rainy and the dry seasons. The rainy season, which is the monsoon period, extends roughly from June to October with a peak in August-September. The rain varies degressively depending on the latitude. The dry season that lasts from November to June is marked by the presence of a hot and dry wind; it's the harmattan.

CURRENT SITUATION OF WATER RESOURCES IN SENEGAL

Water is needed to meet the needs of consumption (including agricultural, domestic and industrial needs) and non-water consuming needs (these needs are generally at the level of rivers such as navigation, fishing, control of salinity and dilution of pollution). It is also necessary for ecological protection and the preservation of wetlands. For proper planning, development and use of water resources, a proper assessment of available water resources is essential but difficult (Nadira and Shixiang, 2018). In Senegal, water really becomes a scarce resource during the dry months of the year coinciding with the period of maximum water demand. But the potential of Senegal's water resources (surface and groundwater) is important. It consists of three rivers that have their source in Guinea (Senegal, Gambia and Kayanga rivers) that irrigate large part of the country. Thus, the Senegalese portion of the Senegal River basin and the Gambia is respectively 27,500 km^2 (or 9.5% of the basin) and 54,631 km^2 (70.9% of the basin).Thus, Senegal has a fairly rich and diversified hydrological potential. In fact, most of the surface water reserves are located in the basins of the Senegal and Gambia rivers whose waters come from the Fouta Djallon massif in the Republic of Guinea (Sané, 2015). Alongside these two large rivers, there are smaller rivers characterized by intermittent flows. These are Casamance, Kayanga with its main tributary Anambé, Sine, Saloum and coastal creeks (Fig. 1). A number of listed lakes and ponds complete this hydrographic network; the most important being: Guiers Lake, the bolongs of the estuaries and the ponds of the Niayes region of the northern coast and Ferlo. For example, at a height of + 1 m, the surface of Lake Guiers is 240 km^2 for an average volume of 390 million m^3. As for groundwater have always been an essential component of Senegal's water potential, but even more prevalent since the beginning of the drought. The country has four major aquifer systems corresponding to the main geological formations: the superficial aquifer system (reserves estimated at 50-75 km^3); the intermediate aquifer system (reserves estimated at 100 km^3); the deep aquifer system (reserves estimated between 300 and 500 km^3); the aquifer system of the basement (weak reserves).

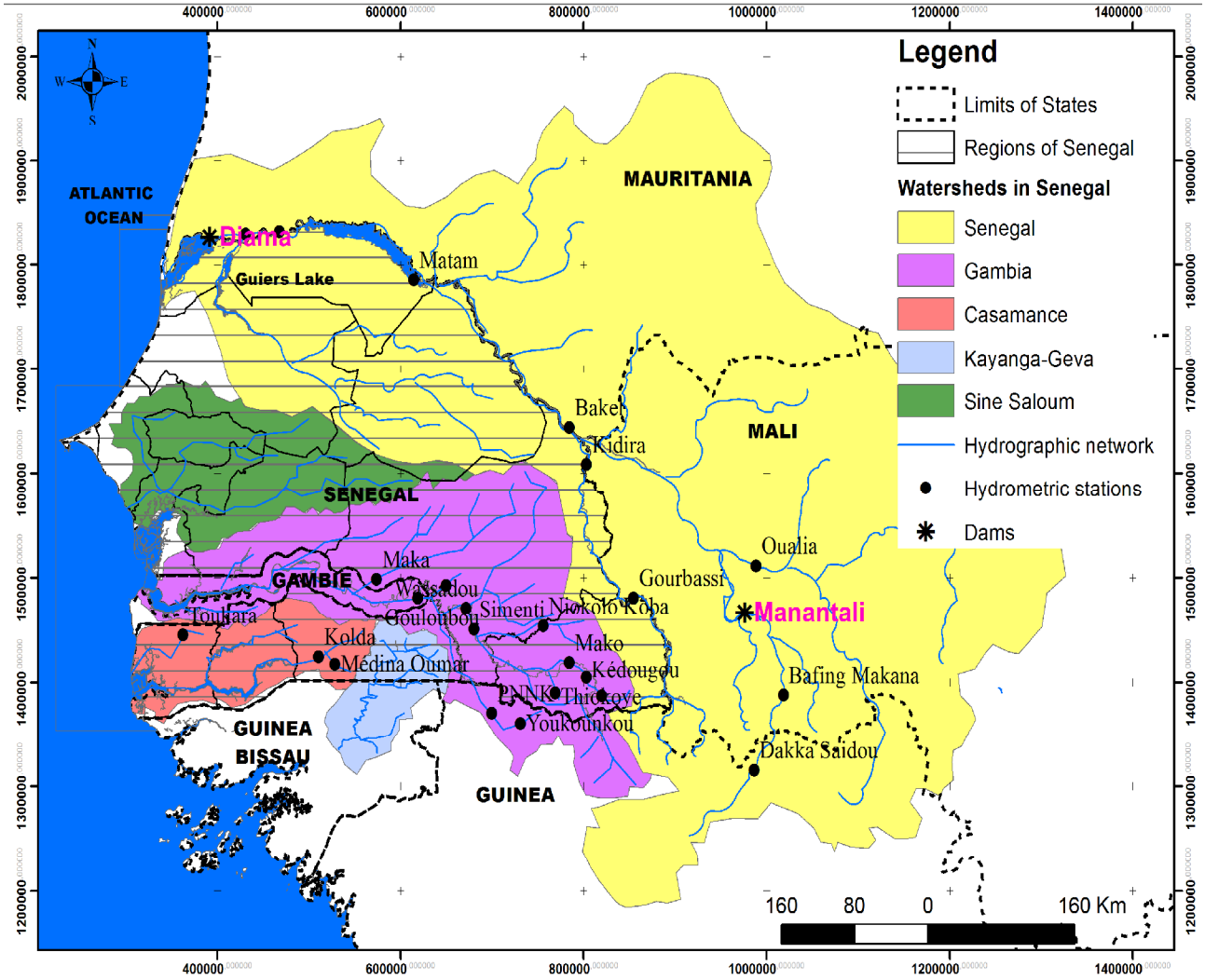

Fig. 1. Watersheds draining the Senegalese territory (Source: DGPRE)

The amount of water available, as reported by FAO (2016), is presented in Table 1. The total renewable water resources (surface water, groundwater, inland and external waters) are estimated at 38.97 km^3/year in 2014. The surface renewable water resources are estimated at 36.97 km^3/year and the internal renewable water resources in the order of 25.8 km^3/year, which is an index of dependence of 33.8% (Table 1). Today, unfortunately, Senegal's water resources are threatened by the extent of drought and climate change (Faye, 2013; Faye et al., 2017).

The total volume of renewable groundwater available is estimated at 3.5 km^3/year (Table 1). This groundwater is the main source of safe and reliable drinking water supply in rural areas and in many cities, for irrigation of thousands of hectares of arable land and for livestock watering. Many mines and industries also rely on groundwater for their supplies, such as Chemical Industries of Senegal, Mineral Deposits Limited, etc. In 2000, withdrawals from water resources (from surface and underground waters) amounted to 1,591 million m^3, of which 1,435 million m^3 for agriculture (93%), 98 million m^3 for communities (4%) and 58 million m^3 for industry (3%) (FAO 2016). Depending on the different estimates, the irrigation potential varies from 160 000 ha to more than 640 000 ha. In 2014, total removals (from surface and underground waters) are estimated at 2.22 km^3/year in Senegal. Given the considerable potential of water reserves in the country, the exploitation index is relatively low (5.75%).

Table 1. Renewable water resources available in 2014 for the three countries (Source: FAO, 2016)

Renewable Water Resources (RWR)	**Senegal**	
	value	**%**
Total interior RWR (km^3 /year)	25.8	66.2
Total external RWR (km^3 /year)	13.17	33.8
Total superficial RWR (km^3 /year)	36.97	94.9
Total underground RWR (km^3 /year)	3.5	9.0
Total RWR (km^3 / year)	38.97	100
Dependency index (%)	33.8	
Total RWR per capita (m^3 /year /inhabitant)	2853	
Total withdrawals (km^3 /year)	2.22	
Farming index (%)	5.71	
Total capacity of dams (km^3)	0.25	
Total capacity of dams per capita (m^3 /inhabitant)	16.52	

In Senegal, social development leads to an increasing demand for water, where water plays a central role in most national planning initiatives, such as agricultural development, energy security, tourism and recreation, mining, industry and municipal water supply (Mwendera and Atyosi, 2018). Demographic and urban growth is putting great pressure on available water resources, often limited in the dry season. According to FAO (2016), renewable freshwater resources per capita (in m^3) are steadily decreasing. They thus went from 11612 m^3 in Senegal in 1958-62 to only 2576 m^3 in 2013-17. These results show the evolution of the country towards a situation of water stress (if Total RWR per capita below 1700 m^3/inhabitant/year) first and then towards a situation of water shortage (if Total RWR per capita in below 1000 m^3/inhabitant/year). Senegal is close to a situation of water vulnerability (if Total RWR per capita below 2500 m^3 /inhabitant/year).

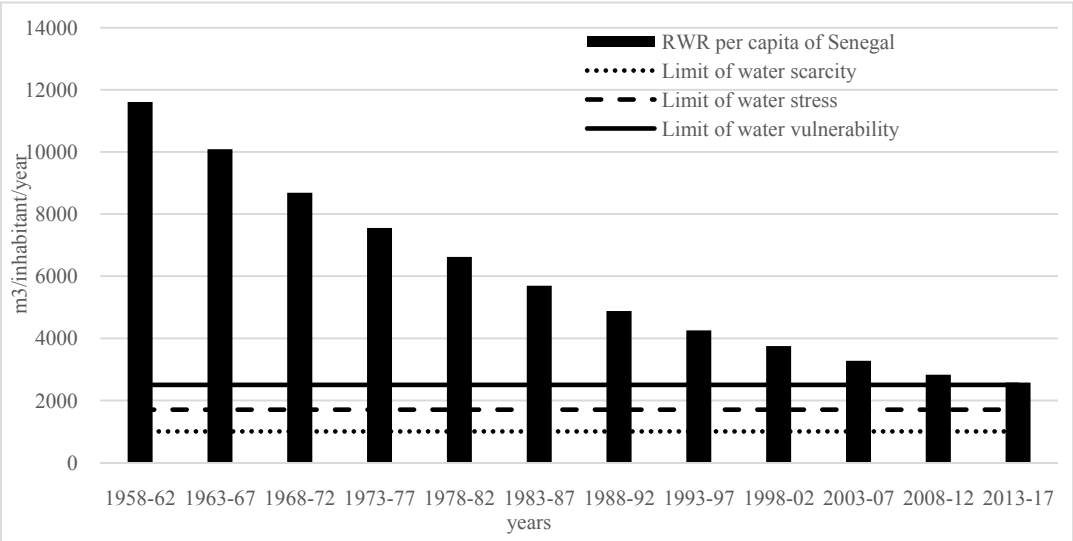

Fig. 2: Evolution of total renewable water resources per capita between 1958-62 and 2013-17 for Senegal (Source: FAO, 2016)

This observation points to a worrying situation as water consumption increases exponentially in relation to the population growth of the riparian countries of the Senegal River Basin. The total volume of water withdrawn is estimated at 5.19 km^3/year in Mali, 2.22 km^3/year for Senegal and 1.70 km^3/year for Mauritania. The logical outcome of such a situation could be competition for the resource (Boinet, 2011). Senegal could seek to reduce its own uncertainty about the water resource by making adjustments on the rivers that cross its territory, for a better water availability of the users, without making use of the force to safeguard the interests of other riparian countries on this issue of national security (Descroix and Lasserre, 2003). Although the country has rivers of great water quality (more than 26 billion m^3/year), large areas, previously crossed by rivers, have become almost completely devoid of surface water as a result of dewatering rivers (Sané, 2015).

To characterize the human control of the country's water resources, the comparative evolution between water availability and the level of development of Senegal, other West African countries and some developed countries in the world, is given on Fig. 3. Human control of water resources, understood here as the ability of societies to mobilize and control (soft) water across space and time, is a powerful tool for sustainable socio-economic development (Gray and Sadoff, 2006). Fig. 3 highlights four different situations: countries with low water availability per capita (per capita RWR) and low level of development (GDP per capita) (Senegal, Mali, Côte d'Ivoire, Guinea); countries with low water availability per capita and at high levels of development; countries with good water availability per inhabitant and low level of development (Sierra Leone); countries with good water availability per inhabitant and at a high level of development (Japan, France, Germany, United States). Generally, in Senegal, like all West African countries, if the resource is theoretically relatively good (2 576 m^3 per inhabitant), the level of development is relatively low (GDP per capita US $ 911) and plays an important role in the country's inability to put its water resources at the service of its sustainable development. Senegal, like the other West African countries, is therefore faced with a "social" scarcity of water, that is to say a structurally induced scarcity (Julien, 2006).

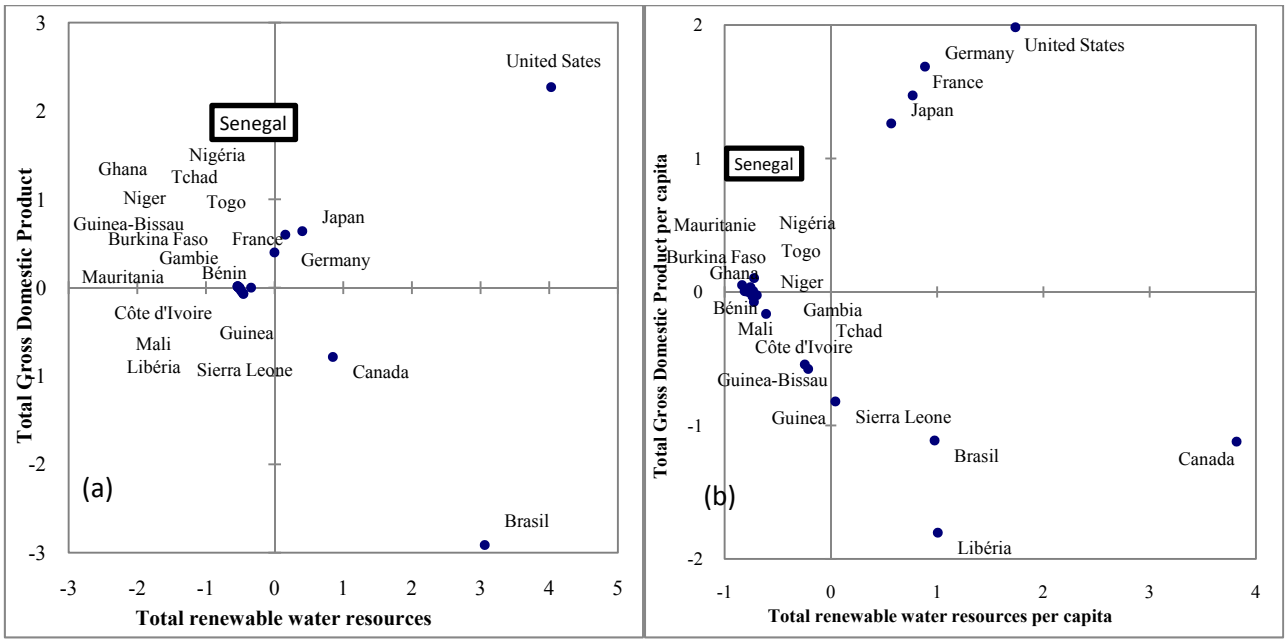

Fig. 3: Comparative factorial representation between water availability and the level of development between Senegal, other West African countries and some developed countries in the world in 2015: (a) between total GDP and RWR total; (b) between GDP per capita and total RWR per capita

This situation has a particular resonance in the West African context of fragmentation of the resource (Julien, 2006). This is what Senegal understood very early and began negotiations with West African States bordering the basins that cross the national territory, for the design of infrastructures capable of ensuring a cooperative management of water resources and water resources,

increase the water availability. This resulted in the construction of the main regulation works of the Senegal River: the Manantali dam which controls 50% of river flows and the Diama anti-salt dam, located near the mouth (Faye, 2013).

However, the reservation of surface water potential is limited by a number of factors, although an immense amount of surface water flows through the Senegal River and the Gambia River. More importantly, there is not much possibility of surface storage beyond Lake Guiers, and there are few diversion opportunities on the Senegal River due to the opposition of riparian countries like Mauritania, (which depend on 96.49% of foreign resources) which safeguards its interests on this issue of national security. Under current conditions, a large volume of Senegal River water flows towards the Atlantic Ocean. At the same time, agriculture currently consumes 4.069 billion cubic meters / year compared to 84 million cubic meters / year for industry and 196 million cubic meters / year for domestic uses (Table 2).

Table 2 : Current distribution of water resources by state and by sector (in millions of m^3) (Source : OMVS)

Sectors/State	Mali	Mauritanie	Senegal
Agriculture	1319	1499	1251
Domestic uses	27	101	68
Industry	14	29	41
Total	1360	1630	1380

In Senegal, agriculture is a sector at the heart of its economy, and as such it is a priority for the political authorities, as it occupies 2/3 of the working population. The agriculture sector is the main user of water in the country (Faye et Dieye, 2018). With the intensification of irrigated agriculture, water requirements have increased. In 2002, withdrawals from water resources amounted to 2221 million m^3, of which 2065 million for agriculture (93%) (FAO, 2016). Table 3 shows the distribution of water withdrawals from the agricultural sector in Senegal in different areas (DGPRE, 2016)

Table 3: Water withdrawals from the agricultural sector in Senegal (Source: DGPRE, 2016)

Designation	Quantity of water withdrawn (m^3)	Proportion %
River Valley Area (North)	1 345 050 000	73,27
Delta River Area (North)	194 441 107	10,59
Niayes area	228 268 000	12,43
Casamance area	50 000 000	2,72
Other	17 942 701	0,98
Total	**1 835 701 808**	**100**

MAIN CAUSES OF WATER PROBLEMS IN SENEGAL

Senegal now has many problems and challenges related to water. These problems and challenges are likely to worsen with population growth, socio-economic development and climate change. Water is at the heart of Senegal's life and culture, especially for the inhabitants living along the river systems.

Water pollution

Water pollution is yet another cause of water scarcity in Senegal. Sources of water pollution include pesticides and fertilizers, industrial and human wastes that are directly dumped into rivers

without being treated. In addition, in Senegal, oil spills on the ground and leaking sewage from landfills can seep underground and pollute groundwater, rendering it unfit for human consumption, as indicated by Nadira and Shixiang (2018) in Bangladesh. Indeed, in developing countries such as Senegal, 80 to 90% of wastewater and around 70% of household and industrial waste are discharged without treatment into surface water. Of 25 million m^3 of sewage collected per year, only 8.6 million are treated and transited into network of the National Office for Sanitation in Senegal (ONAS), or about 35% of collected water, which makes a volume of 16.4 million m^3 of sewage (65%) discharged directly into sea without any treatment (Hydraulic and Sanitation Ministry). The resulting deterioration in water quality is due to the weakness and overload of existing municipal and industrial water treatment and/or sanitation facilities. It can also stem from the inappropriate or archaic nature of existing infrastructure. The network is very old, with some sections that are over 65 years old and others very damaged. In Senegal, wastewater effluents and waste containing hazardous materials, heavy metals, etc. are not treated by industries before being discharged directly into the drains (Faye, 2017).

Table 4: Water Quality Based on PROGRES Data (Source : DGPRE)

Regions	Population served with excess Fluor	Population served with excess salinity	Fluoride blanket	Salinity coverage
DIOURBEL	148 413,79	159 225,35	32,2%	34,5%
FATICK	133 313,12	66 163,30	32,8%	16,3%
KAOLACK	62 747,96	20 417,78	15,6%	5,1%
THIES	46 921,26	36 452,62	8,0%	6,2%
CENTER AREA	391 396,13	282 259,06	21,1%	15,2%

Despite many efforts, the issue of water quality has become strategically important, making it a public health issue. The analyzes conducted (on available data managed by the DGPRE) show that the localities served by boreholes located in the central zone of the country (Fatick, Kaolack, Kaffrine and Diourbel) with fluorine levels in excess (above the MDG standard = 1.5 mg/l) total a population estimated at 391400 people while those with a dry residue greater than 1500 mg/l globally affect 282 260 people (Table 4) (PEPAM, 2011).

The problem of increasing the population

In the 1976 census, 4,997,885 million people lived in Senegal. In 1988, the population is estimated at 6,896,808. Thus, from 1976 to 1988, the population of Senegal increased by 1,898,923, ie an average rate of 2.7% per year. The country's population (last census in 2013) is 13,508,715, ie an average intercensal annual growth rate of 2.5% between 2002 and 2013 (ANSD, 2014). In 2015, the Senegalese population is estimated at 14,356,575 inhabitants with an average annual growth rate of 2.7% (ANSD, 2015). This population growth has an impact on the environment mainly through the consumption of natural resources and the production of waste. It is also associated with environmental stresses such as loss of biodiversity, air and water pollution and increased pressure on arable land (UNRISD, 1994). As the population and the demand increase, the impact on the environment is striking through the degradation of soil and water. The rapid increase in the human population combined with the massive growth of the industrial sector has transformed aquatic ecosystems and led to a loss of biodiversity. As the population grows at an ever increasing rate, the demand for new resources will put additional pressure on freshwater sources. (Nadira and Shixiang, 2018).

In addition, the increase in population can contribute to the deterioration of water quality, especially with the sanitation deficit and / or the dumping of waste and wastewater directly into the environment (Faye, 2017). According to a UNESCO report, water quality will drop mainly due to human activities with high population growth, rapid urbanization, rejection of new pollutants and new chemicals that are the main factors that contribute to

the deterioration of water quality (UNESCO, 2015). The closure of the Thiaroye factories in the suburbs for reasons of heavy pollution is a perfect example of groundwater pollution (CONGAD, 2009).

Agriculture

In Senegal, agriculture is a sector at the heart of its economy, and as such, it is a priority for the political authorities, because it represents 2/3 of the active population. The agriculture sector is the main user of water in the country. With the intensification of irrigated agriculture, water requirements have increased. As part of the rice self-sufficiency project, many projects, particularly in the field of water management and rice production are in sight or at the beginning of implementation to reinforce the dynamics of agricultural development of the riverbank, left of the Senegal River (Senegal River valley) and in the Anambé basin. To achieve food self-sufficiency in rice, the rate of completion of hydro-agricultural development is increased (Diouf, 2017). Despite its high potential, Senegalese agriculture remains dependent on rainfall, which has decreased overall by 35% between the period 1950-1965 and the period 1970-1995 (Diagne, 2000). Extensive agriculture is characterized by excessive clearing, slash-and-burn agriculture and agricultural nomadism, all of which lead to the loss of biodiversity (OMVS, 2008). Although agriculture uses the majority of available freshwater, about 60% of this water is wasted due to inefficient farming methods and leaky irrigation systems (Nadira and Shixiang, 2018). In addition to this, pesticides and fertilizers are washed away in rivers and lakes that further affect the human and animal population.

SENEGAL'S WATER POLICY

Types of water management policies

Due to the physical, socio-economic and environmental characteristics of water resources in Senegal, it is essential for the country to: (1) mitigate the risks associated with water (flood and drought); (2) store water for use in the dry season; and (3) protect or conserve water quality in river basins. This is why water policy has always been the most important concern. Contemporary water governance in the country can be classified into the following four periods: (i) water policy from the independence period to 1974; (ii) the water policy of the 1974-1980 period; (iii) the water policy for the period 1981-1995; (iv) the water policy of the current period.

Current water management policy in Senegal

It is from 1995 that the public authorities give a very marked inflection to the organization of the water sector, as well in urban as rural and on the durability of the water supply of the populations. Thus, a reform of the urban water subsector was initiated through the Water Sector Project, which led to the separation of drinking water from sanitation. This reform embodied by the law n° 95 - 10 of April 07, 1995 resulted in the creation of two different entities which are in charge of the management of the urban water subsector: the National Water Company of Senegal (SONES) and Senegalaise des Eaux (SDE), operating company, private operator (CONGAD, 2009, Tine, 2009). Sanitation is then managed by an independent office specially created for this purpose, the National Office of Sanitation of Senegal (ONAS).

In the aftermath of the International Decade of Drinking Water and Sanitation (1980-1990), Senegal successively put in place three Letters of Sectoral Policies for Hydraulics and Sanitation (LPSHA) (1995, 2001 and 2005). These strategic documents define the sector's intervention frameworks. The last sectoral policy letter prepared in 2005 is the basic instrument for the implementation of the Potable Water and Sanitation Program for the Millennium (PEPAM-2015). Indeed, since 2005, the PEPAM has become the reference framework for intervention of all the actors of the sector with objectives and indicators of results based on the achievement of the Millennium Development Goals (MDGs) in 2015. The role of the PEPAM is to unite all the initiatives of the sector and ensure coherence of interventions on the ground. Thus, a unified framework of interventions has been put in place. Through the PEPAM, Senegal has opted for the principle of a program approach to achieve the Millennium Development Goals defined at the World Summit in Johannesburg in 2002 by the international community. After 2015 and for the achievement of the Sustainable Development Goals (SDG) by 2030 in Senegal, SDG 6 on sustainable water management in particular, a national monitoring framework has been put in place by the Coordination and Monitoring Unit for Water and Sanitation Programs (Ex PEPAM) (Ndour, 2016).

Because of the multiplicity of uses of water, the issues related to the management of water resources can only be validly apprehended in a comprehensive way through a sectoral approach. To this end, an integrated water resources

management approach was initiated in 2004 by the Ministry of Agriculture and Hydraulics with the steering of the Directorate of Management and Planning of Water Resources (DGPRE). This process was completed by the development of the IWRMP, which ended in 2007. The objectives of the LPSHA in the management of water resources are to ensure their availability and quality in order to support the increase of water supply, by 2015, in rural areas. In particular, it will: Establish and ensure sustainable management of Lake Guiers, whose importance for the urban water supply sector is vital; to improve the water quality offered to rural users of the Groundnut Basin, at a reasonable cost for these users; to identify alternative water resources for market gardening irrigation in the Niayes area; to strengthen the quality of data and monitoring analyzes of water resources (Tine, 2009). It is in this wake that the office of Lake Guiers (OLAG) is transformed into the Office of Lakes and Waterways (OLAC) and the new structure will have the mission to ensure better integrated management of lakes, courses of water in Senegal.

In rural areas, the Office of Rural Drilling (OFOR), established by law 2014-13 of 28 February 2014, carries out the management of the heritage of rural water supply, including drinking water supply systems. It provides assistance to local authorities in the context of the project management of rural water works. It delegates the responsibility for the management of the public water service in rural areas, the monitoring, the control, the audit of the exploitation of rural water infrastructure and the quality of the service of the water as well as the accompaniment of actors (DEM, 2013). As part of the rural water reform, the populations of several villages are protesting against the abolition of Association of users of boreholes, and the delegation of the exploitation and maintenance of motorized rural boreholes to private operators.

SUSTAINABLE DEVELOPMENT OF WATER RESOURCES IN SENEGAL

SDG 6 proposes to ensure the availability and sustainable management of water and sanitation for all. A specific goal is to achieve universal and equitable access to safe and affordable drinking water for all by 2030 (Ndour, 2016). The challenges and obstacles to the sustainable development of water resources in Senegal can be divided into cross-border and national categories. Most of Senegal's freshwater resources are located in transboundary watercourse systems and shared river basins whose management and protection is necessary through a strong commitment to regional collaboration (Thiam, 2016). The Senegal River which is the main river of the country has only 9.5% of its basin on the national territory on an area of 289000 km2, against 53.5% for Mali, 26% for Mauritania and 11% for Guinea. Senegal being located downstream of the basins (Senegal and Gambia), the state of water, in terms of quantity and quality, is directly related to activities in the upper part of these basins. All the major rivers in Senegal come from outside the country (rivers of Senegal, Gambia and Kayanga). In these transboundary basins, there are several treaties between Senegal and the other riparian states on the use of these shared resources. This resulted in the establishment of basin organizations (OMVS in the Senegal River Basin and OMVG in the Gambia River Basin) and the construction of a dam (Djama and Manantali) (Faye, 2013).

Senegal's dependence on the water flows of the upper riparian countries is the primary cause of the vulnerability of this precious resource. Of the total annual renewable flows of 38.97 billion m^3 of water on the territory, 13.17 (33.8%) come from outside. Unilateral control of surface water flows in transboundary basins by the upper riparian countries (Guinea and Mali) would lead to insecurity of water resources in Senegal and constitute a major obstacle to the sustainable development of water resources. In addition, Mauritania's disagreement over the revitalization of the fossil valleys has deprived the country of storing some of the excess water from the Senegal River for very important uses such as agricultural and industrial production.

Fortunately, these different constraints are overcome by the integrated vision and planning of water resources in the basins. Thus, thanks to OMVS, which ensures cooperation in the Senegal River Basin, each member country has the obligation to respect its commitments by cooperating with its neighbors in the management of shared waters in the interest of regional economic integration of peace and security (Niasse, 2004). The OMVS has therefore established a global vision of the development of the Senegal River Basin, integrating the different sectoral objectives of hydropower, navigation, the development of drinking water and sanitation, transport and rural development. , mining and industry.

Although many changes have been made to Senegal's water policies, many environmental, physical and socio-economic challenges have yet to

be solved. Among other challenges, there is mismanagement, lack of investment, weak policy and administration, weak technology. The State must therefore ensure the supply of drinking water to urban and rural populations, develop sustainable agriculture through the optimization of the country's water potential, meet the water needs of industries, manage the sustainability of the water resources of the country.

RECOMMENDATIONS

As a riverine state downstream of major river systems, Senegal must continue to work with its neighbors as part of overall basin management, focusing on the different hydrological regions and promoting the exchange of information. Although the establishment of basin organizations (OMVS in the Senegal River Basin and OMVG in the Gambia River Basin) is an important milestone, further efforts are needed to ensure a secure resource base, water in transboundary rivers. National water management policies must try to balance the high variability of water resources (too much water in the rainy season and too little water in the dry season), which would require exploiting the resources of surface water and groundwater.

- Water Management: Water management through the use of regulations and policies can help reduce water scarcity, especially in the dry season. Regulations and policies can address water-related issues such as water reuse, water resource management, water rights, wetland restoration, water supply, domestic water and water pollution. In precise terms, water management has the capacity to address human interventions and various natural events in relation to resources and long-term decisions about water policy on the environment and the environment economy.

- Repair and maintenance of infrastructure: One of the main ways of dealing with the problem of water scarcity in Senegal may be the repair of infrastructure and the maintenance of water channels. Leaking pipes and sewage systems normally lead to wasting water and contamination, respectively. If these infrastructures are left unattended over time, cumulative effects can create water shortages.

- Investment and training of staff: The government must provide funds to companies engaged in infrastructure maintenance. It should also facilitate the training of personnel in the exploration of the resource for future development and the economy. An audit system should be put in place for the monitoring and proper use of funds allocated to water management. The government must further develop appropriate infrastructure such as dam construction, and provide appropriate technology for the management of its water resources. Long-term solutions to problems require greater investment, more technology, higher human capacity, and intensified cooperation among countries, sectors, organizations and social strata.

CONCLUSION

Monitoring and development of water resources have been important considerations in Senegal since 1960. The characteristics of water availability and supply have been influenced by environmental changes and socio-economic factors. Senegal has developed water management policies, through a series of progressive reforms, to provide a continuous response to these surrounding conditions. Nevertheless, the water sector faces a set of challenges that persist such as the increasing demand for water due to population growth, the need for acceptable water quality in many regions, the implementation insufficient and inefficient practice of the water management system and uncertainties related to climate change.

Senegalese authorities, non-governmental organizations (NGOs) and UN international organizations must take responsibility for managing water and accumulating resources because water is life and there is no life without water. In addition to the large dams, several small reservoirs could be built to increase the water storage capacity. Nevertheless, Senegal has the privilege and the chance to have a rich and varied water resource potential. However, the quality of this precious resource is deteriorating more and more. Only by better understanding the sources of pollution and the processes that affect the quantity and quality of water could it be saved for present and future generations. In addition, there are collective management actions with its immediate neighbors with the establishment of basin organizations. The basin population can also play a role in preserving water quality. In addition, all countries bordering the basins must continue to join their efforts (OMVS on Senegal, OMVG on Gambia) to protect this precious resource.

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ТЕКУЩО СЪСТОЯНИЕ И УСТОЙЧИВО РАЗВИТИЕ НА ВОДНИТЕ РЕСУРСИ В СЕНЕГАЛ

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Резюме: Водата е от съществено значение за човешкия живот, социално-икономическия напредък на държавата и опазването на нейната природна среда. Сенегал има богат и разнообразен хидроложки потенциал. Повечето запаси от повърхностни води са разположени в басейните на реките Сенегал и Гамбия, и като подземни води. За съжаление водните ресурси могат да бъдат застрашени от антропогенни действия от различен произход и от неблагоприятните последици от изменението на климата. Тази статия има за цел да анализира текущото състояние на водните ресурси, водните проблеми и перспективите за устойчивото им развитие в Сенегал. Информацията е събирана от вторични източници и налична статистика (книги и интернет). Резултатите показват важността на водните ресурси в Сенегал (повърхностни и подземни води), които често са сериозно влошени поради замърсяване, селскостопански дейности и увеличено търсене на вода от населението. Тази деградация вероятно ще се увеличи с нарастване на населението, икономическото развитие и изменението на климата. Например сенегалското правителство провежда политика за контрол на водата в продължение на няколко десетилетия, целяща да осигури на различните сектори вода в достатъчно количество и с подходящо качество съгласно изискванията на потребителите, за да се ускори балансираното икономическо развитие. Съществуват няколко политики и действия за формулиране на правила и регламенти за използване на водата. За да бъде в съответствие с целите за устойчиво развитие, включително цел 6, Сенегал се ангажира с устойчивото управление на водните ресурси, за да осигури до 2030 г. всеобщ и справедлив достъп до безопасна питейна вода за цялото население.

Ключови думи: интегрирано управление, водни ресурси, устойчиво развитие, социоикономическо развитие, Сенегал

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