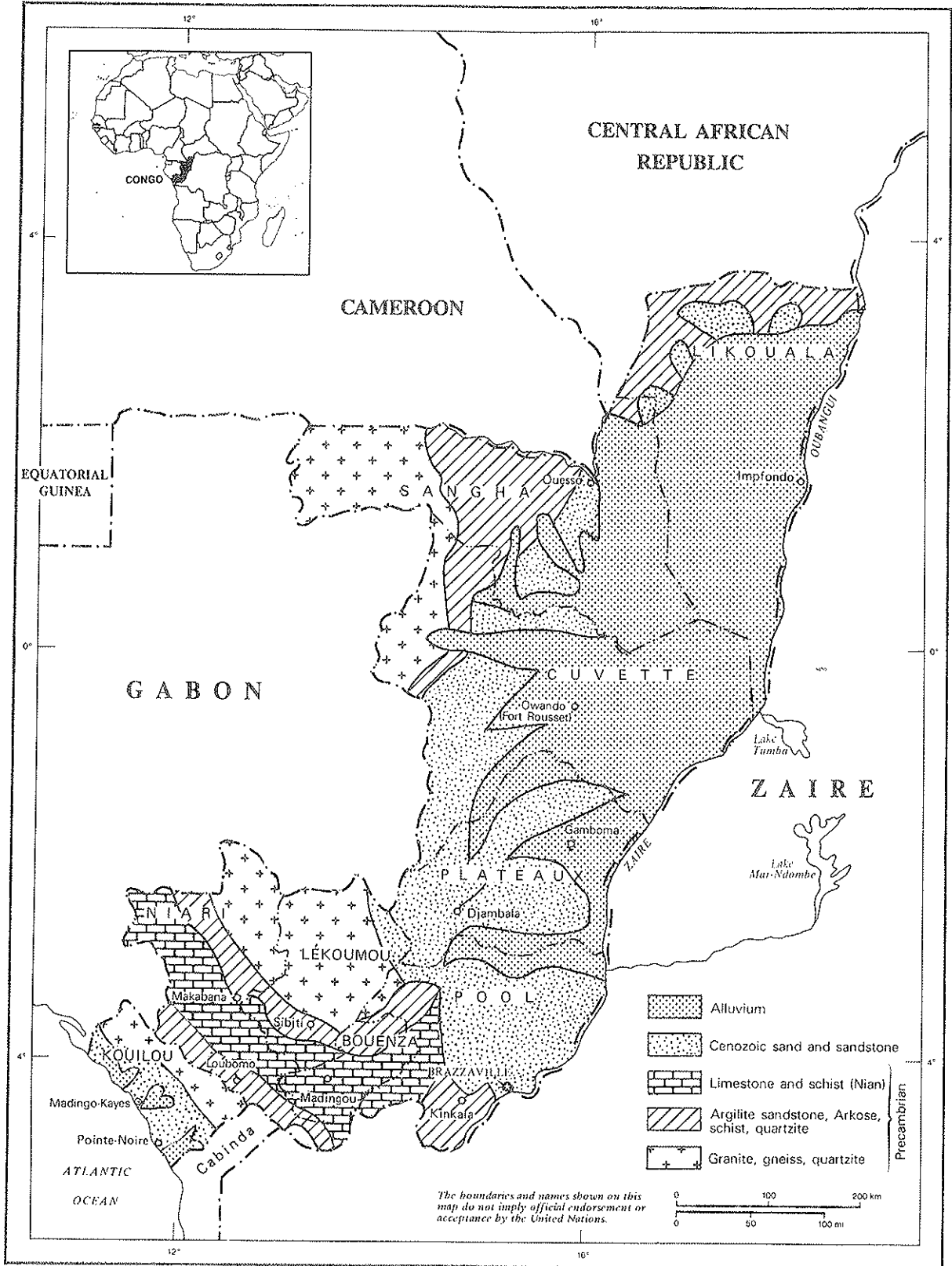


MAP 6. CONGO — GENERAL MAP



MAP NO.3484.4 UNITED NATIONS
MARCH 1988

CONGO

Area: 342,000 km²
Population: 1.7 million

I. BACKGROUND

Relief

The People's Republic of Congo is situated on the equator, north-west of the basin of the Zaire River, with in its centre the mountains and plateaus which separate the Congo Basin from the Atlantic Ocean. The country has three types of relief.

Plains

The plains include first the Congo Basin drained by the Zaire River and occupied mainly by flooded forest where the average altitude is 200 to 400 m. Next comes the Niari valley which extends into the Nyanga depression. This depression lies between two mountain ranges, the Mayombe mountains and the massif of Chaillu, and extends eastwards between the plateaus of Bembé and the Cataractes; it is covered mainly with savannah and its altitude ranges from 0 to 400 m. Lastly, there is the rectangular low-lying coastal plain (0 to 200 m) running for 170 km between the Atlantic Ocean and the Mayombe mountains, with an average width of 50 km.

Hills and plateaus

The hills and plateaus enclose the basin and extend south and west of Brazzaville. The Oubangui plateaus, 600 to 800 m above sea level, end north of the Likouala region.

The plateaus of the north-west are divided by the Lengoué and Mambili Rivers into a series of chains of hills and a lower and more complex area towards the west containing swampy valleys, hills and a isolated mountain, Congo's highest point: Mt. Nabemba at over 1,000 m.

In the centre there is a vast area of sandy hills dominated by four plateaus (Koukouya, Djambala, Ngo or Nsah, and Mbé) constituting the Batéké country. Here the average altitude is 600 to 800 m.

Sand-sandstone plateaus, most of them eroded into hills, are found again south of Brazzaville and around Mouyondzi (Bembé country); these are the Bembé and Cataractes plateaus.

Mountain area

The Mayombe range is covered with low forest and has its highest point at Mt. Mbamba (810 m). The massif of Chaillu is a forested mountainous region rising to over 900 m (Birougou mountains).

Climate

Congo is situated in the equatorial zone and has two periods of maximum rainfall (March/April and October/November); there are three main climatic zones:

- Equatorial zone

In the north of the country (Sangha and Likouala) it rains throughout the year, with only two less rainy periods from December to February and in July. It is always very humid. The average annual rainfall in this zone varies from 1,000 to 2,000 mm, with the maximums at Ouessou, Impfondo and Dongou.

- Wet tropical zone

In the south-west the rainy season lasts about eight months (October-May) with a main dry season of three to four months from June to September. The rains are intermittent in January and February. The average annual rainfall is in the order of 1,000 to 2,000 mm, with the minimum in the Niari valley (850 mm) and the maximum north of the massif of Chaillu (2,000 to 3,000 mm).

- Sub-equatorial zone

The central regions of the country have a climate which lies between the two previous ones. The average annual rainfall ranges from 1,500 to 2,000 mm. The Batéké country has heavier rainfall (2,000 to 3,000 mm) towards the frontier with Gabon.

Like the total rainfall, the effective precipitation is large. This is because the runoff, which is confined to rain falling directly on the surface of the rivers and on the occasional impermeable formations, is extremely small, and the vegetation and surface alteration of the rocks facilitate the immediate absorption of rainwater.

The real evaporation is relatively high in Congo, for the temperature remains fairly high throughout much of the year and the vegetation cover is abundant.

The data observed by ORSTOM over 16 consecutive years (1955-1970) and recorded on the water resources planning map of Gabon and Congo highlight the following features:

- The effective precipitation ranges from 750 to 1,250 mm in the coastal basin, with a total rainfall of 1,250 to 1,750 mm;
- In the Niari valley the effective precipitation is 200 to 750 mm for a total rainfall of 1,250 to 1,500 mm. The highest levels occur in the Batéké plateaus towards the Gabonese frontier, with effective precipitation of 1,000 to 1,250 mm and an average rainfall of 2,200 to 2,250 mm.

From the Congo Basin northwards the effective precipitation ranges from 250 to 750 mm and the total rainfall is 1,500 to 1,750 mm.

The average annual temperature for the whole country is around 25 °C.

Geology

Congo has formations of very different ages.

The Precambrian (from earliest times to 580 million years ago). These are the oldest formations. They occur in the massif of Chaillu and in western Sangha (granite basement rock), in the Mayombe mountains (metamorphized and folded formations), and in the Niari valley (sub-horizontal sedimentary formation).

The Paleozoic is not represented.

The Mesozoic (from 230 to 70 million years ago). These formations are found along the banks of the Congo and its tributaries in Pool and in northern Likouala.

The Cenozoic (70 to 2 million years ago). Found in the coastal plains and the Batéké plateaus.

The Quaternary (2 million years ago to the present time). This period is represented by alluviums (Recent deposits) along the coast and especially in the Congo Basin.

Surface water

Owing to its climate, Congo has a large hydrographic system consisting of many rivers distributed between two main basins: the Congo in the centre and north and the Kouilou-Niari in the south-west. There are also the small coastal basins (Loémé, Nombi, Ngongo) and the upper part of the Nyanga and Ogooué basins. The largest basin, that of the Congo, covers an area of 3,475,000 km² and extends over several States (Central African Republic, Zaire, Angola, Congo, etc.). The large input of rainfall in the rainy season and of ground water ensures that the main watercourses flow throughout the year. The flow variation for different basins and the volume of the ground-water input (up to 85 % of the average annual flow for some watercourse) indicate the decisive influence of the lithological characteristics of the basins.

The hydrological data for the Congo's main watercourses are listed in the table below. The source of these data is ORSTOM, Brazzaville, May 1984.

If the average interannual flow calculated for an area of 157,000 km² is extrapolated to the whole country (342,000 km²), 600 million m³ of water a day flow from Congolese territory.

II. GROUND WATER - ORGANIZATION OF STUDIES

Bodies and organs concerned

The present knowledge of the Congo's ground-water resources is based on various climatic, hydrologic and geologic observations made by specialized international and national bodies.

The Ministry of Planning is responsible for co-ordination of the sector through its service for drinking-water supply and sanitation planning.

The Department of Agricultural Engineering and Farm Machinery (DGRMA) is responsible for hydro-agricultural development and in 1984 it provided the administrative follow-up for the village water supply drilling project in the Niari valley carried out under German-Congolese co-operation.

The National Water and Energy Corporation (SNDE) is responsible for supplying water to the urban centres. It has researched and implemented several projects. The resources harnessed have usually been surface water, with the exception of the Pointe-Noire water supply, where part of the requirement is met by tapping ground water in the coastal basin.

Hydrological characteristics of some watercourses of the people's Republic of Congo

Watercourse	No. of station and location	Area of catchment basin (km ²)	Interannual averages					Minimum flow Q _m (m ³ /s)	Maximum flow Q _m (m ³ /s)
			Flow (m ³ /s)	Specific flow (l/s/km ²)	Water layer (mm)	Water loss (mm)	Flow coefficient (%)		
<u>Zaire catchment basin</u>									
Congo	1. Brazzaville	3,475,000	42,900	12.3	390	1,160	25	23,200	76,200
Foulakary	3. Kimpandzou	2,980	46	15.4	486	954	33.8	3.25	470
Djoué	6. Kibossi	5,365	123	23.0	726	826	46.8	63.1	500
Léfini	7. Bwambé	13,500	428	31.7	999	918	52.1	341	670
Nkéni	8. Gamboma	6,200	207	33.4	1,053	802	56.8	151	240
Alima	9. Tchikapika	20,070	593	29.5	931	947	49.6	370	814
Komo	11. Olombo	1,870	24.9	13.3	419	1,404	23.0	6.53	86.6
Likouala-Mossaka	15. Ntokou	46,000	743	16.2	509	1,024	33.2	365	2,600
Kouyou	17. Linnegué	10,750	237	22.0	695	1,059	39.6	74.6	674
Ngoko	23. Tsongo	1,545	37.4	24.2	763	1,026	42.6	17.6	99
Mambili	27. Yenko	12,000	189	15.8	496	1,204	29.2	55.4	503
Sangha	28. Ouesso	158,350	1,698	10.7	338	-	-	-	-
Likouala aux herbes	32. Epena	11,300	85	7.52	237	1,421	14.3	20.7	269
<u>Kouilou-Niari Basin</u>									
Kouilou	38. Sounda	55,010	926	16.8	530	951	35.8	179	4,090
Niari	40. Kibangou	48,990	838	17.1	539	694	43.7	159	9,550
Ndouo	46. Moukono	3,384	77	22.8	717	905	44.2	21	305
Bouenza	54. Niambou	4,920	112	22.8	717	893	44.5	36	396
<u>Coastal Basin</u>									
Nyanga	69. Ndonguila	5,800	215	37.1	1,168	601	66	38.2	812
Loéné	72. Bilinga	1,650	-	-	-	-	-	-	-

In February 1984 a drinking-water supply unit was established in the Ministry of Mines and Energy to study and prepare works projects designed to improve the water supplies available to the people, and to organize a documentation centre. This organ operates under Franco-Congolese co-operation.

The recent creation of the Ministry of Energy and Water Supply (August 1984) ought to facilitate the co-ordination of administrative activities in the study, exploitation and management of Congo's water resources.

Hydrogeological works and research

Ground-water research is very fragmentary and only a few studies are so far available, dealing with:

- The water supply of the town of Pointe-Noire (1953);
- Potash research;
- Private sounding and drilling (Kronenbourg Brewery);
- Works carried out by Agricultural Engineering in the early 1960s, much of the documentation on which is unfortunately lost;
- Drilling at Loudima;
- Sounding and drilling on the Koukouya plateau (Ntchoumou);
- Data from the study on the Mpama dam;
- Site study of the Imboulou dam;
- Drinking water supply on the Koukouya plateau (by the Soviet Union in 1967);
- The Batéké plateaus (CIEH study);
- Sheep farming on behalf of FAO (ASTIER 1982).

In addition, BRGM has published with CIEH financing a first summary document on surface and ground-water resources: the water resources planning map of Gabon and Congo (1982).

The drinking-water supply unit is at present producing an inventory of the conditions of village water supply in the Plateaus, Pool and Bouenza regions.

Personnel, training and equipment

The national corps of personnel is few in numbers, but agricultural, hydraulic and civil engineers are working in the water sector.

Training activities have begun in the drinking-water supply unit, but it is ineffective owing to lack of resources.

Prospecting equipment is available for electrical geophysical sounding and interpretation of aerial photographs.

III. AQUIFERS

The country has two categories of formation: more or less porous and fissured sedimentary formations containing extensive aquifers and covering four-fifths of the territory; and crystalline and crystallophylian formations where the aquifers are of only local size.

1. Widespread aquifers

Coastal basin: 6,000 km²

The Congo's sedimentary coastal basin is the best known area as a result of research drilling for oil, potash and water. It rests on the Lower Precambrian massif of Mayombe and includes, from the surface downwards, the following series:

- Sandy to sandy-argillaceous series (50 to 200 m);
- Series of cirques: more or less sandy clays and argillaceous sands (0 to 150 m);
- Coarse ferruginous sands (0 to 100 m);
- Dolomitic sandstone clay series;
- Dolomitic-limestone series (60 to 400 m).

In this region 44 potash exploration holes have been drilled, in addition to a guide hole, numbered K 1 to K 43 and SG 1, together with an oil exploration hole "MENGO 101" (M 101).

The following results were obtained from testing of the four potash exploitation holes.

Hole	Depth tested (m)	Maximum estimated yield (m ³ /h)	Salinity (g/l)
K 28	240.50 - 270	14.4	0.805
	240.50 - 270	16.5	0.77
	273.66 - 298	19.0	3.64
	298.00 - 307	Nil	
K 29	246 - 277	10.8	-
	246 - 277	13.0	-
	280 - 304	10.8	14.7
	309 - 325	Nil	-
K 30	320 - 348	7.92	0.56
	348 - 372	14.4	0.35
	372 - 395	Nil	-
SG 1	266 - 285	Imprecise	1.1

Note: These yields are only indicative. The salinity is expressed in NaCl equivalent.

Stanley Pool series

This series is located at Brazzaville and rests on the sandstone of the Inkisi series; it includes:

- A lower stratum of red argilites with sandstone seams and sandy marls (10 m);
- A middle stratum of compact white sandstones;
- An upper stratum of yellow kaolinic sandstone.

Batéké plateaus series (105,000 km²)

- At the base: polymorphic sandstones (300 m);
- At the summit: sandy silts (40 to 90 m).

There are apparently very few installations for tapping the ground-water aquifers: there are a few wells and boreholes 20 to 30 m deep on the plateau of Maya-Maya airport at the western edge of the town of Brazzaville. Two boreholes and five wells have been installed on the Koukouya plateau, near the south-east corner of Gabon. The Tchoumou borehole, 303 m deep, was drilled in 1960; its water stabilizes at 250 m and the yield is about 6 m³/h, with 20 to 25 m of drawdown.

The presence of perched aquifers has been indicated by five installations (3.35 to 67 m in depth) with little or no yield. The presence of these aquifers is also indicated by small springs flowing from the side of the rocks.

Two boreholes were drilled and eight soundings were made in the valley of the Mpama and its tributary, the Abili; one borehole in the Mary valley and two others and a well in the southern part of the Mbé plateau; five soundings at the Imboulou site in the Léfini valley.

The data provided by these works are very uneven. Nevertheless, the permeability of between 0.7 and 5.10⁻⁵ m/s in the sandy formations is worthy of note.

Congo Basin

Here sands and silts cover immense areas of swamp (400 m). The sedimentary series overlying the basement rock is up to 4,000 m thick.

Upper Precambrian (45,000 km²)

This formation includes six series:

- Inkisi series (south-west of Brazzaville - 700 m):
 - A base conglomerate consisting of coarse arkoses with quartz pebbles and various rocks;
 - A lower stage: arkoses with white mica;
 - An upper stage: siliceous or micaceous sandstones.

- Mpioka series from the massif of Chaillu to Djoué:
 - A base conglomerate: various elements in a sandstone-limestone cement (30 m);
 - A lower stage: sandstones, microsandstone argilites, arkosic sandstones;
 - An upper stage: siliceous or micaceous sandstones.
- Schist-limestone series which occupies the Djoué valley in the south-east of the country as far as Gabon. This series is 700 to 1,000 m thick.
 - It consists mainly of carbonated rocks: at the base - dolomites, marly limestones and marls, oolitic and stromatolithic limestones;
 - At the upper level - argillaceous sandstones, sandstones and argilites.

In this series the paths of the watercourses are determined by numerous tectonic features running north-west/south-east and north-east/south-west and the karstic features which frequently affect the rocks. These two factors determine the movement of the ground water.

The results of drilling operations indicate average to high permeability. The specific yields indicated in the same formations in Gabon in about 20 holes vary from under 0.5 m³/h.m to 24 m³/h.m. The borehole on the Télémine plateau at Loudima has delivered 16 m³/h with hardly any drawdown. The boreholes drilled under the KFW project had the following characteristics:

Depth	20 to 70 m
Static level	6 to 35 m
Specific discharge	0.01 m ³ /h.m to 18 m ³ /h.m

- Upper tillite series of the Lower Congo

This is a non-stratified formation with a clay-sandstone and calcareous base with clay intercalations (170 m).

- Bouenza and Louila series

The Bouenza series outcrops on the north-east slope of the Niari syncline forming a strip 400 km long and 15 to 50 km wide. It rests directly on the Chaillu granitic complex. Its thickness varies from 100 to 230 m. It consists of argilites at the base, followed by feldspathic sandstones, limestones or marly argilites and marls, and finally calcareous sandstones.

The Louila series is the counterpart of the Bouenza series in the south-west of the Niari syncline. It outcrops only in the Mayombe mountains, intercalated between the upper and lower tillite. Its thickness varies from 650 to 1,000 m. It includes, from base to summit:

- Predominant clay deposits, microsandstone argilites, lenses of feldspathic quartzitic sandstones and secondary marls;

- Calcareous marls, argilites and sandstones;
- Coarse arkosic sandstones and argilites followed by marly limestones.
- Lower tillite series of the Lower Congo

This series in the south-west of the Congo Basin consists of black argillaceous schists and slates. Feldspathic sandstones are found here (150 to 500 m).

2. Discontinuous aquifers

The granitic and metamorphic rocks of the Middle and Lower Precambrian cover about 20 % of the territory of Congo.

The Middle Precambrian is represented in the south-west of the country in the Mayombe mountains and in the north, where it occupies the upstream part of the basins between Likouala and Ngoko. It is represented by pelites, ampelites, sandstones and dolomites of poor overall permeability.

IV. PHYSICAL, CHEMICAL AND BACTERIOLOGICAL PROPERTIES

Although they are insufficient in number and despite their many gaps and disparities (depending on their origin), the results of the 27 analyses of ground water (boreholes, wells, springs) do provide information about the quality of the waters.

The water of the schist-limestone formations has an average mineral content of between 350 and 500 mg/l; it is of average hardness (TH of 25 to 30 °F) and its pH is 7 or higher.

The water of the coastal basin has a low overall mineral content, below 250 mg/l; it is fairly sweet (TH from 14 to 19°) and its pH is close to 7. The chloride and sulphate concentrations vary between 2 and 80 mg/l.

The water of the other aquifers has a low mineral content and its pH is always below 6.5.

The bacteriological results show that the spring water is always of satisfactory bacteriological quality.

The well water, which is usually drinkable at source from the bacteriological standpoint, is subject to pollution.

Quality of ground water - physical and chemical analysis

Aquifer or lithology:	Coastal basin sand + sandstone	Batéké country	Upper Precambrian sandstones	Schist- limestone	Upper Precambrian schists	Middle Precambrian sandstones and schists	Lower Precambrian sandstones	Granite
No. of observations:	7	7	1	3	2	1	1	5
pH:	6.3 - 7.2	5.3 - 6	6.6	7 - 7.8	5.4 - 6	6.5	5.9	5.8 - 6.2
Température:	-	25.5	21	-	21 - 23	-	23	22 - 23
Resistivity	-	11,000	-	-	-	-	-	-
RS 110 °C mg/1	180 - 236	50 - 158	-	372 - 496	-	-	-	-
RS 500 °C mg/1	139.5	-	-	-	-	-	-	-
THF dF	13.9 - 19.2	0.1 - 1	2.2	24.8 - 30.4	0.4 - 2	3.8	1.1	0.6 - 4.1
TA mg/1	0	-	0	-	0	0	0	0
TAC mg/1	13.7 - 20	0.25 - 5	2.4	-	0.4 - 0.7	1.5	1.1	0.5 - 0.9
Free CO ₂ mg/1	12.2	13.4 - 30	-	-	-	-	-	-
Nat. org. KMn O ₄ mg/1	0.1 - 0.2	-	-	-	-	-	-	-
Si O ₂	19	31	-	-	-	-	-	-
Ca ++ mg/1	23.2 - 44.4	3.8	6	54.5 - 110	1.2 - 4	8	3.2	1.6 - 7.2
Ng ++	17.8 - 28.5	1.4	1.7	127 - 52.6	0.25 - 2.4	4.3	0.7	0.55 - 8.2
Na ++	1.5 - 5.4	-	-	2.7 - 3.5	-	-	-	-
K +	3.8 - 5.5	1.7	-	2 - 2.2	-	-	-	-
NH ₄ +	0 - 0.0025	-	0.2	-	0	0.1	0.4	0.01 - 0.65
Fe + total	0 - 2	0	0	-	0.3	-	0	0
Mn ++	Traces	0	-	-	-	-	-	-
Al +++	-	-	-	-	-	-	-	-
HCO ₃ mg/1	82.5 - 111	-	-	280 - 372	-	-	-	-
Cl	6.4 - 80	2 - 4	4	2.13	2 - 7	16	2	2 - 5
So ₄	2.4 - 50	Traces - 3.84	4	7 - 38.4	0 - 5	3	2	0 - 5
No ₃	Traces	-	0.4	0.5	0.5 - 0.8	4.5	0.8	0.2 - 0.8
No ₂	0	-	0	-	0	0.12	0	0 - 0.4
F	Traces	-	0	0.3	0	0	0	0
Po ₄	0	-	0.8	0	0	0	0	-

V. EXPLOITATION OF THE GROUND WATER

Little is known about Congo's ground water, for there is little demand for it, owing mainly to the relative abundance of easily accessible surface water.

In order to provide a water supply for the town of Pointe-Noire, the African Public Services Company (CASP) had to drill three wells in addition to tapping the surface water which constitutes the main resource. These three boreholes are at present exploited by the National Water Distribution Corporation (SNDE) which is now completing the tapping installations with new boreholes. Apart from the Pointe-Noire boreholes, other boreholes are exploited by private entities such as the Kronenbourg Brewery, also at Pointe-Noire. There is no governmental service specializing in the exploitation of boreholes as such, and the most recent boreholes, drilled by the German company Wild on behalf of Agricultural Engineering, will certainly be exploited by one of the services of the Ministry of Rural Equipment and Supply and Co-operative Activities, which was created in August 1984. The Pointe-Noire boreholes were drilled by FORAMINE for the Kronenbourg Brewery and by SASIF for CASP.

Two village programmes are being executed:

- The FRG-KFW programme which consists of 80 boreholes equipped with hand-operated pumps in the Niari region (Kayes-Kimongo-Loudima-Makabana sector);
- The drinking-water supply programme which is at the inventory stage prior to the determination of a first programme of installations.

Much of the country has been covered by a team, as part of these programmes, notably the Plateaus and Pool regions. Inventories of water points and conditions of water supply usually constitute the basic data for the design of the future project. Many electrical reconnaissance soundings have been made during these campaigns.

The basic aim of these two programmes is to improve water supplies in rural areas.

The details of the exact situation with respect to current water supplies in the villages will gradually be established as a result of the surveys which have been under way since April 1984 as part of the drinking-water supply programme carried out by the unit established in March 1984 in the Ministry of Energy and Water Supply, with the financial assistance of the Fonds d'aide et de coopération (FAC) of the French Republic.

VI. CONCLUSION

The importance attached up to now to the tapping of surface water to supply the people has been matched by almost total neglect of the resources of ground-water aquifers. The opportunity of easy exploitation which these aquifers might offer has not been taken up. The cost price of a cubic metre of water drawn off cannot be assessed from the small number of boreholes in operation.

The condition of water supply in the villages are not satisfactory. The surface water used is almost always of defective bacteriological quality and causes a high morbidity rate in rural areas. It is in order to correct this situation and improve living conditions in the villages that the Congolese Government, with the aide of the

French Republic, has begun the first drinking-water supply programme. The recent establishment of the Ministry of Energy and Water Supply indicates the determination of the country's authorities to develop the water-supply sector.

Favourable climatic factors and abundant ground-water aquifers with good recharge are major assets which can form the basis for a water-supply policy which will improve the people's living conditions and health, developments which are essential indeed for the harmonious advancement of Congolese society.

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