Chapter 23

POSSIBILITY OF HELICOPTER USE IN SOUNDING SURVEY FOR HYDROGRAPHIC PLANS OF MOUTHS NAUTICALLY UNKNOWN

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SYNOPSIS

Reference is made to the method that it was necessary to resort to for the first complete hydrographic survey of the Cuama mouth on the Zambezi delta, where the plans for the economic development of the Zambezi Valley foresee the need for the establishment of a fluvio-maritime harbour.

This corresponds to the execution of sounding by means of a direct intersection method (shore controlled survey), using heli - copters for the transportation of the echo sounder.

The operational techniques for sounding with helicopters and localization of the points sounded are described, indicating also the equipment and personnel required for such operations.

The results obtained through two hydrographic surveys carried out in 1962 and 1963 are indicated and analysed, examining the technical worth of the method, its efficiency, costs and safety, as compared to the classical sounding methods.

Further, reference is made to the possibilities for improvement offered by the method being described and to the circumstances under which it has been applied, taking into consideration the results obtained during the trial sounding operation.

1. FOREWORD

The Mission for the Development and Settlement of the Zambezi is a technical organization set up by the Portuguese Government to carry out the survey and inventory of the resources to be found in the Zambezi Valley, Mozambique, with a view to the establishment of a program of development for a region of approximately 200,000 squar kilometers.

In view of the necessity to have these studies completed within the shortest possible period this Mission was formed by a series of experts in various fields which in turn were grouped into teams , and provided with the adequate working aids allowing them to attain the Mission's objectives.

Among such working aids, stand out the private fleets of motor vehicles and aircraft (aeroplanes and helicopters) and the necessary workshops for their maintenance.

These teams of experts cover topography, agronomy and forestry, geology and mining prospection, social and economic studies, and hydraulic engineering.

From the latter a working group was detached to the delta zone of the Zambezi river in order to study its fluvio-maritime reach.

1.1 OBJECTIVES OF THE STUDY OF THE FLUVIO-MARITIME REACH OF THE ZAMBEZI RIVER

The planning of the development of the region led to the study of the establishment of a system of transportation for the products which will result from the activities of extraction and transformation, sufficiently economical to make them competitive on the various markets.

The importance of this particular aspect of the studies initiated under the infrastructure plans can be clearly seen, for the majority of those goods will consist of ores or products from their primary transformation which will, as estimated, surpass 3,000,000 metri

tons per year.

As the Zambezi River, owing to its geographical position on the axis of the region to be developed, is the natural outlet for its products, a system of fluvial navigation together with maritime navigation of long and short range, with a harbour at its mouth, was considered under the preliminary plans.

The main purpose of the study of the fluvio-maritime reach consists therefore in the building of an inner harbour on one of the arms of the delta, as near as possible to the sea, accessible to seagoing vessels and not only to coastal navigation as is the case up to now and this under precarious conditions.

1.2 - MAIN STUDIES COMPLETED AND IN COURSE

The Zambezi delta covers approximately 60 km of the coast of Mozambique and includes 7 mouths, of which only three - Pambane, Chinde and Cuama - appear to offer conditions for navigation. The remainder are connected to interior canals with pronounced and progressive silting up and highly developed outer shoals.

The Pambane mouth offers conditions for small draught vessels but its interior canal is excessively narrow, rather shallow , and with no connection into the Zambezi.

The Chinde mouth is still open to coastal navigation but has insufficient depth.

The mouth is unstable, subject to litoral drift and connected to the Zambezi by the Chinde arm, which is very narrow and sinous.

The Cuama mouth is not presently accessible to navigation but historical references show that for a long time it was utilized by all types of vessels. However, even today it appears to be the mouth most suitable for accommodating seagoing vessels. It is in fact joined to the arm connecting it to the Zambezi by areas of width and depth greater than the former and is situated in a neutral zone of litoral drift.

For these reasons, the Chinde and Cuama mouths, and especially

the latter, have been studied in greater detail.

These studies refer mainly to the collection of topographical data for a better planimetric and altimetric knowledge of the part of the delta above low tide water level, drawing up of hydrographic plans of the submerged part, obtention of hydrometric and tidal data, studies of the characteristics of sea and swell waves, and collection and analysis of sedimentation on the interior arms, mouth shoals and shore line.

Based on this data, as well as on that now being collected, studies on scale models are being carried out at the National Laboratory of Civil Engineering, of the terminal reaches of the Cuama and Chinde branches.

Such studies aim at analysing, particularly as far as Cuama is concerned:

- the behaviour of the harbour regarding capacity for maintaining the depth of the access channel between 7.30 to 8.00 meters, under low water level.
- the best location and conditions of shelter for the harbour installations to be situated in the inner part of the Cuama arm;
- the general lines for gauging the Zambezi at its fluvio-maritime reach up to approximately 55 km to the interior of the Cuama mouth.

1.3 - NEED FOR PERIODICAL HYDROGRAPHIC SURVEYS OF THE CUAMA MOUTH - - SOUNDING USING HELICOPTERS

Whereas various hydrographic information on the Chinde mouth has been available since 1883 for owing to its navigability, it has always been possible to sound it using the classical methods, this does not apply to the Cuama mouth which has for one century been unknown to the navigation, seeing that all attempts to have it surveyed with such methods had been unsuccessful.

Back in 1958, and included under the studies of the Zambezi region the Hydrographic Mission of Mozambique was requested to carry

out a complete hydrographic survey of the Cuama mouth, together with those of the other mouths, but this was not possible at the time.

Until the end of 1961 - and after our repeated requests, justified by the advancement of the studies - it was not possible for that Hydrographic Mission to carry out such a survey.

Faced with an increasing need for a hydrographic survey of the Cuama mouth, entirely unknown to today's navigation and the difficulties entailed by its execution according to the experts, the Mission for the Development and Settlement of the Zambezi, in the beginning of 1962, decided to attempt the use of one of its helicopters for the obtention of hydrographic plans of that mouth.

Although a new survey of the Chinde and Cuama mouths with the classical methods, had been programmed for July 1962 by the Hydrographic Mission, in view of the uncertainty of the success of such methods when applied to the Cuama mouth, the Zambezi Mission decided to attempt the use of the helicopter with the method already tested by that time. This was successfully done in April 1962 and made it possible to provide the Hydrographic Mission with a preliminary sketch of the bottom of the mouth in order to enable them to face their survey of the Cuama, to take place in July, no longer as that of an unknown mouth.

The success that met the sounding operations of the mouth using helicopters was confirmed later by the comparison established with the sounding by the classical method that was at last possible to carry out in the course of that same year. Bearing in mind the need for repeating periodically the survey of that mouth, either in connection with scale model under study, or for the examination of its evolution resulting from the newly-built Kariba Dam and the works planned for the Mozambican reach of the Zambezi, the Mission promoted the improvement of the sounding technique making use of helicopters and the repetition of the hydrographic surveys applying this method.

Thus a new survey was carried out in August 1963 and another is under preparation to take place in July 1964.

The description of the sounding techniques applied by the Zam -

bezi Mission using its helicopters, the analysis of the results obtained, and the presentation of the hydrographic plans that it was possible to draw from such surveys, are the object of this paper.

2. SOUNDING TECHNIQUE USING HELICOPTER

2.1 - EQUIPMENT

Before entering the description of the equipment used, it must be pointed out that the method tested and applied in two successive years was entirely executed using solely the equipment and facilities already owned by the Mission. It was necessarily considered as an experiment and because of this there was the preocupation of avoidin the purchase of new equipment during that experimental stage. On th other hand during the stage when the technique was being improved it was not possible to purchase the new equipment that the experien acquired during earlier operations had shown to be useful.

Reference to such equipment, useful for the development and improvement of the method being presented, will be found in the las chapter of this paper.

The following equipment was used for the sounding with heli - copters: one "Kelvin Hughes MS-21" echo sounder whose power transmission and recording units and accessories are mounted inside the helicopter's cabin. The oscillator for out-board use and weighi about 26 kilos hangs from the helicopter hoist. This oscillator i fitted to a buoy which floats on the water surface and thus maintai it approximately 1 ft underwater.

The two pictures of Fig 1 show how the two first mentioned ha been installed inside the helicopter cabin, near the seat of the sounder operator (1a) and the oscillator enveloped by its buoy and hanging from the hoisting cable at the moment it touches the water (1b).

1a.- Recording and power transmission units inside the helicopter's cabin.

1b.- Buoy and oscillator in contact with the water, hanging from the hoist cable.

Fig. 1

Three Wild T-1 theodolites and three S.M.D. high frequency(H. F.) radio-telephones with fixed crystals, set up at three coordinate shore stations.

One A.Ott tide recorder and hydrometric scale mounted on the shore.

Signal buoys scattered over the zone to be sounded and consisting of drums with flags.

One Agusta-Bell 47J helicopter with the following main characteristics of interest for the sounding work:

- Using the hoisting kit and the pneumatic float tubes that permit landing on beaches and alighting on the water surface provided the sea is calm, and taking into consideration the weight of both pilot and fuel, there are about 260 kilos left for the sounder operator and sounding equipment;
- Cruising speed, at sea level, of approximately 135 km/ /hr carrying maximum weight;
- Possibility of installing very high frequency (V.H.F.) radio communications;
- Autonomy of 1:30 hr to 1:55 hr under sounding conditions;
- Stationary flight in ground effect, hovering at 6 m to 8 m from the water surface.

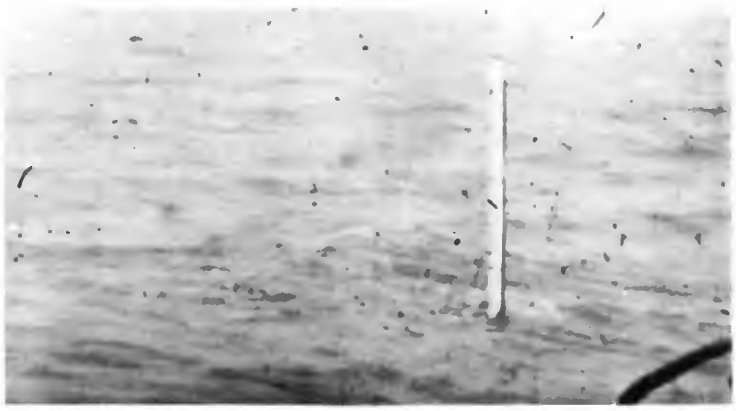
Fig 2 shows a hydrometric scale for recording tide levels (2a) and one of the shore stations where a theodolite and a radio unit and operator are installed (2b).

Fig 3 illustrates the hoisting kit and hanging cable in the helicopter cabin (picture 3a) as well as the helicopter while in flight and lowering the oscillator into the water for the sounding of one point (picture 3b).

2.2 - OPERATING STAFF

The operating staff engaged in the various surveys underwent certain variations but in general it was formed by:

One pilot and one helicopter mechanic, the latter being in



2a.- Hydrometric scale.

2b.- Shore station with theodolite, radio-communications, and its personnel.

Fig. 2

3a.- Pilot and sounder operator while in action inside the helicopter - Hoist and cable.

3b.- Helicopter in flight, showing the oscillator unit hanging from the cable.

Fig. 3

dispensable for the refueling and maintenance of the aircraft, but also acting as radio operator at the shore station. The pilot always cooperates in the planning of the lines to be sounded and, besides flying the helicopter,he operates the hoist and performs the lifting and lowering movements of the oscillator hanging cable.

One sounder operator, normally the technician that plans the sounding lines and whose duties also include the lowering or lifting of the electric cable of the sounder following the movements of the hanging cable activated by the hoist. He controls the whole sounding operation and does the recording of the sounding times and number of points.

Fig 3 and picture 3a show the pilot and the sounder operator in action in the helicopter cabin.

Three surveyors, who must be highly experienced as for each sounding line they have to keep a constant watch, through the theodolite, on the oscillator hanging cable, and about every 35 seconds take readings of the azimuthal angle recording same on the field log. They must also do the plotting of the sounded points at the end of each day's field work.

Fig 2 and picture 2a show a shore station-the one controlling the other two shore stations - where the surveyor instructs the radio operator to transmit to the other surveyors the signal indicating the reading of the azimuthal angle at the moment when the oscillator , lowered from the helicopter, touches the water surface for the sounding of one point.

Finally, and apart from a few workmen, there are the tide recorder and hydrometric scale operator.

2.3 - METHOD OF OPERATION

2.3.1 - Sounding technique

Sounding is carried out point by point, following lines parallel to the wind direction and in a sense contrary to the action of the wind. The distance between the points of each line as well as

between lines is of around 100 meters. However, this distance may be increased for zones of lesser interest and decreased in areas calling for more detailed sounding.

For the sounding of each point the helicopter is kept hovering in ground effect, at about 6 meters from the water level, with the oscillator lowered so as to reach that level, during a period of time long enough for the sounder to record the trough of a wave and the crest of the next one.

At the beginning of each series of lines - their number being conditioned by the autonomy of the aircraft - the oscillator is lowered to a convenient level and remains hanging from the cable (diameter 3/8") activated by the hoist till the end of the line immed_ately preceding the refueling of the helicopter is reached.The pilo operates the hoist as its electrio switch is coupled to the cyclic stick of the helicopter, this controlling the position changes of the angle of the surface determined by the rotation of the main roto blades of the helicopter.

This technique of operation, owing to the outline of the cours followed by the osoillator, might be aptly designated as frog's lea sounding.

Fig 4 shows schematically the technique of operation describe in this and the following paragraphs.

Sounding is carried out following lines parallel to the win direction and in the sense contrary to its action, for two reasons:

- one, to avoid that the wind will throw the helicopter off its course when carrying out the sounding of a line in a certain direction, with the resulting alterations to the sounding plans;
- the other, the fact that sounding is made point by poin and with the helicopter hovering in ground effect, which is onl possible under those conditions.

Sounding is carried out point by point for previous tests ha demonstrated that it is not possible to operate the helicopter continuous horizontal flight when carrying an oscillator of the weight and surface of contact characteristic of the one suppli

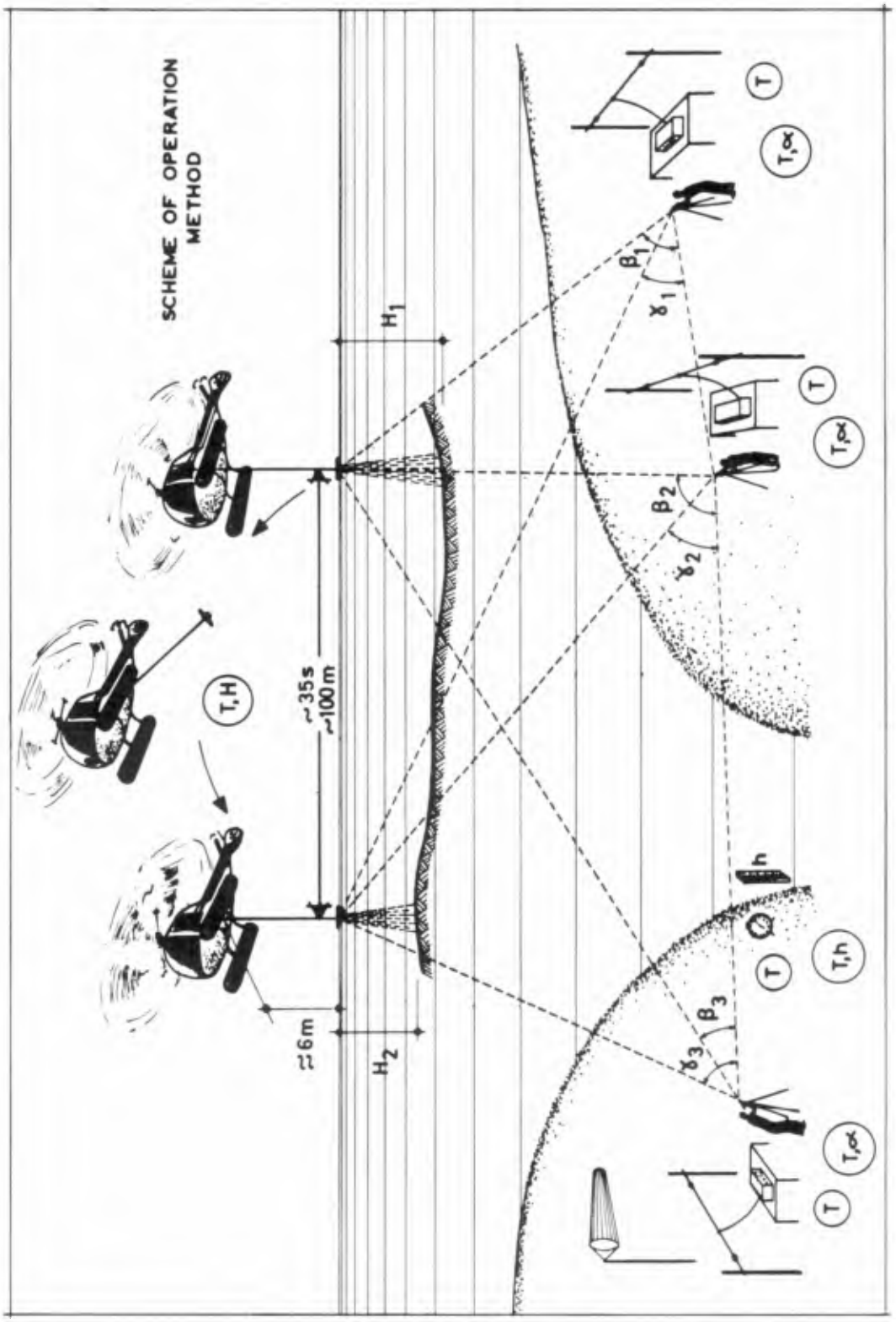

SCHEME OF OPERATION METHOD
T,H
~35s
~100m
≈6m
H1
H2
β1
γ1
β2
γ2
β3
γ3
T
T,α
T,h
h

Fig. 4

with the echo sounder used.

The sounding of each point was carried out with the helicopte hovering at about 6.00 meters above the water level owing to th following:

- firstly, because on account of the equipment used, th work is done just inside the weight limitations for this type c aircraft, and it becomes imperative to benefit from the additional thrust obtained through hovering in ground effect; this groun effect may only be felt up to 8.00 meters above the water surface this at sea level and under the conditions locally prevalent;

- secondly, because the operations were also conditione by the length of the electric cable supplied with the sounder fc connecting the oscillator to the power transmission and recordir units;it would have been necessary to alter its cross section befo replacing it by a longer cable, as by merely increasing the lengt of the existing electric cable the recording of the soundings woul not take place in the recording unit, and it was impossible to ob locally the required electric cable of adequate characteristics.

2.3.2 - Localization of the points sounded

The planimetric location of the points sounded is carried o following the method of direct intersections (shore controlled survey), based on three shore stations set up at coordinate poin on the coast.

In each of these three stations an equal number of surveyo (anglemen) observe, by means of their theodolites, the oscillato hanging cable and all of them read simultaneously the azimuthal angles whilst the oscillator is underwater for the sounding of ea point.

The exact moment for the position reading of the cable (simultaneous) is determined by the surveyor at one of the thre shore stations - the one selected as controlling station - and transmitted by him to the radio operator working by his side whc

in turn immediately instructs the other surveyors, so as to ensure that the reading is taken simultaneously by all three of them.

Fig 2 is a picture of this controlling shore station taken at the moment the surveyor was signalling the radio operator.

The shore stations were set up in accordance with the shape of the shoreline and the layout of the area to be sounded as related to it, for the simultaneous use of three stations as already indicated.

For the case under description a total of only 5 shore stations has been necessary.

Two shore stations for simultaneous observation might be considered sufficient for a reasonable accuracy, but in order to ensure the maximum possible exactitude for the determination of the planimetric location of each point of this sounding survey , three stations were used guaranteeing:

- higher probability of at least two stations recording intersection angles of more than 30 degrees;
- the possibility of checking each point in case of the reading eventually becoming unfeasible at one of the stations , either due to the interposition of any object, operator or radio failure, or to any other reason.

The location of the reading angles is schematically presented under Fig 4.

2.3.3 - Recording and Plotting

The following information is recorded in the course of the sounding and localization operations:

The sounder operator aboard the helicopter inscribes on the sounder graphical records the serial number of each point and its time of execution.

At the reading stations ashore, the surveyors log down the azimuthal angles of each point, their serial numbers and time of execution. The starting angle is previously determined at each

station by the observation of a reference mark (which as a rule is located at the other stations). This starting angle will always be maintained whenever operating at that station, thus enabling each station to determine one scale only, for use when plotting the points sounded.

The water levels are recorded at the hydrometric station at the given time intervals.

The plotting of the points sounded, at the 1:10,000 scale, is made daily, after the sounding work. Once the planimetric location of each point has been determined, the recorded depth is immediately referred to the hydrographic zero adopted, based on the tidal records available.

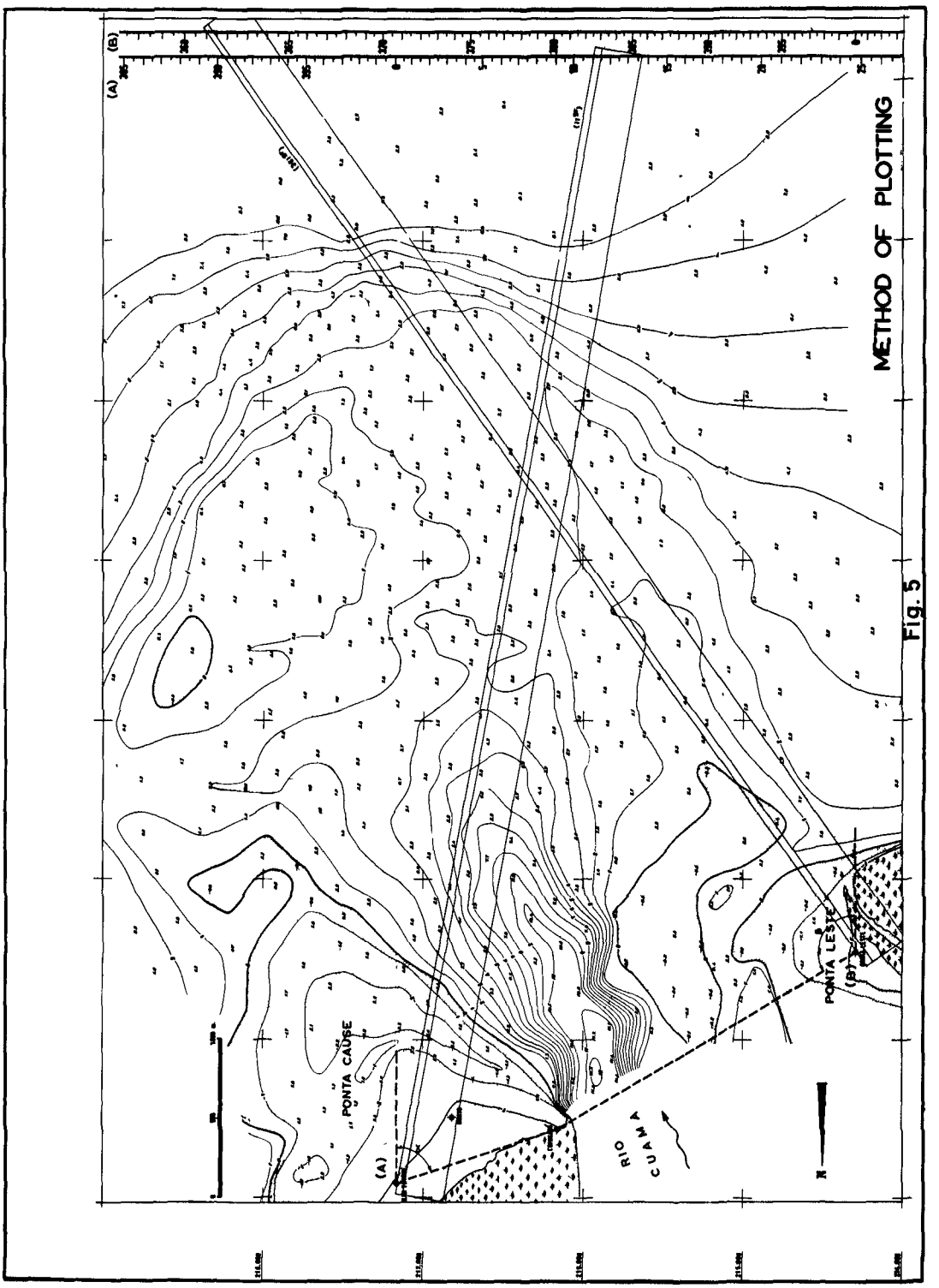
Fig 5 gives an example of the plotting method, representing only two shore stations in order not to crowd the drawing.

Plotting scales are established for each shore station and marked with the tangents of the angles susceptible of representation in the area to be sounded by each particular station. Once the reading angles of each point are made known the scales obtained with the values of the corresponding tangents, come next, and by setting the rulers the position of a point is then determined.

By using this plotting system, based on the definition of a sole starting angle for each station and placing on the original drawing the scales established at convenient distances from the plotting position of the corresponding stations, it was attempted to make the best possible use of the exactitude allowed by the readings originated at the fixed stations and using theodolites thus giving the plotting the corresponding highest possible degree of accuracy as well.

2.3.4 - Planning the sounding survey

The lines and series of points to be sounded are planned before the start of the field operations. This planning takes place at the work site itself, taking the predominant wind into consideration.


METHOD OF PLOTTING
Fig. 5
PONTA CAUBE
RIO CUAMA
PONTA LESTE
(A)
(B)

Because of these conditions the sounding plan is revised every day, and the fact that the plotting of the points sounded is also done daily makes it possible to correct eventual deviations on the course of the lines and give better coverage to zones that owing to such deviations, or offering greater interest, would require a larger number of sounding points.

During the hydrographic survey carried out in 1963, buoys consisting of drums with flags were used and placed on the zone to be sounded to serve as reference points of the course of the lines for the staff operating aboard the helicopter. It was not always possible to establish such reference points by means of signal lines on the shore, seeing that the work had to be carried out in accordance with the direction and sense of the wind.

This measure has greatly contributed to reducing the operating time and to a better distribution of the points as compared to the hydrographic survey effected in 1962, as indicated under the heading "Results".

2.4 - RESULTS

The first hydrographic survey of the Cuama mouth was carried out in April 1962 using the method under description and took 12 field working days sounding an area of approximately 30 square kilometers and recording around 1,200 points.

The second hydrographic survey took place in August 1963, with improved operation techniques, making it possible to reduce the working time to 6 days for the sounding of the same area, and just about the same number of sounding points were registered.

On the average, to the two hydrographic surveys already effected correspond around 40 sounding points per square kilometer.

Fig 6 and 7 represent, in reduced scale, the above mentioned hydrographic plans with 1-meter equidistant depth contours but it should be pointed out that the final drawing does not show all the

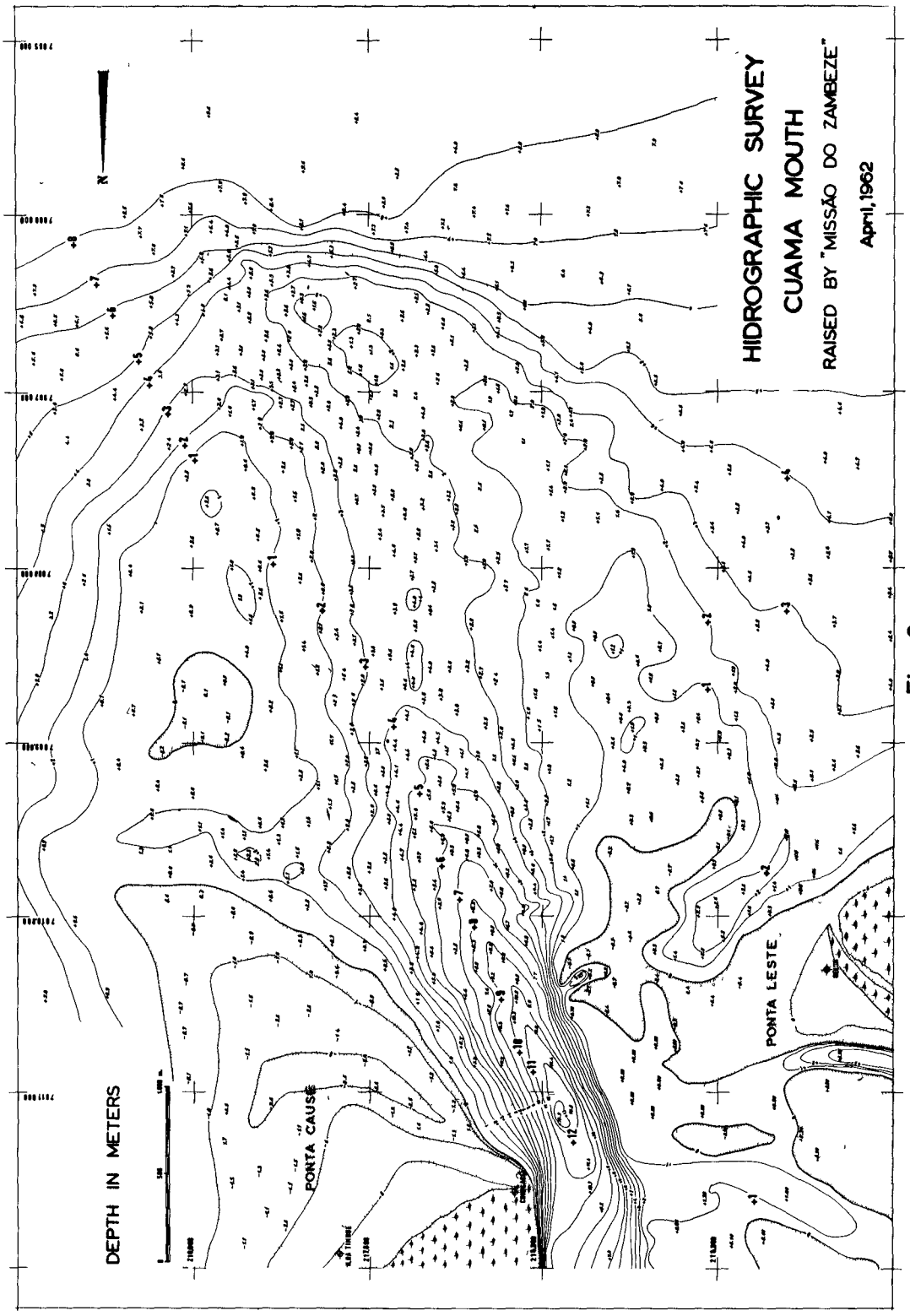
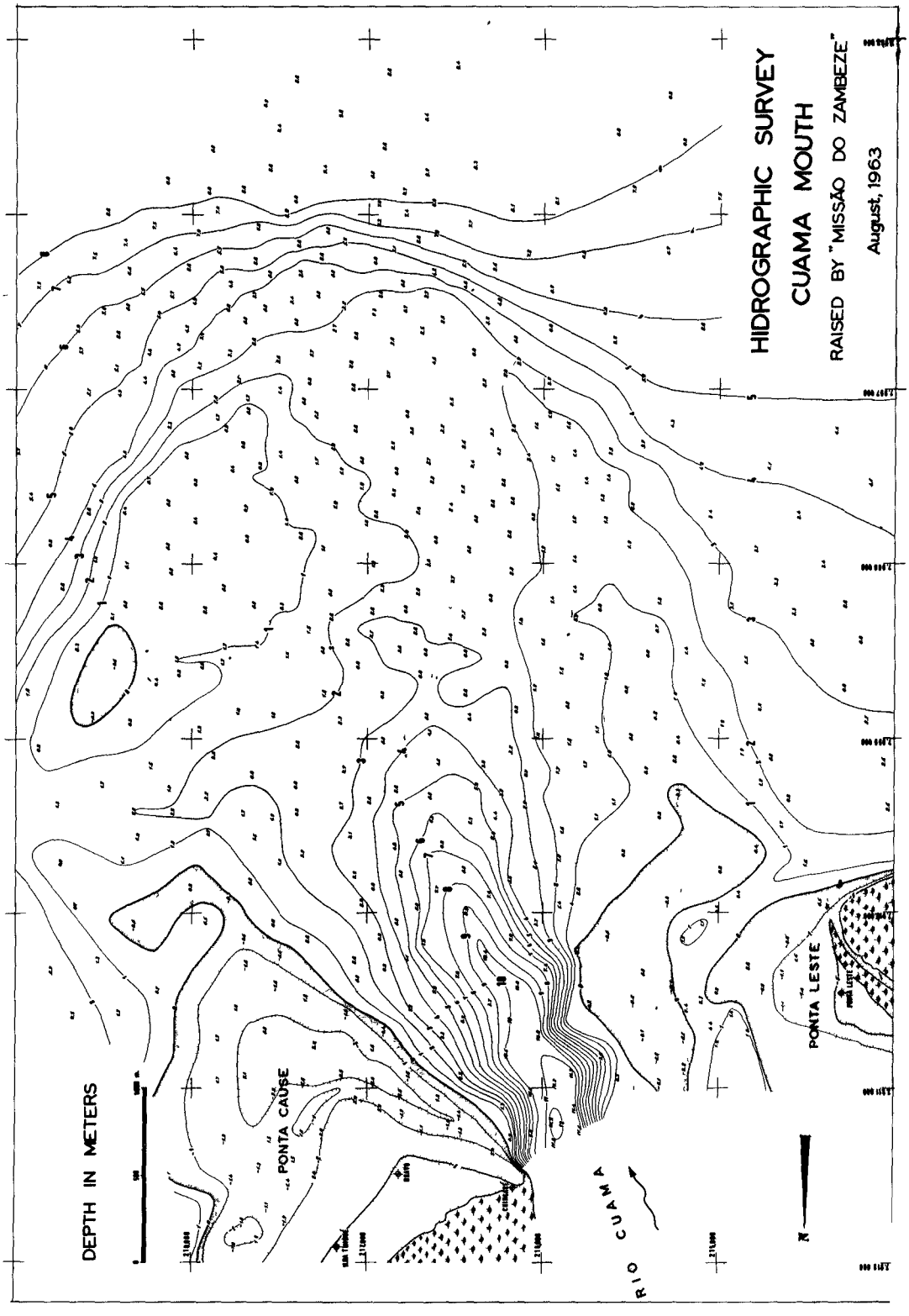

HIDROGRAPHIC SURVEY
CUAMA MOUTH
RAISED BY "MISSÃO DO ZAMBEZE"
April, 1962
DEPTH IN METERS
PONTA CAUSE
PONTA LESTE

Fig. 6


HIDROGRAPHIC SURVEY
CUAMA MOUTH
RAISED BY "MISSÃO DO ZAMBEZE"
August, 1963
DEPTH IN METERS
PONTA CAUSE
PONTA LESTE
RIO CUAMA
N

points sounded, but only those necessary for the correct interpretation of those plans with a distribution as uniform as possible.

3. ANALYSIS OF RESULTS

3.1 - TECHNICAL EFFICIENCY OF THE METHOD

From the examination of the hydrographic plans already obtained, and bearing in mind the attention and care given to the various operations and the comparison established under paragraph 3.5 below, it may be said in connection with the technical worth of the method that:

- The planimetric location of the points sounded is highly accurate.
- The altimetric accuracy appears to be acceptable, seeing that each point always includes the depth recording during at least one trough and one wave crest, for the determination of the average water level; it is granted however that the accuracy attained is nevertheless below the one that would be possible to reach by continuous sounding using the same means of operation.
- It offers the advantage of making it possible to sound shoals and zones non-accessible by boat.
- It allows continuity of operation as it is hardly subject to the sea conditions, which can therefore no longer hinder the access to the work site or the sounding proper.
- It entails reduced inland topographical support, always a lengthy and costly operation.

3.2 - WORKING EFFICIENCY

In order to contribute to the full realization of the technical worth of this method or simply to give a clearer picture of the working efficiency that may be attained through the sounding method described in this paper, the efficiency indexes are being given below and refer to the hydrographic survey carried out in 1963 when improved

operational techniques were applied - made possible by the planning resulting from an earlier experiment and better trained personnel - - resulting in the completion of all field operations at the end of six days only.

- 64 lines of points 100 meters apart approximately were sounded. Though both the length and number of points varied, on the average these represent a length of 1,800 meters and 18 points per line.

- The average sounding time for each point of a line,100 meters apart, was 35 seconds.

- The average sounding time for each point, including the return before starting on a new line, amounted to 59 seconds.

- The average operating time between consecutive refuelings of the aircraft was approximately 1:30 hr, allowing for the execution of 5 lines between each refueling; the average time required for each refueling was of 25 minutes.

- The flight time for the sounding operations, including the time necessary for refueling, averaged 5 hrs.

The number of hours flown per day, including also the displacement of the helicopter to the supporting base of the Delta group located in Chinde and the transportation of operators and equipment on the shore opposite the location of the Cuama camp, goes up to 6:15 hrs.

- Average number of points sounded per day - 200.
- Average area sounded per day - 5 sq.km.
- Average number of points per km2 - 40.

3.3 - COSTS

For a generic appreciation of the worth and interest warranted by this method, and to allow its comparison with other methods and the selection of the procedure to be adopted for sounding, bearing in mind the desired degree of accuracy and the conditions offered by the zone to be sounded, it is also important to refer the costs for the sounding operations using helicopters during the two hydro-

graphic surveys in 1962 and 1963.

Based on the prices for the exploitation of the aircraft fleet belonging to the Zambezi Mission during the period 1958-1963 and including the amortization of the flying equipment, fuel and lubricants, maintenance workshop costs, and flying personnel, the cost per hour of flight of the Augusta-Bell 47J helicopter amounted to 2,640 escudos.

The personnel engaged in the sounding operations - excluding the pilot and the mechanic who have already been included under the price indicated above - and the consumable goods represent an expenditure of 2,450 escudos per day.

Thus, the costs for the hydrographic surveys in question were as follows:

a) In 1962

Considering 12 days' field work and 48.30 hrs of flight - adding to the operating hours the time required to fly between Chinde and Tete where the Zambezi Mission's headquarters are located, and return, the costs amounted to

12 days ×	2,450$00	29,400$00
48.5 hours ×	2,640$00	128,040$00
		157,440$00

b) In 1963

Considering 6 days' field work and 41.30 hrs of flying the helicopter - adding also the return trip referred to above:

6 days ×	2,450$00	14,700$00
41.5 hours ×	2,640$00	109,560$00
		124,260$00

The corresponding average cost per unit thus amounted to:

	Per km2	Per point
1962 Hydrographic Survey	5,258$00	131$00
1963 Hydrographic Survey	4,142$00	104$00

3.4 - SAFETY

Safety depends almost exclusively upon the conditions of maintenance and the guarantees offered by the means of conveyance used and is practically independent from the conditions of the sea.

Transportation being effected by aircraft, subject to very careful and strict maintenance and overhauling rules, the possibilities of engine or other trouble resulting in an accident are therefore very reduced.

But even considering the possibility of an accident occurring, the necessary precautions were taken to reduce the hazards of such an accident being mortal for the occupants of the aircraft by fitting it with pneumatic float tubes.

As subsidiary safety measures, both the pilot and sounder operato wear life jackets and are provided with shark repellent.

The influence of the sea conditions might only be felt if,when sounding zones of surf and high waves - it is pointed out that the helicopter operates at 6 meters above water level - the pilot does not climb high enough to prevent a wave crest from hitting the helicopter float tubes. For this reason, when operating under those circumstances, the concentration and attention demanded from the pilot will evidently be far greater than that demanded from the helmsman of a boat since the first, besides having to watch the conditions of the sea, has to pilot the helicopter, and handle the controls, especially those of the number of rotations, pressure feed unit, and oil temperature in the gear boxes and engine.

In this respect the safety measures adopted forbid the pilot to fly lower than 6 meters when carrying out the sounding operation and to exceed a certain number of flying hours beyond which the resulting tiredness would become dangerous.

3.5 - COMPARISON WITH THE CLASSICAL SOUNDING METHODS

For a better evaluation of the technical worth of the direct

intersection sounding method making use of the helicopter (I), a comparison should be drawn between this and one of the classical sounding methods, amongst which it would seem logical to select the inverse intersections method using the sextant aboard a boat (II), adopted by the Hydrographic Mission of Mozambique for the sounding of the same region.

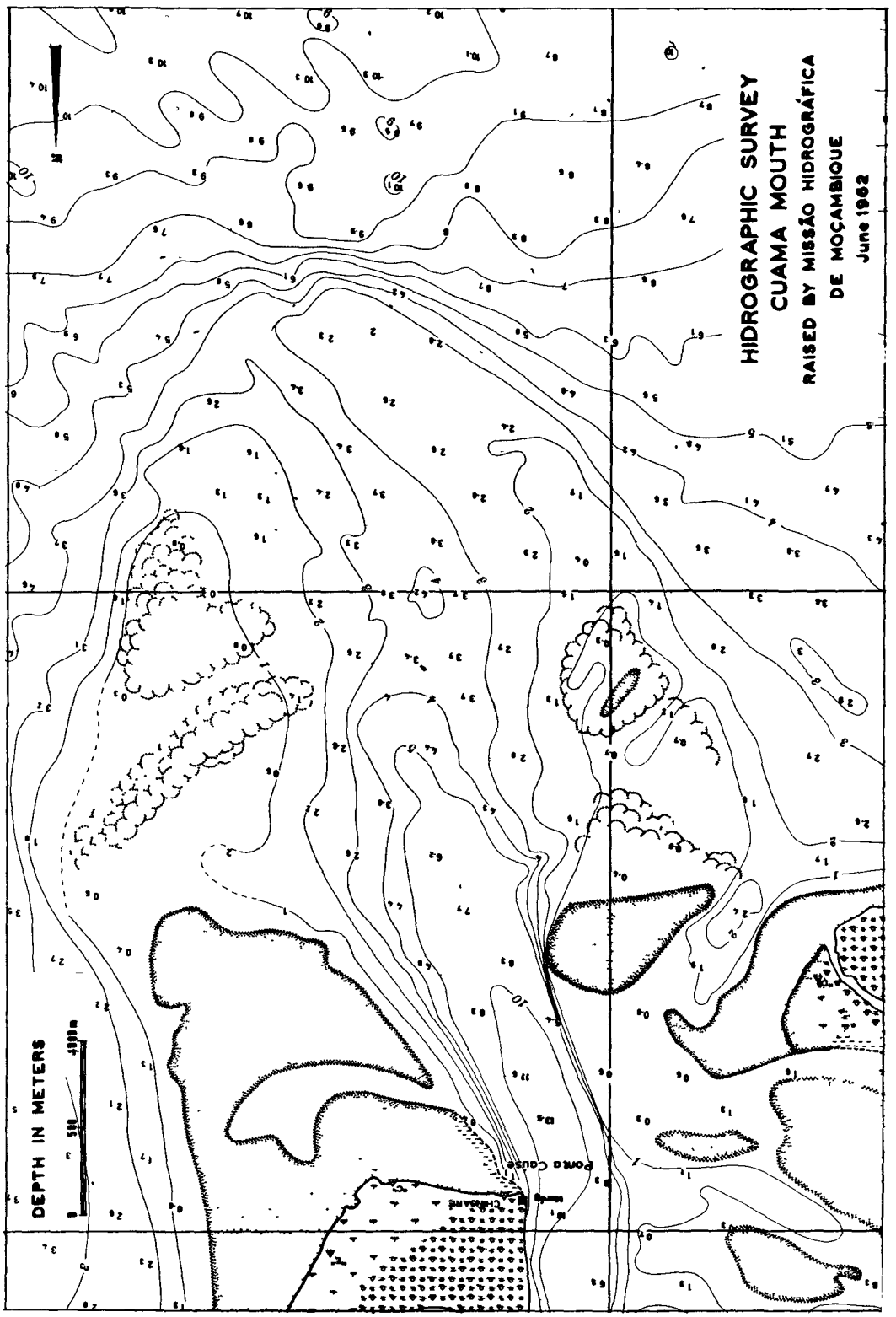
The information given under paragraph 3, namely that the sounding using helicopters was attempted owing to the uncertainty regarding the feasibility of sounding the Cuama mouth by the classical method aboard boats, and that the sketch of the sounding carried out by helicopter in 1962 permitted that the mouth in question be no longer regarded as entirely unknown at the time the sounding by the classical method took place, give added interest to the choice of this method for comparison purposes.

For a better knowledge of the survey carried out with both methods and corresponding comparison, fig 8 shows the part of the hydrographic survey of the Cuama mouth effected by the Hydrographic Mission in 1962 which corresponds to the zone of that mouth surveyed by the Zambezi Mission. The part represented on Fig 8 is an excerpt of the hydrographic survey already published at the scale of 1:25,000, after reducing it to the same scale used for the surveys represented by fig 6 and 7.

The advantages of method I over method II are considered to be:

- Greater planimetric accuracy;
- Feasibility of sounding in zones hardly accessible or non -accessible by boat and thus possibility of surveying areas with strong swelling and insufficient depth;
- Less dependence upon the sea conditions;
- No need of towers for inland signals;
- Speedier connections between the members of the working team;
- Reduction in the time required for the complete hydrographic survey;
- Reduced operation risks.

The disadvantages presented by method I as compared to method


HIDROGRAPHIC SURVEY
CUAMA MOUTH
RAISED BY MISSÃO HIDROGRÁFICA
DE MOÇAMBIQUE
June 1962
DEPTH IN METERS
Ponta Cuase
Chibalane

II, and generally speaking, the inconvenients of the first, will be:

- No possibility of continuous sounding (with the sounder being currently used) and the resulting decrease of altimetric accuracy of the method;

- Operation always conditioned by the direction and sense of the wind, and owing to this conditioning greater difficulties in carrying out a pre-determined sounding net;

- Due to the non-existence of towers for inland signals, necessity of reference points on the zone to be sounded, so as to minimize the above mentioned disadvantage.

It should however be made clear that the method using the helicopter offers possibilities of reducing or even eliminating the main inconveniences, as outlined in the paragraphs below.

It should be further clarified that when establishing such a comparison between the two methods, stating the advantages and dis - advantages of one over the other, there has not been the slightest intention of making the new method appear preferable to the classical one under all circumstances.

The object of this comparison is merely to draw conclusions regarding the value and interest of a method tested and initiated be - cause a classical method appeared inadequate for the sounding of a certain zone, and point out its advantages and disadvantages so that, according to the circumstances, it will be possible to chose the most suitable method for the sounding survey contemplated, taking into consideration the desired degree of accuracy, the working aids available, and the possibilities that the method already tested and now being presented added to the usual sounding methods, with a view to reducing their limitations.

In the case of the Zambezi Mission, the already mentioned need for the periodical repetition of the hydrographic survey of the Cua- ma mouth, the existing conditionings regarding working aids for the application of other methods, the availability of the helicopters , and the cost of the survey using the new method, made its application of undisputable interest for the studies now in course on the Zambe

zi delta.

3.6 - POSSIBILITIES FOR IMPROVEMENT

The possibilities for improvement should fall mainly on the feasibility of:

- equipping the helicopter and the shore stations with V.H.F. radio communications for easier intercommunications;

- carrying out the sounding operations with equipment selected so as to use a light-weight oscillator unit hardly resistant to towing.

It is believed that in this manner it will be possible to reduce the main disadvantages of the method because:

- the first mentioned improvement will allow the starting of the sounding lines at points adequately referred to the lines earlier surveyed and thus with a shorter time of operation ensure a better distribution of the net of points to be sounded; it will also eliminate the need for placing reference points in the zone to be sounded;

- The improvement mentioned second may allow the continuous sounding of each line instead of having to execute it point by point; together with the recommended V.H.F. radio communications, the control of the reading points might be done from the aircraft in the event of continuous sounding.

Lisbon, June 1964.