# CHAPTER 4
# CHARACTERIZATION OF THE REFERENCE SITUATION

**Abbreviations**

| | |
|---|---|
| AAR | Regional Coverage Area |
| ADA | Directly Affected Area |
| AID | Direct Influence Area |
| AII | Indirect Influence Area |
| AH | Hydroelectric Power Plant |
| ART. | Article |
| BCR | Rolled Compacted Concrete |
| CCD | Convention to Combat Desertification |
| CDB | Convention on Biological Diversity |
| DEC. | Decree |
| EFB | Concrete Face Rock Fill |
| EIA | Environmental Impact Study |
| ENE | National Energy Company |
| FAO | Food and Agriculture Organization of the United Nations |
| GAMEK | Middle Kwanza Management Office |
| GSHAP | Global Seismic Hazard Map |
| LBA | Basic Environmental Law |
| LBRA | Basic Law on Water Biological Resources |
| LGT | Basic Labor Law |
| LOTU | Law on Territorial Organization and Urbanism |
| MINAGRI | Ministry of Agriculture |
| MINAMB | Ministry for the Environment |
| NBSAP | National Biodiversity Strategy and Action Plan |
| OIT | International Labor Organization |
| ONS | National Electric System Operator |
| OP | World Bank Operational Policy |
| SADC | Southern Africa Development Community |
| SEA | State Office for Water Resources |
| SONEFE | National Society for Study and Financing of Overseas Enterprises |
| TIRFAA | International Treaty on Plant Genetic Resources for Food and Agriculture |
| USDA | United States Department of Agriculture |
| ZCIT | Intertropical Convergence Zone |

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# 4. CHARACTERIZATION OF THE REFERENCE SITUATION

This chapter provides information and data on the characterization of the current reference situation on the project site and surrounding area.

It is divided according to the physical, biotic, and antitropical environment. The characterization is based on bibliographical and field survey data in the four (4) areas of influence defined for the construction of the Laúca dam.

Emphasis is placed on the direct influence areas (AID) and the directly affected area (ADA), as these may have greater direct interference on the populations and on the biotic environment.

## 4.1 PHYSICAL ENVIRONMENT

For the characterization of the physical environment in the undertaking's influence areas a bibliographical survey was done regarding each aspect (climate, hydrography, geology, geomorphology, and soil conditions) as herein described. In respect of water resources, a field survey was done to determine water quality.

### 4.1.1 CLIMATE

According to the Köppen classification, the climate in the Middle Kwanza River Basin is tropical, with a dry winter season (Aw). In Aw-type climates the monthly mean temperature throughout the year is above 18° C and in at least one month mean total rainfall is lower than 60 mm. The typical biome of regions with this type of climate is the savanna, hence their common denomination.

As they are megathermal, i.e., above the 18° C isothermal range, and located in the intertropical region, the savanna climates have two well-defined seasons: a dry season,

during which potential evapotranspiration greatly exceeds rainfall, occasioning in some cases extreme dryness conditions; and a humid, rainy season, when rainfall is more or less abundant, but always in excess of potential evapotranspiration, thereby permitting the replacement of water reserves in the biomass, the soils, and the aquifers.

As is the case in equatorial climate, the main rainfall generating mechanisms are convective phenomena, usually associated with thunder at night, when the soil temperature is higher and air instability is more pronounced. Thus, the period of greater rainfall is associated with the presence of the Zone of Intertropical Convergence Zone (ZCIT) over the region.

In this type of climate, rainy seasons coincide with summer in the respective hemisphere owing to the ZCIT presence in the region. Under these conditions, the moisture brought by the trade winds that converge over these regions feed the convection, giving origin to cumulonimbus clouds that cause heavy rains.

In the Middle Kwanza region, though the geographical factors (relief and altitude) lead to diversity, the atmospheric mechanism creates a regional uniformity, determining a seasonal rain pattern, with maximum rainfall in the summer and minimum rainfall in the winter, as described above.

### 4.1.2 CLIMATOLOGIC MAGNITUDES AND SEASON ANALYSIS

The climatologic magnitudes chosen for the analysis in this study are as follows:

- Monthly temperatures: absolute maximum, mean, and absolute minimum (°C);
- Mean monthly humidity (%);
- Mean insolation (hour/day);
- Monthly maximum and mean wind speed (m/s);
- Percent duration of each wind direction and respective mean and maximum speed (m/s);
- Mean monthly rainfall (mm/month) and daily maximum for each month (mm/day), and number of rainy days per month;
- Mean monthly atmospheric pressure (mb); and

- Evaporation (mm).

The climatologic data for the study of the Kwanza River Basin were gleaned from the following sources:

- Hydrometeorological study of the Capanda AH (ANGOLA, 19--), hereinafter denominated “Capanda Project;”
- Three technical studies by the hydrologic services, pertaining to the 1987-1988, 1988-1989, and 1989-1990 hydrologic years, published by GAMEK, and providing data gathered by the Capanda meteorological station; and
- Five yearbooks on surface meteorological observations by several meteorological stations geographically scattered throughout the country, pertaining to 1955, 1959, 1960, 1962, and 1970. Hereinafter these the data will be designated as obtained from the “yearbooks.”

The results of the abovementioned studies will be compared with each other to ensure greater accuracy in the climatologic characterization of the Kwanza River Basin. Table 4.1 shows the stations evaluated in the study, the elements available in each of them, and the respective data sources.

**Table 4.1:** Middle Kwanza River Basin – Selected Meteorological Stations –1955/1990

| Station | Latitude | Longitude | Altitude (m) | Data Source | | | Magnitude | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (i) | (ii) | (iii) | (1) | (2) | (3) | (4) | (5) | (6) |
| Capanda | 9°46'S | 15°36'E | 1024 | | | x | | | | | | |
| Malanje | 9°33'S | 16°22'E | 1140 | x | x | | x | x | x | x | X | x |
| Silva Porto | 12°23'S | 16°57'E | 1701 | | x | | x | x | x | x | X | x |
| Cacuso | 9°25'S | 15°45'E | 1070 | x | x | | x | x | | x | | x |
| Damba | 9°25'S | 16°45'E | 1210 | | x | | x | x | | | | x |
| Matari-la-Ginga | 9°30'S | 16°20'E | 1175 | | x | | x | x | | | | x |
| 5 de Outubro | 9°31'S | 17°48'E | 1017 | | x | | x | x | | | | x |
| Quitota | 9°33'S | 15°30'E | 864 | | x | | x | x | | | | x |
| Nova Gaia | 10°04'S | 17°33'E | 1260 | x | x | | x | x | | | | x |
| Capunda | 10°41'S | 17°21'E | 1130 | | x | | x | x | | | | x |
| Andulo | 11°30'S | 16°42'E | 1700 | x | x | | X | x | | | | x |
| Ceilunga | 12°22'S | 16°54'E | 1712 | | x | | X | x | | | | x |
| Chiumbo | 12°27'S | 16°06'E | 1810 | | x | | X | x | | | | x |
| Pungo Andongo | 9°40'S | 15°35'E | 1240 | x | | | | | | | | x |
| Nhangue ya Pepe | 9°42'S | 15°07'E | 740 | x | | | | | | | | x |
| Kiuto | 12°23'S | 16°57'E | 1711 | x | | | X | | | | | x |

**Source:** (i) Capanda Study; (ii) Yearbooks; (iii) Capanda Station. Magnitudes: (1) Temperature; (2) Relative Humidity: (3) Insolation; (4) Wind; (5) Atmospheric Pressure; (6) Evaporation.]

The meteorological data obtained from the Capanda Project show long-term averages for stations in the Kwanza River basin that represent both the basin and the Capanda utilization influence area – relatively close to the Laúca dam, this study's object.

As regards yearbook data, only stations located in the Kwanza River Basin were selected for this study's preparation; annual averages were compiled for the years 1955, 1959, 1960, 1962, and 1969.

In respect of the period of meteorological observation, both the yearbooks and the Capanda study data refer to the 1950s, 1960s, and 1970s. The data from the Capanda AH station refer to a shorter period (1987-1990) and to only one locality.

As the data were obtained from three different sources, analyses of all magnitudes were done to verify the consistence of results. In general, the yearbooks and the Capanda AH Project data showed the same trend, as they cover stations in common and refer to a similar period. Data from the Capanda station, though, often showed a quite different trend from the others. As this station is close to the Laúca AH and the period covered by its data is quite different, the decision was made to present this station's data separately whenever their trend deviated from the trend shown by the other stations. For simplification purposes, hereinafter the yearbook results, combined with those of the Capanda AH Project, will be indicated as having been obtained from the series "yearbooks + Capanda AH."

## Air Temperature

Table 4.2 shows maximum, mean, and minimum air temperatures from January thru December, given in the two series analyzed: Capanda AH station and "yearbooks + Capanda AH." The disparity of the data between the two series stems mainly from the fact that the observation periods were different. In addition, the series "yearbooks + Capanda AH" consists of data from various meteorological stations, and at times some of these stations may have shown extreme results, which have influenced the data trend.

Absolute maximum temperatures observed range between 30.1° C and 34° C at the Capanda AH station, and between 33° C and 37° in the "yearbooks + Capanda AH" series. In both series, the highest temperatures occur in September.

Mean temperatures in the two series show a slightly different trend. In the "yearbooks + Capanda AH" they range between 18.7° C and 21.5° C, with a long-term mean of 20.7°, while in the Capanda AH station series they range between 20.1° C and 23° C, with an mean of 21.9° C. The data show little seasonal difference in mean temperatures. June, July, and August are the coldest and the driest months, while December-March are the warmest and wettest.

Table 4.2 also shows extreme minimum air temperatures. Minimum temperatures observed range between 9.6° C and 0.1° C in the "yearbooks + Capanda AH" series, and between 16.3° C and 8.7° C in the Capanda AH series. The minimum temperature observed was 0.1° C in June. June thru August are the coldest months, already mentioned in connection with mean temperatures as well as with minimum temperatures observed.

**Table 4.2:** Middle Kwanza River Basin – Temperatures (Maximum, mean, and minimum) – 1955/1990

| Maximum temperature observed (°C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Source** | **Jan** | **Feb** | **Mar** | **Apr** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Maximum** |
| **Series 1** | 32.0 | 31.2 | 30.1 | 31.5 | 33.3 | 31.0 | 31.2 | 33.0 | 34.0 | 32.6 | 30.3 | 30.5 |
| **Series 2** | 33.0 | 34.8 | 33.0 | 33.0 | 35.2 | 33.8 | 33.5 | 33.8 | 37.0 | 34.0 | 35.0 | 32.6 |
| Mean temperature (°C) | | | | | | | | | | | | |
| **Source** | **Jan** | **Feb** | **Mar** | **Apr** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Mean** |
| **Series 1** | 22.5 | 23.0 | 22.6 | 22.7 | 22.8 | 21.4 | 20.1 | 20.4 | 20.7 | 22.3 | 22.2 | 22.3 |
| **Series 2** | 21.7 | 21.4 | 21.3 | 21.3 | 20.2 | 18.7 | 18.7 | 20.1 | 21.5 | 21.5 | 20.7 | 20.9 |
| Minimum temperature observed (°C) | | | | | | | | | | | | |
| **Source** | **Jan** | **Feb** | **Mar** | **Apr** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Minimum** |
| **Series 1** | 16.0 | 16.3 | 16.5 | 14.5 | 11.0 | 8.7 | 9.0 | 9.9 | 11.7 | 16.2 | 10.7 | 11.0 |
| **Series 2** | 9.6 | 7.7 | 9.6 | 8.5 | 2.7 | 0.1 | 1.6 | 3.0 | 5.0 | 8.4 | 9.4 | 9.0 |

**Source:** Capanda Station, Capanda Project, and Yearbooks Series 1 = Capanda Station and "Yearbook + Capanda Project Series 2.

## Relative Humidity

Relative humidity refers to the degree of saturation of the air with water vapor. The record shows that the monthly mean has ranged between 55% and 80% at the meteorological stations (including the Capanda AH Station).

The results for humidity from both the "yearbooks + Capanda AH" and the Capanda AH station converge. The results for monthly averages, whose long-term mean was 70%, are shown in Fig. 4.1. This Figure shows that the lowest relative humidity was recorded in the dry months, June-August, and the highest in the rainy months, November-April.

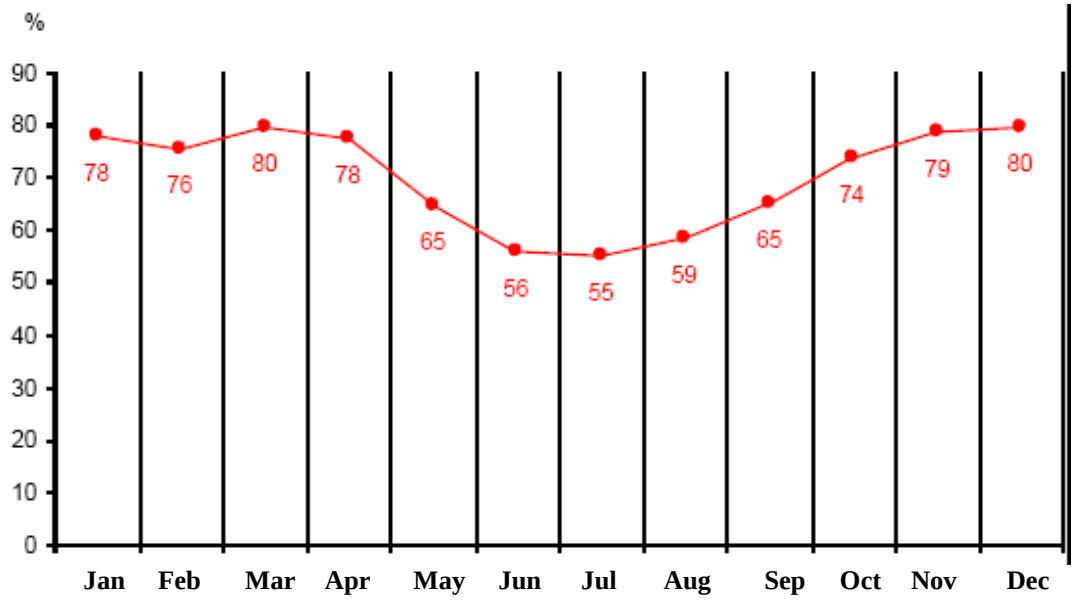


**Figure 4.1:** Middle Kwanza River Basin – Relative air humidity averages – 1955/1990.
**Source:** Capanda AH Station, Capanda AH Project, and Yearbooks.

## Insolation

Insolation in a given period is defined by the number of direct sunlight exposure, measured by a device called heliograph. The insolation data in the "yearbooks + Capanda AH Project" and the Capanda AH series converge. Figure 4.2 shows the monthly averages, with long-term mean of 199.3 hours/month.

The months of greatest insolation are the less rainy and less humid, May thru July. The highest insolation mean is recorded in May, at 281 hours/month, while the lowest is recorded in November, at 132.3 hours/month.

A frequent behavior of data has been noticed, as insolation shows a trend complementary to that of humidity: the months with a highest number of sunlight hours are also the driest, while those with less insolation are the most humid.

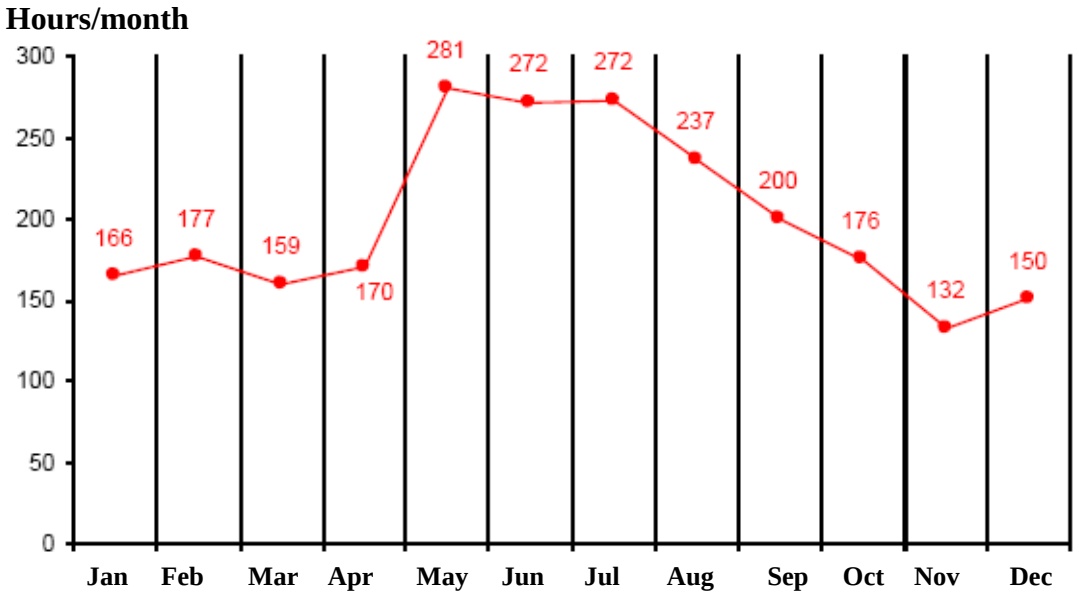


**Figure 4.2:** Middle Kwanza River Basin – Number of insolation hours – 1955/1990.
**Source:** Capanda AH Station, Capanda AH Project, and Yearbooks.

## Wind

The monthly averages in the "yearbooks + Capanda AH Project" series are quite different from those in the Capanda station, as can be seen from Figure 4.3.

The long-term mean in the "yearbooks + Capanda AH Project" series is 2 m/s, while the mean at the Capanda AH station is 3.9 m/s. The Capanda AH station was selected for

the studies of wind maximums and directions hereinafter because it is located near the Laúca AH and has maximum records.

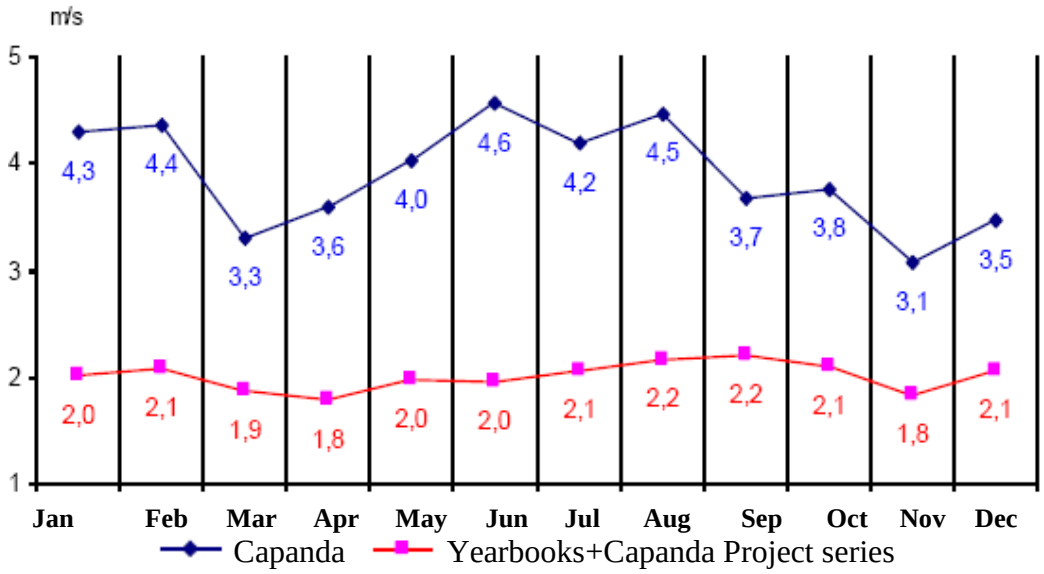


**Figure 4.3:** Wind speed averages (m/s) – 1955-1990
**Source:** Capanda AH Stations, Capanda AH Project, and Yearbooks.]

Table 4.3 shows the predominant wind directions on a monthly basis as well as mean and maximum speeds at the Capanda station. This table also sums up the percentage of time winds blew in each direction, and the respective mean and maximum speeds.

**Table 4.3:** Middle Kwanza River Basin – Wind Speeds and Directions at the Capanda AH Station – (1955/1990).

| **Predominant Direction and attendant mean and maximum speed** | | | |
|---|---|---|---|
| **Month** | **Direction** | **Mean (m/s)** | **Maximum (m/s)** |
| Jan | NW | 4.30 | 12.00 |
| Feb | NW | 4.37 | 12.00 |
| Mar | E | 3.30 | 9.00 |
| Apr | E | 3.60 | 12.00 |
| May | E | 4.03 | 12.00 |
| Jun | E | 4.57 | 12.00 |
| Jul | W | 4.20 | 14.00 |
| Aug | W | 4.47 | 13.00 |
| Sep | W | 3.67 | 10.00 |
| Oct | NW | 3.77 | 9.00 |
| Nov | NW | 3.07 | 7.00 |
| Dec | NW | 3.47 | 9.00 |
| **Wind speed summary** | | | |
| **Direction** | **%** | **Mean (m/s)** | **Maximum (m/s)** |
| N | 2.0 | 2.27 | 12.00 |

| | | | |
|---|---|---|---|
| NE | 2.23 | 2.60 | 17.00 |
| E | 21.33 | 3.47 | 12.00 |
| SE | 10.63 | 2.73 | 17.40 |
| S | 1.97 | 2.00 | 7.00 |
| SW | 5.17 | 2.13 | 7.00 |
| W | 25.07 | 3.80 | 13.00 |
| NW | 25.40 | 3.97 | 14.00 |
| Calm | 6.2 | 0.00 | 0.00 |

**Source:** Capanda AH Station, Capanda AH Project, and Yearbooks.

Figure 4.4 shows a summary of predominant wind directions at the Capanda Station.

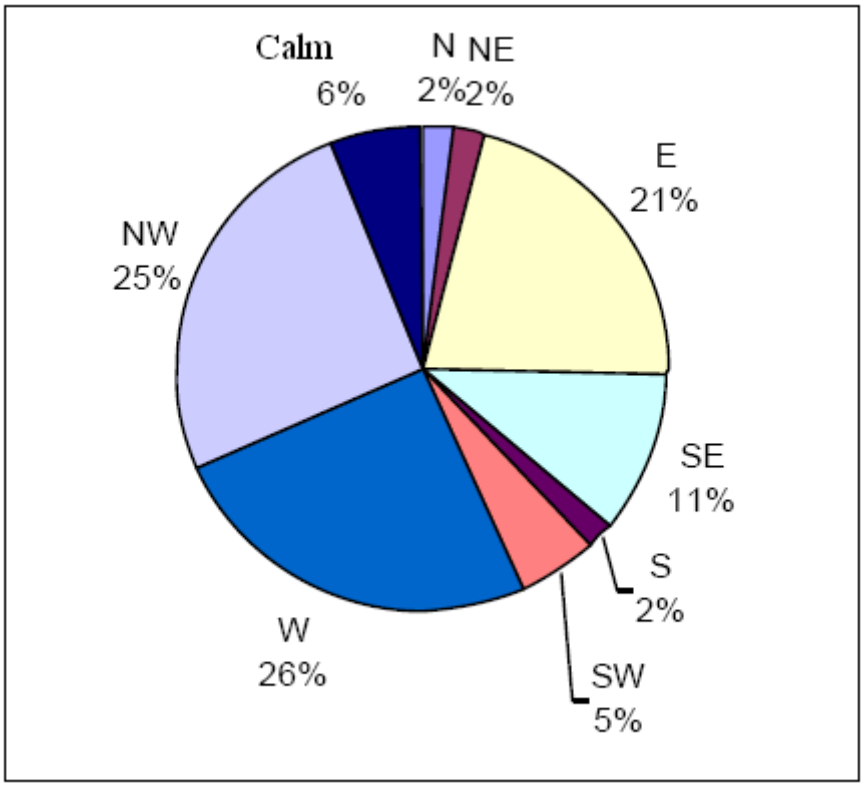


**Figure 4.4:** Summary of predominant wind directions at the Capanda AH Station – (1955/1990).
**Source:** Capanda AH Station, Capanda AH Project, and Yearbooks.

Some of the information that may be gathered from Figure 4.4 and Table 4.3 include the following:

- The predominant wind directions at the Capanda station are W and NW, each one accounting for 30% of the time;
- The maximum wind speed recorded at this station was 17.4 m/s on a SE direction; and

- From October thru February the predominant wind direction is NW; from March thru June, E; and from July thru September, W.

## Atmospheric Pressure

Atmospheric pressure data could be obtained only from the yearbooks; a summary of monthly data is shown in Figure 4.5. Long-term mean is 860.1 mb, which changes little over the year.

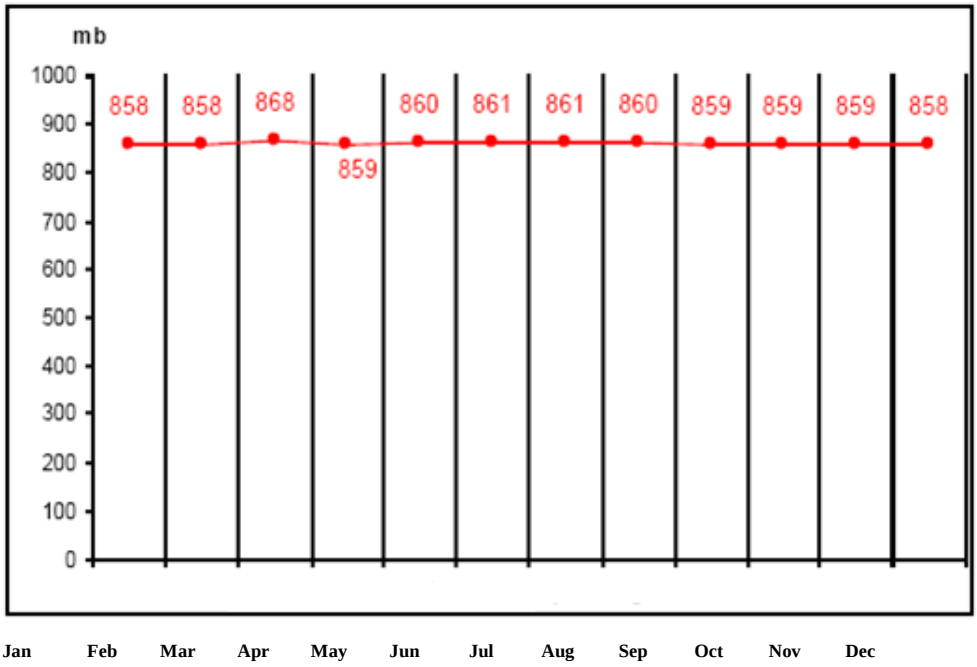


**Figure 4.5:** Middle Kwanza River Basin – Atmospheric pressure – 1955/1990.
**Source:** Yearbooks.

## Evaporation

Evaporation is a phenomenon that depends on various factors, such as the degree of relative air humidity, temperature, radiation, and the albedo, among others. Surface changes, as in the case of the construction of reservoirs, increase the amount of water evaporated in an environment, known as net evaporation.

The method employed for measuring net evaporation in the Kwanza River reservoirs was the same used by the National Electric System Operator (ONS) at the reservoirs of the Brazilian Northeast (ONS, 2004), which has similar characteristics as Angola in some aspects.

Table 4.4 shows the results of the calculation of the monthly net evaporation figures, which resulted in 547.01 mm/year. This corresponds to the reservoir's moderate evaporation capacity, i.e., 1.5 mm/day. A comparison between the drier months (June-August) with those of the rainy season (October-April) shows a marked difference. For instance, if we take the month of August, when net daily evaporation reaches a maximum of 3.18 mm/day, and the month of January, when evaporation is only 0.25 mm/day, one can see that at the height of the dry season the liquid surfaces (particularly of reservoirs) lose up to 12 times more water to the atmosphere than during the rainy season.

In dry periods a series of factors contribute to these high evaporation rates. The low rainfall index, coupled with increased insolation and lower relative air moisture, favor increased evaporation on the water surface.

**Table 4.4:** Middle Kwanza River Basin – Net evaporation – 1955/1990.

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.54 | 31.22 | 30.80 | 20.44 | 52.18 | 94.54 | 93.57 | 95.60 | 75.26 | 22.96 | 13.30 | 9.60 | 547.01 |

**Source:** Capanda Project and Yearbooks.

**Precipitation**

Hydrologic data from previous studies are not homogenous in terms of time; they stem from various sources, and show extensive gaps. Thus, the analysis of the consistency of these data has been based on the Lorenz curve.

For obtaining the monthly precipitation mean in the segment of interest the rain gauging posts shown on Table 4.5 have been taken into consideration. Posts not on this table have been excluded because their series are too short.

**Table 4.5:** Middle Kwanza River Basin – Rain gauging posts considered at the Cambambe AH and Capanda AH stations.

| Number | Post | Longitude | Latitude |
|---|---|---|---|
| 1 | Andulo | 16°41,25' | 11°28,22' |
| 2 | Cacuso | 15°45,10' | 9°25,51' |
| 3 | Cassanha | 14°54,57' | 9°47,41' |
| 4 | Calulo | 14°54,57' | 10°0,02' |
| 5 | Ceilunga | 16°52,59' | 12°21,47' |
| 6 | Chiengue | 16°13,60' | 11°25,42' |
| 7 | Chitembo | 16°43,61' | 13°31,26' |
| 8 | Coemba | 18°3,21' | 12°7,98' |
| 9 | Damba | 16°42,04' | 9°23,21' |
| 10 | Gangassol | 16°21,77' | 9°16,56' |
| 11 | Gen. Machado | 17°26,93' | 12°0,57' |
| 12 | Malanje | 16°21,33' | 9°32,84' |
| 13 | Munhango | 18°29,82' | 12°9,46' |
| 14 | Nova Gaia | 17°32,06' | 10°3,15' |

**Source:** Capanda Project and Yearbooks.

Data from the selected posts provided the basis for establishing the average precipitation in the Cambambe AH station segment of the basin, shown together with data from the Capanda AH meteorological station in Table 4.6.

**Table 4.6:** Middle Kwanza River Basin – Monthly precipitation averages series (mm) – 1955/1990.

| Month | Cambambe | Capanda |
|---|---|---|
| **January** | 173.70 | 59.60 |
| **February** | 148.10 | 111.50 |
| **March** | 205.60 | 297.80 |
| **April** | 135.30 | 159.80 |
| **May** | 18.10 | 11.30 |
| **June** | 0.60 | 0.00 |
| **July** | 0.30 | 1.00 |
| **August** | 2.60 | 3.20 |
| **September** | 30.10 | 20.00 |
| **October** | 102.60 | 81.90 |
| **November** | 182.50 | 251.90 |
| **December** | 184.10 | 131.40 |
| **Mean=** | 98.63 | 94.12 |
| **Maximum=** | 205.60 | 297.80 |

**Source:** Capanda Station, Capanda Project, and Yearbooks

From the available information one can see that the spatial distribution of precipitation is uniform. The Capanda AH station shows a cycle similar to that of the regional rainfall regime, represented by the Cambambe AH station, with the exception of the intensity of rains at the peak, which shows a record of 297.8 mm in March.

Two clearly distinct seasons are observed: May-September, when monthly totals are less than 60 mm; and October-April, when average precipitation is around 160 mm. The most critical quarter is June-August, when precipitation is less than 10 mm, often with periods with no precipitation at all. The rainiest quarter is January-March, with 40% of the annual rainfall total. The humid station is characterized by two rainy peaks: the first varying between November, with 182.5 mm and December, with 184.1 mm; and the second, with the highest precipitation: 205.6 in March.

## 4.1.3. GEOLOGY

From a regional viewpoint, the Regional Coverage Area (AAR) forms part of an area characterized by extensive, profound continental faults. Between such faults is located the Kwanza Horst, a latitudinal linear elevation of the crystalline basement, about 300 kilometers long and 20-50 meters wide, with lithographic structures covered in the Lower Proterozoic. The Kwanza Horst separates two other major geological structures: the Maiombe Shield in the Northwest and the Angola Shield in the Southwest.

Regionally, the portion of the Middle Kwanza River Basin, located in the proximity of the city of Dondo (coastal peneplain surface) encompasses rocky and crystalline formations from the ancient rock mass. Most of these rock formations are characterized by a high degree of metamorphism, including the Basement Complex, in which gneiss, paragneiss, migmatite, mica schist, and granite-gneiss, and other rocky materials are more abundant. In general, these materials are very rich in vein quartz, although granitic faced rocky outcrops, little or non-metamorphosed, do occur.

Between the Upper Dondo and the Kwanza River there occur expanses of schistous rocks associated with arkoses (in the Sansikwa Series-Western Congo System). The sedimentary coverage formations crop out first in a narrow margin, which widens considerably from then on until it becomes part of the Kwanza sedimentary basin, where there are deposit outcrops that range from the Lower Cretaceous to the Holocene, forming the expanse's inner peripheral strip, in contact with the crystalline complex, and then largely forming the low seashore. The geology of Middle Kwanza River Basin is shown in Figure 4.6.

In the Malanje Plateau region, the basement complex formations display a wide distribution along an E-W central strip, which surrounds a major part of the Lucala River basin on the west, where rocky outcrops are frequent. These formations consist of metamorphic rocks, particularly gneisses, migmatites, and granite-gneisses, with abundant quartz veins, characterized by their varied texture and mineralogical composition, as well as the occasional occurrence of quartzites and quartzitic schist that form high-profile rocky reliefs and other highly metamorphosed rocks.

The greatest occurrence is of ancient Higher Precambrian sedimentary formations that have largely covered the crystalline rocks of the metamorphic base. They consist primarily of sandstone and conglomerates of reddish or pink colors, and of arkoses, greywacke, and clayey, silty schist.

These formations form part of the silty schist series, of the more recent age of the Western Congo System, and of the various rocky materials that also form part of the series; the coarse and consolidated sandy materials are the formations that occupy the most extensive areas, where the outcrops that make up the Lucala and Luando falls stand out. The Gango sub-basin region is located on the Old Continental Massif, consistently with the Precambrian formations.

The Silty Schist series include the Pungo Andongo layers, which consist of arkoses, conglomeratic and conglomerate sandstone, with the predominance of rolled, roundish pebbles. The cement that aggregates these materials is sandy and purple. The rock monoliths that rise up from the Pungo Andongo plain, known as Black Rocks and Guinga Rocks, belong to these typical conglomerates. In addition to these rocky outcrops, there are others on the lower plane west of Pungo Andongo, sometimes disposed in ridges along the margins of the Kwanza River and even in its riverbed, giving origin to frequent rapids and falls (Salto do Cavalo and the Mucala rapids). In these places conglomerates and sandstone alternate, frequently alternated with reddish argillites.

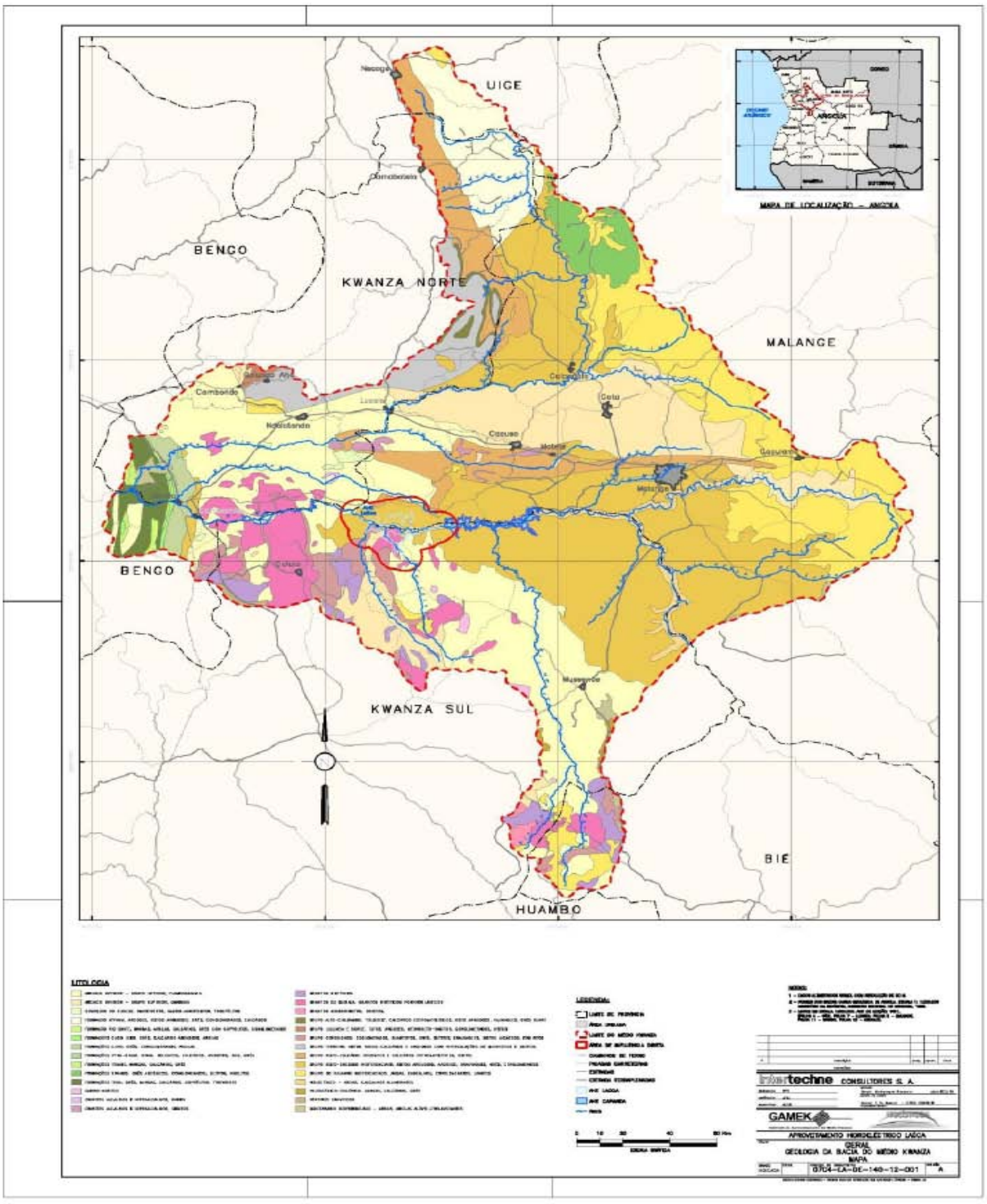


**Figure 4.6:** Geological Map of the Middle Kwanza River Basin

Other than these cases, rarely are outcrops seen on the surfaces of the Precambrian sedimentary substrate. There are also various surfaces covered by coarse, nonconsolidated deposits, particularly of Kalahari sand (Higher Tertiary and Pleistocene), which become more abundant in the northeast, and have their boundary defined by the Cassange Lowland escarpment. The Kalahari System,

which is related to continental and tertiary quartzitic sediments, consists essentially of coarse and friable yellowish, grayish, or brownish sandstone, consistently in thick horizontal layers. Their quartz components are rounded owing to the action of the wind, and are agglomerated by soft, ferruginous cement. Nearly the entire Kalahari formation is covered by a layer of nonconsolidated, predominantly wind-driven sand of more recent age, probably deposited in the Pleistocene.

In addition to the large expanses of sand, smaller, thinner ones are sparsely found in the northern part of the plateau surface, in sharp contrast to the old silty formations, and consisting of lightly consolidated or even lose sand, with outcrops of pebbly debris, rolled or sub rolled, of a sandy, quartzitic, and gneissic nature, mingled with abundant lateritic material. On top of this pebbly layer there is a thin quartzous sand stratum.

In the city of Calulo region, in the South Kwanza province, the Precambrian eruptive complex formations form part of the great batholiths that start next to the Kwanza River and fans out toward the south, encompassing a large part of the plateau and sub-plateau regions of the Angolan territory's Center-West. These are essentially rocks consisting of granite, granodiorite, quartz-diorite, and nonzonitic granite.

To the south of the Kwanza River are found rocks of the Silty Schist series and the Basement Complex. These formations are found in the northern portion of the zone of outcrops of compact coarse- or medium-grained, purplish sandstone, physiographically identified by smooth surfaces. The Basement Complex has crystallophyfillic formations of marked metamorphism, with metamorphosed and semi-metamorphosed rocks, particularly gneisses, granite gneisses, and different schistous rocks. The top of mountain forms are of quartzitic rocks and particularly quartzites. There are formations of the Precambrian eruptive complex, consisting essentially of granite, granodiorite, quartz-diorite, and nonzonitic granite, with a greater quantity of granitic rocks. To the west of the city of Calulo there are expanses of sedimentary rocks of the Sansíkwa formation, associated with outcrops of quartzitic rocks and quartziferous sandstone, similar to the crowning of the major mountainous massifs, and of clayish schist more frequently found in level areas.

According to the Angola Geological Survey (Mouta, 1998), the AID and the ADA are under lithostratigraphic units that encompass the rock formations of the Ancient Continental Massif, characterized by the predominance of formations of the Precambrian eruptive complex, represented by large-scale granitic rocks of the Basement Complex formation, as well as eruptive rocks. Precambrian sedimentary rocks of the Silty Schist and Calc-Schist formation are found, as are small recent alluvial deposits.

On the basis of the available topographic and surveying data and of the mapping of both margins, faults and fractures have been identified in the area of the Laúca dam construction site, consisting of sedimentary rocks of the Silty Schist Group and older crystalline rocks. The location of the axis of the future reservoir is firmly set, with sloping lateral walls of sandstone, siltstone, and conglomerates. The stratigraphy observed on the slopes consists, at the top, to a 3-meter depth, of sandstone of variable grain size, followed by more consistent sandstone with a little feldspar and 40-meter thickness, then by finely stratified intercalations of subordinated siltstone, calcarenite, and claystone, with an estimated thickness of 15 meters-20 meters, with a predominance of siltstones of about 15 meters. At the base there are sedimentary deposits with a depth of up to 5 meters. The geologic map of the region is shown in Figure 4.7.

The Silty Schist Group consist of sedimentary rocks of the lower Proterozoic (Late Riftean /*Vediano*) similar to the formations of the Western Congo System (late Precambrian), formed by meteronites with thick stratification, metasiltites; at the base, cemented gravel and gravel metaconglomerates. This unit is prevalent in the area directly affected by the construction of the tunnels, which extend from the Queta Candombe hilly formations, on the left bank of the Kwanza River, to the embankment of the Capanda AH, in a SW/NE direction. They are also prevalent in the Serra M'Bango formation. On the right bank, this unit extends from the escarpment joining the Kwanza River channel, and extending further northwards.

The Quibala Complex, the oldest formations on the Angolan territory, consists of granites, biotites, and *siento-diorites* and is composed of intrusive rocks of the lower

Archean, which occur on the left bank of the Kwanza River, and sparsely downstream of the Luinga and the Buiza Rivers. On the right bank, they occur sparsely in the form of steep hills locally known as Quizacala, Lunga, and Calombe.

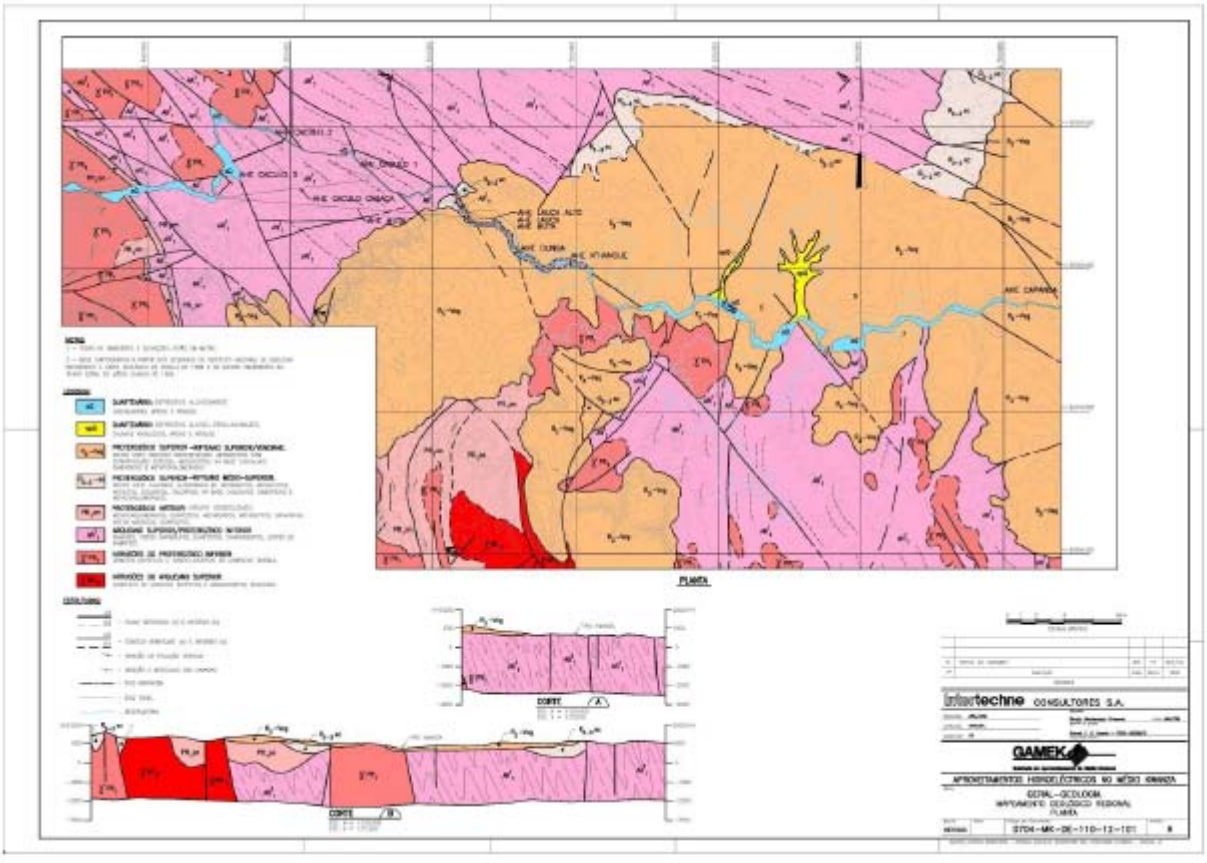

**Figure 4.7:** Regional Geological Map

The alluvial-pluvial deposits are formations from the quaternary, usually with surfaces covered by extensive sedimentary deposits, up to a few meters deep, and consisting of angular pebbles, sand, and clay. They have been identified in the AID, on the alluvial plains of the Malassangi and Dibo Rivers, both located on the Kwanza Rivers right bank.

The Calcareous Schist Group consists of calcareous rocks from the late Proterozoic (Late-Middle-Riftean), with alternating metarenites, metastiltites, argillites, dolomites, and cemented gravel and gravel metaconglommerates at the base. In the AID this formation occurs in a narrow strip, to the north of the Kwanza River's right bank, between 800 meters and 900 meters altitudes, in the Mucoso River watershed, in the Quimbalacata region, which marks the transition between the formations of

the Silty Schist Group (late Proterozoic) and the Basement Complex (late Archean/lower Proterozoic).

### 4.1.4 SEISMICITY

Though modest as compared with other regions of the world, seismicity in Angola is significant, as several earthquakes measuring 5.0 on the Richter scale have occurred, and for this reason seismic risk in the country cannot be ignored.

Notwithstanding the seismic studies done in recent years in connection with the *Global Seismic Hazard Map-GSHAP*, which points to few areas in Angola recognized as having active tectonics, seismicity in the country is not well-known. The identification of homogenous sources zones is hindered by the sparse, incomplete seismic records and the lack of more modern seismic stations, which causes uncertainty as to the earthquake parameters.

Seismologic studies (ANGOLA, 1986, 1988, and CATANIA, 2006) indicate that seismic activity in the AAR is low, and that the areas with greater activity are located in the country's Center-South. Studies done for the Capanda AH Project located in the neighborhood of the dam construction site have indicated seismicity associated with the two profound regional faults within the perimeter established for the AAR.

The first profound fault, known as the Eventual Seismic Focus (FSE-1) or South Kwanza fault, runs at about 15 kilometers north of the reservoirs' location, being limited on the south by the Kwanza Horst, which geologically divides the Maiombe and the Angolan crystalline shields. On the right flank it has an approximate E-W direction, and was associated with two quakes that occurred in 1968 and 1976, with a magnitude of 4.4 and 4.8, respectively. The latter quake's focal depth was 33 km.

The second profound fault, the Eventual Seismic Fault IV, runs at about 50 kilometers from the Capanda AH dam, on its left flank, and was associated with a great quake in 1914, of a 6.54 magnitude, and two smaller quakes of 4 and 6 magnitudes.

An analysis of the seismic intensities of various quakes recorded at the Capanda AH and their acceleration indicate that the parameters calculated for the events included in international catalogues, with maximum accelerations of 0.02g, are consistent with the values estimated in the regional studies done in recent years under the GSHAP. The quakes studied by SONDOTÉCNICA were located to the west and at long distances (a minimum of 245 kilometers) from the Capanda AH site, with their epicenters located mainly in the Kwanza Sedimentary Basin.

The values calculated for the quakes associated with the FSE-1 ad FSE-IV faults, at 15 kilometers and 50 kilometers from the Capanda AH dam, which are not shown in the international records, indicate considerably greater accelerations, between 0.1434g and 0.314g for the maximum magnitudes adopted for the faults. These quakes were probably recorded in regional seismographic stations and are not included in international records.

It is thus recommended that the same seismic parameters employed in the Capanda AH projects be adopted. These parameters are related to intensity 7 on the MSK-64 scale, which corresponds to intensity VII-III (7.5) on the Modified Mercalli scale, as noted in the "Relatório Detalhado do Projecto – RPD – Parte VIII – Investigações – Livro 3 – Estabilidade da Barragem e Fundações – Memória Explicativa," issued by Hidroprojekt" [Detailed Project Report-DPR – Part VIII – Surveys – Book 3 – Stability of the Dam and Foundations – Explanatory Document].

## 4.1.5. MINERAL RESOURCES

In view of the impossibility of gathering secondary data for lack of specific studies, it is not possible to know the AAR's current mineral potential.

Although there is evidence that the Middle Kwanza River Basin has some mineral resources deposits, such as diamond iron, copper, and limestone, according to the available literature, only manganese has been exploited so far.

Prior to independence, manganese was exploited in 20 mining sites in the northwest of the Malange province, in the Lucala region, in more than 80 small deposits, particularly in those of Quiota and Lengué, where ferromanganese with 25%-45% manganese and 2%-44% iron content. The main metallic minerals were psilomelane and pyrosulite, and in smaller quantities, manganite and braunite with Fe, Ba, and Ca impregnations. Alluvial ores are found in surface deposits in the form of a carapace measuring up to hundreds of meters in length and width and up to 3.0 meters depth on the surface.

Reserves of high grade manganese are estimated at 4-5 billion tons. But this figure can be higher, as sufficient studies have not been made to determine the total area where manganese occurs in the Angolan subsoil.

As regards possible mineral resources to be found, particularly in the AII, according to the Capanda Agro-Industrial Hub Project, some minerals of commercial interest may occur, indicated by the type of rock and lithological stratification found in the region, including gold and diamond in the rock substrate of the Silty Schist group. Manganese, as well as limestone, may occur in rocks of the Calc-Schist group. Ornamental stones and aggregates for civil construction may occur in the arkosean basement, in different types of gneiss, migmatites, granites, and quartzites.

Sandy soils in river channels, appropriate for asphalt paving, are easily available, as are sandy clay soils appropriate for embankments in civil construction. There are thick layers of laterite in grainy soils, which are used as road paving base and sub-base, railroad ballast, and protection of slopes.

## 4.1.6. GEOMORPHOLOGY

The relief of the Angolan territory is characterized by a series of plateaus that slope down from inland towards the East and the Southeast and to the ocean shoreline; some of these plateaus reach altitudes above 1,500 meters (Figure 4.8).

The territory consists mainly of a highland massif, limited by a narrow strip of lowland, whose altitude ranges from 0.0 meters to 200 meters. Above 200 meters come mountains and plateaus, which occupy most of the Angolan territory.

The Moco Mount in the Huambo province, approximately 2,620-meters high, is the highest point. The coast slopes down slightly and has few bays and promontories. (Figure 4.9).

Relief in the Middle Kwanza River hydrographic basin is diversified, encompassing coastal and sub-coastal, sub-plateau, and plateau areas. The coastal area has altitudes of 50 meters to 100 meters, and is cut by an intricate hydrographic network. The gently rolling relief gradually becomes hilly and steep.

In the Kwanza River valley there are residual reliefs up to 800-m high; and inselbergs, known as “isle mounts,” are frequent. In some areas, drainage is internal, and is characterized by small internal basins that converge to a central, lower point, where they remain for a long period during the dry season. These natural reservoirs are regionally known as *cacimbas*.

The sub-coastal surface has altitudes of 400 meters-600 meters and is characterized by forms of strong relief or hills, particularly in the inner strip, which marks the transition to the sub-plateau surface.

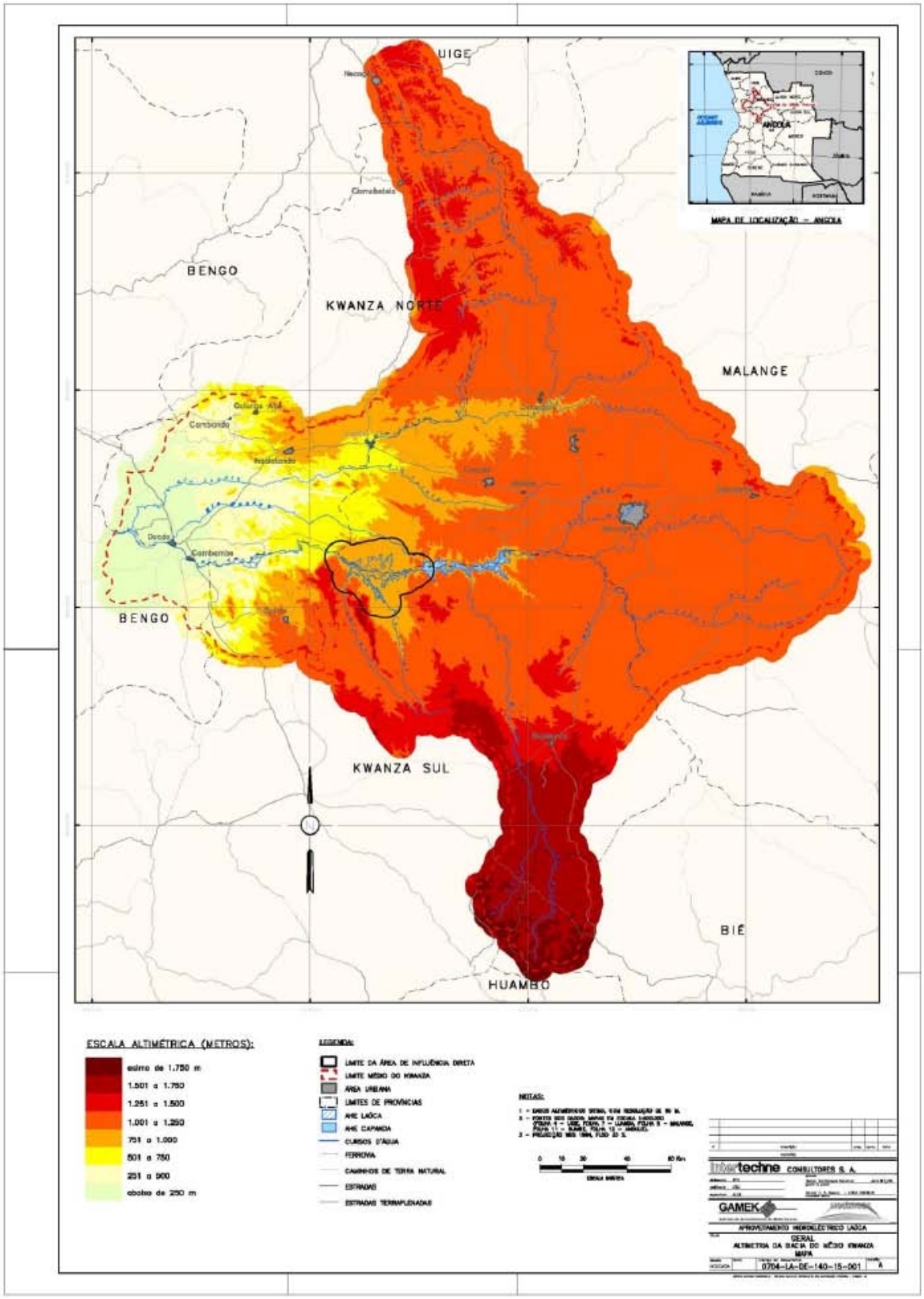


**Figure 4.8:** Altimetric Map of the Middle Kwanza River Basin

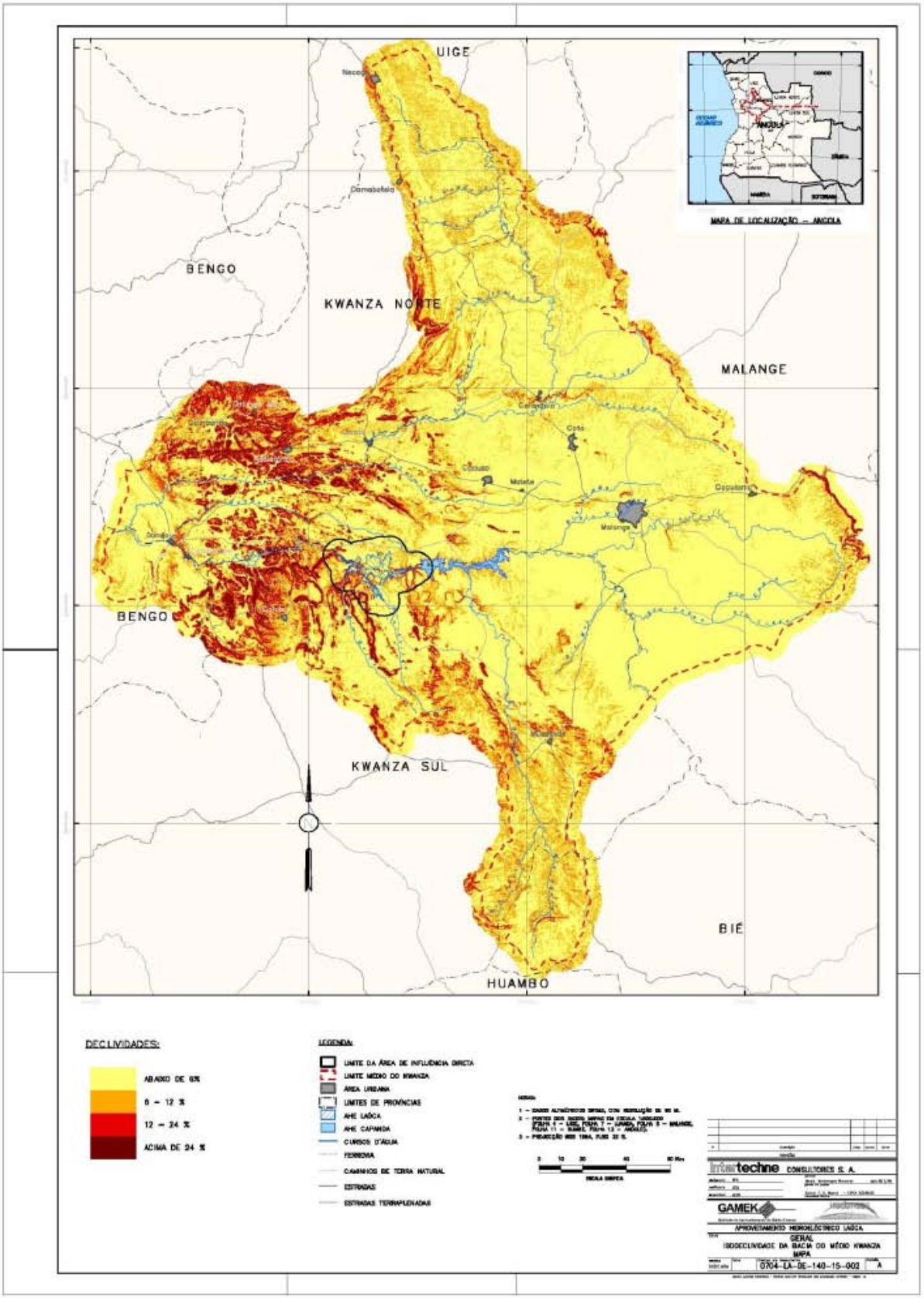


**Figure 4.9:** Iso-declivity map of the Middle Kwanza River Basin

The escarpment grade beginning in the Kwanza River increases and extends southward. The craggy surface takes on steep forms, with levels ranging from 600

meters to 750 meters from the base, with contour curves 300 meters to 400 meters up to the crest that marks the beginning of the high plain; isolines range between 900 meters to 1100 m. With an approximate N-S orientation, the escarpment veers toward the NE (10°30'), often showing an abrupt profile. At other times, the level difference is marked by a succession of hills and heights bordering on deep valleys. There are spots where the terrain is more or less level or gently rolling, where major rivers flow, such as the Muconga and the Mucoso, with significant river banks. But rough, craggy terrain predominates owing to the concentration of rock outcrops at the soil level, where inselbergs (Photo 4.1) are found, which in some cases change into mountainous massifs.

The hydrographic network has little density; it becomes denser in areas where river flow volumes are temporary, such as the Mucoso, Moisés, Luime, and Muconga; or dry up, with the exception of the Kwanza and the Lua Rivers. The rivers flow almost at the plain level, without forming significant valleys, except for the Kwanza, which has a deep channel, drying up the surface as it runs speedily through rocky, deep beds, where rapids and falls are frequent. These characteristics evidence its potential for hydroelectric power generation.

**Photo 4.1**: Residual hills (inselbergs) in the Mucoso River basin, São Pedro da Quilemba district.

On the sub-plateau surface altitudes range between 700 meters and 800 meters and on the typically rolling terrain bristly outcrops rise, as do small hills in some areas. The hydrographic network is moderately dense, encompassing the basins of the Lucala and the Middle Kwanza Rivers. The flow volume of the main rivers is reduced in the dry period, becoming intermittent downstream, as is the case of the Mucoso River. The Malanje Plateau region (Photo 4.2) is a vast plateau expanse of gently or moderately rolling terrain, where altitudes average between 1,050 meters and 1,250 meters. This surface forms an extensive peneplain starting from the Kwanza River and continuing northward toward the Camabatela Plateau. This plateau is the oldest regional plain, above which no residual relief forms are to be found to indicate the existence of primitive erosion surfaces.

The aspect of the relief evidences marked stabilization, with extensive undulating surfaces; in some places it shows level terrain cut through by frequent water courses that run through very wide, broad-bottom valleys, with little level differentiation.

**Photo 4.2:** View of the Malange Plateau near the right bank of the Kwanza River. Pungo Andongo district.

To the east and northeast, the Malanje Plateau is abruptly interrupted at the top by a single escarpment that marks the limit of the Cassange Lowland. The springs of the Gango River are located in the ancient plains in the hinterland, but a large part of its sub-basin forms part of a peneplain of moderately rolling terrain devised from the crest of the great Amboim-Seles escarpment, with its northeastern prolongation (Libolo), dipping significantly thence until it meets, inland, another steep terrace that marks the abrupt transition to the higher altitude plateau plains. On the steep terrace that separates the local base levels from the higher level, the river courses flow in a succession of rapids and falls, evidencing the movement of the terrain through deep cuts in the old surface. Thus are formed significant interfluves that, through progressive erosion, have resulted in inselbergs on the escarpment border.

The portion east of the Malanje Plateau belongs to another major geomorphologic unit separated from the higher plateau surface by an escarpment where level differences range from 100 meters to 150 meters. As they cross this escarpment, the rivers precipitate down overhangs, forming falls such as those on the Lucala River and those of the Luando River, its tributary; or they traverse it through successive rapids and waterfalls, such as those on the Lutete River. This lower surface, already rather dry, with altitudes that range between 700 meters and 950 meters, is characterized by an irregular, rough terrain, with residual forms resulting from the escarpments' retreat and the activity of the rivers, which define deep valleys, thus separating significant interfluves in certain places. The relief's movement is witnessed by the various forms of rejuvenation, notably various inselbergs and some sierras with rocky tops parallel to the rivers' course. In these sierras, the tops reach altitudes practically identical to those of the higher level planations, which become more evident eastward, as can be noticed between the Lucala and the Kwanza Rivers.

The Lucala River, a major Kwanza River tributary, plays a significant role in modeling the landscape. Upstream from the Duque de Bragança Falls, whose rocky entrance functions as a dyke, all the hydrographic network is of perennial flow, with rivers slowly circulating in deep valleys with a marshy base, forming meanders whose beds are not always well defined. In the rainy season, the margin lowlands become easily flooded and remain thus for long periods; in a humid climate, this

makes for an appropriate environment for the formation of organic or peat hydromorphic soils. After the falls, the Lucala River begins to run speedily on a deeper bed in a more pronounced valley, without giving room to low surfaces – or, when these occur, they are narrow margin strips.

The area under study is located in the middle portion of the Kwanza River Basin and is characterized by gently rolling hills and extensive pedimentary ramps, occasionally interrupted by residual elevations formed by inselbergs and steep sierras that result from the dissection of ancient surfaces based on sedimentary rocks of the Middle Kwanza River Basin and of the crystalline basement.

The AID geomorphologic units are located within Angola's central plateau. They are divided into two geomorphologic regions: one located to the north of the Kwanza River, encompassing the Malange plateau and sub-plateau zone; and one to the south, encompassing the Bié plateau, with sierra formations of middle and high declivity.

On the basis of lithology, structure, chronology, and drainage criteria applied to the relief's regional compartmentation and morphological sculpturing, the following geomorphologic units are defined in the area under study: the Malange Plateau, the N'gango-Buiza Interfluves, and Lower Platforms.

**The Malange Plateau**

This unit, located on the right bank of the Kwanza River, is characterized by a little dissected morphostructural arrangement; relief is generally level, gently to moderately rolling, and encompasses a vast surface with 800 meters-900 meters elevations. In the portion next to the Kwanza River, contact with sub-horizontal flat hills displays an erosive surface formed by pedimentary ramps at the foothills. Northward, in the interfluves with the Mucoso River, the gently rolling pediplain is occasionally broken up by residual elevations (inselbergs). The level relief is responsible for the little density of the hydrographic network, characterized by temporary rivers that feed the reduced flow of the Mucoso River in the rainy season. As their relief is typically rolling, these areas have low declivity, between 3% and 5%, and are broken up by hills (inselbergs), that have a declivity above 15 %. Given

these terrain characteristics, the surface drainage processes form ravines and fluvial trenches. This small effect of surface erosion is counteracted by the intermittent channels and by their connection to the drainage system flowing toward the Mucoso River. The contribution of this morphostructural arrangement has little significance as regards the transportation of detritus from the river channels toward future reservoirs.

**N'gango-Buiza interfluves plateau**

This unit is characterized by a morphosculptural plateau arrangement, including the frequent occurrence of residual reliefs in the N'gango-Buiza interfluves. In the AID, this unit starts from the Kwanza River and extends to the sources of the Luinga and Buiza. The relief in this area is typically gently rolling, with altitudes ranging from 900 meters to 1,000 meters; the terrain is broken up at the point of contact with mountain formations, formed by a pediplain resulting from erosion of the steep hillsides. The hydrographic network that forms the Luinga River valley is little dense, with river channels with intermittent flow and little level difference, owing to the relief characteristics. Starting from the Kwanza River, the sierra formations display a succession of crests and escarpments in the NW/SE direction, reaching heights above 1,600 meters (Serra M'bango) and 1,300 meters (Serra Quissangi), marking the Luinga and Buiza Rivers basins watersheds, in the case of Serra M'bango, and of the Luinga and N'gango Rivers basins, in the case of Serra Quissangi. The lithostructural arrangement of the Luinga River valley plateau consists of quartiziferous crystallophic rocks, and the formation of the higher arkosean Basement Complex, but with the occurrence of intrusive Lower Proterozoic rocks above 1,000 meters. The sierra residual formations consist of rocks of the grainy schist group from the Lower Proterozoic, and, less often, rocks of the calco-schist group. The Luinga River valley's plateau surface has little declivity – between 3% and 5%. The sierra formations have steep escarpment surfaces, with level differences between 400 meters and 500 meters and declivities above 30%.

**Lower terraces**

This unit is represented by lower topography, formed by pedimentary terraces whose altitude ranges between 500 meters and 700 meters. The morphosculptural

arrangement has relief features inclined toward the Kwanza River channel, forming alluvial fans, a result of the setting of the hydrographic network, with scattered residual forms caused by the escarpment's retreat. In the AID this unit starts at the escarpments upstream in the Caculo Cabaça area, with a 30%-declivity and a northwest orientation, extending up to the area's boundaries. The lithostructural condition consists of higher arkosean rock substrate, made up of gneisses, quartzites, charnockites, and amphibolitic schists. This unit's relief has a rather restrict influence on the dynamics of the river basin. The minute result of surface and river channel erosion is carried away through the channels and incorporated into the drainage network that flows into the Kwanza River.

## 4.1.7. PEDOLOGY

The country has vast expanses of fertile soils and abundant natural resources. However, over 50% of the soils suffer under constant or periodic erosion processes caused by rains. The more fertile soils are found near the rivers, where there is a concentration of alluvion, generally rich in minerals and organic materials, while soil fertility in the drier regions of desert climate is small.

In the Angolan territory there is a predominance of soils of the Arenosol and Ferrasol types, according to the classification system adopted by the Food and Agriculture Organization of the United Nations-FAO. According to the classification system used by the U.S. Department of Agriculture-USDA, the Angolan soils are entisols, ultisols, and oxisols. The Huambo and Bié provinces have various types and combinations of these soils, depending on the detailed horizon characteristics, such as ferralicarenosols, gleyicarenosols, and acric ferrasols, which are predominantly of the arenosol and ferralsol types, but with other characteristics, such as humidity regime, mineralogy, and the occurrence of certain horizons specific to the location.

In the Middle Kwanza River Basin's hydrography one notices a distribution of the soil types associated to the climate and the parent rock (Figure 4.10).

In the lands located in the dry climate one finds alluvial-fluvial soils, which are very appropriate for hydro-agricultural use. In higher lands, there are sparse areas with

favorable topography and more or less deep soils, and with favorable physical characteristics, making farming viable. These soils include brown lime soil (associated with Cretaceous formations); tropical aridic soils, particularly the modal reddish brown meso-aridic and modal grayish brown ultiaridic soils; loam (clays-modal black and reddish brown litho-clays); and tropical fersialitic soils, particularly brownish chrome clino-clayish eutrofersialic soils.

Other than in the plains and in some level spots in the highlands, hydro-agriculture is limited owing to unfavorable relief conditions, with a predominance of lithosoils often associated with rock outcrops. Even in surfaces of gently rolling relief gravelly elements occur, and in addition, soils have little depth in some cases.

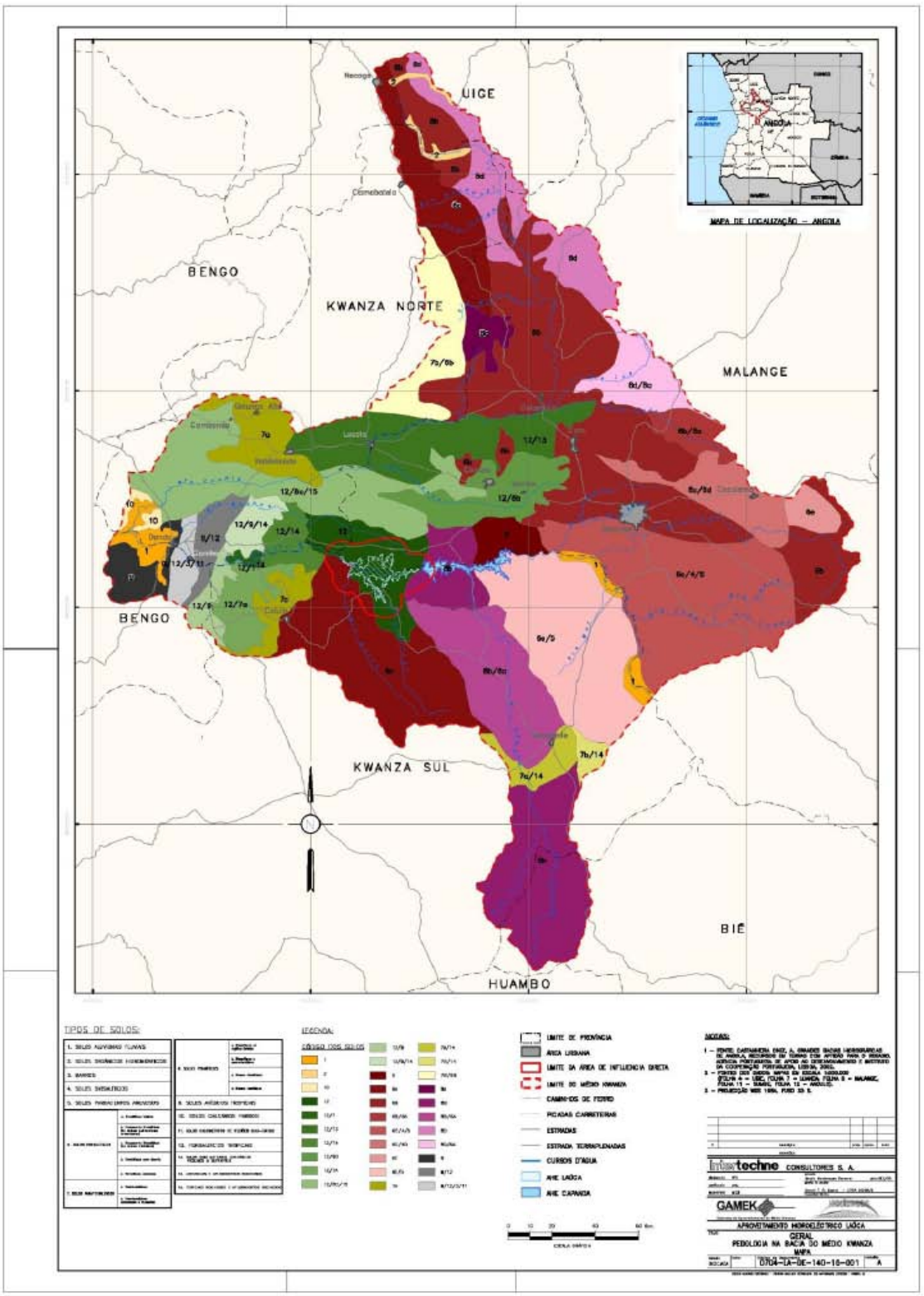


**Figure 4.10:** Pedological Map of the Middle Kwanza River Basin.

In other areas coarse/semi-coarse psamitic soils occur, often consisting of cover quartzous materials or quartzous materials originating in Precambrian quartiziferous

rocks, containing changeable minerals (feldspathic and micaceous materials) and a spare portion of fine soil related to fersialitic clay (psamo-fersialitic soils). In this zone, alluvion-filled valley bottoms occur, corresponding to colluvional and coluvio-alluvional soils.

In transition zones, climatic conditions favor the occurrence of tropical fersialitic soils, usually fine-grained and well-structured. Chrome clino-argillic tipofersialic soils, with little mineral reserve but of good depth predominate.

In humid climate zones, particularly ferralitic soils occur on the planation surface, related to crystalline rock formations and to ancient Precambrian sedimentary rocks. These soils have good physical characteristics, low or very low fertility, occurring usually in planation surfaces.

Paraferralitic soils occur in association with ferralitic soils, in rough but highly fertile terrain owing to the presence of minerals. Coarse-grained soils are also found, owing to the sandy material deposits related to the lower Kalahari and the Pleistocene. They are psamitic soils from the humid regions (brownish or grayish) and the psamo-ferralic soils (orangey or reddish), both consisting essentially of quartzous sand and a small argillic amount. The fluvial lowlands have humic as well as organic hydromorphic soils. The latter occur in more extensive areas where water is retained permanently or for long periods. They occur also in humid climate zones with soils with lateritic materials near the surface (thin soils).

The soils of the AID contributing basins originate mostly from rocks of the undifferentiated silty schist group and the Basement Complex. On the basis of the predominant soils in the AID, bibliographic material, and the pedological map (Figure 4.11), the pedological units have been classified as follows:

**Tropical fersiliatic soils**

These soils occur in the Laúca area and in the Middle Luinga River sub-basins, and extend to the Kwanza River channel, occurring also on its left bank in the entire northern part of the AID. In general, these soils are medium- and fine-grained, argillic, or sandy-argillic, brownish on the top layer and in vivid colors in the texture

B horizon. In this area there may also occur mineralogical soils dependent on the parent rock, with high concentration of feldspar and quartzous elements.

**Ferralitic soils**

Associated with highly stabilized level surfaces, these soils are considered to be of high maturity. They are very common in the AID, within the western boundaries of the Luinga River basin and extend to Serra Quissangi. In respect of morphological aspects, ferralitic soils are friable and fragile, usually unstructured. They are fine- or medium-gained chromic mineral soils consisting of kaolinic minerals, ferrous oxides, and aluminum.

**Paraferralitic soils**

These soils occur in rolling and steep terrain and their depth is less than that of the ferralitic soils. They have a dark horizon, which depends on the type of vegetal cover and topographic location. They are usually bright red, reddish, or orangey, and may be brown, depending on the parent rock. Their occurrence is frequent south of the Caculo-Cabaça area and extends southward along the Buiza River valley.

**Litholitic soils or lithosoils**

This unit is frequent in rougher terrains, and is represented in the various residual forms that occur in the AID, such as Serra do M'bango, and is more or less frequently associated with rock outcrops.

**Psamo-ferralic soils**

Associated with surface sandy formation, these soils have a sandy texture, with a small portion of ferralitic origin, consisting of ferrous oxides and aluminum. They occur in a small part of the AID, on the left bank of the Kwanza River.

## 4.1.8 SUSCEPTIBILITY TO EROSION

On the basis of bibliographical sources and of geomorphologic and soil types studies, the AID's susceptibility to erosion is very low (Figure 4.11). Some contributing the factors to this condition include the following:

- Good physical properties of the soil;
- Gentle, slightly rolling relief;
- Little dissected and high maturity relief;
- Predominance of declivities under 10%, except on the slopes of some residual mounts, where declivities exceed 25%;
- The region is little anthropized; and
- Predominance of native vegetation cover.

Field surveys have identified few scars of the erosive action of rain, and extremely low occurrence of linear erosion (trenches and gullies), which occur only in roadbeds. Given its climatic, geologic, geomorphologic, and vegetation cover characteristics and anthropic activities, the AID is only moderately susceptible to laminar erosion. As there is little anthropic activity, no silting up of water courses in the region has been identified.

## 4.1.9 PHYSIOGRAPHIC CHARACTERIZATION

The AAR is located in the middle course of the Kwanza River, in a transition zone between the coastal peneplain of Luanda and the interior plateaus.

In the initial stretch of the Kwanza River conglomeratic sandstone of the silty schist series occurs, while in the lower portion it occurs in the basement complex. The upstream stretch is characterized by a narrowing of the channel in the initial portion, which has gentle declivity; from Pungo Andongo on the river displays a more marked declivity and a concentration of successive rapids and falls, with little occurrence of widening banks.

On the right bank, the Malanje Plateau predominates, a vast expanse of gently or moderately rolling relief, which differs from the western portion by a escarpment with level differences ranging between 100 meters and 150 meters, crossed by rivers in successive rapids and falls. The terrain is characterized by irregular, rough relief marked by residual forms owing to the retreat of the escarpments, which define deep valleys and significant interfluves.

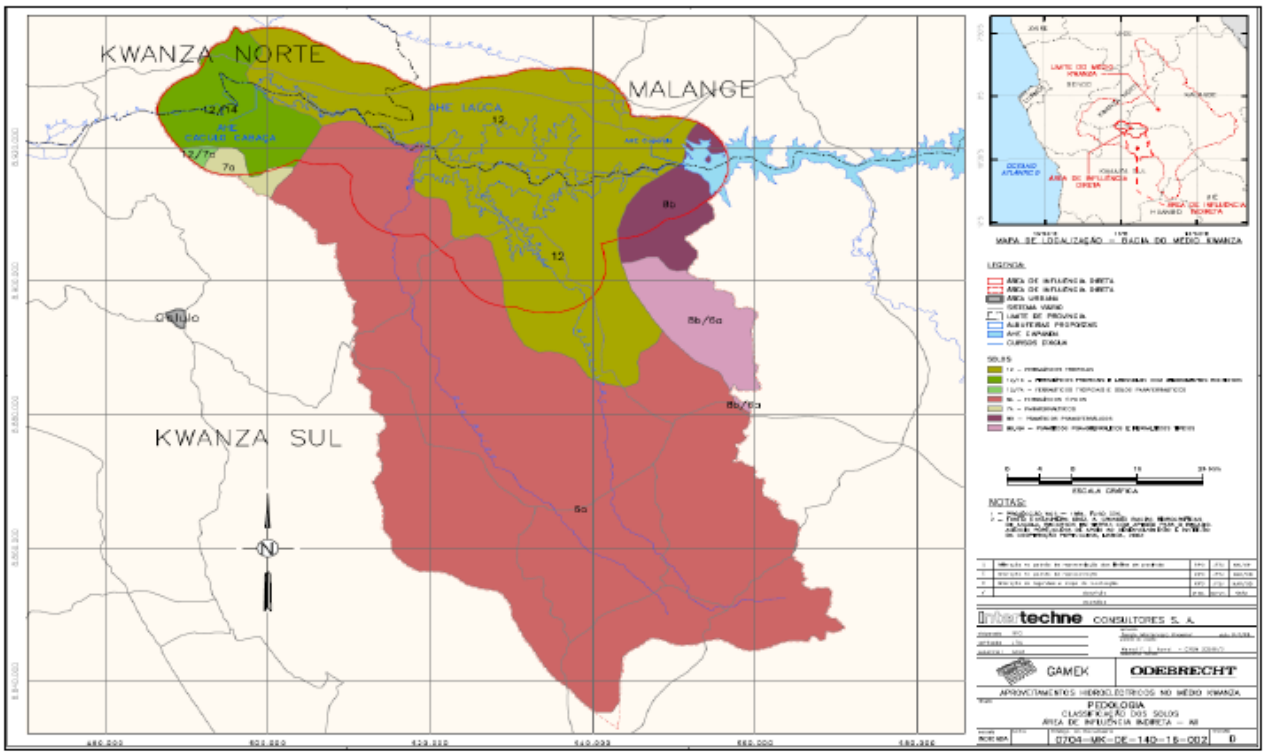


**Figure 4.11:** Pedology – Soils Classification – Indirect Influence Area

The southern portion of the AAR, to the Middle Kwanza River's left, consists of two major units with sharply contrasting relief forms of great significance in the landscape. To the west, a rugged surface with steep, craggy forms, with a level difference ranging between 600 meters and 750 meters, begins with a peneplain at heights ranging between 300 meters and 400 meters, which extends up to the crest that marks the beginning of the higher planation (unit's predominant relief) that reaches about 1,000 meters on the edge of the escarpments and gradually rises toward the south to 1,500 meters or more on the basin's boundary.

The AII's relief encompasses a small portion of the Malanje Plateau on the North, and the region formed by the Luinga and Buiza rivers' sub-basins, which account for 80% of the total area. In general terms, drainage is intermittent, except for the main water courses, which at times follow the fracture lines, assuming a rectilinear line

broken up into acute angles, as a result of intense tectonic activity, with possible influence on the relief’s local movement.

Between the two basins there are forms of residual relief resulting from pediplanation processes, especially in connection with Serra do M'Bango, the main divide, with heights of up to 1,600 meters, a level difference between 400 meters and 500 meters, and declivities above 30%.

## 4.1.10. WATER RESOURCES

The middle portion of the Middle Kwanza River Basin encompasses an area of approximately 54,537 square kilometers; it has an elongated shape, with a latitudinal orientation, and is approximately 435 kilometers in length and 350 kilometers in width.

The drainage network in this zone is asymmetrical, with predominance of the right bank. The major tributaries are the Lucala, Mucoso, Lombe, Kuiji, and Kuque rivers on the right bank, and the N'Gango, Mui, Luinga, and Buiza rivers on the left bank. Of these rivers, the Lucala and the N'Gango stand out owing to the size of their hydrographic basins.

- **Surface water availability**

The temporal distribution of the fluvial regime in the Middle Kwanza River Basin is highly seasonable, and many of its tributaries are intermittent. Between June and December the flow volume is below average, with a dry period between June and November, and lesser flow in September. The greatest flow volumes occur between March and May, peaking in April.

Approximately 15% of the annual precipitation in the area of the Middle Kwanza River Basin results in surface runoff. In the months of smaller flow volumes (June-October), runoff is 18% of the annual total. This characteristic is partly associated with the temporary retention of the runoff in lakes and in the sandy formations on the plateau of the Kwanza River's upper basin.

Between 1951 and 1974, the Cambambe AH rain gauge post recorded extreme minimum and maximum readings: 122 $m^3$ and 3,740 $m^3$. The long-term outflow mean recorded in this post between 1952 and 1982 was 684 $m^3/s$.

- **Flows**

Hydrological data from previous studies do not indicate temporal homogeneity. These data come from different sources and show considerable gaps. Nevertheless, an analysis of the available data points to the hydrological regime's great regularity, ensured by the fact that the Upper Kwanza River functions as a great reservoir that regularizes the river flows, storing them in flood times and maintaining the flows in dry periods.

The average flow series in the Laúca AH area have been regionalized on the basis of the available Capanda AH region data (1952-1974), by using the relation between drainage areas and specific water courses. The seasonal pattern of the projected medium courses indicates that the largest flow volumes occur between November and May, totaling 73% of the annual flow volume. The largest flow identified in the projections was 2,808 $m^3/s$ in April 1962, while the smallest was 129 $m^3/s$ in October 1958.

**Annual maximum flows**

Annual maximum flow data were obtained in a similar manner as above, by using the extrapolation of the information available at the Cangandala and Cambambe stations, in addition to the Capanda monitoring records. On the basis of the statistical analysis performed, the decision was made to adopt the results generated through GEV/PWM distribution (Generalized Extreme Values obtained by Probabilistic Weighted Values), which proved conservative.

However, as the spillways project flow, the decision was made to adopt the Capanda AH spillway's discharge capacity in operation upstream of the future Laúca AH, transferred through the relation between drainage areas to the site of the hydroelectric plants under analysis. Table 4.7 shows the results obtained.

**Table 4.7:** Flood flows in the Laúca hydroelectric plants

| TR (years) | Laúca AH ($m^3/s$) |
|---|---|

| | |
|---|---|
| 2 | 1,841 |
| 5 | 2,633 |
| 10 | 3,161 |
| 50 | 4,337 |
| 100 | 4,839 |
| 200 | 5,343 |
| 500 | 6,012 |
| 1,000 | 6,522 |
| 10,000 | 8,239 |
| Vertedouro | 10,020 |

**Source:** Intertechne Consultores S.A.

**Annual Flood Hydrographs**

To determine the typical annual flood hydrograph, use was made of the daily data from the Cambambe AH post, available in the SONEFE yearbooks. It was noted that over the years taken into consideration, there was the occurrence of floods that lasted up to eight months, which maintained, during nearly the entire period, flows of considerable magnitude and, consequently, of great volume. It was also noted that, despite the different magnitude of the floods analyzed, they show great regularity and similarity as regards form, volume variation, and duration. Also noted was the fairly regular occurrence of flood events with two peaks.

On the basis of these observations, the decision was made to adopt as typical flood hydrograph the hydrograph format resulting from the maximum flow recorded each day, i.e., comprehensively, as shown in Figure 4.12.

An analysis of volume variation and duration of floods was also performed on the basis of the maximum flow recorded. Based on adjusted regressions, the volumes and duration of floods in Laúca were determined, as shown in Table 4.8.

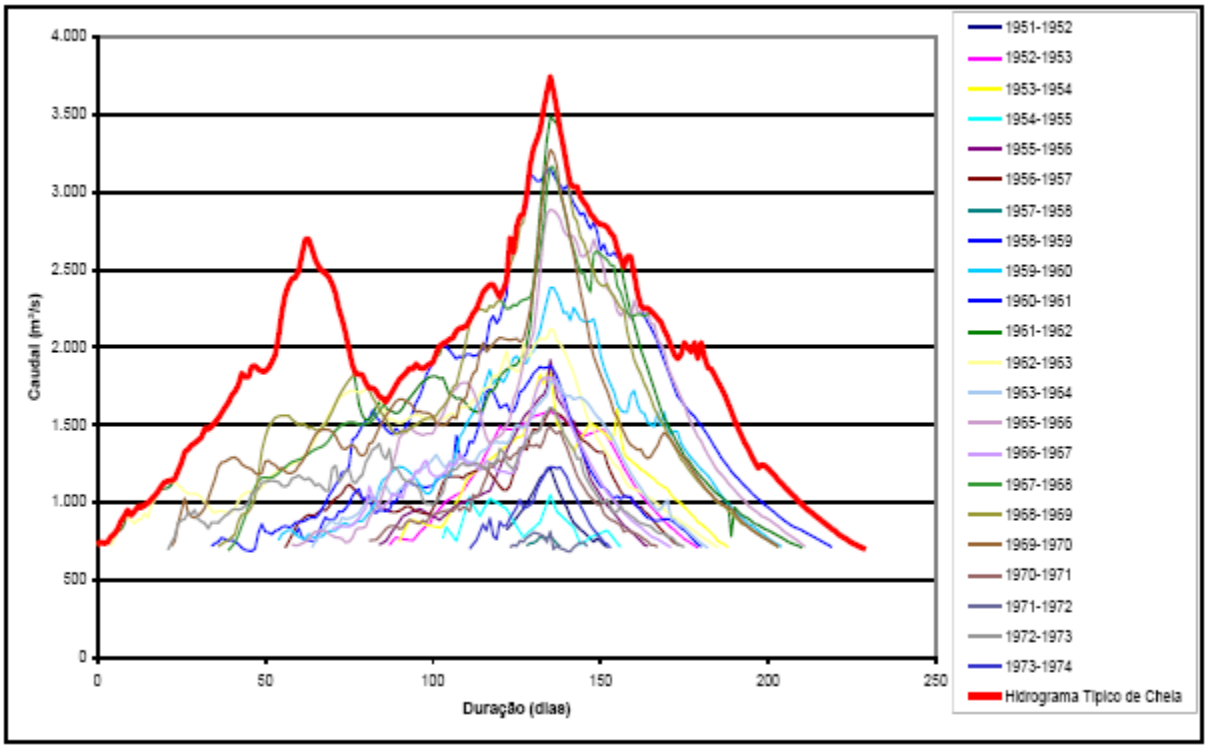


**Figure 4.12:** Format of the typical hydrograph adopted.

***Legend:***

Flow ($m^3/s$)

Typical flood hydrograph

Duration (days)

**Table 4.8:** Volumes and duration of flood hydrographs in Laúca AH localities.

| TR (years) | Laúca | | |
|---|---|---|---|
| | Max flow ($m^3/s$) | Volume ($m^3/s$) | Duration (days) |
| 2 | 1,841 | 11,798 | 116 |
| 5 | 2,633 | 19,697 | 159 |
| 10 | 3,161 | 24,973 | 181 |
| 50 | 4,337 | 36,713 | 220 |
| 100 | 4,839 | 41,730 | 233 |
| 200 | 5,343 | 46,761 | 245 |
| 500 | 6,012 | 53,448 | 259 |
| 1,000 | 6,522 | 58,539 | 269 |
| 10,000 | 8,239 | 75,677 | 297 |
| Vertedouro | 10,020 | 93,464 | 321 |

**Source:** Intertechne Consultores S.A.

**Minimum flows**

Minimum flows for the recurrence periods of five, ten, and fifty years and the periods of drought duration of seven, thirty, and ninety days were calculated according to the Weibull distribution, one of the most used worldwide in the study of droughts. The moments method (Kite, 1977) was employed to estimate parameters.

The distribution chosen was applied to the Cambambe station, and the dry period flows for the durations and recurrences indicated above were locally calculated. These values were then transferred to the Laúca AH station through drainage area relations. Owing the proximity of results for the two plants, the same values were adopted for both. Results are shown in Table 9 and in Figure 4.13.

**Table 4.9:** Middle Kwanza River Basin – Minimum flows at the Laúca AH ($m^3/s$)

| Duration of drought (days) | Minimum flows ($m^3/s$) | | |
|---|---|---|---|
| | 5 years | 10 years | 50 years |
| 7 | 137.6 | 120.6 | 99.3 |
| 30 | 146.4 | 128.5 | 105.5 |
| 90 | 166.6 | 146.6 | 119.9 |

**Source:** Intertechne Consultores S.A.

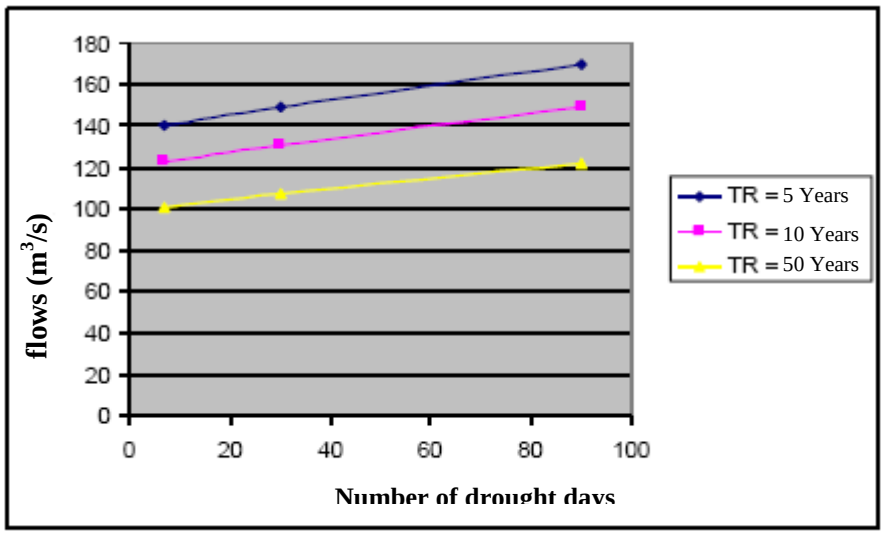


**Figure 4.13:** Middle Kwanza River Basin – Minimum flows for recurrences of 5, 10, and 50 years, with duration of 30 and 90 days. **Source:** Intertechne Consultores S.A.

**Compromise flows downstream**

According to the *Water Research Commission* (apud Benetti et al., 2003), complex computational programs to calculate minimum ecologic runoffs, which employ a wide range of entry data (such as the IFIM or the PHABSIM), are not viable for such countries as those of Southern Africa, for lack of the requisite information, time, specialized personnel, and financial resources. This applies also to Angola. Moreover, in some cases results obtained through complex methods are not better than those obtained through simpler methods (Benetti et al., 2003).

In view of the preceding, it seems that the use of the simpler method of ecologic flow maintenance is perfectly justifiable in the case of the Middle Kwanza River Basin. For the Laúca AH, the criterion chosen for maintenance of minimum flows downstream is the same adopted in the state of Paraná, Brazil, which is 50% of the $Q_{7,10}$ flow, i.e., the minimum flow with seven days of duration and ten years of recurrence.

The $Q_{7,10}$ flow criterion has been employed in water quality studies to determine the efficiency of pollutants removal in residual water treatment plants that do not violates the water quality standards in receiving bodies (Thomann and Mueller, 1987, apud Benetti et al., 2003).

## 4.1.11. SEDIMENTS

The hydro-sedimentological information for the Kwanza River is very scarce and indicates only quantitative data regarding solids transport. The only data pertaining to the area under study are found in the Capanda AH Hydro-meteorological Studies and Hydrologic Yearbook (1988-1989).

Based on available records, the Capanda AH Hydro-meteorological Studies estimate the volume of sediments at 430,000 $m^3$/year, with a specific weight of 1.2 t/$m^3$, which corresponds to an annual burden of 516,000 t/year. However, the study mentioned recommends the adoption of the figure of 720,000 t/year.

The 1988-1989 Yearbook on hydrological services done for the Capanda AH show three solid flow measures taken in that period 1986 and 1989, indicating an average burden of 550,000 t/year. But, given the serious lack of information on the subject, the calculation of sediments retained in the reservoirs has adopted the aforementioned higher figure of 720,000 t/year.

The efficiency of sediment retention in a reservoir may be determined by the curves in the chart proposed by Brune (1953), which relates efficiency to the ratio between the reservoir volume and the affluent flow. Table 4.10 shows a summary of the data used in this calculation.

**Table 4.10.** Data used to calculate sediment retention in the Middle Kwanza River Basin.

| Entry data | Laúca dam |
|---|---|
| **Reservoir volume – maximum level (hm3)** | 5651.2 |
| **Mean flow in the period ($m^3$/s)** | 684.5 |
| **Retention efficiency – Brune curve (%)** | 94.6 |

**Source:** Intertechne Consultores S.A.

The analysis results indicate that the future Laúca dam reservoir may retain water for a long time, thereby permitting the nearly total depositing of suspended solids. For example, with an annual burden of 720,000 t/year, the Laúca AH reservoir will discharge about 38,880 t/year, of which 15,202 t/year will be discharged by the Caculo Cabaça AH, which means a 98% reduction by the two reservoirs together. Based on this information, one can conclude that retention efficiency will have a bearing on the river's erosive capacity downstream the reservoirs.

It is important to remember that the calculations performed are approximate and that the data available refer to a scenario prior to the existence of the Capanda AH reservoir.

More refined results may be obtained by considering a non-horizontal depositing of sediments, as well as variations in the material's specific weight and the reservoirs' retention efficiency over time. Moreover, it is crucially important to confirm the sediments burden in the sites of interest.

## 4.1.12. WATER QUALITY

The hydrochemical and biological characterization of reservoirs is necessary for a prognosis of the future immunological conditions in the lacustrine environment that will be created. This characterization is all the more important as the more complex is the drainage basins' runoff regime and the more diversified is the soil occupation pattern and the use of water resources.

The stretch of the Kwanza River to be flooded for the reservoirs in the proposed projects (i.e., Caculo Cabaça, Laúca, and the raising up of Cambambe) has a generally wide channel, but with steep banks that make the access to the water course difficult or impossible.

According to satellite images, there is a stretch of apparently slower flow, with some islands that seem to be of little ecological significance for the fluvial environment during the rainy season; but it is highly likely that planktonic and benthonic communities may flourish there during the dry period (Photo 4.3).

There are no relevant tributaries between the Capanda AH and the Laúca AH axis, so that the hydrochemical conditions determined by the Capanda discharges and the sequence of numerous rapids along the stretch predominate.

**Photo 4.3:** Site of the future Laúca AH dam (April 2008).

These rapids promote the oxidation of chemically reduced substances transported downstream the dam by the turbines catchment and bottom discharge. The normally observed impact from the discharge of water without oxygen may be minimized by the rapids in Laúca's proximity.

Once the rainy season is over, the spillway operation will cease, as will bottom discharge. At this time it is important to know the Capanda AH reservoir's thermal pattern, as the quality of the water that will pass through the turbines will result from the water gauge mixing processes, common in both autumn and winter. A lower oxygenation rate is to be expected in the discharge channel, but there is the expectation of prompt recovery of dissolved oxygen, though this possibility can be confirmed only by monitoring.

During the months of April-July 2008, the Capanda laboratory performed chemical analyses of the Kwanza River water. Three sectors were well defined: downstream the Capanda AH; the middle stretch of the Kwanza River course (where the Laúca axis will be built and near the Muta village); and at the Filomeno Câmara bridge downstream. The analyses were limited to the available reactants. Table 4.11 shows the results obtained.

The data from the limnological and water quality sample parameters indicate that the Kwanza River waters do not transport a large quantity of nutrients, thus reflecting the little soil use in the region. The waters are clear and tend to neutral pH, with moderate plugging, indicated by alkalinity. This would reduce the risk of machine corrosion. Hardness, though, is low, as is the concentration of calcium an manganese ions.

Phosphate analyses in the stretches directly downstream the Capanda AH, in Toca do Coiso (Photo 4.4), suggest the existence of a phosphate stock in the reservoir's bottom. This phosphate could be potentially available to phytoplankton. In April 0.05 mg/L of sulfate was detected . The sulfate is an indicator of aerobic environments, in which phosphate is found dissolved. Transferred downstream through the turbines or bottom discharge, phosphate would have eutrophication potential, though neutralized by the Kwanza River's vigorous rapids, which do not favor the growth of algae, even when nutritional conditions are appropriate.

The total nitrogen and its fractions indicate low concentration of this nutrient in the river, reflecting a probable stabilization of the Capanda AH reservoir's trophic condition and the absence of agricultural activities or urban areas near the river. As to the sanitary aspect and

organic pollution, the water environment studied has shown lack and low rates of nitrogenous nutrients in the river portions studied.

This is due to the inexistence of intense settlement in the influence area.

**Photo 4.4:** Middle Kwanza River Basin – Toca do Coiso.

**Table 4.11:** Water quality analyses results. (2008)

| Water Quality | | Downstream Capanda | | | Middle Stretch | | Downstream Caculo-Cabaça | |
|---|---|---|---|---|---|---|---|---|
| | | 04/22/2008 | 05/20/2008 | 07/10/2008 | 04/22/2008 | 06/12/2008 | 05/21/2008 | 07/10/2008 |
| **Variables** | **unit** | **Toca do Coiso** | **Toca do Coiso** | **Toca do Coiso** | **Laúca** | **Muta** | **Filomeno Camara** | **Filomeno Camara** |
| **Turbidity** | NTU | 4 | 5 | 4 | x | 4 | 5 | 4 |
| **pH** | - | 7.12 | 7.3 | 6.8 | 7.16 | 7.24 | 7.7 | 7.33 |
| **Total hardness** | mg/L | 4.4 | 4.1 | 4.89 | 4.46 | 4.53 | 4.4 | 4.44 |
| **Calcium** | mg/L | 1.06 | 1.08 | 1.64 | 1.3 | 1.72 | 1.24 | 1.08 |
| **Total alkalinity** | mg/L | 31.12 | 24.4 | 31.12 | 32.95 | x | 24.4 | x |
| **Magnesium** | mg/L | 3.34 | 3.03 | 3.25 | 3.16 | 2.81 | 3.1 | 3.35 |
| **Aluminum** | mg/L | 0.02 | 0.07 | 0.03 | 0.17 | 0.06 | 0.06 | 0.11 |
| **Manganese** | mg/L | 0.41 | 0.21 | 0.25 | 0.31 | x | 0.2 | x |
| **Iron** | mg/L | 0.23 | 0.21 | 0.16 | 0.22 | 0.26 | 0.23 | 0.16 |
| **Phosphate** | mg/L | 0.11 | x | x | x | x | x | x |
| **Total nitrogen** | mg/L | 0.8 | 0.3 | x | 0.1 | 0 | 0.2 | x |
| **Nitrite** | mg/L | x | 0,009 | x | x | x | 0.005 | x |
| **Nitrate** | mg/L | x | 0,1 | x | x | 0 | 0.2 | x |
| **Ammonia** | mg/L | 0.019 | x | x | x | x | x | x |
| **Sulfates** | mg/L | 0.05 | 0.018 | 0.013 | 0.01 | 0.014 | 0.015 | 0.009 |
| **Sulfites** | mg/L | 1.2 | x | 0.8 | 1.1 | 1.1 | x | 0.6 |

**Source** Intertechne Consultores s.A.

A social survey (2013) showed that the Kwanza River water near the Laúca AH is little used by the local population. The water is commonly used for fishing and washing clothes. These uses do not change the water's quality. The river does not receive organic discharges near the Laúca AH.

Odebrecht has a Kwanza River Water Monitoring Plan, whose main objectives are the publicizing of the analyses and the comparison of the results obtained according to the limits established by Presidential Decree no. 206/11 (Water Quality Regulation).

As a first evidence of this plan, a punctual sampling was done in three points of the Kwanza River to update the previously sampled points under the 2007-2009 limnologic surveys of the area.

Once again notice should be taken of the difficult access to the river and the occurrence of rapids, which hinder water sampling. Consideration was also given to the future access to the sampling sites, in view of the changes that will occur with the work on the dam site. Samplings were done on April 11 and 12, 2013 (See photo 4.5).

Measurements for the water's physiochemical characterization were taken on the surface; *in situ* readings were done with a Horiba (U-52G) multiparameter probe, which defined the following parameters: pH, conductivity, dissolved oxygen, water temperature, total dissolved solids, and oxidation reduction potential. Results are shown in Table 4.12.


**Photo 4.5:** Water sampling points. A) Praia Muta; B) km 41 of EN 322; and C) Emboque Laúca.

**Table 4.12:** Sampling results (April/2013)

| Parameters | Units | Praia Muta | Km 41 (EN 322) | Emboque Laúca |
|---|---|---|---|---|
| T | ºC | 26.34 | 26.52 | 25.30 |
| pH | - | 7.76 | 7.88 | 7.72 |

| | | | | |
|---|---|---|---|---|
| ORP | mV | 225.00 | 206.00 | 171.00 |
| COND | mS/cm | 0.04 | 0.03 | 0.03 |
| DO | mg/l | 10.63 | 11.00 | 10.68 |
| TDS | g/l | 0.02 | 0.02 | 0.02 |
| TURB | NTU | 0.00 | 0.00 | 0.00 |
| SAL | ppt | 0.00 | 0.00 | 0.00 |

The physiochemical characterization of the water done in April 2013 (Table 4.12) indicates that the Kwanza River in the study area has clear, slightly alkaline waters with low conductivity and a low rate of dissolved solids, and well oxygenated, mainly because of the occurrence of several rapids that permit mixing and oxygenation.

The water's physical and chemical characteristics in the study area are probably determined by the basin's geochemical properties, the occurrence of numerous rapids along the stretch, the climatic conditions, and the Capanda dam' discharge regime.

The results obtained were also compared and interpreted in light of the national legislation in force (Presidential Decree no. 261/11 of October 6) and the international standard values, especially as regards the European Union's (Directive 2008/105/EC - *Environmental Quality Standards*-EQS) for water quality in natural environments.

These results show that in general the Kwanza River, in the study area, has good quality water, which clearly shows little influence of upstream diffuse and punctual pollution.

Comparison of the results obtained with previous studies show some analogy, thereby corroborating the preceding statements. However, the available data do not permit an accurate evaluation, as continuous sampling has not been done to establish with rigor the current quality of the water in the area under study. Thus, the results of physiochemical analyses shown in Table 4.12 should be taken with due caution, as they have a punctual character and only an indicative value.

# 4.2. THE BIOTIC ENVIRONMENT

For the characterization of the biotic environment in the undertaking's influence areas various field surveys were done, with the employment of specialized techniques. Initially, in 2007 and 2009, extensive field surveys were carried out, encompassing all location alternatives (shown in Chapter 2), under a study titled Caculo-Cabaça. The Laúca influence areas were visited again to confirm and validate the 2012 information for the Environmental Impact Study (EIA) regarding the deviation of the river course. In 2013 new field visits were undertaken to update the data for this study (dam construction).

The starting point for the drafting of a work plan was the acquisition of knowledge of the reference situation of the species and environmental conditions in the undertaking's influence areas. To this end, a bibliographical research was done, based on scientific publications, technical documents, and reports and consultations available on the Internet.

Compilation of this information made possible a preliminary reconnoitering of the diversity of species likely to occur in the region, and the establishment of a database about their morphological, biological, and reproductive characteristics, their feeding habits, distribution patterns, and the main impact of anthropic origin to which they are subjected. Assembling the greatest number of scientific publications on the area was crucial, as there are no reference collections in the Angolan Museum of Natural History or in the Luanda Herbarium (Santos, 2002).

On the basis of the data thus compiled, it was possible to determine the size of the teams, the number of specialists, and the study's target groups, as well as the methodology and the most appropriate field sampling techniques. It was also possible to prepare field guides to facilitate the identification of the biological material collected and of the feeding habits and preferred habitats of local species, as well as their conservation status, reproductive characteristics, and other pertinent information.

Field visits were undertaken to update data in phase two of the study (dam construction), emphasizing the ADA, i.e., the reservoir filling area. Some of the information gathered in the area is herein presented.

## 4.2.1. VEGETATION COVER

The undertaking under study is located in the phytogeographical savanna domain. In general, savannas consist of small, crooked trees, sparse shrubs, and a dense grass layer vegetating on soils with low rates of nutrients (Photos 4.6 and 4.7)

**Photo 4.6:** Savanna in the Middle Kwanza River Basin.

**Photo 4.7:** Tract of savanna with predominance of the herbaceous layer.

Characteristics of the tree/shrub savanna are thick bark, large leaves and thick, leathery leaves. The root system may reach a depth of 15 meters, absorbing water from permanently moist layers of the soil even in the dry season.

The herbaceous and undergrowth vegetation consists of predominantly perennial species that have underground resistance organs, such as bulbs, xylopodia, and soboles, which allow the plants to survive drought and fire. The root system is usually superficial, attaining up to 40 centimeters. Aerial branches are annual; they dry and die during the dry season; their leaves are small and their stem and branches are less twisted.

Between these physiognomic extremes there is a wide range of intermediary forms. This mosaic is determined by patches of soils more or less poor in nutrients, the irregularity of the climatic regimes, the fire characteristics in each location (frequency, time, intensity), and human action.

## 4.2.2. MAIN VEGETATION CHARACTERISTICS

There follows a description of the main characteristics of the vegetation encountered in the Middle Kwanza River region and in the areas influenced by the dam construction. Definitions seek to provide a basic characterization of the types as well as of some subtypes (Figure 4.14).

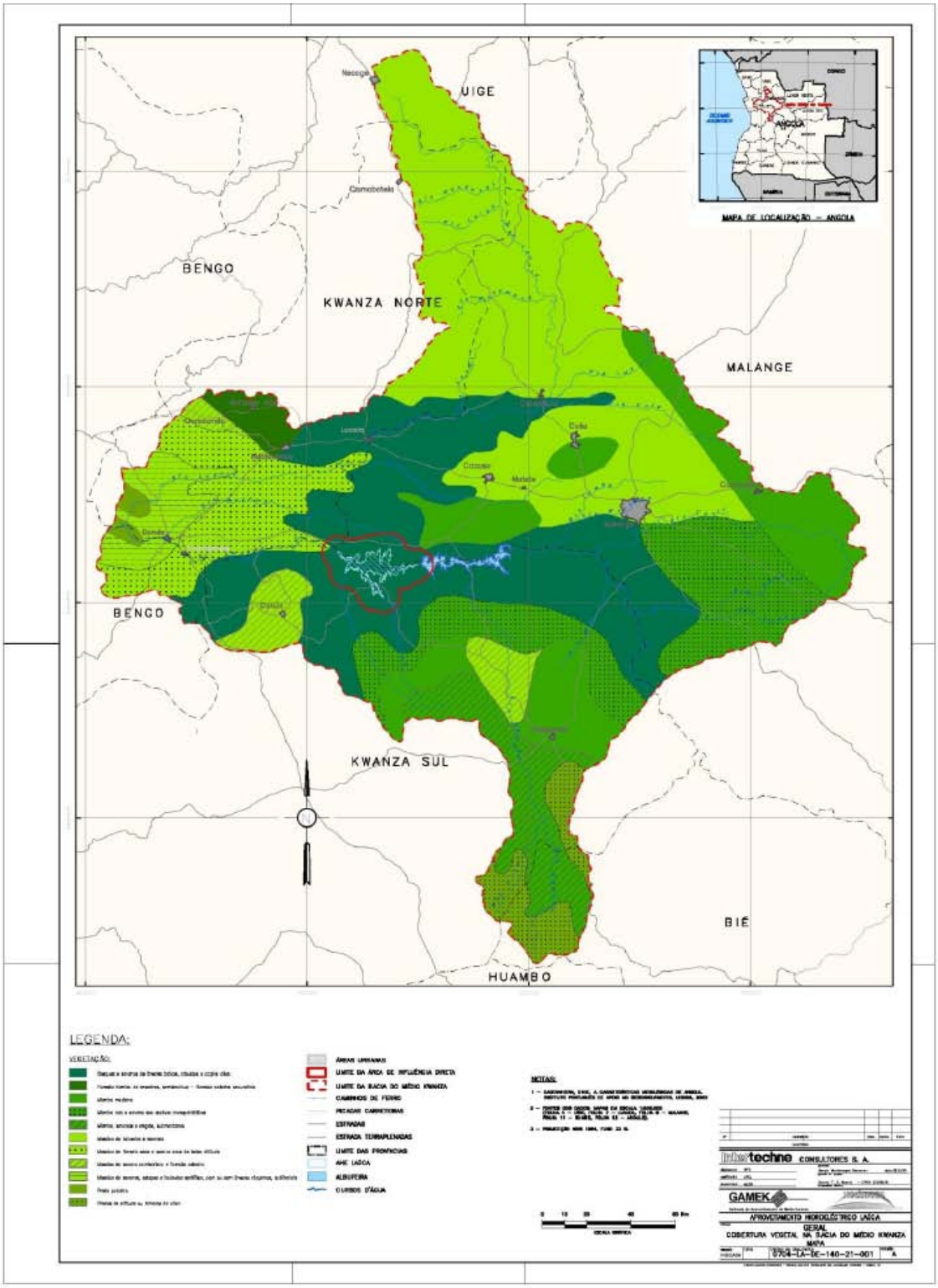


**Figure 4.14:** Map of the vegetation cover in the Middle Kwanza River Basin.

**Forests**

- **Woods/Riparian woods** (dense riparian alluvion forests/foggy humid, semi deciduous forests); riparian forest associated with wide water courses (rivers), particularly with the Kwanza River. The canopy height reaches 15 meters to 20 meters from the soil, without visible emergent trees, and there are places where oil palms dominate (Photo 4.8).

- **Woods/Gallery forests** (dense, humid, hygrophytic, riparian forest in deep valleys/discontinuous woods and forests in dense masses, with evergreens and annual species/wetland forests on river banks): ombrophilous evergreen forest associated with streams and small water courses in valleys or narrow ravines. Usually of modest width (Photo 4.9).

- ***Panda*** **woods/Open forests** Open forests/more or less dense woods of Brachystegia spiciformis, Julbernadia paniculata, and submontane *miombo*, savannas, and *ongote*/more or less dense, tall, and mixed *miombo*/sparse *miombo* and savanna on medium altitude plateau declivities/*Panda* woods; *Miombo*): thin forest or dense groves, with predominance of leguminous plants of the Brachystegia, Julbernardia, and Pterocarpus genders (Photos 4.10 and 4.11). This vegetation is essentially deciduous.

**Photo 4.8:** Riparian forest along the Kwanza River in the riparian stretch above Laúca-Alto. Predominance of oil palms [*Elaeis guineensis* Jacq] can be noted.

**Photo 4.9:** Gallery forest (Buiza River). Tree canopy is seen over the river.

**Photo 4.10:** Tract of *Panda* Woods

**Photo 4.11:** Tract of *Panda* Woods after fire in the dry season, when the grassy layer was charred. The soil, with rock outcrops, becomes practically exposed.

**Savannas**

- **Open savanna** (including a mosaic of thickets and savannas on ferralitic soils or ferralsols/thin *Baikiaea cocholospermum* woods): area with low trees or bushes scattered over a dense grassy layer (Photos 4.12 and 4.13).

- **Mono-dominated open savanna** (more or less secondary savanna or savanna on deficient soil): tract with low trees or shrubs scattered over a dense grassy layer, dominated by one or a few woody species (Photo 4.14).

- **"Thin" savanna** (low, sandy savanna/savanna on sandy lowlands, poorly drained, with or without trees): tract with few trees or thick shrubs scattered over a dense grassy layer (Photo 4.15).

- **Park savanna:** tract with tall trees forming small stands concentrated on specific portions of the terrain, separated from similar copses by a considerable expanse of exclusively herbaceous, grassy vegetation (Photo 4.16).

- **Park savannas with *murundus*:** tract with arboreous-shrubby vegetation concentrated on patches of slightly elevated terrain (*murundus*), separated from other similar woody vegetation by considerable expanses of exclusively herbaceous vegetation (Photo 4:17).

**Photo 4.12:** Open savanna after fire (dry season).

**Photo 4.13:** Middle Kwanza River Basin – Tract of open savanna after fire in the dry season, already showing vigorous, newly sprouted grass.

**Photo 4.14:** Tract of open mono-dominated savanna in the Laúca influence area, with the predominance of fruiting *Julbernadia sp*.

**Photo 4.15:** Thin savanna in the Middle Kwanza River Basin.

**Photo 4.16:** Park savanna in the dry season. One can note open tracts covered only by the grassy layer and tracts with groups of trees forming small woods.

**Photo 4.17:** Tract of Park savanna with *murundus* in the Middle Kwanza River Basin. One can note the terrain with some more elevated patches (*murundus*), where arboreous woody plants (area not burnt) are concentrated. These small islands check the advance of fire in the dry season, which spreads over the field.

**Fields**

- **Dry grassy field** (low sandy, poorly drained savannas, with or without trees[1]; "*chana*": tract without woody vegetation and with dense grassy cover and plants adapted to dry soils. It may be seasonally flooded in areas adjacent to rivers, when it is called *chana* (Photo 4.18).

- **Humid grassy field** (lowland savanna; *chana*) tract without woody vegetation in lowlands, with plants adapted to soaked soils in the rainy season, formed by herbaceous species, with predominance of *Poaceae* and *Cyperaceae* (Photo 4.19). These fields are also known as "low-lying fields."

- **Rupestrian field** (skeletal soils vegetation and rock outcrops/altitude meadows): tracts with large outcrops in level areas or small outcrops on steep slopes, with flora adapted to a rupestrian environment, such as *Vellozia sp* (Photo 4.20).

[1] It should be noted that Grandvaux-Barbosa (1970) treat these types of clear fields as "savanna," but this view is not shared in this study.

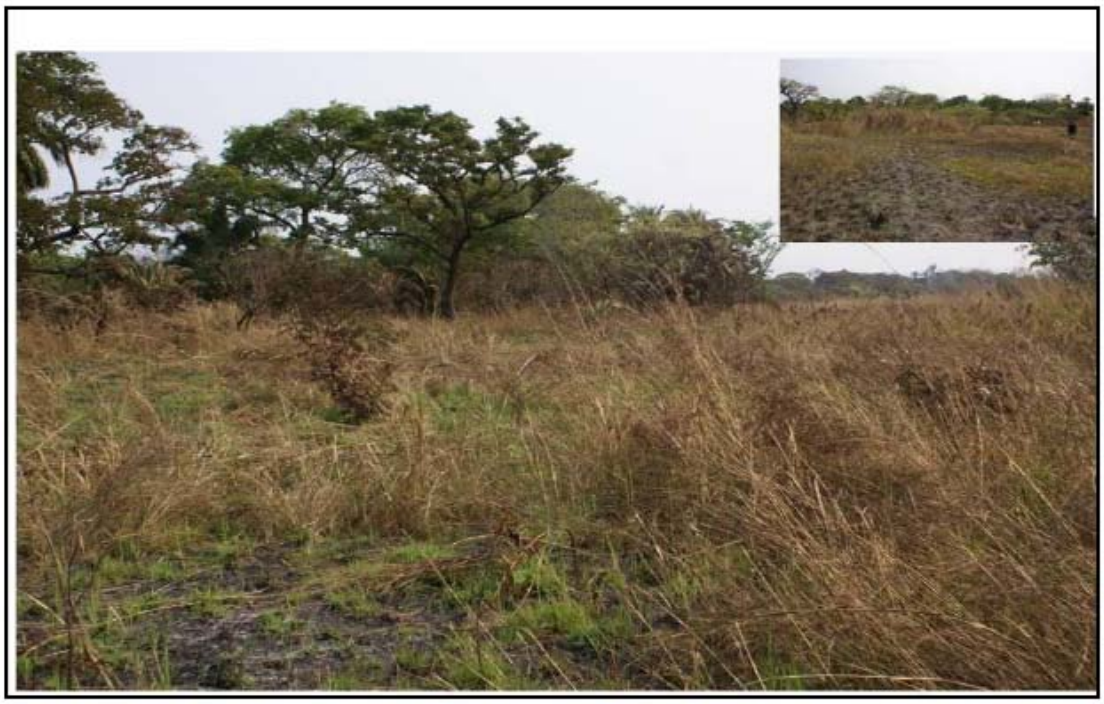

**Photo 4.18:** *Chana* adjacent to gallery forest by the Kwanza River. In the detail, a strip of level grassy field (drained in the dry season) that is flooded in the rainy season.

**Photo 4.19:** Humid grassy field in the Capanda surroundings. Grass adapted to soaked soil at the end of the rainy season.

**Photo 4.20:** Detail of *Vellozia sp* specimen in a tract of rupestrian field.

**Other types**

- **Marsh** (palustrine meadow; grass in flooding depressions): permanently flooded tract (even in the dry season), with dense shrubby-herbaceous flora adapted to this environment, and presence of genders such as *Typha* (Photo 4.21).

- **Riparian arboreous-shrubby vegetation** (non-forest): riparian tracts adjacent to river pools, consisting of arboreous aquatic macrophytes, including *Pandanus* and occasional greater grass density (Photo 4.22).

- **Riparian beaches** (pioneer, psammophyte, steppe-type vegetation): discontinuous sandy tracts with thin herbaceous vegetation adjacent to the Kwanza River (Photo 4.23).

- **Anthropic, agricultural, and ruderal areas:** tracts with secondary vegetation, anthropized or crop areas (Photo 4.24).

**Photo 4.21:** Marshy tract with *Typha p.* predominance.

**Photo 4.22:** Dense grassy tract, common in river pool areas, above Laúca (Kwanza River).

**Photo 4.23:** Area adjacent to the Kwanza River; sandy soil, with widened stretches.

**Photo 4.24:** Anthropic area in the Capanda village. Secondary vegetation in the grassy stratum and exotic plants under cultivation.

# 4.3. BIOTIC ENVIRONMENT IN THE ADA AND SURROUNDINGS

This section describes the characterization of the main biological aspects of the ADA and surroundings abutting on the Laúca dam. Tools used included field trips made between 2007 and 2009 by a specialized team, and bibliographical material related to specific regional reports. Visits to the site were made for the EIA regarding the deviation of the river course (2012) and again in 2013 for updating and validating the information.

## 4.3.1. METHODOLOGICAL PROCEDURES

Note should first be taken of some difficulties encountered in planning and carrying out the collection of information in 2007 and 2009, such as limited access to the field owing to the possible existence of mines in the locations to be visited, the scarce bibliography on the subject, and the difficulty in biological material identification.

The general methodology employed in this project was thus an adaptation of the rapid ecological evaluation (Sobrevilla and Bath, 1992), which consists in investing heavily in obtaining the greatest volume of data in the time available for field activities, and integrating the various specialists' evaluation of different subjects in common sampling locations. For greater data integration, all information was georeferenced.

To understand the region's biological complexity, some indicative parameters have been chosen on the basis of logistic and ecologic factors, as follows:

- **Biological diversity:** the groups involved ought to represent a set of trophic and functional levels of the aquatic and terrestrial systems;

- **Biological characterization:** identification of species or group of species likely to assist in the characterization of local environments and their interaction within species and between species;

- **Species composition:** recognition of species in both the aquatic and the terrestrial ecosystems that might be impacted by the dam's construction and operation; and

- **Environmental parameters:** definition of ecological parameters of terrestrial ecosystems (natural and anthropic) and aquatic ecosystems (limnological and water quality aspects) for the establishment of future prognosis.

The data generated are essential for determining possible endemisms, the presence of rare or threatened species; areas of greater biodiversity concentration; biological aspects of natural populations; recognition of different landscapes and habitats; identification of existing anthropic pressures; and survey of the limnological characteristics of the region's watercourses. In addition, these studies provide important data for a better programming of fauna and flora recovery activities as well as monitoring activities or any other conservation strategy to be proposed for the undertaking.

The ADA has been defined as an area where the majority of environmental phenomena that will be reflected in the project's implementation are agglutinated, so as to permit the analysis of the inherent environmental processes, as well as the identification and evaluation of the impacting processes to be generated by the undertaking's implementation, as a basis for projecting the Laúca AH.

To represent accurately the biological components of the influence area, several sampling locations were selected, whose definition was based on satellite images and maps of the region, as well as on information provided by the teams that did the previous reconnoitering of the work site. Consideration was also given to the teams' safety and to the accessibility and integrity of the ecosystems, i.e., the state of conservation of the environments to be sampled. The specific strategies regarding each component of the biotic environment will be addressed under the appropriate items.

Each sampling location is characterized from the standpoint of vegetation on a wide, ample scale of the predominant landscape, with emphasis on locations where samples were collected from water and from aquatic and terrestrial fauna and flora

groups. For the 2007 and 2009 surveys, eleven specific locations were studied during the expedition, from Caculo-Cabaça to Capanda. As this study addresses only the Laúca dam construction work, only six locations are presented here, as the other five are more pertinent to the future Caculo-Cabaça AH. Figure 4.15 shows the localization of the locations of the 2007 and 2009 collection of aquatic and terrestrial fauna and flora samples.

For the first phase of the work (deviation of the river's course), where the incidence zones for the collection of environmental information were updated, the Directly Affected Area was targeted, i.e., the ADA as defined in Chapter 1. There were also incursions into the AID, in a radius of 15 kilometers from the river course deviation worksite.

For the 2013 updating work, the focus was directed at the reservoir filling area, as this is likely to suffer the greatest impact. The list of species found in the previous studies has been corrected and updated.

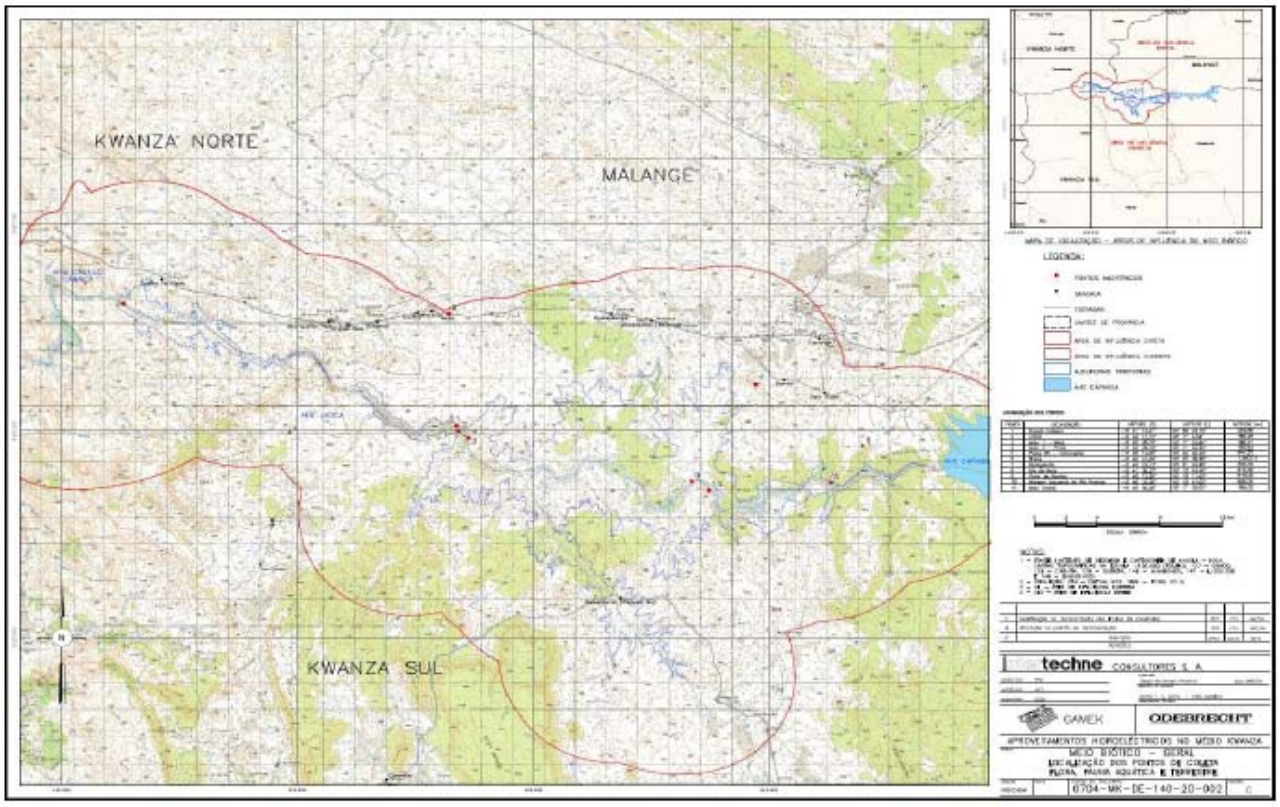


**Figure 4.15:** Map showing the localization of locations for the collection of biotic material (aquatic and terrestrial flora and fauna).

## 4.3.2. CACULO-CABAÇA COLLECTION LOCATION

Located at 9°41’13”S and 14°59’23”E (altitude ± 560 meters) in the North Kwanza province, this location is a tract of gallery forest of uneven width, now narrow in relation to the river bank (about 30 meters to 50 meters), now wider (about 150 meters to 200 meters), with a strip of trees bordering on the river, ranging between 15 meters and 20 meters in height, on rough terrain. The forest transition proceeds through open savanna tracts, though there are also some limited patches of what may be considered as rupestrian fields abutting on the forest fringe. A tributary stream runs through gallery forests. Large outcrop rocks are scattered from the forest into the riverbed, separated by sandy-clayey soil with some detritus layer. Afternoon shade owing to the forest trees (Photo 4.25).

**Photo 4.25:** Caculo-Cabaça collection location.

## 4.3.3. LAÚCA COLLECTION LOCATION

Situated at 9°46’12”S and 15°11’04”E (altitude ± 785 meters) in the Malanje province, this location is a tract of wide gallery forest about 200 meters to 300 meters in width, with transition into a open forest of the *Panda* type. The terrain is steep (more than 100-meter altitude variation). It has a diversity of arboreous species; even the shrubby-herbaceous undergrowth plants are tall. Many species of herbs, shrubs, epiphytes, and lianas species are pending collection and identification.

In the proximity of this location there is a dry ravine with a large amount of lianas in the trees and a patch of a grass species (BW 5593 in table 4.13) growing on moister soil. In addition to the lianas, the lay of the terrain leaves the location in much shaded all afternoon (Photo 4.26).

**Photo 4.26:** Laúca location.

## 4.3.4. MUTA 1 COLLECTION LOCATION – FOREST

The Muta 1 – Forest location is situated at 9°46”28”S and 15°11’24”E (altitude ±780 meters) in the Malanje province. It is an area consisting of a gallery forest of uneven width ranging between 50 meters and 200 meters. The canopy height is about 20 meters. It lies on rolling, at times rugged terrain, much less steep than the Caculo-Cabaça and the Laúca locations.

There is a transition area with tracts of both open grassy savanna and dense, wooded savanna, where woody vegetation is denser. A small tract on the gentle slope, which may be called *Panda* forest, starts a difficult to be delineated transition to a gallery forest. It is a relatively homogeneous place from a vegetation standpoint of the forest’s arboreous vegetation, with abundant shrubby, scandent lianas under the treetops. These lianas, hanging down into the undergrowth in the area adjacent to the river made it difficult to advance through the tangle of branches; this could be done only by opening trails. Afternoon shade was similar to that of the Caculo-Cabaça location (Photo 4.27).

**Photo 4.27:** Muta 1 collection location – Forest.

## 4.3.5. MUTA 2 COLLECTION LOCATION – BEACH

Situated at 9°46’28”S and 15°11’24”E (altitude ± 785 meters) in the Malanje province, this location is characterized by a white sand, rocky beach, without trees (Photo 4.28). Both downstream and upstream the beach there is a succession of tracts of narrow gallery forest. Upstream the forest is low, followed by savannas that approach the river. The collection was done in an open area with only a grassy layer and a few shrubby and semi-shrubby phanerogamae (such as *Mimosa cf Pigra*, BW 5757 shown in Table 4.13) in patches of exposed sandy soil, and a few herbaceous aquatic macrophytes. The terrain at the site is basically level with open savannas extending quit close to the river channel upstream, and rock outcrops, as part of the natural riverine vegetation. No shading all day (Photo 4.29).

**Photo 4.28:** Muta 2 collection location. Beach, strip of gallery forest, bare rocks abutting on the Kwanza River channel in the Laúca direct influence area.

**Photo 4.29:** Collection Location 4 – Beach in the rainy season

## 4.3.6. VILA DE MUTA COLLECTION POINT

Situated at 9°41’36”S and 15°10’43”E (altitude ± 815 meters) in the Malanje province, it is an anthropized area with some isolated baobabs. The surrounding vegetation matrix is open savannas, where baobabs, *Cussonia*, *Julbernardia*, and *Phylostigma* may be found, as well as gallery forests with oil palm less than 1.0 kilometer away (Photo 4:30).

## 4.3.7. GALLERY FOREST COLLECTION LOCATION

Situated across and above the Muta 2 Collection Location – Beach (at 9°46’S and 15°11’E (altitude ± 785 meters) in the South Kwanza province, this is a tract of gallery forest on a left bank tributary of the Kwanza River, in the midst of an open savanna matrix, and denser stretches. Botanical collections were taken from both the forest and the adjacent savannas (Photo 4.31).

**Photo 4.30:** Vila de Muta Collection Location 8.

**Photo 4.31:** Gallery Forest collection location

# 4.3.8. VEGETATION COVER IN THE ADA AND SURROUNDINGS

This section presents data pertaining to the vegetation and flora on the tracts explored by the expeditions for the preliminary inventory of the biotic environment in the Middle Kwanza River Basin (2007-2009), as well as new species found by surveys for the river course deviation (2012) and for the dam's construction (2013).

According to chorological divisions, the collection locations are situated in the Sudanese-Zambezian floristic region within the Zambezian Domain. Still according to Monteiro (1970, p. 170), the Zambezian Domain encompasses a small part of the Democratic Republic of Congo, nearly all of Angola, Zambia, Zimbabwe, most of Mozambique, Malawi, and almost half of Tanzania. The region addressed in this report is situated basically in the Bié Sector, where various types of savanna and open forests predominate, in addition to the Huila-Moxico-Lunda-Malanje Sector, dominated by open forests (Monteiro, 1970, p. 122).

- **Methodological Procedures**

The objective of this study was to identify and locate the different vegetation formations and the various uses of the soil in the ADA and surroundings, make qualitative surveys of the flora in the most representative formations, and identify areas of relevant interest for preservation.

As seasonal variation is a basic characteristic of the savanna climate and vegetation, the first expedition was undertaken April 14-27, 2008, which coincided with the end of the rainy season. The plan was to cover especially areas on the Kwanza River's right bank to identify natural vegetation formations and other uses of the soil (farming and grazing). The second expedition, undertaken in August 2008, assigned priority to investigating the left bank of the Kwanza River. The third survey was done in November 2012, focusing on the locations near the Laúca AH construction work site. The sampled areas and the photographed locations were recorded, with the help of GPS, which permitted the spacing of both information and data.

On the basis of the maps available, the region's representative physiognomies and the field sampling locations in the AID were defined. The different physiognomies served as a basis for surveying the floristic composition, which is fundamental to a qualitative assessment of the flora to be studied and for estimating the impact on the vegetation populations and communities.

The bibliographical support available in Angola comes from the scientific production of neighboring countries, such as South Africa (Palgrave, 2002) and old data, some with a lag of more than four decades, although still accurate and useful (i.e., Shaw, 1947; Gossweiler, 1953; Exell and Fernandes, 1956, 1962-1966; Monteiro, 1967; Exell et al., 1970; Grandvaux-Barbosa, 1970; Machado, 1970; Diniz 1973). The Angolan flora (*Conspectus Florae Angolensis*), for instance, was partially edited by Arthur Wallis Exell and collaborators from 1930 to 1970 under the auspices of the Coimbra Botanical Institute and with the collaboration of the British Museum, when many taxonomic works, monographs, and revisions were published in journals such as the Kew Bulletin and Taxon. All these sources provide information that should be fully exploited.

The methods employed in surveying the floristic composition focused the following topics:

- Identification of physiognomies in the study area;
- Surveying, during random walks in the representative areas of each phyto-physiognomy, the greatest possible number of each. It should be noted that botanical collections were limited to locations near roads, trails, and the precise locations allowed by the military after the terrain had been demined;
- In each segment and in the two expeditions (2007 and 2009), botanical collections were made of fertile vascular species from the different physiognomies;
- Collection of specimens of the arboreous, shrubby, and grassy strata were made, including epiphytes and aquatic macrophytes; and

- Sampling efforts aimed at locating populations of the target species, finding ways to access the various collection areas, and defining the needs to be encountered for future conservation actions (such as germplasm recovery).

On the field, the material was placed in plastic bags, and then on field presses, each botanical specimen separated from another by newspaper. At the laboratory, the specimens were transferred to field dryers; after they were dry, they were sent to their final destination. On a field log were recorded data, including identification of the specimen collected (scientific and/or common name, family), type of material collected, growth pattern (tree, shrub, grass); morphological features (color, size, etc.), general environment, substrate, localization, relative frequency, and other pertinent information.

Randomly, based on observation of the plants in flower and/or with fruit, a small though significant herbarium collection was started. In the average four to five duplicates were obtained for each number (up to seven duplicates during the August expedition).

For a preliminary identification were used the references of Gossweiler (1953); Grandvaux-Barbosa (1970); Bärtels (2007); Pooley (1998); and Palgrave (2002). Despite the lack of access to the collected botanic material, brief attempts were made to consult the *Conspectus Florae Angolensis* volumes (Exell and Fernandes, 1956, 1962-1966; Exell et al., 1970).

To help taxon identification, each item collected was photographed on the field. In addition, photos were taken of several plants in flower; some of these helped enrich the region's floristic list. In view of the difficulties inherent to collection work in the region, some species that were only photographed are included in this report's listing.

Cultivated, invading, ruderal, and widely distributed plants were also observed, photographed, and entered into the records to expand the list of species. This list figures separately from the list of autochthonous species.

The families ordering, which followed Cronquist (1988) in April, was transferred to the APG II (2003) system, as planned. The names of the authors related to the

species were consulted on the site of the Missouri Botanical Garden (Mobot, W3 Tropics).

The 2012 field study assigned priority to the area directly affected by the river course deviation work and by the future dam construction, to verify the existing phytocoenosis and its condition.

- **Landscapes description**

The tract preliminarily studied (from Laúca to the Capanda AH) consists essentially of forest and savanna formations and restricted tracts in typically rustic areas: forests, savannas, and fields taken here in the Ribeiro and Walter (2008)[1] sense. There are also marshy tracts on permanently poorly drained or flooded terrains, where soils must be shallow. These formations' phyto-physiognomy has been defined under a specific item and succinctly described. But it should be recalled that Gandvaux-Barbosa (1970, p. 146) issued a warning about part of the savanna vegetation on the central plateau, so vast ad complex, pointing out that the area of the Angolan central plateau holds various[2] subtypes that should be presented in greater detail in future works. This being the case, it is difficult, in the course of only two expeditions of short duration, to record all the vegetation nuances that more detailed previous works were not able to clarify.

Along the Middle Kwanza River, the riverine vegetation alternates forest and savanna tracts that extend to the river channel, small tracts of sandy beaches and others with outcrops, with only grassy vegetation, as well as some tracts of denser vegetation, with large aquatic macrophytes in river pools. In the latter case, the *Pandanus* gender is characteristic. Forest tracts are the predominant pattern, with a typical gallery forest, with a canopy about 15 meters to 20 meters in height, without visible emergent trees (Photos 4.32 and 4.33).

[1] In a physiognomic sense, these authors treat as forest vegetation tracts or areas with predominance of arboreous species, where a continuous or discontinuous canopy occurs. The term savanna refers to areas with trees and shrubs scattered over a grassy layer, without the formation of a continuous canopy. The term field designates areas with predominance of herbaceous and some shrubby plants, with no trees in the landscape. This definition of savanna is not universal, as there are different concepts around the world, which may also encompass physiognomic, floristic, or ecological meanings. But it is in that sense that the term is used in this report.

[2] What Grandvaux-Barbosa (1970) treat as subtype is occasionally treated in this study as "type" – "type of vegetation." A "type of vegetation" is defined by physiognomy, flora, and environmental features. Physiognomy includes structure, consistence, and leaf size as well as seasonal changes (Ribeiro and Walter, 2008).

**Photo 4.32:** Tract of gallery forest on the Middle Kwanza River (dense vegetation adjacent to the river) in the Caculo-Cabaça region.

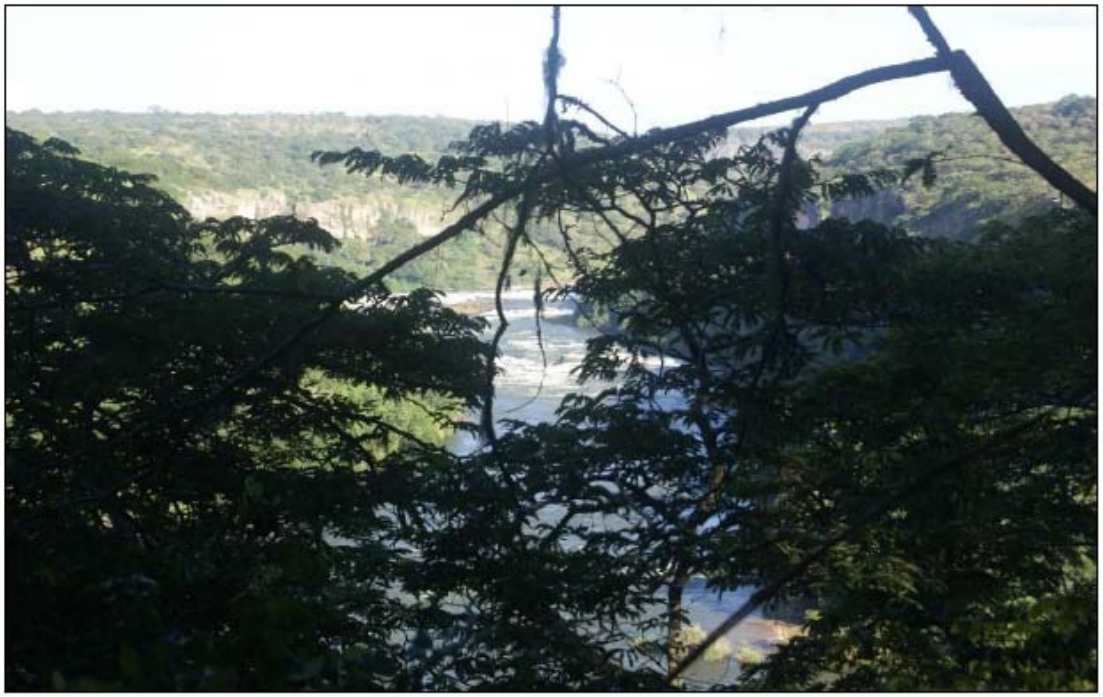

**Photo 4.33:** Inside a gallery forest adjacent to the Kwanza River, in the Laúca region, on the right bank.

Lianas are found throughout the forest (border-dam direction), particularly in the strip adjacent to the river. The forest width changes according to the terrain, from a few meters in some cases, when the river bank terrain tends to be more level, to a strip of 200 meters-300 meters of closed forest, which is characteristic of steep terrain excavated by the river over time.

In this case, the forest on the slopes seem to be dry rather than of the gallery type, and terminates abruptly in the upper part, being succeeded by savanna vegetation formations (which may be open or denser) until the *Panda* Forest, which is characteristic of Miombo. Savanna tracts are also found adjacent to the gallery forest strip, where arboreous-shrubby and low grassy vegetation approaches the river channel on sandy soil. Bare rocks are frequent in the river channel along the Middle Kwanza, as shown in Photo 4.34.

**Photo 4.34:** Gallery forest and bare rocks adjacent to the Kwanza River in the lower part of its middle course (Filomeno Câmara Bridge region).

The vegetation that follows rarely seems to be a forest, rather resembling savannas with a dense grassy biomass. The tracts of gallery forest consist of some ten species[3], ranging between 6 meters and 8 meters in height. In river pools, some grass and dense *Cyperaceae* are also characteristic, particularly *Cyperus papyrus* L., which is also found in stretches with more rapid waters.

In river pool areas and sandy beach formations, a pure layer of lower grass and small shrubs occur, a sign that in the Middle Kwanza River the gallery forest is not restricted to a single phytophysiognomic type or to a single formation. Each case has a particular flora, which suggests that the gallery forest is rich in species.

It should be noted that many plants in the Kwanza River gallery forest have thorns and/or prickles. Of these, the following have been collected by the two expeditions: BW 5667 (*Blepharis cf. subvolubilis* C.B. Clarke), BW 5612 (*Commiphora cf. angolensis* Engl.), BW 5757 (*Mimosa cf. pigra* Oliv.), BW 5627 (cf. *Erythroxylum*), BW 5736 (*cf. Maytenus*), BW 5633 (cf. *Zanthoxylum*), BW 5668 (cf. *Flacourtiaceae*) and BW 5604 (indeterminate, species 1), among others.

On both banks, Kwanza River tributary streams are covered by gallery forests which join the river's gallery forest. Both in this tract and in that other type of forest (Photo 4.35) *Elaeis guineensis Jacq.*, the oil palm is found (*palmeiras-de-dendém*, according to Almeida, 2006).

Structurally, the gallery forests are usually narrow, covering perennial or temporary streams, with abrupt transition to open savanna tracts. The forests' width is always less than 40 meters-50 meters.

[3] According to Monteiro (1970), the *Pandanus welwitschii Rendle* species, the same one found in the Middle Kwanza River, occurs in association with *Syzgium cordatum* Hochst ex C. Krauss*, Gardenia imperialis* K. Schum, and *Phragmites mauritianus* Kunth on the margins of the Cuiva River, south of Cuemba, on the Bié plateau.

**Photo 4.35:** Gallery forest with the occurrence of oil palms (*Elaeis guineensis*).

The type of open forest known as *Panda Forest*, already mentioned several times in this study, should be commented here. Shaw (1947) defines it as an extensive forest of the inner plateau, in which the baobab does not occur. According to Grandvaux-Barbosa (1970), the *Panda Forest* is a dry, thin plateau forest, whose varying definition and circumscribing by the different authors are somewhat confusing. It is generally treated as a forest, but also as grove or copse subordinated to the *Miombo* or synonymous with it. Grandvaux-Barbosa (1970, p. 182) identifies tracts of the Huambo as being "*Panda Woods*," whose forest structure is similar to the tracts referred to in this report. According to Shaw (1947), the word *Panda* comes from certain leguminous species of the *Isoberlinia* and the *Brachystegia* genders, which are dominant in extensive areas. These are two of the main *Panda Forest* indicators, and thus also of the *Miombo* (Photo 4.36). One characteristic noted only on the second field expedition (2007 and 2009) is that the *Panda Forest* consists of deciduous species that do not drop their leaves simultaneously (Photo 4.37).

**Photo 4.36:** Tract of *Miombo* in the vicinity of Capanda.

**Photo 4.37:** Tract of *Panda Forest* in the Laúca access region.

Similarly to the *Panda Forest*, the aforementioned *Miombo* is also considered a particular type of open forest, grove, or yet a densely wooded savanna, an interpretation that varies from author to author. According to Grandvaux-Barbosa (1970, p. 147), this is the vernacular term that became more widely used in the specialized literature to designate woodland with a heavy representation of the *Brachystegia* and the *Julbernardia*, and at times the *Berlinia* genders[4]. For Kindgon (1997), *Miombo* is classified under woodland, an intermediary type of vegetation between forest and savanna.

According to Mistry (2000), the *Miombo* is one of Africa's more extensive and uniform vegetation types, which displays a uniform structure over long tracts. In the area covered by this study, *Combretum* and certainly *Brachystegia*, *Julbernardia*, and *Pterocarpus* species, in addition to plants such as *Afzelia quanzensis* Welw[5], occur in associations that characterize this type of open forest (or dense savanna), whose trees reach about 10 meters to 12 meters in the canopy. *Miombo* tracts join riparian forests in the region under study, whose ecotone is difficult to distinguish between one phyto-physiognomic type and another.

Grandvaux-Barbosa (1970) describes numerous Miombo subtypes, which vary regionally throughout the Angolan territory and receive floristic influences according to their geographical localization. Criteria such as location (i.e., if they contain elements from the flora of the southern or the northern part of the country, or periguinean elements), altitude, type of soil, and vertical structure (trees height) have been taken in consideration in the subdivisions.

For the purposes of this study, though, in which the definition of type is sufficient, expressions such as *Miombo* and *Panda Forest* are treated as synonymous, although the former may conceptually encompass the latter[6], and the Angolan vernacular phytophysiognomic names will be avoided in case they could not be confirmed by the two field expeditions.

[4] Notice the similarity with Shaw's concept (1947) of *Panda Forest*.
[5] A species that bears fruit and particularly highly ornamental red and black seeds on the fringe of a gallery forest, found on the August expedition.
[6] This is a treatment similar to that of the Brazilian *cerrado*, according to which the *Miombo* would be the *cerrado lato sensu* and the *Panda Forest* would be *cerrado in strict sensu*.

In addition to the forests, and more important than them in terms of areas occupied, the predominant landscape is formed by humid savannas, now more open, now more closed, interspersed with the aforementioned forest tracts along water courses. The predominant grasses are Andropogonaceae (*Andropogon spp.*) and Paniceas (*Panicum spp.*) according to Grandvaux-Barbosa (1970), although other genders also cover considerable tracts of the terrain. According to Shaw (1947), the grassy stratum in the dry season is highly susceptible to yearly fires.

Classic African continent savannas occur in the region and are in excellent state of conservation. In many places, a single woody arboreous species dominate the vegetation. As mentioned earlier, plants such as *Piliostigma thonningii* (Schumach. and Thonn) Milne-Redh. (BW 5585), in addition to *Brachystegia cf. Glaucescens* Burtt. Davy and Hutch. (BW 5623), *Coccoloba sp.* (BW 5701) and *cf. Julbernardia sp.1 (BW 5779)* are examples of specimens found in aggregated, dominant distribution.

With wide distribution but without being dominant, the conspicuous *Cussonia angolensis (Seem.)* Hiern. species, with its rounded frond, is also found in open areas. With denser populations than the *Cussonia angolensis*, the *Cochlospermum cf. angolense Welw* arboreous species also frequently occurs in the savannas and forest fringes on the Middle Kwanza River.

Another typical plant is the *Accacia* sp. (BW 5697), always associated with places with higher grass. On open savannas, the strong characteristic, pleasant scent of the *Lippia adoensis Hochst,* ex Walp (BW 5654), a widely distributed species that was in full bloom at the time of the April expedition, was remarkable. In the dry season, the species has nothing remarkable. It is used by local populations for medicinal purposes and, according to Gossweiler (1953), its medicinal use is current in different local populations.

Similarly to the baobab, the *Sterculia cf. quinqueloba* (Garcke) K. Schum is a clear trunk tree with a generalized habitat. Although apparently dominant on the savannas, where it is an important flora element, it may be found in the forest quite close to the river, where the savanna extends to the riverine strip, as well as in the high borders of a typical gallery forest. Grandvaux-Barbosa (1970, p. 200) describes a vegetation subtype (rupicolous *Sterculia* vegetation on outcrops) on the basis of this species, and it is likely that this is the subtype found in Kyangulungo. This species occurs also in denser savannas.

Observed clearly only on the second field expedition in the stretch between the Kyangulungo *sanzala* [village] and the Kwanza River, tracts of savanna vegetation typically in the form of Parks occur. In some places, one can notice even the formation of *murundus* (i.e., slight concentric elevations on the terrain), on which woody vegetation concentrates, forming a landscape similar to a vegetation island, with clean grassy fields around murundus. The savanna-parks seem to be of two main types: tall arboreous vegetation, forming copses without the occurrence of *murundus*; and another type, that might be provisionally called "fields with *murundus*." Also there is arborescent vegetation on the *murundus*, this does not characterize a "field;" the expression "field with *murundus*" intends to stress the terrain rather than the vegetation.

In rustic areas, although some small patches of pure grassy fields in the midst of the savanna matrix[7] in outcrop areas have been observed, the aforementioned type of rupicolous vegetation on outcrops occurs. These fields vary from a few square meters in occupied areas (when located on hill slopes) to some hectares (the case of Kyangulungo), have a very rich flora, possibly with various endemisms, with plants usually adapted to altitudes above 900 meters, little soil volume, and other stress conditions. Plants restricted to these locations include the *Vellozia*, two species of which have been collected by the April expedition[8], as well as *Euphorbia grandicornis* Goebel, ex N.E.Br. (Photo 4.38), collected in August for a herbarium. Regarding Angola, Shaw (1947) has indicated that several *Vellozia* species populations might be significant in some parts of the country.

[7] The preceding example of vegetation among *murundus* is one of them.

[8] Gossweiler (1953) cited only the *Vellozia capillaris* Welw, ex Bak., actually a *nomen nudum*, as the correct name is *Vellozia capillaris* (Baker) Baker. Today the most accepted name would be *Xerophyta capillaris* Baker. Gossweiler (1953) mentioned that there might be six more *Vellozia* species in Angola, occurring in altitudes ranging from 100 meters to 2,000 meters.

**Photo 4.38:** Rupiculous area in Kyangulungo, where the *Euphorbia grandicornis* is common.

In the ADA and the AID, the rustic vegetation subject to periodic river flooding in the rainy season, particularly to the Kwanza River flooding, is treated under the name of *Chana* (Shaw, 1947). *Chana* is a tract of level grassy field on sandy soil. Although there has been no detailed exploration of such places, Photo 4.39 shows their phyto-physiognomy, which is the area of perambulation by the mammal megafauna that so well characterizes the African continent. It distinguishes itself for being essentially grassy vegetation, with the scarce presence of woody and shrubby plants.

**Photo 4.39:** Tract of *chana* adjacent to a Kwanza River gallery forest. In the detail, a tract of grassy field (drained in the dry season), which becomes flooded in the rainy season.

The landscape downstream the dam and near the powerhouse (ADA), popularly known as Pedra de Laúca, is a place of unique beauty (Photo 4.40). In both the ADA and the AID, the predominance of savannas has been observed, as has the occurrence of the *Accacia welwitschii*, a very common species in the region (Photo 4.41). Note should be taken of the occurrence of various grasses in the grassy layer, particularly the *Andropogon gayanus*, the *Hyparrhemia* sp., the *Heteropogon contortus*, the *Panicum maximum*, and the *Brachyaria* sp., *among others.*

**Photo 4.40:** Pedra de Laúca

**Photo 4.41:** *Accacia welsitschii* in the ADA.

In the proximity of the Kwanza River one can notice the presence of gallery forests, an outstanding characteristic of valleys and watercourses (Photo 4.42). Terre are also occurrences of species such as *Diospyrus mespiliiformis*, *Pterocarpus angolensis*, *Combretum apiculatum*, *Albizia versicolor*, as well as of shrubs, such as *Grewia flavescens* and *Grewia* sp.

**Photo 4.42** Area near the caisson construction site.

On the steep rocky banks of difficult access and even in the cracks of exposed rocks in the riverbed, various species of pteridophytes grow, such as the *Aloe* sp., the *Sanseviera cilindrica*, the *Asclepsias* sp., and other plants (Photo 4.43).

**Photo 4.43:** Vegetation on steep banks near the area where the dam will be constructed.

Members of the Orchidaceae family are found in various ADA locations, particularly the Eulophia othoplecta and the Eulophia spp (Photos 4.44 and 4.45).

**Photo 4.44:** Orchid specimen (*Eulophia spp.*).

**Photo 4.45:** Orchid specimen (*Eulophia othoplecta*).

- Results of the Floristic Composition Survey

The collection made by the expeditions totaled 183 herbarium numbers. Also added were the photographed taxa of those sighted or obtained through information. Table 4.13 shows part of the autochthonous flora of the Middle Kwanza River region, while Table 4.14 shows the widely distributed exotic plants found there. The lists on these tables show plants recorded essentially in the tract of the Laúca AH and surroundings, and a few that were confirmed between the Filomeno Câmara Bridge and the vicinity of Pungo Andongo.

Table 4.13 shows the family, the gender/species, the habit, and the specimen's occurrence environment, and a herbarium code or the criterion used to confirm the taxon's occurrence in the area. On these tables are indicated 232 species[9] belonging to 68 families[10] (three of which are Pteridophytes), a still little expressive number to register the rich flora observed in that region. Of this total, 36 materials have not had even their family identified, and in some cases there are still

[9] Table 4.13 has 245 entries, as in 13 cases the same species was collected more than once, such as the two herbaceous Apocynaceae with yellow flowers (BW 5650 and 5698) and the *Lagenaria* cf. *sphaerica* (Sond.) Naudin, a ruderal plant collected with flowers (BW 5658) and with fruit (BW 5619).

[10] Fabaceae (or Leguminosae) is interpreted as a single family by APG II (BW 2003). Likewise, traditional families, such as Sterculiaceae and Tiliaceae, are now included in Malvaceae.

doubts about them (for instance, the Scrophulariaceae BW 5646). Table 4.14 lists an additional 35 species (included in 23 families[11]), which expands the record obtained by the expedition to 267 species. But only 74 the species on Table 4.13 (plus another 26 on Table 4.14) could be classified down to the species level; this accounts for little more than 30 percent of the Table. There is thus a great lack of knowledge about the flora of the region under focus, and the sum of taxa of the two tables is below what it certainly holds, particularly as regards the autochthonous flora (Table 4.14).

It should be noted that the region's important taxa are already listed, as illustrated by the genders *Afzelia (Fabaceae*, Table 4.13), *Brachystegia* (BW 5623; BW 5722*), Cochlospermum* (BW 5622), *Cussonia, Erythrina* (BW 5717), *Julbernardia* (BW 5779); (Table 4.14, *Pterocarpus*, BW 5591), and *Combretum* (five species collected – BW 5605, 5608, 5700, 5716, and 5735). All the authors that address Angola's and vicinity's flora (e.g., Shaw, 1947; Gossweiler, 1953; Monteiro, 1967; Grandvaux-Barbosa, 1970; Mistry, 2000; Palgrave, 2002) emphasize these genders.

Some plants used by local populations are already included, such as the baobab (*Adansonia digitata*), whose bark fibers are used for clothing, seeds for medicinal purposes, seeds and leaves for food (Gossweiler (1953); the oil palm (Elaeis guieneensis), of high nutritional value; the medicinal plants *Lippiaadoensis* (Gossweiler, 1953), *Strychnos cocculoides, Cycnium adonense*, and *Boophone disticha*, the latter's bulb is also used as poison for arrows (Pooley, 1998); in addition to ictiotoxic plants, such as the *Piliostigma thonningii* (Schumach. and Thonn.) Milne-Redh. and *Lagenaria (breviflora)*Benth. (Machado, 1970). Not to speak of various grass specimens that serve as natural pasture for cattle, species for timber or fuel, other medicinal plants, and ornamental plants.

Considering only (Table 4.14), Fabaceae is the most important family, with 38 species entered (29 *Leguminosae Papilioinoideae*; five *Leguminosae Mimosoideae*; and four *Leguminosae Caesalpinioideae*), followed by *Poaceae* (11 species); *Malvaceae* (9 species); *Asteracaeae* (seven species); *Lamiaceae* (six species); *Combretaceae, Euphorbiaceae, Loganiaceae*, and *Rubiaceae* (five species each), followed by *Amaryllidaceae, Apocynaceae, Convolvulaceae, Cyperaceae, Moraceae,* and *Solanaceae*, with four species each. It strikes the attention how little represented are the *Orchidaceae* (three species) and the *Myrtaceae* (one species).

[11] The reduction in the number of families by three in relation to the April report is due to the adoption of the APG II (2003).

In view of the numerous species observed in flower on the two expeditions that could not be collected, and even sterile plants to which the team had access, a systematic collection program should be undertaken for a more thorough knowledge of the flora around the Laúca AH.

Given the local phytophysiognomic diversity, with at least 12 natural phytophysiognomic types, which express a floristic composition pertinent to each type, it is suggested that new occurrence citations, amplifications in the distribution area, indications of endemisms, and even species new to science may indeed be revealed by a detailed taxonomic survey in those explorations.

**Table 4.13.** List of autochthonous species recorded during the expeditions – April and August 2008

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Acanthaceae | *Blepharis* cf. *subvolubilis* C.B.Clarke | Erva | Vegetação ribeirinha | BW 5657 |
| Acanthaceae | *Thunbergia natalensis* Hook. | Erva | Miombo? | "Trab. SPP" |
| Amaranthaceae ? | Espécie 1 | Erva | Borda de mata ciliar | BW 5587 |
| Amaranthaceae ? | Espécie 2 | Erva | Vegetação ribeirinha | BW 5656 |
| Amaryllidaceae | *Amaryllis johnstonii* Hort. | Erva | Savana antropizada | BW 5780 |
| Amaryllidaceae | *Ammocharis coranica* Herb. [Indeterminada Espécie 19/E1 - folha plana, harmônica] | Erva | Campo rupestre | |
| Amaryllidaceae | *Boophone disticha* Herb. [Buphone] | Erva | Savana aberta | BW 5777 |
| Amaryllidaceae | *Crinum macowanii* Baker | Erva | Savana? | "Trab. SPP" |
| Anacardiaceae | *Protorhus longifolia* (Bernh.) Engl. | Árvore | Mata ciliar/Miombo | BW 5610 |
| Anacardiaceae | *Protorhus longifolia* (Bernh.) Engl. | Árvore | Mata ciliar | BW 5632 |
| Annonaceae | Espécie 1 | Árvore | Mata ciliar | BW 5628 |
| Aplaceae | *Stegnotaenia araliacea* Hochst. | Arvoreta | Mata/área rupestre | BW 5740 |
| Apocynaceae | *Diplorhynchus condylocarpon* (Mull.Arg.) Pichon | arvoreta | Mata ciliar | BW 5607 |
| Apocynaceae | *Strophanthus* cf. *gerrardii* Stapf | liana arbustiva | Mata/área rupestre | BW 5743 |
| Apocynaceae | *Strophanthus welwitschii* (Bull.) K. Schum. | liana arbustiva | Miombo? | "Trab. SPP" |
| Apocynaceae | Espécie 1 ("amarelinha") | erva | Savana | BW 5650 |
| Apocynaceae | Espécie 1 ("amarelinha") | erva | Vegetação ribeirinha | BW 5698 |
| Araliaceae | *Cussonia angolensis* (Seem.) Hiern | árvore | Savana | |
| Arecaceae | *Elaeis guineensis* Jacq. | palm. arbórea | Mata ciliar/de Galeria | |
| Arecaceae | Espécie 1 | palm. arbórea | Mata ciliar | |
| Asparagaceae (Liliaceae) | *Asparagus virgatus* Baker | erva | Mata? | "Trab. SPP" |
| Asphodelaceae (Liliaceae/Aloeaceae) | *Aloe* sp.1 | erva | Mata ciliar | |
| Asphodelaceae (Liliaceae/Aloeaceae) | *Aloe* sp.2 [planta afim de *A. ferox* Mill.] | erva | Campo rupestre | |
| Asteraceae | cf. *Ichtiyothere* sp.1 | erva | Savana aberta | BW 5775 |
| Asteraceae | cf. *Vernonia* sp.1 | subarbusto | Savana | BW 5614 |
| Asteraceae | cf. *Vernonia* sp.1 | subarbusto | Savana | BW 5634 |
| Asteraceae | cf. *Vernonia* sp.2 | erva | Savana | BW 5655 |
| Asteraceae | Espécie 1 ("roxinha") | erva | Borda de Mata ciliar | BW 5589 |
| Asteraceae | Espécie 1 ("roxinha") | subarbusto | Savana | BW 5673 |
| Asteraceae | Espécie 2 ("cosmusinho") | erva | Borda de Mata ciliar | BW 5596 |
| Asteraceae | Espécie 3 ("cosmus") | subarbusto | Savana, ruderal | BW 5672 |
| Asteraceae ? | Espécie 4 | subarbusto | Savana | BW 5636 |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Bignoniaceae | *Spathodea* cf. *campanulata* P.Beauv. | árvore | Mata Seca/Galeria | |
| Bixaceae (Cochlospermaceae) | *Cochlospermum angolense* Welw. | árvore | Savana | BW 5622 |
| Burseraceae | *Commiphora* cf. *angolensis* Engl. | árvore | Mata ciliar | BW 5612 |
| Cactaceae | *Rhipsalis baccifera* (J.S. Muell.) Stearn | erva epífita | Mata? | "Trab. SPP" |
| Cannabaceae (Ulmaceae) | *Celtis* sp.1 | liana arbustiva | Mata ciliar | BW 5595 |
| Cannabaceae (Ulmaceae) | *Celtis* sp.2 | árvore | Mata ciliar | BW 5625 |
| Cannabaceae (Ulmaceae) | *Trema* sp. | árvore | Mata de Galeria | BW 5766 |
| Celastraceae | cf. *Maytenus* | árvore | Mata ciliar | BW 5736 |
| Chrysobalanaceae | *Parinari* cf. *latifolia* (Oliv.) Exell | árvore | Savana aberta | BW 5685 |
| Chrysobalanaceae | *Parinari* cf. *latifolia* (Oliv.) Exell | árvore | Vegetação ribeirinha | BW 5721 |
| Chrysobalanaceae | *Parinari* sp. | arbusto | Savana aberta | BW 5679 |
| Clusiaceae | *Psorospermum febrifugum* Spach | arvoreta | Miombo? | "Inf. pes. SPP" |
| Colchicaceae (Liliaceae) | *Gloriosa superba* L. | erva | Mata? | "Trab. SPP" |
| Combretaceae | *Combretum platypetalum* Welw. ex Laws. subsp.*baumii*(Engl. e Gilg) Exell[=*Combretum baumii* Engl. e Gilg.) | arbusto | Miombo | BW 5716 |
| Combretaceae | *Combretum zeyheri* Sond. | árvore | Miombo | BW 5700 |
| Combretaceae | *Combretum* sp.1 | árvore | Mata ciliar | BW 5605 |
| Combretaceae | *Combretum* sp.2 | árvore | Mata ciliar | BW 5608 |
| Combretaceae | *Combretum* sp.3 | árvore | Mata ciliar | BW 5735 |
| Commelinaceae | *Commelina benghalensis* L. | erva | Mata? | "Trab. SPP" |
| Commelinaceae | *Commelina* sp. | erva | Mata ciliar | BW 5601 |
| cf. Commelinaceae | Espécie 1 | trepadeira | Vegetação ribeirinha | BW 5659 |
| Convolvulaceae (Cuscutaceae) | *Cuscuta* aff. *campestris* Yunck. | erva | Vegetação ribeirinha | BW 5655 |
| Convolvulaceae | *Ipomoea pes-caprae* (L.) R.Br. | erva | Mata? | "Trab. SPP" |
| Convolvulaceae | Espécie 1 | erva | Savana | BW 5648 |
| Convolvulaceae | Espécie 2 | erva | Savana | BW 5651 |
| Cucurbitaceae | *Lagenaria* cf. *sphaerica* (Sond.) Naudin | liana | Área antrópica (floresta) | BW 5619 |
| Cucurbitaceae | *Lagenaria* cf. *sphaerica* (Sond.) Naudin | liana | Área antrópica (floresta) | BW 5658 |
| Cyperaceae | *Cyperus papyrus* L. | erva | Mata ciliar/Campo úmido/Brejo | BW 5746 |
| Cyperaceae | Espécie 1 | erva | Savana | BW 5647 |
| Cyperaceae | Espécie 2 | erva | Vegetação ribeirinha | BW 5677 |
| Cyperaceae | Espécie 3 | erva | Campo rupestre | BW 5691 |
| Dipterocarpaceae | *Monotes glaber* Sprague | árvore | Miombo ? | Col SPP (D),E1 |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| cf. Dipterocarpaceae | Espécie 1 | árvore | Miombo ? | Col SPP (A).E1 |
| Erythroxylaceae | *cf. Erythroxylum* sp. | árvore | Mata ciliar | BW 5627 |
| Euphorbiaceae | *Acalypha punctata* Melsn. ex C. Krauss | erva | Savana? | "Trab. SPP" |
| Euphorbiaceae | *cf. Acalypha* sp. | subarbusto | Mata ciliar | BW 5598 |
| Euphorbiaceae | *Euphorbia conspicua* N.E. Br.[35] | erva | Vegetação ribeirinha | |
| Euphorbiaceae | *Euphorbia grandicornis* Goebel ex N.E.Br. | erva | Campo rupestre | BW 5724 |
| Euphorbiaceae | *Ricinus communis* L. | arbusto | Área antrópica (floresta) | BW 5657 |
| Fabaceae (Leguminosae Caesalpin./Cercideae) | *Bauhinia cf. tomentosa* L. | árvore | Mata ciliar | BW 5602 |
| Fabaceae (Leguminosae Caesalpin./Cercideae) | *Bauhinia cf. tomentosa* L. | árvore | Mata ciliar | BW 5624 |
| Fabaceae (Leguminosae Caesalpinioideae) | *cf. Chamaecrista* sp.1 | subarbusto | Borda de Mata ciliar | BW 5644 |
| Fabaceae (Leguminosae Caesalpinioideae) | *cf. Chamaecrista* sp.2 | subarbusto | Vegetação ribeirinha | BW 5674 |
| Fabaceae (Leguminosae Caesalpinioideae) | *Piliostigma thonningii* (Schumach. e Thonn.) Milne-Redh. | arvoreta | Savana aberta | BW 5585 |
| Fabaceae (Leguminosae Mimosoideae) | *Acacia* sp.1 | árvore | Savana aberta | BW 5686 |
| Fabaceae (Leguminosae Mimosoideae) | *Acacia* sp.1 | árvore | Ambiente rupestre | BW 5697 |
| Fabaceae (Leguminosae Mimosoideae) | *Acacia* sp.2 (galhos espinhosos - flor globosa) | árvore | Savana | BW 5734 |
| Fabaceae (Leguminosae Mimosoideae) | *Acacia* sp.3 (galhos espinhosos - flor em espigaAngola 08.08 630) | árvore | Savana arbórea | BW 5744 |
| Fabaceae (Leguminosae Mimosoideae) | *Albizia cf. versicolor* Oliv. | árvore | Miombo/Mata ciliar | BW 5592 |
| Fabaceae (Leguminosae Mimosoideae) | *Albizia cf. versicolor* Oliv. | árvore | Mata Seca/Miombo/ Mata ciliar | BW 5726 |
| Fabaceae (Leguminosae Mimosoideae) | *Mimosa cf. pigra* Oliv. | arbusto | Ambiente ribeirinho | BW 5757 |
| Fabaceae (Leguminosae Papilionoideae) | *cf. Aeschynomene* sp. | subarbusto | Savana | BW 5613 |
| Fabaceae (Leguminosae Papilionoideae) | *Afzelia quanzensis* Welw. | árvore | Miombo/Mata de Galeria | Reg. visual * |
| Fabaceae (Leguminosae Papilionoideae) | *Brachystegia cf. glaucescens* Burtt. Davy e Hutch. | árvore | Savana | BW 5623 |
| Fabaceae (Leguminosae Papilionoideae) | *Brachystegia spiciformis* Benth. | árvore | Mata Seca/Miombo | BW 5722 |
| Fabaceae (Leguminosae Papilionoideae) | *Crotalaria kaburnifolia* L. | subarbusto? | Savana? | "Trab. SPP" |
| Fabaceae (Leguminosae Papilionoideae) | *Crotalaria* sp. | arbusto | Savana, área antrópica | BW 5621 |
| Fabaceae (Leguminosae Papilionoideae) | *Erythrina abyssinica* Lam. ex DC. | árvore | Savana/Miombo | BW 5717 |
| Fabaceae (Leguminosae Papilionoideae) | *cf. Galactia* sp. | erva | Savana | BW 5652 |
| Fabaceae (Leguminosae Papilionoideae) | *cf. Julbernardia* sp.1 | árvore | Savana aberta | BW 5779 |
| Fabaceae (Leguminosae Papilionoideae) | *Julbernardia* sp.2 | árvore | Miombo | |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Fabaceae (Leguminosae Papilionoideae) | cf. *Lonchocarpus* sp. | liana arbustiva | Mata ciliar | BW 5745 |
| Fabaceae (Leguminosae Papilionoideae) | *Pterocarpus angolensis* DC. | árvore | Mata ciliar/Miombo | BW 5591 |
| Fabaceae (Leguminosae Papilionoideae) | *Pterocarpus* sp. | árvore | Miombo/Savana arbórea | Col SPP (E).E1 |
| Fabaceae (Leguminosae Papilionoideae) | *Stylosanthes fruticosa* (Retz) Alston | subarbusto | Vegetação ribeirinha | BW 5675 |
| Fabaceae (Leguminosae Papilionoideae) | cf. *Swartzia* sp. | árvore | Mata ciliar/Miombo | BW 5600 |
| Fabaceae (Leguminosae Papilionoideae) | cf. *Tephrosia* sp. | arbusto | Vegetação ribeirinha | BW 5676 |
| Fabaceae (Leguminosae Papilionoideae) | *Vigna vexillata* (L.) A. Rich. | erva | Savana? | "Trab. SPP" |
| Fabaceae (Leguminosae Papilionoideae) | *Vigna* sp. | liana herbácea | Savana | BW 5656 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 1 (*Desmodium* ?) | arbusto | Borda de Mata ciliar | BW 5586 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 2 (*Tephrosia* ?) | subarbusto | Savana | BW 5615 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 3 | subarbusto | Savana | BW 5635 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 4 | erva | Savana | BW 5649 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 4 | subarbusto | Vegetação ribeirinha | BW 5652 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 5 | subarbusto | Savana | BW 5645 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 6 | árvore | Savana aberta | BW 5753 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 7 | arvoreta | Savana aberta (Miombo) | BW 5763 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 8 (rosinha, pós fogo) | erva | Savana aberta | BW 5769 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 9 (rasteirinha, pós fogo) | erva | Savana aberta | BW 5772 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 10 (*Crotalaria*?, pós fogo) | erva | Savana aberta | BW 5774 |
| Fabaceae (Leguminosae Papilionoideae) | Espécie 11 ("labelo") | árvore | Ambiente ribeirinho (Mata ciliar) | BW 5760 |
| cf. Flacourtiaceae[34] | Espécie 1 | árvore | Vegetação ribeirinha | BW 5658 |
| cf. Gentianaceae | Espécie 1 | erva | Campo rupestre | BW 5694 |
| Iridaceae | *Gladiolus* cf. *dalenii* Van Geel | erva | Savana rala, húmida | BW 5584 |
| Lamiaceae | *Leonotis nepetifolia* (L.) R. Br. | erva | Mata? | "Trab. SPP" |
| Lamiaceae | *Leucas lavandulifolia* Sm. | erva | Mata? | "Trab. SPP" |
| Lamiaceae | Espécie 1 (cf. *Leucas*) [Indeterminada Espécie 18/E1] | erva | Campo rupestre | |
| Lamiaceae | Espécie 1 | erva | Borda de Mata ciliar | BW 5588 |
| Lamiaceae ? | Espécie 2 | erva | Borda de Mata ciliar | BW 5590 |
| Lamiaceae ? | Espécie 3 | erva | Campo rupestre | BW 5725 |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Lamiaceae ? | Espécie 3 | erva | Savana aberta | BW 5778 |
| Lentibulariaceae | *Utricularia* sp. | erva | Campo rupestre | BW 5696 |
| Liliaceae (sensu *lato*) | Espécie 1 | erva | Campo rupestre | BW 5617 |
| Loganiaceae | *Strychnos cocculoides* Baker | árvore | Savana aberta | BW 5752 |
| Loganiaceae ? | *Strychnos* ? | árvore | Mata ciliar | BW 5630 |
| Loganiaceae | Espécie 1 | liana arbustiva | Mata ciliar | BW 5597 |
| Loganiaceae ? | Espécie 2 | arvoreta | Mata/área rupestre | BW 5739 |
| Loganiaceae ? | Espécie 3 | liana herbácea | Mata ciliar | BW 5749 |
| Loranthaceae | Espécie 1 | hemiparasita | Savana aberta (Miombo) | BW 5764 |
| Malvaceae (Bombacaceae) | *Adansonia digitata* L. | árvore | Matas/Savanas | |
| Malvaceae | *Hibiscus* cf. *cannabinus* L. | arbusto | Savana aberta, ruderal | BW 5688 |
| Malvaceae | *Hibiscus* cf. *dongolensis* Calll. ex Delile | arbusto | Savana aberta, ruderal | BW 5689 |
| Malvaceae | *Hibiscuspedunculatus* L.f. | arbusto? | Miombo? | "Trab. SPP" |
| Malvaceae (Sterculiaceae) | *Sterculia* cf. *quinqueloba* (Garcke) K.Schum. | árvore | Mata ciliar | BW 5611 |
| Malvaceae (Sterculiaceae) | *Sterculia* sp. [Indeterminada Espécie 13/E1] | árvore | Mata Seca/Miombo | BW 5723 |
| Malvaceae (Sterculiaceae) | *Waltheria* cf. *indica* L. | arbusto | Savana, ruderal | |
| Malvaceae (Tiliaceae) | *Triumfetta* sp. | arbusto | Vegetação ribeirinha | BW 5651 |
| Malvaceae | Espécie 1 (*Urena* ?) | arbusto | Savana, ruderal | BW 5618 |
| Marantaceae | Espécie 1 | erva | Campo úmido | |
| Melastomataceae | cf. *Dissotis*[3] | arbusto | Campo Úmido | BW 5699 |
| Melastomataceae | Espécie 1 | erva | Campo rupestre | |
| Moraceae | *Ficus* cf. *sansibarica* Warb. | árvore | Mata de Galeria | BW 5768 |
| Moraceae | *Ficus* sp.1 (Capanda - Ponto 5) | árvore | Mata ciliar | |
| Moraceae | *Ficus* sp.2 (Ponte Filomeno da Camara) | árvore | Mata ciliar | |
| Moraceae | *Ficus* sp.3 | árvore | Mata ciliar | BW 5733 |
| Myrtaceae | Espécie 1 | arbusto | Ambiente ribeirinho | BW 5759 |
| Ochnaceae | *Ochna* cf. *pulchra* Hook. | arvoreta | Savana aberta | BW 5747 |
| Ochnaceae | *Ochna* cf. *pulchra* Hook. | arvoreta | Savana aberta | BW 5761 |
| Ochnaceae | cf. *Ouratea* sp. | arbusto | Mata ciliar | BW 5594 |
| Oleaceae | *Schrebera trichoclada* Welw. | árvore | Miombo? | "Inf. pass.SPP" |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Onagraceae | Espécie 1 | erva terrestre | Mata de Galeria | |
| Orchidaceae | *Eulophia* sp. | erva terrestre | Cultivada? | |
| Orchidaceae | Espécie 1 | erva terrestre | Área rupestre | |
| Pandanaceae | *Pandanus welwitschii* Rendle | arbusto | Mata ciliar/de Galeria | |
| Passifloraceae | cf. *Passiflora* sp. | liana herbácea | Mata de Galeria | BW 5729 |
| Pedaliaceae | *Ceratotheca integribracteata* Engl. | erva | Mata? | "Trab. SPP" |
| Piperaceae | Espécie 1 | erva terrestre | Mata ciliar (Laúca) | Reg. visual/E1 |
| Poaceae | *Andropogon* sp.1 | erva | Área antrópica (savânica) | BW 5620 |
| Poaceae | *Andropogon* sp.2 | erva | Vegetação ribeirinha | BW 5660 |
| Poaceae | *Eleusine indica* (L.) Gaertn subsp. *coracana* (L.) Lye [=*Eleusine coracana* (L.) Gaertn.] | erva | Savana? | "Trab. SPP" |
| Poaceae | cf. *Gymnopogon* sp. | erva | Vegetação ribeirinha | BW 5678 |
| Poaceae | *Melinis minutiflora* P. Beauv. | erva | Savana | |
| Poaceae | cf. *Setaria* sp. | erva | Vegetação ribeirinha | BW 5684 |
| Poaceae | Espécie 1 | erva | Mata ciliar | BW 5593 |
| Poaceae | Espécie 2 | erva | Vegetação ribeirinha | BW 5682 |
| Poaceae | Espécie 3 (inflorescência rosa) | erva | Campo úmido | |
| Poaceae | Espécie 4 | erva | Savana aberta/Chana | BW 5737 |
| Poaceae | Espécie 5 | erva | Vegetação ribeirinha | BW 5756 |
| Polygalaceae | *Polygala* sp.1 | erva | Vegetação ribeirinha | BW 5681 |
| Polygalaceae | *Polygala* sp.2 | erva | Campo rupestre | BW 5695 |
| cf. Polygonaceae | cf. *Coccoloba* (?) | árvore | Savana aberta | BW 5701 |
| Polygonaceae | *Polygonum* sp. | erva | Vegetação ribeirinha antropizada | |
| Polygonaceae | Espécie 1 | erva | Mata ciliar | BW 5629 |
| Pteridophyta | Espécie 1 | erva epífita | Mata ciliar | BW 5599 |
| Pteridophyta | Espécie 2 | erva terrestre | Mata ciliar | BW 5637 |
| Pteridophyta | Espécie 3 (indeterminada Espécie 15/E1, próxima à *Vellozia* sp.1) | erva | Campo rupestre | |
| Rubiaceae | *Gardenia volkensii* K. Schum. | árvore | Miombo? | "Inf. pess.SPP" |
| Rubiaceae | Espécie 1 | árvore | Mata ciliar | BW 5603 |
| Rubiaceae | Espécie 2 | árvore | Mata ciliar | BW 5631 |
| Rubiaceae | Espécie 3 | arvoreta | Mata ciliar | BW 5643 |
| Rubiaceae | Espécie 4 | subarbusto | Savana | BW 5653 |
| Ruscaceae (Liliaceae) | *Sansevieria* cf. *cylindrica* Bojer | erva | Mata ciliar/Campo rupestre | BW 5731 (Foto E1/417,E2/118) |
| Ruscaceae (Liliaceae) | *Sansevieria* cf. *metallica* Hort. ex Gérôme e Labroy | erva | (Laúca) | |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Rutaceae | cf. *Zanthoxylum* | árvore | Mata ciliar | BW 5633 |
| Sapindaceae | *Allophylus* sp.1 | árvore | Mata ciliar | BW 5641 |
| Sapindaceae | cf. *Allophylus* sp.2 | trepadeira | Vegetação ribeirinha | BW 5669 |
| Sapindaceae | Espécie 1 | árvore | Mata ciliar | BW 5748 |
| Scrophulariaceae | *Cycnium adonense* E. Mey. ex Benth. | erva | Savana aberta | BW 5776 |
| Scrophulariaceae ? | Espécie 1 | subarbusto | Savana | BW 5646 |
| Solanaceae | *Nicandra physaloides* (L.) Gaertn. | subarbusto | Mata? | "Trab. SPP" |
| Solanaceae | *Physalis angulata* L. | erva | Mata? | "Trab. SPP" |
| Solanaceae | *Solanum nodiflorum* Jacq. | erva | Mata? | "Trab. SPP" |
| Solanaceae | *Solanum* sp.1 | arvoreta | Vegetação ribeirinha | BW 5663 |
| Solanaceae | *Solanum* sp.1 ? | arvoreta | Vegetação ribeirinha | BW 5671 |
| cf. Turneraceae | Espécie 1 | subarbusto | Savana aberta | BW 5687 |
| Typhaceae | *Typha* cf. *capensis* N.E. Br. | erva | Brejo/Campo úmido | |
| Velloziaceae | *Vellozia* sp.1 | arbusto | Campo rupestre | BW 5616 |
| Velloziaceae | *Vellozia* sp.2 | erva | Campo rupestre | BW 5692 |
| Verbenaceae | *Lippia adoensis* Hochst. ex Walp. | arbusto | Savana | BW 5654 |
| Verbenaceae | cf. *Stachytarpheta* sp. | erva | Vegetação ribeirinha | BW 5683 |
| Verbenaceae | Espécie 1 (flor amarela - ponte F.Camara) | arbusto | Vegetação ribeirinha | |
| Vitaceae | *Cissus* cf. *quadrangularis* L. | liana herbácea | Mata ciliar | BW 5626 |
| Vitaceae | *Cissus* sp. | liana arbustiva | Mata ciliar | BW 5606 |
| Zingiberaceae | *Aframomum albo-violaceum* (Ridl.) K.Schum. | erva | Miombo? | "Trab. SPP" |
| Zingiberaceae | *Siphonochilus aethiopicus* B.L. Burtt | erva | Mata? | "Trab. SPP" |
| Indeterminada | Espécie 1 (Rhamnaceae ?) | árvore | Mata ciliar | BW 5604 |
| Indeterminada | Espécie 2 | arbusto | Mata ciliar (clareira) | BW 5609 |
| Indeterminada | Espécie 3 | arvoreta | Mata ciliar | BW 5638 |
| Indeterminada | Espécie 4 | árvore | Mata ciliar | BW 5639 |
| Indeterminada | Espécie 5 ("pseudo-marula") | árvore | Mata ciliar | BW 5640 |
| Indeterminada | Espécie 5 ("pseudo-marula") | árvore | Savana aberta | BW 5670 |
| Indeterminada | Espécie 5 ("pseudo-marula") | árvore | Mata/área rupestre | BW 5738 |
| Indeterminada | Espécie 6 | árvore | Mata ciliar | BW 5642 |
| Indeterminada | Espécie 7 (fruto alado) | árvore | Vegetação ribeirinha | BW 5654 |
| Indeterminada | Espécie 8 (Amaranthaceae?) | erva | Vegetação ribeirinha | BW 5680 |
| Indeterminada | Espécie 9 (Amaryllidaceae ?*Hypoxis* sp.?) | erva | Vegetação ribeirinha | |

| Família | Espécie | Hábito | Ambiente | Voucher/Comprovante |
|---|---|---|---|---|
| Indeterminada | Espécie 10 (cf. Rubiaceae) | erva | Campo rupestre | BW 5693 |
| Indeterminada | Espécie 11 (parece Tapura. Ponto Filomeno da Camara) | árvore | Mata ciliar | |
| Indeterminada | Espécie 12 (Sterculiaceae? cf. Dombeya?) | árvore | Savana aberta | BW 5690 |
| Indeterminada | Espécie 14 | árvore | Miombo ? | Col SPP (C) |
| Indeterminada | Espécie 16 (planta amarela) | erva | Campo rupestre | |
| Indeterminada | Espécie 17 (parece Orchidaceae) | erva | Campo rupestre | |
| Indeterminada | Espécie 20 (Capanda - Ponto 5) | árvore | Miombo | BW 5718 |
| Indeterminada | Espécie 21 (Rubiaceae? parece flor de *Styrax*. Capanda - Ponto 5) | arbusto | Vegetação ribeirinha | BW 5719 |
| Indeterminada | Espécie 22 (comum, faixa ciliar) | árvore | Vegetação ribeirinha | BW 5720 |
| Indeterminada | Espécie 23 (folha oposta. cf. Myrtaceae) | árvore | Mata Galeria | BW 5727 |
| Indeterminada | Espécie 24 (trifoliolada) | árvore | Mata Galeria | BW 5728 |
| Indeterminada | Espécie 25 (lembra *Fuchsia*) | liana arbustiva | Mata Galeria | BW 5730 |
| Indeterminada | Espécie 26 (parece Polygonaceae) | arbusto | Mata ciliar | BW 5732 |
| Indeterminada | Espécie 27 (cipó fruto vermelho) | liana herbácea | Mata/área rupestre | BW 5741 |
| Indeterminada | Espécie 28 (Sterculiaceae?) | árvore | Mata/área rupestre | BW 5742 |
| Indeterminada | Espécie 29 (frutão bola) | árvore | Mata ciliar | BW 5750 |
| Indeterminada | Espécie 30 (Meliaceae? parece Anacardiaceae) | árvore | Mata ciliar | BW 5751 |
| Indeterminada | Espécie 31 (Flor de cheiro ruim) | arvoreta | Chana, arredores de Mata ciliar | BW 5754 |
| Indeterminada | Espécie 32 (Apocynaceae? com látex) | árvore | Mata ciliar, arredores de Chana | BW 5755 |
| Indeterminada | Espécie 33 (folha oposta) | árvore | Ambiente ribeirinho (Mata ciliar) | BW 5758 |
| Indeterminada | Espécie 34 (flora branca gamopétala) | arvoreta | Savana aberta (Miombo) | BW 5762 ( |
| Indeterminada | Espécie 35 (parece Verbenaceae - *Aegiphyla*) | arvoreta | Savana aberta (Miombo) | BW 5765 |
| Indeterminada | Espécie 36 (folha comprida - lembra 5720) | árvore | Mata de Galeria | BW 5767 |
| Indeterminada | Espécie 37 (flor amarela - pós-fogo) | erva | Savana aberta | BW 5770 |
| Indeterminada | Espécie 38 (pós-fogo) | erva | Savana aberta | BW 5771 |
| Indeterminada | Espécie 39 (espinhosinha - pós-fogo) | erva | Savana aberta | BW 5773 |
| Indeterminada | Espécie 40 (pequenina) | erva | Savana aberta | |

[Legendas para a tabela:
**Family Species Habit Environment Code/tab**
**[**A coluna **“Family”** permanece inalterada, exceto pela palavra “indeterminada”, que deve ser substituída por “not determined” .]

[Na coluna “**Species**”, a palavra “espécie” deve ser mudada para “Species” e, na sexta linha primeira página , substituir (indeterminada Espécie 19/E1 – folha plana, harmônica” por:
“not determined Species 19/E1 – plane, harmonious leaf”.
Substituir “pós fogo” por “after fire”

Substituir “labelo” por “labellum”
Substituir “Ponte Filomeno Câmara” por “Filomeno Câmara Bridge”
Substituir “inflorescência roxa” por “purple inflorescence”
“próxima a *Vellozia* sp. 1” por “close to *Vellozia sp* 1”.
“flor amarela – ponte F. Câmara” = “yellow flower – F. Câmara Bridge”
“fruto alado” = “winged fruit”
“parece *Tapura”* = “looks like *Tapura*”
“planta amarela” = “yellow plant”
“parece *Orchidaceae* = “looks like *Orchidaceae”*
“parece flor de Styrax. Capanda Ponto 5” = “looks like *Styrax* flower. Capanda Location 5”
“comum, faixa ciliar” = “common, gallery tract”
“folha oposta” = “opposite leaf”
“lembra *Fuchsia”* = “recalls *Fuchsia”*
“parece” = “looks like”
“cipó fruto vermelho” = “liana, red fruit”
“frutão bola” = “large ball fruit”
“flor de cheiro ruim” = “unpleasant scent flower”
“com látex” = “with latex”
“flor branca gamopétala” = “gamopetal white flower”
“amarelinha” = “tiny yellow”
“roxinha” “tiny purple”
“cosmusinho” “tiny cosmos”
“folha comprida – lembra“ = “long leaf – recalls”
“espinhosinha, pós fogo” = “prickly, after fire”
“roxinha, pós fogo” = “tiny purple, after fire”
“rasteirinha” = “tiny creeper”
“pequenina” = “tiny”
“labelo” = “labellum”
“ou *Hibiscuspendulatus* L.f” = “or *Hibiscuspendulatus* L.f”

Na 3a. página da Tabela:
Na 14a. linha: substituir “galhos espinhosos – flor globosa” por “prickly branches – globose flower.
Na 15ª. Linha: substituir “galhos espinhosos – flor em espiga” por “prickly branches – flower spike” ]

[Legendas para a coluna "**Habit**":
Erva = Herb
Árvore = Tree
Arvoreta = Shrub
Liana arbustiva = Shrubby liana
Palm. Arbórea = Arboreous palm
Subarbusto = sub-shrub]
Liana = Liana
Arbusto = Shrub
Trepadeira = Vine

[Legendas para a coluna **"Environment":**
Vegetação ribeirinha = Riverine Vegetation
Miombo = *Miombo*
Borda de mata ciliar = gallery forest fringe
Savana antropizada = Anthropized Savanna
Campo rupestre = Rustic Field
Mata ciliar = Gallery Forest
Mata = Forest
Mata/ area rupestre = Forest/Rustic Area
Mata = Forest
Savanna = Savanna
Mata ciliar/de Galleria = Gallery Forest
Borda de mata ciliar = Gallery forest fringe
Savana, ruderal = Savanna, ruderal]
Mata seca/ Galeria = Dry forest/Gallery
Savana aberta = Open Savanna
Área antrópica (floresta) = Anthropic area (Forest)
Mata ciliar/Campo húmido/Brejo = Gallery Forest/Humid field/Marsh
Savanna arbórea = Shrubby savanna
Ambiente rupestre = Rustic Environment
Ambiente ribeirinho = Riverine environment

Savana rala, húmida = Thin, humid savanna

[A 5a. coluna permanece inalterada]

[NOTAS DE RODAPÉ DA TABELA:
Página 4-110:

Here the name *Euphorbia conspicuo* N.E. Br. has been considered correct, based on Gossweiler (1953, p. 412). Sónia P. Pereira's work adopts the epithet *Euphorbia pentagona* Haw, considered today as synonymous with *Euphorbia royleana* Boiss, probably an Asian plant (India), not cited for Angola.

Página 4-111:

*Flacourtiaceae* is not a family considered by APG II (2003); its genders have been distributed as *Salicaceae*, *Achariaceae*, and *Perisdiscaceae*, particularly the first. Here, solely to help identification, the plant collected (BW 5668) has been designated as *Flacourtiaceae*, though this taxon has not been included in the number of families occurring in the Middle Kwanza River.

Página 4-115:

Plants ordered by families (*sensu* APG II, 2003). BW = B.M.T. Walter et al. collection.

Additional support in Gossweiler (1953) or Palgrave (2002). "Trab. SPP = occurrence recorded in Sónia P. Pereira's graduation thesis. "Inf. Pes. SPP" = Occurrence reported by Sónia P. Pereira. "Col. SPP" = collected by Sónia P. Pereira (with photo), kept in Capanda. Photo – photographic record by B. M. T Walter (E1-April 2008 expedition); E2- August 2008 expedition. Reg. visual = visually attested by M T. Walter.

Environment: "riverine vegetation" includes open savanna and rustic areas, as well as sandy beaches (white sand banks). "Miombo" includes preferentially plants that occur in a *Panda Forest* (i.e., open forest or dense savanna), as defined in the August report (second expedition).

Página 4-117:

**Occurrence record:**

1. Sighting.
2. Sighting, with photo.
3. Personal information by Sónia P. Pereira.
4. Species to be confirmed. Plantio = species cultivated owing to human interest; work site = Capanda village.

**Table 4.14:** List of cultivated and ruderal plants of wide distribution occurring in the middle Kwanza, established the first expedition (April 2008) region species.

| Família | Espécie | Registo | Nome comum |
|---|---|---|---|
| Amaranthaceae | *cf. Amaranthus* | ruderal[1] | - |
| Anacardiaceae | *Anacardium occidentale* L. | cultivo no cantelro[3] | cajueiro |
| Anacardiaceae | *Mangifera indica* L. | plantio[1] | mangueira |
| Apocynaceae | *Allamanda cathartica* L. | cultivo no cantelro[3] | alamanda-amarela |
| Apocynaceae (Asclepiadaceae) | *Calotropis procera* (Aiton) R.Br. | ruderal | - |
| Apocynaceae | *Catharanthus roseus* G.Don | cultivo no cantelro[3] | vinca, boa-noite |
| Apocynaceae | *Nerium oleander* L. | cultivo no cantelro[3] | espirradeira |
| Apocynaceae | *Thevetia peruviana* (Pers.) K.Schum. | cultivo geral[3] | chapéu-de-napoleão |
| Araceae | *Spilanthes* sp. | ruderal[1] | margaridinha |
| Arecaceae | *Areca cf. triandra* Roxb. | cultivo no cantelro[3] | areca |
| Asteraceae | *Tagetes cf. erecta* L. | cultivo no cantelro[3] | cravo-de-defunto |
| Asteraceae | *Tithonia diversifolia* (Hemsl.) A.Gray | ruderal em vilas[1,4] | girassol-africano |
| Bixaceae | *Bixa cf. orellana* L. | cultivo no cantelro[3] | urucum |
| Cannabaceae | *Cannabis sativa* L. | ruderal[4] | maconha (liamba) |
| Cannaceae | *Canna* spp. | cultivo em vilas[3] | cana-de-índia |
| Caricaceae | *Carica papaya* L. | plantio[1] | mamoeiro |
| Casuarinaceae | *Casuarina* sp. | cultivo no cantelro[3] | casuarina |
| Euphorbiaceae | *Manihot esculenta* Crantz | plantio[1] | mandioca |
| Iridaceae | *Gladiolus* aff. *aurantiacus* Klatt | cultivo em vilas[1,4] | - |
| Fabaceae (Leg. Caesalpinioideae) | *Caesalpinia pulcherrima* Sw. | cultivo no cantelro[4] | flamboyem-de-jardim |
| Fabaceae (Leg. Mimosoideae) | *Acacia nigra* Clos | cultivo no cantelro[3] | acacia-negra |
| Fabaceae (Leg. Mimosoideae) | *Mimosa caesalpiniifolia* Benth. | cultivo no cantelro[3] | sansão-do-campo |
| Fabaceae (Leg. Papilionoideae) | *Arachis cf. hypogaea* L. | ruderal[1] | amendoim |
| Fabaceae (Leg. Papilionoideae) | *Tamarindus indica* L. | cultivo em vilas[3] | tamarindo |
| Malvaceae | *Hibiscus* aff. *rosa-sinensis* L. (ou *Hibiscuspedunculatus* L.f.) | cultivo no cantelro[3] | hibisco |
| Musaceae | *Musa x paradisiaca* L. | plantio[1] | bananeira |
| Myrtaceae | *Eucalyptus* sp. | cultivo no cantelro[3] | eucalipto |
| Myrtaceae | *Psidium cf. guajava* L. | cultivo no cantelro[3] | goiabeira |
| Passifloraceae | *Passiflora* spp. | plantio[1] | maracujá |
| Pontederiaceae | *Eichhornia* sp. | cultivo no cantelro[3] | aguapé |
| Poaceae | *Bambusa* sp. | ruderal[1] | bambu |
| Poaceae | *Zea mays* L. | plantio[2] | milho |

| Família | Espécie | Registo | Nome comum |
|---|---|---|---|
| Rosaceae | *Rosa* sp. | cultivo no canteiro[3] | roseira |
| Solanaceae | *Nicotiana tabacum* L. | cultivo em vilas[3] | fumo |
| Verbenaceae | *Duranta* cf. *repens* L. | cultivo no canteiro[3] | pingo-de-ouro |

**Occurrence record:**

1. Sighting.
2. Sighting, with photo.
3. Personal information by Sónia P. Pereira.
4. Species to be confirmed. Plantio = species cultivated owing to human interest; work site = Capanda village.

# 4.3.9 TERRESTRIAL FAUNA

- **Methodological procedures**

The purpose of the study was to expand the knowledge about the fauna communities in the Laúca AH region and the problems associated with the conservation of habitats. Priority was assigned to this terrestrial vertebrate group in 2007 and 2009. The focus of the 2013 survey was on reptiles and birds.

The terrestrial fauna survey was done in two phases: gathering of secondary data (already compiled lists, studies undertaken in the region, visits to zoological collections, interviews with the population, etc.); and gathering of primary data (capture, direct sighting, and observation of vestiges, such as nests, footprints, and feces) in both the rainy and the dry seasons.

The geographical coordinates of the collection locations and the material records were obtained whenever feasible. In the case of records based on interviews, attempts were made to situate them in relation to the Kwanza River banks.

Given the diversity and particularities of each group of terrestrial vertebrates, efforts were made to ensure specific collection and methodologies regarding each group, as described herein.

- **Mammal fauna**

The adoption of different methods for inventorying the mammal fauna is explained by the great morphological, behavioral, and ecologic diversity of the species in this group. Other than direct capture methods, (described below), use was made of specimens that had been run over on the roads giving access to the collecting areas, carcasses found on the field, and skins and skeletons in the possession of local residents.

For small mammalians, transects were established at duly numbered spots, where box-style live traps (Sherman traps) were set up on the ground, and on trees whenever possible. This methodology makes possible the coverage of routes randomly scattered

for estimating the abundance of species; it is indicated for surveys, as it captures a larger number of individuals and species. This was the methodology employed in the 2007 and 2009 surveys.

A series of Sherman traps were set up in three locations, each with 30 traps. At the runoff measuring site, the traps were set up along the access road, near the Kwanza River: 12 on grassy spots adjacent to the road a little before the last point accessible by car (where there is a masonry house). After this point, 18 traps were set up, along the trail used by hunters and fishermen, on the river bank, and on a slope recently burnt in various places. This series was set up on August 12 and collected on August 17.

At the “Kyangulungo” location another series of 30 traps was set up in the proximity of the Kyangulungo village. The traps were placed along the dry bed of a stream that in the rainy season drains part of the rocky area where rupicolous vegetation grows and is characteristic of the region. This region is much used by local trappers. This series of traps was set up on August 13 and collected the following day 14, as it was discovered that on that day 15 traps had vanished.

The “Porto do Dombo” location, also near Kyangulungo, is situated at the end of a road recently opened to give access to the Kwanza River at the Dombo Port. Another two series were set up in this area, each with 15 traps. Several spots along the road had been burnt. Only on the river bank, where the traps were set up, the vegetation was thriving. These series were set up on August 13, daily checked, and collected on August 19.

In addition to the data obtained from traps and direct observation, data based on vestiges of feces and footprints (Photo 4.46) were also compiled.


**Photo 4.46:** Footprint vestiges recorded in the region.

The traps were checked every morning and the captured animals were transferred to cloth bags to be identified, weighed, have their sex determined and their biometric data recorded, and photographed. After their handling, the animals were duly labeled to be deposited in the zoological collection of the National Museum of Natural History or at the Capanda AH Environmental Laboratory.

As regards medium- and large-size mammals, surveys were done in various selected areas, in an attempt to undertake direct observation and to search for signs (footprints, feces, bone remains). Each pertinent sign was georeferenced and photographically documented, with the use of an object of known dimensions as a scale, and a synthetic description was made whenever necessary. The records compiled were compared with data already available in current literature, so as to arrive at a reliable taxonomic identification.

Bats were captured with 12-meter 36-milimeter mesh mist nets (Photo 4.47) placed in the region's representative phytophysiognomies, near water courses, and opened at

dusk. The average number of mist nets used in the different collection sites was six, which covered an area of approximately 50 square meters.

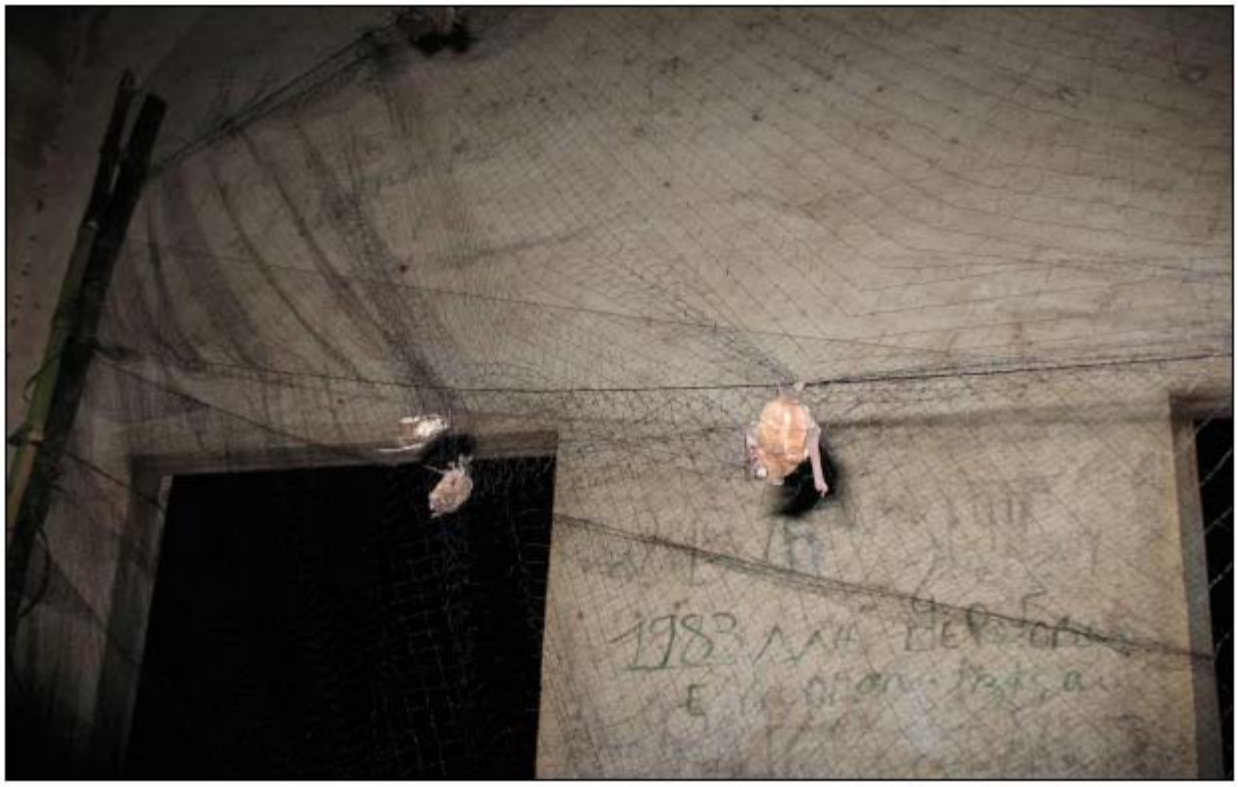

**Photo 4.47:** Capture of bats with mist nets.

All the collected material was handled according to a standard protocol of individualized record, with field number, body measurements, tissue withdrawal for molecular comprehensiveness analysis, and fixation.

Camera traps (DeerCam, “Tigrinus”) were set up in selected locations, using baits as an allurement. A camera trap was set up at approximately 3.5 meters up a tree, where it remained from August 15 thru August 19, in a location near the left margin of the road, where baboons, galagos, and hyraxes had been sighted already on the first day. Four other camera traps were set up on the Kwanza River left bank, where they remained from August 15 thru August 19. This technique was also employed on 2012 field visits for the EIA on the deviation of the river course. This camera trap was set up on the right bank downstream the tunnel construction site (Photo 4.48).

**Photo 4.48:** Setting up a night vision camera in the ADA.

A camera was setup on a forest island in a Kyangulungo rocky spot, where it was left from August 13 thru August 19. Three other cameras were set up on the Kwanza River right bank (in the transition from savanna to gallery forest), where it remained from August 14 thru August 19.

Immaterial evidence was obtained on a preliminary basis from interviews with military personnel on duty during visits to collection sites. Evaluation depended on the quality of the information obtained by the interviewee, as regards essentially the level of specificity of the taxonomic diversity presented. But the basic criterion applies to the recognition of the existence of recoverable coincident standards among the interviewees.

Two kinds of interviews were held. One was more informal, without following a specific protocol, taking advantage of the opportunities for interaction with local trappers and residents in general, including soldiers on duty in the Middle Kwanza River region. For the second kind of interview the African Mammals guide (Kingdon, 1997) was used and two basic norms were followed: showing the photos in the guide that illustrate the species listed for this part of the continent; and carefully avoiding to elicit positive answers from interviewees. For this work, the interview results were used only to corroborate the collected material evidence, with particular emphasis on interviews with local trappers.

For the EIA regarding the river course deviation daytime and nighttime visits were made to make records based on direct observation, with the help of a flashlight, to check characteristics described on the occasion of the first surveys and verify the current condition. These surveys also paid attention to vestiges of certain species for complementation of the reference situation's current condition (Photos 4.49, 4.50, and 4.51).

To update this 2013 study, daytime and nighttime visits were made for establishing records based on direct observation, with the help of flashlights. No sighting of species of the mammalian fauna occurred in this expedition.

**Photo 4.49:** Vestiges of the presence of porcupines.

**Photo 4.50:** Footprint of young common duiker (*Sylvicapra grimmia*).

**Photo 4.51:** Footprint of an aardvark (*Orycteropus afer*).

- **Avifauna**

The locations chosen for collection of specimens of the region's avifauna were the same selected for collecting specimens of the mammalian fauna and the herpetofauna, in addition to the daily sightings on the way between the various sampling locations. Three differentiated sampling methods were adopted for this:

- **Direct sighting:** identification through direct observation, always in the morning and at nightfall, during random walks in the region's representative landscapes, at the time of the birds' greatest activity. For this, binoculars and specific bibliography for field work were employed;

- **Indirect records:** based on interviews with local residents for confirmation of some species present; and

- **Direct capture:** using 12-meter, 36-milimmeter mesh mist nets positioned in the region's representative phytophysiognomies. The specimens captured were photographed (for later confirmation and identification); a record was made of their biometric data (length of the beak, wing, tarsus, and tail), weight, sex (whenever possible), molting, and other pertinent information. After these procedures, the birds were released.

For the EIA regarding the deviation of the river course, field visits were undertaken to check the condition of the habitat and to complete direct observation for updating the list of species, assigning priority to the ADA.

For this study's updating in 2013 observation of the fauna was done on four consecutive days (April 9-12, 2013). In view of the great extension of the area to be covered, but particularly because of the difficulty of access to many locations for lack of trails, the decision was made to gather information according to the opportunities. All roads and trails in the undertaking's direct influence area were traveled on foot, particularly to reach places closer to the Kwanza River and to some of its tributaries. Birds were recorded in all types of habitats and all over the area of the project's immediate implementation, either from a 4x4 vehicle or during short walks. Some species were also recorded at night.

For observation, a Swarovski SLC 10x42 binocular and a Swarovski SD 80 10x50 telescope were used, as well as an Edirol 99 sound system, manual Sony loudspeakers, and bird recordings available for Angola (Roberts, 1999; Chappuis, 2002; Mills, 2005). Specialized field guides were used (Van Perlo 1999; Sinclair & Ryan 2002; Dean 2000; Branch 1998; Marais 1999; Channing 2001; Kingdon 2005), as well as a Canon 7D and a Canon 5D cameras with a 400mm and 100mm Cannon Macro objectives. Whenever possible, the recorded animals were photographed.

- **Herpetofauna**

Initially three types of strategy had been planned for herpetofauna sampling: pitfalls with drift fences; direct capture on occasional encounters; and sightings. As aluminum cans were not available for making traps (pitfalls or trapdoors), this technique was discarded.

Data about the species listed for the region were complemented with research in the specialized literature in scientific collections deposited at the Luanda Museum of Natural History and at the Capanda AH Environmental Laboratory. Both collections

result from activities for inventorying and recovery of the Capanda AH fauna (between 2001 and 2003).

Although amphibian variations have been recorded on night walks, locomotion limitations hindered access to specimens. Samplings were thus limited to casual encounters and to collections already in existence for the region.

Animals that had been run over (Photo 4.52) were photographed and taken into consideration in this study's final results. In addition, information was gleaned from informal interviews with the local population.

**Photo 4.52:** Run over Bits sp, found on the Capanda road.

In complementation of the herpetofauna sampling techniques, random walks were taken in the daytime, and the ground under dry leaves and fallen tree trunks was scrutinized.

As Angola does not produce immunobiologicals against ophidian accidents, direct collection of snakes of the *Elapidae* (spitting and mamba snakes) and *Viperidae* (vipers) families was avoided. For identification of the presence of these animals, censuses were taken with the local populations, and information was gathered during the Capanda AH construction work.

For *Chelonia* and *Crocodylia*, in addition to some large-size lizards (e.g., *Varanus* spp), priority was given to visual and photographic identification.

The biometric data of all animals captured were taken down on field logs and fixed with 10% buffered formalin and preserved in alcohol at 40% (amphibian) and 70% (reptiles).

One of the undertaking's workers, Mr. Henrique Lima, made available to us a photographic file for the surveys' updating (2013). This allowed us to confirm the

occurrence of some additional species in the area, particularly reptiles. Still in 2013 amphibians were spotted and captured by hand for later identification, whenever possible. The recording of reptiles presents an additional difficulty, given the elusive nature of most species, which often hinders their observation and capture. Be that as it may, some species were observed, while others were recorded on the basis of consultation of photographic files of the location and field guides.

- **Fauna survey results**

Under this item are presented the results of the field survey of members of the fauna in the AAR, the AID, and the ADA. This study shows that the AID region's mammalian fauna is quite rich. Although the density of the fauna populations does not seem to be very high, there are no comparative references for the Angolan Miombo and adjacent areas. Thus, it is not possible to make consistent statements at this time. The environment's support capacity is considerable, as large mammals, both ungulates ad predators, still inhabit the region. This suggests that the ecologic systems remain relatively intact in this region.

As regards the threats of extinction, consistently with the UICN listings, most identified species have been classified under "low risk of extinction," with extensive geographical distribution of habitats.

However, it should be noted that the *Panthera pardus* (leopard) has been classified as "vulnerable" to extinction; the *Hippopotamus amphibious* (hippopotamus) as "vulnerable"; and, among the birds, the *Glareola nordmanni* as under "critical danger," and the *Grus carunculatus* as also vulnerable.

- **Mammals**

The identified mammals potentially present in the study area encompass 40 species belonging to 24 families and 8 orders, as shown in Table 4.15.

**Table 4.15:** Mammalian fauna present in the study area.

| Order | Family | Species |
|---|---|---|
| Chiroptera | Pteropodidae | *Epomophorus wahlbergi* |
| | Nycteridae | *Nycteris cf. Grandis* |
| | Rhinolophidae | *Rhinolophus clivosus* |
| | Vespertilionidae | *Nycticeius schlieffenii* |
| | Hipposideridae | *Eptesicus SP* |
| | | *Hipposideros ruber* |
| | Molossidae | *Chaerodon sp.* |
| | | *Mopscf. Condylurus* |
| | | *Lepus cf. saxatilis* |
| Rodentia | Thryonomyidae | *Thryonomys swinderianus* |
| | Bathyergidae | *Cryptomys SP* |
| | Hystricidae | *Hystrix africaeaustralis* |
| | Nesomyidae | *Cricetomys* sp |
| | Sciuridae | *Heliosciurus gambianus* |
| | | *Not identified 01* |
| Primates | Cercopitecidae | *Cercopithecus cf. pygerythrus* |
| | | *Miopithecus talapoin* |
| | | *Papio cynocephalus* |
| | Galagidae | *Otolemur crassicaudatus* |
| | Lorisidae | *Not identified 01* |

| Order | Family | Species |
|---|---|---|
| **Soricomorpha** | Soricidae | *Not identified 01* |
| **Macroscelidea** | Macroscelididae | *Not identified 01* |
| | Herpestidae | *Herpestes sanguineus* |
| | | *cf. Atilax paludinosus* |
| | | *Ichneumia albicauda* |
| | | *Mungos Mungo* |
| | Viverridae | *Genetta tigrina* |
| | Felidae | *Leptailurus serval* |
| | | *Panthera pardus* |
| **Tubulidentata** | Orycteropodidae | *Orycterus afer* |
| **Hyracoidea** | Procaviidae | *Heterohyrax cf. Brucei* |
| **Artiodactyla** | Hippopotamidae | *Hippopotamus ampjibius* |
| | Bovidae | *Cephalophus monticola* |
| | | *Oreotragus oreotragus* |
| | | *Sylvicapra grimmia* |
| | | *Tragelaphus scriptus* |
| | | *Syncerus caffer* |
| | | *Kobus ellipsiprymnus* |
| | Suidae | *Phacochoerus africanus* |
| | | *Potamochoerus larvatus* |

**Order Tubulidentata**

Aardvark (*Orycteropus* afer) footprints (Photo 4.53) and burrows (Photo 4.54) were found in several places on both banks of the Kwanza River. This species seems to be relatively frequent in areas where the soil is less rocky, which facilitates the digging of burrows for shelter. This characteristic thus determines an uneven distribution of the *Orycteropus afer* in the Middle Kwanza River region. This is an important species from the standpoint of conservation, and is little known in Angola.


**Photo 4.53:** Footprint of an aardvark (*Orycteropus afer* (left front paw) on the Kwanza River left bank.

**Photo 4.54:** Aardvark (*Orycteropus afer*) burrows on the Kwanza River left bank. The diameter of the camera objective lid (arrow) is 6 centimeters.

**Order Hyraccoidae**

The hyrax (H*eterohyrax cf. brucei)* is a species recorded on the basis of a considerable number of sightings of isolated individuals and colonies between the Capanda AH and the Kwanza River, and on the river's rocky banks. These animals use a wide range of habitats, though showing preference for rocky areas, and have daylight habits (Photo 4.55). Some individuals have shown great locomotion skill in the arboreous stratum. This behavior has been noted at night on the part of individuals on the road connecting the Capanda AH to Location 5[1], suggesting that a predominantly arboreal form (gender *Dendrohyrax*) may also occur in the Kwanza River region.

**Photo 4.55:** A Hyrax (*Heterohyrax cf. brucei*) photographed on the left bank of the Kwanza River near a stretch of steep bank.

[1] Location 5 was one of the 2007-2009 field survey locations (sampling coordinates: 9°48'14"S; 15°24'02"E).

**Order Primate**

Some of the primates observed were thick-tailed galago individuals (*Otolemur crassicaudatus*) in the Miombo region between the Capanda AH and Location 5 (Photo 4.56). Some individuals (at least three) were sighted in a same area and may have been a family group (mother and its young), as in Southern African regions August and September are the reproduction period.

**Photo 4.56:** *Otolemur crassicaudatus* individuals photographed near the Capanda village road/location 5 (on the left) and near the Dombo port (on the right).

A young Cercopithecus (*Chlorocebus pygerythrus*) was captured by the military (Photo 4.57) in a savanna area in the Kyangulungo region. Another female with young was recorded by a camera trap in the vicinity of the Dombo port. Several individuals have been observed on both banks of the Kwanza River, in open savanna areas or even on river islands or in riparian zones near tracts of discontinuous gallery forests. Several *Chlorocebus* species and subspecies are recognized, but information on the Angolan populations is insufficiently consistent to facilitate comparisons with other African

regions where data are more abundant. The recording of young individuals during the current expedition documents the occurrence of the reproductive season in the region in the period evaluated, for the *Chlorocebus* is known for having a synchronized reproductive peak, with approximately 80% of births occurring within a two- to three-month interval. Females give birth once a year, and the reproductive period usually coincides with the beginning of the season, when resources are more abundant.

**Photo 4.57:** Young *Chlorocebus pygerythrus* captured in the area by the road that connects Kyangulungo to the Kwanza River. The smaller photo shows a female with its young photographed on the Kwanza River right bank, near the Dombo port.

There has been also a daytime record of the yellow baboon (*Papio cynocephalus*) and two nighttime records in the area adjacent to the road to the Capanda AH. Five individuals have been observed also in the Pungo Andongo area (Photo 4.58).

**Photo 4.58:** *Papiocynocephalus* (yellow baboon) photographed in the rustic area on the left margin of the road to Capanda village/Location 5.

**Order Rondetia**

Rodents of the gender *Cricetomys* are large-sized in the Myomorpha group, weighing up to three kilograms and attaining 80 centimeters in length, tail included. Four species are known for the gender and little information is available for Angola, though *C. ansorgei* is a form recognized for the Pungo Andongo region. Two of the species captured in the traps were not identified.

One individual was photographed in a rocky zone on the Kwanza River left bank (Photo 4.59) where hyraxes also occur. One specimen of this gender is preserved at the Capanda AH Environmental Laboratory. Footprints have been observed on the Kwanza River left bank (Capanda AH).

**Photo 4.59:** *Cricetomys* sp. photographed on the Kwanza River left bank, near a steep rock formation.

One individual of an unidentified species of the Sc*iuridae* family (squirrel family) was observed on the Kwanza River left bank. However, no further information has been obtained and there is great need for collecting zoological material for a precise identification.

There were two sightings of mole-rats (*Criptomys* sp.) in the vicinity of Location 5. They were probably moving from one colony to another, as their movements in open areas are unusual, for these rats are burrowing animals. Signs of the presence of mole-rats have been observed in the form of mounds of excavated earth in a continuous pattern, photographically recorded on the Kwanza River left bank (Photo 4.60).

**Photo 4.60:** Burrows of mole-rats on the left bank of the Kwanza River.

The presence of Cape porcupines (*Hystrix africaeaustralis*) has been recorded on the basis of the layout of the burrows and footprints system (Photo 4.61). These evidences of occurrence are abundant on both margins of the Kwanza River, in savanna zones where soils are deeper and less rocky. No individual has been directly observed, as the evaluation work was done in the daytime in the areas with greater probability of occurrence of this species, whose activity is essentially nocturnal.

The greater cane rat (*Thryonomys swinderianus*) is a relatively common species in open areas with dense grass (Photos 4.62 and 4.63). It has been sighted in the field in a zone of gallery vegetation on a left bank tributary of the Kwanza River. A high frequency of feces has been observed in grassy areas on the Kwanza River left bank. The differences in the occurrence of these evidences suggest sharp contrast in the abundance of this species, when the two banks of the river are considered, as he right bank is under a greater hunting pressure, owing to its easier access.

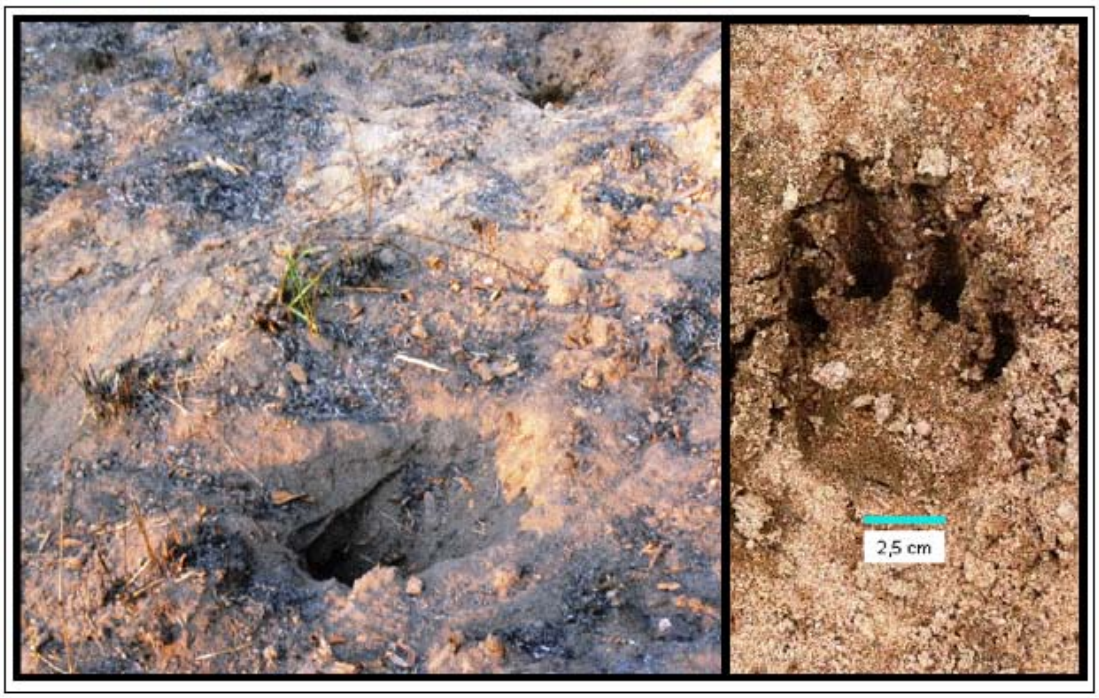


**Photo 4.61:** Burrows of the *Hystrix africaeaustralis* (in this case, apparently in search of food instead of shelter) observed on the right bank of the Kwanza River (Photo on the left). Footprint (right front paw) observed near a small left bank tributary (Photo on the right).

**Photo 4.62:** *Thryonomys* area on the Kwanza River left bank.


**Photo 4.63:** *Thryonomys swinderianus* specimen obtained from trappers; and feces observed on the left bank of the Kwanza River.

**Order Lagomorpha**

Scrub hares (*Lepus lcf. Saxatilis*) have been occasionally sighted on the road between the Capanda AH and Location 5 (bank of the Kwanza River). One particularity of the individuals sighted, which suggests confirmation of the species, is the brownish stripe on the top of the head, the black stripe on the upper part of the tail, and ears not as long as those of the *L. capensis*. The species, which seems to be common n the region, was photographed (Photo 4.64) already during the first expedition (April 2008).

Another leporid sighted was possibly a *Peolagus*, seen on the banks of the Kwanza River, including in the vicinity of the Capanda AH. The *Peolagus* is very similar to the *Oryctolaguscuniculus* (common rabbit in the wild). However, the *O. cuniculus* is restricted to the extreme northwest of the African continent, in the Mediterranean region.

Hares have been sighted numerous times during nocturnal surveys for this update (2013), but no species could be identified.

**Photo 4.64:** *Lepus* cf *saxatilis* photographed in the study area. The species characteristics are noticeable (see detail on the Photo), but there is need of confirmation, given the great *Lepus* variability on the African continent.

**Order Chiroptera**

The *Nycteris* gender is easily distinguishable owing to its unique tail with a cartilaginous end in the form of a Y or a T. The *Nycteris grandis* has a fur pattern that ranges from an orangey red to a creamy brown (Hickey and Dunlop, 2000). It should be noted that this specific identification is preliminary.

Should this record as *N. grandis* be confirmed, it will be an actual extension of this species's distribution, as today it is only know on the northern border of Angola. Such confirmation would corroborate the assumptions of Hickey and Dunlop (2000) that this species considered until now to inhabit preferentially forests can also occur in savanna areas.

The *Hipposideros* gender consists of a group of approximately 67 species widely distributed in Africa, except for a considerable part of the north and of extreme south of the continent. The little known *H. ruber* species inhabits savanna regions and subtropical and tropical forests. In the case of the *N. grandis*, a taxonomic reevaluation would be necessary.

**Order Carnivora**

Identification of the serval (*Leptailurus serval*), a specimen available at the Capanda AH Environmental Laboratory, has been confirmed by examination of the collected material. There have been also signs of the presence of a leopard (*Panthera pardus*) on the Kwanza River right bank (in the vicinity of the Dombo port). These signs have been associated with the odor of urine deposited for territory demarcation by a large-size feline (possibly this species). Comments by local hunters about the frequent occurrence of leopards in the region and a possible sighting by geologist Rogério Pinto Ribeiro (Intertechne) in the Caculo-Cabaça AH region point to their occurrence in the region. Although it is not an easily detected species, its occurrence may still be common in the Middle Kwanza River region.

Genet individuals (*Genetta spp.*) have been sighted along the Capanda AH road, in open grassy savanna between the Dombo port and the Muta/Capanda road. Footprints have been observed in some places on the left bank of the Kwanza River (Photo 4.65) (09° 49’ 49.86” S; 15° 30’ 53.92” E), and a photo has been taken on the river’s right bank, near the Dombo port (Photo 4.66).


**Photo 4.65:** Genet footprints on the left bank of the Kwanza River.

Four species are known in Angola and at least three more are expected to be found in the Middle Kwanza River region. There is an unidentified specimen at the Capanda AH Environmental Laboratory.

**Photo 4.66:** Genet photographed on the right bank of the Kwanza River near a gallery forest in transition to a grassy savanna.

**Order Herpestidae**

The marsh mongoose (cf. *Atilax paludinosus*) is a relatively small carnivore (adults attain little more than 5.0 kilograms), they are normally associated with bodies of water, where they feed on crustaceans and small vertebrates, such as amphibians. Evidence of its occurrence (Photo 4.67) has been noticed on the Kwanza River banks, at the Capanda dam, but the species may be widely distributed. The longish toes are quite particular, as it is the only herpestide with this characteristic and footprints as large as those found.

The white-tailed mongoose (*Ichneumia albicauda*) has been photographed (Photo 4.68) on the Kwanza River's right bank. Color particularities and overall appearance indicate that it belongs to this species. This form has wide geographical distribution on the African continent and a great variety of breeds with distinct variations. A subspecies (*Ichneumia albicauda loandae* Thomas, 1904) has been described for Angola, typically in Pungo Andongo, which makes the Middle Kwanza River a region of particular interest for understanding this group's variability on the African continent.


**Photo 4.67:** cf. *Atilax paludinosus* footprints seen on the Kwanza River's left bank.

**Photo 4.68:** *Ichneumia albicauda* photographed in the vicinity of the Dombo port, on the Kwanza River's right bank.

## Order Artiodactyla

Vestiges (teeth) of a warthog (*Phacochoerus africanus*) have been found on the right bank of the Kwanza River (Dombo port). Several footprints have been spotted in mud bath areas (dry in August) in a grassy tract near the river's right bank. One individual was photographed (Photo 4.69) near the Caculo-Cabaça AH. A trapper interviewed said that this species is quite common in the region and is frequently trapped with wire lassoes (several traps of this type were seen in the Kyangulungo region).

**Photo 4.69:** Warthog (*Phacochoerus africanus)* photographed in the Caculo-Cabaça AH region.

The presence of the bushpig (*Potamochoerus larvatus*) was described by a trapper in the Kyangulungo region. This species differs from the warthog mainly by the dense hairs on the body, which facilitate identification, in addition to the fact that this form is expected for the Middle Kwanza River region, consistently with the pertinent literature. The hairs' particularity has been underlined by two trappers interviewed; this information was considered to be reliable, although no individual has been sighted. The species is much hunted by the regional population as a major source of protein.

The hippopotamus (*Hippopotamus amphibious*) and its usual vestiges (footprints, trails, and grazing areas) (Photo 4.70) has been sighted on both banks of the Kwanza River. It seems to be more common on the river's left bank. Five individuals have been sighted at the Capanda AH, and two about 2.0 kilometers downstream from the Dombo port (Photo 4.71).

The isolated footprints of a forest buffalo (*Syncerus caffer*) (Photo 4.70) have been seen on the Kwanza River's left bank. Isolated footprints may indicate the presence of males, as females usually live in groups. This species occurs in the area, but it has been heavily

hunted by local populations; it is now experiencing a time of recovery, as the conflicts have ceased and the traffic of war weapons has declined.

**Photo 4.70:** Hippopotamus grazing areas, trails, and footprints on the banks or vicinity of the Kwanza River.

**Photo 4.71:** Hippopotamus photographed approximately 2.0 kilometers downstream from the Dombo port (Kwanza River).


**Photo 4.69:** Forest buffalo footprint on the Kwanza River's left bank.

This is an important species, not only from the great predators' conservation point of view, but also as a source food for the populations of the Middle Kwanza River. There are indications of the occurrence (abundance of footprints and feces) of smaller antelopes such as bushbuck (*Tragelaphus scriptus*), duiker (*Sylvicapra grimmia*), and blue duiker (*Cephalophus monticola*). These forms seem to be abundant in areas with relatively dense vegetation (grassy tracts and zones of transition to gallery forests).

Small antelopes are extremely important for supporting the carnivore populations, including local human populations that have in them a valuable resource. Signs of the occurrence of waterbuck (*Kobus ellipsiprymnus*) have been seen on the right bank of the Kwanza River; this is reinforced by both footprints and by hunters' reports. The hairs of the animal's posterior (usually white in this species) are used as arrow stabilizers by hunters of the region. This species must mean an important resource for the region's populations, given its size (adult males may weigh up to 270 kilograms) and the frequent comments about it as a hunting target.

- **Avifauna**

In the study area 92 species of birds, belonging to 43 families, and 17 orders were found on the field surveys done between 2007 and 2009. They are listed on Table 4.16 below.

**Table 4.16:** Avifauna recorded in the study area.

| Order | Family | Species |
|---|---|---|
| Passeriformes | Alaudidae | *Mirafra angolensis* |
| | Corvidae | *Corvus albus* |
| | Emberizidae | *Emberiza* sp. |
| | Estrildidae | *Euschistospiza cinereovinacea* |
| | | *Lagonosticta landanae* |

| Order | Family | Species |
|---|---|---|
| | | *Estrilda melanotis* |
| | | *Uraeginthus bengalus* |
| | Hirundinidae | *Hirundo angolensis* |
| | Laniidae | *Corvinella melanoleuca* |
| | | *Lanius souzae* |
| | Malaconotidae | *Laniarius* sp. |
| | | *Tchagua* sp. |
| | Motacillidae | *Macronyx fuellebornii* |
| | Muscicapidae | *Muscicapa boehmi* |
| | | *Muscicapa infuscata* |
| | Nectariniidae | *Anthreptes anchietae* |
| | | *Nectarinia bannermani* |
| | | *Nectarinia bocagii* |
| | | *Nectarinia kilimensis* |
| | | *Nectarinia rubescens* |
| | | *Nectarinia oustaleti* |
| | | *Nectarinia talatala* |
| | Paridae | *Parus griseiventris* |
| | | *Parus rufiventris* |
| | Passeridae | *Passer motilensis* |
| | | *Ploceus angolensis* |
| | | *Ploceus temporalis* |
| | | *Plocepasser rufoscapulatus* |
| | Platysteridae | *Batis* sp |
| | Pycnonotidae | *Andropadus* sp. |
| | | *Phyllastreohus* sp |
| | Sturnidae | *Lamprotornis acuticaudus* |
| | Sylviidae | *Eremomela atricollis* |
| | | *Cisticola bulliens* |
| | | *Cisticola pipiens* |
| | | *Cisticola melanurus* |
| | | *Sylvietta virens* |
| | | *Sylvietta ruficapilla* |

| Order | Family | Species |
|---|---|---|
| Piciformes | Sylviidae | *Camaroptera undosa* |
| | Timaliidae | *Pseudoalcippe abyssinica* |
| | | *Turdoides hartlaubii* |
| | | *Illadopsis fulvescens* |
| | Turdidade | *Cercotrichas* sp. |
| | | *Turdus libonyanus* |
| | | *Monticola angolensis* |
| | | *Erythropygia barbata* |
| | | *Myrmecocichla arnoti* |
| | | *Myrmecocichla nigra* |
| | | *Cossypha heinrichi* |
| | Viduidae | *Vidua obtusa* |
| | | *Vidua macrouma* |
| | | *Vidua paradiseae* |
| | Capitoidae | *Stactolaema anchietae* |
| | | *Lybius minor* |
| | | *Tricholaema frontata* |
| | Picidae | *Campethera nivosa* |
| Caprimulgiformes | Caprimulgidae | *Caprimulgus cf. Climacurus* |
| | | *Campethera* sp. |
| | | *Dendropicus* sp. |
| Colliformes | Collidae | *Colius castanotus* |
| Musiphagiformes | Musophagidae | *Tauraco erythrolophus* |
| Charadriiformes | Charadriidae | *Vanellus lugubris* |
| | Jacanidae | *Actophilornis africana* |
| | Glareolidae | *Glareola nordmanni* |
| | | *Cursorius temmincki* |
| Columbiformes | Columbidae | *Streptopolia decipiens* |
| | | *Treron calva* |
| Anseriformes | Anatidae | *Plectopterus gambensis* |
| Ciconiiformes | Ardeidae | *Bulbulcus íbis* |
| | | *Egretta intermédia* |
| | Ciconiidae | *Ciconia abdimii* |

| Order | Family | Species |
|---|---|---|
| | | *Ciconia episcopus* |
| Coraciiformes | Alcedinidae | *Halcyon badia* |
| | | *Halcyon chelicutensis* |
| | Coraciidae | *Coracias spatulatus* |
| | Bucerotidae | *Tockus pallidirostris* |
| Cuculiformes | Cuculidae | *Centropus cupreicaudus* |
| Falconiformes | Falconidae | *Aquila rapax* |
| | | *Falco curvierii* |
| Falconiformes | Falconidae | *Falco dickinsoni* |
| | | *Falco biarmicus* |
| | | *Milvus aegyptius* |
| | Acciptridae | *Accipter* sp. |
| | | *Circaetus pectoralis* |
| | | *Gypohierax angolensis* |
| | | *Necrosyrtes monachus* |
| | | *Gyps africanus* |
| Gruiformes | Rallidae | *Sarothrura pulchra* |
| Galliformes | Phasianidae | *Numida meleagris* |
| | | *Peliperdix* sp |
| Pelicaniformes | Phalacrocoracidae | *Phalacrocorax africanus* |
| Strigiformes | Tytonidae | *Tyto Alba* |
| | Strigidae | Glaucidium perlatum |

The field work for this study (2013) identified 82 species, shown on Table 4.17.

Most of the birds recorded in the area were visually observed, except for five species, whose identification was done only by bird calling. There were seven species whose identification is considered "probable;" not only it is extremely difficult to identify them, buy they were sighted only fleetingly, which hindered a more careful analysis. It was possible to photograph 27% of the bird species recorded (22 out of 82).

In view of the limited observation time, the figures do not adequately reflect the local ornithological wealth; the survey remained incomplete because it was impossible to have access to the entire left bank of the Kwanza River, just as it was difficult to explore the river itself properly.

The region of the project's implementation has a considerable avifauna wealth, owing particularly to its condition of transition between the coastal dry savannas that extend into the hinterland, following the Kwanza River above Cambambe, to the proximity of some forest ecosystems typical of the Angolan escarpment, but above all to the *Miombo* forest biome that covers a large part of the Angolan plateau and is dominant in the area affected by the project. Moreover, the Kwanza River itself, on a rocky bed, with a considerable, permanent flow, often set deep between mighty cliffs, contributes to the existence of quite interesting lacustrine ecosystems and of significant forests on some slopes. All these factors contribute to the wealth of the area's biological communities.

Most of the information collected is related to habitats consisting of *Miombo* savannas, grassy grazing lands, and some more developed forests next to the Kwanza River or to its tributaries. However, given the aforementioned conditions, the fluvial areas of the denser forests are underrepresented, for access and logistic reasons. This limitation is reflected on the analysis of the list of birds obtained. Accordingly, the number of water or marsh birds is lower than expected. Similarly, the number of forest birds is far lower and does not conveniently reflect the number of specimens that must occur in some dense forest areas that remained inaccessible to us.

As to the structure of the ornithological listing, we may say that it is relatively balanced, with 57% of the birds belonging to the Order Passeriformes (47 out of 82). It is

surprising that so many passerines have been identified, as they are usually smaller and more difficult to identify.

The absence of species of the *Phalacrocoracidae*, *Anatidae*, *Rallidae*, and *Glareolidae* families among those that are not Passeriformes is also surprising, as is the nearly complete absence of members of the *Ardeidae* and *Ciconidae* families, which can be explained by the impossibility of doing proper surveys along the Kwanza River and by accidental circumstances.

One of the most relevant ornithological categories in any study is that of the birds of prey, the predators at the top of the food chain, a good environmental indicator of the ecosystems' overall condition. In our case, eight species were recorded, i.e., 10% of the total, which should be seen as a typical, normal ratio in relatively balanced ecosystems. Six species considered stand out; they belong to the *Accipitridae* (including two vultures) and the *Falconidae* (two species).

Still as regards those that are not Passeriformes, mention should be made of the abundance of birds of the *Columbidae* family, with five species of turtledoves and three species of nightjar (*Caprimulgidae*). All of them have been photographed.

As regards the Passeriformes, one should first note the extraordinary wealth of the *Hirundinidae* family, of which swallows and kindred birds are examples, and whose presence is favored by the Kwanza River and the diversity of fluvial habitats and associated cliffs and savannas. Mention should also be made of the abundance of members of the *Ploceidae* family, 13 species of which have been identified; this is not only extremely relevant but also an indicator of good savanna habitats and an abundance of grasses, as these birds are essentially grain eaters. On the negative side, one may point out the poverty of P*ycnonotidae*, *Turdidae*, *Sylvidae*, and *Nectarinidae*, of which only from one to three have been recorded. The low representativeness of these four families may be simply a question of chance, the difficulty of identifying some of their species, and mainly the impossibility of conveniently exploring the dense forest and some tracts of riparian habitats.

Some photographed and identified species in the area (shown on Table 4.17) are listed in Annex VI.

There follow some comments on the identified species that are considered to be relevant, on which basis some conclusions may be drawn about the condition of the ecosystems in the area.

**Table 4.17:** Birds recorded by the field survey (2013)

| Portuguese name | English name | Scientific name |
|---|---|---|
| Garça-boieira | *Cattle Egret* | *Bubulcus ibis* |
| Cabeça-de-martelo | *Hamerkop* | *Scopus umbretta* |
| Cegonha-episcopal | *Whooly-necked Stork* | *Ciconia cf episcopus* |
| Abutre-de-cabeça-branca | *White-headed Vulture* | *Trigonoceps occipitalis* |
| Bemba | *Palm-nut Vulture* | *Gypohierax angolensis* |
| Búteo-de-pescoço-vermelho | *Red-necked Buzzard* | *Buteo auguralis* |
| Águia-cobreira-castanha | *Brown Snake-Eagle* | *Circaetus cinereus* |
| Serpentário-pequeno | *Gymnogene* | *Polyboroides typus* |
| Gavião-pequeno | *Little Sparrowhawk* | *Accipiter cf minullus* |

| Portuguese name | English name | Scientific name |
|---|---|---|
| Francelho-cinzento | *Grey Kestrel* | *Falco ardosiaceus* |
| Falcão-peregrino | *Peregrine Falcon* | *Falco peregrinus* |
| Perdiz-de-gola-vermelha | *Red-necked Francolin* | *Pternistes afer* |
| Toirão-comum | *Kurrichane Button-Quail* | *Turnix sylvatica* |
| Alcarvão-do-cabo | *Spotted Thicknee* | *Burhinus capensis* |
| Asa-de-bronze | *Bronze-winged Courser* | *Cursorius chalcopterus* |
| Rola-de-coleira | *Cape Turtle Dove* | *Streptopelia capicola* |
| Rola-negra | *Red-eyed Dove* | *Streptopelia semitorquata* |
| Rola-esmeraldina | *Emerald-spotted Dove* | *Turtur chalcospilos* |
| Rolinha-do-cabo | *Namaqua Dove* | *Oena capensis* |
| Pombo-verde | *Green Pigeon* | *Treron calvus* |
| Andua-de-crista-vermelha | *Red-crested Turaco* | *Tauraco erythrolophus* |
| Cuco-jacobino | *Jacobin Cuckoo* | *Oxylophus jacobinus* |
| Cucal-de-luanda | *White-browed Coucal* | *Centropus superciliosus* |
| Corujão-malhado | *Spotted Eagle-Owl* | *Bubo africanus* |
| Noitibó-de-welwitsch | *Square-tailed Nightjar* | *Caprimulgus fossii* |
| Noitibó-de-pescoço-dourado | *Fiery-necked Nightjar* | *Caprimulgus pectoralis* |
| Noitibó-sardento | *Freckled Nightjar* | *Caprimulgus cf tristigma* |
| Guincho-das-palmeiras | *African Palm Swift* | *Cypsiurus parvus* |
| Guincho-pequeno | *Little Swift* | *Apus affinis* |
| Rabo-de-junco-de-rabadilha-vermelha | *Red-backed Mousebird* | *Colius castanotus* |
| Pica-peixe-riscado | *Striped Kingfisher* | *Halcyon chelicuti* |
| Pica-peixe-malhado | *Pied Kingfisher* | *Ceryle rudis* |
| Abelharuco-pequeno | *Little Bee-eater* | *Merops pusillus* |
| Rolieiro-de-peito-lilás | *Lilac-breasted Roller* | *Coracias caudata* |
| Barbaças-de-peito-preto | *Black-collared Barbet* | *Lybius torquatus* |
| Cotovia-de-crista | *Rufous-naped Lark* | *Mirafra cf africana* |
| Cotovia-de-castanholas | *Flapped Lark* | *Mirafra rufocinnamomea* |
| Andorinha-preta | *Black Saw-wing* | *Psalidoprocne pristoptera* |
| Andorinha-das-ravinas | *Angolan Cliff Swallow* | *Hirundo rufigula* |
| Andorinha-de-papo-estriado | *Lesser-striped Swallow* | *Hirundo abyssinica* |
| Andorinha-de-Angola | *Angolan Swallow* | *Hirundo angolensis* |
| Andorinha-de-monteiro | *Mosque Swallow* | *Hirundo senegalensis* |
| Andorinha-cauda-de-arame | *Wire-tailed Swallow* | *Hirundo smithii* |
| Andorinha-das-rochas | *Rock Martin* | *Hirundo fuligula* |
| Alvéola-preta-e-branca | *African Pied Wagtail* | *Motacilla aguimp* |
| Chiricuata-amarela | *Yellow-bellied Greenbul* | *Chlorocichla flaviventris* |
| Brimblau | *Black-capped Bulbul* | *Pycnonotus tricolor* |

| Portuguese name | English name | Scientific |
|---|---|---|
| Rouxinol-de-heuglin | *White-browed Robin-Chat* | *Cossypha heuglini* |
| Cartaxo | *Stone Chat* | *Saxicola torquata* |
| Chasco negro | *Sooty Chat* | *Myrmerocichla nigra* |
| Boita-de-asa-curta | *Short-winged Cisticola* | *Cisticola cf brachypterus* |
| Boita-da-Huíla | *Rattling Cisticola* | *Cisticola chiniana* |
| Eremomela-de-salvadori | *Salvadori's Eremomela* | *Eremomela cf salvadorii* |
| Beija-flor-cúpreo | *Copper Sunbird* | *Cinnyris cuprea* |
| Picanço-cinzento | *Lesser Grey Shrike* | *Lanius minor* |
| Picanço-fiscal | *Fiscal Shrike* | *Lanius collaris* |
| Picanço-de-almofadinha | *Black-backed Puffback* | *Dryoscopus cubla* |
| Tchagra-de-coroa-preta | *Black-crowned Tchagra* | *Tchagra senegalus* |
| Tchagra-de-cabeça-castanha | *Brown-crowned Tchagra* | *Tchagra australis* |
| Picanço-de-peito-alaranjado | *Orange-breasted Bush-Shrike* | *Malaconotus sulfureopectus* |
| Corvo-de-peito-branco | *Pied Crow* | *Corvus albus* |
| Estorninho-metálico-de-ombro-violeta | *Cape Glossy Starling* | *Lamprotornis nitens* |
| Tecelão-dourado | *Holub's Golden Weaver* | *Ploceus xanthops* |
| Cardeal-tecelão-vermelho | *Black-winged Red Bishop* | *Euplectes hordeaceus* |
| Cardeal-tecelão-amarelo | *Yellow Bishop* | *Euplectes capensis* |
| Viúva-de-asa-branca | *White-winged Widowbird* | *Euplectes albonatus* |
| Viúva-de-dorso-amarelo | *Yellow-mantled Widowbird* | *Euplectes macrourus* |
| Viúva-de-coleira-vermelha | *Red-collared Widowbird* | *Euplectes ardens* |
| Macarachão-de-asa-verde | *Melba Finch* | *Pytilia melba* |
| Macarachão-de-asa-laranja | *Orange-winged Pytilia* | *Pytilia afra* |
| Peito-de-fogo-de-Lândana | *Pale-billed Firefinch* | *Lagonosticta cf landanae* |
| Peito-celeste | *Blue Waxbill* | *Uraeginthus angolensis* |
| Bico-de-lacre-de-face-laranja | *Orange-cheeked Waxbill* | *Estrilda melpoda* |
| Bico-de-lacre-de-peito-laranja | *Orange-breasted Waxbill* | *Sporaeginthus subflavus* |
| Guarda-marinha | *Bronze Mannikin* | *Spermestes cucullatus* |
| Viuvinha-malhada | *Pin-tailed Whydah* | *Vidua macroura* |
| Viuvinha-do-paraíso | *Paradise-Whydah* | *Vidua paradisaea* |
| Viuvinha-real | *Broad-tailed Paradise-Whydah* | *Vidua obtusa* |
| Bico-de-prata | *Dusky Indigobird* | *Vidua cf funerea* |
| Bigodinho | *Yellow-fronted-canary* | *Serinus mozambicus* |
| Escrevedeira-das-pedras | *Rock Bunting* | *Emberiza tahapisi* |
| Escrevedeira-de-peito-dourado | *Golden-breasted Bunting* | *Emberiza flaviventris* |

## Birds that benefit from human communities

These are birds that usually proliferate in close proximity of human communities and that benefit directly from human impact on the ecosystem. They may be good indicators of the degree of degradation of a habitat. Two of these birds have been identified, but both with low intensity.

- **Cattle egret** (***Bubulcus ibis)***: This is a species usually found where there are cattle but which also seeks urbanized areas, where it feeds on garbage and debris left by man. They have been sighted in small flocks on two occasions, concentrated on trees on the left bank of the Kwanza River, near the dam site. But its presence still seems to be little significant.

- **Pied crow** (***Corvus albus***): This is another species nearly always absent from pristine habitats. Its presence thus promptly denotes some degree of disturbance. Only two specimens have been sighted on just one occasion as they flew over the project's urban area. Though this species's presence seems to be little significant, as in the previous case, it is expected that its numbers will increase.

**Birds of prey**

There follows a list of some birds of prey recorded, which give an indication of the environmental condition of the ecosystems:

- **White-head vulture** (***Trigonoceps occipitalis***): This is the only threatened species recorded in the course of this study, which is classified as vulnerable on the IUCN Red List. This species has significantly declined in the entire distribution area, which is a sign of slow reproduction and of sensitiveness to environmental disturbance. It is thus another good biological marker, indicating the existence of extensive tracts of *miombo* forests and savannas not yet much disturbed by man. One adult and one young have been sighted, both flying high upstream from the dam, within the project's direct influence area. The sighting of both adult and young clearly suggests this species's nesting in the undertaking's area, something worth stressing.
- **Palm-nut vulture** (**Gypohierax angolensis**): This is a very common species in Angola; many specimens were sighted both along the Kwanza River and on the adjacent savannas. This species is very tolerant to man-made disturbances of the environment; its abundance in the area is a good environment indicator, possibly reflecting the wealth of the fluvial ecosystems (Photo 4.72).

- **African red-necked buzzard** (**Buteo auguralis**): As this is a species usually associated with the mosaic of dense forests and woods of northern Angola, its sighting in the area should be stressed (Photo 4.73), as it is a good environmental indicator, which probably reflects geographical proximity to North Kwanza forests.
- **Peregrine falcon** (***Falco peregrinus***): The sighting of a couple of peregrine falcons in the dam area is a quite relevant fact as this is a highly emblematic bird and a top predator. Although it is not listed as a threatened species, it is extremely sensitive and a prime environmental indicator. The sighting of a couple strongly suggests the possibility of nesting in the area, probably owing to the abundance of steep cliffs along the Kwanza River.

**Photo 4.72:** *Palm-nut buzzard*.

**Photo 4.73:** Red-necked buzzard.

**Endemic birds**

The two species below are endemic to Angola, i.e., they do not occur in other countries. Although many species endemic to Angola are rare or threatened, these two do not raise particular conservation concerns.

- **Red-crested turaco** (***Tauraco erythrolophus***): This bird is quite possibly Angola's emblem owing to its uniqueness and beauty. Despite everything, it is common in the central and northern part of the country, always associated with escarpment and gallery forests. Abundant on the coastal plain, it is also found in the northern hinterland along rivers. It may be seen as a good environmental indicator; its sighting on one of the Kwanza River tributaries upstream from the dam is worth stressing.
- **Red-backed mousebird** (***Colius castanotus***): This is another endemic species, quite abundant in the western half of the country, which proliferates in both preserved spaces and in impacted and even urban zones, a reason why it cannot be considered as a good indicator. It proved quite common in the project's area.

**Other birds**

There follows a list of some birds whose occurrence or abundance in the project's site deserve to be mentioned:

- **Common button quail** (***Turnix sylvatica***): Neither rare nor threatened, this species is in great abundance in the area. This is surprising, and deserves mentioning (Photo 4.74). A very elusive species, it was nevertheless sighted every day, particularly on forest trails upstream from the dam. It is thus a good indicator of the condition of the area's grassy savanna.
- **Namaqua dove** (***Oena capensis***): Although not a rare species either, it is prevalent in desert or semiarid areas. The sighting of some specimens (Photo 4.75) was thus somewhat unexpected. However, it reflects both its migratory, wandering nature and the proximity of semiarid habitats that extend from the coastal plain along the Kwanza River to the vicinity of the Dondo.
- **Lesser grey shrike** (***Lanius minor***): Though clearly migratory, this species is rare or little common in Angola, a reason why the sighting of a specimen near the project's urban area should be underlined (Photo 4.76).

**Photo 4.74:** Common button quail (*Turnix sylvatica).*

**Photo 4.75:** Female Namaqua dove (*Oena capensis).*

**Photo 4.76:** Lesser grey shrike (*Lanius minor).*

- **Herpetofauna**

Given their sensitiveness to any changes in the environment, amphibians are an extremely important fauna group. As they depend on water and breathe in and absorb substances through the skin, they are extremely vulnerable to pollution. They are thus one of the best environmental indicators, and for this reason their populations should be monitored.

And yet, localization, observation, and identification of amphibians are very problematic, owing to their small size and cryptic, seasonal behavior, as well as to the lack of up-to-date knowledge about them in Angola. In general, the best time to survey amphibians is the first peak of the rainy season, November-December. Although April is not the ideal time, it is still possible to gather some information that can be very useful.

Three amphibian species belonging to three families and 28 reptile species belonging to 13 families and three Orders, as shown in the Table 4.18 below (2007-2009) were found.

**Table 4.18:** Herpetofauna occurring in the study area.

| Group | Order | Family | Species |
|---|---|---|---|
| Amphibians | | Arthroleptidae | *Artholeptis lameerei* |
| | | Bufonidae | *Bufo gutturalis* |
| | | Hyperoliidae | *Hyperolius* sp |
| Reptiles | Chelonia | Testudinidae | *Kinixys belliana* |
| | | Pelomedusidae | *Pelusios cf. Subniger* |
| | Lacertilia | Agamidae | *Agama agama* |
| | | | *Agama* sp |
| | | Chamaeleonidae | *Chamaeleo dilepis* |
| | | | *Chamaeleo gracilis* |
| | | Gekkonidae | *Hemidactylus* sp |

| Group | Order | Family | Species |
|---|---|---|---|
| | | | *Lygodactylus* sp |
| | | | *Pachydactylus* sp |
| | | Gerrhosauridae | *Gerrhosaurus flavigularis* |
| | | Scincidae | *Mabuya varia* |
| | | Varanidae | *Varanus albigularis* |
| | | | *Varanus niloticus* |
| | Ophidea | Boidae | *Python natalensis* |
| | | Colubridae | *Dasypeltis* sp |
| | | | *Dispholidus typus* |
| | | | *Lamprophis fuliginosus* |
| | | | *Philothamnus cf. Hoplogaster* |
| | | | *Philothamnus* sp 1 |
| | | | *Philothamnus* sp 2 |
| | | | *Psammophis* sp |
| | | | *Telescopus semiannulatus* |
| | | Elapidae | *Dendroaspis polylepis* |
| | | | *Elapsoidea semiannulata* |
| | | | *Naja melanoleuca* |
| | | | *Naja nigricollis* |
| | | Viperidae | *Bitis arietans* |
| | | Typhlopidae | *Unidentified species* |

It should be noted that some of the species described in the 2013 survey should have their identification confirmed (See Table 4.19). Be as it may, the doubtful species were collected and are awaiting conclusive identification. These species are described below:

- **Flat-backed toad** (***Bufo maculatus***): This species is very common and widely distributed in Angola. Several of these toads were spotted along small streams and tributaries; in one place they were very active and in a reproductive phase. Two specimens were photographed (Photo 4.77).

- **Angolan reed frog** (***Hyperolius angolensis***): A very common species widely distributed throughout the entire country. It is usually associated with humid, swampy areas. Several specimens were captured (Photo 4.78) in Kwanza River tributaries upstream from the dam. We were also able to record their characteristic sound by the Kwanza River downstream from the dam.
- **Senegal Kassina** (***Kassina senegalensis***): Several specimens of this species were located on a property near an old quarry by the roadside on the basis of their quite characteristic call. It is widely distributed in the country in swampy areas and shallow waters. Owing to its cryptic behavior, it is very difficult to capture.
- **Natal puddle frog** (***Phrynobatrachus natalensis***): This species is very common in swamps, ditches, and shallow waters. Several specimens were located on the Kwanza River banks through their characteristic call.
- **Anchieta's ridged frog** (***Ptychadena anchietae***): A relatively common species found in swampy areas in humid savannas or *miombo*. Several specimens were captured in the urban area and duly photographed (Photo 4.79).
- **Crowned bullfrog** (***Hoplobatrachus accipitalis***): Relatively uncommon species and a frightening predator for other amphibians and thus a good environmental indicator. Several specimens were sighted in temporary puddles, next to trails downstream from the dam, but no capture was possible.

No threatened amphibian species on the IUCN Red List was found.

**Photo 4.77:** Flat-backed toad.

**Photo 4.78:** Angolan reed frog.

**Photo 4.79:** Anchieta's ridged frog.

**Table 4.19:** Amphibians identified by the environmental survey (2013)

| Portuguese name | English name | Scientific name |
|---|---|---|
| Sapo-de-costas-achatadas | Flat-backed Toad | *Bufo maculatus* |
| Rela-de-angola | Angolan Reed Frog | *Hyperolius angolensis* |
| Rã-kassina | Senegal Kassina | *Kassina senagalensis* |
| Rã-dos-charcos-de-Natal | Natal Puddle Frog | *Phrynobatrachus natalensis* |
| Rã-saltadora-de-anchieta | Anchieta Ridge Frog | *Ptychadena anchietae* |
| Rã-touro-coroada | Crowned Bullfrog | *Hoplobatrachus occipitalis* |

Reptiles are a major fauna group and their characterization is important in studies such as this. However, a herpetological survey faces great difficulties, given the species's elusive nature, which hinders capture. In addition, there is a lack of publications about Angola's reptiles.

Accordingly, the survey was based on chance, in an attempt to identify the maximum number of species (See Table 4.20). It was also possible to consult Mr. Henrique Lima's photographic file, which made possible the identification of some snake species that occur in the area.

- **Leopard tortoise** (***Geochelone pardalis***): A commons species in the entire country. One specimen was found by workers in the urban area during our stay.

- **Puff adder** (***Bitis arietans***): Commonly known as "surucucu," this poisonous snake was photographed by Mr. Henrique Lima near the Laúca dockyard.
- **Short-snouted grass snake** (**Psammophis brevirostris**): this harmless snake was also photographed by Mr. Henrique Lima in the Laúca dockyard.
- **Black mamba** (***Dendroaspis polylepis***): the infamous and feared black mamba was also photographed by Mr. Henrique Lima in the project's urban area.
- **African rock python** (***Python natalensis):*** commonly known as *"jiboia"*, this species was also photographed by Mr. Henrique Lima.
- **Skink** (***Mabuya sp.***)*:* a female skink was sighted in one of the cliffs directly downstream from the dam, but it was not possible to capture or to photograph it; its identification thus remained incomplete.
- **Yellow-throated plated lizard** (***Gerrhosaurus flavigularis***): several specimens were sighted and photographed on forest trails upstream from the dam (Photo 4.80).
- **Black-lined plated lizard** (***Gerrhosaurus cf. nigrolineatus***): one specimen was photographed (Photo 4.81), but needs confirmation.
- **Namibian rock agama** (***Agama planiceps***): several specimens were sighted and photographed (Photo 4.82) on rocks and cliffs on the right bank of the Kwanza River.
- **Tree agama** (***Acanthrocercus atricollis***): only one specimen was found on a tree and photographed (4.83).
- **Nile crocodile** (***Crocodylus niloticus***): Several photographs taken of this species by Mr. Henrique Lima in various locations of the Kwanza River were shown to the team.

No threatened reptile species figuring on the UICN Red List was found.

**Table 4.20:** Reptiles recorded by the environmental survey (2013).

| Portuguese name | English name | Scientific name |
|---|---|---|
| Tartaruga-terrestre-malhada | *Leopard Tortoise* | *Geochelone pardalis* |
| Víbora-de-aríete | *Puff Adder* | *Bitis arietans* |
| Cobra-leopardo | *Short-snouted Grass Snake* | *Psammophis brevirostris* |
| Mamba-negra | *Black Mamba* | *Dendroaspis polylepis* |
| Pitão-africana | *African Rock Python* | *Python natalensis* |
| Lagartixa-das-pedras | *Skink* | *Mabuya sp.* |
| Lagarto-de-garganta-amarela | *Yellow-throated Plated Lizard* | *Gerrhosaurus flavigularis* |
| Lagarto-de-faixa-preta | *Black-lined Plated Lizard* | *Gerrhosaurus cf nigrolineatus* |
| Agama-das-pedras-comum | *Namibian Rock Agama* | *Agama planiceps* |
| Agama-das-árvores | *Tree Agama* | *Acanthocercus atricollis* |
| Crocodilo-do-nilo | *Nile Crocodile* | *Crocodylus niloticus* |

**Photo 4.80:** Male yellow-throated plated lizard.

**Photo 4.81:** Black-lined plated lizard.

**Photo 4.82:** Male Namibian rock agama.

**Photo 4.83:** Tree agama.

## 4.3.10. AQUATIC FAUNA

- **Benthic macroinvertebrates**

The benthic macro-invertebrate community, which inhabits the bottom substrate, is represented by organisms larger than 210 µm, associated with some type of submerged substrate, such as leaves, rocks, trunks, or sand. Populations coexist and interact among themselves and with the environment in a given habitat, forming associations of organisms. These associations' structure has characteristics such as specific composition, wealth of species, density, biomass, diversity, and trophic relations among the individuals. Their dynamics is related to these associations' temporal organization, owing to fluctuations in recruiting, abundance of organisms, and efficiency in the re-colonization of the substrates after natural or artificial disturbances.

In general they live their entire lifecycle or part of it in the aquatic environment; their energetic base is debris, particularly of an allochthonous origin. The nature of sediments

and the depth of the body of water, coupled with the availability of food and oxygen, are the main factors on which the communities' structure and distribution in the environment are based.

They are important not only because of their role in the food chain but also in processing allochthonous and autochthonous organic carbon (Fisher and Lihens, 1973; Petersen et al., 1989), thereby influencing the availability of food for fish and other vertebrates associated with water courses, such as birds and mammals (Sagar and Eldon, 1983; Bachman, 1984; Pierce, 1989).

This group has been used as an efficient tool for this environmental diagnostic of rivers. In temperate regions, environmental quality indexes have been developed on the basis of data on this community, which have become part of official biomonitoring protocols.

- Methodological procedures

Collections were made along the Kwanza River, where sampling areas were defined always with a view to the representativeness of the study area (2007-2009). Collection points were similar to those of limnological studies and of studies on water quality and fishes, so that parameters can be applied to both projects.

Choice of the equipment for biological collections depended on the sampling location and the type of locally available infrastructure. Specific nets were used for benthic organisms, as well as traps.

All biological material collected on the field was placed in a plastic container with 10% formalin, and then in flasks specific to each of the different taxa, and duly identified and labeled. Data pertaining to the sampling locations' environmental parameters (temperature, dissolved oxygen, conductivity, and transparency of the body of water) were duly recorded in the field notebook for later analysis.

In the rainy season the water speed hinders the permanence of benthic organisms in the stretches of rapid flow. At the same time, the margin areas expand, owing to the widening of the river channel. The shallow margins are usually dry in the dry season, so that the compacted clayey or sandy soil of poor consistency makes difficult the colonization of annelids, mollusks, or insect larvae, and offer no shelter or feeding

ground for crustaceans. On the other hand, the bank vegetation, being temporarily flooded, may provide shelter and food for aquatic organisms when the waters' speed slows down.

In the dry season the scenario changes to its opposite, giving rise to specific environments for the development of this particular fauna, especially decapod crustaceans. None of these organisms was collected live; only the remains of a crustacean was recorded (Photo 4.84).

**Photo 4.84:** Carapace of a crustacean typical of the Kwanza River.

**Ichthyologic fauna**

The purpose of this study is to make a diagnosis of the fish species collected from the Kwanza River. The fishes were collected during an expedition in the flooding season (April 2008), and also in 2002 by Hamilton Garboggini dos Santos, the Capanda AH's resident biologist. This study has thus served as a preliminary guide for knowing the in the Middle Kwanza River, and will be used here for providing data on the possible impact of the Laúca AH from a general perspective.

- Methodological procedures

The ichthyologic specimens were collected at the locations specified below with 3.0 m and 10-m dragnets, both of 4.0 mm mesh. The 3.0 m net was the one most used, as it

was easier to handle in locations of rapid flow and rugged bottom. A dip net about 35 cm x 35 cm was also employed in lentic environments, with slow flows and still waters. It should be noted that at the time of the field work (April 2008, the end of the rainy season), the Kwanza River had a voluminous, rapid flow, which hindered access to many collection points.

All collected specimens were fixed *in situ* with 10% formalin. To ensure more efficient fixation, formalin diluted at 10% was applied with a syringe on medium- and large-sized fishes (usually more than 12 cm longer than the standard, i.e., from the snout to the base of the tail fin). The collected specimens were placed in duly labeled plastic bags, which were then sealed. Later, the specimens were identified and photographed at the laboratory.

The Caculo-Cabaça location (Photo 4.85) was the westernmost (downstream) visited. At this point the Kwanza River has lotic characteristics (rapids and strong currents) in the middle, and lentic (pools and small marginal lagoons) on the margins. As the current locations were not accessible, the collection effort was done on the right bank.

A small stream measuring 0.5 m at its widest point flows into the Kwanza River at the sampling location after flowing down a steep slope. The sampling environment is an area flooded by the river, with some small marginal trees that have their roots submerged, lagoons, streams, and puddles. The current varied from weak to moderate. The collection was done in a small marginal lagoon whose depth varied from tens of centimeters to 2.0 meters, running parallel to the river on the right bank; its width ranged between 3,0 meters and 4.0 meters and its length was about 15 meters. Rocks and trunks hampered the dragging of the net (the 3.0 m dragnet was used). The region has environments favorable to fishes that usually live in lairs (e.g., small and large pebbles in abundance, rocks, submerged trunks, much shade, etc.). Much effort was made to catch such fish but none was sighted nor caught, except for one *Cichlidae* specimen: a *Pharyngochromis cf. schwetzi.*

**Photo 4.85:** Marginal environment at the Caculo-Cabaça location.

At the Laúca location on the river's right bank, at the foot of a steep slope of difficult access (105-meter high), the Kwanza River takes the form of a small basin on the right bank, and has calmer waters, like puddles. Trees with submerged trunks indicate that this environment exists only in the flooding season. Near the bank, the sampling spot was 2.0-meter deep. Although the location is a sort of pool, there is a reasonable current very close to the bank. The area had many submerged trunks and rocks, which hampered the dragging of the small net (3.0 meters). The bottom was muddy, with large submerged rocks and pebbles.

The species collected were as follows: *Cyprinidae* (*Barbus sp. 1),* one specimen*;* (*Barbus brevidorsalis),* three specimens; *Poeciliidae* (*Aplocheilichthys cf. johnstonii*), 14 specimens.

The Muta 1-Mata location, also on the river's right bank, is situated next to a stretch of steep bank (Photo 4.86). The collection environment is lentic, with strong current a few meters from the bank. There was also much grass partially submerged on the edge, giving rise to flooded environments appropriate for sheltering fish. The bottom is predominantly muddy, with many submerged trunks and large rocks. The sampling environment was very close to the bank and shallow, about 1.0-meter deep, but a few

meters from the bank the depth increased to over 2.0 meters and the current was strong. Only the small dragnet (3.0 meters was employed).

**Photo 4.86:** Marginal environment at the Muta 1-Mata location.

The species collected at this location were as follows: Cyprinidae - *Barbus sp.*, one specimen; *Barbus sp.*, five specimens; *Alestidae – Brycinus cf. lateralis*, one specimen; *Cichlidae – Tilapia rendali*, four specimens; *Pharyngochromis cf. schwetzi*, 9 specimens; *Mastacembelidae – Mastacembelus cf. batesii*, two specimens; *Poeciliidae – Aplocheilichthys cf. johnstonii*, 39 specimens.

The Muta 2-Mata location, a few hundred meters upstream from the Muta 1-Mata location, is settled into more sheltered and varied areas (Photo 4.87) – a large basin with partially submersed trees, indicating that this environment is dependent on flooding.

This basin had strong, variable currents. There were many submerged rocks and trunks, in addition to grass in abundance, and other kinds of vegetation in the water. This location encompassed two types of micro-environments, where fishes were collected: a larger basin and a small marginal, still-water lagoon. This lagoon was 3,0-meter wide and 5-meter long, shallow (less than 1.5-meter deep), with slightly warmer, stagnant water. Both the 10-meter and the 3.0-meter dragnets were used. The collected species

were as follows: Cyprinidae – *Barbus sp.*, one specimen; *Labeobarbus marequensis*, one specimen; Cichlidae- *Tilapia rendalli*, two specimens; *Pharyngochromis cf. schwetzi*, two specimens; Poeciliidae - *Aplocheilichthys cf. johnstonii*, 27 specimens.

**Photo 4.87:** Marginal environment at the Muta 2-Mata location.

Location 5 was easily accessible by the road from Capanda. It is a basin with muddy bottom, with a submerged plank (used by bathers) (Photo 4.88). The environment had little current, as it was a reasonably sheltered beach. Some trees were partially submerged, owing to the flood. There was much vegetation, but the occurrence of submerged grasses is uncertain. This location was sampled on successive nights and many catfish were caught.

The species collected were as follows: Schilbeidae – *Schilbe cf. bocagii*, one specimen; Mochokidae – *Synodontis sp.*, 31 specimens; *Claroteidae - Parauchenoglanis ngamensis*, one specimen; *Cyprinidae – Barbus greenwoodi*, two specimens; *Cichlidae – Pharyngochromis cf. schwetzi*, 17 specimens.

**Photo 4.88:** Sampled marginal environment at the rain gage post.

- Ichthyologic fauna survey results

The list herein included follows the modern classification of the *Actinopterygii* group, which encompasses bony fishes (Nelson, 2006) and includes the species collected during the April 2008 expedition (marked with *) and those collected mainly by Hamilton Garboggini dos Santos in 2002. This material is kept at the Capanda AH Environmental Laboratory. It must be noted that the fish specimens recorded in the literature and that were not collected or examined by the author were not included on this list. The list farther ahead includes only species collected, examined, and screened at the Capanda AH.

For identification of fish genders and species, the invaluable Poll monograph (1967) on Angolan fishes was repeatedly consulted, as well as other more recent works.

Most specimens of the species listed below were captured with gillnetting with meshes of 30 mm to 40 mm between knots. About 1,200 specimens of fish of the Middle Kwanza River were examined during the expedition that coincided with the flooding. Some of these are shown in the photos included here.

The number between braces after the species's name indicates specimens examined, and may be an approximation in some cases (e.g., *Cyprinidae*). The designation *"Cyprinidae gen. et spec. indet."* includes hundreds of larger *Cyprinidae* specimens, many of which could not be identified as to gender, but approximately ten distinct forms were recognized at the first screening done at the Capanda AH.

The list below includes 42 species recognized as being different (some provisionally) in 24 genders, with an additional eight possible genders (and at least the same number of species) yet to be confirmed. These are grouped under *"Cyprinidae gen. et spec. indet."* and *"Cichlidae gen, et spec. indet"*. A more precise identification of nearly all species require a more thorough study to determine their specific characteristics, which includes counting bones and fin rays and scales situated on the lateral line, in addition to Rx for counting vertebrae in certain cases (e.g., representatives of the *Mormyridae* family).

The following abbreviations are used: cf. = (Latin confer), to indicate that the species's identification is uncertain (e.g., *Petrocephalus cf. simus*); *sp.*, to indicate species pending further studies for a more precise identification and which possibly have not been identified yet (e.g., *Labeo sp.1 Barbus sp.2*).

Some relevant characteristics of identified species are presented here. Cyprinidae and Cichlidae groups have not been addressed; in general, only species but also genders) of doubtful identification. In the following paragraphs, "bone" refers to a rigid structure, usually sharp, serrated or not or not, that may form the anterior part of pectoral, dorsal, and anal fins. The word *"ray"* refers to a more flexible structure, which may be segmented or distally forked, found in all fins (even when one bone or more are also found). The listed characters are diagnosed together and do not mean an affirmation about the possible monophylia of the species under scrutiny.

**Chart 4.1:** Ichtyofauna list. OSTEICHTHYES

ACTINOPERYGII

NEOPTERYGII

TELEOSTEI

OSTEOGLOSSOMORPHA

OSTEOGLOSSIFORMES

MORMYRIDAE [18]

*Petrocephalus* cf. *simus* [1]

*Marcusenius dundoensis* [6]

*Marcusenius* cf. *moorii* [10]

*Marcusenius* cf. *stanleyanus* [1]

OSTARIOCLUPEOMORPHA

OSTARIOPHYSI

OTOPHYSI

GONORYNCHIFORMES

KNERIIDAE [5]

*Parakneria* cf. *vilhenae* [5]

CYPRINIFORMES

CYPRINIDAE [approx. 750]

*Raimas* cf. *christyi* [151]

*Barbusbrevidorsalis* [9]*

*Barbusgreenwoodi* [10]*

*Barbusradiatus* [82]*

*Barbus* sp. 1 [1]

*Barbus* sp. 2 [1]

*Barbus* sp. 3 [3]

*Barbus* sp. 4 [3]

*Barbus* sp. 5 [28]

*Barbus* sp. 6 [3]

*Barbus* sp. 7 [3]

*Barbus* sp. 8 [39]

*Barbus* sp. 9 [57]

*Barbus* sp. 10 [19]

*Barbus* sp. 11 [57]

*Labeo* cf. *annectens* [1]

*Labeo* sp. [8]

*Labeobarbus marequensis* [9]*

Cyprinidae gen. et spec. indet. 1

Cyprinidae gen. et spec. indet. 2

Cyprinidae gen. et spec. indet. 3

Cyprinidae gen. et spec. indet. 4

Cyprinidae gen. et spec. indet. 5

Cyprinidae gen. et spec. indet. 6

CHARACIFORMES

ALESTIDAE [51]

*Brycinus* cf. *lateralis* [50]*

*Rhabdalestes* cf. *rhodesiensis* [1]

HEPSETIDAE [17]

*Hepsetus odoe* [17]

SILURIFORMES

AMPHILIDAE [2]

*Doumea angolensis* [2]

CLAROTEIDAE [34]

*Parauchenoglanis ngamensis* [33]*

*Chrysichthys* cf. *delhezi* [1]

MOCHOKIDAE [92]

*Synodontis* sp. [91]*

*Chiloglanis* cf. *lukugae* [1]

SCHILBEIDAE [98]

*Schilbe* cf. *bocagii* [98]*

CLARIIDAE [13]

*Clariasngamensis* [9]

*Clariallabes platyprosopos* [4]

EUTELEOSTEI

NEOTELEOSTEI

ACANTHOPTERYGII

PERCOMORPHA

PERCIFORMES

CICHLIDAE [211]

*Serranochromis* cf. *angusticeps* [21]

?*Oreochromis* sp. [3]

*Tilapia rendalli* [110]*

*Pharyngochromis* cf. *schwetzi* [44]*

*Pharyngochromis* sp. [2]

Cichlidae gen. et spec. indet. 1 [15]

Cichlidae gen. et spec. indet. 2 [16]

SYNBRANCHIFORMES

MASTACEMBELIDAE [12]

*Mastacembelus* cf. *batesii* [12]*

ATHERINOMORPHA

CYPRINODONTIFORMES

POECILIIDAE [80]

*Aplocheilichthys* cf. *johnstonii* [80]*

**Order Osteoglossiforms**

The *Mormyridae*, popularly known as “elephant fish” is formed by fresh water fishes of the Order Osteoglossiforms. It is one of Africa’s most diversified freshwater families, with about 18 genders and 201 species (Nelson, 2006). *Mormyridae* may generate (in organs located at the caudal peduncle) and interpret weak electric currents used for communication, predatory activity, and to detect predators. It is believed that they can build nests for keeping their fecundated eggs, but little is known about their reproductive physiology. In general, fishes of this family are more active at night; during the day many prefer to remain hidden in the vegetation on river banks, in lentic environments, while others frequent environments with stronger currents and rocky bottoms. Some inhabit higher water, while others prefer the bottom. They feed on invertebrates and small fishes (Skelton, 2001).

The only specimen of *Petrocephalus cf. Simus* examined from the Kwanza River is very similar to *Petrocephalus simus,* a species recognized by the following characteristics (Hopkins et al., 2007): fusiform body, laterally compressed, very small subterminal mouth, olphactory organs close to each other, the posterior located very close to the eye; small, bicuspid teeth in a single row in each jaw, with 8-14 upper teeth and 16-22 lower teeth; large eyes (at 23%-30% of the body height); dorsal fin with two non-segmented rays and 19-28 segmented rays; the pre-dorsal distance is almost equal to the pre-anal distance; anal fin with one nonsegmented ray and 26-32 segmented rays; caudal peduncle narrower in the anterior part; 36-44 scales disposed on the lateral line and 10-16 parallel rows of scales below the lateral line; markedly forked caudal fin; dark brown color (in preservative), without conspicuous marks.

The *Marcusenius dundoensis*, according to Poll (1967) an Boden et al. (1997), is characterized by a slightly oval body; laterally compressed; small, terminal mouth, with a roundish subterminal anterior projection; small, bicuspid teeth in a single row in each jaw, with five upper and six lower teeth; dorsal fin with 20-23 rays; anal fin with 26-30 rays; anal fin originating before the dorsal fin; dorsal fin ending before the anal fin; eight circumpeduncular scales; 51-61 scales disposed on the lateral line; forked caudal fin; caudal peduncle narrower in the anterior part; brown color (in preservative); a darker, narrow vertical bar between the dorsal and the anal fins; and equally darker head and caudal peduncle.

Ten specimens of a *Marcusenius* species very similar to *M. moorii* (previously known as *M. lambouri*) were caught in the Kwanza River. This species's description, based on Boden et al. (1997) and Hopkins et al. (2007) is as follows: slightly oval, laterally compressed body; small, terminal mouth projected forward owing to a submentonian extension; small, bicuspid teeth in a single row in each jaw, with five upper and six lower teeth; relatively small eyes (eye length: 12.9%-15.6% of the length of the head; 17-24 rays in the dorsal fin; 24-33 rays in the anal fin; anal fin originating before the origin of the dorsal fin (by a distance equivalent to 3-4 rays); eight circumpeduncular scales; 37-45 scales disposed on the lateral line; relatively small forked caudal fin; caudal peduncle narrower in the anterior part; dark brown color (in preservative), with a darker vertical bar between the dorsal and the anal fins.

A single specimen of *Marcusenius* (Photo 4.89), closely resembling the *M. stanleyanus*, was caught, although this identification is provisional, still pending more thorough studies.

**Photo 4.89: *Marcusenius cf. stanleyanus* (measuring about 20 centimeters)**

According to Poll (1967), this species has slightly oval, laterally compressed, and relatively tall body; terminal mouth nearly at the same height as the eyes and with well-developed sumentoniana projection; relatively large dorsal cephalic region in relation to the eyes ; small bicuspid teeth in a single row in each jaw, with 5-7 upper and 8-9 lower teeth; dorsal fin with 28-33 rays; anal fin with 38-42 rays; anal fin originating before the origin of the dorsal fin and terminating after the dorsal fin; 78-84 scales on the lateral line; caudal peduncle narrower in the anterior part; dark brown color (in preservative),

with slightly darker shades on the head's dorsal region, below the dorsal fin, and on the caudal peduncle.

**Order Gonorynchiformes**

The species of the *Kneridade* occur exclusively in fresh waters of Africa. This family consists of four or five genders and 30 species (Nelson 2006). The gender *Parakneria* encompasses relatively small species, but with larger sizes in the family, measuring up to a standard 15-cm length. Opercular organs are absent in both sexes in *Parakneria* (in *Kneria* they help the male remain adjacent to the female during reproduction. Little is known about reproduction in this family, and practically nothing about the *Parakneria*. About 12 species are recognized as valid for this gender. They are rheofile fish of flowing waters, which feed on *Diatomaceae* and algae scratched off rocks.

According to Poll (1967), the *Parakneria cf. Vilhenae* (Photo 4.90) is described as follows: elongated, fusiform, not very tall body, with widened, flattened ventral surface; ventral mouth, in slit form; relatively straight lateral line; origin of the dorsal fin anterior to the origin of the pelvic fins; three bone spines in the dorsal fin, followed by eight rays; anal fin closer to the caudal fin than to the pelvic fins; three bone spines in the anal fin, followed by 5-6 rays; 16-18 rays in the pectoral fins; pelvic fins with nine rays; caudal fin with 19 rays; minute scales, 73-82 of which on the lateral line; color of the fixed material: brown with large, dark, not well-defined blotches on the flanks and at the base of the caudal fin.

The five specimens caught in the Middle Kwanza River, of a single species, resemble the *P. vilhenae*, but this identification needs confirmation, as these specimens may be actually *P. marmorata*.


**Photo 4.90:** *Parakneria cf.* Vilhenae.

**Order Cypriniformes**

The *Cyprinidae* consists of about 321 genders and 3,260 species (Nelson, 2006). It is the most diversified family of fresh water fishes. It has economic importance, as it is the fish most caught and most consumed by the riverine populations of the Middle Kwanza River, especially near the Dondo. Its general biology is quite varied and complex, with neofílicas, benthic species of still waters, with feeding preferences that range from predators of the top of the food chain to algae scratched off rocks.

There are many reproductive strategies in this family. Some species have more elaborate reproductive strategies in terms of laying of eggs and caring for them, but all species reproduce by scattering their eggs, which are extremely fecundated, and without parental custody (De Weirdt et al., 2007).

The captures made indicate that the *Cyprinids* make up the most diversified and abundant fish group also on the Middle Kwanza River. The diversity of species in this family in this river in relation to the other fish groups is greater than it was expected. Many species and even genders have not been accurately identified. Thus, several taxa included in the aforementioned list as "*Cyprinidae gen. et spec. indet"* and many species distinct from *Barbus*, listed as *Barbus sp.*, and some *Labeo*, *Labeobarbus*, and possibly *Varicorhinus* are still unidentified.

The *Raimas cf. christyi* (Photo 4.91) is recognized according to Poll (1967) by the following characteristics: fusiform, low, and laterally compressed body; large oblique mouth extending to the eyes' posterior limit; relatively large eyes; three spines in the dorsal fin, followed by 7-9 rays; relatively long anal fin with three spines followed by 13-15 rays; caudal fin with 19-21 rays; 49-51 scales on the lateral line; brownish color in the fixed material, with 11-15 longitudinal, more or less elongated spots on the flanks and a circular spot on the caudal peduncle. This identification needs confirmation. The species is abundant in the Middle Kwanza River.

The *Barbus brevidorsalis*, also abundant in the Middle Kwanza River, was identified by Poll (1967) and by Skelton (2001) by the following characteristics: relatively short, tall body; slightly oblique mouth; absence of barbels or a pair of vestigial barbels in larger individuals; relatively large scales; 24-27 scales on the median horizontal line on the flanks; lateral line restricted to only a few anterior scales; dorsal fin with three non-forked rays and seven forked rays; anal fin with about 24 rays; a wide horizontal band on the flanks and a dark, roundish spot around the caudal peduncle.

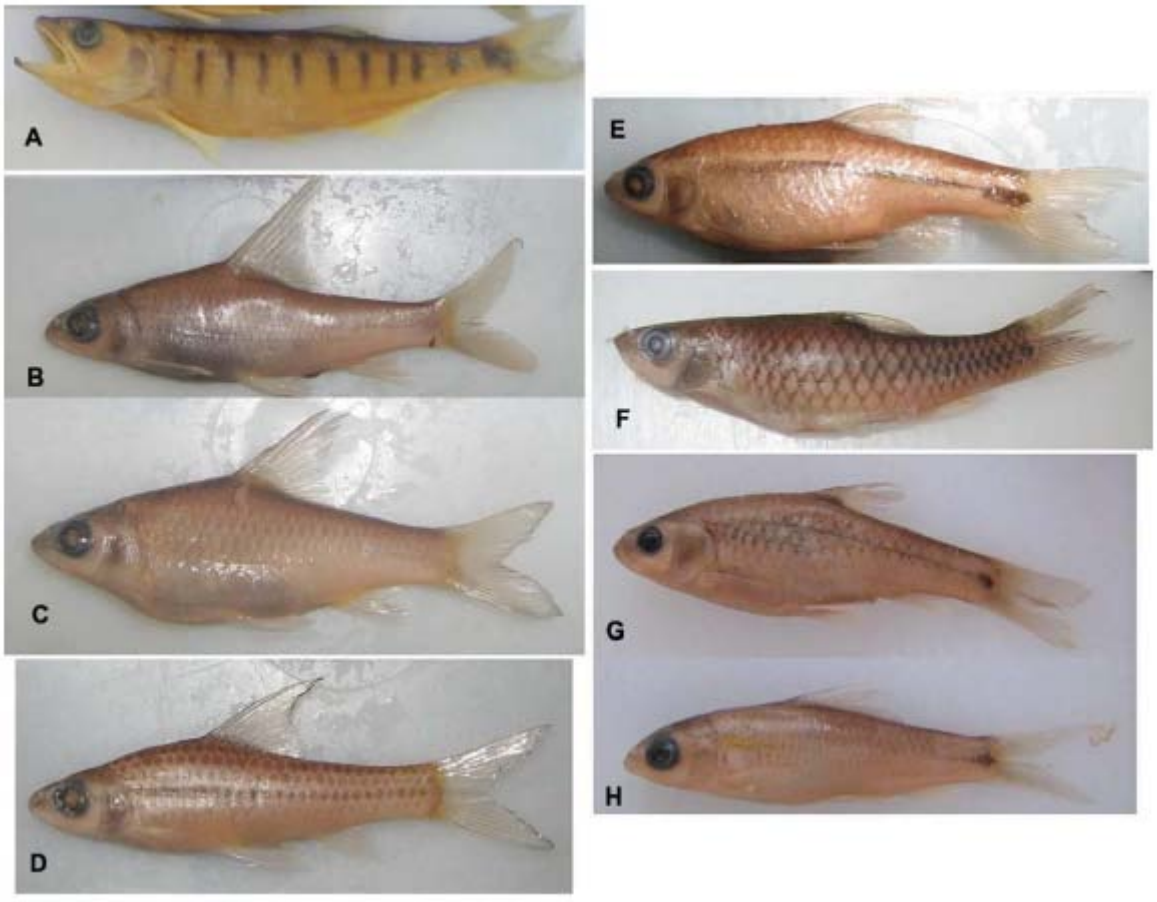

**Photo 4.91:** Specimens of the order Cypriniformes: A) *Raimas cf. christyi;* B) -H) different species of the gender *Barbus*.

The *Barbus greenwoodi* species, according to Poll (1967), has the following characteristics: relatively elongated body; terminal, non-inclined mouth; two pairs of barbels, of which the posterior is more developed; relatively large scales forming a series 30 on the lateral line; relatively long dorsal fin with three non-forked and nine forked rays; anal fin with three non-forked and six forked rays; forked anal fin, with about 22 rays; small dark spots on the lateral line, forming a more or less complete series extending nearly to the caudal peduncle, where there is a larger and darker oval spot, and an elongated spot at the base of the anal fin, as well as another elongated, oval spot above the pectoral fin and under the dorsal fin; the color may vary with the dark spots' location.

The *Barbus cf. radiatussp.* is relatively abundant on the Middle Kwanza River. According to Poll (1967) and Skelton (2001), this species is recognized by the following characteristics: relatively thin body; terminal, slightly oblique mouth; two pairs of very small oral barbells; apparent sensorial channels in the head and facies; relatively large scales in a series of 24-29 on the lateral line; complete lateral line; relatively tall dorsal fin with three non-forked and nine forked rays; relatively small anal fin with three non-forked en five forked rays; dorsal and pectoral fins starting on the same vertical line; forked caudal fin with about 21 rays; darker dorsal color, with a dark horizontal line starting in the snout, passing over the eye and continuing over the lateral line, without conspicuous spots.

The *Labeo* species included here is very similar to the *L. annectens* (Photo 4.92), a species originally described for Cameroon, but widely distributed in western Africa, especially in the Congo basin (Poll, 1967; Skelton, 2001; Tchibwabwa, 2007). These authors describe this species thus: markedly, elongated, tubular body; elongated head with eyes in a posterior position; not very large eyes, positioned laterally and dorsally; snout with an accentuated groove and a small fleshy projection at the extremity; granular nodules on the head and snout; thick lips, particularly the superior lip; large scales; 35-38 scales on the lateral line; complete lateral line; robust dorsal fin with a concave superior border with 9-10 forked nodes; anal fin with six forked rays; anal

operculum located somewhat distant from the origin of the anal fin; dark chestnut color (in preservative), somewhat darker dorsally, with a dark horizontal strip in smaller individuals.

The *Labeobarbus marequensis* species attains relatively large sizes (50-centimeter length standard and weighs up to 6.0 kilograms). It has been described by Poll (1967) and Skelton (2001) as having a relatively elongated, not very tall body; not very large eyes; subterminal, slightly oblique mouth, which varies somewhat among individuals; two pairs of barbels separated by a gap, the posterior barbel being the most developed; large scales, with 27-33 scales on the lateral line; complete lateral line; not very large dorsal fin with four non-forked and 8-10 forked rays; not very large anal fin, with three non-forked and five forked rays; forked caudal fin; pectoral and pelvic fins not very large; uniform color, without significant spots in adults, but in a darker shade in the head and dorsum; in live specimens the color is described as changing from greenish to yellowish and as being more intense dorsally.


**Photo 4.92:** *Labeo cf. annectens* (A, B) and *Labeobarbus marequensis* (C).

**Order Characiformes**

The species of the *Alestidae* family are relatively common in African rivers. The family encompasses 18 genders and 110 species (Nelson 2006). Many species form schools and may migrate upstream to reproduce. They are usually omnivorous. In many species the male has a modified anal fin to direct the semen deposition during reproduction. The eggs are affixed on floating nests or marginal vegetation.

The numerous specimens of *Brycinus* collected are very similar to *B. lateralis*, better known in the Congo and Zambezi Rivers' basins. According to Poll (1967) and Skelton (2001), this species may be identified by the following characteristics: fusiform, laterally compressed body; small terminal mouth with two rows of sharp teeth in each jaw; relatively tall and short dorsal fin, with two non-segmented rays and eight segmented rays situated in the middle of the dorsal region, more or less on the pelvic vertical; anal fin with three non-segmented and 15-16 segmented rays; anal fin with significant sexual dimorphism (this fin is larger and curved in males); relatively large scales, with 30-33 scales on the lateral line; brownish or orangey color (in preservative), with a thin, dark horizontal band on the lateral line and a significant oval spot in the caudal peduncle.

The only specimens of the gender *Rhabdalestes* collected may be tentatively identified as *R. Rhodesiensis* (Photo 4.93). According to Poll (1967), this species has a fusiform, laterally flattened and relatively thin body; small terminal mouth, with the jaw projecting somewhat forward; multi-cuspid teeth in a single row in each jaw, with 6-8 upper and eight lower teeth. Dorsal fin with two non-segmented and 7-9 segmented rays, in a posterior position in relation to the pelvic fins; relatively long anal fin, with two or three non-segmented and 16-19 segmented rays; males with convex anal and females with concave anal; brownish or orangey color (without preservative), with a dark, thin stripe on the lateral line, and an oval spot on the caudal peduncle and a small horizontal spot above the anal fin.


**Photo 4.93:** *Brycinus cf.* lateralis (A and B); and *Rhabdalestes cf. rhodensiensis (C).*

The *Hepsetus odoe* (Photo 4.94), with wide distribution in the rivers of western and southern Africa, is easily identified. It inhabits calmer, deep waters in canals or flooding lagoons. The young prefer marginal environments to hide in the vegetation. A carnivorous species, it is a predator of the top of the chain food. Couples are paired for reproduction and prefer to affix their eggs to floating vegetation nests in lagoons and calm waters. Adults protect the incubated eggs in the nests. The young remain associated with the nests in the early metamorphose stages (Skelton, 2001).

According to Paugy (2007), some of their characteristics are as follows: a fusiform, elongated and straight body, but not very tall; well-developed terminal mouth extending from the top the snout to the eye level; flat top of the head; developed eyes, reaching 1/6-1/8 of the lead's length; dorsal fin posterior to the pelvic fins, with two spines and 7-9 rays; anal fin with 2-3 spines and nine rays; adipose fin; well-developed, forked caudal fin; 45-49 vertebrae; darker color on the dorsal region and lighter in the belly (in preservative), with at least three wide, dark horizontal bands on the head, and

vertical spots on the flanks, plus numerous dark spots on the fins. This large-size species measures up to 50 cm standard length.

**Photo 4.94:** Hepsetus odoe.

**Order Siluriforms**

Fishes of the *Amphilidae* family are very conspicuous catfish, as their body is attenuated, usually small, benthic, and rheophilic, that prefer rocky substrates. There are about 12 genders and 66 species (Nelson, 2006). Most of them feed by scrapping algae off rocks and hard substrates. Almost nothing is known about their reproduction.

The two specimens of the *Doumea angolensis* (Photo 4.95) caught are minute and unfortunately are not very well preserved. According to Poll (1967), this species may be identified by a relatively small head, with a longer snout than the post-orbital cranial roof; a relatively elongated body; three pairs of short barbels, the longest being the internal mandible's; relatively tall dorsal fin with one spine and seven rays; adipose lower fin, long rather than tall, equidistant from the dorsal and the caudal fins; caudal fin with the inferior lobe slightly longer than the superior; relatively elongated anal fin located closer to the pelvic fins than to the caudal fin, with three spines and six rays; pelvic fin with one well-developed, thick spine and five forked rays; very large pectoral fin with an equally well-developed spine and 11 rays; dark chestnut color (in preservative), darker dorsally and lighter in the belly, with diffuse spots on the dorsum, at the base of the pelvic fin and on the head, with not well-defined stripes on the fins.

**Photo 4.95:** *Doumea angolensis.*

Fishes of the *Claroteidae* family, according to Nelson (2006), are classified into seven genders and 59 species. These species prefer rocky or slow waters where there is vegetation and shade. They feed preferentially on invertebrates and on fish. Details on their reproductive biology are unknown, but some members lay few, relatively large eggs, which may suggest parental care (Skelton, 2001).

According to Poll (1967) and Skelton (2001), the *Parauchenoglanis ngamensis* (Photo 4.96 A) has a relatively large, flat head; three pairs of barbels with robust bases, the mandible barbels being the most developed; relatively thick lips; small, thin teeth set on a rectangular dorsal and a ventral plate; dorsal fin with a strong, robust spine and seven segmented rays; spine in the pectoral fins serrated on the interior borders and well developed; anal fin with four to five non-segmented rays and eight-nine segmented rays; adipose, well-developed, elongated fin; yellowish or light brown dorsum and flanks and white belly; circular spots on five-seven vertical bands on the flanks; fins with dark spots, usually smaller than or the same size as the eyes.

The only specimen of the gender *Chrysichthys* resembles a *C. delhezi* (Photo 4.96), which, according to Poll (1967), is identified by a relatively large, flat head; large eyes; large mouth with thick lips; four pairs of thin barbels, the longer of which is the maxillary; dorsal fin with one spine and six soft rays; adipose, little developed fin situated closer to the caudal fin than to the dorsal fin; well-developed anal fin with 11-13 rays; robust, moderately forked caudal fin; more or less equidistant ventral fins of similar size; grayish color (in preservative), dorsally darker, without conspicuous spots.


**Photo 4.96:** *Parauchenoglanis ngamensis* (A) and *Chrysichthys cf. delhezi* (B).

The *Mochokidade* is the largest family in terms of number of species of African catfishes, with about ten genders and 180 species (Nelson, 2006). Some genders (*Synodontis*) inhabit stagnant waters rich in vegetation, while others (*Chiloglanis*) live in environments with stronger currents. It prefers small invertebrates as food, but may also scratch algae off hard substrates. Almost nothing is known about their reproduction, except that fecundation is external and the deposited eggs probably do not have parental protection.

The collected *Synodontis* species (Photo 4.97 A) does not seem to be the same reported for the major basins near the Kwanza River (e.g., Congo, Okavango/Zambezi), such as the *S. zambeziensis*, the *S. nigrospottus* and the *S. macrostigma* (Skelton, 2006). In general, it resembles rather the *S. nigrospottus*, but differs from it at least in color. The species collected in the Middle Kwanza River has the following characteristics: relatively flat head; robust eyes; three pairs of barbels, of which the maxillary is the longest, while the mandibular two are branched; pointed humeral process; dorsal fin with robust serrated spine followed by six rays, with a quite visible prolongation of the

first ray; anal fin with nine rays; adipose anal fin originating almost on the same vertical line; relatively robust anal fin; forked caudal fin with about 30 rays; brown dorsal color, ventrally lighter (yellowish) with large, darker spots and spots on the flanks and small circular spots (more or less the same size as the eyes) on the fins.

The only *Chiloglanis* specimen collected (Photo 4.79B) needs to be studied in more detail to confirm whether it belongs to the *C. lukugae* species. Poll (1967) characterized this species as having flat head; relatively small eyes; three pairs of short barbels; medium-size anterior dorsal fin with one spine and five rays; adipose fin situated closer to the caudal than to the dorsal fin and much longer and tall; forked caudal fin; well-developed anal fin, larger than the pelvic fins, with three short spines and six-seven rays; pectoral fin with one thin spine and nine rays; pelvic fins with one thin spine and seven rays, situated closer to the anal fin than to the pectoral fins; brown color (in preservative), with large, lighter spots on the dorsum, head, and flanks, and darker spots on the fins, particularly on the caudal fins, which have two better defined spots.


**Photo 4.97:** *Synodontis sp.* (A) and *Chiloglanis cf. lukugae* (B).

The *Shilbeidade* has about 20 genders and 34 families (Nelson, 2006). It consists of catfishes, which are active swimmers and inhabit the central waters. They may form schools and are more active at night. They are carnivorous. The eggs are usually

deposited on floating vegetation on the margins of the river. They are economically important.

The many collected specimens of this species probably belong to the *S. bocagii* (Photo 4.98), the only member of the gender recorded on the lower Kwanza River (De Vos, 1995). This author identified this species as follows: flat head somewhat rectangular as compared with the dorsum and relatively small; posterior nostrils close together; four pairs of barbels, the longest being the external maxillary; relatively long spines in the pectoral and dorsal fins; pectoral spine, slightly serrated on the internal border; dorsal fin with one spine and six rays; anal fin with 43-53 rays; small adipose fin, always present; dorsal chestnut color and lighter ventral shade, with a significant humeral spot and another at the center of the caudal fin.

**Photo 4.98:** *Schilbe cf. Bocagii.*

The *Clariidae* are catfish of economic significance (especially *Clarias*), which attain large sizes in general (there are records of specimens weighing 59 kilograms). Currently 14 genders and 90 species are recognized as valid (Nelson, 2006). Accessory organs (subbranchial organ) permit this species of the family to survive for long periods out of

water. Most of the species are omnivorous; many feed on actively fishes and even on other vertebrates. Many may migrate upstream to reproduce, but may also reproduce in lagoons with stiller waters. Some species lay eggs that fix themselves onto submerged roots and trunks.

The collected specimens of this gender may be considered with some assurance to be *C. ngamensis*. According to Poll (1967), Teugels (1986), and Skelton (2001), this species may be identified by the following characteristics: robust, fleshy body; flat, elongated head; well-developed eyes; four pairs of barbels; dorsal fin with 56-66 rays; anal fin with 50-58 rays; a small adipose fin or crest; caudal fin clearly separated from the dorsal and anal fins; relatively small pectoral and caudal fins; pectoral fin with a spine, serrated only externally; well-developed suprabranchial organ; dorsal grayish color and white belly.

The species *Clariallabes platyprosopus* (Photo 4.99B), according to Skelton (2001), is characterized by a wide, flat head, with robust cheeks; small eyes close to the nostrils; four pairs of barbels, the external maxillary being the longest, reaching the head; dorsal fin with 73-82 rays, originating behind the pectoral fins; anal fin with 56-63 rays; caudal fin not continuous with the dorsal or anal fin; reduced suprabranchial organ; small, roundish pectoral fins with one fin serrated on both borders; dark color almost on the entire body, but dorsally darker, with exception of the area anterior to the pelvic fins.


**Photo 4.99:** *Clariasngamensis* (A) and *Clariallabes platyprosopos* (B).

**Order Perciformes**

The fishes of *Cichilidae* family have different forms of incubating their fecundated eggs and many different reproductive and trophic strategies (Stiassny et al., 2007). There are two basic kinds of parental care of the offspring: oral incubation (which involves polygamy, and only the female incubates the eggs) and incubation in nests formed in the substrate (usually involves monogamy and the males also care for the eggs). In general, they are omnivorous.

According to Nelson (2006), this family has 112 genders and 1,350 species. During the expeditions to the Middle Kwanza River 200 specimens of this family were collected. Many individuals could not be identified as to gender. Two groups of species may belong to unidentified genders *"Cichilidae gen. et spec. indet. 1 and 2,"* in the listing shown) and three probably *Oreochromis* specimens were also collected, but their identification is very imprecise, requiring further data.

Another *Pharyngochromis* family may have been collected, different of the species identified as *Pharyngochromis cf. schwetzi* addressed further ahead. Thus, these groups whose identification is very uncertain have not been treated in detail, although they are also included on the list.

The *Serranochromis* specimens collected (Photo 4.A) resemble the *S. angusticeps*, and, according to Poll (1967, Skelton 2001), may be identified by the following characteristics: robust head and body; head indented above the eyes; large mouth almost reaching behind the eyes, and oblique; 23-24 scales on the superior lateral line and 15-17 on the inferior lateral line; dorsal fin with 13-16 spines and 14-17 non-segmented rays; anal fin with 11-13 non-segmented rays; vivid color when alive, with numerous reddish spots on the head and the fins; long vertical bars on the flanks and cephalic bars starting from the eyes in a radiating pattern; dark brown color (in preservative), lighter on the belly, with faded vertical bars and spots of a less defined and less vivid color.

The *Tilapia rendalli* (Photo 4.B), a quite common species in the Kwanza River, may be recognized by the following characteristics (Poll, 1967; Skelton, 2001): relatively tall

body; convex head; dorsal fin with 14-16 rays and 12-13 rays; anal fin with three rays and 9-10 rays; 28-32 scales on the lateral line; dark brown color (in preservative) with 6-7 darker, somewhat faded vertical bars; a large, though diffuse spot on the operculum; small round spots on the fins, at times forming horizontal bands; lighter, little reddish ventral color.

The species *Pharyngochromis cf. schwetzi* (Photo 4.C) is very abundant in the Middle Kwanza River, but its identification is still uncertain. It is possible that another species of this gender was collected during the expeditions, but a more thorough study is needed. The collected specimens resemble the *P. schwetzi*, which may be identified by the following characteristics, according to Poll (1967): a not very tall body; relatively large eyes; thick, slightly oblique lips; numerous bicuspid teeth on the external row and tricuspid on the internal row; relatively tall dorsal fin, with 15 spines and nine rays; anal fin with three spines and nine rays; 20 scales on the superior lateral line and 12 on the inferior lateral line; vivid color (in life), golden or yellowish on the dorsum, the head, and the flanks, and lighter on the belly, with numerous small, orangey and reddish spots (smaller than the eyes) on the fins and flanks.

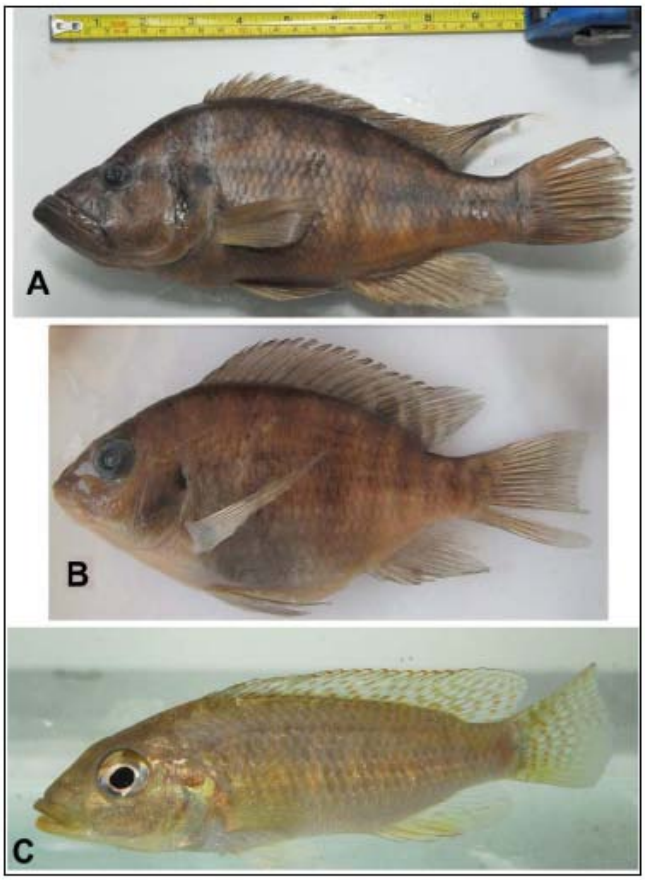

**Photo 4.100:** *Serranochromis cf. angusticeps* (A); *Tilapia rendalli* (B); and *Pharyngochromis cf. schwetzi.* (C).

## Order Synbranchiformes

The *Mastacembelidae* family consists of about five genders and 73 species (Nelson, 2006), which inhabit a great variety of environments. Many prefer the rivers' marginal vegetation (some may even bury themselves in the riverbed). They are carnivores. Little is known about their reproduction.

Identification of the species *Mastacembelidae* is very difficult, and the identification of the *M. cf. batesii* (Photo 4.101) is only provisional. Poll (1967) points to the following characteristics:, eel-like body; snout anteriorly projected, prominent but not as much as in other species of the gender, and projecting slightly downward in its anterior extremity; triangular head as seen from above; small, rounded pectoral fins; 31-32 spines preceding the dorsal fin, the anterior ones being the smallest; dorsal fin with 75-90 rays, originating near the median line and continuous with the caudal and anal fins; two spines precede the anal fin ventrally; 15-16 scales arranged between the lateral line and the dorsal fin; dark chestnut color on the dorsum and yellow color on the belly; irregular, interrupted dorsal spots; brown horizontal bands o the head and the operculum; dorsal, caudal, and anal fins with a pattern of irregular vertical bars.

**Photo 4.101:** *Mastacembelus cf. batesii*.

**Order Cyprinodontiformes**

The *Poecilid* family is currently represented by 37 genders and 304 species (Nelson, 2006). These fishes are popular with aquarists. Many members of this family are characterized by internal fecundation. They lay their eggs on marginal or floating vegetation. The eggs of the species collected in the Middle Kwanza River are not resistant to the dry period (differently from the eggs of annual fishes, which are closely related to the collected gender). In general, the members of this family occupy river banks, hidden in the vegetation in calmer waters. They feed mainly on insects that inhabit the water surface.

The species *Aplocheilichthys cf. johnstonii* collected (in abundance) may actually belong to a new species of this gender; the identification as being possibly *A. johnstonii* (Photo 4.102) is provisional, pending further studies. The diagnostic presented here was taken from Poll (1967) and Skelton (2001): tubular body, a little flattened dorsally, more robust in males than in females; small terminal mouth turned upward; relatively large eyes; dorsal fin in an anterior position, preceding the origin of the anal fin; dorsal fin with 6-8 rays; anal fin with 11-15 rays; anal fin showing sexual dimorphism, with males having a much longer fin than females; caudal fin also much longer in males; 27-32 relatively large scales arranged into a horizontal band (the lateral line is limited to

the head); caudal peduncle is twice as long as it is tall; color also indicating sexual dimorphism, with males displaying more vivid colors, with a bluish bar (in life) on the dorsal, caudal, and anal fins and with numerous small, round spots forming broken bands on male fins; yellowish dorsum, lighter ventral shade, with a bluish horizontal band at the height of the lateral line; dark top of the head, with a horizontal band passing through the eye. Some authors recognize this species as *Micropanchax*.

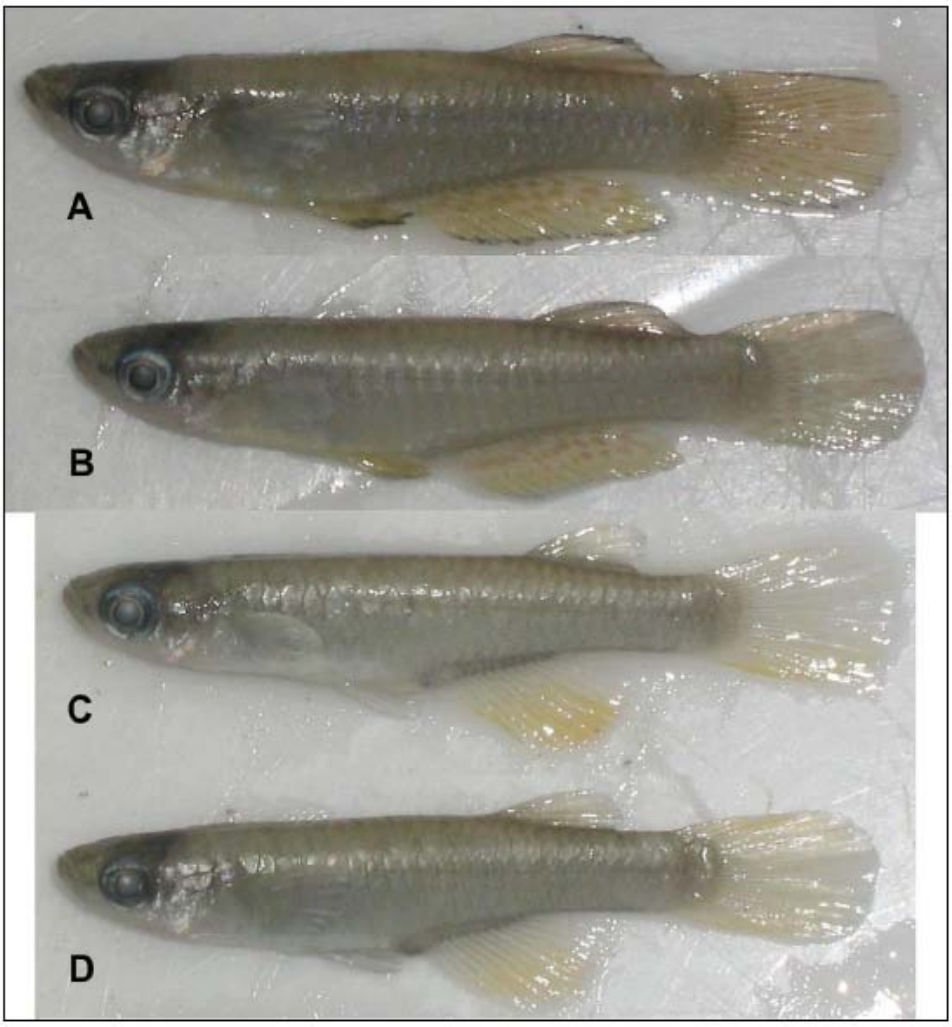


**Photo 4.102:** *Aplocheilichthys cf. johnstonii*.

- General observations

The preceding list of species shows that there is a great variation among fishes of the *Cyprinidae* family, the most diversified in the idle Middle Kwanza River. As a rule, these fishes are detritvorous or omnivorous, and provide a food source for carnivorous fishes (such as the *Alestid Hepsetus*), thus being an important element of the food chain. Other predators include the catfish *Clarias ngamensis*, the largest catfish found in the river, which differs from the smaller catfishes for being a voracious carnivore. However, most of the species listed would fall into the lowest ranges of the food chain (i.e., they are herbivorous and detritvorous species).

Most of the individuals collected are young, but already metamorphosed specimens, with the exception of the *Mastacembelids* and the *Cyprinodontids*. This was to be expected, as the expedition's collecting work was done on the river's margins and in

lentic environments, such as pools and small marginal lagoons, where typically young individuals concentrate (many species deposit their eggs in the margins). The *Mastacembelids* and the *Cyprinodontids* spend their entire life cycle among submerged vegetation. The *Poecilid Aplocheilichthys cf. johnstonii*, however, are small-sized fishes that live in areas flooded according to the flood cycle.

Another aspect to be considered is the endemism of species in the Middle Kwanza River, as yet not very well known. As regards possibly migratory species, the Middle Kwanza River has already suffered a strong impact from the Capanda AH and the Cambambe AH dams, situated, respectively, upstream and downstream from the Laúca AH. Migrating fishes cannot overcome these barriers. Migratory species include at least members of the families *Alestidae, Cyprinidae*, and *Clariidae.*

## 4.4. ANTHROPIC ENVIRONMENT

### 4.4.1. METHODOLOGICAL PROCEDURE

For the diagnostic of the Direct Influence Area and the Directly Affected Area, in addition to secondary data gathering, the same procedures that were indicated for the Regional Coverage Area and the Indirect Influence Area were employed. The most thorough field work was done in 2009 and included visits to the municipalities and communes, where administrative authorities were interviewed.

For the EIA on the deviation of the river course (2012) members of the villages affected by the undertaking were contacted and interviewed within a radius of 25 kilometers downstream the river. The objective was to secure information on current living conditions of the local populations. The quantitative and qualitative procedures followed for this study were as follows:

- Interviews with key sources of information, such as the Adjunct Communal Administrator of São Pedro da Quilemba, and the village *Sobas* [local traditional village leaders];
- Determination of the number of social initiatives in the AID;

- Preparation of guides for individual interviews with Municipal and Communal Administrators and with focal groups in the communities;
- Interviews with focal resident groups in the localities close to the project.
- Walks, direct observation, and recording of images (photographs were taken of homes, croplands, work tools, fruit trees, etc.), and the geographical coordinates of the studied locations were determined (GPS);
- Visit to the Libolo municipality (South Kwanza), where the Municipal and Communal Administrators of Quissongo and Cabuta were interviewed;
- Visit to the Mussende municipality (also in South Kwanza), where the communities of Kissaquina and Bangwangwa were studied, localities were observed, and the Municipal Administrator was interviewed;
- Visit to the Cacuso municipality (Malanje), where in addition to interviews with the Municipal and Communal Administrator of Pungo Andongo, the communities situated along the Capanda-Dondo road were studied in the undertaking's indirect influence area, as they are at a quite high altitude in relation to the Kwanza River; and
- For updating the study and stressing the deviation of the river course, visits were made to the villages of Nhangue Ya Pepe and Ndala Ngola, Dumbo Ya Pepe, and Kibenda, which are located within 15 kilometers downstream from the undertaking's site. AID localities situated within a radius upstream from the deviation of the river course were not considered, under the assumption that these populations will not be affected; and
- Visit to the Communal Administration of Quilemba.

For the social survey regarding the EIA on the river course deviation (2012), the work consisted first in the preparation of guides for information gathering, the gathering process proper, and analysis and treatment of the information obtained. In the first phase of information gathering, the focus was centered on the municipalities of Libolo and Mussende (South Kwanza), Cacuso (Malanje), and Cambambe (North Kwanza), particularly on some communities that will be directly or indirectly affected by the project. The second phase, which consisted in technical updating, visits were made to the villages of Nhangue Ya Pepe, Ndala Ngola, Dumbo Ya Pepe, Kibenda, and Muta.

The first surveys done (2007-2009) faced limitations related to insufficient, little reliable information on the part of institutions, which varied greatly from source to source. Thus, figures pertaining to the provinces are skewed, both as to quantity and quality, and should be taken with reservation.

The methodology adopted sought to systematize the study of this diagnostic, so as to arrive at an analysis that identified the relation between demographic variables and qualitative data, and thus establish interfaces in the socioeconomic and anthropologic domains. Figure 4.16 shows the municipalities, communes, and *sanzalas* encompassed by the AII along the EN 322 road

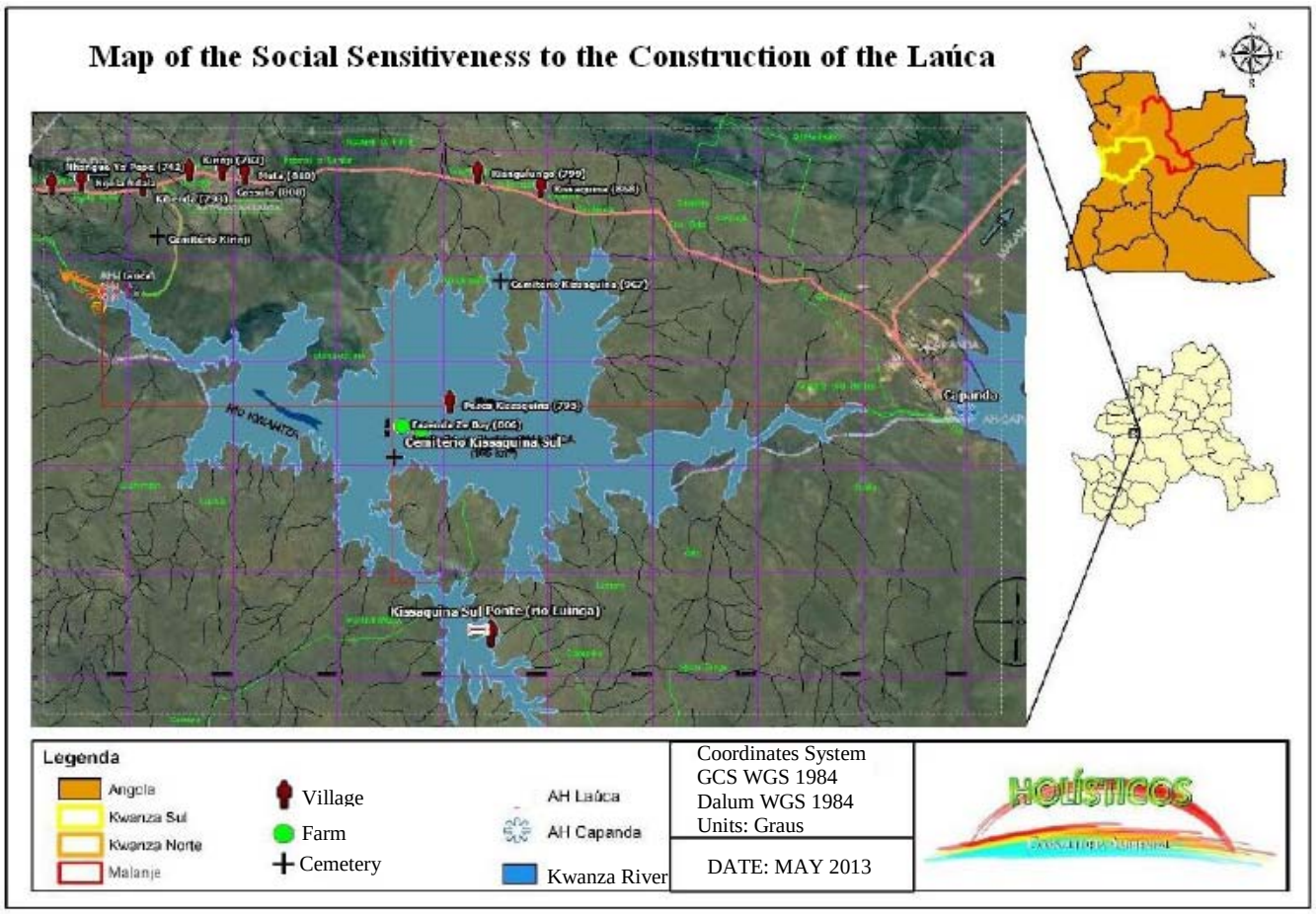


**Figure 4.16:** Map of the Anthropic Environment – Territorial Organization – Indirect Influence Area.

For the diagnostic of the direct influence area for this study (2013), in addition to the procedures for gathering secondary data for the regional coverage area, field work was also done, including visits to municipalities and communes, where administrative authorities were interviewed and heard. Members of the villages and localities situated upstream and downstream from the Laúca AH dam were also contacted and interviewed, within a distance of up to 43 kilometers from the project. To secure information on the current living conditions of the local populations, a brochure and a form for registration and commentaries (Annexes III and IV) were distributed do participants, with

images and text illustrating the localization of the Laúca Project and its main aspects (Photos 4.103 and 4.104).

**Photo 4.103:** Social team's visit to villages in influence areas.

**Photo 4.104:** Distribution and reading of the information brochure.

Quantitative and qualitative procedures for this study and for surveying the terrain combined the following techniques:

- Individual interviews with key sources of information, such as the Cacuso Municipal Administrator and village *Sobas;*
- Interviews with specific groups of localities near the project; and
- Cross-country walks, direct observation, and photograph record of properties (homes, croplands, and farms), work implements, trees, etc.; and determination of the geographical coordinates of the studied locations with the use of GPS.

Information gathering in the localities took place May 8-12, 2013, and adopted as samples the communities located within up to 43 kilometers upstream and up to 25 kilometers downstream from the project, as mentioned in Chapter 1 (influence areas).

An assessment was also undertaken of some provincial and local socioeconomic aspects, for a better comprehension of the context, including demographic figures, institutional and cultural aspects, main social and economic activities, employment and unemployment, family income, legal land tenure, relation to the river in the direct influence and the directly affected areas.

## 4.4.2. CURRENT SITUATION

- Villages' Social Organization

The villages studied are under the direction of traditional authorities structured as established by the Government: Heads, Associate Heads, *Sobas*, Associate *Sobas*, and *Sekulos*. Although the Traditional Authorities Statute has not been approved yet, their role as intermediaries between the Government and other State powers and the populations is unquestionable. In addition to the "official" traditional authorities, other informal leaders are found in the villages, including the notables of the communities, usually elders that as a rule form part of the *Mbanza*. Other leaders that cannot be bypassed are the MPLA leaders, the representatives of churches (catechists, pastors, and deacons), the healers, and the more influential teachers. The services provided by the Municipal Administrations of Cacuso and Cambambe to the citizens are usually very limited, and consist

mainly, other than inservices in the health and educational areas, in the access to farming inputs, the issuing of residence certificates and of opinions for obtaining land for agricultural purposes, vaccine certificates, notary services[1] (birth records, identity cards, certificates, and authorization for informal trade, among other documents). This situation is the same as in 2012.

- Demography

Currently available demographic data are little reliable and extremely varied. According to the information gathered from the populations studied, total population is estimated at 1,014 inhabitants. The 2012 survey estimated the total population at 273, not including the inhabitants of the villages in the South Kwanza province, consisting of the "Ambundu" ethnolinguistic group.

**Table 4.21:** Number of inhabitants per village studied (2013).

| Villages | Adults | | | | | Children | | | Total Geral |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Men Seniors | Woman | Woman Seniors | Total | Boys | Girls | Total | |
| Kibenda | 4 | 2 | 5 | 1 | 12 | 6 | 2 | 8 | 20 |
| Kiangulungo | 9 | 6 | 9 | 3 | 27 | 12 | 12 | 24 | 51 |
| Kirinje | 3 | 0 | 3 | 0 | 6 | 5 | 2 | 7 | 13 |
| Muta | 18 | 3 | 18 | 3 | 42 | 28 | 18 | 46 | 88 |
| Cassula | 9 | 3 | 8 | 1 | 21 | 7 | 8 | 15 | 36 |
| Nhangue Ya Pepe | 19 | 3 | 26 | 4 | 52 | 32 | 34 | 66 | 118 |
| Kissaquina | 14 | 3 | 19 | 3 | 39 | 29 | 12 | 41 | 80 |
| Dumbo Ya Pepe | 3 | 1 | 1 | 1 | 6 | | | 0 | 6 |
| Ngola Ndala | 28 | 0 | 30 | 0 | 58 | 25 | 35 | 60 | 118 |
| Dala Kiosa | 106 | 0 | 102 | 0 | 208 | 27 | 28 | 55 | 263 |

[1] This service is provided only at the Chief Municipality.

| Villages | Adults | | | | | Children | | | Total Geral |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Men Seniors | Woman | Woman Seniors | Total | Boys | Girls | Total | |
| Kissaquina Sul | 9 | 3 | 7 | 2 | 21 | 6 | 5 | 11 | 32 |
| Bangwangwa | 8 | 2 | 7 | 2 | 19 | 9 | 8 | 17 | 36 |
| Calombe | 40 | 9 | 41 | 0 | 90 | 33 | 30 | 63 | 153 |
| | | | | | 601 | | | 413 | 1.014 |

The number of inhabitants per village is much lower than the average in other regions of the country. As Table 4.21 shows, only four villages have more than 100 inhabitants. Those with the largest population are Dala Kiosa, with 261; Calombe, with 153; Nhangue Ya Pepe, with 123; and Ngola Ndala, with 108. Those with the smallest number of inhabitants are Kiringe, Cassula, Kibenda, and Dumbo Ya Pepe, with eight inhabitants each.

However, there are different data on population increase and decrease in the villages in relation to November 2012. In some, the population has decreased owing to the beginning of classes, as many school age children had to leave for the city to attend school. In some cases, as in Ngola Ndala and Muta, the population increased because these villages are close to the project and offer better living conditions, having attracted young people waiting for employment in the Laúca AH.

- Living conditions

Living conditions in the villages studied are very precarious owing to the lack of basic infrastructure, such as water supply, basic sanitation, and electric power, as well as to the scarceness and precariousness of health and education services, the lack of a transportation system, and an absolute lack of employment and productive activities.

A major part of the population does not have an identity document, a significant datum, as this document is essential for an individual's access to institutions and for obtaining employment.

- Health

Most of the villages lack medical services or medication, leading the population to resort with greater frequency to the Dondo Municipal Hospital and to Cacuso, as is the case of the village of Kibenda. In many cases, people resort to medicinal plants and herbs harvested in the vicinity. The

main diseases are malaria, diarrhea, urinary infections, and conjunctivitis; there is no record of HIV or AIDS.

Villages on the left bank of the Kwanza River (Calombe, Bangwangwa, and Kissaquina Sul) resort to the Libolo Municipal Hospital and to the Caculo Regional Hospital.

The village of Ngola Ndala has a health center with 20 beds (Photo 4.105) and lodgings for a nurse, financed by the farmer Manuel Vicente. This center is abandoned for lack of doctors and nurses. According to witnesses in the community, the medical center will soon come under the management of ODEBRECHT.

**Photo 4.105:** The abandoned health center in Ngola Ndala.

In addition to the abovementioned diseases, the sleeping sickness is also a reason of concern for the local authorities; some cases of this disease have been recorded in the village of Ngola Ndala. The use of medicinal herbs for treating diseases is widespread, and is common in all the villages visited. Usually these medicinal herbs and plants are picked in the surrounding woods or are cultivated by the residents. Delivery is done by traditional midwives in all the villages studied.

- Education

There are no schools in most villages; and when they do exist, they are in an advanced state of degradation.

**Table 4.22:** Access to school, and schooling level per village.

| Villages | Access to School | Schooling level |
|---|---|---|
| **Kibenda** | Women are forced to leave the village for the city so that the children may attend school. Children attend school in the village of Nhangue ya Pepe, approximately 4.0 kilometers away. | Only one adult can read and write at a 4th grade level. |
| **Kyangulungo** | It has a school built 60 years ago, now in a poor state of conservation. Children are forced to go to the village of Kissaquina to attend school. The teacher is the village *"Regedor"* who teaches in Kissaquina, owing to the local school conditions. | The highest schooling level in the village is 6th grade. |
| **Kirinje** | There are no school-age children. | All villagers are illiterate. |
| **Muta** | The village has two schools: one with six classrooms and no teachers; and one with one classroom, built in colonial times and now abandoned. In 2012 the Cacuso Municipal Administration had designated a teacher, who taught from 1st to 4th grades, but he left, for reasons the villagers ignore. | The highest schooling level in the village is 4th grade. |
| **Cassula** | The village has no school. | All villagers are illiterate. |
| **Nhangue Ya Pepe** | The village has one school and one teacher who teaches three classes in the morning (1st and 2nd grades together); and one in the afternoon (3rd grade). The school was built by a farmer, José da Fisga. Fourth grade pupils are forced to stay in Dondo or in Luanda to attend school. | The highest schooling level in the village is 3rd grade. |
| **Kassakina** | The village has no school. Children attend | |

| Villages | Access to School | Schooling level |
|---|---|---|
| | classes in the chapel of the Evangelical church. The district *Regedor* is the teacher, who teaches from 1rst to 3rd grade. Fourth grade students have to live in the Cacuso Municipalities and in the Dondo village. | |
| **Dumbo Ya Pepe** | The village has no school. | Villagers are illiterate. |
| **Ngola Ndala** | Primary school children attend school, from 1st to 3rd grade, in the neighboring village of Nhangue Ya Pepe, at a school built by the farmer José Fisga. Fourth grade students have to live in the Dondo Municipalities and Luanda to attend school. | The highest schooling level in the community is 6th grade. |
| **Dala Kiosa** | Children attend school in the chapel of the Evangelical church. | The highest schooling level in the community is 6th grade. |
| **Calombe** | Primary school children attend school in the *Jango* built by the Libolo Municipal Administration | The highest schooling level in the community is 5th grade. |
| **Bangwangwa** | Children attend school up to 3rd grade in the neighboring village of Caxinga. | The highest schooling level in the community is 5th grade. |
| **Kissaquina Sul** | Children do not attend school, as there is no local school and the closest one is about 20 kilometers away. | Most of the population is illiterate and the highest schooling level is 4th grade. |

The school system in the villages is deficient and does not attend all school age children and youths. Of the ten communities studied, only Nhangue Ya Pepe and Muta have schools, and only the Nhange Ya Pepe School is in operation. The Muta school has no teacher. In Kissaquina and Dala Kiosa children attend school in a church.

Owing to the lack of schools and teachers in most villages, children study up to fourth grade and then are forced to live in cities or other villages, particularly in Dondo and Cacuso. This has caused

economic destabilization, as parents or those responsible for the children's education have to outlay large sums, including for food, for the children's upkeep. Another issue that deserves attention is the fact that there are only three teachers in the villages studied in the Laúca Project region. One of these teachers lives in one of the villages, while the other two live in Dondo and in Cacuso.

The Calombe teacher has his permanent residence in the headquarters of the Kissongo Commune and travels every day to Calombe, where he teaches from 1st to 3rd grade. Some of the Kissaquina children have to live in Calombe to attend school.

- Housing

In all villages houses are made of adobe with a plate roof (Photo 4.106), blocks covered with luzalite and/or mud, as specified on Table 4.23.

**Table 4.23:** Types and number of homes per village.

| **Type and number of houses** | | | | | |
|---|---|---|---|---|---|
| **Villages** | Adobe with plate roof | Blocks with luzalite roof | mud house | Total | Observations |
| **Kibenda** | 6 | 1 | 12 | **17** | |
| **Kyangulungo** | 14 | 1 | 3 | **18** | Located on the two sides of the national highway connecting Dondo/Cacuso. |
| **Kirinje** | 5 | - | 2 | **7** | |
| **Muta** | 22 | 1 | 2 | **26** | Located on the two sides of the national highway connecting Dondo/Cacuso. |
| **Cassula** | 9 | 2 | 3 | **14** | |
| **Nhangue Ya Pepe** | 34 | 1 | 3 | **38** | |
| **Kissaquina** | 24 | 1 | 5 | **30** | Located on the two sides of the national highway connecting Dondo/Cacuso. |
| **Dumbo Ya Pepe** | 4 | 2 | - | **6** | |

| Type and number of houses | | | | | |
|---|---|---|---|---|---|
| **Villages** | Adobe with plate roof | Blocks with luzalite roof | mud house | Total | Observations |
| **Ndala Ngola** | 29 | 3 | 1 | **33** | |
| **Dala Kiosa** | 41 | 5 | 7 | **53** | |
| **Calombe** | 27 | 3 | 11 | **41** | Located on the two sides of the shortcut road connecting Kissongo to Kissaquina. |
| **Bangwangwa** | 11 | 0 | 2 | **13** | The houses do not include kitchens, which are built behind the large houses. |
| **Kissaquina Sul** | 5 | 0 | 17 | **22** | Two of the houses in the village are abandoned. |
| **Total** | | | | **318** | |

According to the information obtained, no houses have an official document (CISA, title, or title to land for construction).

**Photo 4.106:** Houses in Kissaquina.

- Water, Electric Power, and Basic Sanitation

The seats of the Cacuso and Cambambe Municipalities have running water. No village studied has access to potable water, and depends essentially on rivers and LAGOONS in their vicinity.

**Table 4.24:** Access to potable water in the villages.

| Villages | Access | |
|---|---|---|
| | Rivers | Lagoon |
| **Kibenda** | Ganda River 400 meters from the village | - |
| **Kyangulungo** | Kassela River about 500 meters from houses | |
| **Kirinje** | Teteje River | Lagoons about 500 meters from the village |
| **Muta** | Ngola River about 1,000 meters from the village | - |
| **Cassula** | Teteje River and some Lagoons less than 500 meters from houses | - |
| **Nhange Ya Pepe** | - | Lagoons less than 100 meters from houses |
| **Kissaquina** | Kaluage and Canganga Rivers | - |
| **Dumbo Ya Pepe** | - | Lagoons less than 40 meters from the houses |
| **Ngola Ndala** | - | Lagoons less than 100 meters from the houses |
| **Dala Kiosa** | Cacuso and Kibulu Rivers | - |
| **Calombe** | Mouiza River (indirectly) | River lagoons |
| **Bangwangwa** | Luinga River about 1.0 kilometer from the village | - |
| **Kissaquina Sul** | Luinga River with access by the bridge located less than 200 meters | - |

In the villages studied there is no sanitation, and no treatment of house garbage. Garbage is thrown out in the village surroundings and when it accumulates it is burned. In some cases it is buried in holes made when dirt is dug out for making adobes for house construction.

A fact worthy mentioning is the reutilization of solid waste. In the villages studied the population reuses plastic bottles and cans (from soft drinks, beer, sausage, butter, edible oil, etc.) as containers.

As to latrines, usually and for cultural questions, unprivileged families seem little inclined to use them, relieving themselves in the open air. Until five years ago, imperatives related to habit and

ancestral taboos caused a certain resistance to the use of latrines. None of the concerns and complaints expressed by the population had to do with the building of latrines.

No village population has access to electric power; gas oil is used for lighting, and avery small number of families have their own generators: four in Kibenda; three in Kyangulungo, including the *Soba* family; two in Kirinje; seven in Muta; four in Cassula; five in Nhangue Ya Pepe; five in Kassaquina; one in Ndumbo Ya Pepe; five in Ngola Ndala; eight in Calombe; three in Bangwangwa; and two in Kissaquina Sul.

- Transportation

There is no regular public transportation system serving the communes. The populations travel on foot, covering great distances, rarely making use of private taxi or *candongas*.

The *candongas* are private vehicles that circulate irregularly on the Capanda AH-Dondo road or between Laúca and Cacuso. As the only means of transportation available, they charge too high a tariff for the residents' purchasing power.

- Local productive structure

Most of the populations have in agriculture their main economic activity; and a very small number of young men work on the Laúca project or on local farms (Table 4.25).

**Table 4.25:** Number of people employed on the Laúca Project or on farms

| Villages | Number of young men | |
|---|---|---|
| | Laúca | Farms |
| Kibenda | 4 | - |
| Kiangulungo | 2 | - |
| Kirinje | 2 | - |
| Muta | 3 | - |
| Cassula | 8 | - |
| Nhangue Ya Pepe | 9 | 8 |
| Kissaquina | - | - |
| Dumbo Ya Pepe | - | 1 |
| Ngola Ndala | 12 | 5 |
| Dala Kiosa | 12 | 1 |
| Total | **51** | **15** |

The populations of the villages on the left bank devote themselves exclusively to working on the field, hunting, and fishing. To earn some money, they sell some farm products, but much of this production is wasted for lack of an outlet.

In nearly all villages most young men have registered for employment on the Laúca Project more than three months ago, particularly young men from Dala Kiosa (30) and Kissaquina (20), and are awaiting word from Odebrecht.

The villages' production system consists exclusively in subsistence farming, with the utilization of rudimentary, extremely low productivity techniques, and in occasional sales of surplus and of fruit. The main crops are traditional products, such as manioc, the families' basic food, squash, cowpeas, and in some cases garlic and onions. The small plots are located at some distance from the villages, to protect them from the goats, which are raised lose near the homes. The burning practice is widely used to prepare the land for cultivation.

Two farms belonging to Kissaquina residents are located 12 kilometers from the village, right next to the margin of the Kwanza River. These farms belong to the Boy brothers; they are productive farms that employ young people from the region (Photo 4.107). Each of these farms has 2.0

hectares. The oldest farm (Ze Boy's) produces mainly maize, sweet potato, and manioc, and has many buyers for its products in Cacuso and Malanje. The Jackson Boy farm has not yet had its first harvest (according to the environmental consultant). In addition to the aforementioned products, one should mention potatoes, bananas, and peanuts.

**Photo 4.107:** Irrigation system on the Jackson Boy farm.

**Photo 4.108:** Crops on the Ze Boy farm.

As to animal husbandry, all families in the villages raise small animals, such as goats, pigs, hens, and rabbits. The average number of animals per family is four to five. In the Nhangue Ya Pepe village this average climbs to eight animals. Bovines are scarce; only nine families have heads of cattle: two in Kyangulungo; six in Muta; and one in Kissaquina.

Hunting and fishing are exclusively male activities. As to fishing, according to the local population, the Kwanza River has a wealth of fish species, the most common of which are *cacusso,* catfish, *and russombo,* but distance from the river makes fishing difficult. Thus, when they go fishing, the men remain several days on the banks, bringing back the dry fish in baskets called *muhamba*.

On the banks of the Kwanza River there are some straw shacks that belong to some 25 fishermen, who live there with their families. These families are from the Kissaquina village (Photo 4.109).

Nearly all families in the villages sell some kind of farm product or fish from the Kwanza River (Kyangulungo, Muta, Nhangue Ya Pepe, and Kissaquina) to ensure family income. Those who work on the Laúca Project or on the farms draw a monthly salary of 10-15 kwanzas.

**Photo 4.109:** Fishing community from the Kissaquina village.

Surplus farm products are often sold by the roadside and, if there is transportation, on the Dondo or Cacuso popular markets. There are also some intermediaries, truck or pickup truck owners that collect the products from the roadside to sell in Luanda. With such earnings, families buy salt, sugar, clothing, and school and hygiene materials in the nearest towns, particularly in Dondo and Cacuso. Many families gather *múcua* [baobab fruit] to sell by the roadside; this fruit is used for making beverages or ice cream. In addition, the fabrication of coal on the savanna surrounding the villages is a significant source of income complementation for some families. In the Ngola Ndala and the Dala Kiosa villages, there are some food and beverage shops that may also cater to residents from neighboring villages.

- Support organizations

There are no nongovernmental organizations to support the rural communities. In Ngola Ndala and Nhangue Ya Pepe there are some small initiatives for the establishment of traditional farming cooperatives. These small associations operate this way, according to an interviewee: “a group of people work together on a common tract of land, with responsibilities individually assigned, with a view to achieve a good collective harvest, which is sold, and the sale product is distributed among the group members.”

- Land use

The role of the regular authorities in land management is directly related to the system of social representation and use of partnerships. In the villages studied, this role consists in:

- ✓ Guaranteeing the right of each community member to own land for farming;
- ✓ Guaranteeing to members who absent themselves from the community their right to cultivate and maintain their residence when they intend to come back, a right extended to their legitimate heirs;
- ✓ Granting land to non-natives, provided they are interested in building their homes and cultivating the land; and
- ✓ Organizing burnings for hunting purposes.

Access to land is obtained by a request to the *Soba* (in the case of non-natives). All members of the villages, including women, have their own plot of land to work on, according to the customary right; widows may inherit land from their husbands.

- Religion

In a large part of the villages the predominant religion is Methodism, with the exception of Kissaquina, where the predominant religion is the Evangelical. The Kyangulungo population attends Sunday worship services in Kissaquina. Kirinje and Muta residents attend morning services in the village of Muta.

In the Calombe and Kissaquina Sul villages there is no church. In the Bangwangwa village the population is predominantly Catholic.

- Culture, crafts, and leisure

The villagers share cultural habits, holding a celebration during the yearly cleaning of the *Sobas'* cemetery, popularly known as *Jindambo* and considered a sacred place.

**Table 4.26:** Cemetery localization in relation to the villages and the Laúca Project

| Villages | Cemetery location |
|---|---|
| **Kibenda** | 30 meters from the village |
| **Kyangulungo** | Just a few meters from the village |
| **Kirinje** | In the area known as "fuxi-ya-lemba," about 3.0 kilometers from the Laúca Project and 6.0 kilometers from the Kwanza River |
| **Muta** | A few meters from the village |

| Villages | Cemetery location |
|---|---|
| **Cassula** | A few meters from the village |
| **Nhangue Ya Pepe** | |
| **Kissaquina** | 7.0 kilometers from the Kwanza River (9°44'254"; 15°16'9.67"; 967-meter altitude). Te old *Jindambu* is located on the margin of the Kwanza River, about 1,000 meters from the fishermen settlement, across from Kissaquina, Kwanza Sul. To reach the cemetery on the other side one must cross the river by canoe, barge, or go by land, through Libolo, Kwanza Sul. |
| **Dumbo Ya Pepe** | About 200 meters from the village |
| **Ngola Ndala** | On the left margin of the road |
| **Dala Kiosa** | About 8.0 kilometers from the Kwanza River. There are sacred places located in the quarry, where six great *Sobas* are buried (six stone tombs). |
| **Calombe** | About 3.0 kilometers from the village |
| **Bangwangwa** | The *Sobas*' cemetery is the same as the general population's and is located about 100 meters from the houses. |
| **Kissaquina Sul** | The ancient cemetery is located on the slope of a hill, less than 500 meters from the Kwanza River, at the same distance from the Luinga River, and at about 1.5 kilometers from the Ze Boy farm. Eleven *Soba* generations are buried in this cemetery. |

A mass on the cemetery of the Nhangue Ya Pepe is also celebrated each year in memory of the missionaries buried there.

Crafts are not practiced in all the villages for lack of clients. The villages where they are still practiced are as follows: Kibenda, where older people make baskets, wood mortar-and-pestles, washing boards, and clay cooking pots; Nhangue Ya Pepe and Ngola Ndala, where clay cooking pots, palm-leaves mats, and baskets are made.

Not all villages have spaces for leisure. Those that do are: Kyangulungo, Muta, Nhangue Ya Pepe, Kassaquina, and Ngola Dala, which have soccer fields. In Muta, Nhangue Ya Pepe, the young men assemble on Sundays to play friendly matches with neighboring communities. Calombe also has a soccer field, where friendly matches are also played on Sundays with neighboring communities, particularly with the Kissongo Commune on Sundays.

## 4.4.3. RESULTS OF INTERVIEWS IN THE VILLAGES

The social survey was based on interviews with the population of villages located within 25 kilometers downstream and 43 kilometers upstream from the Laúca Project. The objective was to give the parties interested in and affected by the Project an opportunity to learn about it, its potential

impacts, and the recommended mitigation measures to improve its implementation, as part of the process of analysis of the study under way.

Local authorities, including traditional authorities, have been informed of the construction of the future Laúca Dam, although they claim that some details are insufficient. The population in general also knows about the dam to be built, but demand more information regarding a possible improvement of their living conditions.

- Expectations

The population is pleased with the Project because, in addition to creating jobs for the young people, it will lead to many social projects for the welfare of the entire population of the area. There is expectation that the Project will bring in electric power.

As one interviewee said,

*We have neither schools nor health services, which has caused people to abandon their villages. With this project we will have water and schools, in addition to other social projects; and we do believe that in a few years we will have those people back.*

The possibility of employment in the construction work and in the structures that will support it, and of access to services the Laúca AH will bring in, such as medical care, education, potable water, civil records (for the issuing of the identity card that is indispensable for getting a job), farming support, transportation, and trade—all of this forms parts of the expectations expressed by participants.

- Concerns

There is some skepticism about Odebrecht's discharging its social responsibilities, having in view the experience related to the construction of the Capanda Dam.

One Kyangulungo interviewee made the following comment:

*The project is welcome, as it will bring development to our region, although when the Odebrecht was in Capanda, other than the water it provided for the population, it did nothing else related to its social responsibility. I would like to know if in Laúca the Odebrecht will fulfill what it promised when it was in Capanda?.*

There is also dissatisfaction over whether young people's access to jobs in the Laúca Project will be harmed by the hiring of young people from other places, as well as over the access criteria such as the requirement of an identity card, as the majority of them face financial difficulties for obtaining it. They also allege the payment of bribes to get a job.

In all villages there were comments similar to the following:

*How does Odebrecht plan to solve the problem of access to jobs for the young people from this village, as there have been so many complaints? Many young people do not have an identity card; can't the voter's registration card serve? How to get information about the job vacancies at the enterprise?*

The Kyangulungo *Soba* made the following remark:
*The village young people call me names because most of the neighboring villages have managed to get jobs with the Laúca Project, differently from several young people from my village.*

Some of the young people said that they want to work on the Laúca Project:
*We spend most of the time at the gate of the Laúca Project in search of a job. We have submitted the documents at the gate of the Laúca Project about four months ago and so far we have not been called.*

*For 15,000 kwanzas you can get a job with the Laúca Project. Some of the village young men area trying to make some money to be able to join the Laúca Project labor market. There is a network of national workers on the project that accept money in exchange for a job.* (Joaquim João, a resident)

*Most of the village young people have a low level of schooling; they have already submitted all the documents for getting a job at Laúca but they are still waiting to hear from the ODEBRECHT people. The village young people have had enough of this. Can't the voter's registration card be enough? (*Nhangue Ya Pepe village*)*

*In terms of the economically active population, Kissaquina is better off than the other villages in the region; it should be given priority in hiring, as its young people have some professional skill and some of them have already worked on the Capanda Project. (Kassakina village)*

Some have also expressed concern over the possible flooding of some villages and localities owing to the dam reservoir, as is the case of the Kassakina cemetery, the Sobas' cemetery, and the makeshift village set up by the fishermen of Kissaquina, Kyangulungo, and Muta on the margin of the Kwanza River; some crops of the Boy family; as well as over the question of crossing to the other bank of the Kwanza River to reach
Kissaquina and Bangwangwa.

*Which mechanism does the Project have to solve the situation of the Kissaquina cemetery, which will be flooded when the river overflows?*

*We are concerned over the possibility that in the future the floods in the rainy season will flood the makeshift village the Kassaquina fishermen have set up on the bank of the Kwanza River.*

*With the construction of the Laúca dam, the coffee and palm tree plantations near the Laúca Stone will disappear, as that is a place from where the Odebrecht will certainly extract material for the dam's construction.* (Nhangue Ya Pepe village)

*I am concerned over the farming activity I am developing here in the region. I have given jobs to seven young people from the village and the farm is now beginning to produce something. Today one speaks of the Laúca Dam construction and, as one might expect, after it is finished, when heavy rains fall, the water will flood my farm. From whom shall I claim for any damage that might result from the dam's flooding?* (Kassakina village farmer)

*We are worried because our village is bounded in the north by the Capanda dam and in the south by the Laúca dam. In case of heavy rains, when they open the Capanda floodgates the fish disappear, owing to the oscillation in the volume of the Kwanza River. With the construction of the Laúca Dam, the situation will get worse, because when the heavy rains will fall in the region, the flooding may reach the cemetery where our ancestors are buried, not to speak of the one across the Kwanza River.* (Kassakina village)

Some express concern over the felling of trees in the areas where material is to be extracted for the dam construction and over the fact that the area where the river course will be deviated was a battlefield between the peoples of the north and of the south at the time of King Ngola Kiluange

*…a ritual should be performed to pacify the spirits of the ancestors that lost their lives in that very place.* (Cassula village)

The population is worried about the rumors of a possible transfer of the populations to other localities and the loss of their old croplands located in the area of the Laúca Project. Fourteen people in the village complained about the loss of their crops. They also worry about the connection with the populations that live across the river.

*Will the Odebrecht or the Government build a bridge in the area of the Kassakina port to facilitate the crossing of the river?*

*Our village is located near the Laúca Project and a little farther are the coffee, palm, and banana plantations. We have seen some people connected with the Project wandering in that area and some heavy machinery extracting material near the abandoned crops since the beginning of the Project. Will those responsible for the Laúca Project meet with the population to inform us about the Project, as at the time of demining? Also, will the Project force the transfer of our village to other localities?* (Nhangue Ya Pepe and Kissaquina villages)

*We have relatives across the Kwanza River and use the area where the fishermen community is located for crossing the river to the other side. With the construction of the Laúca Project and the coming of the rains the river flow will increase and this will make it impossible for us to cross to the other side of the river.* (Kissaquina *Soba*)

The villagers are also worried about the aquatic fauna. They believe that with the construction of the dam many aquatic species may disappear or be forced to migrate to other, safer zones.

*In the past there were hippopotamuses, alligators, and other large-size animals such as lions, warthogs, and even antelopes. Today, because of the presence of humans and the noise of the machines, many species are disappearing from the region.* (Kissaquina villager)

One interviewee commented that:

*This year, owing to the drought that plagued our region, we have not been able to catch fish as we used to three years ago. Also, with the construction of the Capanda dam, the quantity of fish caught decreased considerably, owing to the oscillation of the flow, and with the construction of the LaúcaD, this situation will worsen even more.* (Ngola **N**dala village)

Mr. Ngunza Canhanga, the *Soba* of the Kissaquina Sul village, said:

*We agree with these two dams because we are too isolated. If they pave the road, people will be able to sell their products. When we have much rain, the flooding waters cover the Luinga River Bridge, which often hinders the crossing over to Calulo. With the construction of the Laúca Dam, we are absolutely sure that our houses will disappear with the flooding caused by the rains, but all this because of the dam. This does not worry us too much, because if this happens we can move to another, safer place. Our great worry is about the* Malombes *or* Jindambus *located on the banks of the Kwanza and the Luinga Rivers, as according to the culture of the Kissaquina land, they cannot be moved. So, what is to be done? Would the Laúca Project engineers have techniques for protecting that place? Building a protecting wall, perhaps, as one way to prevent the place from being submerged?*

*We cannot move the* Malombes*, nor can we trade jobs or any other project for the removal of the* Malombes*; that place is very sacred; one cannot go there any old way. At the time of the war, that place served as a refuge for the Kissaquina villagers and the UNITA never set foot there; and those who dared to go there without the presence of the* Soba *got lost on the way, that is, they never managed to see the way to reach it. This is why we insist that this situation should be duly analyzed, with much care.* (Benzina Jerónimo, a Kissaquina Sul villager).

*We need water and electricity and jobs; we have to find a solution that will ensure some stability between the population and the Laúca Project. I believe that if there is no negligence on the part of the Laúca Project, we will be able to sort out this situation.* (Josefa Serafim, Kissaquina Sul villager)

*We are worried because these last days it has been said that the Project will force the resettlement of the village population. Can Mr. SF tell us where we will be relocated and what conditions the ODEBRECHT or the Government will guarantee for us, and what will be the situation of the lands,*

*as our croplands and the cemetery of our* Sobas *and other ancestors are also located in this small space of our territory?* (Domingos Matos, Kissaquina Sul villager)

Mr. André Júlio, the Adjunct *Soba* of the Calombe village said:

*We have little information about the Laúca Project. We have practical examples of our experience with the Odebrecht in Capanda. Before the construction of the Capanda Dam, the promise given by the Odebrecht people was that as soon as the production of electric power started, priority for supplying electricity would be given the population near the project – in this case, the Dala Kiosa and the Kissaquina Norte villages. To this day, that promise has not been fulfilled… We are not worried about the flooding; we are worried about the* Jindambu *of our ancestors, of our Kissaquina brethren… The population can move anywhere, but the* Malombes *can't. Thus, the need to study this question carefully.*

The elderly of the Calombe village are very worried and defensive about the *Malombes* of the Kissaquina village, which will be swallowed up by the floods caused by the rains. They advise those responsible for the project to visit the place to see the problem for themselves and find strategies for negotiating with that region's traditional authorities. In their view, this is not a question for the Kissaquina village population, but for the villages located in that area; and this begins to worry the population located in the project's area.

*We have never had anyone come to our village to talk about the Laúca Project; not even the Kissongo Communal Administrator spoke officially about the dam. Today, from you we are getting more detailed information about the Laúca Project. Can you tell us how stands the situation of employment for the young people of our village? Will they, if they don't have an ID, have a chance of getting a job on the project?* (Luís António, a Calombe villager)

An issue that worries the Calombe villagers is the bridge over the Mbuiza River (09°58'336"; 15° 9"661"; altitude, 1,045 meters). Although they are at a higher altitude than the flooding area, the population says that that is the only place for reaching Kissaquina and other villages of the Mussende Municipality and also villages on the Dondo-Cacuso road.

The Bangwangwa population has doubts about the implementation of the project. It says that it had great expectations in relation to the Capanda Project, and today there is no point in talking about expectations related to the Laúca Project, as the enterprise responsible for it is the Odebrecht.

*The Laúca Project is going to benefit and at the same harm the population that uses the Kwanza River as a survival basis, particularly the fishermen. In terms of benefits, it will bring development to the country. What will happen to the question of crossing over, that is, to Kissaquina North, Dala Kiosa, where we have our relatives? (*Anacleto Agostinho, Bangwangwa village*)*

*We have our croplands on the banks of the Luinga River and believe that the construction of the Laúca Dam and the floods caused by the rains will damage our crops, as the river flow will increase. Who will pay for the damages?* (Aníbal Neto, Bangwangwa village)

## 4.4.4. RESULTS OF INTERVIEWS WITH THE COMMUNAL ADMINISTRATIONS

**São Pedro da Quilemba**

At a meeting with the Adjunct Communal Administrator to apprise him of the interviews with the villagers, he listed some a series of concerns and expectations.

- Expectations

  - ✓ With the deviation of the course of the Kwanza River, in case there is a great flood, the villages will be spared from the flood; and
  - ✓ In addition to jobs, which are already a reality, the project will provide several basic services for the localities near the project.

- Concerns

- ✓ With the construction of the Capanda Dam, the flow downstream from the dam considerably reduced the capture of fish; and with the construction of the Laúca Dam the situation will become even worse and make the fishermen of the riverine areas become jobless. How does the Project look at this question?
- ✓ Is concerned with the defense of the protection of flora, fauna. Odebrecht, for the diversion of the river certainly will drop some natural trees without replacement hypothesis;

- ✓ Getting an ID remains a problem in the region. As a rule, the population, including the elderly, does not have a birth certificate. To enter the birth of a child into the records, the Conservadoria Civil requires a birth certificate from the parents; in many cases this is not possible because no family member has ever had such a document.

**Cacuso**

A meeting was held with the Cacuso Municipal Administrator to inform him of the interview results. He also expressed some concerns and expectations.

- Main expectations

- ✓ The project is going to create job opportunities for the young people and give origin to social projects. The Laúca Project is also going to encourage the improvement of agricultural production in the communities, and this will contribute to the development of the Angolan economy.

- Main concerns and complaints

- ✓ The population's complaints have already been presented in the preceding. Except for the employment question, the populations are collaborating, and even those that might have to be relocated will listen to our appeal, because they are aware that this is a Government, not an Odebrecht project, which will bring development to the region.

- ✓ *It is important that the technical people involved in the Project learn a little about the culture of the populations that live near it, so that they won't run roughshod over traditional elements of those people."*

- ✓ *The Kissaquina fishing community by the river will be submerged by the floods caused by the rains. Also, the Boy family farms, in the same type of location, will have the same fate, not to speak of the old cemetery where the* Sobas *of the two Kissaquinas are buried."*

- ✓ *The Administration is also concerned about the protection of the flora and the fauna, as well as with the felling of native trees that will not be replaced, and the fleeing of*

*the animals toward safer areas, because of the human presence and the noise of the machinery.*

## 4.4.5. CONCLUSIONS

The living conditions of the villages' populations are very precarious, owing to the lack of basic infrastructure, such as water supply, basic sanitation, and electric power, as well as to the scarceness and precariousness of infrastructure in the areas of health care and education, to the lack of a public transportation system, and the absolute lack of jobs and productive activities to support the families.

The fact that a large part of the population (including the young people) does not have an identity card is an important issue, as this document is fundamental for an individual to become covered by the institutions and to obtain employment.

Local authorities, including traditional authorities, and the general population are informed about the Laúca Project. But they want more information, and want to be informed on a continuous basis.

Some hold a favorable opinion about the Project and thus have high expectations of improvement in their living conditions. They expect first employment for the young people on the construction and for them to continue to be connected with the undertaking, not only in respect of the Laúca Dam but also of the economic and social activities planned or that may be encouraged in areas such as trade, education, and health, among others. In the second place, there are many expectations, especially because this is the third dam to be built on the Middle Kwanza River, and the second within the Cacuso Municipality. Expectations are mixed with some concerns and complaints.

The situation of the farms and the fishermen's settlement has already been addressed. It should deserve double attention as this is a concern on the part of the Cacuso Municipal Administrator, the Kissaquina *Soba*, and of other villages and some inhabitants. Moreover, one should not ignore the concerns expressed in relation to cultural aspects of these villages, especially in relation to the *Sobas*' cemetery and the hunter's tomb, a subject frequently brought up during all visits.

Concerns are centered on the negative environmental changes, which reflect on human life in the region. Interviewees were much worried about the Project's implementation, owing to the presence of some expatriate workers in the different phases, which may increase prostitution in that area.

The populations see the social survey and the interviews as something positive, as the only means to make their opinions reach those responsible for the Laúca Project. The question of employment opportunities for the young people and the construction of infrastructure as a social responsibility of Odebrecht's were issues brought up in all the villages visited, with the obtaining of employment being the main concern.

The majority of the population is aware that there will be no flooding of villages, with exception of the Kissaquina, Nhangue Ya Pepe, and Kirinje villages, which are worried about this, as explained in previous chapters.

With respect to the dissemination and intensity of the interviews, we have the following suggestions and recommendations:

- The Odebrecht should set up social promoters in the villages for the effective dissemination of information about the deviation of the river course project, as some people lack knowledge about the subject in a planned, continuous way.
- Greater use should be made of the local radio, the distribution of brochures, and the affixing of advertisement posters at the end of streets, as well as the setting up of large-size billboards or bulletin boards to post publicity materials regularly.

Table 4.27 below sums up the main aspects of the socioeconomic survey and the interviews in the areas affected by the Laúca Project.

**Table 4.27:** Summary of the relevant socioeconomic aspects.

| Influence Area | Locality | Main Aspects |
|---|---|---|
| | | o In this area are located the *Sobas* |

| Influence Area | Locality | Main Aspects |
|---|---|---|
| Directly Affected Area | Kissaquina village and Kissaquina Sul village | Cemetery (Kissaqina Sul), the fishermen's village, and the two farms (Kissaquina) that will be flooded with the filling of the Laúca AH reservoir.<br>o These villages should be resettled and the cemetery should be transferred to a safe area; this will require contacts with the representatives of these communities to define the resettlement form and location;<br>o The population is worried about the resettlement, afraid that it will lose access to its resources, particularly its agricultural resources;<br>o The village *Soba* is not happy with the flooding of the sacred cemetery. |
| Direct Influence Area | Village:<br>• Dumbo Ya Pepe<br>• Nhangue Ya Pepe<br>• Ndala Ngola<br>• Kibenda<br>• Kirinje<br>• Cassula<br>• Muta<br>• Kyangulungo<br>• Kissaquina<br>• Dala Dosa (Dombo)<br>• Calombe<br>• Bangwangwa | • These areas located along the main road have working-age young people , who wish to work on the Laúca Project. But often their employment need is not met.<br>• A great majority of the population does not have an ID, which makes it difficult to join the Project.<br>• These communities require special attention from future social projects to be developed in the area.<br>• The cemetery of the Kirinje village is located in a risk area, susceptible to flooding during the Kwanza River's flood season. The village *Soba* does |

| Influence Area | Locality | Main Aspects |
|---|---|---|
| | | not agree with the Project and says that the area has to be submitted to a spiritual cleansing. |
| Indirect Influence Area | Municipalities:<br>• Cambambe<br>• Libolo<br>• Mussende<br>• Cacuso | • People may be hired in these areas, where materials needed for dockyard construction may also be obtained. |

All the population of the villages visited and heard expressed appreciation for the Laúca Project and has great expectations for improved quality of life. The health, education, and basic sanitation conditions are precarious in all villages. Thus, both the project's proponent and its executor should plan actions and social plans in these areas for the population. These will be further discussed in Chapter 6.