

## ZAIRE

Area: 2,345,400 km<sup>2</sup>  
Population: 31 million

### I. BACKGROUND

#### Physiography

The centre of the country consists of a depression covering 750,000 km<sup>2</sup> and ranging in altitude from 340 to 700 m above sea level.

This basin is bounded in the north by the watershed of the Oubangui River, in the east by the mountain ridge which marks the edge of the African Rift, in the south and south-east by the Kasai and Shaba plateaus, and in the west by the Mayumbe hills. The landscape is tranquil, consisting of broad steep-sided valleys set between very flat interfluves in the south-east and regular dry terraces with abrupt walls in the west. The limit of the depression corresponds almost exactly with that of the equatorial forest.

The Kasai plateaus are about 1,000 m above sea level and covered with wooded savannah intersected by areas of forest.

The high plateaus of Shaba are between 1,400 and 2,000 m above sea level and are covered with thinly wooded savannah. The Mayumbe hills are 750 m high on average and form a system of hills linked by narrow cols with a tangled network of valleys. These hills carry a continuation of the great Gabonese forest with its various species.

The mountain ridge in the east, which is between 2,300 and 3,800 m above sea level, marks the edge of the Great African Rift, 1,400 km long and 40 km wide. This trench contains Lakes Tanganyika, Kivu, Idi Amin and Mobutu.

The coastal area around Banana (Atlantic Ocean) consists of either low areas and vast sandy beaches, or cliffs.

#### Climate

The country is crossed by the equator. The average annual temperature is 25 °C at the coast, and 24-25 °C in the north, the central basin, North-Shaba, Kasai, Kinshasa and Bas-Zaire. In the mountainous regions of the east where the altitude is higher, the average annual temperature is 19-20 °C. The highest average temperatures occur in March or April in the north of the country, the central basin and Bas-Zaire, in September in southern Kasai and North-Shaba, and in October in South-Shaba. The annual temperature range is generally very small: 2 °C between the hottest and the coldest months. But the daily range is high in the low regions: 9-11 °C in the wet season.

Owing to the cloud cover, the equatorial region has less sunshine (2,000 hours a year) than the tropical regions (2,700 hours a year in southern Shaba). The maximum sunshine occurs in the dry season: 225-250 hours a month in January in the north and 300 hours in July in the south. The minimum occurs in the rainy season: 150 hours in July and August in the north and 125 hours in January in the south.

The country is traversed by four types of airflow:

- The south-west current or Atlantic monsoon is cool wet air flowing at altitudes below 1,500 m. This current is the main source of humidity;
- The very hot and dry north-east prevailing wind blows from the Sudan during the northern dry season;
- The cold dry south-east prevailing wind blows during the southern dry season;
- The eastern equatorial flow, which is hot and dry, comes from the Indian Ocean and is virtually permanent above 4,000 m.

The annual precipitation is over 1,200 mm for the whole country. The centre of the basin receives more than 2,000 mm and the rainfall declines with distance from the equator. The maximum rainfall occurs on the western slopes of the eastern mountains and the minimum at the coast (Banana - 840 mm).

Zaire has two seasons: the rainy season which runs from September to June in the south and from February to November in the north; and the dry season in December and January in the north and June and July in the south.

The maximum humidity (over 85 %) occurs in the central basin and declines with distance from the equator. It ranges from 70 to 80 % in the mountain regions.

#### Hydrography

The Zaire River which crosses the country drains all the surface water. It is 4,700 km long and its basin covers an area of 3,822,000 km<sup>2</sup>; it is thus the largest basin in Africa and the second largest in the world after the Amazon River (6,300,000 km<sup>2</sup>). The basin extends on both sides of the equator and occupies the central part of the African continent.

The main tributaries of the Zaire are:

- Left bank: Lubudi, Lomami, Lulonga, Ruki, Kwango, Kasai;
- Right bank: Lufira, Luvua, Lukunga, Luana, Ella, Ulindi, Lowa, Malko, Lindi, Aruwimi, Itimbiri, Mongala, Oubangui, Sangha, Aftma, Foulakary and Djue.

The flow of the Zaire River has been measured at several points:

Banana:	40,684 m <sup>3</sup> /s
Kinshasa:	38,844 m <sup>3</sup> /s
Kisangani:	6,378 m <sup>3</sup> /s
Bukama:	322 m <sup>3</sup> /s

Most of the rivers of the central basin are navigable. At the edges of the Zaire basin the rivers have waterfalls where dams have been constructed for hydroelectric power stations.

Table 1

## Flow of the basin's main rivers

River	Measuring station			Period of observation (since)	Mean annual flow 1950-1959 (m <sup>3</sup> /s)	Total average annual flow 1950-1959 (mm)
	Name	Longitude	Latitude			
1. Zaire River	Bukama	25° 51' 35" E	9° 11' 35" S	1933 -	322	161.14
2. Zaire River	Kindu	25° 55' 45" E	2° 57' 10" S	1912 -	2,213	86.08
3. Zaire River	Kisangani	25° 11' 30" E	0° 30' 20" N	1907 -	6,378	206.58
4. Zaire River	Kinshasa	15° 18' 30" E	4° 17' 45" S	1925 -	38,844	327.08
5. Zaire River	Boma	13° 03' 00" E	5° 51' 30" S	1915 -	40,684	335.87
6. Inkisi	Inkisi (bridge)	15° 04' 05" E	5° 07' 45" S	1949 -	-	-
7. Foulakary	Kimpanzu	14° 56' E	4° 36" S	1950 -	54.5	570.74
8. Kasai	Ilebo	20° 34' 55" E	4° 20' S	1922	2,240	303.94
9. Kasai	Kutu Moke	17° 20' 45" E	3° 11' 50" S	1932	8,790	376.50
10. Kasai	Lediba	16° 33' 25" E	3° 03' 25" S	1932	11,318	406.50
11. Kwanko	Bandundu	17° 22' 15" E	3° 17' 55" S	1929	3,299	396.02
12. Oubangui	Bangui	18° 35' 45" E	3° 21' 30" N	1911	4,024	253.98
13. Sengha	Onesso	16° 05' E	1° 39' N	1947	1,763	351.69
14. Itimbiri	Aketi	23° 50' 20" E	2° 42' 45" N	1928	356	353.88
15. Shari	Budana	30° 09' 35" E	1° 35' 55" N	1937	33	250.63
16. Lomami	Opala	24° 21' 10" E	0° 36' 10" S	1917	2.98	429.37
17. Lukunga	Kalemie (bridge)	28° 12' 10" E	5° 54' 40" S	1952	-	-
18. Ruzizi	Bukavu	28° 53' 32" E	2° 29' 25" S	1950	-	-
19. Luvua	Kiambi	28° 00' 45" E	7° 20' 15" S	1935	669	85.96
20. Luapula	Kasenga	28° 36' 55" E	10° 21' 35" S	1934	616	119.96
21. Lufira	Kapolowe	26° 57' 40" E	11° 02' 40" S	1920	49	190.72

## Geology

Zaire has two large geological systems separated by a discontinuity and/or major hiatus: the non-metamorphic surface formations have remained horizontal and are generally fossiliferous, dating from the Upper Carboniferous to the Holocene; the formations of the Precambrian basement are variously metamorphized and folded. The country also has the following "geological zones":

- A coastal zone between the Atlantic Ocean and the Mayumbe hills with marine formations of Cenozoic and Cretaceous age;
- The central basin which contains deposits of Mesozoic and Cenozoic age;
- The edge of the Precambrian formations, subdivided into four tectonostratigraphic units.

The formations of each of these zones are variously covered wholly or in part by:

- Recent formations with various facies;
- The "ochre sands" series and the "polymorphic sandstones" series which extend over vast areas of the southern half of the country.

## II. GROUND WATER - BACKGROUND

The following are the government services and other organizations concerned with water resources in general:

Department of Mines and Energy: drinking water and hydroelectric power;

Department of Agriculture and Rural Development: drinking water in rural areas, irrigation water, drainage;

Department of the Environment: drinking water quality;

Department of Transport and Communication: navigable waterways;

National Action Committee for Water and Sanitation.

The government services specializing in ground-water study and evaluation are: REGIDESO, the Faculty of Sciences, the Department of Geology at Lubumbashi, the Geological and Mining Research Centre (CRGM).

Zaire has not so far carried out any systematic hydrogeological prospecting; the only hydrogeological data are those produced by mineral prospecting in the various regions of the country and they have been used only to make good the shortage of surface water, especially in the regions where intense drought causes rapid evaporation. More recently, ground water research has been carried out in several places with a view to supplying the people with drinking water. This is the case of the main urban areas, which are found both in the central basin (for example, Boende, Lisala, Basankusu, etc.) and in the areas where the Precambrian formations consist essentially of limestones (Mbanza-Ngungu, Likasi, Lubumbashi).

The research methods used have been interpretation of aerial photographs and of the results of drilling for minerals, and to a lesser extent geophysical prospecting.

Table 2

Description of existing wells in Zaire  
Consolidated and non-consolidated sedimentary formations

No.	Location	Geographic co-ord.		Aquifer Formation	Thickness (m)	Depth of well (m)	Hydraulic properties			
		Longitude	Latitude				Specific yield: m <sup>3</sup> /h per m of drawdown	Permea- bility K (m/d)	Transmis- sivity T (m <sup>2</sup> /d)	Storage coefficient S (%)
1.	Mbanza-Ngu (F1)	14° 50' E	5° 16' S	Precambrian karstic fissured limestone	82.5	152	11	1.583	130.6	0.3 x 10 <sup>-5</sup>
2.	Mbanza-Ngu (F2)	14° 50' E	5° 16' S	<u>Idem</u>	45	117	12	3.072	138.2	0.3 x 10 <sup>-5</sup>
3.	Kikwit (P3)	18° 49' E	5° 18' S	Cretaceous soft sandstones with layers of argilites		160	4	1.296	129.6	6.5 x 10 <sup>-4</sup>
4.	Kikwit (P6)	18° 49' E	5° 18' S	<u>Idem</u>		201	3.1	0.604	103.68	2.6 x 10 <sup>-4</sup>
5.	Moanda	12° 22' E	5° 56' S	Coarse sands	10	93.8	1.52	8.64	86.4	5 x 10 <sup>-4</sup>
6.	Likasi (Kikula)	26° E	10° S	Precambrian dolomitic limestones	40	202	3.3	-	-	-
7.	Luiza	22° 30' E	7° 11' S	Precambrian coarse sands and clay gravels	15	94	0.1	-	-	-
8.	Bolobo	16° 14' E	2° 9' S	Fine to coarse white sands	7	38	6.8	5.69	39.83	1.65 x 10 <sup>-3</sup>
9.	Ikela	23° 10' E	0° 1' 10" S	Clay sands and sandy clay	13	53	6.45	16.615	216	3.8 x 10 <sup>-4</sup>
10.	Luebo	21° 22' E	5° 22' S	Sands and gravels	3	20.5	10.08	36.67	290	0.1

N.B. This list is not exhaustive as it is not possible to list the properties of all the wells in Zaire.

On the basis of the interpretation of aerial photographs the National Welfare Fund (FBI) carried out a vast well-drilling programme with a view to supplying drinking water to the rural centres in the plateaus region.

The following water-bearing formations have been identified:

Coastal zone: Residual sands of sublittoral sandstones, granitic sands north of Boma.

Central Basin: Lateritic gravels, fine to coarse sands, soft fine to coarse sandstones. The aquifers in the sandstone are situated at great depths below the Kwango plateaus.

Precambrian formations: Sand-clay alluviums in the shallow strata; dolomitic limestone formations in the karstic strata.

REGIDESO is currently carrying out feasibility studies of several locations in the country with a view to supplying them with drinking water. These studies are carried out either by REGIDESO's own personnel or by consulting engineers. They are available for inspection at REGIDESO.

In most of the locations it is ground water which is selected as the resource to be developed. The implementation of the water-supply projects will provide an opportunity for acquiring more detailed knowledge of ground-water.

### III. EXPLOITATION OF THE GROUND WATER

REGIDESO is responsible for the development of ground water to supply urban dwellers. It has the following general organization and structure:

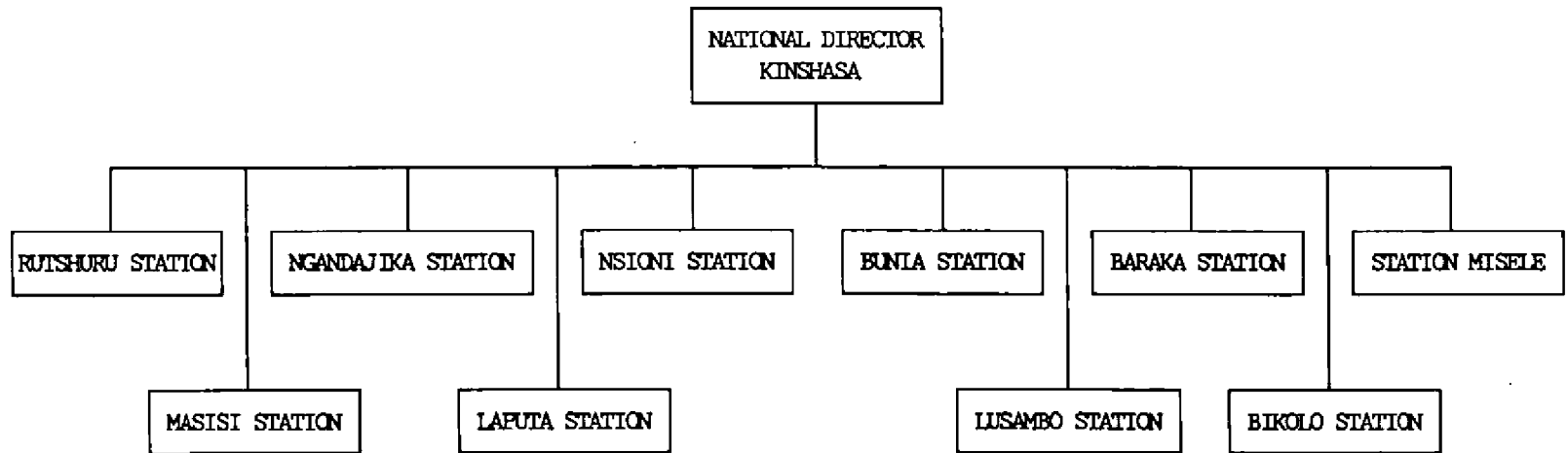
1. A governing Council with seven members;
2. A Management Committee consisting of the Président-délégué-général assisted by two chief administrators and a staff representative. As delegated by the Governing Council, the Managing Committee administers REGIDESO's current activities, especially with respect to the preparation of economic and financial accounts and the implementation of the Council's decisions;
3. Central and regional offices, corresponding to the country's geopolitical composition.

REGIDESO has eight regional offices and two headquarters offices distributed in accordance with the country's political subdivisions which supervise 59 operational centres or stations, each with its own operational area.

There is a regional office at Kinshasa and in the regions of equator, Bas-Zaire, Kasai Oriental, Kasai Occidental, Haut-Zaire and Shaba, and two headquarters offices at Banfundu and Kamina.

Tableau 3

Structure of the National Rural Water Service



The National Rural Water Service is responsible for rural and village water-supplies.

The National Rural Water Service is responsible for the needs of rural dwellers.

Zaire has the following water-drilling organizations:

REGIDESO which has:

3 percussion rigs

1 rotary rig

Drilling capacity: 1,000 m to be drilled in 1985

Drillers: 5 (3 civil engineers, 2 technicians)

Hydrogeologists: 6

Four private companies:

SOTRAF (Société de grands travaux africains) at Kinshasa

SOZAGEC (Société zairoise de génie civil) at Kinshasa

C.D.I. (Integrated Development Centre)

FORAKY

The following places use ground water extracted by standard and deep wells:

1. Deep wells (boreholes)

<u>Region and place</u>	<u>Number</u>	<u>Diameter (mm)</u>	<u>Depth (m)</u>	<u>Yield (m<sup>3</sup>/h)</u>	<u>Drawdown (m)</u>
<u>Kinshasa</u>					
Kinkole	1	300	17.40	50	
<u>Bas-Zaire</u>					
Inkisi	6	250	16 to 21	40	0.04
<u>Equateur</u>					
Bokungu	2	250	111.75	4	
<u>Shaba</u>					
Likasi	1	500	205	300	2
Kasenga	3	200	30 to 33.5	22	1
Kamina	4	150	18 to 29	15	4
	2	200	18	15	3
	1	300	18	15	3
<u>Bandundu</u>					
Masi-Manimba	2			15	

2. Large diameter wells

Bas-Zaire

Mbanza-Ngungu	1	2.9	3.80		
Inkisi	1	1	16	40	



<u>Region and place</u>	<u>Number</u>	<u>Diameter (mm)</u>	<u>Depth (m)</u>	<u>Yield (m<sup>3</sup>/h)</u>	<u>Drawdown (m)</u>
<u>Equateur</u>					
Lisala	1	0.80	3.8	50	
Libenge	2	2.90	5.03	15	
		1.00	6.10	15	
Boende	2	0.80	7.2 to 8	30	
<u>Shaba</u>					
Kabongo	1	2	6	7	
<u>Kasai-Oriental</u>					
Lusambo	6	1.50	6 to 8	11	
3. <u>Resurgences and springs</u>					
<u>Kinshasa</u>					
Mutendi	1			60	
<u>Bas-Zaire</u>					
Kimpese	1			< 200	
Mbanza-Ngungu	1			18	
<u>Shaba</u>					
Lubumbashi	3			< 5,000	
Sandoa	1			8	
Dilolo	1			25	
Malemba-Nkulu	1			8	
Moba	1			20	
Kolwezi	1			(GCM)	
Kipushi	1			75	
Kasumbalesa	1			15	
<u>Kivu</u>					
Bukavu	13			15	
Uvira	2			12	
Kasongo	1			15	
Butembo	2			35	
<u>Bandundu</u>					
Kenge	1			25	

<u>Region and place</u>	<u>Number</u>	<u>Diameter (mm)</u>	<u>Depth (m)</u>	<u>Yield (m<sup>3</sup>/h)</u>	<u>Drawdown (m)</u>
<u>Haut-Zaire</u>					
Kisangani	3			30	
Bunia	1			45	
Watsa	2			15	
Buta	1			8	
<u>Kasai-Oriental</u>					
Mbuji-Mayi	1			14,000	
<u>Kasai-Occidental</u>					
Mweka	2			80	
Tshikapa	5			60	

Problems:

Most of the installations are old and their yields do not meet the people's needs. In most place, new installations are needed to meet future needs.

Under construction (1985)

<u>Location</u>	<u>Station</u>	<u>Number</u>	<u>Diameter (mm)</u>	<u>Depth (m)</u>	<u>Yield (m<sup>3</sup>/h)</u>
<u>Equateur</u>	Ikela	4	200	53	16
	Bolomba				
	Djolu				
<u>Bandundu</u>	Bulungu	3	200	40	15
	Bolobo	2	200		
<u>Kasai-Oriental</u>	Lodja				
	Kole				
	Katako-Kombe				
	Lomela				
	Lusambo				
<u>Kasai-Occidental</u>	Luebo				
<u>Haut-Zaire</u>	Opala				
	Ubundu				
	Irumu				
<u>Bas-Zaire</u>	Muanda				
	Mbanza-Ngungu				

IV. CONCLUSION

After a slow start, the study of ground water in Zaire seems to be developing fairly rapidly with the drinking-water programme which is being carried out under the International Decade for Drinking Water Supply and Sanitation. However, hydrology is

generally considered from the practical angle of construction work, for it is responsibility of the State bodies responsible for urban and rural water-supply installations.

It will certainly be necessary at a later stage to consider strengthening the data collection, storage and utilization system and to provide facilities for scientific study of the results obtained, with a view to evaluating the ground-water potential and incorporating the evaluation in the planning of water resources development for the whole country.

#### V. REFERENCES

- Borgniez, G., Problèmes hydrogéologiques au Congo belge et au Rwanda-Urundi, Belgian Congo Geological Service, Tome VIII, 1952.
- Direction de la Géologie, Notice explicative de la carte géologique du Zaïre au 1/2 000 000, 1974.
- Grooya-Dhechuvi, Makabu-Kayembe, Contribution à l'investigation pétrolière de la cuvette centrale (Haut-Zaïre). University of Lubumbashi, Faculty of Sciences, 1983.
- Kalala Mwamba, Carte des provinces hydrogéologiques du Zaïre (échelle 1/2 500 000). Office of the President of the Republic of Zaire, ERTS programme, 1981.
- \_\_\_\_\_, Carte d'orientation des projets hydrauliques au Zaïre (échelle 1/1 000 000). International Association of Hydrogeologists, Zaire section, 1985.
- Rorive, R., Le site hydrogéologique des sources de la Kimilolo, CSK, Series A-3, Vol. XVII, 1952.
- Scott Wilson Kirkpatrick and Partners, Wimpey Laboratories, Etudes de sources d'alimentation en eau potable de huit centres. Feasibility studies, 1984.
- Snel, N.J., Etudes des formations de travertins calcaires dans la province du Kivu. Belgian Congo Geological Service, 1957.
- \_\_\_\_\_, Contribution à l'étude hydrogéologique du Congo belge. Belgian Congo Geological Service, 1957.
- \_\_\_\_\_, Statistiques sur l'utilisation de l'eau dans l'industrie au Congo belge et au Rwanda-Urundi. Belgian Congo Geological Service, 1957.
- Van Caillie, X., Ngoy Mudia, Etude hydrologique et alimentation en eau de Kinshasa, Ville Est, 1977.