(1st draft, November 1998)

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

INFORMATION ON EASTERN AFRICAN SEA LEVEL

MOZAMBIQUE

António Mubango Hoguane

ACKNOWLEDGEMENT

This work was made with the participation of Mr. J. Ruby and Mr. A. Sitoe. Thanks are due to the Director of INAHINA, Engº Albano Gove, for his critical comments and valuable contribution.

I – STATUS OF SEA LEVEL OBSERVATION AND RELATED ACTIVITIES

1. Introduction

Mozambique is situated in the eastern coast of Southern Africa, between 10°27´ S and 26°52´ S latitude and 30°12´ E and 40°51´ E longitude. Mozambique is a coastal state, with about 2700 Km of coastline, the third longest in Africa. The ocean plays an important role in the country's social, cultural and economy. To some extent Mozambique is a country built up from marine resources or related activities. From centuries Mozambican coast was one of the main point of trading and so, of communication between African (Southern Africa) and other civilisations such as Asians (since the V Century), Europeans (since XV Century). The culture of the people along the coast exhibits a mixture of cultures from Africa, Asia, and Europe. Muslim, Christian and African religions coexists together in a complex relationship. The main cities are located in coastal zone and most of the population about

Being the ocean a traditional and economical vein of communication, the maritime transports had been one of the most important Mozambican source foreign incomes. There are three large ports in Mozambique: Maputo, Beira and Nacala, and several small ports: Inhambane, Quelimane, Pebane, Angoche, Pemba. The main ports are the main gateway for the neighbouring countries. These ports provide valuable services not only for national customers but also, and mostly, for the inland states namely: Swaziland, South Africa, Zimbabwe, Zambia, Malawi and Congo. For example the total cargo handled in 1995 and 1996 was about 7.5x106 ton and 8.4x106 ton, respectively. Both the road and railways networks are built to facilitate regional trade rather than the national economic integration of the country. The transport sector used to be an important foreign exchange earner from the transit facilities offered to the neighbouring countries. The total goods transported through the Mozambican railways were 3.1x106 ton and 4.1x106 ton in 1995 and 1996, respectively. Apart from the maritime transports, there is an important fishing fleet operating in bays, coastal waters and open sea waters adjacent to Mozambique. Further, Mozambique Channel is a root for cargo ships connecting Southern Africa, South America and the Northern Africa, Persian Gulf and India. Before the opening of the Suez Channel, ships from Europe to Asia used to sail through Mozambican waters.

Most of the ports are located in the Bay and estuaries, with dynamical seabed and shallow banks. The important fishing grounds are located in the shelf, and most of it is shallow or with patches of corals or rocks, which makes it danger for fishing and navigation. Hence, there was a need to develop efficient maritime services to ensure safe navigation for the vessels travelling from/to Mozambican harbours or in transit through the Mozambican coastal waters. The Mozambican hydrographic institute (INAHINA) was given the mandate to, among others, render necessary support to navigators and carry out research on techniques of maritime aids to navigation. This institutions is thus, the main responsible for the establishment and maintenance of the tide gauge stations, production of tide tables and hydrographic maps. In Mozambique there are more institutions dealing with Marine sciences, coastal zone management or related areas. These institutions may use the products provided by INAHINA or, in many cases, may develop their on tide prediction scheme for other areas apart from the harbours, where INAGINA is covering. The main institutions dealing with marine

sciences or maritime affairs are the University, IIP and INAHINA. In annex it is presented a summary of their job description. For IIP a list of the technical staff is also presented.

The tide gauge stations net work of the country is presented in figure 1. Most of the tide gauge stations are located in the harbours, and primarily designed to provide aid to navigation to the vessels sailing to and from the harbours, and along the Mozambican coastal waters, and not much for scientific interest.

Initial there were about 13 tide gauge stations in operation along the coast. However, due to the long civil war and to the lack of financial and technical capacity to maintain the stations, they were reduced to 4 stations operational stations. Two stations were selected for GLOSS network, the Inhambane and Pemba stations located in southern and northern Mozambique, respectively. The Pemba station, is currently in operation, but the tide gauge at Inhambane is not, at the moment, functioning. It worked at irregular intervals only for two year, and the data obtained was of poor quality.

2. Status of the Sea Level network

2.1 Operational stations

From a total of 13 stations previously installed only 4, which are located in the main harbours, are currently operational (Figure 1), and these are Maputo, Beira, Nancala and Pemba. All the gauges are of float type. The Mozambican Hydrographic Institute (INAHINA) is the main responsible for the installation and maintenance of the tide gauges. More details on the serial numbers and year of installation are given in Table 2-1.

Table 2-1. Operational tide gauge stations. All these stations were installed by INAHINA

Tide gauge station	Location	Instruments		Year of installation	Gloss Station
		Model	Serial No.		
Maputo	Maputo fishing harbour	OTT R20		1994	No
Beira	Beira fishing harbour	OTT R20	20102	1995	No
Nacala	Nacala commercial harbour	OTT R20		1995	No
Pemba	Pemba commercial harbour	OTT R20	20102	1992	Yes

The data is collected and kept by INAHINA. The tide prediction, however, is processed at the Portuguese Hydrographic institute in Lisbon, while the printing is done in Mozambique under the responsibility of INAHINA.

There is at least a meteorological station near most of the stations, because they are located in the port towns. The runoff gauges are located further upstream to avoid tidal effect on the river flow measurements. Both the Meteorological and river runoff data collected by the local stations are sent to the respective headquarters in Maputo the end of each month, via radio.

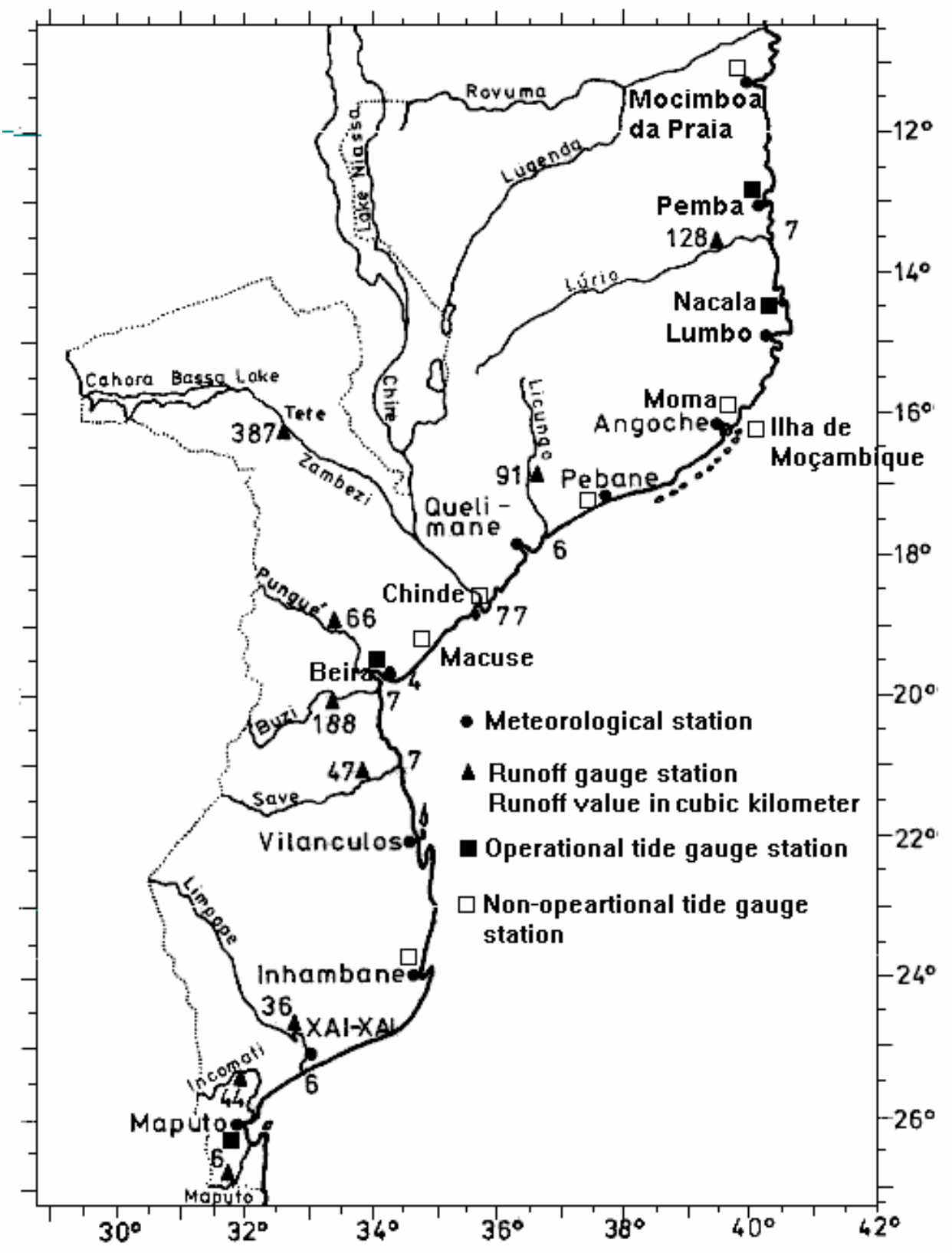

Figure 1. Location map of the tide gauge and of the nearest meteorological and runoff stations in Mozambique.

Maputo

The tide gauge is located in the Maputo City, in the fishing harbour, near the entrance of the Maputo Estuary (see location map). The city is located at the western site of the Maputo Bay. The bay is located in the southern part of Mozambique at latitude 26oS (see location map). The bay is on average about 40 km long and 30 km wide. It is open to the sea from the northern side and bounded at the eastern side by the Inhaca island and the Machangulo peninsula.

There are three rivers draining into the bay: the Incomati river in the north-western side, the Umbeluzi in the western side and Maputo in the south-western side. The rainy season is from December to April and it is almost dry for the rest of the year. Figure 2.3 shows the mean monthly average discharge over 25 years, from 1960 to 1985, for the three rivers. The data were obtained from the National Directorate for Water, in Maputo. The mean monthly river discharge varied from 10 to 800 m3 s-1. High discharge was recorded in the Incomati, in February and low discharge was recorded in the Umbeluzi, in September.

The climate is subtropical with a transition from tropical to warm temperate (Kalk, 1995). The mean diurnal air temperature varies between 18oC, in the winter to 27oC, in summer. The mean annual rainfall is about 1100 mm. Winds are mainly from SE (trade winds). Mean monthly wind speed as observed at the Maputo meteorological station varies from 2 m s-1, during winter to 4 m s-1, during summer. Winds within the bay are generally stronger compared to those observed in the main land and weaker compared to those observed in the open sea.

Maputo Bay is shallow, with water depths less than 10 m in most of the bay, except in the channels. There are a considerable number of sand banks and some deep channels (over 15 m). The channels are generally oriented north-south. The tides are semi-diurnal, with an appreciated diurnal inequality, about 3 metres during the spring tides. There is a small tidal phase lag between the western and eastern sides of the bay, with high water about half an hour late at the maputo harbour in relation to the eastern site of the bay and to the entrance.

According to previous records of water temperature and salinity, the bay may be divided into two parts: the eastern side, with oceanic and less variable salinity throughout the year and, western side, with more diluted and variable salinity (more influenced by river discharge). Water column structure in the bay may be considered vertically homogeneous, save in the estuaries (western side) and in the deep channels. There is a horizontal gradient of salinity between the two sides. Figure 2.4 shows two sections taken across the bay from west to east, during dry and wet seasons, respectively.

The water in the bay is warmer during the summer and cooler during the winter than that of the open ocean. The diurnal mean temperature ranges from 17oC, in the winter to 37oC, in summer. This high temperature range is due to the shallowness of the bay.

The circulation pattern of Maputo Bay itself is not known. Some current meters have been deployed and sea level records made at discrete locations, by the Department of Oceanography of the Institute for Fisheries Research, in Maputo. Most of the moorings were of short duration, about 2 days. The longest records are about 20 days

at the entrance of the bay in 1993. These moorings gave only an indication of the currents at particular sites at certain times. Figure shows some of the results from the moorings made in the eastern side of the bay, near Inhaca Island. The currents in the bay seem to be primarily driven by the tides and modified by the bottom topography (deriven from earlier records of velocity in the bay).

The ocean side adjacent to Maputo Bay is characterised by the warm Mozambique current flowing southward and by the cold northwards coastal counter-current (Sætre and Jorge da Silva, 1984 and Sætre, 1985). Figure shows schematically the circulation pattern in the Mozambique Channel.

Beira

The tide gauge is installed in the fishing harbour, located in the southern end of the city.

Beira is an international harbour, with connection to Zimbabwe, Zambia and other inland states. It has also an important fishing activity. The city of Beira is located in the central Mozambique, at approximately 19º 50' S and 34º 50'E, in the northern margim of the Púngoe River mouth. The estuary is connected to a large bay, the Sofala Bay, which is freely and widely connected to the shelf, the Sofala Bank. Unlike most of the harbours, the Beira harbour is only 3-4 nautical miles distance away from the open sea. Hence there is no significant tidal phase lag between the tide gauge station and those observed in the adjoining sea. The Sofala Bay constitutes the southern part of the Sofala Bank. This region is the largest part of the shelf, about 80 nautical miles from the coast to the shelf break. The average depth of the shelf, in this region, is about 20 m.

The morphology of the coastal zone in Sofala Bank is characterised by flat land with an almost continuos fringe of mangrove swamps. These swamps are associated with main rivers and with tidal creeks. These only carry freshwater during the rainy season. Bare soil flat of varying width separates the mangrove forest from the terrestrial forest.

The bottom in the central and northern Sofala Bank is flat and mostly muddy. It is where most of the industrial fleet operates. The southern Sofala Bank is characterised by sandwaves thought to be due to strong tidal currents mentioned above (Sætre and Paula e Silva, 1979 and Brinca et al., 1982). The wavelength of those sandwaves ranges between 200 and 400 m and the height varies from 10 to 15 m, and in some cases exceeds over 20 m. The bottom is thus inappropriate for bottom trawl, save near the shore where semi-industrial fleet and artisanal fisherman operate mainly bottom trawls and beach seines, respectively, and fishing mostly shrimp.

Sofala Bank is mostly dominated by the Southeast Trade Winds (Sætre and Jorge da Silva, 1982). Winds are mostly from NE - E - S. SE trade winds winds, with frequencies above 20%, occasionally exceeding 30%, and with the mean monthly force above 3 m s-1, are the most predominant. The southerly winds are the strongest, with the mean monthly force exceeding 5 m s-1 during September and January.

The rainy season last from November to May. The annual rainfall is about 1140 mm. In the southern Sofala Bank the evaporation is about 1650 mm per year, thus the evaporation prevails over the precipitation by about 500 mm per year, on average.

Most of the rivers of Mozambique enter the sea through Sofala Bank. The annual runoff of the all-Mozambican rivers is estimated to be 141 km3, and the rivers within Sofala bank contribute with about 85%. Zambezi River, the most important river in Mozambique, contributes with 67% for the total of all rivers. The Púngoe, which passes through Beira is shared with Zimbabwe and contributes with about 3.3 km3. Other important river in the vicinity of Beira is the Búzi river, which contribute with about 6.7 km3 of water per year.

Sofala Bank is characterised by estuarine environment, with high salinity variability. In the central and northern part is influenced by Zambezi river, hence low salinity. In the southern part, in the Sofala Bay, high salinity are found during the dry season, when the river runoff is low and also because the evapotranspiration exceeds the precipitation, as mentioned above.

The watermasses were discussed by Jorge da Silva (1984) and he had identified the following watermasses:

i. Low Salinity Water (LSW), with salinity below 34.8. It is found near the river mouths.

ii. Oceanic Water, with salinity between 34.8 and 35.4. It is found near the shelf break.

iii. High Salinity Shelf Water (HSSW), with salinity above 35.4, found in the southern Sofala Bank.

The water temperature vary from about 23ºC in winter to about 28ºC in summer. Unlike salinity, temperature does not show significant spatial variability.

The circulation pattern over the Sofala Bank is dominated by the southgoing warm Mozambique current flowing south, and along the shelf edge (Sætre and Silva, 1984), an counter-current over the shelf, an cyclonic eddy in the southern Sofala bank (Jorge da Silva 1984), and a nearshore current flowing south (Steen and Hoguane 1990). Hoguane 1997, present an up-dated tentative circulation pattern of the Sofala Bank.

The tidal range near the coast in Sofala Bank is relatively bigger compared with the tides in the neighbourhood. The mean tidal range near Beira Harbour during the spring is about 6.4 m (Brinca et al., 1982)..JCI Limited (1998) has estimated 6.6 m for the Highest Astronomical Tide for the northern part of Sofala Bay. Whereas in the Southern Mozambique the tidal range is about 3 m (Hoguane, 1996), at the shelf break in Sofala Bank, is also about 3 m (Gammelsrød and Hoguane, 1995). The tides are magnified as they travel over the long shelf. In addition, the Kelvin effect as the tidal waves enter the Mozambique Channel from the South, may contribute to the magnification of the tides in the Mozambican coast, compared to the Madagascar coast

The currents in the region are mostly tidal driven and strongly affected by wind. Earlier measurements of currents (November 1987) made at the shelf breaker have shown that the subsurface currents are unidirectional, along the slope, hence

topographical controlled. There was a strong cross slope component at the surface layer due to the tides (Gammelsrød and Hoguane, 1995), with characteristic velocity of about 50 cm s-1.

Quelimane

Quelimane is located in the central Sofala Bank. The tide gauge is located in the fishing harbour. The city is located at about 13-14 nautical miles up the River dos Bons Sinais, at about 18º 52'S and 36º 53'E. The river is relatively small and narrow with some islands and sand banks. Because the tide gauge is located at some relatively long distance from the coast upstream, the phase lag between the tides at the sea adjacent to the river mouth and at the tide gauge station, in the harbour, may be of considerable magnitude.

The Port of Quelimane is a national harbour, with no inland state connection. However, it is an important fishing harbour. The most important fishing fleet, based in Quelimane, is jointly owned by the Mozambican Government and a Japanese enterprise, and fish mainly shallow water shrimp.

There has hardly been done any survey near Quelimane so, there is no information about the oceanographic conditions of the region. Most of the studies concentrated in the shelf, where the circulation is dominated by the south going current near the shore and the north going current over the most of the shelf. Zambezi plume is detectable up to the north of the Bons Sinais River mouth, and influences the entire shelf, which at this place starts to narrow.

Nancala

Nancala is located in the northern Mozambique, approximately at 14º 32'S and 40º 40' E. It is in the far end of a north-south oriented lagoon. The lagoon is about 10 nautical miles long, about 2 nautical miles average width and 20 meters average depth. Three adjoining bays compose the lagoon. The harbour is located in the most inward bay. The distance from the harbour to the open sea is about 7 nautical miles; thus there might be a considerable phase lag between the tides in the sea and in the harbour.

Nancala is an important international port, with connection to Malawi and also hosts an important fishing fleet. No studies on oceanographic conditions of the lagoon has been done so far, however the oceanographic conditions in the open sea adjacent to the lagoon is characterised by the warm Mozambique current flowing south and by an seasonal upwelling due to the monsoon winds (Steen and Hoguane, 1990). The monsoon winds rich as far as 15ºS. The shelf in the adjacent sea is narrow and has several island and coral reefs which protects the coast against the storms. Tropical cyclones are common in this region.

Pemba

Pemba is located in the in Cabo Delgado, the northernmost province of Mozambique. The city and thus, the harbour is located in the Pemba Bay, in the southern corner of its entrance. The bay of Pemba is a quasi-circular of a diameter of about 6 nautical miles. It is relatively deep, with depth greater than 30 m in most of the bay. The shelf in the outer part of the bay is narrow. The depth goes down to 200 m at 1 nautical mile distance away from the coast. There is no significant phase lag between the tides

in the open sea and in the harbour. The harbour is only 2-3 nautical males away from the shelf breaker.

The port of Pemba is not connected to any inland state, it serves mainly national customers. There is interest in keeping the tide gauge operational because it integrates the GLOSS network stations. Further, because of its location it may be suitable, in conjunction of the tide gauge station in Nosy-Bé, to study the flux of water through the northern section of the Mozambique Channel (see below).

Benchmarks

All the benchmarks are fixed and referred to the Chart Datum (zero hydrographic). The table bellow presents the benchmarks of the operational tide gauges, including the GLOSS station of Inhambane. The table below presents the location of some of the benchmarks.

2.2 Tide gauge installed but not operational

The stations where the tide gauges were installed and that are not, currently, working are listed below:

Inhambane
Chinde
Macuse
Pebane
Moma
Angoche
Ilha de Moçambique
Mocímboa da Praia

All these stations are located in the tertiary ports, in the remote cities or villages. The main reason for non-operation of the tide gauge lies in:

(i) Absence of adequate equipment

(ii) Lack of qualified personnel for maintaining the tide gauges

(iii) Lack of fund to maintaining the tide gauges

(iv) Difficulty in getting to the remote villages due to the war, poor road and transports network.

Table 2-2. Benchmarks of the operational tide gauges in Mozambique, including the GLOSS station of Inhambane. (IHP) Portuguese Hydrographic Institute

Tide gauge station	Station code	Benchmarks de tails				
		Reference	Year of installation	Responsible	height (m)	Description
Maputo	1	MN1	1941	IHP	6.026	- Bronze mark fixed in the tide gauge door
		MN2	1941	IHP	5.66	- Bronze plate fixed at the entrance of the dry dock
		MNF	1998	INAHINA		- Bronze plate with a galvanised steel ring
		MN23	1995	INAHINA		
Inhambane	2	NP124AT2			8.187	- Small circular bronze plate fixed at the entrance of the old Catholic Church
		SH-MN1	1980	INAHINA	7.286	- Brass plate fixed near the entrance of the Administração Marítima building
Beira	3	MN1	1968	IHP	9.018	- Bronze plate fixed in the wall of the W building of CFM, at the right side of the entrance to the lifts
		SUNP11	1997	INAHINA	8.789	- Brass mark fixed at the top of the stairs of the court building, facing the Manica building.
		NP19			8.014	- Bronze mark …
		MN4	1968	IHP	7.943	
		MN5	1997	INAHINA	7.978	
Quelimane	5	MN1	1971	IHP	6.249	- Brass plate in the pavement over the bridge which gives access to the harbour
		MN2	1963	IHP	6.466	- Plate located on the car gate door in the former residence of the harbour master
		MN2	1963	IHP	4.726	- Mark located near the extreme end of the fixed tub
Nancala	12	MN1	1971	IHP	6.57	- Plate fixed near the gate of the store house of the customers police, at the entrance of the harbour
		MNP	1974	IHP	17.237	- Plate fixed in a cemented mark, protected with a cemented seal, near the house of Eng. Silva
Pemba	9	MN1	1964	IHP	5.71	- Plate fixed on the pavement, in the SW end of the harbour
		MN4	1970	IHP	4.096	- Plated cemented in the stairs, in the W side of the harbour
		MN2	1964	IHP	6.500	

The Inhambane station, as mentioned above, is a GLOSS station. The tide gauge was installed the harbour in the Inhambane City. The city is located in a long north-south oriented lagoon, at approximately 23º 40'S and 35º 19'E. The lagoon is long, narrow and shallow, with several sandbanks. The length is about 20 nautical miles, and 3 nautical miles average width. The harbour is located at about 13 miles from the open sea. There is a small river discharging into the lagoon. The water temperature in the bay varies from 20ºC to 31 ºC over the year (Meisfjord, 1997). There is a large tide phase lag between the tides in the sea and in the harbour, due to the long extension and the shallowness of the lagoon.

The station worked well for one year, from October 1948 to September 1949. The data obtained were of good quality. The station was interrupted for such long period, and it was rehabilitated in 1993 as a GLOSS station. It worked intermittently for two years, from October 1993 to May 1995. The data obtained were of poor quality.

(other information related to these stations, including the costs for maintenance of the station will follow later)

2.3 Planned stations

The stations which are planned to be installed or rehabilitated are as follows: Inhambane, Chinde, Angoche, Mocímboa da Praia and Vilanculo. With these additional stations it is intended to:

a) Obtain high spatial resolution of sea level observations network, to generate better data needed for scientific, management proposes, and for local and regional use,

b) Obtain sufficient time series of data to update the tidal constituents, required providing aid for navigation,

c) Monitor the sea level variability as impact of the variation of the Zambezi river flows over the Sofala Bank, (Quelimane, Chinde, Beira, Vilanculo),

3. Availability of data from the stations

The tide gauge data are recorded hourly and the data are available in both digital and hard copy form at INAHINA. Copy of the data is sent to the Portuguese Hydrographic Institute in Lisbon, and data from GLOSS stations are sent to the world data centre.

4. Capacity Available

4.1 Installation and maintenance of gauges

There is lack of personnel qualified in the field of Marine sciences, with particular incidence in Physical Oceanography. In the whole country, physical oceanographers are less than half a dozen, with only one PhD holder (Table 4-1). The Department of Oceanography of INAHINA, responsible for the tide gauge operation, tidal data analysis and thus, providing aid to navigation, has one MSc degree in Physical Oceanography, one BSc Holder in Meteorology and one technician with large experience in field work operations as well as in data processing.

There is no one in Mozambique who has attended training courses at PSMSL. However, staffs from INAHINA have attended several courses in tide gauge operation and tide data analysis in Portugal (Table below). A Members of staff of IIP and INAHINA have attended IOC sponsored regional courses in Oceanic Data Processing, which include tide data analysis.

Mozambique is independent since 1975. It used to be a Portuguese colonial. In spite of long time freedom the tide prediction are still be done in Portugal. The difficulty for producing it local may be both technical and financial. This situation, although apparently seems to be well justified it should be reversed, particularly if considering that there are tidal analysis packages available almost free of charge. Therefore, is an urgent need for building up confidence in the local staff, particularly at INAHINA, for at least to be able to make the tide predictions.

4.2 Analysis and interpretation of data

Tide data can be used for providing ocean services, in environmental and resources management, and in marine sciences. Hence, the use of tide data is of multi-institutional nature and multidisciplinary nature, such as: Academics, researchers and managers. INAHINA, IIP and the University Eduardo Mondlane are the traditional institutions that have been developing marine science activities.

INAHINA is mainly devoted to production of tide tables in the main harbours and so, they need capacity in tide data collection, data quality control and tidal analysis.

The IIP uses tide data as one of the inputs in the research for environmental impact in the fisheries research. IIP needs to monitor both the short and long term environmental trends, local and global climate changes such as El – ñino, tropical cyclones as they affect the marine and fish productivity. Hence, IIP needs to predict the tides not only in the main fishing bays but also in the offshore fishing grounds. The tide data are analysed, interpreted and related to other environmental parameters in an attempt to explain the variability in fish production. The Department of Aquatic Environmental Studies of IIP, responsible for Oceanography and limnology research applied for fisheries has one PhD holder in Physical Oceanography, one BSc holder in Meteorology, one BSc holder in Aquatic Resources Management and two technicians.

Table 4-1. List of some marine scientists with interest in sea level data, in Mozambique

Name	Academic qualification	Place and year of graduation	Further training	Employee	Interest in tides
D. Chemane	MSc Physical Oceanography	UK (1994)			Tide gauge operation, tidal analysis
J. Ruby	BSc Meteorology	UEM (1993)	Observation and analysis of sea level data (Brasil, 1993 and Portugal , 1996)	INAHINA	Sea level observation, tidal analysis
A. Sitoe	Polytechnic school		Tide gauge installation, maintenance and data quality control (Portugal, 1985/86 and 1995)		Tide gauge installation/maintenance, data quality control
A. Hoguane	PhD Physical Oceanography	UK (1996)	Several courses in applied oceanography and remote sensing	IIP/UEM	Research and teaching
E. André	BSc. Marine Biology	UEM (1994)	On job training courses in applied oceanography	IIP	Research
V. Dove	BSc Meteorology	UEM (1994)	ODINEA, Coastal zone management (Mombasa 1997)	IIP	Research
D. Fernando	General Secondary School		On job training	IIP	
V. Saide	MSc Physical Oceanography	Sweden (1999)	Nansen course in Environmental physics (Namibia, 1995)		
D. Gove	MSc Marine Biology	Sweden (199..)			
A. Macie	MSc Marine Biology	Sweden (199..)		UEM	Research and teaching
S. Bandeira	MSc Marine Biology	Sweden (199..)			
A. Guissamulo	MSc Marine Biology	SA (199..)			
A. Massinga	MSc Marine Biology	UK (199..)			
H. Motta	MSc Marine Biology	UK (199..)	Several courses in resources and coastal zone management	MICOA	Coastal zone management

The University Eduardo Mondlane have been using tide data for biological, marine geology and marine ecology research. They need, as IIP, to be able to predict, analyse and relate tide data with other parameters in their specific research assignment, in other region apart from the main harbour. The University has one MSc in Physical oceanography, one marine geologist currently undertaking PhD studies, 5 MSc in marine biology from which two are currently undertaking PhD studies.

Training requirements

There is a need to train more people on tide gauge installation/maintenance, data quality control, tide analysis and in general sea level data processing and analysis (e.g. return probability of storm surges, sea level anomalies, maps of inundation for different sea level).

5. Sea Level Products

There is no much sea level products produced in the country. The few available are only the tide table, hydrographic charts, navigation guides; all produced by INAHINA. These products can be purchased at INAHINA at fairly low price.

A periodical journal/brochure, every three mouth, with tidal constituents, tide prediction, wave statistics, sea level anomalies would be very useful.

6. Bibliography of sea level literature

7. Recommendations

The communication scheme between the various tide gauge station scattered around the country and the INAHINA's headquarters should be improved as to ensure fast and secure transfer of sea level data to the data bank.

The non-operational stations should rehabilitated as soon as possible as to ensure high-resolution sea level observation.

Staff from Mozambique should be trained in tidal analyses, and INAHINA should be capacitated to be able to make the prediction tide locally, instead of being made in Portugal.

We would like to explore the possibility of using the simultaneous record of sea level in Pemba and Madagascar to study the flow across the northern entrance of the Mozambique Channel.