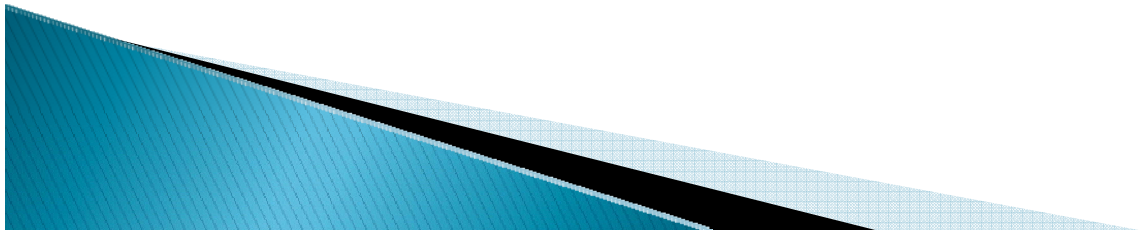
WATER RESERVOIR LINKED TO THE HYDROELECTRIC POWER STATION OF MANDRAKA
(MADAGASCAR Case Study)

I) Natural Conditions

- ***Topography***
- ***Vegetation***
- ***Soils***
- ***Climate***
- ***Geology***

Topography

The station presents a residual multi-faced topography with narrow inter-flows.



Vegetation

The vegetation is composed of natural and planted forests. The former belong to the dense upland evergreen rainforest, while the latter are artificial formations dominated by forests of Eucalyptus spp.

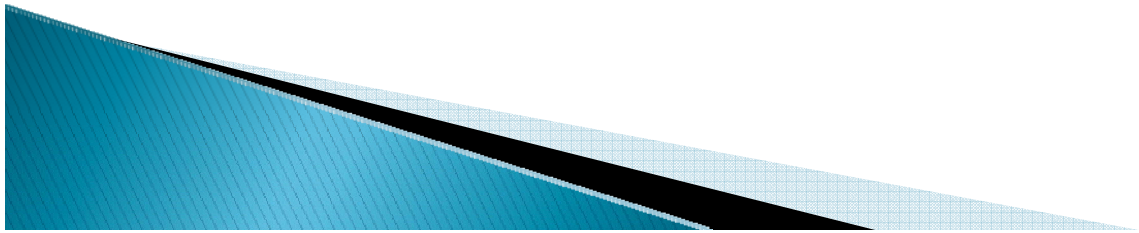
Soils

The general area rests on ferralitic soils. On the hillsides, rejuvenated and strongly rejuvenated ferralitic soils are found. These are textures of loamy sandy clay.

Climate

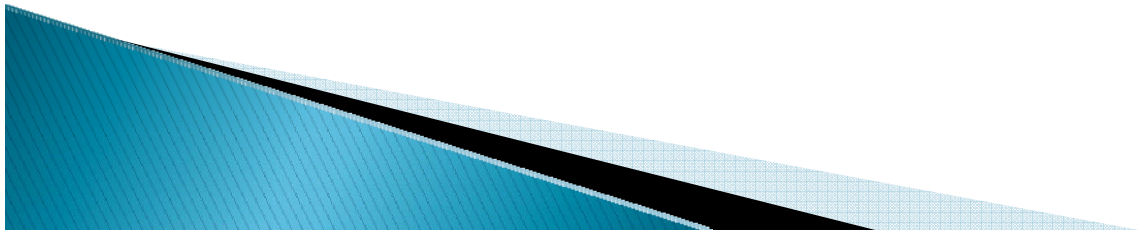
The region belongs in the tropical climate type with an elevation above 900m. The climate is characterized, on the one hand by a mean annual temperature of 16.6° C, and on the other hand by two clearly distinct seasons: a dry season and a rainy season. This region receives an annual rainfall of 1,520mm over a 122-day period. The rainy season extends from November to April.

This region has a moderately warm climate and a fairly cold and moist winter with frequent mists (frosts can occur in the valleys).



Geology

On the whole, the Mandraka basin rests upon the old crystalline shelf, but the primitive substratum derived from this shelf corresponds to features composed of migmatitic granites and granitoid migmatites.



II) Analysis of the operation and maintenance of the dam

- Informations on the dam
- Periodic monitoring
- Approach on the sedimentation problem

Informations on the dam

The dam has a perimeter of 1,459.325m and an area of 43,922m². At an elevation of 1,152m, a water volume of 222,721.721m³ is recorded.

Periodic monitoring

The JIRAMA enterprise, which is the institution tasked with the management of water and power supply, conducts periodic monitoring of hydroelectric power stations, including Mandraka, in order to assess any potential displacement of the dam.

At the Mandraka dam, JIRAMA has also installed monitoring devices that include: a water leaking device, a piezometer, and a Vinson (or triaxial). As a result, a small gap of about ten millimeters has been identified at the dam, but the validation of this measurement still requires an appraisal from expert organizations such as EDF (Électricité de France) or others.

Topographic surveys are also periodically conducted at the dam and of the forced operation of Mandraka, uphill, downhill, as well as vertically. In fact, topographic devices have been installed for these measurements.

Measurements are taken twice a year: at the time of high waters (April-May) and low waters (October-November). Apart from this type of monitoring, it is important to point out that observations with the Vinson device are conducted uphill, downhill and vertically. Regarding the monitoring of water leakage, measurements are taken before the rainy season (summer).

Approach on the sedimentation problem

Results of these types of monitoring are structured in order to establish a database allowing for managing the maintenance of the dam and its water stock, which is largely conditioned by a sedimentation phenomenon.

III) The sedimentation problem and the solution adopted at the Mandraka dam

- *Importance of the dam's sedimentation*
- *Analysis of the causes of the sedimentation problem*
- *Solution adopted for the moment*

IMPORTANCE OF THE DAM'S SEDIMENTATION

After its construction, the first clean-up of the dam took place in 1966. Since that year, considered as baseline, sedimentation measurements uphill and downhill from the dam were conducted (1966, 1996, and 1998).

The report on the sedimentation measurements has therefore provided three profiles regarding the monitoring of the sedimentation levels for these three reference years. Between 1996 and 1998, an increase of 0.40m in the sedimentation level is recorded. Additionally, between 1966 and 1996, i.e., over a 30-year period, 6m of increase in the height of the sedimentation level were registered. It is worth noting that the sedimentation level varies depending on the location of the reference points of the measurement line. In order to have a clear idea for considering the importance of the sedimentation immediately uphill from the dam, two profiles were established, one in length and one across (cf. pictures of profile plans).

Between 1996 and 2007, JIRAMA took measurements to determine the volume of sedimentation over 672m starting from the dam. To this end, a sedimentation amount of 57,000m^3 was recorded. It is important to recall that the cost of dam clean-up or dredging depends on this amount.

ANALYSIS OF THE CAUSES OF THE SEDIMENTATION PROBLEM

- *Erosion due to deforestation on the watershed slopes (presence of ashes, vegetation residues, and topsoil after burning of the vegetational cover)*
- *Presence of a main public road (National route,)used by trucks coming from the largest port in Madagascar, threading through the slope of the watershed that feeds the water reservoir; this can only favor landslides, which facilitate erosion transport*
- *Installation of quarries by the COLAS company next to the road infrastructures (major presence of granite residues in the sedimentation deposits)*
- *…*

SOLUTION ADOPTED FOR THE MOMENT

At the moment, the immediate solution consists of scheduling a clean-up operation on the dam's reservoir requiring an interruption of several days of power supply.

However, efforts to find a sustainable solution have become a necessity, given that electric power requirements continue to increase. Studies on the management of sedimentation must be conducted and should be based on a quantitative analysis of the types of deposits found in the reservoir.

Expectation and others considerations

One of our expectations regarding this workshop is to find out about solutions adopted by the other participating countries in the areas of mechanical or biological devices to control sedimentation in water reservoirs.

One of the knowledge gaps that have also been identified in our case regarding the management of sedimentation in water reservoirs is the application of serious environmental impact assessments prior to the establishment of infrastructures within the watersheds containing the water reservoir.

Thank you for saving our reservoirs