

Ecosystems and Industrial/Economic Development Activities of Madagascar

Prepared by Dr. H. R. Melton and Dr. L. J. Zimmerman (November 2012)

The interaction between marine ecosystems and industrial/economic development activities may be relevant when identifying the factors that could have led to the 2008 mass stranding of melon headed whales in northwest Madagascar. The purpose of this document was to pull together relevant references that are publically available on the internet. It summarizes scientific, industrial and commercial activity off the coast of Northwest Madagascar during the time April to June, 2008 timeframe. It is intended for use by an Independent Scientific Review Panel convened to evaluate the stranding event of melon-headed whales in late May, 2008 at their discretion.

One concise overview source of information on the marine ecosystems and industrial activities of Madagascar can be found in the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) project's report "COASTAL LIVELIHOODS IN THE REPUBLIC OF MADAGASCAR GENERAL INTRODUCTION", which can be found on the internet at:

<http://www.dlist.org/sites/default/files/doclib/Madagascar%20Annex%20XI%20CLA%20final%20draft%20for%20review%209-02-2011.pdf>

We understand that one key contributor to this publication was the Western Indian Ocean Marine Science Association (WIOMSA), which is a regional professional, non-governmental, non-profit, membership organization, registered in Zanzibar, Tanzania. The organization is dedicated to promoting the educational, scientific and technological development of all aspects of marine sciences throughout the region of Western Indian Ocean (Somalia, Kenya, Tanzania, Mozambique, South Africa, Comoros, Madagascar, Seychelles, Mauritius, Reunion(France)), with a view toward sustaining the use and conservation of its marine resources. Dr. Tim Andrew, Director of Outreach and Resource Mobilization, would be a key contact for more information (Email: tim@wiomsa).

The ASCLME project focused on the two large marine ecosystems of the Western Indian Ocean (WIO) region, covering nine countries that are directly influenced by these current systems. The ASCLME project was funded to support these countries in their efforts to collectively manage the marine resources on which their people

and economies depend. As part of their effort they researched fisheries and other key coastal activities, including various forms of tourism, aquaculture, shipping and coastal transport, the energy sector, agriculture and forestry, which are all very important contributors to the economies of the countries of the WIO. In recognition of the complexity and importance of these activities, a Coastal Livelihoods Assessment (CLA) component was developed for the ASCLME project. The document referenced above outlines their methods of analysis and briefly describes each of the sectors.

Three main activity sets may be important to consider if the stranding event was caused all or in part by anthropogenic activities: 1) the geophysical exploration activity sponsored by ExxonMobil Northern Madagascar (Ampasindava) Holding Limited (EM), 2) hydrographic/bathymetric charting using Multi Beam Echo Sounders (MBES) and 3) commercial fishing and other industrial activity in the area such as shipping activity through Narinda Bay and up the Loza River to Antsohihy. The exploration activity supported by EM is known in more detail and is covered in a separate memo. Items 2 and 3 are covered below.

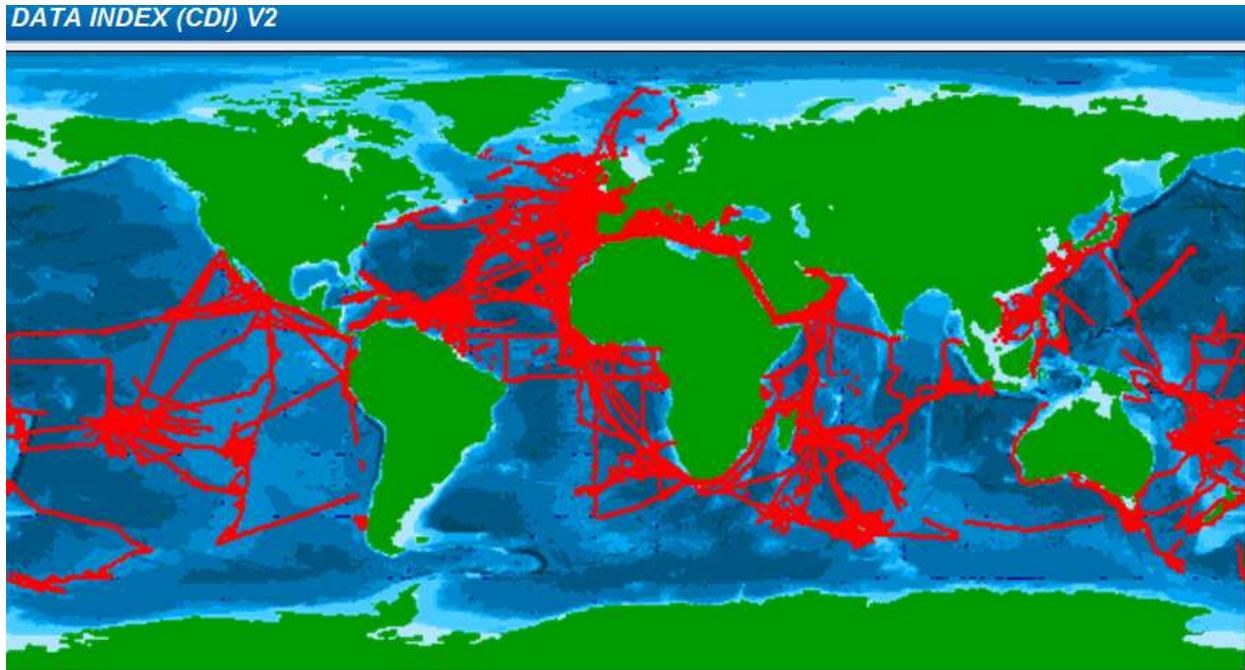
HYDROGRAPHIC SURVEYS

Charting of the bathymetry of coastal areas is important from public safety, shipping safety and economic development perspectives. Hydrographic data is used for coastal zone management, environment monitoring, resource development (hydrocarbon and mineral exploitation), legal and jurisdictional issues, ocean and meteorological modeling, engineering and construction planning and many other uses. To be useful, the data needs to be up-to-date, detailed, reliable, and in digital form. Multi Beam Echo Sounders (MBES) are one favored method of rapidly acquiring cost-effective bathymetric data. These systems can acquire accurate, high-resolution bathymetric data along a ship's track in a wide swath. A MBES is typically used to determine the depth of water and the nature of the seabed.

The International Council for the Exploration of the Sea (ICES), an organization that coordinates and promotes marine research on oceanography, the marine environment, the marine ecosystem, and on living marine resources in the North Atlantic encourages mariners to use their MBES surveys to compile new or updated nautical charts and; therefore, help improve safety for mariners. They advise that these "surveys of opportunity" do not have to be carried out to full charting standards and all data collected is potentially of use. Even without a full search for dangers, a modern survey can improve on our knowledge of the seabed.

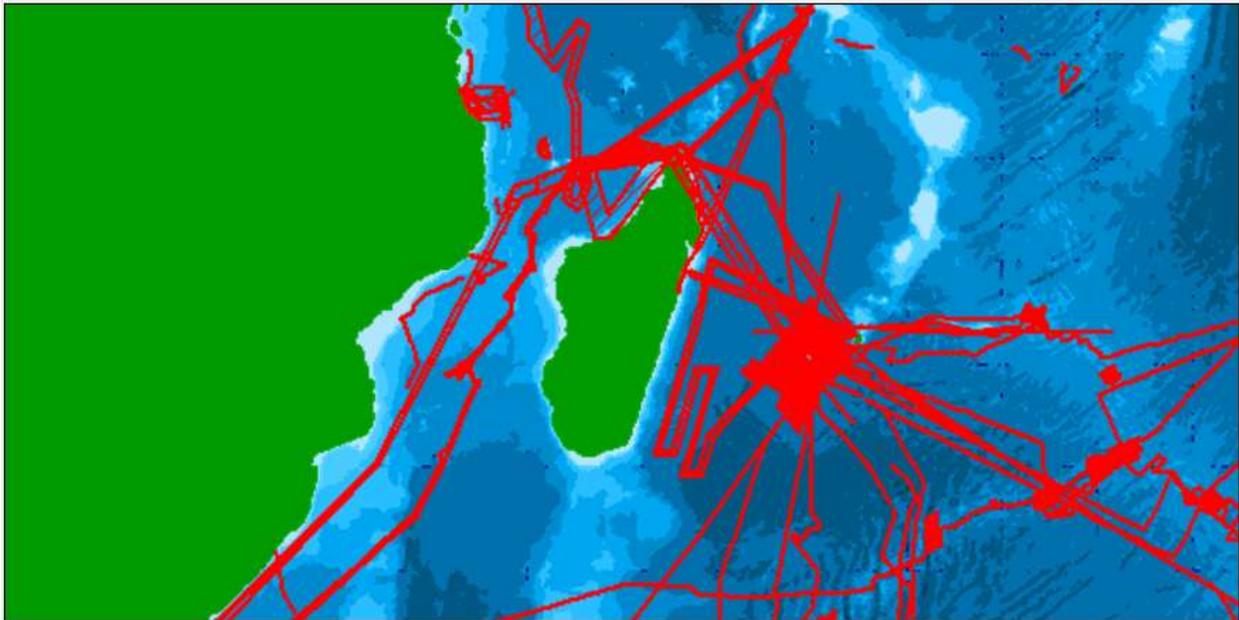
<http://www.ices.dk/datacentre/guidelines/DataTypeGuidelines/Guidelines%20for%20multibeam%20echosounder%20data%20vers%201.0%20.pdf>

The figure below shows the extent of MBES surveys that have been contributed to one such bathymetric data sharing site, SeaDataNet.

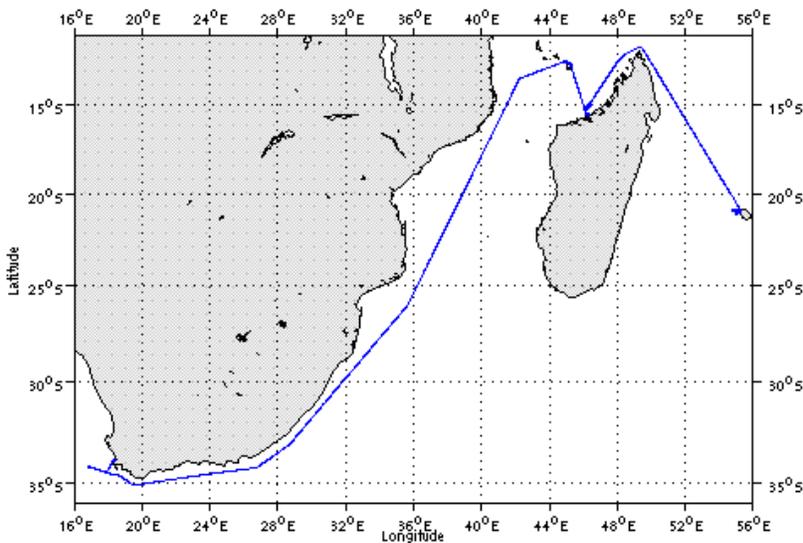


As mapping technology has improved since the 1990s hydrographic survey activity has been increasing in the many of the coastal regions around the world. Madagascar, a region poorly charted in modern times, is no exception. Although some of the data still used to create nautical charts for the ocean surrounding Madagascar date from the early 1900s, the pace of bathymetric mapping is rapidly increasing.

After the devastating December 2004 Indian Ocean earthquake and tsunami the importance of accurate bathymetry for the prediction of tsunamis received increased attention. The figure below from SeaDataNet shows the northern portion of Madagascar's coastline is beginning to be covered by MBES surveys.

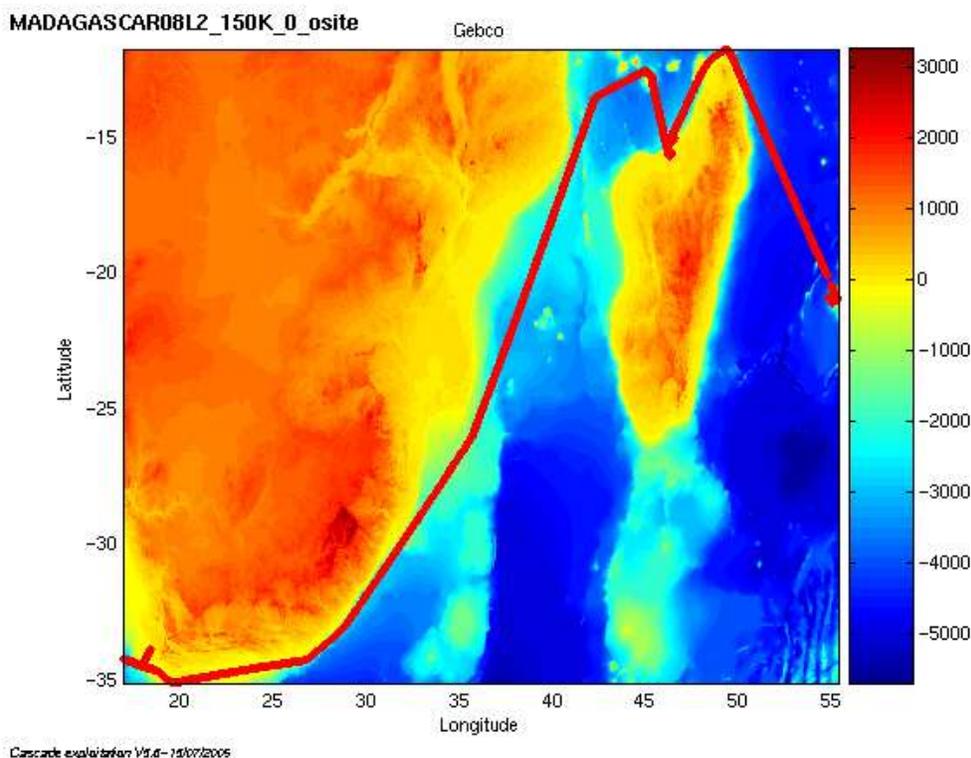


The French hydrographic office conducted two missions using the vessel *Beautemps-Beaupré* to improve hydrographic information off the coast of Madagascar. The second mission (Madagascar Leg 2) occurred during April and May, 2008. The transit of the *Beautemps-Beaupré* along the Northwest coast followed a vessel track very similar to the path used by the EM contractor from the port of Diego Suarez to the Port of Mahajanga. The track of the *Beautemps-Beaupré* is shown immediately below:



Vessel track of the *Beautemps-Beaupré* in April and May 2008

<http://www.ifremer.fr/sismer/UK/catal/campagne/campagnea.htql?crno=8090080>



Bathymetry for Madagascar Leg 2 in April-May 2008

www.ifremer.fr/sismer/catal/campagne/docscan/ADCPBB2008.doc

Based on internet searches, it appears that the Beautemps-Beaupré continuously uses marine echosounders to map the seabottom bathymetry during such transits. In addition to their transit along the Northwest coast of Madagascar, they also conducted a hydrographic survey of the port of Mahajanga and surrounding area during 5 weeks in April and May 2008. Their work included mapping port of Mahajanga approaches to/from deeper water. It is important to note that the echosounders aboard the Beautemps-Beaupré have the same model numbers as those on the vessel contracted by EM. Note that the vessel track for the Beautemps-Beaupré from Northern Madagascar to Mahajanga is very similar to the May 29, 2008 track reported separately for the vessel contracted by EM. Publically available information from this cruise is presented in the Appendix.

TSUNAMI WARNINGS

The world's fourth largest island, Madagascar, has about 4,828 km of coastline. Madagascar has a total land area of 587,040 sq. km. and a population of 18,040,341 with 132 population centers living within 8 km of the coast. No casualties were reported as a result of the 2004 tsunami; however low-lying coastal districts were flooded and waves 1.6 to 10 meters in height swept through the towns of Manakara, Sambava and Vohemar, leaving over 1,000 people homeless.

UNESCO/IOC: The Intergovernmental Oceanographic Commission of UNESCO (IOC), which was created in 1960 to promote international cooperation and coordinate programmes in research, sustainable development, protection of the marine environment, capacity-building for improved management, and decision-making, is now coordinating the establishment of a tsunami early warning system in the Indian Ocean and other regions as well. More details available from

<http://ioc-unesco.org/>

Several internet references highlight the international cooperation in developing a tsunami warning system for coastal areas bordering the Indian Ocean. One good overview paper is "COAST-MAP-IO Report" (Updated June 2008)

<http://www.ioc-cd.org/index.php/activities/coast-map-io>

COAST-MAP-IO: Supported by the Italian Ministry of Foreign Affairs, this project is part of IOC activities to build coastal resilience to marine hazards in the Indian Ocean. Quality near-shore bathymetry is critical for accurate inundation risk mapping and improved safety from tsunami and ocean-based hazard in the coastal zone. COAST-MAP-IO focuses on strengthening capacity of 12 Indian Ocean countries in collection of coastal bathymetry and application to accurate risk mapping and management. More details related to Madagascar are available from:

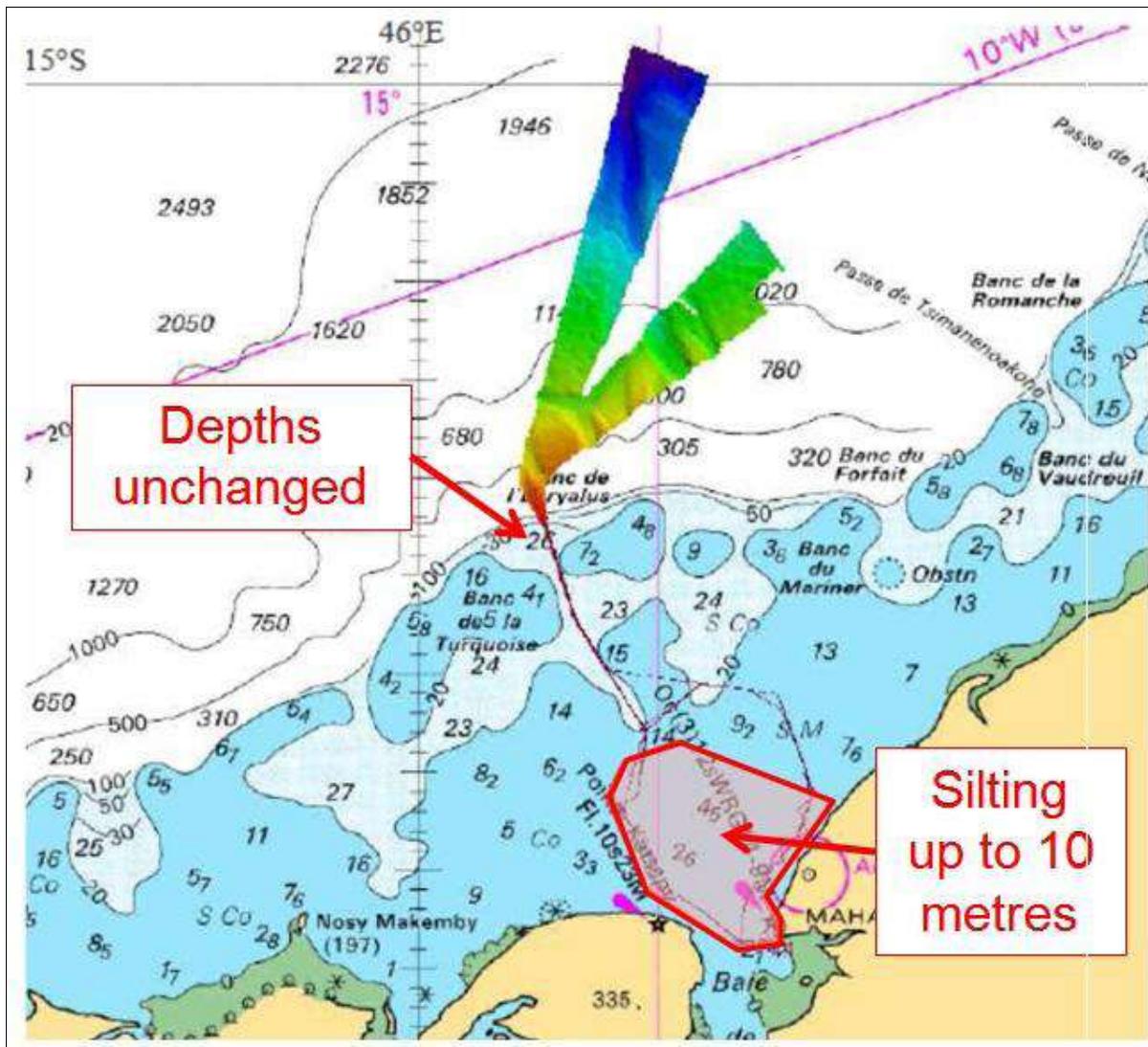
<http://www.ioc-cd.org> (Activities menu, COAST-MAP-IO sub-menu item).

SHIPPING SAFETY- CHARTS FOR HARBORS AND PORTS

French surveys of Madagascar started in 1884 and became fully professional with the creation of a regular Survey Unit, the Mission Hydrographique de l'Océan Indien (MHOI), operating large survey ships and launches. In 2007, by making use among other sources of the Ministry of Plan's reports, SHOM (French Hydrographic and Oceanographic Service) established an exhaustive collection of the known Madagascan priorities. The intention was to prepare a Charting and Survey Scheme, have the hydrographic priorities confirmed by the FTM, and then submitted to the Government for inclusion in the Madagascar Action Plan mentioned in Part II, § SAIHC 5. This, unfortunately, did not materialize but the project was well on its way as Madagascar issued a diplomatic requirement for assistance, both to France and Norway, in April 2008, to which France responded positively. The original project had taken stock of the Madagascan 5 year's development plan and SHOM earlier recommendation that a decent chart scheme of Madagascar should consist of about 200 charts and plans.

Silting in the Port of Mahajanga, the third largest port in Madagascar has raised concerns over navigational safety. It was recognized that over the past few decades the bathymetric profile in the port and approaches to the port were hazardous due to poor navigational information. This was exacerbated by a cyclone that hit the area in 2006. The port has been difficult to fully utilize due to navigational hazards.

A Mahajanga survey was performed simultaneously in April – May 2008 by the ocean survey vessel “Beautemps-Beaupré” and her two survey launches, all fitted with MBES and up-to-date equipment. (EXCERPT OF THE MAHAJANGA 2008-2010 SURVEYS) The intention was to control the original 1960 chart of the port and approaches, which originated from 1888-1892 and 1948 – 1963 surveys, and update the nautical information.



Seafloor Mapping near the Port of Mahajanga (Madagascar Leg 2 April-May 2008)

FISHING, PORT AND SHIPPING ACTIVITY

Commercial fishing, port and shipping activities may be relevant to the stranding event. These include activity near Narinda Bay, which has characteristics of a natural deep harbor and has long been targeted as a potential deep water port site. Narinda Bay is immediately south of the mouth of the Loza River where the whales entered the estuary. Antsohihy, which is significantly inland up the Loza River, was the location where whales were sighted on May 31, 2008. The docks at

Antsohihy handle significant cargo and some relatively large vessels can be seen visiting the docks on satellite photos.



The Google Earth Image above shows the spatial relationship between Narinda Bay, the river/estuary where the whales stranded and the village where the stranded animals were sighted on May 31, 2008 (marked by “A” on the image.)

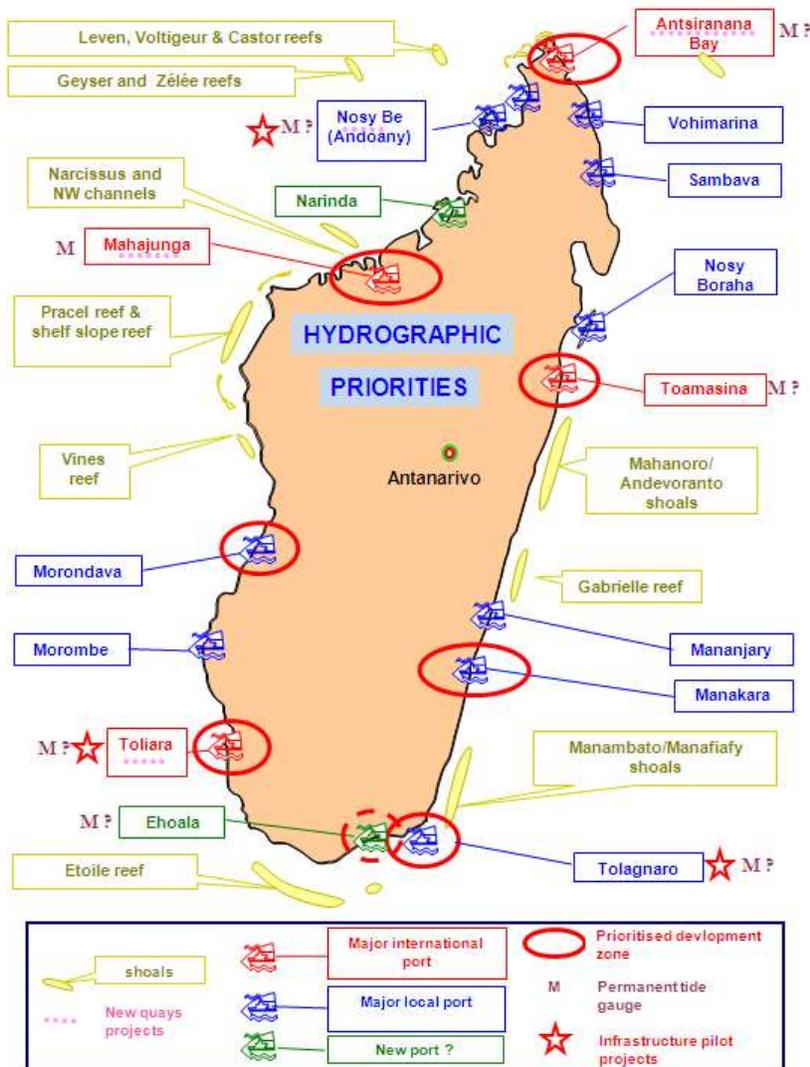
The following section will summarize citations and evidence found for:

- 1) Potential development of a new port facility in Narinda Bay, very near where the stranding event occurred,
- 2) Vessel traffic to and from the dock facilities at Antsohihy, near where the stranded whales were sighted,
- 3) A fairly sudden uptake in satellite imagery acquisition around the time of the stranding event,
- 4) Commercial fishing interested in northwest Madagascar.

There is significant economic interest in the immediate vicinity of the whale stranding. Not all of the information is transparent, so some of the interests are unknown at this time.

PORT DEVELOPMENT

Port development has been widely recognized as crucial to the economic development of Madagascar. Development of modern deep water ports require sophisticated seafloor mapping and significant updating of navigational charts. Hydrographic surveys are a key component of the development plan.

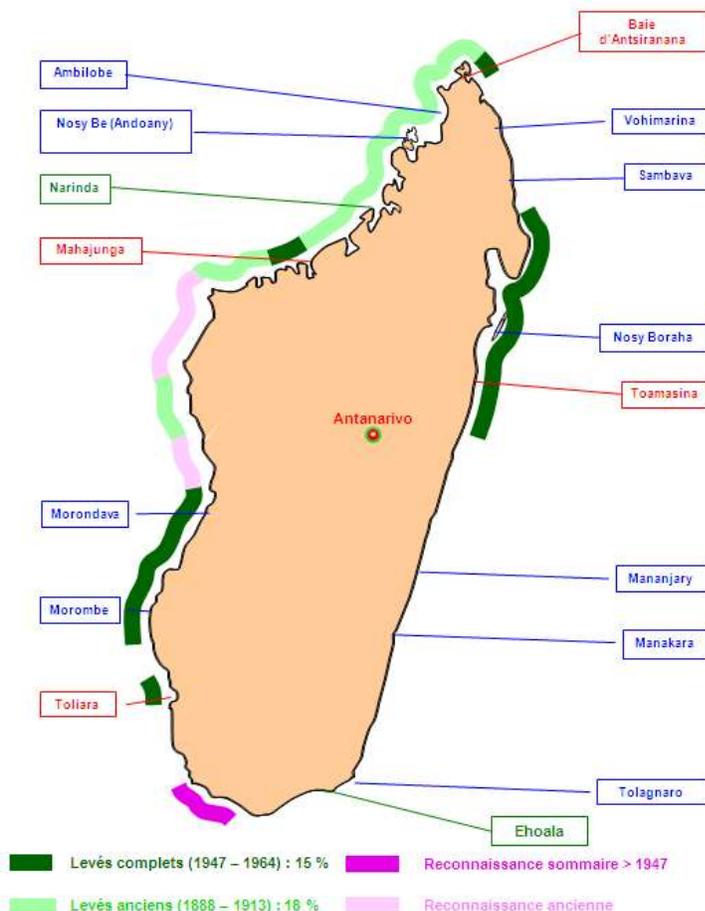


The chart above summarizes the hydrographic priorities in Madagascar. Note the indication that Narinda Bay was selected as a candidate location for a new port. Reference: “REPORT ON THE STATUS OF HYDROGRAPHY IN MADAGASCAR AND OF Aton IN THE PORT OF MAHAJANGA” (26 AUGUST 2011)

http://88.208.211.37/mtg_docs/CB/CBA/Technical%20visits/TV11/Madagascar%20SAIHC%20&%20World%20Bank%20Q&A_final-report.pdf

The following summarizes thoughts from this report:

As a matter of interest it has been assessed that the completion of the Madagascan original survey scheme would take 30 years for a fully equipped vessel operating 2 full months per year (not counting deployments, calls, etc.). This bolsters the need to invest heavily in satellite charting. Whilst high-quality products such as INT charts of main ports & maritime routes and ENCs should remain within well-established HOs, SHOM for the moment, a great deal of national charting could be performed at reasonable cost, locally, by combining valid ancient surveys and modern satellite imagery into a simple GIS.



Status of hydrographic charting in Madagascar

The report referenced above is primarily focused on the port of Mahajanga, but also contained significant information about the prioritization of other port development in Madagascar including Narinda.

The “Madagascar National Transportation Plan” includes plans for development of Narinda Bay and information on the use of the port at Antsohihy.

http://www.transport.gov.mg/document/pdf/rapport_final_maritime.pdf

In this report Narinda Bay is identified as a strong candidate for a new deep water port. The report contains an analysis of the appropriateness of new deep-water ports for 4 potential sites (Narinda Bay, Maintirano, Morondava, and Manakara). A port at Manakara would serve 27% of the population. This region is one of the most populated in Madagascar and remains relatively inaccessible. A new port in the Narinda could serve up to 18% of the national population in 2020, subject to a transfer of goods from the ports of Mahajanga and Anstiranana to the new port would make it the best new deep-water port on the west coast of Madagascar. A new port at Narinda Bay would be about 30% cheaper than a new port in Manakara due to the fact that a sea wall would not need to be constructed at Narinda.

SHIPPING THROUGH NARINDA/ANTSOHIHY

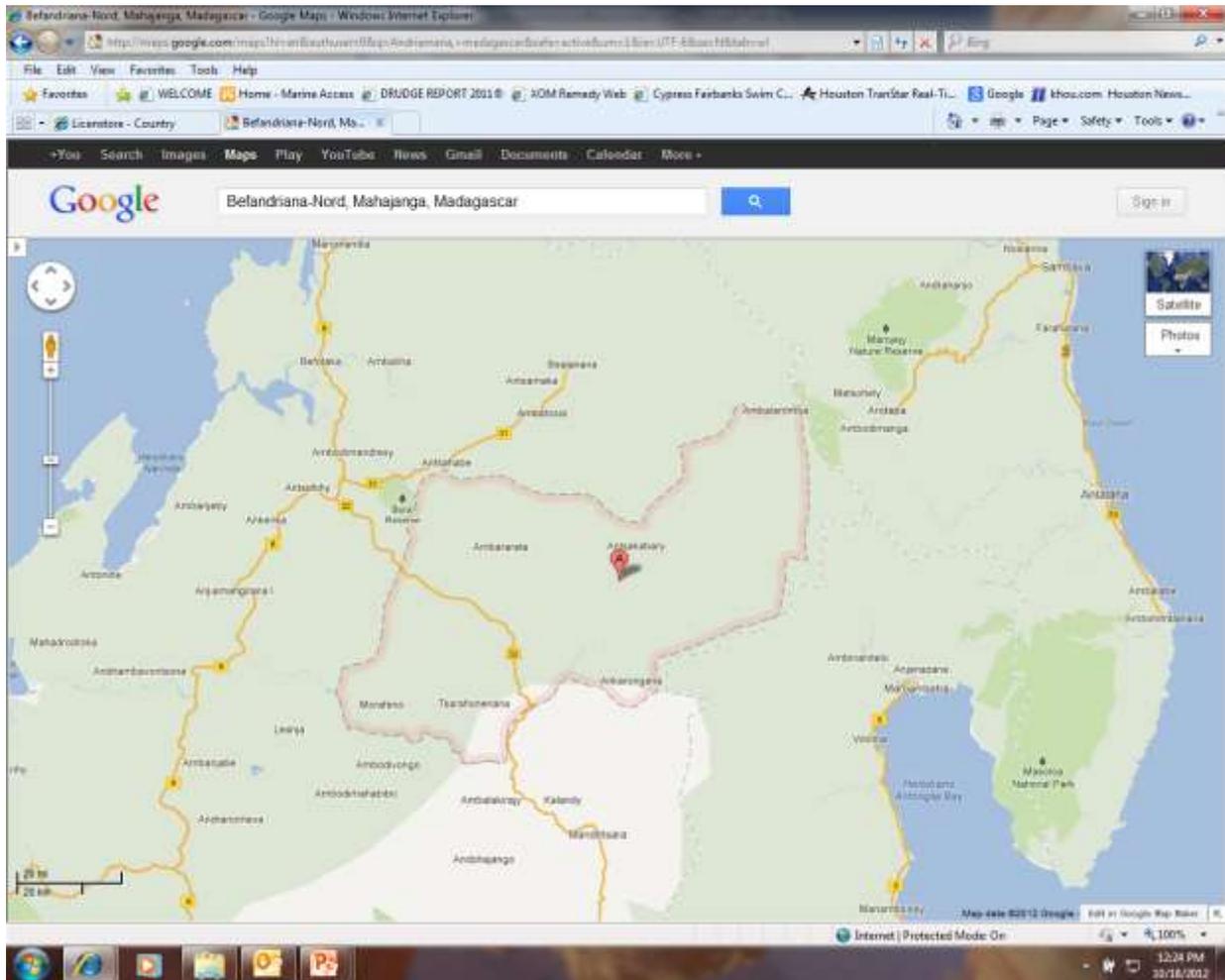
The Madagascar National Transportation Plan cited above highlights that as early as the 2001 and 2002 time frame the port of Antsohihy was transporting some 12,000 to 15,000 tonnes per year. At least some of the shipping activity through the port of Antsohihy is related to the export of minerals.

Chromite is this country’s most important mineral commodity, and all production is for export. Two open pit mines, each with a capacity of 300,000 tons of chromite ore per year, are operated. The Adriamena mine was developed by the French firm Comina before it was nationalized in 1976. Its ores must be processed to reduce an unacceptably high phosphorus level. The newer mine, Befandriana, is a primitive setup consisting of several small open pits and no concentrator. Ores from this mine do not have a high phosphorus level and are simply screened to produce two separate grades.

During monsoon season, December to April, the Befandriana pits cannot be operated. Transportation from Adriamena is by truck and railroad to the port of Toamasina (Tamatave). From Befandriana, ores are trucked about 100 miles to

Narinda Bay for shipment. Due to the shallowness of the bay, ores must be transferred by small vessels to ocean freighters; loading of one shipment can take 3 weeks.

<http://www.princeton.edu/~ota/disk2/1985/8525/852507.PDF> (pages 144-145)

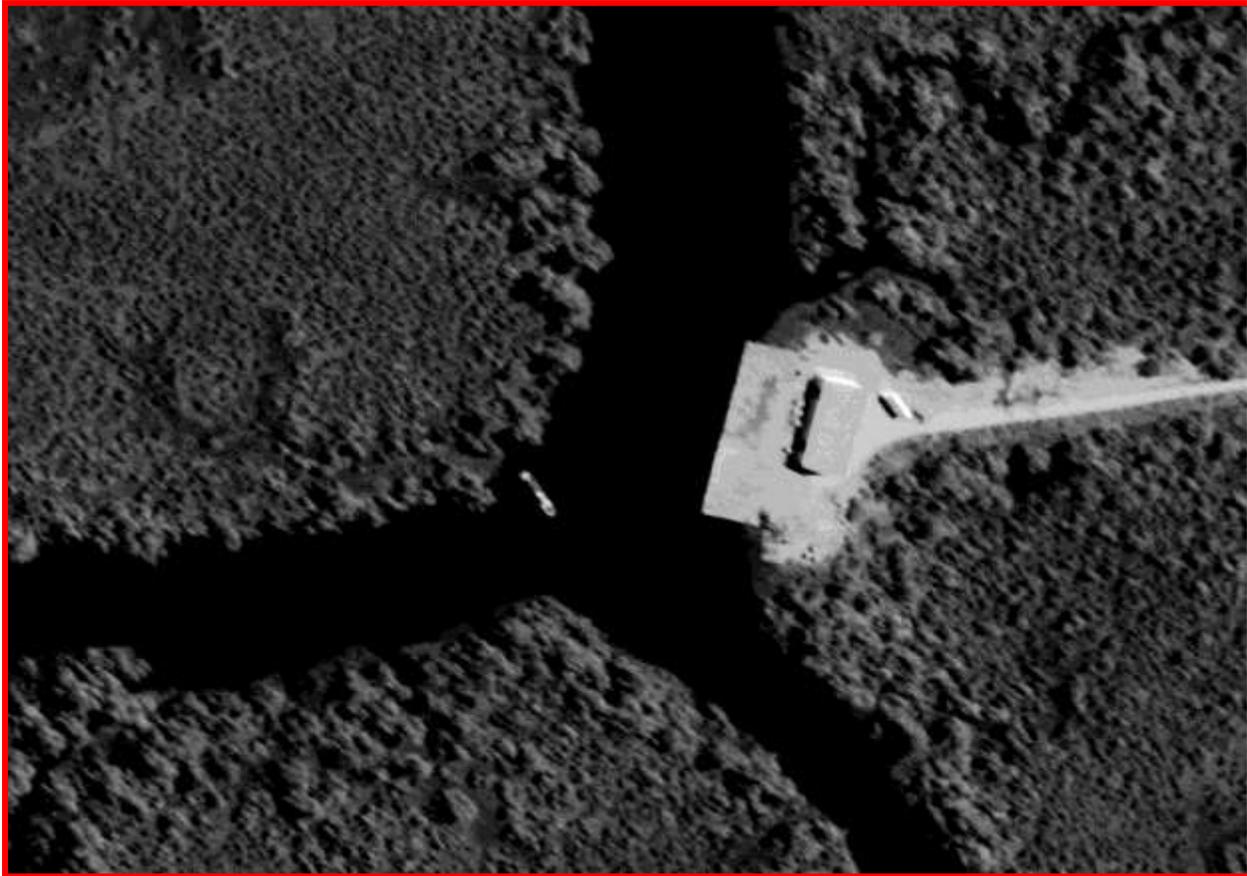


The image above shows the location of the Befandriana mine (marked A) relative to Narinda Bay.

We know from satellite imagery, shown below, that two relatively large vessels were docked in Antsohihy on November 11, 2004. One of those vessels has the characteristics of a naval vessel; the other is consistent with an ore carrier.



A June 14, 2008 satellite image of the same dock at Antsohihy is shown below. In this image a vessel with characteristics of a naval vessel can be seen.



SATELLITE IMAGES

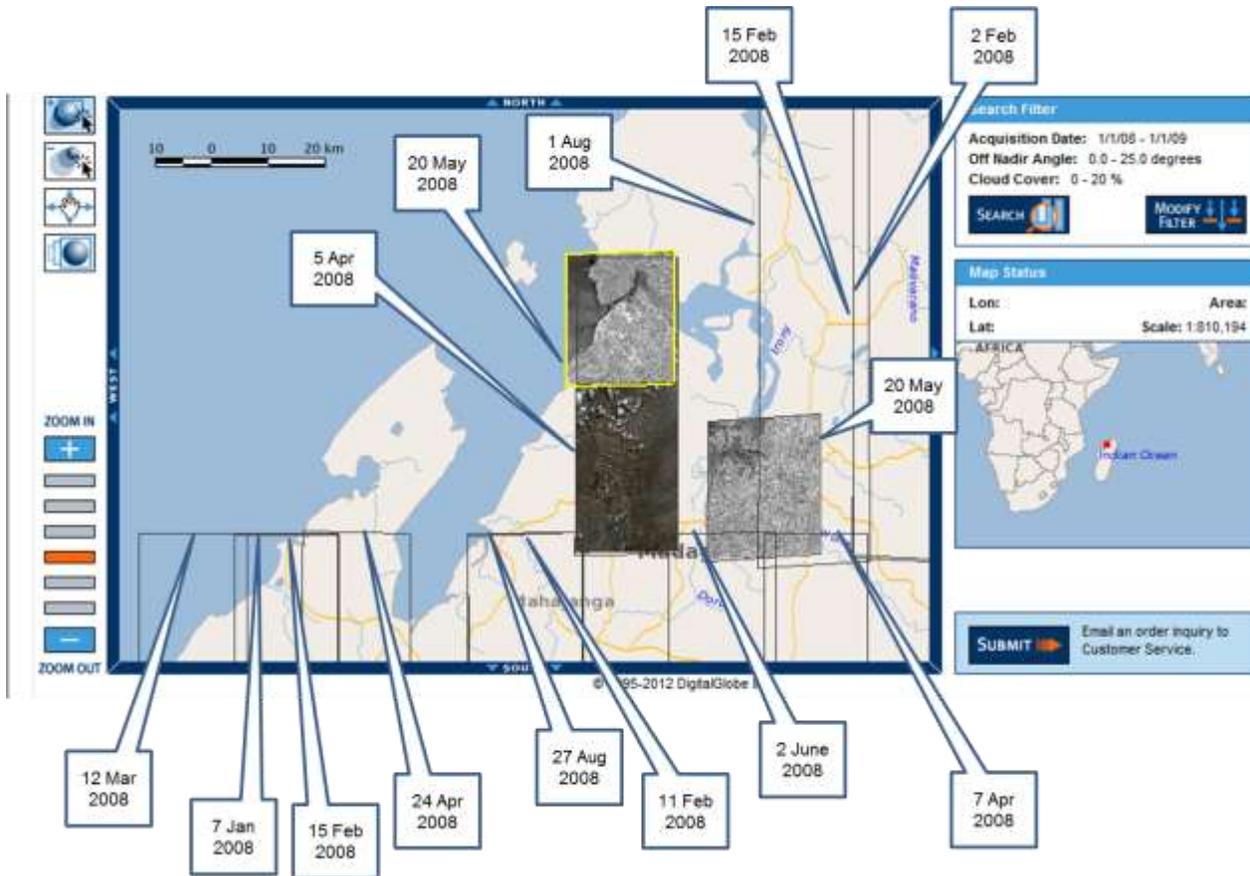
In the reports cited above, heavy interest was expressed in developing bathymetric charts using satellite imagery. The directed acquisition of satellite photos is fairly expensive and is usually associated with either industrial development or military exercises/ intelligence collection.

It is possible to qualitatively gauge the level of interest in an area through time by looking at the imaging of that area in the image archives of Digital Globe.

<https://browse.digitalglobe.com/imagefinder/main.jsp;jsessionid=5C4447C3FD8D7ABA4BB4A09CE4A57E8D?>

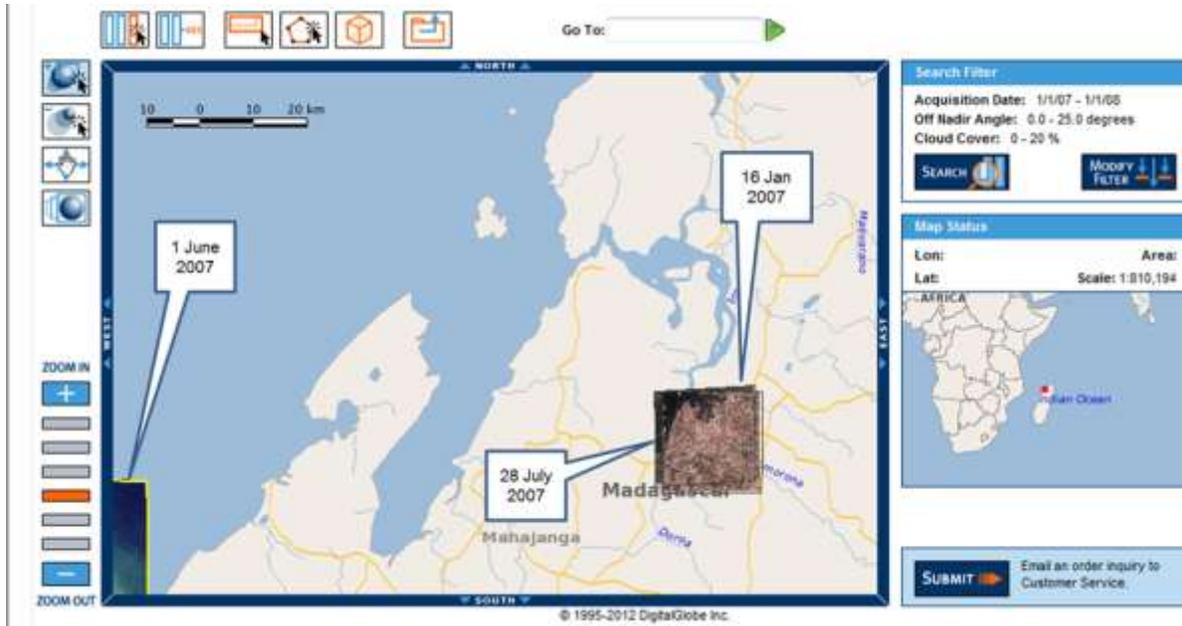
Sixteen satellite images were acquired in 2008 that cover the area around Narinda Bay and Antsohihy (including two commissioned by EM on June 10 which are not

stored in the Digital Globe archive). Fourteen were acquired before and only two after June 2008. Two images were acquired of exactly the area at the mouth of the estuary where the whales entered the river (April 5 and May 20) and one covers the area around Antsohihy (May 20). An unknown source requested acquisition of satellite images in the area of the whale stranding on May 20, 2008. It is our understanding that NOAA can learn who requested the imagery if desired.

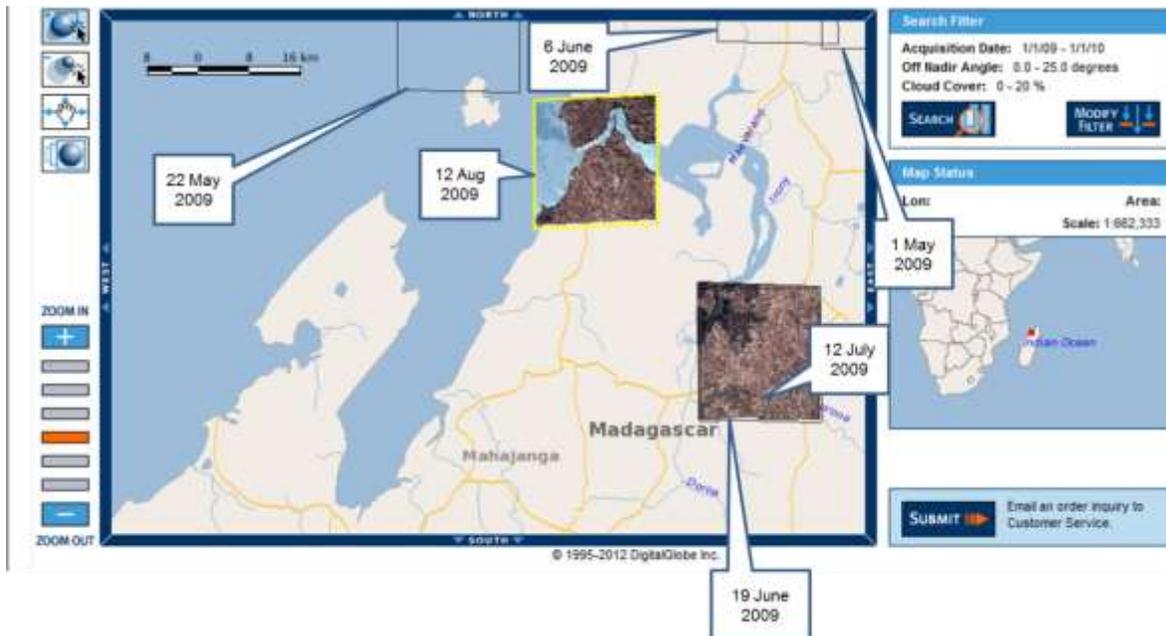


The screen shot above illustrated the images contained in the Digital Globe database that were acquired in 2008.

There are no 2006 satellite images of this region in the archive. But the same areas that were imaged on May 20, 2008 were imaged multiple times between 2007 and 2009. The area around Antsohihy has been imaged 5 times (January and July 2007; May 2008; and June and July 2009). The mouth of the estuary at Narinda Bay has been imaged three times (April and May 2008; and August 2009). The screenshot below shows the images of the area which are contained in the archive and were acquired in 2007.



The screenshot below shows the images of the area which are contained in the archive and were acquired in 2009.



In 2010 the entire area was blanketed by images.

A synopsis of the May 20 and June 14, 2008 images of the area of interest is contained in an accompanying PowerPoint. The images are available on request.

Appendix: Key information about the 2008 French Hydrographic Cruise:

Ship : Beautemps-Beaupré

- Photo of Beautemps-Beaupre
<http://www.shipspotting.com/gallery/photo.php?lid=1263918>
- MBES Equipment aboard Beautemps-Beaupre identical model numbers to MBES used by EM Contractor
ftp://ftp.dms.usm.edu/MBWS_3-4April05/.../B8_SHOM_Debese.ppt
 - EM 120
 - EM 1002

Start : 02/04/2008 **Port of Departure :**Le Port (Reunion)

End : 24/05/2008 **Port of Return :**Cape Town (South Africa)

Scientific Authority:

- SHOM - ETABLISSEMENT DE BREST
SERVICE HYDROGRAPHIQUE DE LA MARINE
13, rue du Chatellier
29228 BREST cedex 2
tél : +33 (0)2 98.22.05.73 fax : +33 (0)2 98.22.05.91 email :
webmaster@shom.fr

Ship Fitting-out Authority : Marine Nationale/SHOM

Chief Scientist(S) : FRABOUL (IETA)

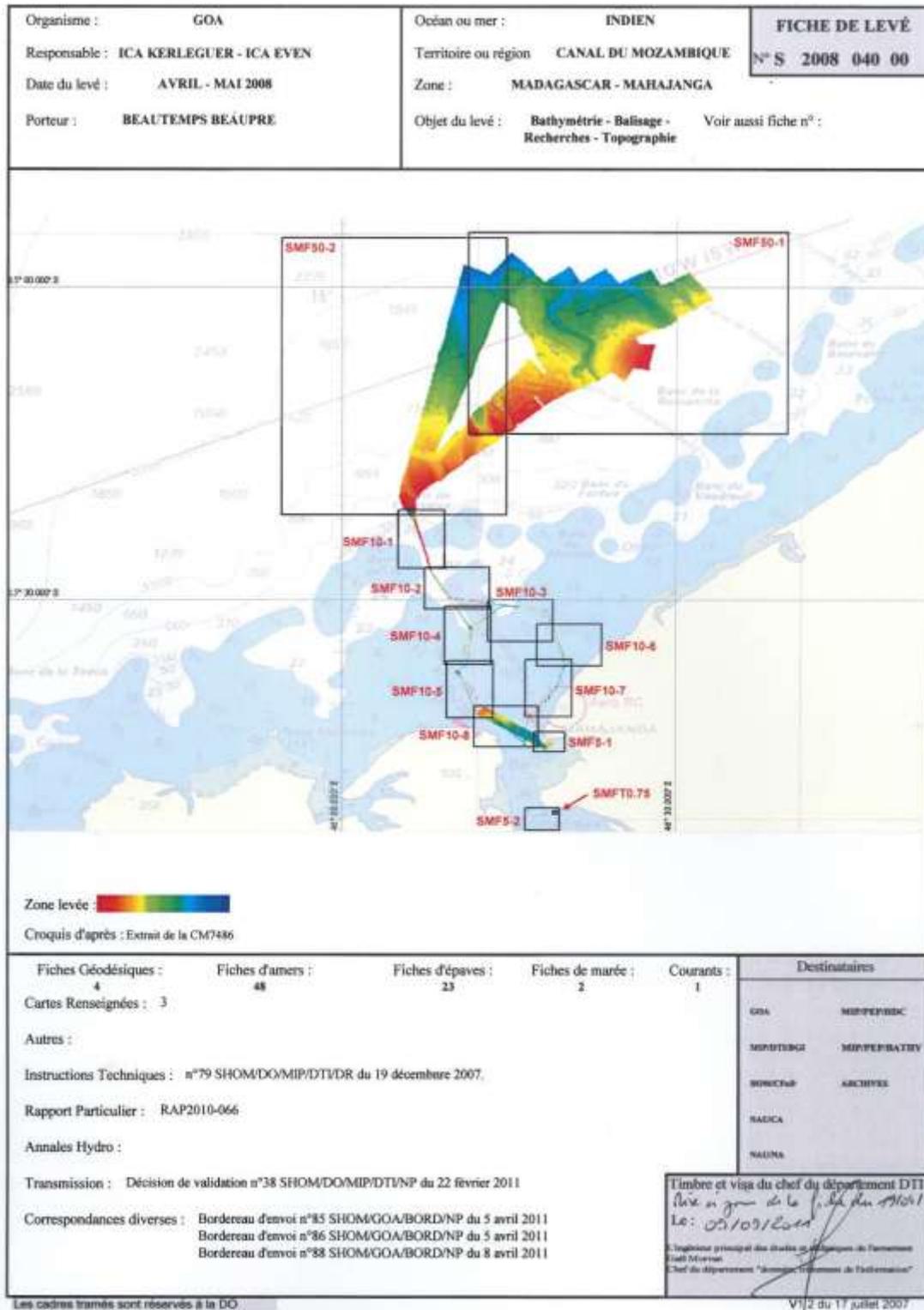
SeaDataNet Common Data Index (CDI) V2

Details

WHAT?					
Data set name	540-S200804100-25				
Discipline	Marine geology Terrestrial				
Category	Gravity, magnetics and bathymetry Terrestrial				
Variables measured	Bathymetry and Elevation				
Abstract	Leve bathymetrique effectue entre La Reunion et Brest. - Levé bathymétrique effectué dans le carreau GEBCO n° 311 aux sondeurs EM120 et EM10025. - 2493 sondes/soundings				
Data format	Ocean Data View ASCII input. Version 0.4				
Data size	6.1				
Data set creation date	20080916				
WHERE?					
Map					
GML id	ms01				
GML objects	<table border="1"> <thead> <tr> <th>Name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>31020</td> <td>coverage</td> </tr> </tbody> </table>	Name	Description	31020	coverage
Name	Description				
31020	coverage				
Datum	World Geodetic System 84				
Measuring area type	surface				
Water depth (m)	-9999				
Depth reference	Lowest Astronomical Tide				
Minimum instrument depth (m)	-9999				
Maximum instrument depth (m)	-9999				
WHEN?					
Start date	20080402				
Start time	00:00:00				
End date	20080701				
End time	23:59:59				
HOW?					
Instrument / gear type	multi-beam echosounders				
Platform type	research vessel				
Cruise name	Nom du leve : Valorisation des transits a bord du BHO <i>Beautemps-Beaupre > au cours du leg2 en 2008.				
Alternative cruise name	S200804100				
Cruise start date	20080402				
WHO?					

Originator	SHOM (SERVICE HYDROGRAPHIQUE ET OCEANOGRAPHIQUE DE LA MARINE)
Data Holding centre	SHOM (SERVICE HYDROGRAPHIQUE ET OCEANOGRAPHIQUE DE LA MARINE)
HOW TO GET THE DATA?	
Data Distributor	SHOM (SERVICE HYDROGRAPHIQUE ET OCEANOGRAPHIQUE DE LA MARINE)
Access/ordering of data	web data access with registration
Access restriction	by negotiation distribution cost charge licence
CDI-METADATA	
CDI-record id	1160261
CDI-record creation date	20110617
CDI-partner	SHOM (SERVICE HYDROGRAPHIQUE ET OCEANOGRAPHIQUE DE LA MARINE)

Bathymetry Data Collected at Port of Mahajanga and Port approaches



Minute ou Vol n°	DÉSIGNATION			FICHE DE LEVÉ
				N° S 2008 040 00
1	SMF50-1	Minute de bathymétrie au 1/50 000	Polyester	Format A0
2	SMF50-2	Minute de bathymétrie au 1/50 000	Polyester	Format A0
3	SMF10-1	Minute de bathymétrie au 1/10 000	Polyester	Format A0
4	SMF10-2	Minute de bathymétrie au 1/10 000	Polyester	Format A0
5	SMF10-3	Minute de bathymétrie au 1/10 000	Polyester	Format A0
6	SMF10-4	Minute de bathymétrie au 1/10 000	Polyester	Format A0
7	SMF10-5	Minute de bathymétrie au 1/10 000	Polyester	Format A0
8	SMF10-6	Minute de bathymétrie au 1/10 000	Polyester	Format A0
9	SMF10-7	Minute de bathymétrie au 1/10 000	Polyester	Format A0
10	SMF10-8	Minute de bathymétrie au 1/10 000	Polyester	Format A0
11	SMF5-1	Minute de bathymétrie au 1/5 000	Polyester	Format A0
12	SMF5-2	Minute de bathymétrie au 1/5 000	Polyester	Format A0
13	SMFT0.75	Minute de bathymétrie au 1/750	Polyester	Format A0
14	RN5	Minute de recherches et de natures de fond au 1/5 000	Polyester	Format A0
15	RN10	Minute de recherches et de natures de fond au 1/10 000	Polyester	Format A0
16	Cr4852	Carte renseignée au 1/121 000	Polyester	Format A0
17	Cr6077	Carte renseignée au 1/35 000	Polyester	Format A0
18	Cr6078	Carte renseignée au 1/10 000	Polyester	Format A1
		Données numériques BRI non contrôlées archivées sous Tina:		
		Voir le fichier lisez-moi_FL_donnees_num_BRI.txt		
		Données numériques HOM non contrôlées archivées sous Tina :		
		Voir le fichier lisez-moi_FL_donnees_num_HOM.txt		
500		5 cahiers VH PELICAN (quart Secchi/quart SMF-SONAL/prélèvement d'eau/relevés bathy).		
		4 cahiers VH CORMORAN (quart Secchi/quart SMF-SONAL/prélèvement d'eau/relevés bathy).		
		1 cahier de quart SMF BHO BBP		
		4 cahiers de fiche de prélèvements superficiels (2 PELICAN/2 CORMORAN)		
		3 cahiers de rédaction de bathymétrie		
		7 cahiers de traitement de bathymétrie		
		2 rapports techniques de l'ASECNA		
		3 cahiers de nivellement et/ou tirants d'air		
		1 dossier FOM et archive marée		
		3 fiches de mouillage (1 marégraphe/2 courantomètre)		
		3 cahiers de terrain (revue d'amers/spatio et stéréo / plageage)		
		1 cahier de clichés photographique pour la stéréopréparation		
		1 cahier de fiches de station des repères géodésiques		
		2 cahier de traitement LGO (spatio / stéréo)		
		1 carte terrestre de Mahajanga		
		1 dossier BRI		

The above plot was obtained directly from SHOM.

-----Original Message-----

From: Christian Mouden [<mailto:christian.mouden@shom.fr>]

Sent: Monday, October 15, 2012 8:41 AM

To: nknutstad@gmail.com

Subject: Survey in Madagascar

Dear Sir,

I'm the person you had on the phone on Friday.

SHOM's survey ship Beautemps-Beaupré effectively conducted a survey in 2008 in Majunga. You can see the details in the attached file.

I'm not sure your request was for this harbour, so if you have any other query about data availability, please contact : philippe.lurton@shom.fr

If you are interested in getting the data of a survey, please contact : bp@shom.fr

Best regards,

Christian Mouden