

Mariners

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## Zambezi Survey -

A report to  
**USAID**

River depths in the Rio Zambeze  
during the dry season of 1993.

Project # 656-0237 & 656-0270.56

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### Preamble:

- I. The signing of the Peace Accords in Mozambique has opened the way for a massive reopening of the interior of the country. Within a very short space of time local truckers were starting to use roads that had not been open for traffic for many years, and the International aid community was not slow in starting to take advantage of this new accessibility of the interior in its endeavours to alleviate hardship.
- II. By the middle of 1993 much work had been done on the planning of demining and road rebuilding to bring back into use the principal axes of road communications. In Sofala, under the aegis of the World Food Programme, convoys started to reach as far as Caia on the River Zambezi, and some vehicles were also arriving in Mutarara on the other side of the river, either passing through Malawi or negotiating the very poor road through Dóá.
- III. Nonetheless, by the end of 1993, many important centres still remained beyond the reach of road transport, and throughout the year there was a very great level of expenditure on the airlifting of emergency goods.
- IV. Furthermore, the reopening of the roads caused something of a breakdown of coastal shipping. Deprived of much of its traffic, the Mozambican shipping industry contracted violently and it became increasingly difficult to obtain ships to undertake deliveries of coastwise consignments. Nonetheless, there remained a great need for the movement of both aid and commercial cargoes northwards from Beira and Maputo into the provinces north of the Zambezi River.
- V. In some instances, cargoes were being forwarded to Quelimane from whence they were being trucked back to destinations near the Zambezi such as Mopeia.
- VI. Meanwhile, refugees, both internal and external, were starting to return to their home regions.
- VII. In almost every instance, all efforts were now being severely hampered by one major deficiency: **The lack of any form of practical transportation along or across the River Zambezi.**

### Commercial Navigation Potential:

- VIII. A number of needs for traffic movement on the Zambezi were noted and some can be deduced from the brief preamble:
- A. Passenger movements were required to facilitate the return home of displaced people.
  - B. The road network to the north-east of the Zambezi urgently needed to be rejoined to the road network in Sofala and the south.
  - C. There remained communities that were beyond the reopening road system that could nonetheless be supplied by river.
  - D. A small commerce between riverine communities on opposite banks could not redevelop without communication.
- IX. Certain specific proposals depended to some degree on knowing whether or not conditions on the Zambezi would permit the reopening of navigation:
- A. Repairs to the rail bridge between Sena and Mutarara were under consideration for many months in 1993. Knowledge of the river conditions within the zone would provide invaluable background information.
  - B. A drive-on/drive-off ferry service between Caia and the opposite bank was under active consideration, and this required knowledge of the water depths.
  - C. Use of barge transport by returnees from Malawi was actively considered, and knowledge of the navigability of the Zambezi, and its tributary, the Rio Chire, was a prerequisite to any plans.
  - D. Air lifts were continuing. Could this expenditure be avoided by the use of barge transport?
- X. As a result of discussions between **Mariners** and USAID, USAID agreed to fund a brief survey of the River Zambezi so that the unknown factors that were hampering planning could be either partially or totally eliminated.

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### Historical Perspective:

- XI. The history of navigation of the Zambezi has a relevance to the current situation and acts as a base line from which changes can be noted.
- XII. Navigation on the Zambezi altered considerably as a result of the opening of the Cahorra Bassa dam. Consideration of the historical perspective covers both the period prior to the opening and the situation from the opening until navigation ceased as a result of the war.

#### A. **Pre-Cahorra Bassa period:**

1. *The flow of the Zambezi was irregular, but in general it was quicker and there was a greater depth of water except in drought periods.*
2. *Navigation was open for much of the year as far as Tete.*
3. *Transshipment services at the port of Chinde at the mouth of the river enabled goods to be consigned to Tete on through bills of lading.*
4. *Passenger services using sternwheel paddle vessels were an established means of transport along the Zambezi valley. These same paddle wheelers also acted as tugs towing relatively large barges.*
5. *The port of Chinde was once a British possession within Portuguese East Africa, reflecting a trade up the Zambezi and the River Chire into what was then Nyassaland.*
6. *The River Chire was a narrower, but faster flowing river which permitted navigation up into what is now Malawi.*

#### B. **After the opening of Cahorra Bassa:**

1. *The opening of the dam meant that the flow of water down the Zambezi was reduced during all periods except when the dam was discharging overspill.*
2. *The periods of opening of the dam gates were not sufficient to maintain the same degree of scouring effect as had previously been the case.*

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3. *Commercial navigation north of Sena and Mutarara ceased.*
4. *Navigation below Sena and Mutarara became more susceptible to the changing levels of the river.*
5. *Nonetheless, navigation up the river as far as the confluence with the Chire and then on up into Malawi continued when possible.*
6. *A Dutch owned company, Zambeco, regularly plied the two rivers with 200 ton capacity barges to load molasses in Malawi.*
7. *These barges can still be seen on the beach in Chinde and are perhaps the best indication of the size and type of vessel that was capable of navigating these waters before the war.*
8. *Because of the reduced flow, there was an increased tendency for sand banks to build up so that navigation was halted when the river level was at its lowest.*

XIII. During the period immediately prior to the closure of navigation because of the war, commercial traffic on the river consisted of the following:

- A. A ferry crossing at Caia. This crossing was effected by a small barge with a ramp, capable of taking one or two cars or a light commercial vehicle. The main spinal road was being transferred to this route with the construction of a bridge at this location, but the construction of the bridge was halted by the advent of war.
- B. The main crossing of the Zambezi was on the national highway that left the later route at Inhamitanga and passed through Chupanga. The crossing then went to the Mopeia side of the river and was effected by a specially built vehicle ferry that was called the "*Mopeia*". The "*Mopeia*" had ramps on each side of the vessel and was wide decked and shallow draft-ed. She was capable of loading about 80 tons of cargo and could take a number of cars or a truck of up to about 16 tons gross weight.

This route was the site of a tragedy earlier in 1968 when the then ferry overturned in midstream when carrying some 400 Portuguese troops, most of which drowned.

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When it became clear that there would be no further traffic crossing at this point and the safety of the vessel could no longer be assured, the "*Mopeia*" was moved downstream and continued to work as a small coastal vessel for many years, despite being totally unsuited for such work. She filled with water on a number of occasions, but was always pumped out and returned to service. Eventually in 1992 she sank while crossing the bar at Chinde on a voyage between Chinde and Quelimane.

- C. There was a further small ferry crossing that served the road between Luabo and Chinde at Chacuma. This service could also take small vehicles only.
- D. Sena Sugar had a large fleet of barges and tugs. The tugs were of the stern wheel paddle variety, as mentioned in XII.A.4. These had a shallow draft that would have varied from less than 3 ft. loaded down to as little as perhaps 1 foot when light and were capable of towing two 60 ton capacity dumb barges. These barges had a loaded draft of up to about 3 feet. This provided an ideal configuration. As the barge had the deepest draft, it was the more likely to ground. The shallower drafted tug could then let go the tow and pull it off in the opposite direction. Latterly a type of propulsion unit designed for use in shallow waters and known as a "Harbormaster" or "Hydromaster" was introduced and this enabled the dumb barges to be converted to self-propulsion.
- E. Not all of the barges were for the carriage of cargo, and there were a number of irrigation barges, used for spraying irrigation on to sugar cane fields that bordered the Zambezi.
- F. Sena Sugar also possessed a small dumb dredger. However, it seems that this was not used for dredging the river, but was employed around the suction points for the cooling water intakes of the factories at Marromeu and Luabo.
- G. The Dutch owned company, Zambeco, operated the 200-ton bulk molasses barges, the "*Doddy*" and the "*Agnes*". These traded regularly to Malawi via the Chire, as mentioned in Para. XII.B.6.
- H. Most transport up and down the river was undertaken by the Sena Sugar barges, though these were used in priority on their own traffic. However, since much of the lower reaches of the river was owned by Sena Sugar, this covered most of the commercial requirements. The Empresa Fluvial which was a state owned company, managed the "*Mopeia*", while the minor crossings such as the Chinde/Luabo one at Chacuma were privately

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owned.

- I. There were also ferries operating across the Chire on the road between Mutarara and Morrumbala. There was competition between a state run ferry and a privately owned one.

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### Navigation at end 1993:

- XIV. For most of the war, navigation remained open as far as Luabo, though up until 1992 only two vessels ever made the voyage, the Sena Sugar self-propelled barge "84" and the then ACTIONAID seagoing landing craft "*Beatrice Laing*". The latter grounded while off Luabo and it was necessary to open the dam gates at Cahorra Bassa to allow her to depart. She was then attacked with RPGs on the return voyage, so no further trips were made. The grounding was caused by the vessel being directed to a shallow area by the military and is not an indication of the navigability of the river at that point.
- XV. During the latter end of the war and the first period after the signing of the peace accords, navigation started once more as far as Marromeu, but no vessel has yet gone further up the river. The principal vessel to undertake this journey on a regular basis was the "84", once again, though one journey upriver was also made by the seagoing landing craft "*Kestrel*" on a draft of some 2 mtrs.
- XVI. The only other vessel to have remained in operation on the Zambezi until the last couple of years has been the stern paddle wheeler "*Mezingo*". The Gardner engine on this vessel was overhauled by Save the Children Fund three years ago, but little repair work was done on the hull. After springing several leaks, she was beached in early 1993 and is now on chocks awaiting repairs to her hull. The engineering team of Sena Sugar remain perfectly competent to undertake repairs of this nature, and they have plenty of steel plate. However, they do not have the finance for oxygen and acetylene, welding rods or fuel to power the generator.
- XVII. In any case, the "*Mezingo*", when operational, does not have any dumb barges in condition for her to tow.
- XVIII. The dumb barge "32" has had most of its hull repaired. **Mariners** have been endeavouring to help the repair process by paying part of the freight charges for use of the "84" in materials to assist repairs.
- XIX. The self-propelled barge "84" also reached the point of being unsafe for navigation. **Mariners** also arranged the payment of advance freight charges to enable a complete rebuild of the hull to take place, and this barge is now trading regularly and successfully.

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- XX. There are a number of barge hulks on the foreshore in Chinde, and it is worth enumerating them and giving a brief resume of their condition. **Mariners** have more comprehensive survey details on these. In the following context it should be noted that repairable means using the existing structure as a template for the replacement of a great deal of both the hull plating and the frames. Barges are only stated to be repairable if they appear to fall within the competence of the Chinde team to use them to create new barges.
- A. The "*Marruma*" was a further stern wheel paddle vessel. Her condition has deteriorated beyond repair.
  - B. The "*Sabre*" was a self-propelled barge with a stated capacity of 40 tons of cargo and 20 tons of fuel. It may be capable of rebuilding, though it would be a major undertaking.
  - C. Barge No. "60": Not repairable.
  - D. Barge No. "28": Some of this barge could be capable of recycling.
  - E. Barge No. "90": Not repairable.
  - F. Barge No. "32": See Para.XVIII. This barge should undoubtedly be brought back into service. It has a capacity of 60 tons.
  - G. General cargo barge No. "447": Not repairable.
  - H. Fuel barge No. "879": This barge appears to be in reasonable condition and may be capable of repair. Bottom plates require replacing in 8MM plate, but frames and deck plates appear serviceable. All new pumping arrangements would need to be supplied, as would "Hydromaster" engine units. The capacity is 120 tons.
  - I. Barge No. "86": Repairs to the hull plating could be effected quite easily to this barge and its return to service is a clear possibility.
  - J. The "*Doddy*" and the "*Agnes*" (see Para XIII.G) are lying on the shore in Chinde. They are beyond repair.
  - K. There are other barges in Chinde, Luabo and Marromeu. Some of these have been sold on to private owners. None are in obviously repairable condition.

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- L. There are plans to reopen a ferry crossing at Caia using Uniflote barge units. The plans for this are already known to USAID.
- M. Further ferry crossings using the same type of equipment are planned for the Chire in due course.
- N. The cutter suction dredger mentioned in Para.XIII.F is relatively new and its hull is in good condition. The cutter equipment is also still in place but would need stripping for examination. The hydraulic engine and the main pump engine would need to be replaced. This unit is not self-propelled.

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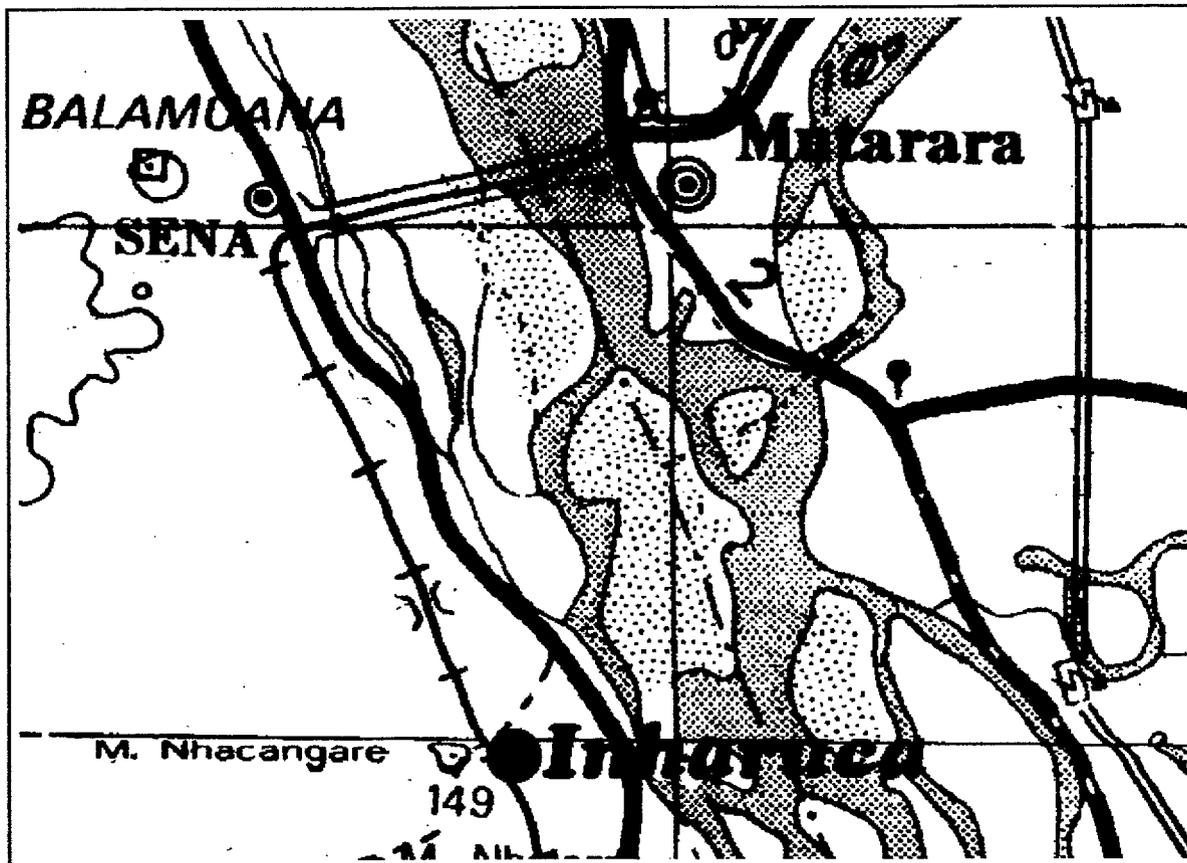
### Survey of river depths:

- XXI. The purpose of this survey was not to provide a comprehensive survey of the river, but was to descend the river to obtain a clear picture of the feasibility of opening navigation beyond the existing limits.
- XXII. **Mariners'** staff member Sr Chico Sampayo was in charge of the work. He was accompanied by members of the Marinha Provincial and the Capitania of Tete.
- XXIII. There were many complications in undertaking the descent of the river, mainly as a result of transport difficulties for the equipment. However, although it was of concern that the coming of the rainy season would cause river levels to rise, thereby providing less useful information, the delay in starting seems to have meant that the descent was made at the period just prior to the rains when the river seemed to be at its very lowest point.
- XXIV. For ease of understanding, the work was carried out on the basis of measurements from a dry season datum level that would normally be the lowest river level at the driest period of the year. Without a study of river levels over a number of years, it is not possible to verify this datum level with precision, and the information must be based on subjective analysis and local knowledge.
- XXV. The descent was undertaken in a 14ft. Zodiac, using sounding poles to obtain depths.
- XXVI. The river level when starting was deemed to be too low to permit navigation of the Zodiac all the way from Tete. Instead, it was decided to transport the Zodiac by road to Mutarara.
- XXVII. On the return passage the river level had risen under the influence of the coming rains and the passage was made almost as far as the gorge between Nhacolo and Tete. At this time the depth was between 1.5 and 4 mtrs. Height of the water above dry season datum level was however, already being exceeded and there is no accurate way of judging by how much.
- XXVIII. The following are the details of the soundings obtained:

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## A. Mutarara to Inharuca

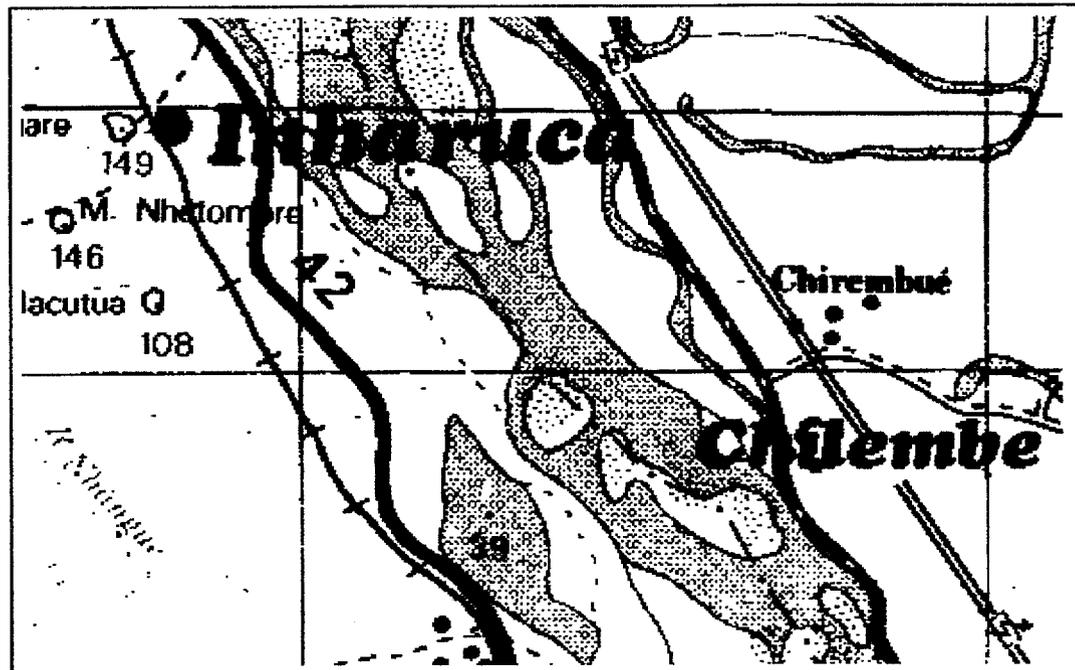


Depth of water in the main channel between these two locations varies between 1.5 and 4 metres. The deeper water is on the NE bank, due to the influence of the Rio Ziu Ziu which enters the Zambezi to the south of Mutarara after rains. This river appears to receive some water from the Chire when that river is high. Crossing to the Inharuca bank is made difficult by the presence of a large island which is difficult to navigate around.

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### B. Inharuca to Chilembe:

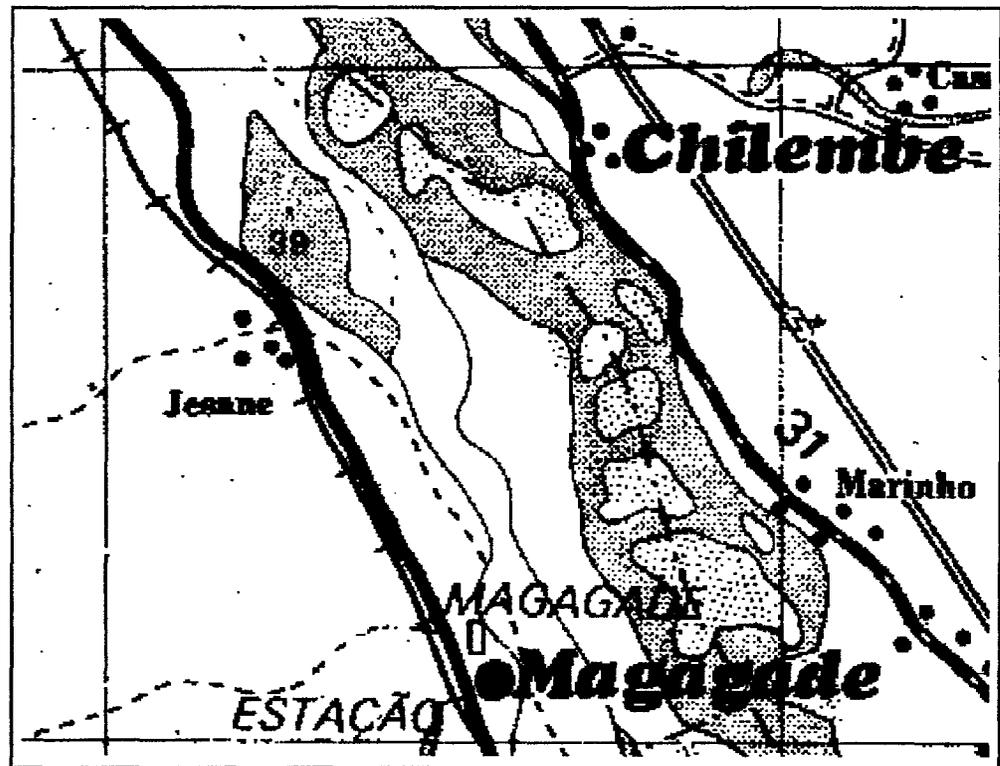


Depths between 1.5 mtrs. and 3 mtrs. The principal channel on this stretch of the river is on the SW bank. This region is almost completely uninhabited.

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### C. Chilembe to Magagade:



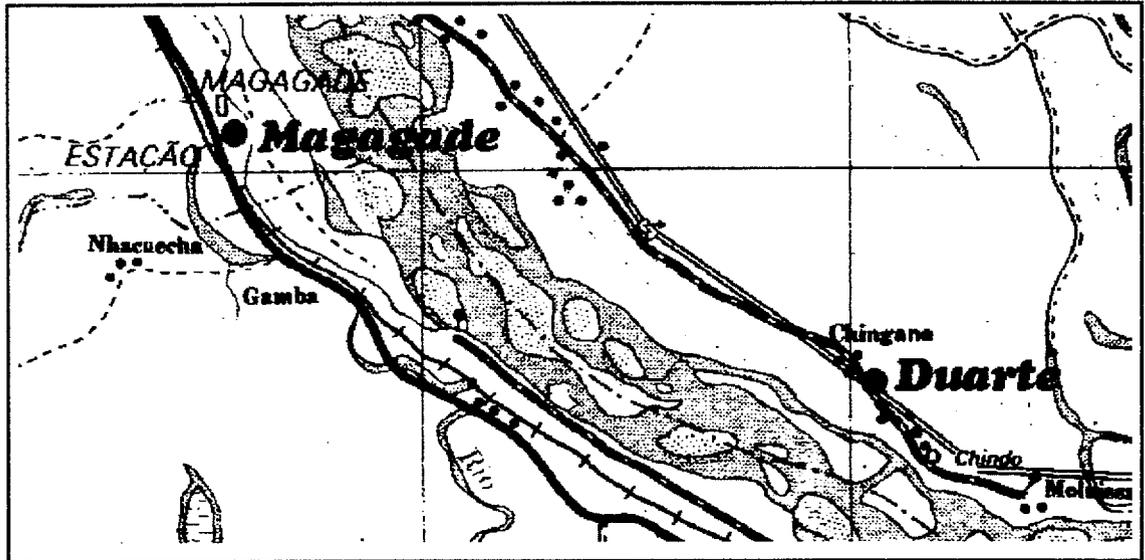
Depths between Chilembe and Magagade fall to between 1mtr. and 3 mtrs, with the channel running parallel to the Magagade shore.

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### D. Magagade to Duarte:

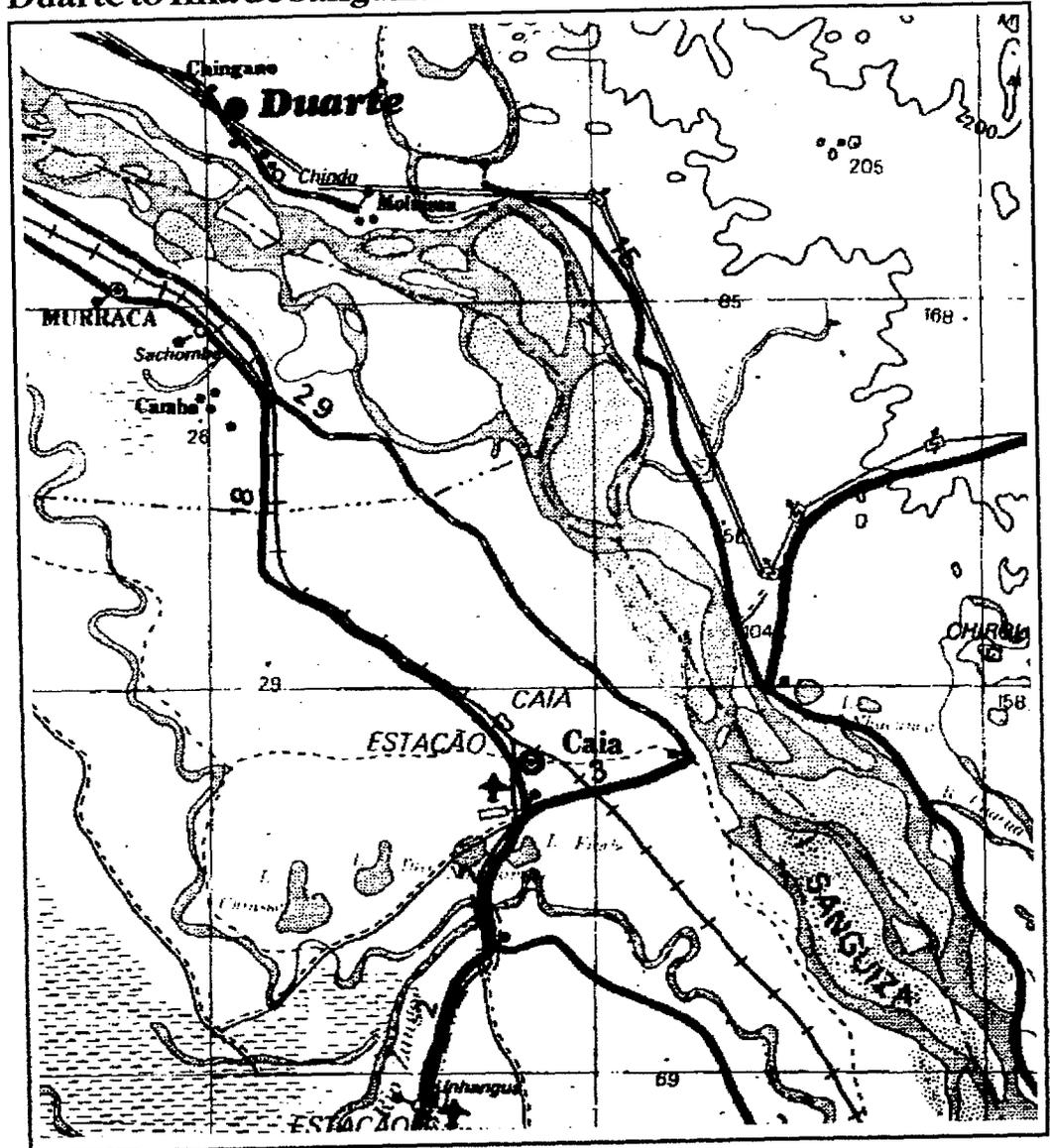


Depths in this area increase to between 6 and 8 mtrs. It is possible that the increase in depth is caused by a backing up effect of the confluence with the Rio Chire.

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### E. Duarte to Ilha de Sanguiza:

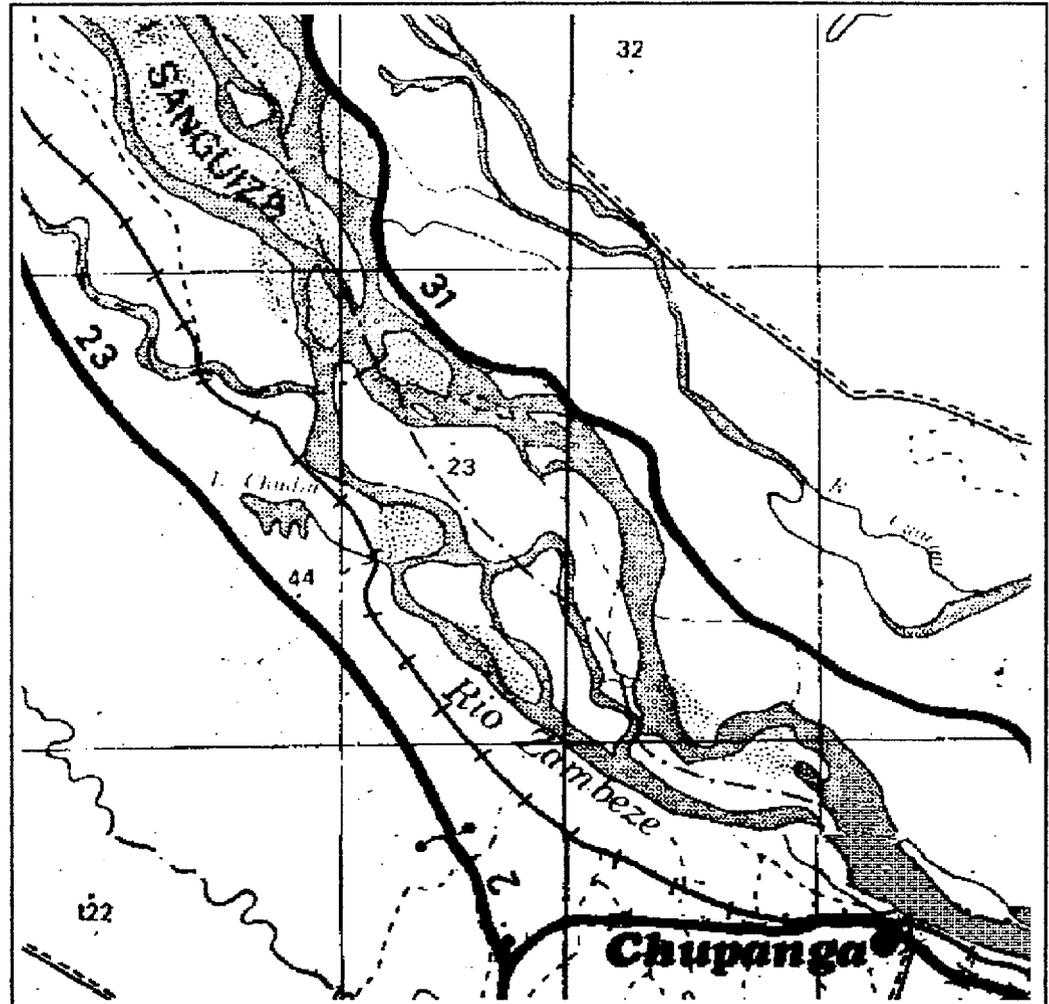


The deep water caused by the confluence of the Chire of between 6 and 8 metres continues to a place called Chinuara, from whence it shallows to a depth of 3 metres, with the channel mainly on the NE bank of the river.

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### F. Ilha de Sanguiza to Chupanga:



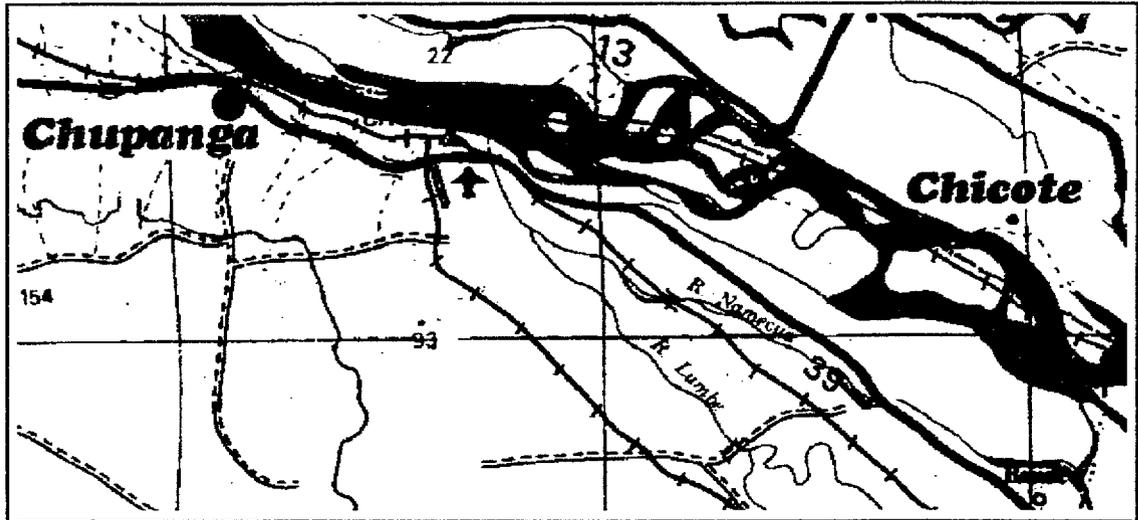
This is another deeper section with depths varying between 5 and 8 Metres. The 8 metre part is by Chupanga itself and was the site of the earlier ferry service. (See Para. XIII B.)

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### G. Chupanga to Chicote:



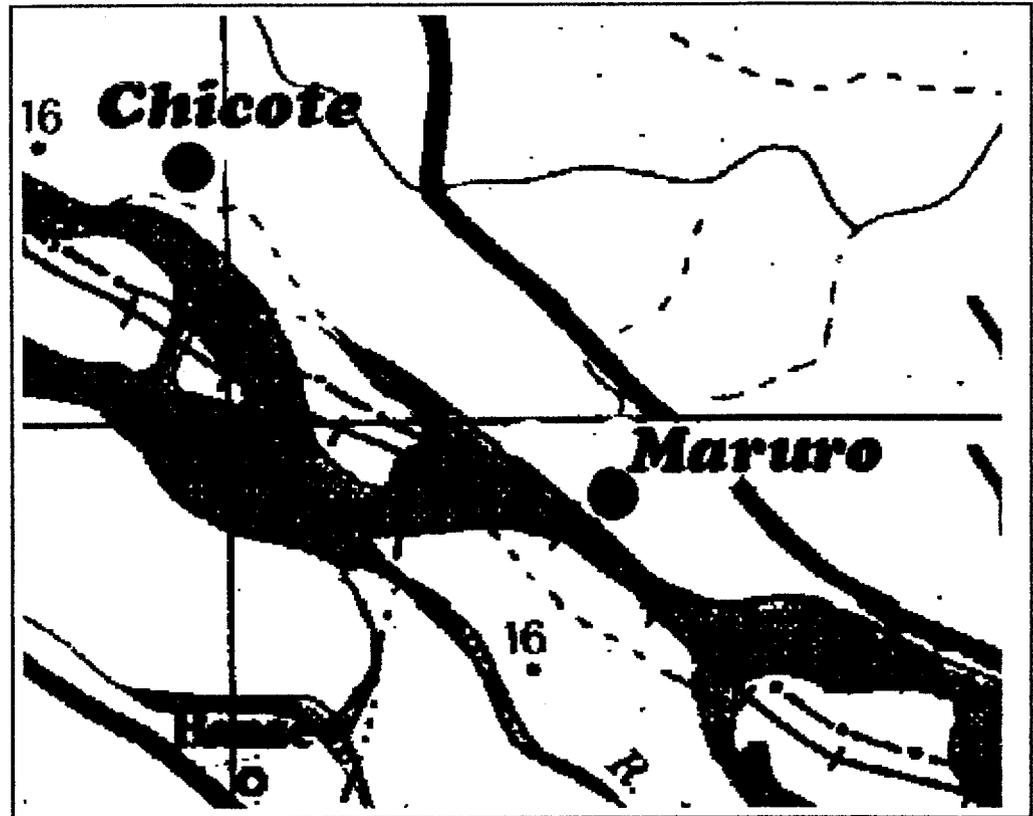
This remains a deep area in general, with depths of up to 7 mtrs. However, some shallower zones with as little as 1 metre were also found.

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### II. Chicote to Maruro:



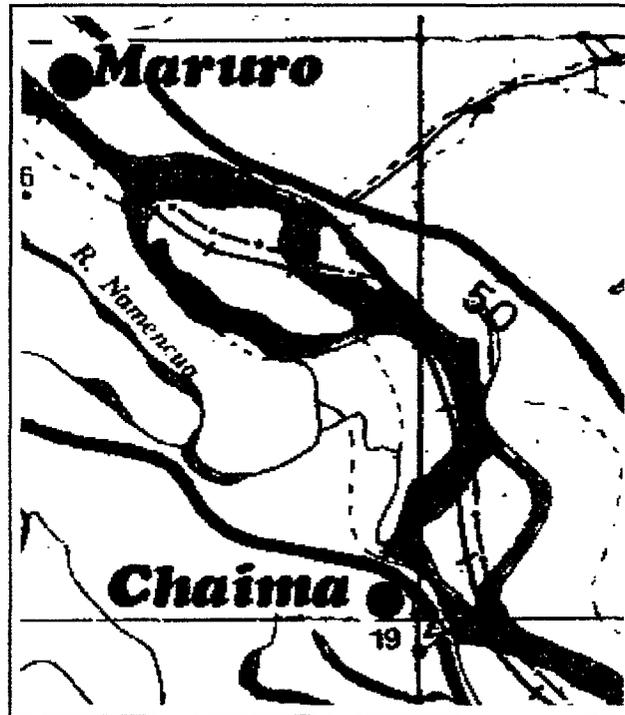
The main channel is on the NE bank of the river and is narrow and normally deep - up to 7 metres once more, but with short shallower sections down to 1 metre.

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### I. Maruro to Chaima:

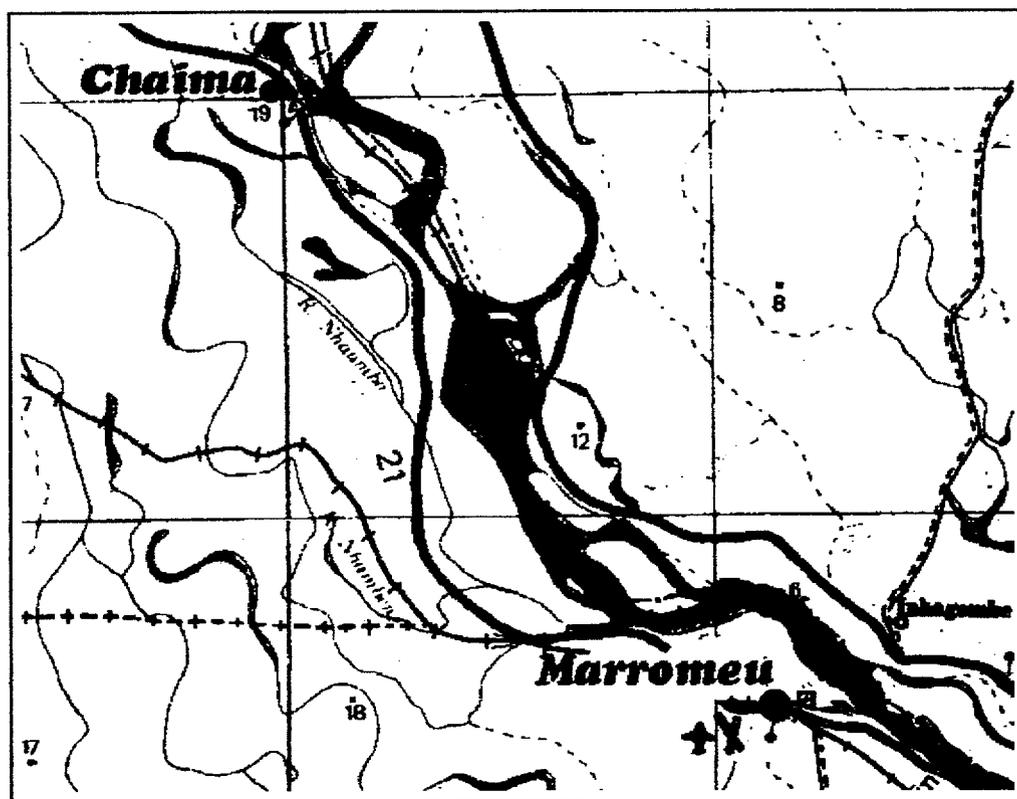


The main channel remains narrow, but deep, still on the NE side of the river. Depths vary between 2.5 and 5.5 mtrs.

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### J. Caimo to Marromeu:



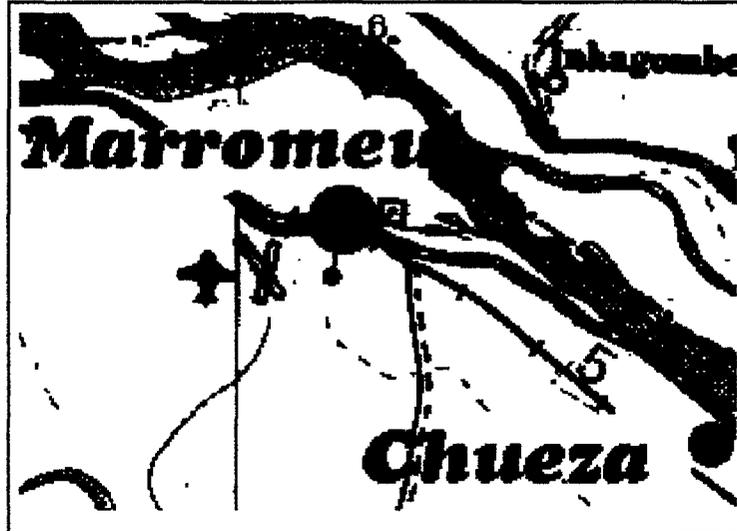
Depths between 1 mtr. and 6 metres. The channel is wider in this zone.

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### K. Marromeu to Chueza:



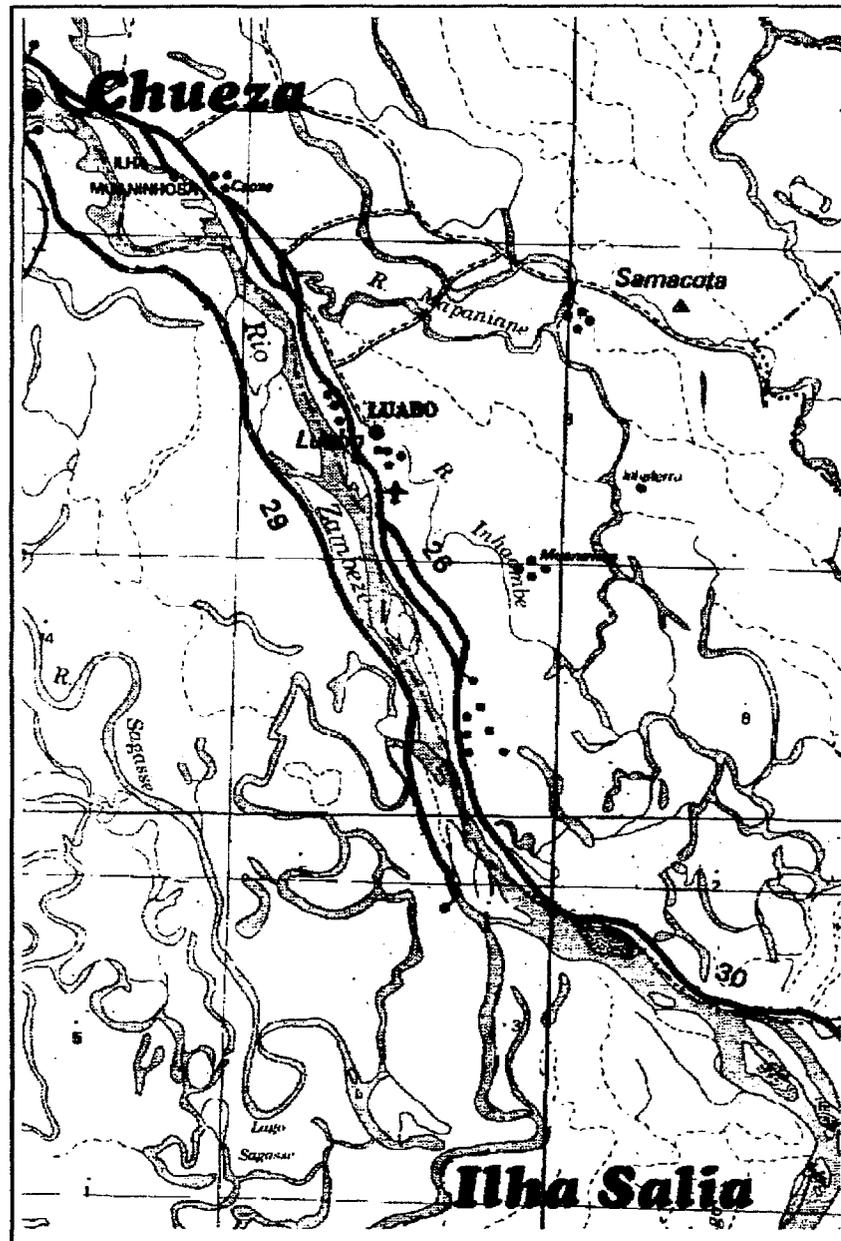
- L. In the short distance between Marromeu and Chueza the depth is mainly between 5 and 5.5 mtrs. However, there is one area where depths only reach 1 mtr. This shallower patch is a limiting factor because it prevents barges from reaching Marromeu during the dry season. Instead, discharge is effected at Chueza and merchandise for Marromeu is taken by tractor from this point.

There is a considerable traffic across the river at Chueza with people crossing by canoe to reach machambas on the far side. Often there are insufficient canoes to carry everybody. Price for the crossing is 200 MTS.

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### M. Chueza to Ilha Salia:



From Chueza to the coast the river is navigated regularly by 60 ton capacity barge at all times of the year and regardless of the river level. This indicates that there is a minimum depth of 1.5 metres, and in most places the depth will be considerably greater. There is, however, a patch just to the south of Luabo where there is a minimum depth of only a little over 1.5 metres when the river is at its lowest.



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The Rio Micelo, on the other hand, seems to be a much deeper channel and has at times been navigable as far as the main Zambezi. H.M.S. "Mosquito" succeeded in navigating through to the Zambezi, albeit with a great deal of difficulty. It is interesting to note that it was by this channel that the explorer David Livingstone first entered the river. However, the islands at the delta mouth are largely uninhabited other than for a few fishing families. Ilha Salia is the first zone to have any substantial habitation.



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### Conclusions:

XXIX. General conclusions can be reached from the information that has been obtained:

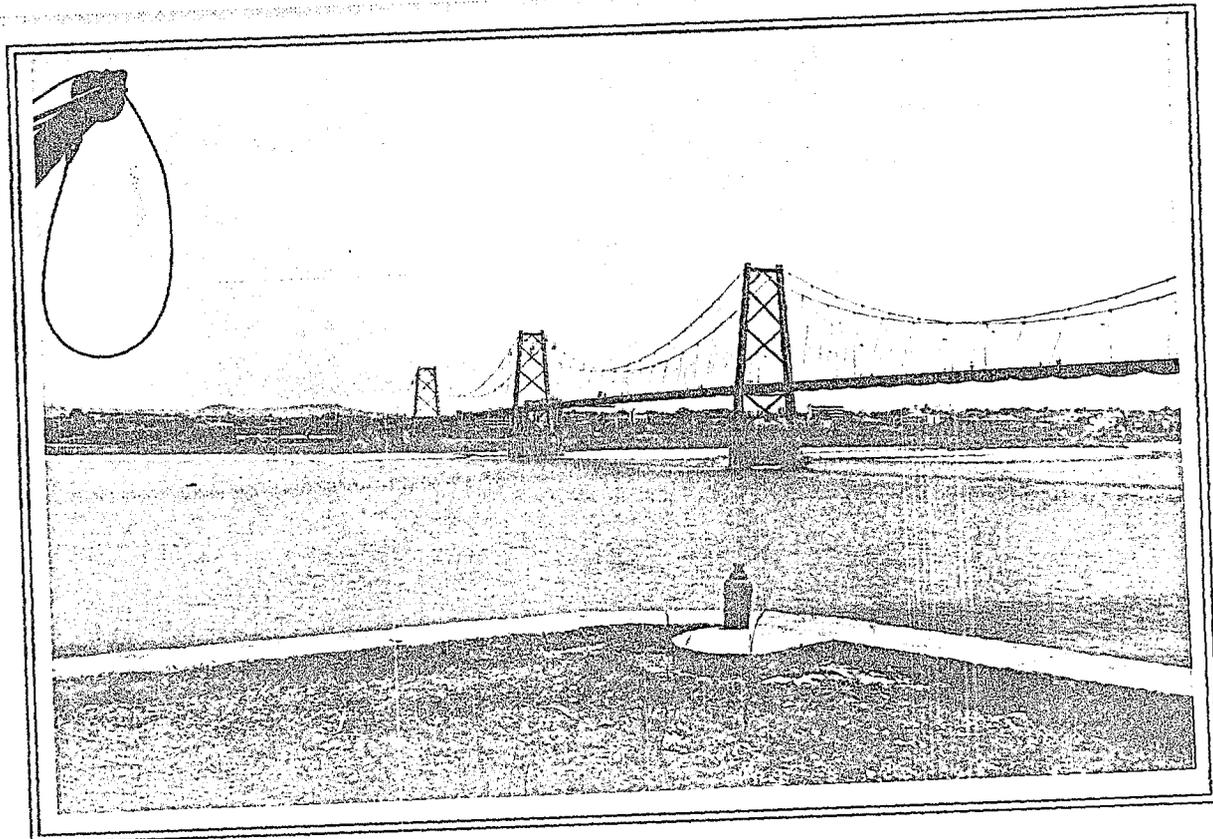
- A. The Zambezi is not capable of navigation throughout the year by vessels with substantial load carrying capacity. (In this context we could usefully say that substantial load carrying capacity would be of the order of 20 tons.)
- B. However, there does not appear to have been any substantial change in the general nature of the river during its period without navigation. It remains constantly changing, but apparently the general parameters within which it alters do not seem to have changed noticeably.
- C. The maximum draught that would permit operation at all times of the year must be considered to be in the order of 30cms.
- D. Nonetheless, areas where passage of vessels is difficult would clearly benefit from dredging, after which it is reasonable to assume that the regular passage of barges would tend to keep those areas open, at least for some while.
- E. It seems likely that the areas where passage becomes difficult would tend to change over a period of time. In other words, opening a passage by dredging in one place would not be a guarantee that passage may not close down later somewhere else.
- F. The comments above apply to navigation when the river is at its lowest. Clearly, the situation would improve rapidly during periods when the river was higher. It would seem highly probable that passage could be made by vessels with a substantial load carrying capacity for at least half the year, and possible more.
- G. If navigation is to be reopened on the Zambezi above Marromeu, it would seem desirable for there to be some form of dredging equipment available on the river. There are two possible cheap options available:
  - 1. *Overhaul and re-equip the cutter-suction dredger that is in Chinde.*
  - 2. *Fit out a Uniflote barge unit with high pressure jet.*

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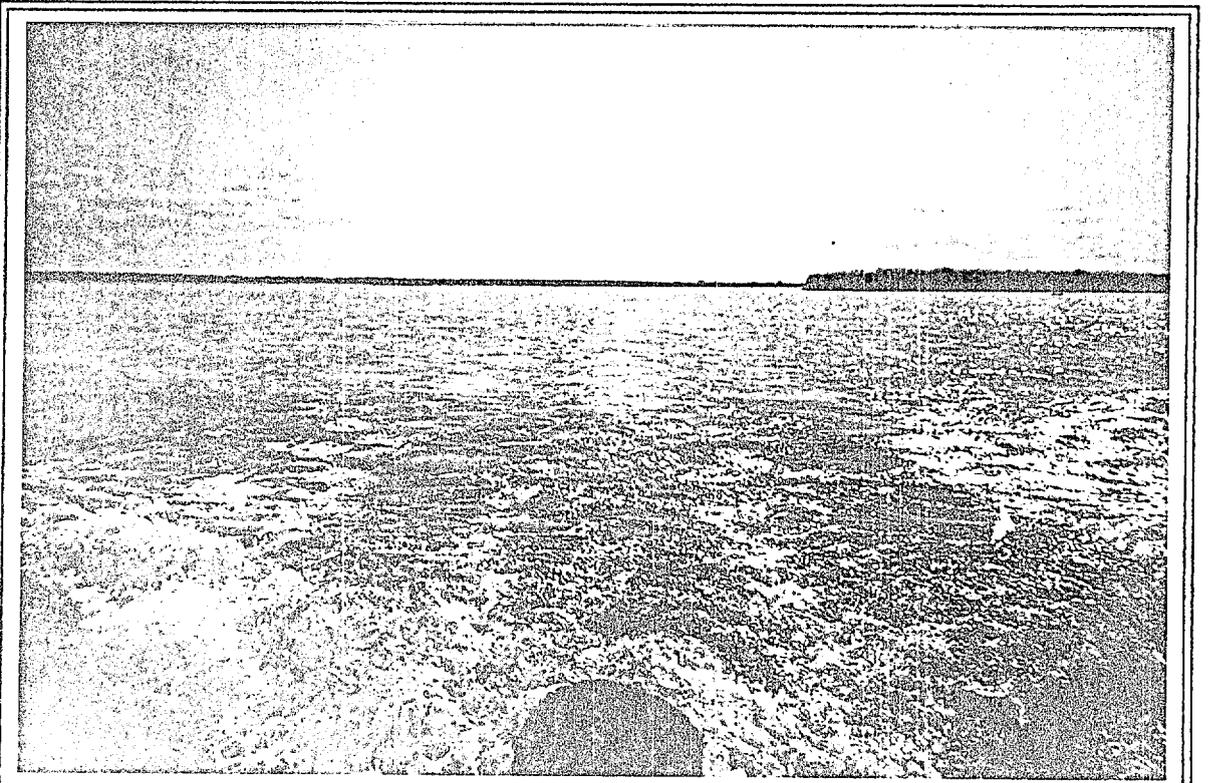
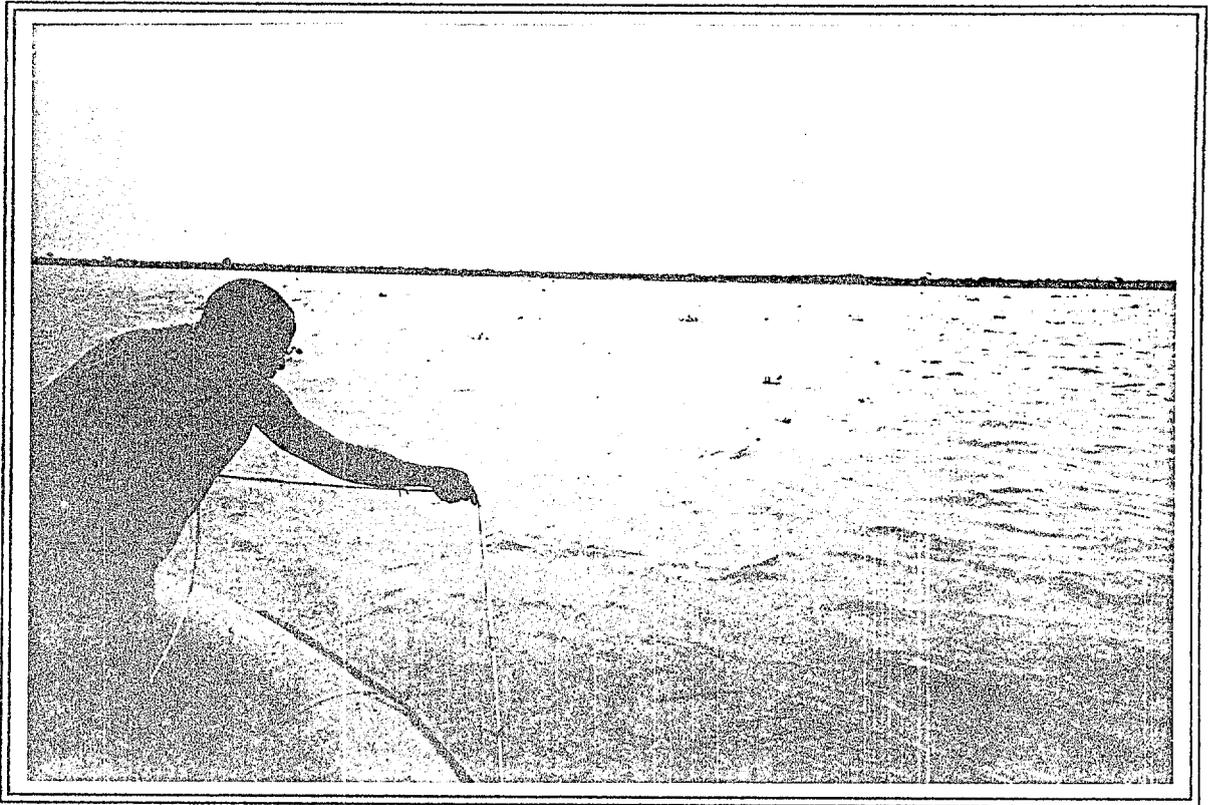
- H. There are so many changeable factors that a definitive view as to the viability of large-scale navigation is virtually impossible to obtain:
1. *Datum level varies from year to year.*
  2. *River depths depend not only on rain in Mozambique, but also on rainfall in Zimbabwe, Zambia and Malawi.*
  3. *The opening of Cahorra Bassa dam has a greater effect on river flow than does rainfall.*
  4. *The long term effectiveness of dredging is uncertain.*
- I. Comparison with advice to navigators from before the war shows that the uncertainty factor remains much the same as before. By further comparison this should mean that navigation can take place for much of the year, but will be restricted during dry spells, as was previously the case.
- J. It seems to come down to a question of the need, the will and the financial incentive to operate river transport. If these factors are present in sufficient quantity, then a determined operator will make a river transport system work on the Zambezi.



*Top. Bridge at Tete. Water Low! Bottom. Zambezi river 4km SW Tete.  
Date: 12/10/93*

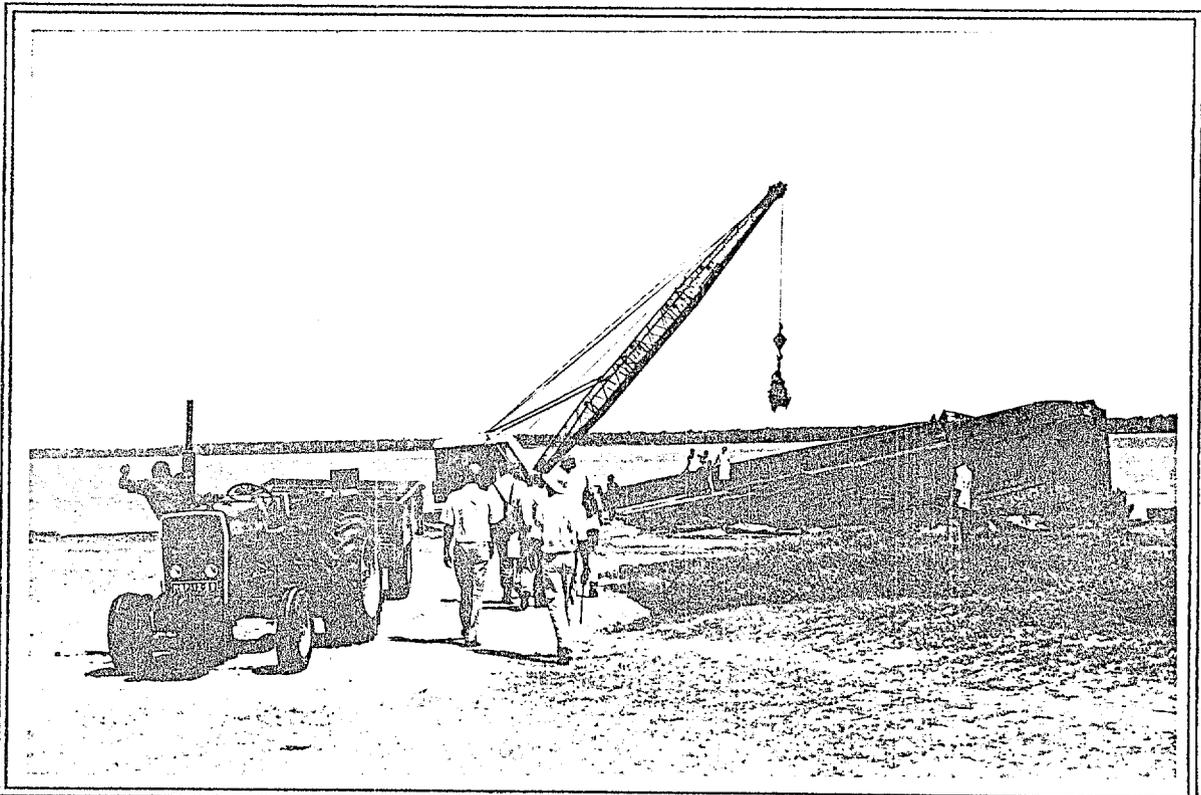


*Top & Bottom.* Bridge at Sena. View from Sena side  
Date: 12/10/93



*Top & Bottom.* Taken 1km South of where the river Chire joins the Zambezi  
Date: 12/10/93

PHOTOGRAPHS OF ACTIVITIES IN MOZAMBIQUE



*Top.* Chinde ship wreck. Zambezi joining the Indian Ocean.  
& *Bottom.* Sunken ship used to discharge and load vessels. Date: 12/10/93