Madagascar

National Marine Pollution Experiences

Land Based Sources and Activities Protocol Workshop, in Maputo, Mozambique

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National context regarding LBSA management

- Madagascar adopted the LBSA Protocole
- Madagascar is a signatory and has adopted the Manila Declaration to confirm its commitment to develop policies to reduce and control wastewater, marine litter, and pollution from nutrients (fertilizers)
- National action plan related to the Manila declaration was designed for funding and implementation

Overview of the national situation regarding land-based sources of pollution

- Coastal and marine pollution is a localized problem mostly confined to surrounding urban centres
- The main sources of marine and coastal pollution include:
  - Municipal wastewater discharge without any prior treatment
  - Inadequate sanitation (migration leading to slum areas), with national access to improved sanitation of 6.9%

The main sources of marine and coastal pollution (continued)

- Wastewater from hotels and restaurants
- Tailing from mining
- Use of pesticide and fertilizer from cotton and sugar cane plantation
- Slash and burn practice and extensive logging of rainforest/mangroves accelerating erosion, and leading to telluric pollution (affecting mostly wertern coast)
- Mismanagement of municipal solid waste

Wastewater outlet discharging into sea

Dump in a mangrove area

Solid waste in sewage

Solid waste dumped on the shore

Rubbish disposal on the beach

Industrial wastewater

Inadequate sanitation

Telluric Pollution

Challenging management of LBSA

- Caused by among others:
  - Lack of effective enforcement of laws, decree related to LBSA
  - ”Polluter pays” principle hardly enforced due to inadequate and incomplete legislation
  - Absence of policy and strategy for solid waste management
  - Designed pollution strategy remains in the closet for lack of political commitment
  - Weak coordination of activities/projects working for the protection of coastal and marine environment
  - Absence EQO and therefore EQG

Overview of LBSA consequences

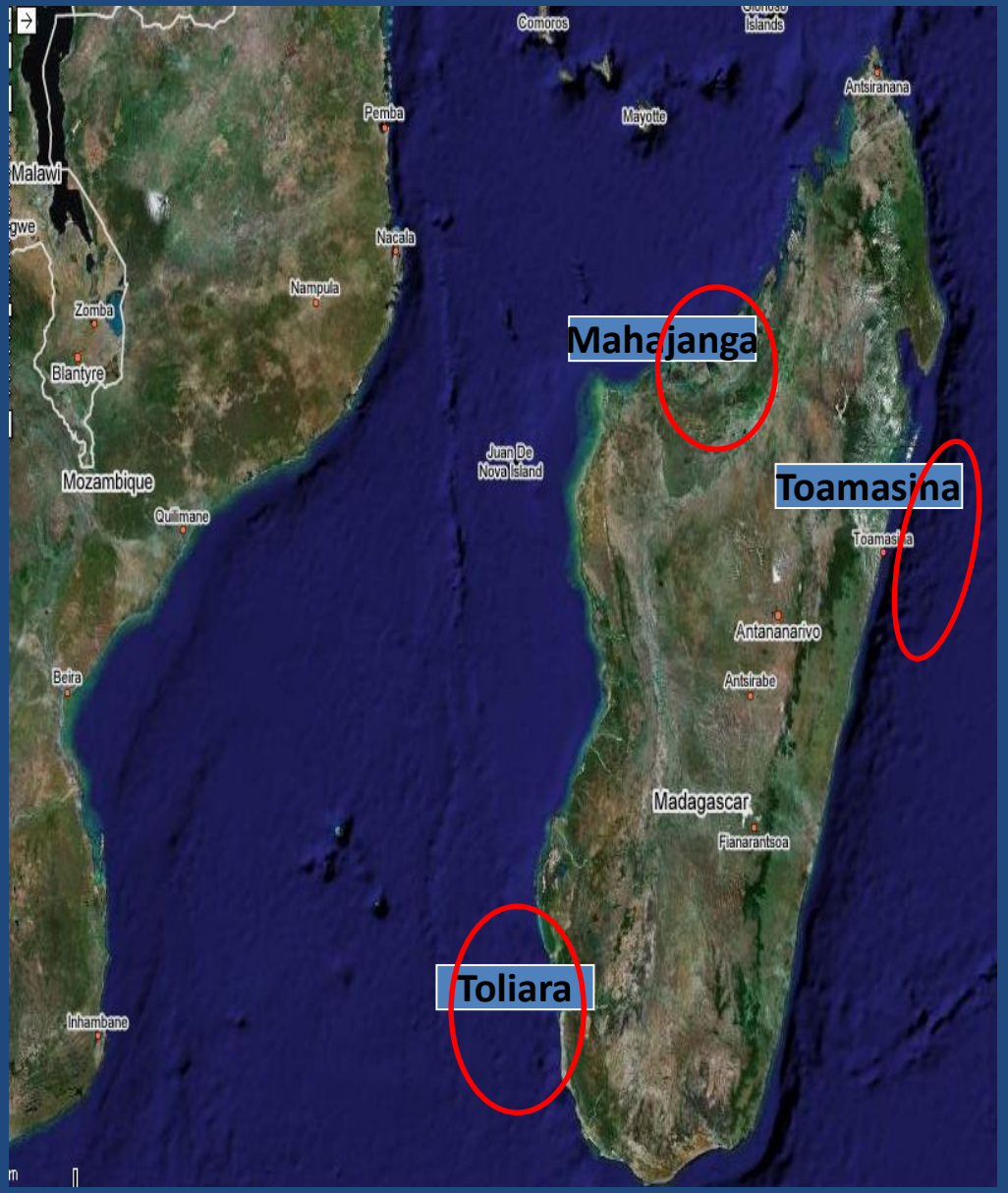
- Sediment and biota contamination by heavy metals due to discharge of municipal waste and mine tailing;
- Beach unfit for recreational use due to relatively bad bacteriological quality of water
- Suspected contamination of certain pelagic fish by cadmium that could impact on exportation
- Frequent case of food poisoning by fish consumption due to degradation of coral reef leading to extensive development of toxic algae
- Visible sign of eutrophicaton of bays

Existing but insufficient response to LBSA

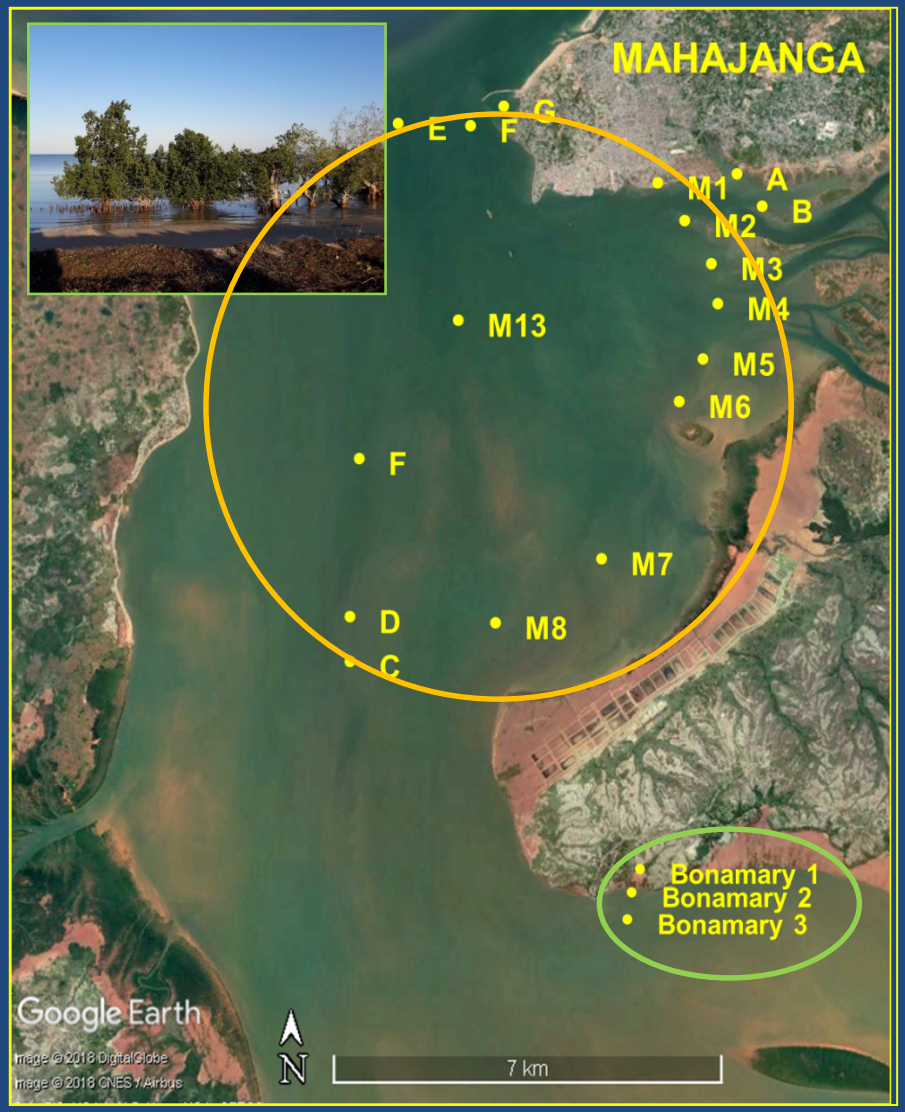
- Incomplete law to fight industrial pollution
- Decree MECIE requiring concerned investments to carry out EIA and design Environmental Management Plan to be object of compliance control
- Wastewater standards but lack of effective control by authority in charge of
- Non effective legislation for solid waste management
- Non effective simple ministerial order to prohibit and curb plastic bags use

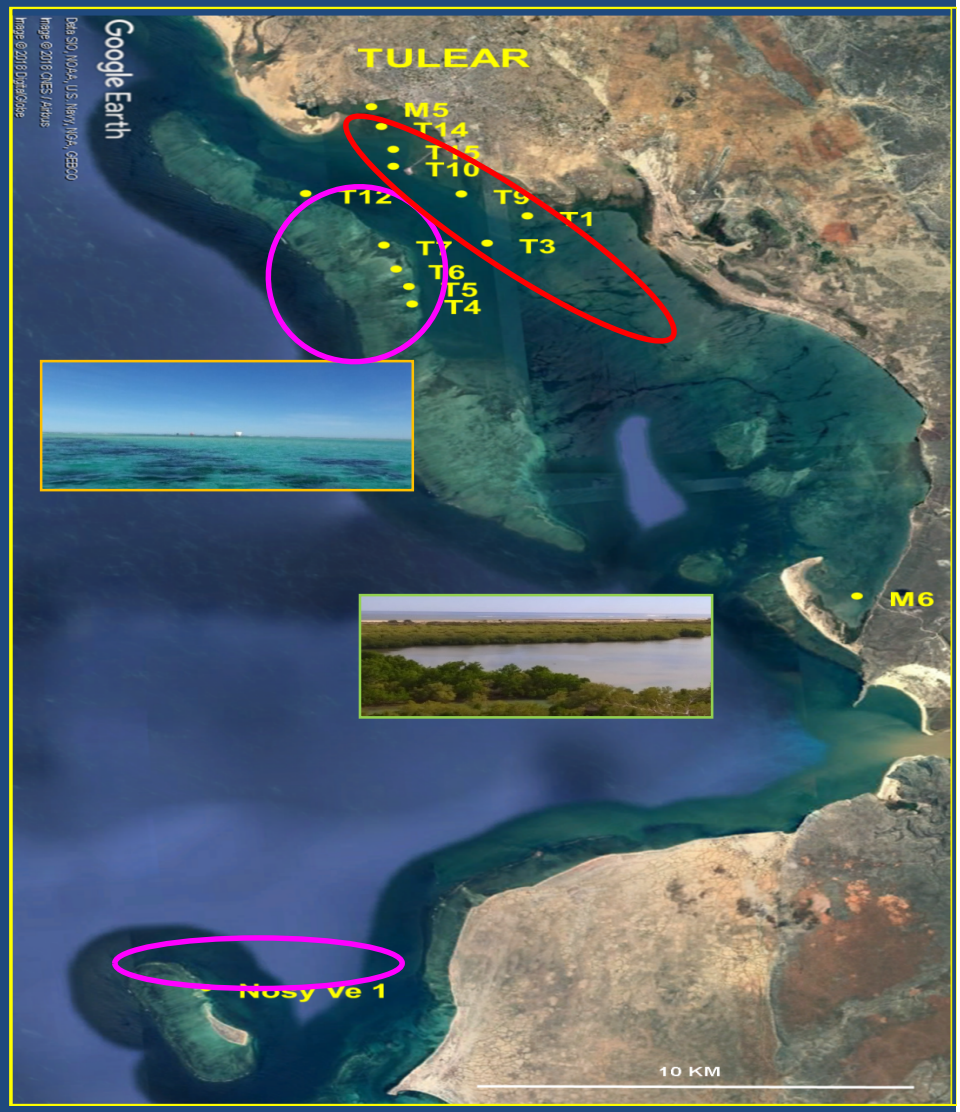
Monitoring LBSA impacts in 3 hotspots

- Monitoring activities as follow up of WIO-LaB project
- 2 hotspots in the west coast: Betsiboka river's estuary (Mahajanga), Great reef in Toliara
- 1 hotspot in the east coast: Toamasina



Monitoring areas





Estuary Mangrove Bay Coral reef

Main objectives

- Reduce stress to the ecosystem by improving water and sediment quality;
- Strengthen and improve national legal framework for effective management of land based sources of pollution;
- Develop national monotoring capacity in order to set up decision making tool (national and local authorities)
- Advocate appropriate solutions to protect healthy environment and to sustainably improve and effectively implement the management of Malagasy biodiversity

Approach

- Identify potential and relevant major pollutants based on WIO-LaB water, sediment and biota quality monitoring resultsmical.
- Combine physico-chemical and biological (foraminifera) monitoring.
- Test and select relevant Environmental quality indicators and indices (contamination indices, background enrichment indices, ecological risk indices (Sediment Quality guidelines), Foram stress index (FSI), Foram-AMBI, Foram index (coral reef)
- Use indicators and indices to process, analyse and convey information to decision-makers

Methodology

- Field sampling : water and sediment
- Lab analyses:
  - Physico-chemical and geochemical analyses: nutrients (water), heavy metals (sediment), organic matter, sand, clay, silt content (sediment)
  - Biological analyses: identification of morphospecies, molecular identification of foraminifera (high throughput sequencing)
- Process and analysis of data using GIS

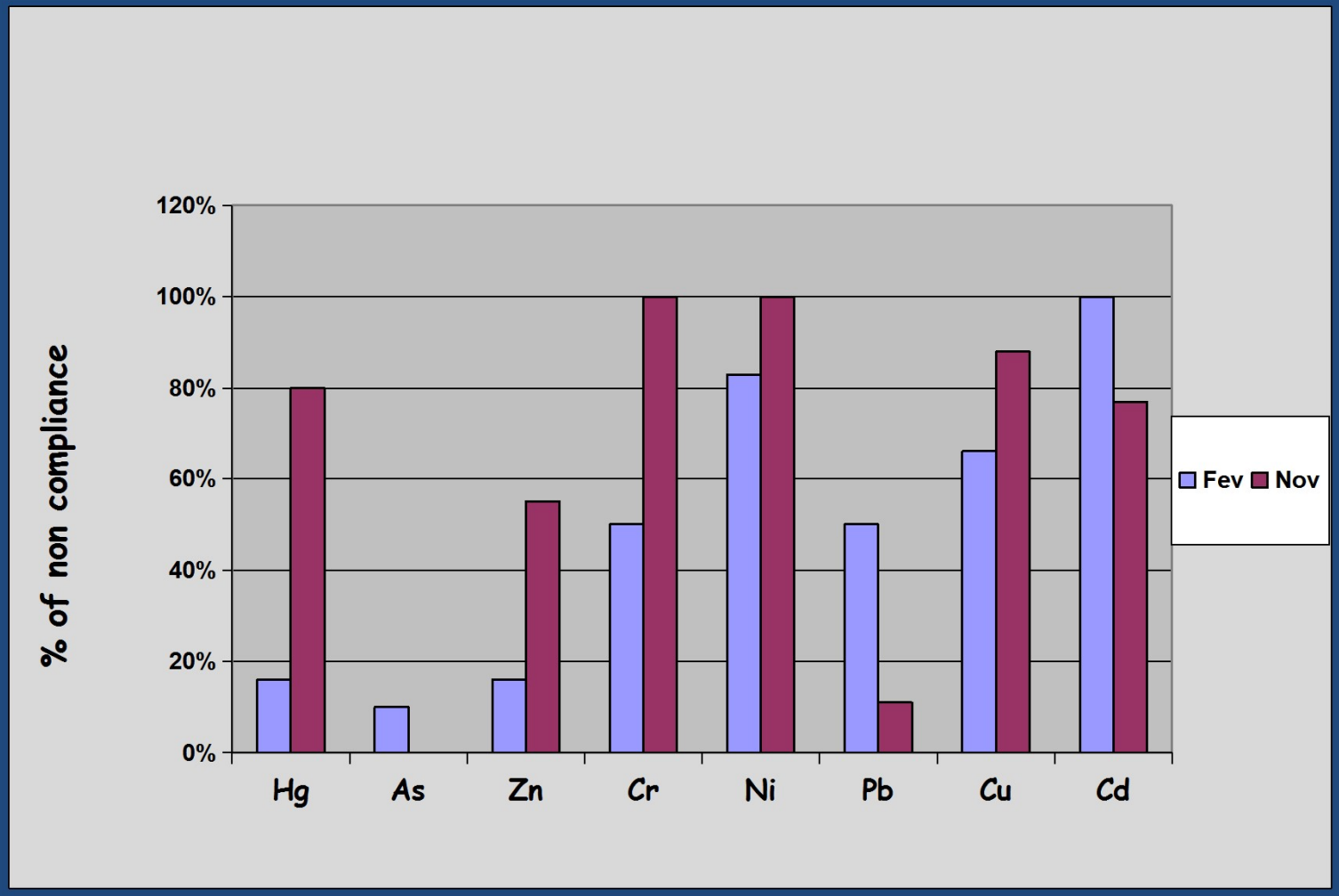
Field sampling

Lab analyses

AAS analysis

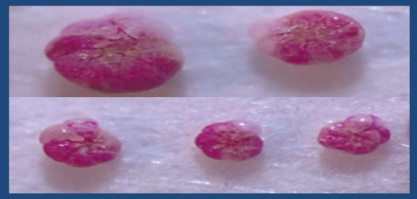
Preliminary results: Conformity to WIO Environmental Quality Guidelines

Case of Mahajanga

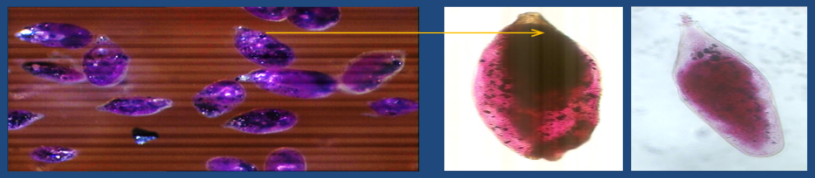


Preliminary data on the first foraminiferal biodiversity census, combined with data on water quality assessment, allowed the identification of:

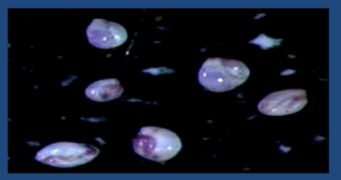
- **Mangrove ecosystems** (Mahajanga and Tulear), characterized by species adapted to very variable daily and seasonal physicochemical conditions:



Ammonia spp.



Psammophaga sp. and detail of heavy metal filling specimens



Quinqueloculina sp.

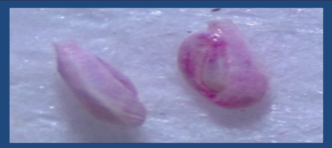
500 µ

- **Bay ecosystems** (Mahajanga and Tulear), characterized by infaunal species and epiphytes, according to the type of substrate:

Bolivina striatula

Ammonia spp.

Triloculina trigonula

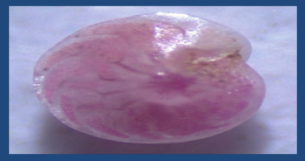


Quinqueloculina carinatostriata

Elphidium sp.

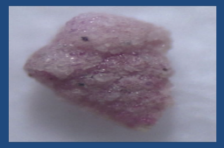
500 µ

- **Coral reef ecosystems** (Tulear), characterized by epiphyte and epilith species:

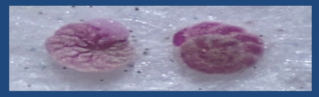


Amphistegina lessonii

Operculina sp.

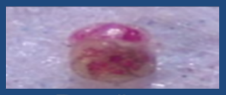


Textularia sp.



Paratrochammina bartrami

Sorites sp.



Rosalina sp.

500 µ

In addition sediment samples have also been taken to perform molecular identification on foraminifera with high-throughput sequencing and to allow the comparison of foraminiferal biodiversity between the different sites. In the future molecular identification will be performed to better understand the different morphotypes of *Ammonia*, presently defined only at the generic level (*Ammonia* spp.).

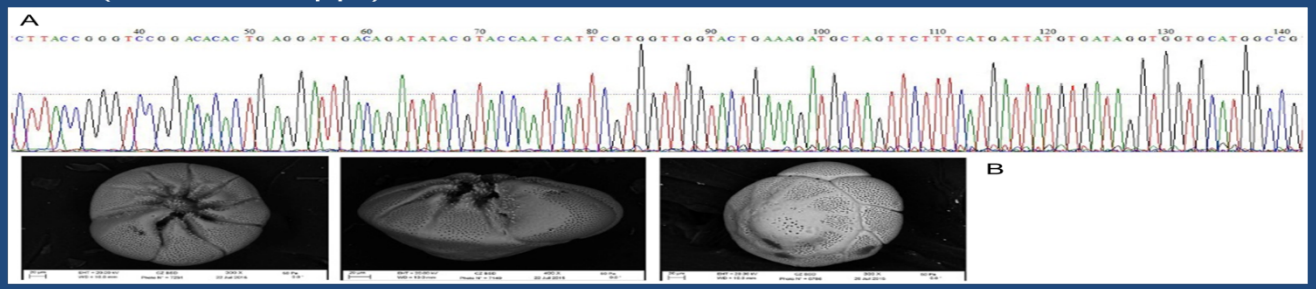
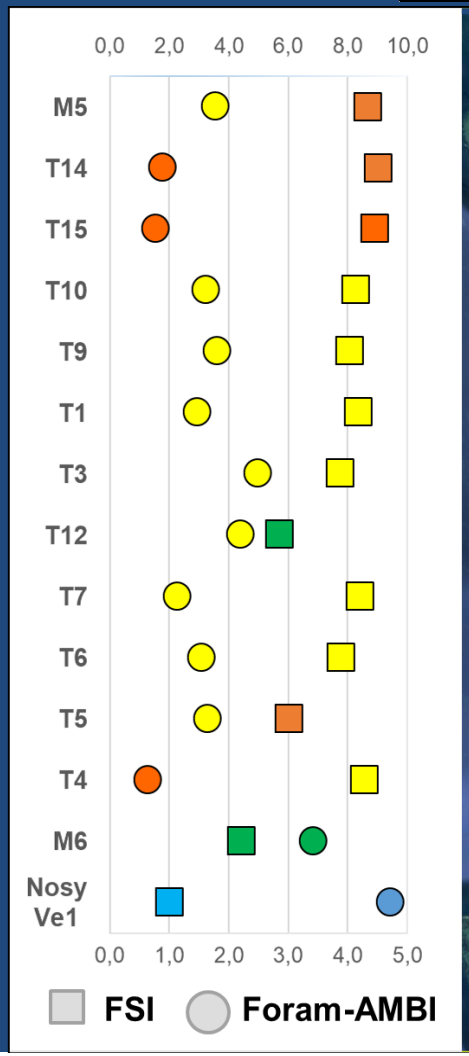


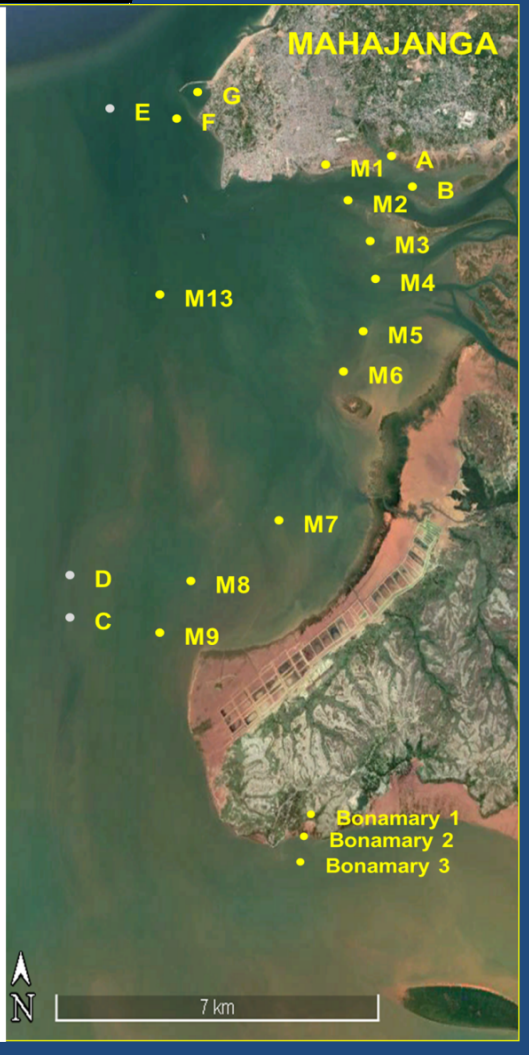
Figure 7.
A) Sequence electropherogram obtained from the partial SSU gene (SSU rDNA) of an *Ammonia* specimen collected in Tulear. This specimen was identified as *Ammonia* sp. T1, which is a cosmopolitan phylotype according to Hayward et al. 2004.

B) SEM images of the sequenced individual (umbilical, apertural and spiral sides).

FSI
9 ≤ FS I ≤ 10 high
5,5 ≤ FSI ≤ 9 good
2 ≤ FSI ≤ 5,5 moderate
1 ≤ FSI ≤ 2 poor
azoic bad

Foram-AMBI
≤ 1,2 very good
1,2 ≤ x ≤ 3,3 good
3,3 ≤ x ≤ 4,3 moderate
4,3 ≤ x ≤ 5,5 poor
5,5 ≤ x ≤ 6 bad





Conclusions and recommandations

- Further multidisciplinary works are still needed (sedimentation process , geochemical analyses, index,...)
- Indices are highly visual data presentation easy to understand by non-scientists so best to convey information to decision-makers
- Development and strengthening national monitoring capacity in line with regional goal is vital due to increasing and uncontrolled threat from LBSA
- Good legal framework without strong monitoring capacity remain inefficient, and therefore useless

Thank you