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# AFRICA, A CONTINENT WITH IGNORED LARGE WATER RESERVES

# L'AFRIQUE, UN CONTINENT AUX GRANDES RESERVES D'EAU IGNOREES

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## ABSTRACT

This article examines the water resources in the African continent. On the basis of a bibliography, we have established a report on the potential for surface and underground water. It turns out that the Africa continent, with an area of over 30 million km$^2$, holds more than 10 longest rivers on the planet. A number of dams of more than 2000. But what impressed us most is the potential of invisible waters which are hidden in the subsoil of the continent. 72 in number, Trans boundary aquifers, hold more than 42% of the continent's total area. It is this type of water resource that can save the continent in the short to medium term in the event of global warming. Africa is a continent full of water.

**Keywords**: African continent - Water resources - Trans boundary aquifer - River - Dam.

## RESUME

Le présent article examine les ressources en eau dans le continent Africain. Sur la base d'une bibliographie, nous avons établi un état sur les potentialités en eau de surface et souterraine. Il s'avère que le continent d'Afrique d'une superficie de plus de 30 millions de km$^2$, détient plus de 10 fleuves les plus longs de la planète. Un nombre de barrage de plus de 2000. Mais ce qui nous a plus impressionnés, c'est le potentiel des eaux invisibles et qui sont cachées dans le sous-sol du continent. Au nombre de 72, Les aquifères transfrontaliers, détiennent plus de 42% de la superficie totale du continent. C'est ce type

de ressource en eau qui peut sauver le continent à court et à moyen terme en cas de réchauffement climatique. L'Afrique est un continent qui regorge d'eau.

**Mots clés** : Continent Africain- Ressources en eau – Aquifère transfrontalier- Fleuve-Barrage.

## INTRODUCTION

Now a scarce commodity, water; this precious odorless, colorless liquid lies at the heart of a nation's food security problem. No socio-economic development of a country can take place without the presence of blue gold. A source of conflict, water has become a major geopolitical issue which, in the near future, will be a source of threat between countries. Thus, several areas of tension are recorded in the four corners of the planet and more particularly in the regions of the Middle East and the Nile. Several specialists predict that the next wars will take place because of the water. Planet earth contains a total water volume of 1.4 billion $km^3$, of which more than 97% is salt water contained in the oceans and seas (Futura Planet, 2020; Lefevre, 2013; Remini, 2010). The remaining 3% represents freshwater that is contained in rivers, streams, lakes, glaciers and groundwater (Boucher, 2017: Remini, 2010). The quantity of accessible fresh water is more than sufficient for the planet. It is shared between three major sectors: irrigation, drinking water supply (DWS) and industry. Only the amount intended for irrigation represents 70% of the total volume, or about 20% of the amount of fresh water is for industrial use. As for the drinking water supply, it holds the remaining 10% of fresh water. Of this quantity (10% of the total volume of fresh water), 62% of drinking water comes from groundwater (water table, surface and deep) (Beaulieu, 2019; U. Water, 2017), while the remaining 38% comes from surface water (rivers and lakes) (Hubert, 1998). Our African continent is often considered a continent very poor in water resources. Since our childhood, watching programs about wild animals in Africa on television, images of droughts and thirst were always present in these films. It has been embodied in our brains that these regions of Africa, especially the Sahel, remain regions without water. Can we affirm that the African continent is a continent poor in water, a continent which ignores or which underestimates these water resources? This modest paper attempts to answer this question and shed light on the real water capacities in this beautiful continent.

## STUDY AREA SITUATION AND CHARACTERISTICS

What a beautiful continent, Africa covers 20% of the land surface. Africa is surrounded to the north by the Mediterranean Sea, to the west by the Atlantic Ocean, and to the east by the Red Sea and the Indian Ocean (Fig. 1). With more than 1.3 billion inhabitants, the African continent is the second most populous continent in the world. It is overtaken by Asia with a population of 4.6 billion. However, according to UN forecasts, demographic development in Africa will be 2.5 billion inhabitants in 2050 and more than 4 billion

inhabitants in 2100 (United Nations environment program, 2010). The longest river in Africa is the Nile with a length of 6,671 km with an area of its catchment area of 2,850,000 km$^2$ (Bethemont, 2003) ahead of the Congo (4,700 km), the Niger (4,185 km), the Zambeze (2,693 km) (Atlasosio, 2018). The greatest hot desert exists in Africa; the Sahara with an area of 8.5 million km$^2$ (Remini, 2017; Remini, 2018. Remini, 2020).

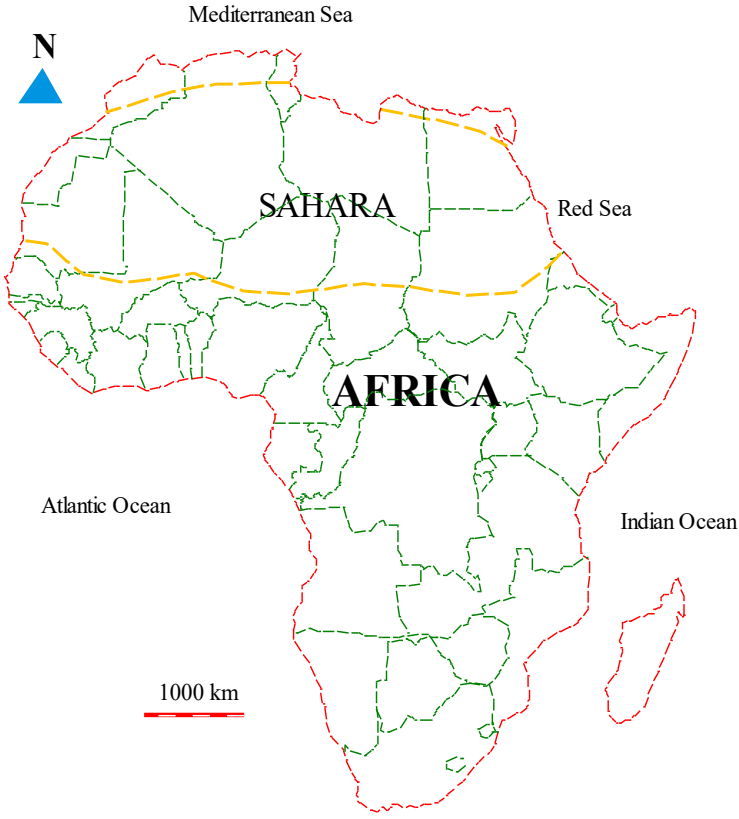


**Figure 1: The African Continent (Remini diagram, 2021)**

Africa is distinguished by four types of climates (Mpounzai and, Samba-Kimbata, 1980; Tsalefac et al, 2015):

- The arid climate that covers the Sahara desert and the countries of the Sahel and the Kalahari desert. The climate of these regions is characterized by high temperatures and low precipitation.
- The Mediterranean climate affecting the coasts of the countries of North Africa and the Nile delta. It is characterized by a hot climate in summer and cold in winter. Precipitation is infrequent but low in intensity.

- The equatorial climate characterized throughout the year by hot and humid. It covers the coasts of Guinea, Congo, the coasts of Zanzibar and eastern Madagascar.
- The tropical climate which covers part of southern Africa, eastern Africa, western Madagascar and the northern Gulf of Guinea.

## RESULTS AND DISCUSSIONS

Africa, the continent of paradoxes, has a stock of accessible fresh water estimated at more than 5,400 billion $m^3$/year (Bazié, 2014; Usher, 2008). Today, only 4% of this potential is mobilized to meet the demands for drinking water, irrigation and industry (Bazié, 2014; Barbier, 2009). This potential is distributed among the surface waters represented by 24 large rivers and 160 lakes to which are added significant groundwater and Albian aquifers (AtlasSocio, 2018). Annual rainfall in Africa totals around 20,360 billion m3, or a continent-wide average of 678 mm (AQUASTAT 2005; Dieng, 2011), Africa is immune to water shortages. However, this great continent can be divided into three distinct parts: North Africa which represents the region of potential shortages. Saharan and Sahelian Africa refers to the region of water scarcity. The third region; Equatorial Africa and West Africa refer to the region of plenty of water. In general, Africa is very rich in water. However, this stock of fresh water is not fully exploited for lack of hydraulic infrastructure, whether for the storage of surface water, for the collection of groundwater, for treatment stations, for water networks, drinking water supply and sanitation. As regards the hydro technical infrastructure, Africa has an arsenal of more than 2,000 large dams in operation, of which more than 80% of these hydraulic structures are concentrated in three large regions: North Africa, West Africa and southern Africa (fig. 2). However, the Mega dams (dams with a capacity exceeding 10 billion $m^3$ of water) are located in southern Africa and West Africa. Today, Africa is moving towards the construction of dams with a capacity of over 2 billion $m^3$ (Trever, 2013).

It should be noted that two dams: Aswan (Egypt) and the Renaissance (Ethiopia) are built on the Nile River in eastern Africa. With a capacity of 162 billion $m^3$, Egypt's Aswan Dam is considered the largest dam in Africa. With an area of 1874 $km^2$ and a capacity of more than 79 billion $m^3$, the Renaissance dam built on the Blue Nile River is primarily intended for the production of electrical energy. With the exception of a few dams with a total capacity not exceeding 4 billion $m^3$, such as the El Wahda dam (Morocco) of 3.9 billion $m^3$, the Beni Haroun dam (Algeria) of 1 billion $m^3$ (Photo. 1) and the El Massira dam (Morocco) of 2.7 billion $m^3$, the hydro technical infrastructure of North Africa with a potential of 300 dams, the unit of which does not exceed 1 billion $m^3$. On the other hand, the Mega dams with a capacity of over 10 billion $m^3$ are located in West Africa and southern Africa, which have large watersheds.

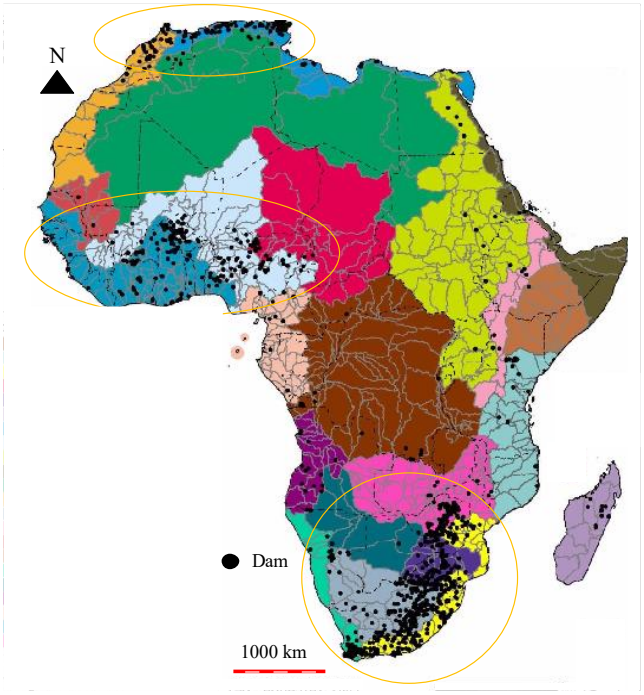


**Figure 2: Africa: International River basins with sub-basin and dam (Source: FAO-AQUASTAT, 2005)**

**Photo 1: The largest dam in Algeria. The Beni Haroun dam with a capacity of 1 billion $m^3$ (Remini, 2014)**

To this end, Africa has 24 long rivers whose length exceeds 1000 km (Atlasocio, 2018). The Nile River holds the first position with a length of 6,671 km followed by the Congo River with 4,700 km long and the Niger River with a length of 4,185 km (Atlasocio, 2018). Africa also has 11 large lakes with a total area equal to 190,000 km$^2$, of which Lake Victoria is ranked 4th in the world and first in Africa with a volume of 2,750 km$^3$, an area of 70,000 km$^2$ and a depth maximum equal to 84 m (Atlasocio, 2017). When it comes to the potential of groundwater, Africa has vast reserves of freshwater underground. Estimated at more than 660,000 km$^3$ (Seguin and Gutierrez, 2015), this water is stored in large underground reservoirs, the majority of which are non-renewable trans boundary aquifers. Numbering 72, trans boundary aquifers occupy 42% of the total area of the African continent (Dien, 2016). Planet Earth has 37 major aquifer systems, 13 of which are located in the African continent (fig. 3) (Demeersan, 2015). Seven aquifer systems are hidden in the subsoil of the Sahara. These are the basins: the Nubian Sandstones, the Northern Sahara, Mourzouk, Senegalese-Mauritanian, Lake Chad, Taoudéni -Tanezrouft and Iullemeden. With this volume of fresh water hidden in the subsoil sheltered from the vagaries of the weather, Africa is sheltered from a water crisis in the near future, especially with the disruption of the climate. Groundwater is the only source that can withstand global warming.

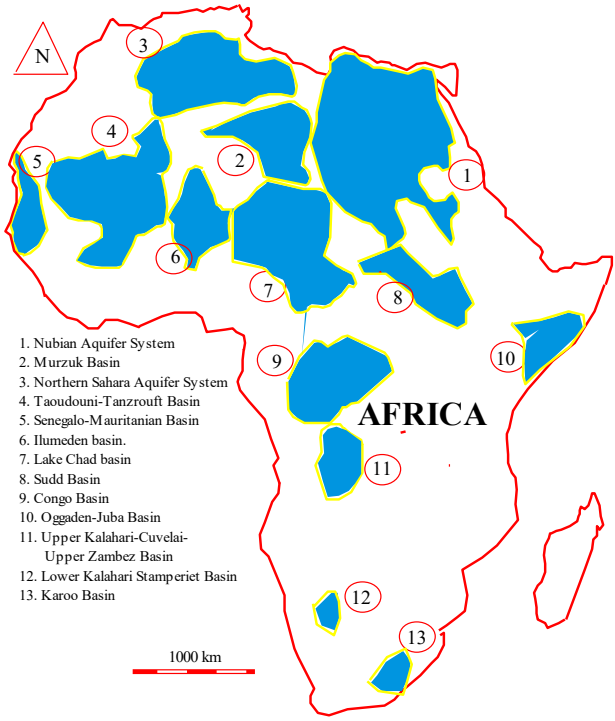


**Figure 3: The largest aquifer systems in Africa (Source IGRAC 2015, modified by the author)**

Thus, in West Africa alone, there are 10 trans boundary aquifers. For example, the Iullemeden/Taoudéni/Tanezrouft basin with an area of 2.6 million $km^2$ shared between 7 countries (Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger and Nigeria) have a flow of 3 to 6 $m^3$/h (Machard De Gramont, 2010; Guyomard et al, 2011; Taithe, 2013; (Seguin and Gutierrez, 2015). Ranked third behind Mali with 41% and Niger with 20%, Algeria has a share of 450,925 $km^2$, or 17% of the total area. The Iullemeden and Taoudéni / Tanezrouft aquifer system is classified as the first largest aquifer in Africa with that of the Nubian Sandstone with the same area equal to 2.6 million $km^2$ (SSO, 2010; SSO, 2017) In North Africa, the Northern Sahara Aquifer System (SASS) is shared between Algeria, Libya and Tunisia.

Two superimposed aquifers; the Continental Intercalary and the Terminal Complex with an area of over 1 million $km^2$. Algeria holds 700,000 $km^2$ followed by Libya of 250,000 $km^2$ and Tunisia with 80,000 $km^2$, with an estimated capacity of 60,000 billion $m^3$ of which 10,000 billion $m^3$ can be exploited (Machard De Gramont, 2010; Seguin and Gutierrez, 2015; Remini, 2010). The Continental Intercalary aquifer, the recharge rate of which has been estimated at 1 billion $m^3$/year. However, the three countries are currently exploiting an amount of 2.2 billion $m^3$/year and by 2030 the flow would be 8 billion $m^3$/year (Taithe, 2013; Guyomard, 2011). The Nubian Sandstone Aquifer System (NSA) is one of the largest reserves of groundwater on the planet. With an area of 2.6 million $km^2$ and a storage capacity of 540,000 $km^3$ of fresh water (Seguin and Gutierrez, 2015). With an average depth of 600 to 1,800 m and can reach 3,500 m in the north, the Nubian Sandstone aquifer system is shared between Egypt, Libya, Sudan and Chad. The depth is on average between 600 to 1,800 m and can reach in the north 3500 m (Taithe, 2013; Seguin and Gutierrez, 2015). In East Africa, the water resources of the IGAD sub-region are shared between 7 countries: Djibouti, Eritrea, Ethiopia, Kenya, Uganda, Somalia and Sudan. The 6 large trans boundary river basins in addition to the Nile basin and 6 trans boundary aquifer systems have a potential for trans boundary water resources estimated at 71.5 $km^3$/year for groundwater and 111 $km^3$/year for surface water for the 6 identified basins. The Murzuk Basin shared between Algeria, Libya and Niger has an area of 450,000 km2. The current operation has been evaluated at 1.7 $km^3$/year. During the last 20 years, the piezometric level of the water table has fallen from 1 to 2 m/year due to repeated droughts (Seguin and Gutierrez, 2015). The Lake Chad Basin is shared between 7 countries: Niger, Nigeria, Chad, Cameroon, and Central African Republic. Covering an area of 1.5 $km^2$, the Lake Chad basin is exploited at 0.25 $km^3$/year (Seguin and Gutierrez, 2015). The Senegalese-Mauritanian Basin, with an area equal to 300,000 $km^2$, is shared between Mauritania and Senegal at a rate of 0.26 $km^3$/year (Seguin and Gutierrez, 2015). What we can learn from this problem contrary to what many people think that the African continent is a land of drought and water shortages, our continent is very rich in water. It is interesting to recall that there are more than 80 trans Boundary River and lake basins, and 72 trans boundary aquifers which represent 42% of the surface area of Africa. These underground water reserves in Africa are more than 100 times larger and correspond to 20 times the fresh water supply of lakes. There are 13 gigantic aquifers like the Grés de Nubie aquifers and the SASS which are veritable freshwater seas. The most important

reserves are found in Libya, Algeria, Sudan, Egypt and Chad. This large number in trans boundary aquifers constitutes a real stake for an equitable development of water resources between neighboring countries. It can also be a parameter of peace between nations if the sharing of this resource is equitable. Yes, Africa is a continent that has underestimated these water resources and especially groundwater. For example, the two Saharan and Sahelian regions which have long been classified as a poor water zone. On the other hand, according to a latest study, the reserves of fresh water stored in aquifers are much greater than what was imagined. As we pointed out at the start, Africa has sufficient water resources, but only 4% of available water is used across the continent. Groundwater, which constitutes 95% of freshwater resources in Africa, is today the safest resource that can cope with global warming.

As we mentioned at the start of this discussion, that only Equatorial Africa and West Africa which are designated as regions of water abundance can be escaped from water shortages in the immediate future. However, North Africa which represents the region of potential scarcity and Saharan and Sahelian Africa which designates the region of water scarcity may be the subject of in-depth research studies by African universities. Unlike Equatorial Africa, where the surface waters are enormous, Saharan and Sahelian Africa has immense quantities of water which are hidden underground in the form of gigantic reservoirs. These are the Northern Sahara Aquifer System (SASS), the Taoudeni-Tanzrouft Aquifer System (SAT), the Iullemeden Aquifer System (SAI), the Murzuk Basin, the Senegalese-Mauritanian Basin and the Nubia Aquifer System. These deep aquifers are considered non-renewable or not very renewable and are shared between several countries. For the Aquifer system of the Northern Sahara, the countries concerned are: Algeria, Libya and Tunisia. The Iullemden -Taoudeni-Tanzrouft Aquifer system is shared between the countries: Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger and Nigeria (Guyomard, 2011). For the Murzuk Aquifer, the countries concerned are: Algeria, Libya and Niger. Today, studies and research must be undertaken by universities and research institutes to better quantify, master and manage water resources in these hyper arid regions of Africa. These are water stored in large transboundary aquifers as well as groundwater and interflow. If today, the SASS is the only aquifer that has been the subject of an in-depth study, the aquifers: Iullemden -Taoudeni-Tanzrouft, the Murzouk basin, the Senegalese-Mauritanian basin, the Nubia aquifer system, the Lake Chad basin have been little studied. The region is distinguished by an imbalance between a supply of water resources increasingly limited by operating conditions and rapidly growing demand. It would be interesting to quantify the SASS with new data. The lowering of the water table should be the subject of research to locate areas of high exploitation. Rigorous monitoring of the pollution and salinity of this groundwater is desirable. Review the flow and determine where to recharge. Locate high potential areas. Development of a common information system: database and Geographic Information System (GIS) (climatology, hydrology, geology, hydrogeology). Regarding the Iullemden-Taoudeni-Tanzrouft basin, we must assess the water potential specific to Algeria. Study and trace the outline of the aquifer. Regularly monitor the quality of the aquifer water. Significantly improve knowledge of water resources. Identify areas with high groundwater potential. Build a

regional database. Address the themes: hydrogeology, land use, groundwater recharge, groundwater piezometry, vulnerability to climate change, groundwater pollution. Regarding the Murzuk Basin, there are no serious studies. In a first study, it would be interesting to draw the boundaries of the reservoirs and assess the available water resources. Rigorous monitoring of water quality is desirable. The regions of Tanezrouft and the north of the Sahel are known by floods and floods which can drain large quantities of water. However, the high temperature values recorded in these regions cause an appreciable volume of water to disappear through evaporation. A study to propose techniques capable of storing this flood water becomes essential. For example, we can offer the technique of artificial groundwater recharge. In this case, the search for favorable sites becomes a necessity. These sites for setting up infiltration basins must take into account the best permeability of the soil.

## CONCLUSION

As we mentioned at the beginning of this article, has the African continent underestimated these water resources? We can affirm that indeed our continent has great water capacities, especially groundwater. Freshwater seas stored in reservoirs had existed for several centuries. These 72 trans boundary aquifer systems occupy an area of 42% of Africa's surface area. This type of aquifer is generally shared between two to 7 neighboring countries. Such a situation can be an asset of peace and fraternity between the countries or on the contrary it can cause tensions between neighboring countries. The technical commissions can play a very important role in proposing a fair and equal sharing between the countries concerned. The case of the aquifer system of the northern Sahara is a good example for other aquifer systems. The majority of these aquifers are classified as low or non-renewable. The problem can be extrapolated into the immediate future when the depletion of aquifers reaches a very advanced stage. One thing is certain; our continent will be able to overcome a water crisis in extreme cases of global warming thanks to the water potential hidden in the subsoil of the continent. How for years it has been thought that the African continent is a continent of thirst and water scarcity. But in reality, Africa is a continent which has large reserves of water and more particularly invisible (underground) water. It will be able to withstand climatic warming.

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