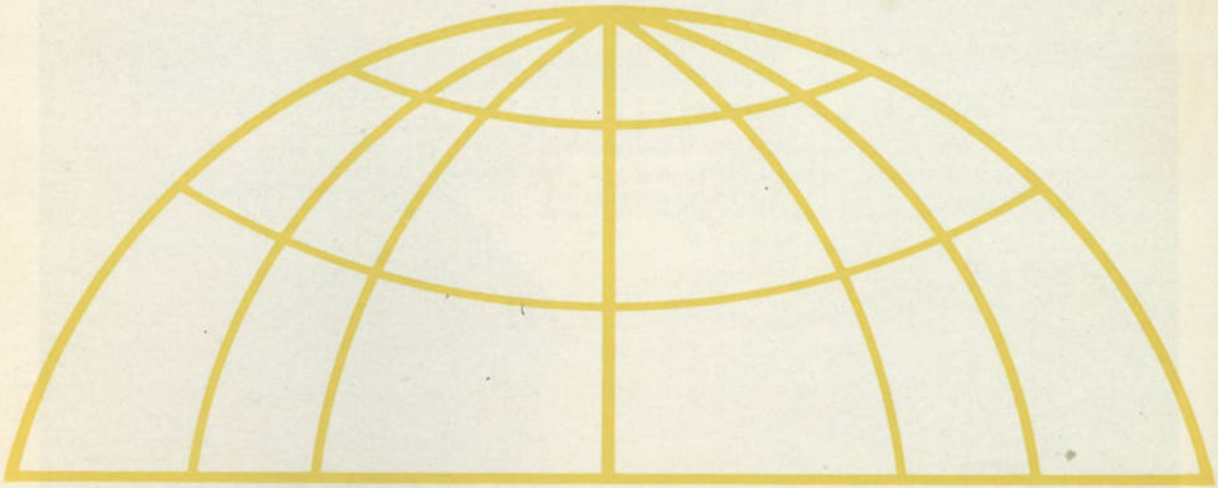
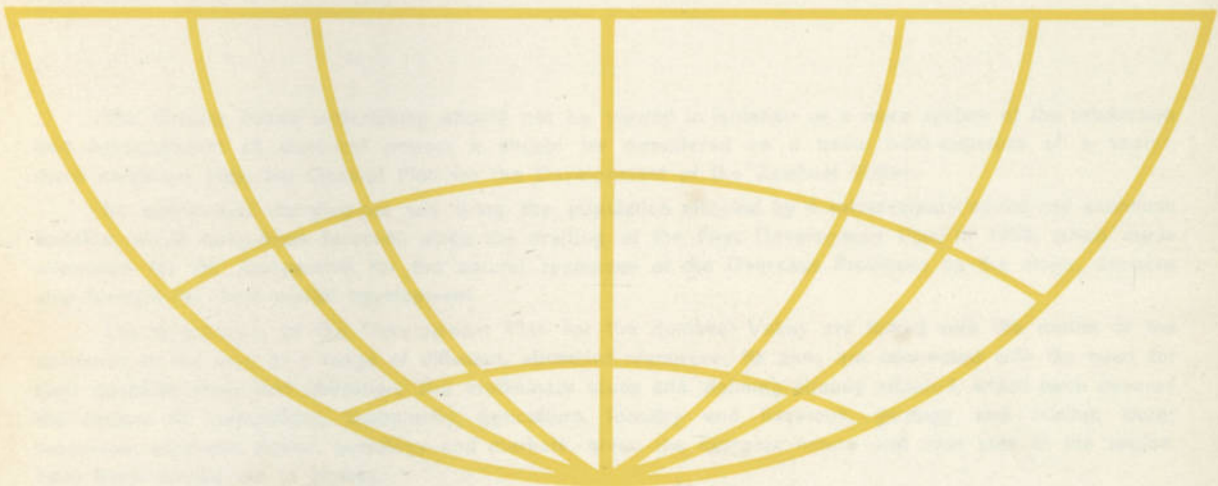
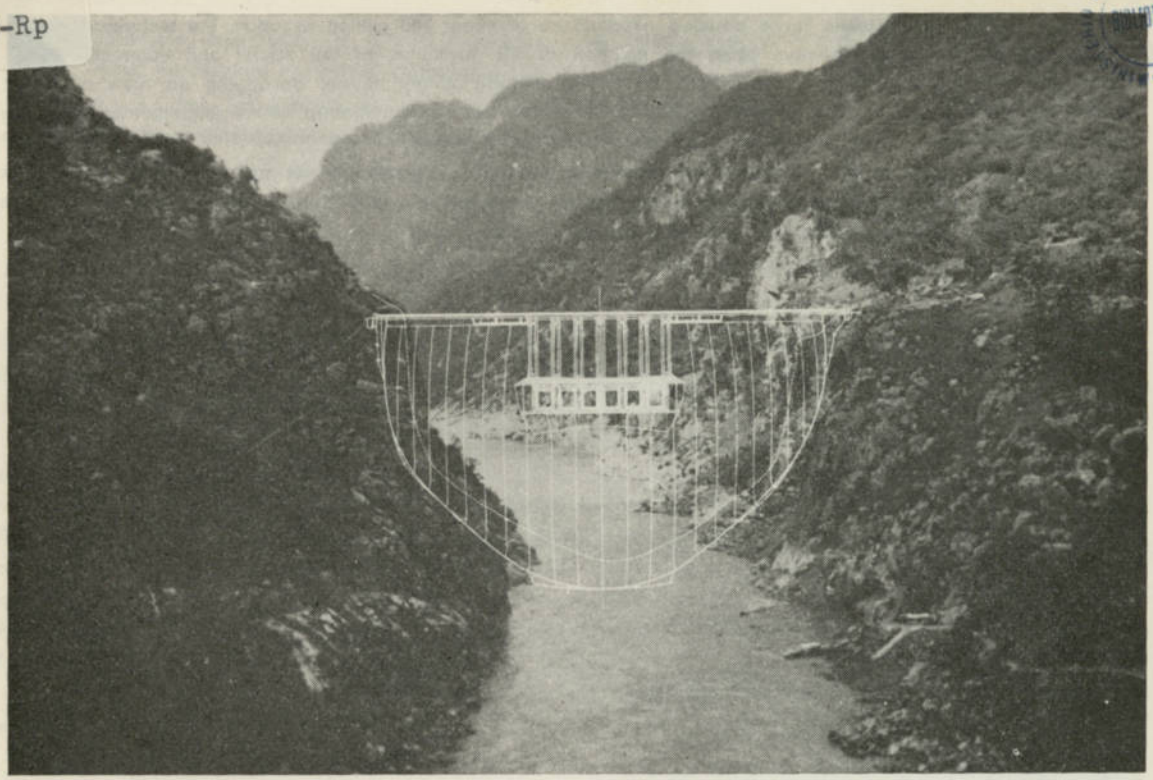


THE DEVELOPMENT OF THE ZAMBEZI VALLEY



CABORA BASSA



The Zambezi Valley: site of the Cabora Bassa Dam

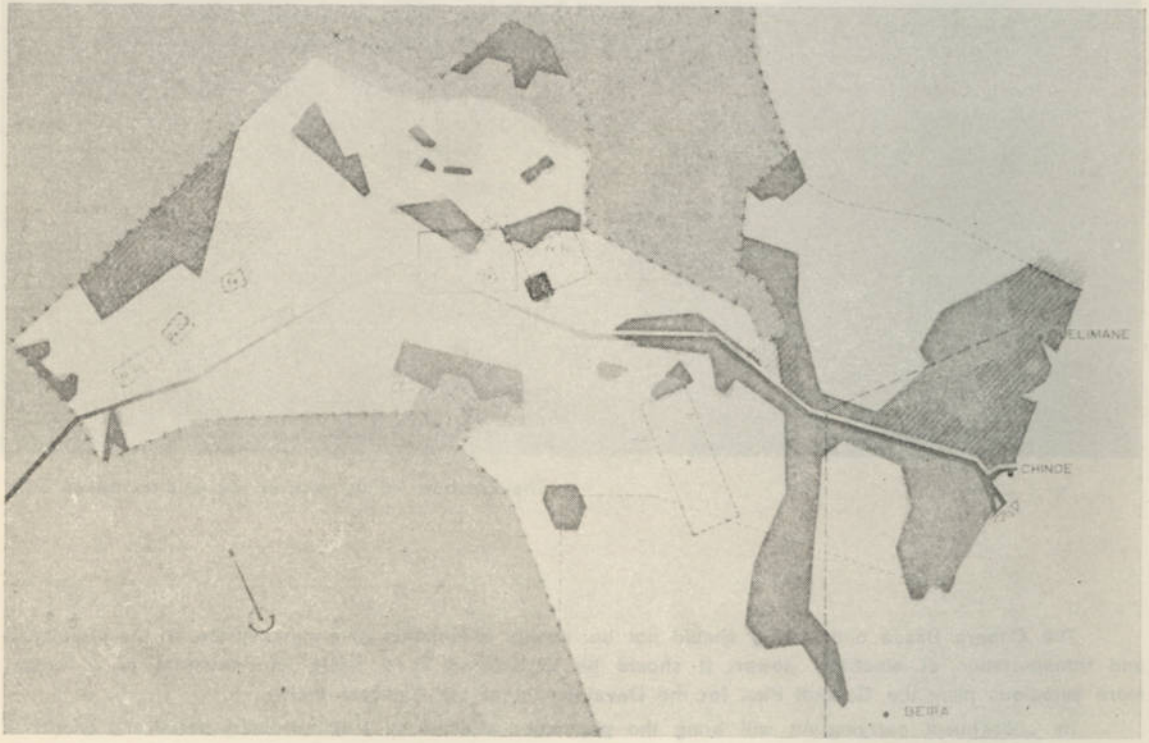
The Cabora Bassa undertaking should not be viewed in isolation as a mere system of the production and transportation of electrical power: it should be considered as a basic infra-structure of a vaster, more ambitious plan, the General Plan for the Development of the Zambezi Valley.

Its subsequent carrying-out will bring the population affected by it extraordinary social and economic benefits, which have been foreseen since the drafting of the First Development Plan in 1953, which made allowance for the prospection for the natural resources of the Overseas Provinces as the major, decisive step forward for their overall development.

The forerunners of the Development Plan for the Zambezi Valley are linked with the notion of the existence in the area of a range of different, abundant resources; its aims are connected with the need for their concrete study and utilization. The preliminary study and planning already affected, which have covered the sectors of map-making, topography, agriculture, forestry and livestock, geology and mining, water resources, electrical power, sociology and markets, given the complex nature and vast size of the region, have been carried out in phases:

— one, a preliminary phase, in which general reconnoitring of natural resources was affected and the programming of their inventorying;
— another, which entailed the evaluation of the overall economic feasibility of the region, and its selection with a view to laying down a development plan;
— finally, the preliminary project of the selected works involved was drafted, and planning of the most significant undertakings.

Since 1957 these tasks have entailed expenditure of about 300 million escudos, the technique applied in this achievement having always been the solution of the problems of the social and economic development of the population of the area, about 1,500,000, overwhelmingly native, occupying an area of about 220,000 square kilometers. On the other hand, in furthering the basic guideline of the implementation of the general plan of work, there has never been any forecast of a massive European settlement of the area, even though it may be considered that the infra-structures that will gradually be set up will provoke an influx of people of all races. So that to speak of an aim of settling, or attracting, «one million new white settlers» to the Zambezi Valley is an impracticable, illogical notion.



Economic potential of the Zambezi Valley: zones for cultivation, planting of exotic trees, development of livestock, mining exploration, prospection for radioactive minerals and oil

What should be stressed, within the activities which will be given priority in developing the Valley, is the following:

— Community development of the native population, with a view to their economic and social progress;

— Guided occupation of agricultural areas, by setting up suitably sized farms to be distributed both among the local population and immigrants, so that they will constitute stable, progressive nuclei of population;

— Extension of agricultural cover and occupation to the forestry and stockraising sectors, bearing in mind the development of the agricultural areas and livestock which already exist and are traditional in the area;

— Intensive exploitation of mineral resources, with mining and, whenever possible, the subsequent total processing, or partial processing, on the spot;

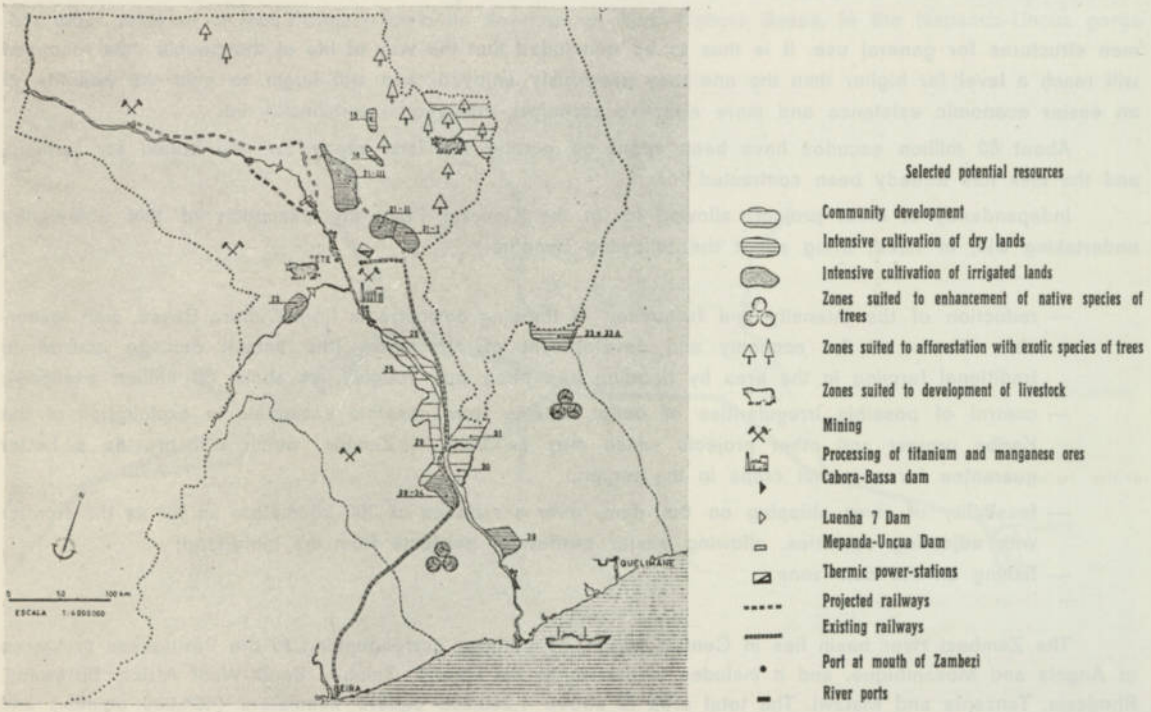
— Laying-down of indispensable infra-structures for the centres of development that already exist or come to be created, especially in the sectors of electrical power, transportation and trading;

— Setting-up in the development zones of an efficient network of health services, assistance and education facilities, to act as a means of enhancement of the local inhabitants and to support such of these, and immigrants from other places, who set up new centres of settlement and, at the same time, to provide a base for the future expansion of such services and facilities in the remaining zones of the Zambezi Valley.

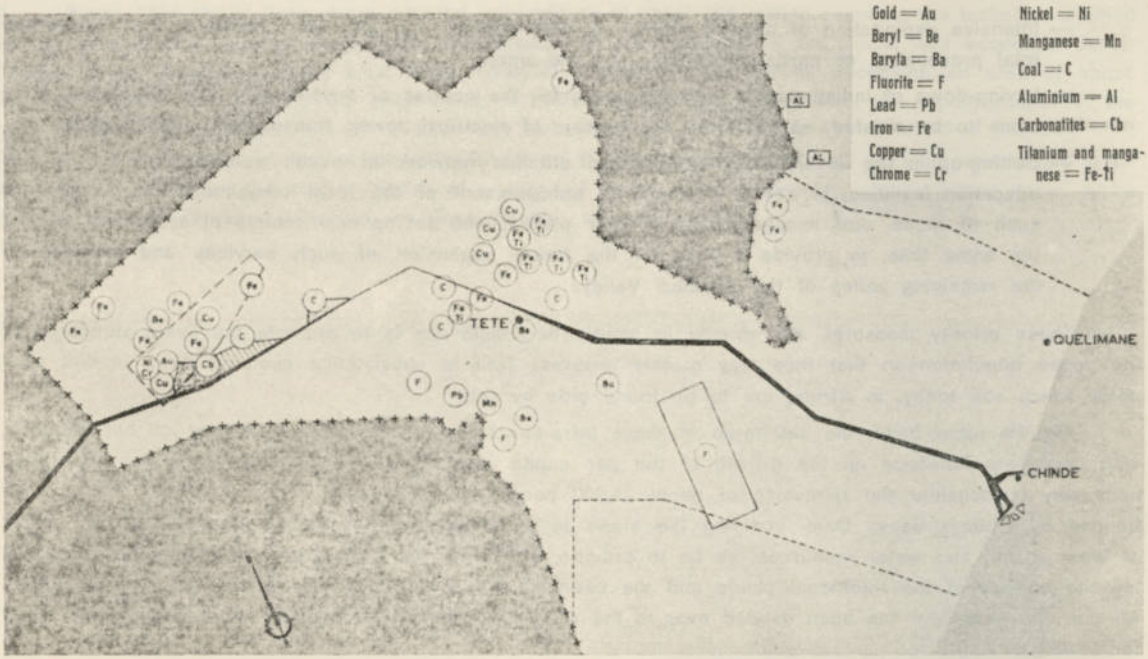
These priority measures are already in hand. Their main aim is to promote the living standards of the native population so that they may quickly progress from a subsistence economy to a market economy which still today, in Africa, are to be found side by side.

On the other hand, the setting-up of these infra-structures will of itself create new job opportunities, with immediate influence on the growth of the per capita income of the inhabitants. It has also been necessary to consider the rehousing of about 25,000 people who today live in the area that will later be flooded by Cabora Bassa Dam, studying the areas to be occupied by the people affected from the points of view of soil and water resources, so as to provide them with the best living conditions, always seeking the opinion of the traditional chiefs and the councils of the elders of the various types of inhabitant. All the cultivable land has been handed over to the respective families, duly ready for cultivation and ready for sowing.

Aid will be given in building housing and, at the same time, the rehousing areas will be provided with schools, health clinics, maternity homes, agricultural training schools, social centres and other com-



The Zambezi Valley:
selected potential resources



Prospects for mining exploitation in the Zambezi Valley

mon structures for general use. It is thus to be concluded that the way of life of the people thus rehoused will reach a level far higher than the one they previously enjoyed, and will begin to gain the benefits of an easier economic existence and more effective technical, educational and health aid.

About 60 million escudos have been spent on getting the land ready for distribution for farming, and the task has already been contracted for.

Independently of other projects allowed for in the General Plan, the execution of this noteworthy undertaking will, of itself, bring about the following benefits:

— reduction of the intensity and frequency of flooding downstream from Cabora Bassa, with favourable effects on the economy and development of agriculture (the annual damage caused to traditional farming in the area by flooding has been put, roughly, at about 60 million escudos);
— control of possible irregularities of outlet, arising from possible anomalies in exploitation of the Kariba project and other projects which may be built in Zambia, which will provide a better guarantee for seasonal crops in the region;
— feasibility of river shipping on the dam, over a distance of 300 kilometers as far as the frontier with adjoining countries, allowing easier outflow of products from the hinterland;
— fishing on the dam zone.

The Zambezi river basin lies in Central Africa, at latitudes corresponding to the Portuguese provinces of Angola and Mozambique, and it includes territories of the Congo, Zambia, South-West Africa, Botswana, Rhodesia, Tanzania and Malawi. The total area is above 1,200,000 square kilometers (464,000 sq.mls.) and the length of the river, from the springs to the Indian Ocean, is about 2,700 kms. of which about 380 kms. lie in Mozambique. The source of the river is at about 5,300 feet altitude.

On the basis of the agronomic prospection of an area of 5,500,000 hectares selected during initial reconnaissance, it has proved possible to set aside 2,500,000 hectares of land suitable for agriculture and, by characterization of the soil pattern, there would seem to be prospects for the intensive settlement of about 1,500,000 hect. on the basis of irrigated land and about 300,000 hect. of dry land.

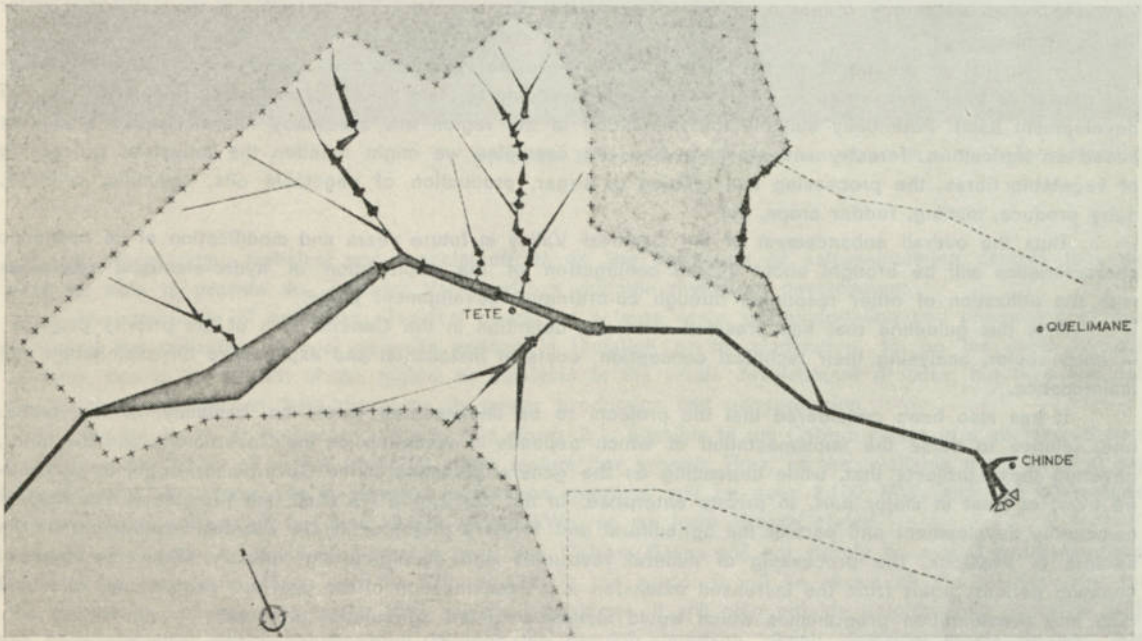
Forestry prospection has led us to conclude that the forest area of present economic value is about 200,000 hect. and those that it is of interest to protect and further their natural regeneration have been identified, so that they may become economically exploitable.

Livestock reconnaissance showed the existence of 200,000 head of cattle, and zones have been marked out of economic significance for the exploitation of cattle for meat, milk-production and other purposes. The potential of each zone has been determined and the methods best suited to their exploitation. In the geological and mining sector, one of the most significant as regards the potential of the region, the major existing mineral wealth is in coal, iron, copper, fluorite and manganese. Reference should also be made, even though more detailed research is still called for, to other minerals found in the area, such as beryl, corundum, chrome iron ore, graphite, magnetite, nickel, titanium and aluminium. Bauxites especially call for research because of the importance of their relation to power resources.

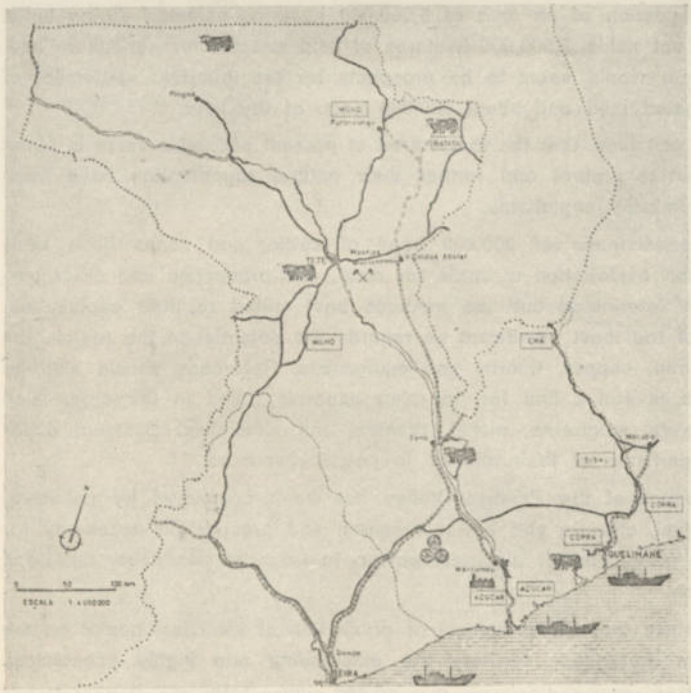
In hydraulics, the hydrological occupation of the Zambezi Valley has been completed by collecting data to serve as a basis for the hydrological, climatic and power research and prospection necessary for the definition of the works involved in the production of electrical power, in irrigation, drainage, anti-flood measures, river regularization and navigation.

Power studies, in particular, have shown that the prospects of production of electrical power on the Zambezi and on some of its tributaries on Portuguese territory are outstanding and highly economical.

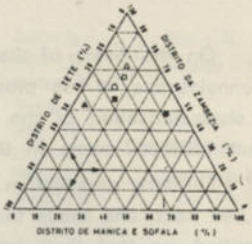
Guaranteed annual output of the plant projected is more than 50,000 million kWh, the Cabora Bassa project itself being the most important: by itself it can guarantee annual output above 18,000 million kWh. The other projects of the Zambezi basin lie downstream from Cabora Bassa, in the Nepanda-Uncua gorge



The Zambezi Valley: Hydro-Electrical Project
Main utilizations



The Zambezi Valley: Present Utilization of Resources



Chief explorations

Sugar Non-traditional crops

Forest products

Major concentrations of cattle

Mining

Sugar-mill

Main roads

Railways

Planned railways

River shipping

Ocean-going shipping

Gross domestic product (average figures for 1955-58)
1,137,2 million escudos

	000 escudos	%
Agri., Stock-raising, Fores. and Fish.	526 540	46,3
● Industry (mining and manufacturing)	206,720	18,3
○ Building	47,562	4,2
▲ Transports	83,061	7,3
△ Trade	104,814	9,1
■ Education and Health	19,305	1,7
□ Others	150,010	13,2
	1,137,200	100

(feasible output of energy of about 12,000 million kWh), Boroma and Zupata which may well, at a later stage, be harnessed.

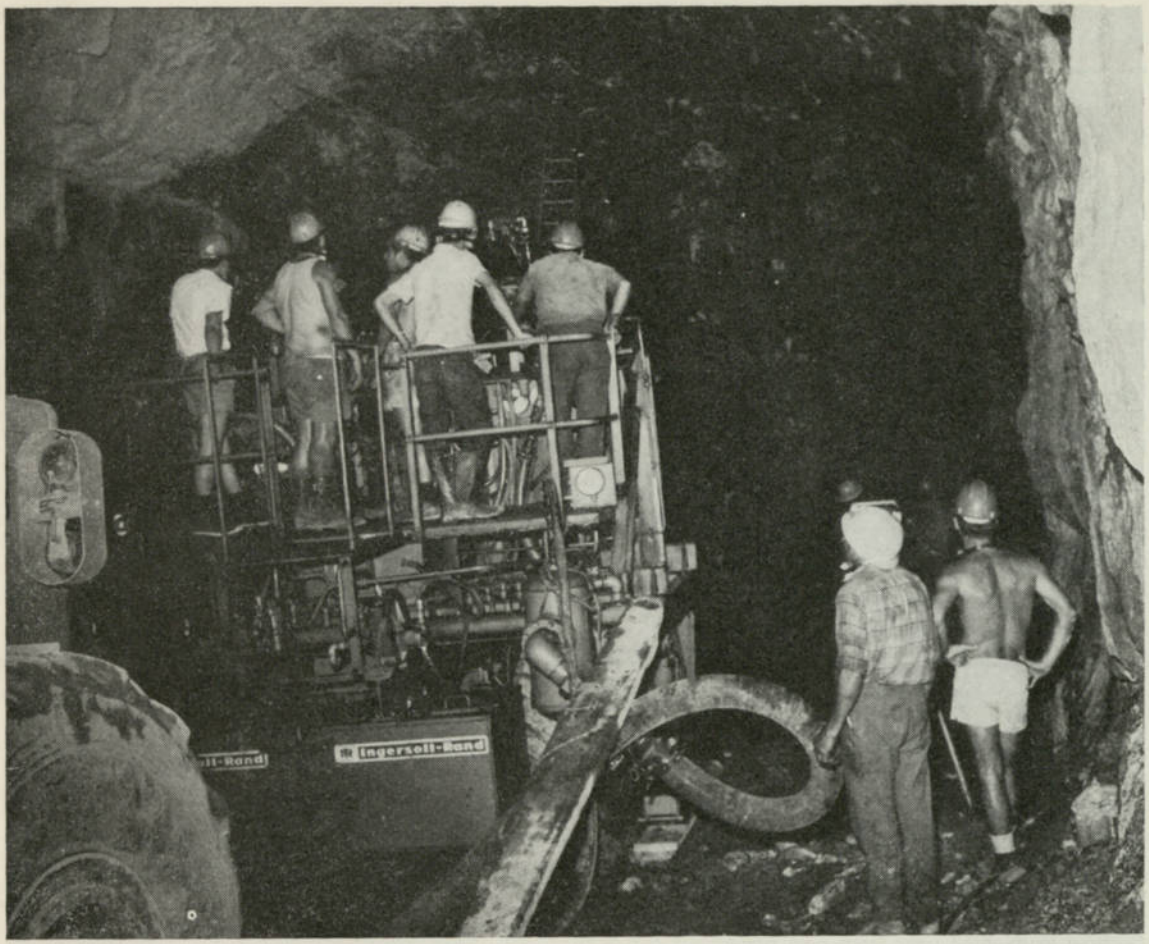
The industrial prospects of the Zambezi Valley are the immediate consequence of the natural resources that have been inventoried in the various sectors, adding to them the direct or indirect results of regional development itself. Potentially suitable for installation in the region are subsidiary and derivative industries based on agriculture, forestry and stockbreeding. As examples we might mention the industrial processing of vegetable fibres, the processing and refining of sugar, production of vegetable oils, sawmills, celulose, dairy produce, tanning, fodder crops, etc.

Thus the overall enhancement of the Zambezi Valley in future years and modification of its economic characteristics will be brought about by the conjugation of the exploitation of hydro-electrical resources with the utilization of other resources through co-ordinated development plans.

It is this guideline that has presided over the definition in the General Plan of the priority projects in each sector, analysing their technical conception, costs of installation and expenditure on exploitation and maintenance.

It has also been considered that the projects to be implemented would be, basically, of two types: one, relative to those the implementation of which depends in essentials on the Government, and the other, covering those projects that, while depending on the general guidance of the Government, ought to be handed over, at least in major part, to private enterprise. In the first group we shall find projects in the field of community development and part of the agricultural and forestry projects; in the second, exploitation in the sectors of livestock, the processing of mineral resources and manufacturing industry. Then, as financial capacity permits, apart from the increased extension and intensification of the previous programme, we could take into consideration programmes which would include irrigated agricultural projects.

Meanwhile it has been realized that a rhythm and level of investment compatible with the need and the opportunities for the economic development of the region could only be attained if public investment were guided so as to be multiplied by the attraction of private capital, both Portuguese and foreign. It is



Diversion tunnel for river, work on which is already far advanced

only by concentrating technical and financial efforts on the setting-up of self-maintaining centres that we shall be able to provide the Zambezi Valley with a suitable rhythm of development.

The prospects of exporting electrical power on a large scale, the exploitation and processing of iron ores and the utilization of coal deposits appear, in isolation or in association, to be the most hopeful projects, due to the growth of the region, as catalysts in the whole development process, but they will call for major investment on infra-structures in power production and transportation.

On the basis of the safety criteria laid down it is possible to run Cabora Bassa at a guaranteed flow (calculated for 95 % of years) of 2,700 cubic meters per second. Thus, as the available gross drop at the dam is over 100 metres, the permanent guaranteed potential will be over 2,100 MW, and the guaranteed annual energy output will be over 18,000 million kWh, as we have already stated.

To conclude, it should be borne in mind that Cabora Bassa will not merely be a vast hydro-electrical project, the biggest in Africa and the fifth biggest in the world: it will be above all the starting-point for the systematic enhancement of the land and its inhabitants. It will also provide neighbouring countries with an opportunity for useful collaboration, through the use of abundant, cheap electrical power, as part and parcel of the policy of co-operation that Portugal traditionally adopts, of which an example, renewed daily, is the efficiency of our transportation system.

PORTUGUESE AND FOREIGN HYDRO-ELECTRICAL POTENTIAL: COMPARATIVE TABLE

Project	Site	Total potential kW	Potential of each group in kW
Cambambe	Portugal-Angola	260.000	65,000
Bemposta	Portugal in Europe	207,000	69,000
Kariba	Rhodesia	900,000	100,000
Furnas	Brazil	1,100,000	137,500
Mani-Cougan 5	Canada	1,340,000	168,000
Malpaso	Mexico	1,296,000	216,000
Ouri	Venezuela	2,180,000	218,000
Bratsk	U. S. S. R.	4,500,000	225,000
Alcântara	Spain	984,000	246,000
Tumut 3	Australia	1,500,000	250,000
Cabora Bassa	**Portugal-Mozambique**	**3,600,000**	**400,000**
Churchill Falls	Canada	4,500,000	450,000
Krasnoyarsk	U. S. S. R.	5,000,000	500,000
Grand-Coalu 3	U. S. A.	3,600,000	600,000

CHARACTERISTICS OF THE CABORA BASSA PROJECT

Hydro-electrical water and power characteristics

Area of total river basin	900,000 km²
Area of own basin	382,000 km²
Outflow in average year from own basin	$43{,}300 \times 10^6$ m³
Outflow from Kariba in average year	$41{,}300 \times 10^6$ m³

Reservoir

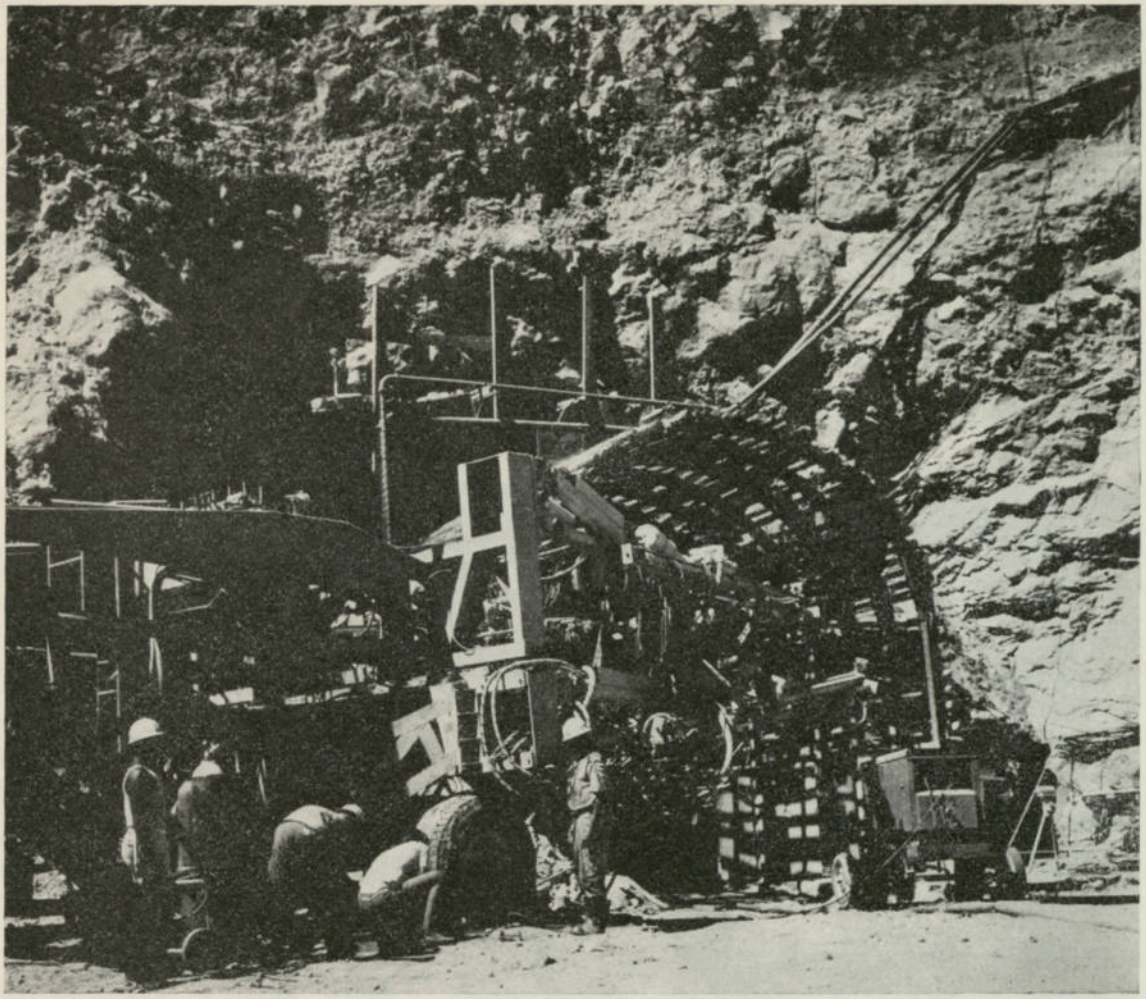
Minimum level of exploitation	295
Full storage level	326
Catastrophic flood level	329

Useful capacity of reservoir

At full storage level	$51{,}750 \times 10^6$ m³
At catastrophic flood level	$59{,}800 \times 10^6$ m³

Flooded area

At full storage level	2,660 km²
At catastrophic flood level	2,890 km²



Tunnel under construction

Provisional river diversion work

Volume diverted	4,500 m^3 per sec.
Number of channels	2
Section of each channel	150 m^2
Length of each channel	400-450 m
Maximum height of upstream cofferdam	45 m
Maximum height of downstream cofferdam	35 m
Output tension	16 kV.

One-phase transformers — 16 kV/220 kV — 160 MVA: 16

220 kV sub-station

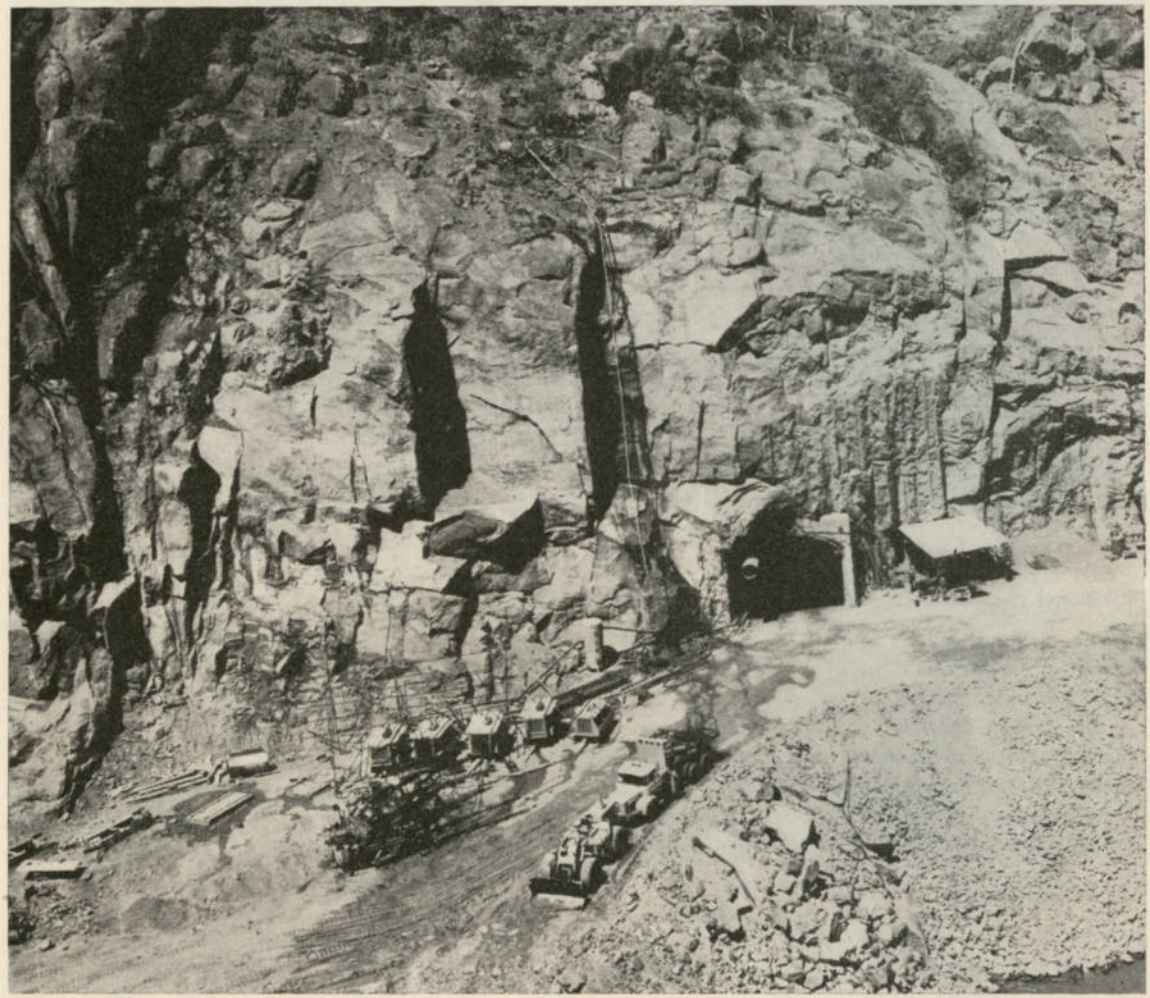
Number of grids	2
Entry control panels	10
Exit control panels	15
Shutting-off power of circuit breakers	25,000 MWA

Transformer station of Cabora Bassa

Power	1,920 MW
Supply tension	220 kV
Outflow tension	±533 kV
Number of transformers	8
Potential of each transformer	240 MW
Nominal tension of each transformer	130 kV
Scheme of transformers	three-phase GRAETZ bridge
Type of valve	mercury vapour, with 6 anodes

Transportation cable

Length	1,400 km
Constitution	2 single-pole circuits on independent supports
Nominal tension	±533 kV



View of construction work in one of the tunnels of the Cabora Bassa Dam

Dam

Type	arch
Extension of crown	303 m
Base level	171 m
Crown level (highway)	331 m
Maximum height above foundations	160 m
Excavation at foundations	210,000 m^3
Volume of concrete	450,000 m^3

Outflow

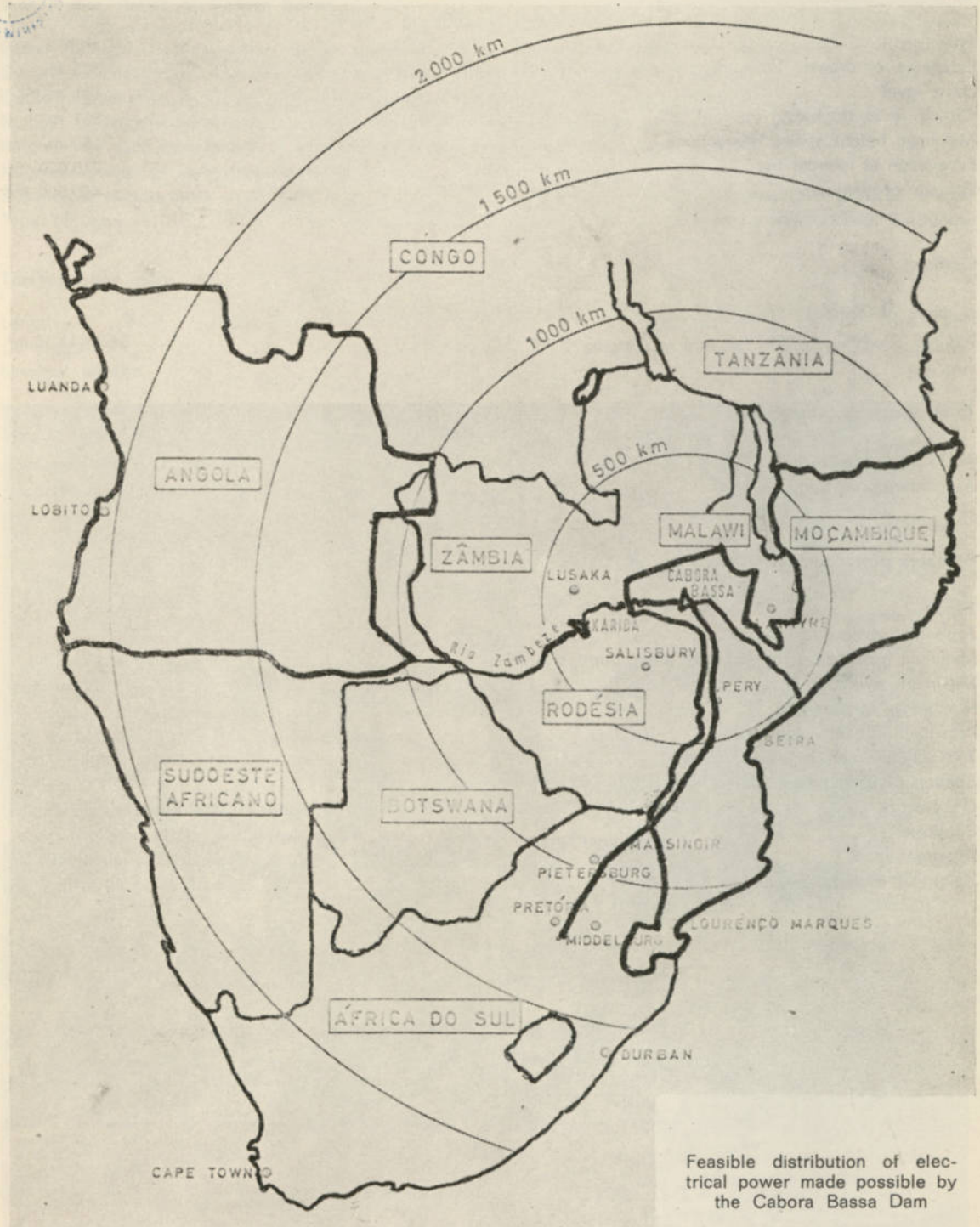
Number of orifices	8
Section of each orifice	5.62×11.10 m^2

Total emptying capacity

At full storage level	12,600 m^3 per sec.
At catastrophic flood level	13,900 m^3 per sec.

Southern power station

Type	underground
Type of turbine	Francis
Minimum gross drop for 400 MW per group	105 m
Maximum overspill flow	2,200 m^3/sec.
Number of groups	5
Potential of each group	400 MW
Tension between poles	1,066 kV
Section of each pole	2,300 mm^2
Conductors	bands of 4 aluminium/steel cables
Supports	rigid metallic towers
Average span	about 400 m
Height of each tower	40 m



Feasible distribution of electrical power made possible by the Cabora Bassa Dam

Tip. Silvas, L.da — Lisboa

Maquete de: JOSÉ AUGUSTO