Anadarko
Moçambique Área 1, Lda

EIA FOR SHALLOW WATER EXPLORATION SEISMIC SURVEY & EXPLORATION DRILLING ROVUMA AREA 1

ENVIRONMENTAL IMPACT STUDY REPORT

ANNEXES OF THE MAIN REPORT (*VOLUME 2 – PART A*)

Prepared by:

Impacto
Projectos e Estudos Ambientais

December, 2008

List of Annexes of the Main Report

Note: The Annexes of the Main Report presented as a stand-alone document.

EIA FOR SHALLOW WATER SEISMIC SURVEY & EXPLORATION DRILLING IN ROVUMA AREA 1

TERMS OF REFERENCE

FOR THE

ENVIRONMENTAL IMPACT STUDY

Prepared by

Impacto, Lda

Prepared for

Anadarko Moçambique Área 1, Lda

1. Study Methodology

The EIS will comprise a combination of desktop studies (based on existing data) and field studies (for collection of primary data). Where data gaps relevant to the project's impacts exist, primary data will be collected to assess environmental and socio-economic features.

A significant amount of baseline data is already available from other studies in, and adjacent to the Project area. These data will be compiled and analyzed for incorporation in the EIS Report.

A limited amount of socio-economic data is available for the study area derived mainly from the Socio-Economic Impact Assessment for the Deep Water Seismic Survey of Area 1 (Impacto and CSA, 2007) and from IIP surveys with artisanal fisheries at the fishing center level. The Impacto & CSA (2007) data refer mainly to artisanal fisheries in waters deeper than 50m depth. Artisanal fishing is an extremely important socio-economic activity in the shallow waters off Palma, Mocimboa da Praia and Macomia Districts. This EIS, therefore, includes a socio-economic sampling methodology to obtain data related to fish catch (volume and value) per fishing type and seasonal fishing trends for artisanal fishers and subsistence.

The description of the environment affected shall cover the following aspects:

- Physical-chemical environment: climate, tides, currents oceanography and bathymetry
- Biological environment – Fish, marine mammals (whales, dolphins and dugongs) and sea turtles; and
- Socio-economic environment – fishing and tourism.

The methodology involves a detailed description of the environment affected, based on the available data, on oceanography, marine habitats and species in the study area, particularly marine mammals and fish.

The EIS will include Underwater Noise Modeling for Shallow Water Seismic Surveys and Exploration Drilling to determine the potential impacts on the marine and socio-economic environments.

Anadarko will commission a separate study on oil spill modeling for shallow water drilling operations. The results of this study will be submitted to Impacto and CSA for independent review and to predict potential impacts arising from oil spills on the marine and socio-economic environments.

The potential impacts on the marine and socio-economic environments will be assessed based on the available literature on the effects of seismic exploration and exploratory drilling. There is significant amount of information in the literature on the propagation and

attenuation of sound from seismic sound sources including data on the distance and intensity of sound that may cause death, injury and/or modified behavior of marine mammals, turtles as well as recreational and artisanal divers.

Based on the findings, mitigating measures will be identified to reduce or eliminate each of the negative impacts and to enhance positive impacts. A discussion will be presented related to the advantages and disadvantages of seismic survey methods as well as different drilling rig types, anchoring methods and drilling fluids.

The Consultant will prepare a draft EIS Report. The draft EIS Report will be presented to stakeholders through Public Meetings prior to submission to MICOA.

The EIS Report will contain as a minimum the following information:

The EIS Report will contain as a minimum the following information:

- Abbreviations and acronyms
- Non-Technical Summary
- Introduction
- Description of the proposed project
- Description of the implementation area
- Outline of the legislation, regulations and administrative organization
- Approaches and techniques utilized for collection of information and analysis of the impacts
- Description of all noise and spill trajectory models employed
- Methodology for Consultation with the stakeholders
- An analysis of alternatives
- Description of the environmental impacts over the proposed Project area
- Proposal for mitigation methods
- List of people / institution contacted
- Bibliography/ References

Impacto will prepare an Environmental Management Plan that will be implemented by AMA1 during the course of its operations in the area of study.

2. Approach for evaluating impacts for activities for which the location is not known

The precise location of 3D seismic surveys and exploration wells will not be known before submission of the EIA Report to MICOA.

The EMP will include a provision that, before any of the above activities are initiated, more detailed site specific studies will be carried out to determine potential environmental and socio-economic impacts. The studies will include gathering of additional data on the physico-chemical, biological, and socio-economic environments. Specifically, for the drilling locations, water quality and the benthic environment will be assessed.

Data collected in this manner will provide a better description of the environmental and socio-economic components subject to potential impact from the 3D seismic surveys and drilling activities. These data will provide additional baseline descriptions to the existing socio-economic and environmental conditions in the 3D seismic survey area and within the vicinity of proposed drilling locations. These additional data will be used for assessing and monitoring the effects of the future activities.

Each individual study will be submitted to MICOA for review to ensure compliance with the guidelines established in the EIA and EMP. Each study will constitute separate Addenda to the EIA Report.

3. Alternatives Considered

In the present EIA the alternative of "no action" will be considered. The only other alternatives that may eventually be considered are related to variations related to location, technology or timing for the project proposed

4. Specialist Studies

The specialist studies that will be undertaken during the Environmental Impact Study are the following:

1. Legal and institutional review – Lucinda Cruz
2. A description of the biophysical environment based on existing information – John Hatton
3. A review of marine mammals and sea turtles that occur in the Project area that are sensitive to noise, and the potential impacts that affect these species – Almeida Guissamulo
4. A review fish biology and impacts coral reef fish (either behavioral or physiological) - David Snyder, CSA
5. Underwater Noise Modeling for Shallow Water Seismic Surveys and Exploration Drilling – CSA
6. Assessments of potential impacts arising from oil spills on the marine and socio-economic environments – Steve Viada/Luis Lagera, CSA
7. A socio-economic survey of artisanal fisheries activity to assess potential impacts – Paula Santos and Horácio Gervásio
8. A study of tourism the Project area – Johan van der Walt
9. Sensitivity mapping and sensitivity analysis

These specialist studies are described in more detail below:

4.1 Legal review

Impacto will carry out a thorough legal review of Mozambican policies, laws and regulations related to environmental protection, environmental impact assessment and environmental quality standards. The legal review will include:

- An evaluation of the legality regarding the exploratory activities being carried out in adjacent concession areas outside of the AMA1 Concession Area.
- An update of the legal status related to existing and proposed conservation areas in/near to the AMA1 Concession Area including the buffer zone Quirimbas National Park (QNP)
- A review of the Mozambican legal requirements for compensation/indemnity for damages or restricted use of resources due to project activities and operations.
- A review policies and laws related to fisheries, maritime transport, tourism, and biodiversity conservation.
- A description of Mozambique's commitment to international protocols, laws and conventions.
- Anadarko's EHS policy and any other relevant international best operating practices.

4.2 Compilation and Analysis and of Existing Biophysical Data related to the Project area.

This task will be accomplished through a combination of literature review, interviews, and use of remote imagery.

Biotic Environment

Importantly, AMA1 has commissioned a study that will contribute to the upgrading of the environmental baseline of the Project area. The study will involve mapping of coastal and marine habitats using detailed satellite imagery. The results of this survey will be available during the course of the EIA and will be used in to prepare a detailed

description of the near shore habitats including sandy beaches, seagrass beds, mangroves and coral reefs.

Additional biological baseline data will be obtained from available literature most notably:

- CSA (2007). *Representative Marine Habitat Survey in Quirimbas Archipelago, Moçambiqu*e. Prepared for Anadarko Moçambique Area 1, LDA

- Impacto and CSA (2007) *Volume II - Environmental Impact Assessment Report and Environmental Management Plan for a Proposed Offshore Seismic Survey in Rovuma Offshore Area 1*. Prepared for Anadarko Moçambique Area 1, LDA

Climate

A general (but limited) description of climate of the Mozambican Channel is described in several references (e.g., Sætre and Silva, 1979 *The marine fish resources of Mozambique. Report on surveys with the R/V Dr. Fridtjft Nansen. Serviços de Investigações Pesqueiras, Maputo and Institute of Marine Research, Bergen).*

In addition, long term meteorological data consisting of wind, rainfall, air temperature, relative humidity and cloud cover referent to two adjacent meteorological stations: Mocimboa da Praia e Pemba, will be obtained from the National Institute of Meteorology in Maputo and processed. Data related to the occurrence catastrophic events (or otherwise) such cyclones will also be obtained and analyzed.

Offshore Geology

An overview of the general offshore geology of the Project area is described in several reports and publications available in the Geological Survey of Mozambique and National Institute of Petroleum. Publications from Flores (1970) and (1973), Förster (1975) and Kent (1972), gives additional overviews of the origin and evolution of the Mozambique Channel, with strong insights into general geology and shallow geology issues.

Bathymetry

Bathymetry data are available in the form of charts produced by the National Institute of Hydrography and Navigation (INAHINA).

Oceanography

The Consultant will review all data related to oceanographic conditions in the Mozambique Channel. The oceanography of the Mozambique Channel has been described by Sætre and Silva in 1979 (see Reference above). Oceanographic conditions of the Mozambique channel have more recently been re-evaluated Di Marco et al (2002), de Ruijter (2002), and Rinderinkhof et al (2003). These documents are available in Impacto's Documentation Center

- de Ruijter, W.P.M., Ridderinkhof, H., Lutjeharms, J.R.E., Schouter, M.W., and Veth, C. (2002) Observations of the flow in the Mozambique Channel. *Geophysical Research Letter*, **29 (10).**

- DiMarco, S.F., Chapman, P., Nowlin Jr. W.P., Hacker, P., Donoture. C., Luther, M., Johnson G.C. and Toole, J. (2002). Volume transport and Property Distributions of the Mozambique Channel. *Deep Sea Research* **II, 49**: 1481 – 1511

- Ridderinkhof, H., and de Ruijter, W.P.M. 2003. Moored current observations in the Mozambique Channel. *Deep Sea Res.* **II 50,** 1933 -1955

The Consultant will also source and incorporate (if available) oceanographic, sediment and water quality data obtained during oceanographic research carried out by the Fisheries Research Institute using the *Fridtjft Nansen* Research Vessel in 2007.

4.3 Review of Marine Mammals and Sea Turtles

The consultant shall undertake the following studies:

1. Detailed review of marine mammals and sea turtle activity in or in the vicinity of the Project area;

2. Review of international research and other existing data concerning acoustic impacts to marine mammals and turtles that are associated with seismic exploration. Data review will additionally consider seasonal occurrence and reproductive cycles of marine mammals and turtles that may occur in the study area;

3. Based on this review, a report will be drawn up covering the following themes:

    a) A discussion on the marine mammals and turtles and other species sensitive to noise that are present in the Mozambique Channel and Project area;

    b) A discussion of the potential impacts that may affect marine mammals and turtles and other species sensitive to noise, as a result of the research proposed; and

    c) A discussion of mitigation measures to avoid or minimize the potential impacts that might occur, taking into consideration the time of the survey so as to avoid critical periods such as the reproductive cycles of the species identified.

Data on marine mammals and marine turtles will be obtained from available literature which will include but not limited to the following:

- CSA (2007). *Aerial Census Survey of Marine Mammals and Sea Turtles within the Rovuma Concession Block and Parque Nacional Quirimbas, Mozambique*. Prepared for Anadarko Moçambique Area 1, LDA

- CSA (2007). *Representative Marine Habitat Survey in Quirimbas Archipelago, Moçambiqu*e. Prepared for Anadarko Moçambique Area 1, LDA

- Impacto and CSA (2007) *Volume II - Environmental Impact Assessment Report and Environmental Management Plan for a Proposed Offshore Seismic Survey in Rovuma Offshore Area 1*. Prepared for Anadarko Moçambique Area 1, LDA

- Zoological Society of London (2006) *Marine Turtle Programme Reports of Activities*. Prepared for the Cabo Delgado Biodiversity and Tourism Project

4.4 Review of fish biology and impacts coral reef fish (either behavioral or physiological)

A review of existing data will be made on areas or habitats within the Project area that are known to be important fish nursery, breeding, and/or feeding areas.

Effects on fishes will be evaluated from the perspective of individuals (e.g., damage to anatomy) as well as populations and assemblages. Information on impacts and risks from seismic operations, (including mitigation measures) on coral reef fish will be gathered from an extensive review of existing data. These data will be used in conjunction with socioeconomic data to determine potential impacts on fisheries.

4.5 Underwater Noise Modeling for Shallow Water Seismic Surveys and Exploration Drilling

Noise from the following operations will be assessed:

- Seismic Program: Seismic vessel and equipment including air source array and support operations;
- Drilling Program: Drilling, drill rig, and support operations (land based and vessels); and

All modeled sound level results will be fully documented in a noise assessment report suitable for inclusion in an EIA report. The data will be presented in a format appropriate

for use in assessing impacts on marine mammals and fish. The underwater acoustics report will include complete descriptions of the geoacoustic and oceanographic environment as it pertains to noise propagation. The noise emission characteristics of the primary noise-generating equipment will be discussed in terms of amplitude versus frequency. The underwater sound level results will be presented in tabular format and as sound level isopleths overlaid on bathymetric contour maps.

4.6 Assessments of potential impacts arising from oil spills on the marine and socio-economic environments

Anadarko will commission a separate study on oil spill modeling for shallow water drilling operations. The results of this study will be submitted to Impacto and CSA for independent review. Based on these studies the Consultant will predict potential impacts arising from oil spills on the marine and socio-economic environments

4.7 Socio-economic survey

The task of information gathering will take two steps, namely: the literature review and the field work (survey).

Literature Review

National Fisheries Research Institute
The Literature review will provide an overview about the general features of the study area. Issues such as population dynamics, socio cultural features as well as fishing activity history will be collected.

Available information regarding artisanal fishing includes:

a) the artisanal fisheries census, provided by IDPPE,
b) data on catch and species provided by the IIP,

However, the available information is solely concerned with the commercial fisheries and is only collected for a specific sample stratum, and thus, does not cover the whole coastal within the study area. Quantitative data regarding subsistence fishing is non existent.

Field work

Meetings with district informants

During the field work, contacts with the district informants will be made to confirm information from the literature review as well as to capture their impressions,

suggestions and identifying the key informants. District informants include: district administrators, district directors of relevant sectors, heads of administrative posts, heads of localities, NGOs, and private sector.

Quantitative survey

A socio-economic quantitative survey will be carried out in a sample of fishing centers represented by 35% of total number of existent centers. The selection methodology will follow a random stratified sampling process, through which fishing centers will be grouped into clusters according to the following criteria:

a) areas where data collection from IIP is being performed
b) areas with no record of data collection initiatives

Fishing centers will then be selected randomly from within each of these groups.

Within the fishing centers, commercial fishers will be subject to a quantitative questionnaire. Respondents to this questionnaire will be selected in accordance with type of fishery that they practice. This will be preceded by a preliminary listing of all existent commercial fishers in each center. The names will then be organized in clusters according to the type of fishing practiced and a random selection of respondents will take place within each cluster. A sample size of 50%, by type of fisher will be defined.

Data collected through this questionnaire will concentrate on he following aspects:

- Main target species per type
- Volume of catch per type
- Variations in volume of catch per month
- Value of catch,
- Type of investments from fish incomes
- Costs per unity of output
- Key community needs

The data related with target species and catch volume will be compared with that produced by the IIP (National Fisheries Research Institute).

Quantitative data produced by this questionnaire will be inputted in SPSS, in previously prepared matrixes, for statistical analysis.

Focus group discussions

As the majority of subsistence fishers are not registered, the selection process will entail a preliminary estimation of number of subsistence fishers in each fishing center. This information will be provided by the local leader/fisheries community councils. As normally subsistence fishers are not permanent in the activity (only do it in a necessity basis) and most likely will not have any accurate quantitative data regarding catch volumes, it is proposed that a focus group discussion is conducted. This discussion will focus on obtaining information regarding:

- Main target species per type

- Volume of catch per type
- Variations in volume of catch per month
- Value of catch,
- Role of fishing activity compared to other subsistence activities
- Key community needs

Further focus group discussion will be conducted with groups of commercial fishers, in order to confirm quantitative tendencies, and also to produce additional information in what regards,

- Role of fishing activity compared to others,
- Fishing stakeholders and their role,
- Migration,
- Fishing areas and pattern of resource access,
- Illegal fishing,
- Seasonal variations in fishing activities
- Fish markets, demand/supply of fish resource
- Location of main fishing grounds

Information provided by focus discussion will be compiled in small structured reports that will be analyzed in comparison with available quantitative data.
Based on the tourism survey and socio-economic survey the Consultant will produce a detailed SIA Report. The Consultant will identify impacts on all components on the socio-economic environment. For each impact the Consultant will identify mitigating measures to eliminate or reduce any negative impacts and measures to enhance positive impacts.

4.8 Tourism Study

The Consultant will update tourism data for the study area. This will entail:

- Updating and verification of information gathered for the AMA1 deep water study.
- Compilation of any new data related to tourism activities and operators within the study area.
- Identification and assessment of the potential effects that the proposed seismic exploration may have on current and future tourism activities in the study area, as well as the tourism sector in general.

Interviews will be conducted with representatives of the various tourism operators in the study area in order to gather data on occupancy rates, seasonal trends in tourism, types of leisure activities, and location of tourism activities (especially recreational angling and diving).

4.9 Sensitivity Mapping and Sensitivity Analysis

The Consultant will produce sensitivity maps showing environmentally and socio-economically sensitive areas.

The sensitivity maps will classify the coastal and marine environments using a vulnerability or environmental sensitivity index (ESI). The ESI will incorporate both biological as well as socio-economic criteria. The ESI will rank habitats and socio-economic features on 10 point scale.

The sensitivity maps will be used to assess the impacts arising from different activities and will indicate the level of restrictions, if any, to be placed on these activities in areas deemed to be ecologically or socio-economically sensitive for that activity. The activities to be evaluated are:

1. 2D seismic surveys using streamer cables.
2. 2D seismic surveys using bottom cables
3. 3D seismic surveys using bottom cables
4. 3D seismic surveys using autonomous receivers that are placed on the sea floor
5. Drilling of exploratory wells

Only a proposed 2D seismic survey program using streamer cables is currently available (activity 1 above). A decision on including 2D bottom cables (activity 2 above) for a small part of this survey (less than 10%) will be determined prior to completion of the EIA. The program as currently planned is shown in Figure 9, Section 3 (Project Description). This program will be adjusted in accordance with guidelines developed during the EIA process.

Once the locations of the other activities are known, these will be subject to a similar exercise to determine the level of restriction for that activity.

5. Preparation of an Impact Assessment

The potential impacts will be evaluated in accordance with internationally accepted assessment criteria, as listed below:

1 Nature of impact – negative or positive (beneficial);
2 Magnitude (Intensity) of impact – Describes the quantity of the resource potentially affected by the project activity (i.e., very low, low, moderate, high and very high)
3 Extent of impact – an assessment of the geographic extent of an impact (i.e., site specific, local, regional, national, or international);
4 Duration of impact – how long the impact would last (i.e., will effects be short-term, medium-term, long-term, or permanent);

5 Probability of occurrence – unlikely, possible, probable, or certain.
6 Type of Impact: Direct or Indirect. When the resource is affected directly by the activity, it is considered to be a direct impact. When the resource is affected through another resource that has been previously affected by the activity, it is considered to be an indirect impact.
7 Cumulative. Cumulative effects may be considered significant if an impact is added to existing or future similar impacts.
8 Reversibility. An impact is considered reversible when the affected resource can revert to its previous state. An impact is considered irreversible when the affected resource can not return to its previous state.

Based on a synthesis of the classifications in the above categories, impacts will be rated as follows:

9 **Beneficial** – likely to cause some enhancement to the environment or social/economic benefit;
10 **Negligible** – will not adversely affect environmental or socioeconomic resources in any meaningful way;
11 **Minor** – will have minimal adverse effects on environmental resources and not require any modification in project plans or specific mitigation measures;
12 **Significant** – will have measurable effects on environmental resources. These impacts may require modifications to the project design and/or implementation of effective mitigation measures; and
13 **Severe** – will have a major effect on environmental resources. Such potential impacts may represent fatal flaws in a project regardless of any mitigation measures that could be implemented.

The Table below defines the impact significance criteria. Impacts are rated on a scale ranging from 1 to 5 as beneficial, negligible, minor, significant, and severe. The likelihood of each impact occurring will be indicated as certain, likely, unlikely, or rare. Impacts also will be characterized as direct or indirect, and temporary (only during the project) or persistent (may persist after the project is completed).

Numerical Rating	Impact Description	Resource Category		
		Physical Environment (air, water, sediment)	Biological Environment	Socioeconomic and Health Environment
1	Beneficial	Likely to cause some enhancement to the environment or social/economic benefits.		
2	Negligible	No changes or changes that are unlikely to be noticed or measurable against background activities.		
3	Minor	Changes that can be monitored and/or noticed, but are within the scope of existing variability and do not meet any of the “significant” or “severe” impact definitions (below).		
4	Significant	Likely to result in one or more of the following: Localized, occasional violations of air or water quality	Likely to result in one or more of the following: Localized damage to coral reefs, mangroves, marshes, seagrass beds, or other sensitive habitats.	Likely to result in one or more of the following: Localized, temporary displacement of fishers from preferred fishing sites. Occasional negative

		standards or guidelines. Localized contamination of sediments with hydrocarbons, toxic metals, or other toxic substances.	A few deaths or injuries of endangered, critically endangered, or vulnerable species; occasional, temporary disruption of their critical activities (e.g., breeding, nesting, or nursing); and/or localized damage to their critical habitat.	interactions with fishers (e.g., fishing boats escorted away from an area, nets or traps damaged). A localized, short-term decline in fishery harvest. Localized damage to or contamination of beaches, parks or other recreational resources.
5	Severe	Likely to result in one or more of the following: Extensive, continual violation of air or water quality standards or guidelines. Widespread contamination of sediments with hydrocarbons, toxic metals, or other toxic substances.	Likely to result in one or more of the following: Extensive damage to coral reefs, mangroves, marshes, seagrass beds, or other sensitive habitats. Extensive damage to non-sensitive habitats to the extent that ecosystem function and ecological relationships would be altered. Numerous deaths or injuries of an endangered, critically endangered, or vulnerable species; continual disruption of their critical activities (e.g., breeding, nesting, nursing); and/or destruction of their critical habitat.	Likely to result in one or more of the following: Extensive, permanent displacement of fishers from preferred fishing sites. Continual negative interactions with fishers. An extensive, persistent decline in fishery harvest. Damage to or contamination of important cultural, historical, or religious sites. A threat to public health or public safety. Substantial public controversy or social unrest.

As part of the EIA, an Environmental Management Plan (EMP) will be prepared. The EMP will describe management and monitoring measures that AMA1 and ENH will put into place to avoid, minimize, or mitigate any adverse impacts from the seismic and drilling activities. The Consultants will consider the option of real time monitoring of social impacts with regards to artisanal fishers.

6. Preparation of a Social Impact Assessment

Based on the tourism survey and socio-economic survey the Consultant will produce a detailed SIA Report. The Consultant will identify impacts on all components on the socio-economic environment. For each impact the Consultant will identify mitigating measures to eliminate or reduce any negative impacts and measures to enhance positive impacts.

7. Preparation of a Compensation Plan

The Compensation Plan will mainly focus on the potential effects of the proposed seismic and drilling exploration on artisanal fishers and people harvesting marine resources for subsistence.

The information gathered through the social survey, the sound modeling as well as selected information from the marine fisheries specialist study will be used, and where required, extrapolated to provide a first order quantification of the potential effects of the proposed seismic and drilling exploration on fishermen.

Based on market value of potential catch/harvest lost, the value of the potential loss would be determined. The consultant will evaluate various forms of compensation including community compensation as well as individual compensation. For the compensation option or options chosen, the consultant will present the rationale for the selected option.

The Compensation plan will be in line with Mozambican regulations and guidelines as well as World Bank and International Finance Corporation's compensation guidelines.

8. Preparation of a Communication Plan

The Consultant will prepare a communication plan for effective communication between the Project and stakeholders who will most likely to be effected by the seismic and drilling operations most notably artisanal fishers and tourism operators. Effective communication will be one of the most important methods to minimize the effects of the exploratory operations on stakeholders.

9. PUBLIC PARTICIPATION PROCESS

9.1 Objectives of the Public Participation Process

The main objective of public consultation is to ensure that concerns and issues raised by IAPs, organizations or individuals are taken into account during the EIA. It will also provide opportunities for the IAPs to comment on the results of the EIS. Public consultation also creates a channel of communication between the public, the consultants and the client for the duration of the EIA.

Public Consultation activities will be conducted following the approved guidelines "Regulamento da AIA, Decreto 45/2004" and "Diploma Ministerial n. 130/2006 Directiva Geral de Participação Pública no processo de Avaliação do Impacto Ambiental ."

9.2 Public Participation Methodology

The Public Consultation (PC) will be conducted with reference of three main components as follows:

(i) Presentation of the Draft Environmental Pre-feasibility and Scope Definition Study (EPDA) Report

District level

Meetings with the District Consultative Councils of Mocímboa da Praia and Palma will take place to present the EPDA and ToR. For Macomia (as only a portion of the district will be affected) a separate focus meeting will be organized.

Provincial level

After public meetings at district level, one public meeting will be held in Pemba.

The Draft EPDA Report and ToR will be distributed in advance to the stakeholders. Their views will be integrated in the final EPDA Report submitted to MICOA together with the proposed EIS ToR for approval.

All the comments received will be documented in the Issues and Responses Report (IRR).

Invitations will be made through invitation letters to be sent to the relevant authorities/institutions, NGOs and tourist operators. Additionally, an advert will be posted in "*Notícias"* Newspaper and broadcasted through Radio Moçambique provincial station in Pemba. E-mail and telephone contacts will also be made to other IAPs. The draft EPDA report will be distributed to stakeholders at least one week before the meeting.

(ii) Dissemination of information at the community level

Divulging information about the project at community level (Villages and Fisheries Centers) will be carried out by the socio-economic team during the field work.

Formal and informal meetings will take place at community level (mainly Community Fisheries Centers) in Palma, Macomia and Mocimboa da Praia District coastal areas where artisanal fishers are concentrated.

Consultants from Impacto will start this process by meetings with the District administrations before proceeding with visits to local communities. The same consultants will be incorporated in the socio-economic team and will go to the field as soon as the field work starts.

(iii) Presentation of the Draft Environmental Impact Study (EIS) Report

Public Meeting in Pemba and Districts Meetings

Meetings with the District Consultative Councils of Mocímboa da Praia and Palma will take place to present the Draft EIS. For Macomia (as only a portion of the district will be affected) a separate focus meeting will be organized. The district meetings will be followed by an open meeting in Pemba.

There will be a two week period for the IAPs and the relevant authorities to review the findings of the draft EIA. All comments will be considered in the final EIR.

All the comments received will be documented in the final version of the Issues and Responses Report. The final version of the EIA Report will be submitted to MICOA together with the overall PC report.

Invitations will be made through invitation letters to be sent to the relevant authorities/institutions, NGOs and tourist operators. Additionally, an advert will be posted in "*Notícias"* Newspaper and broadcasted through Radio Moçambique provincial station in Pemba. E-mail and telephone contacts will also be made to other IAPs. For this meeting Non Technical Summary of the EIA report will be distributed to the stakeholders.

It is proposed that these meetings be conducted in the third week of September.

Additional focus group meetings will be organized as needed.

9.3 Identification of Interested and Affected Parties

Interested and Affected Parties (IAPs) for this project are identified on the basis of the Consultant's wide experience with similar projects involving Public Participation processes throughout Cabo Delgado Province and the Rovuma Basin in particular. Other stakeholders will be targeted via newspaper and radio announcements. Invitations will also be sent by email and fax.

The target groups for this project include:

- National, provincial and district government officials;
- Environmental authority (MICOA and Provincial Directorate for the Coordination Environmental Affairs);
- Petroleum National Institute;
- Tourism Authorities;
- Fisheries authority;

- Local fishing industry representatives and local artisanal fishermen;
- Fisheries Communities Councils and Associations;
- Tourism industry representatives and lodge owners;
- Environmental groups and NGOs;
- Local and International conservation NGOs;
- Local communities;
- Academic/Research organizations;
- Media; and
- General public

9.4 Integration of Issues Raised

The issues related to the specialist studies during the EIA will be identified through the following sources:

- Public meetings in Pemba, Mocimboa da Praia and Palma;
- Dissemination of information at the community level; and
- Written comments from the IAPs, on comment forms distributed at the meetings.

As mentioned earlier, all the comments received from stakeholders will be documented in the form of an Issues and Response Report (IRR). These relevant comments from the IRR will be integrated in the specialist studies as appropriate.

REPUBLICA DE MOÇAMBIQUE

MINISTÉRIO PARA A COORDENAÇÃO DA ACÇÃO AMBIENTAL

GABINETE DA MINISTRA

OFÍCIO N.º 65 /GM/MICOA

ASSUNTO: **Relatório de Revisão do Estudo de Pré-Viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência (TdR) do Projecto de Pesquisa Sísmica e Perfuração de Pesquisa em Águas Pouco Profundas na Área 1 da Bacia do Rovuma, Moçambique.**

Exmos Senhores,

O Ministério para a Coordenação da Acção Ambiental (MICOA), recebeu de V.Excias, o documento referente ao projecto mencionado em epígrafe, tendo merecido a devida apreciação.

Efectuada a revisão técnica do mesmo, nos termos do Decreto 45/2004, de 29 de Setembro, que aprova o Regulamento sobre o Processo de Avaliação do Impacto Ambiental, o MICOA comunica à V.Excias que o documento em referência fornece elementos essencias a serem analisados no Estudo de Impacto Ambiental (EIA), e pelo facto, aprova o mesmo. Contudo, na elaboração do EIA, recomenda-se que sejam observados os aspectos referenciados no EPDA e TdR, bem como a clarificação e inclusão de todos os aspectos constantes do relatório de revisão em anexo.

Para o prosseguimento do processo de licenciamento ambiental, solicitamos que V.Excias submetam à Direcção Nacional de Avaliação do Impacto Ambiental (DNAIA), 15 (quinze) cópias do Relatório do Estudo de Impacto Ambiental (REIA) em suporte de papel, e 5 (cinco) cópias do mesmo documento em suporte de papel deverão ser submetidas à Direcção Provincial para a Coordenação da Acção Ambiental de Cabo Delgado.

Com os nossos melhores cumprimentos.

Maputo, 01 de Agosto de 2008

A Vice- Ministra

Ana Paulo Samo Gudo Chichava

Exmos Senhores,
ANADARKO MOÇAMBIQUE ÁREA 1, Lda

MAPUTO

C.C. S.Excia o Ministra dos Recursos Minerais
S.Excia o Ministro das Pescas
S.Excia o Ministro do Turismo
S.Excia o Ministro dos Transportes e Comunicações
S.Excia o Governador da Província de Cabo Delgado

Rua de Kassuende nº 167, C.P. 2020, Tel: 21 496109/492403, Fax:21496108

Assunto: **Relatório de Revisão do Estudo de Pré-viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência (TdR) do Projecto de Pesquisa Sísmica e Perfuração de Pesquisa em Águas Pouco Profundas na Área 1 da Bacia do Rovuma, Moçambique.**

1. Introdução

O presente documento constitui o relatório de revisão do Estudo de Pré-viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência (TdR) do projecto de Pesquisa Sísmica e Perfuração de Pesquisa em Águas pouco Profundas na Área 1 da Bacia do Rovuma, cujo proponente é a Anadarko Moçambique Área 1, Lda (AMA1).

A empresa Anadarko Moçambique Área 1, Lda, juntamente com a Empresa Nacional de Hidrocarbonetos, E.P. (ENH), assinaram com o Governo da República de Moçambique, um contrato de Concessão de Prospecção e Exploração (CPE), para a área de águas pouco profundas (*offshore*), designada Área 1.

O contrato de Concessão de Prospecção e Exploração, fornece a AMA1 e a ENH, direitos de exclusividade de prospecção e exploração de quantidades comercializáveis de hidrocarbonetos no bloco, sendo o período inicial do contrato de 5 anos.

Para a execução da Avaliação do Impacto Ambiental do projecto, a AMA1 contratou a IMPACTO Lda, (Projectos e Estudos de Impacto Ambiental, Limitada), uma empresa devidamente registada no MICOA.

O valor do investimento da proposta da actividade é de USD 150.000.000,00 (Cento e cinquenta milhões de dólares americanos).

2. Comentários Gerais

2.1. Âmbito da Revisão do EPDA e TdR

No processo de revisão do presente relatório, o MICOA formou uma Comissão Técnica de Avaliação, composta por instituições do Estado e organizações não governamentais, nomeadamente: Direcção Nacional do Turismo, Direcção Nacional de Áreas de Conservação, Direcção Nacional de Gestão Ambiental, Direcção Provincial para a Coordenação da Acção Ambiental de Cabo Delgado, Instituto para o Desenvolvimento de Pesca de Pequena Escala, Instituto de Petróleo, Instituto Nacional de Investigação Pesqueira, Instituto Nacional da Marinha, World Wildlife Fund- WWF, União Internacional para a Conservação da Natureza- IUCN, Fórum Empresarial para o Meio Ambiente-FEMA e o Centro Terrra Viva.

Das instituições envolvidas, apenas a Direcção Nacional de Áreas de Conservação, Direcção Nacional de Gestão Ambiental, Direcção Provincial para a Coordenação da Acção Ambiental de Cabo Delgado, Instituto Nacional de Investigação Pesqueira e o Instituto Nacional da Marinha emitiram os seus pareceres. As restantes instituições não se pronunciaram.

3. Equipe Técnica do Estudo

A equipe técnica apresentada é multidisciplinar para projectos desta natureza, sendo a IMPACTO Lda, empresa credenciada pelo MICOA, em associação com a CSA International Inc, (empresa de consultoria ambiental baseada nos Estados Unidos e com 30 anos de experiência).

4. Participação do Público

Feita a revisão do relatório de Consulta Pública, constata-se que houve participação das partes interessadas e afectadas (PI&A's), e constam no documento, as actas de consulta pública e comentários dos participantes nos encontros.

5. Comunicação dos Resultados

Em termos de formato e estrutura, o documento fornece uma qualidade aceitável para projectos desta natureza, e apresenta aspectos essenciais que julgamos que serão analisados com maior profundidade nas fases de construção e operação da actividade.

6. Comentários Específicos

6.1. Identificação da Actividade

A actividade é apresentada de forma detalhada, e a equipe composta para a realização do estudo, é multidisciplinar e composta por técnicos de diferentes áreas de formação.

6.2. Área de influência da Actividae

- ✓ A área em estudo localiza-se na eco-região Marinha da África Oriental, onde se encontra o Arquipélago das Quirimbas;
- ✓ A região é constituída por um sistema de ecossistemas sensíveis, como é o caso de recifes de coral, Mangais e ervas marinhas;
- ✓ A perfuração de pesquisa de hidrocarbonetos acarretará uma série de impactos negativos, principalmente sobre o ambiente e o ecossistema marinho.

7. Conclusões e Recomendações

Da revisão efectuada ao documento em referência pela equipe técnica, julgamos que o mesmo apresenta elementos essenciais para projectos desta natureza e que serão analisados com maior profundidade no Estudo de Impacto Ambiental, pelo que, propomos a sua aprovação.

No entanto, na elaboração do EIA, para além dos aspectos previstos no EPDA e TdR, recomenda-se:

- A clarificação das medidas de mitigação a serem implementadas para a minimização dos impactos que poderão advir da actividade, como é o caso dos derrames dos hidrocarbonetos e a propagação de ruídos subaquáticos provenientes de sondas que possam perturbar a estabilidade dos ecossistemas naturais, *habitats* e fauna marinha no local, uma vez tratar-se de uma área muito sensível.

- A indicação de mecanismos a serem usados para minimizar o deslocamento a longo prazo e/ou mudança nas rotas de migração de animais, causado pela actividade sísmica;

- A actualização da informação sobre o senso da pesca artesanal pois, o presente documento refere-se ao censo de 2002 realizado pelo IDPP, quando existe uma informação mais recente, o censo de 2007 (IDPP).

Maputo, 01 de Agosto de 2008

A equipe técnica de revisão:

Luís Varela
Luis Varela
(Sociólogo)

Rosalina Naife
Naife
(Bióloga)

Josefa Jussar
Josefa Jussar
(Engª Química

Nilsa Racune
Nilsa Racune
(Bióloga/Química)

1. NAME OF PRODUCT AND SUPPLIER

MOSSPAR H

Chemical name:	Isoparaffinic solvent
Art- no:	PP10
CAS- no:	90662-58-5
EU- no:	292-460-6
Formula:	
Supplier:	Fred Holmberg & Co AB
Telephone no:	+46 (0)40 15 79 20
Fax no:	+46 (0)40 16 22 95
E- mail:	fred.info@holmberg.se
Issued by:	Fred Holmberg
Contact person:	Fred Holmberg
Emergency Tel. No:	+46 (0)40 15 79 20

2. COMPOSITION/INFORMATION ON INGREDIENTS

Name:	CAS- no:	Konc. (w%):	Classification:	R- phrases:
Isoparaffinics	90662-58-5	80-90	Xn	65-66
N-paraffinics	64771-72-8	1-10	Xn	65-66
Cycloparaffinics	68521-90-3	10-15	Xn	65-66

R-phrases in full text are found in chapter 16.

3. HAZARDS IDENTIFICATION

Harmful: may cause lung damage if swallowed.
Repeated contact may cause dry skin.

Harmful

4. FIRST AID MEASURES

In general: Show this MSDS to emergency doctor/medical. Never give fluide or cause vomiting if the person is unconsious or has cramps.

After inhalation: Remove the victim into fresh air.
Unconscious: maintain adequate airway and respiration.
Consult a doctor/medical service if breathing problems develop.

Eye contact: Rinse immediately with plenty of water for 15 minutes.
Do not apply neutralizing agents.
Consult a doctor/medical service if breathing irritation persists.

After ingestion: Never give water to an unconscious person.
Do not allow vomiting.

Skin contact: Consult a doctor/medical service if you feel unwell.
Wash immediately with lots of water and soap for 15 minutes.
Remove clothing before washing.
Consult a doctor/medical service if irritation persists.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media:	Water spray, alcohol foam, BC powder and carbon dioxide.
Unsuitable extinguishing media.:	Solid water jet ineffective as extinguishing medium.
Special exposure hazards:	Material presenting a fire hazard. On burning; release of carbon monoxide – carbone dioxide.
Special protective equipment for firefighters:	Heat/fire exposure: compressed air/oxygen aparatus. Protective clothing for exposure to chemicals.

6. ACCIDENTAL RELEASE MEASURES

Personal protection:	See 8.3.
Environmental precautions:	Contain leaking substance, pump over in suitable containers Plug the leak, cut off the supply.
Clean-up:	Take up liquid spill into inert absorbent material, e.g.: sand/earth. Scoop absorbed substance into closing containers. Clean contaminated surfaces with an excess of water. Wash clothing and equipment after handling.

7. HANDLING AND STORAGE

Handling:	Observe normal hygiene standards. Avoid prolonged and repeated contact with skin. Use earthed equipment. Remove contaminated clothing immediately. Clean contaminated clothing.
Storage:	Keep container tightly closed. Store in a dry area. Store in a well-ventilated area. Keep away from: heat sources, oxidizing agents.
Storage temperature:	N.D.
Materials for packaging:	Suitable: metal. To avoid: No data available.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure limits:

Name:	CAS- no:	Exposure limits:
Alifactic hydrocarbons	-	350 mg/m3

PERSONAL PROTECTION:

In general:

Eye protection.: Safety glasses.

Hand prtotection: Gloves.

Skin protection: Protective clothing.

Materials for protective clothing: No data available.

Respriatory protection: High vapour concentration: gas mask.

9. PHYSICAL AND CHEMICAL PROPERTIES

Apperance (at 20°): Liquid.

Odour: Mild..

Colour: Clear.

Soluble in: Insolvable in water, miscable in organic solvents and mineral oils.

Freezing point:	< -30°C	**Boiling pont/boiling range:**	290-300 °C
Relative density (at 20°C):	790-820 kg/m_	**Flashpoint:**	90 °C
Explosion limits:	0,7-5,0	**PH value:**	N.D.
Vapour pressure (at 20°C):	< 2,1 hPa	**Viscosity:**	<7 cSt (40 °C)
Water solubility:	Insoluble	**Auto-ignition point:**	>228 °C
Saturation concencentration:	-	**Log Pow:**	3,7-4,5
Reltive vapour density (air=1):	8		

10. STABILITY AND REACTIVITY

Stability: Stable under normal conditions.

Hazardous decomposition products: On burning: Release of carbon monoxide – carbon dioxide.

Conditions/materials to avoid: Heat sources, oxidizing agents.

11. TOXICOLOGICAL INFORMATION

Acute toxicity:

Method	**Animal**	**Amount**	**Unit**
LD50 (oral)	rat	> 5000	mg/kg

Generellt: If product in case of ingestion or vomiting has entered respiratory passages, pneumonia may occur after a couple of hours to 24 h.

Skin contact: Repeated or prolonged skin contact can cause slight irritation and blushing.

Eye contact: Eye contact causes pain and may cause irritation.

Ingestion: Can cause nausia, vomiting or similar symptoms as inhalation.

Inhalation: Inhalation of high quantaties of vapor can cause headache, dizziness, tiredness and nausia. Product has low vapor pressure which decreases the risk of symptoms.

12. ECOLOGICAL INFORMATION

LOW TOXICITY ON WATER ORGANISMS. Accessible environmental data show that only larger local outlets might represent an environmental risks.

EASILY BIODEGRADABLE. Relatively quick degradation of naturally occurring micro organisms.

BIOACKUMULATES in water environment

AQUATIC TOXICITY:
LC50 rainbow trout, 96h: > 1000 mg/l
EC50 Daphnia magna, 48h: > 1000 mg/l

BIOLOGICAL DEGRADABILITY:
The product is biologically degradable (inherent) according to OECD 301 D; 95% reduction of DOC (loose organic carbon) after 18 days.

BIOACKUMULATION:
Log Pow = 6,5 - > 7 which indicates some potential för bioackumulation.

Proporties / risks
Bioackumulation: This product bioackumulates. Log Pow (6,5 - > 7)
Degradability: This product is biologically degradable (inherent).

13. WASTE DISPOSAL CONSIDERATIONS

Empty drums can be recycled or returned for reconditioning or metal recykling after properly executed emptying.

WASTE CLASSIFICATION:
Decide waste date according to SFS 1996:97, regulation of hazardous waste. This information only applies to the product as such..

Disposal methods:
Landfill or incenerate at an approved site in accordance with national and local regulations.
Remove to an authorized incinerator.

14. TRANSPORT INFORMATION

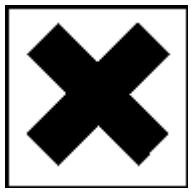
This product is not classified.

15. REGULATORY INFORMATION

Labelling in accordance with EC directives 67/548/EEC and 1999/45/EEC.

Classification:

Xn; Harmful



Harmful

CONTENT: Isoparaffinic solvent.

R- Phrases:
R65 Harmful: may cause lung damage if swallowed.
R66 Frequent contact may cause dry skin orr chaps in the skin.

S- Phrases:
S23 Avoid to inhale vapour.
S24 Avoid contact with skin.
S62 If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.
S29/56 Do not empty into sewer. Leave this material and its containers to a dangerous waste disposal location.
S60 This material and its containers are to be handled as dangerous waste.

16. OTHER INFORMATION

R-phrases in full text from chapter 2:
R65 Harmful: may cause lung damage if swallowed.
R66 Frequent contact may cause dry skin orr chaps in the skin.

Revisiondate: 2004-01-20
Replaces previous MSDS: 2002-06-12

The information provided on this MSDS is the correct to the best of our knowledge, information avnd belief at the det of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combinationwith any other meaterial or in any process, unless specified in the text.

Anadarko
Moçambique Área 1, Lda

ENVIRONMENTAL IMPACT ASSESSMENT FOR SHALLOW WATER EXPLORATION SEISMIC SURVEY & EXPLORATION DRILLING FOR THE ROVUMA AREA 1

ENVIRONMENTAL IMPACT STUDY REPORT (*DRAFT*)

Annex V

HABITATS MAPS

November, 2008

Prepared by:

Impacto
Projectos e Estudos Ambientais

CSA
CSA International, Inc.

TESSELLATIONS
INCORPORATED

Annex V

HABITAT MAPS

1 Methodology

Step 1 - Initial Classification

A total of 219 QuickBird imagery tiles covering 11,612.22 km^2 of which 5,664.84 km^2 near shore and island habitats were classified. Imagery was grouped into four groups based on acquisition date (i.e. images were made at different dates). Data were delivered and remained in World Geodetic System (WGS) 1984 Universal Transverse Mercator (UTM) Zone 37S.

Leica ERDAS Imagine v9.1/9.2, a remote sensing software, and ESRI ArcGIS v9.2 were utilized to perform habitat characterization.

The initial step involved mosaicing each imagery of the imagery groups, based upon acquisition date. Various enhancement techniques were then applied to the imagery data to better distinguish habitat features, following standard remote sensing protocols. Spectral and spatial enhancement were tested on each imagery class to determine which technique, if any, were applicable. Habitat boundaries were not noticeably improved through spatial filtering. Normalized Difference Vegetation Index (NDVI) was applied to delineate mangroves from surrounding vegetation. Normalized Difference Water Index (NDWI) was also applied to better define the water/land boundary in the source imagery. This index increases with vegetation water content or from dry soil to free water. This method was of limited value due to the water clarity, but it was helpful for identifying deepwater areas.

The analysis identified and mapped incorporated seven habitat classifications:

- Sand/Mud Flat,
- Mangrove,
- Mangrove/Dense Vegetation,
- Coral,
- SAV,
- Barren Land, and
- Unclassified/Deep Water.

In the interpretation, sand, seagrass or submerged aquatic vegetation (SAV), mangroves, and coral reefs were the most abundant near shore features.

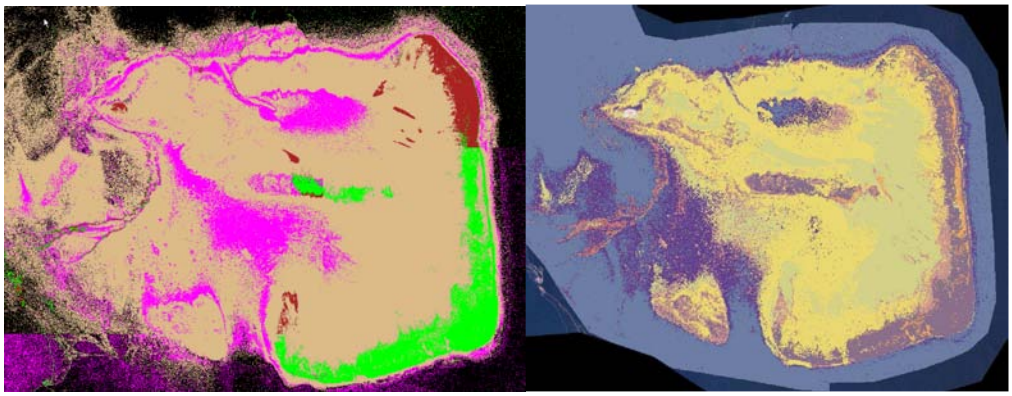
Step 2 - Reclassification

Multiple image processing tests confirmed that a single classification of all imagery from each of the four image date groupings would result in a more uniform classification.

The improvements in the revision are the result of a combination of the following techniques/tools:

- Separate classification of land and water;
- Separation of near-surface marine habitat from slightly deeper marine habitat. This provides greater range of classes and less overlap between deep/shallows;
- Identification of image tile blends (in the source imagery) and separation of the same into unique tiles having relatively consistent spectral characteristics. Classes are assigned independently to each of these tiles. The tiles are then compared and matched for consistency.

The reclassification improved the mapping of the habitat by creating a more homogenous classification of the imagery, especially were discrepancies occurred along the borders of **mosaic** tiles (as shown in the figure below), but there were still some areas that required further improvement. For example, there were still some problem where the sub-aquatic vegetation (closer to the coast) and the coral (around the islands were being classified into a single class (either coral or SAV).



Step 3 Final classification

Further reclassification proved necessary to improve the quality of the habitat maps. A team was put together, which included GIS specialists as well as marine biologist with extensive knowledge of the study area.

This exercise consisted in comparing the initial reclassified maps with the imagery. The marine biologists re analyzed in detail each habitat classification systematically to derive the final habitat classification.

The problem areas which had been identified where thoroughly examined and classes redefined.

The clouds over important areas were digitized based on the experts' knowledge to cover the gaps in the habitat maps.

Areas previously identified as "indeterminate" and excluded from the classification were also examined. Certain of those did have some areas with coral, which were also digitized to be included in the map.

Large areas of dense coastal vegetation had been misclassified as mangroves throughout the map. The separation of these two classes proved to be impossible if it were to be based on the existing classification. Mangroves were therefore digitized for the study area, and treated separate.

Sandy shores needed to have a class of its own, due to its importance as turtle nesting sites. The classification did not separate those from sandy bottoms, so the option was equally to digitize those separately.

The final classes obtained for the habitat maps are:

- Mangrove
- SAV
- Sand/Sparse SAV
- SAV/Coral/Sand
- Sandy shores
- Sand/Barren
- Mud/Sand/Silt/Turbid
- Rocky Bottom
- Rocky Bottom/sand
- Rocky Bottom/algae
- Coral
- Coral/Coral fringe/Sand
- Sand/Sparse Coral
- Deep Coral
- Low sparse Vegetation
- Low Vegetation/Scrub
- Mixed Vegetation
- Woody Vegetation
- Deep/Indeterminate (water)
- Turbid water
- Shadow

2 Habitat Maps

The Habitat Mapping exercise described above resulted in the maps presented in this document as a Mapbook, consisting of an overview map showing the study area as a whole, and 24 maps each representing a tile at a scale of approximately 1:50 000.

The overview map acts as grid/index showing the tiles labelled with numbers 1 to 24, corresponding to the page number of each close-up map.

From these data, a condensed list of six marine habitats was generated for the purpose of the sensitivity rating. These included:

1. Mangrove-dominated communities
    - Mangroves
2. Seagrass- and macroalgal-dominated communities;
    - SAV
    - Sand/Sparse SAV

    - SAV/Coral/Sand
3. Sand and mud substrates;
    - Sandy shores
    - Sand/Barren
    - Mud/Sand/Silt/Turbid
4. Emergent hard substrate;
    - Rocky Bottom
    - Rocky Bottom/sand
    - Rocky Bottom/algae
5. Shallow and emergent coral communities
    - Coral
    - Coral/Coral fringe/Sand
    - Sand/Sparse Coral
6. Deep coral communities.
    - Deep Coral

Below is a brief definition of each marine habitat and lists significant biological resources that characterize the habitat and socioeconomic elements that occur within the habitat.

1. <u>Mangrove-dominated communities;</u>

Mangrove-dominated communities may be defined as tropical intertidal forest communities.

The following are significant biological resources of mangrove-dominated communities within the project area:

- Constituent mangrove trees and shrubs and a diverse group of plant species often described as "mangrove associates;"
- Diverse, sessile invertebrate fauna attached to mangrove aerial roots and exposed hard substrates within the mangal community (e.g., sponges, cnidarians, bryozoans,ascideans, and mollusks);
- Benthic infauna living within mangal seafloor sediments (e.g., polychaetes,crustaceans, and mollusks);
- Benthic epifaunal motile invertebrates (e.g., crustaceans, echinoderms, and mollusks);
- Plankton;
- Diverse larval, juvenile, and adult fishes;
- Crocodiles; and
- Birds (e.g., waders and shorebirds).

Socioeconomic elements dependent upon mangrove-dominated communities within the project area include artisanal and recreational fishing in and around the fringes of the mangal communities.

2. <u>Seagrass- and macroalgal-dominated communities (SAV);</u>

Seagrass- and macroalgal-dominated communities may be more broadly termed “submerged aquatic vegetation” (SAV) and defined as subtidal seafloor supporting a biological community dominated by diverse seagrass and macroalgal species. The

relative densities of these constituents exhibit significant spatial and perhaps temporal variability within the project area.

Significant biological resources of seagrass- and macroalgal-dominated communities include the following:

- Beds or meadows of diverse seagrasses and macroalgae on soft substrate or low sand-covered hard substrate;
- Sessile invertebrates (e.g., sponges, cnidarians, bryozoans, and ascideans);
- Infaunal invertebrates (e.g., cnidarians, polychaetes, crustaceans, and mollusks);
- Motile epifaunal invertebrates (e.g., crustaceans, echinoderms, and mollusks);
- Plankton;
- Diverse larval, juvenile, and adult fishes;
- Hatchling, subadult, and adult sea turtles;
- Birds (e.g., seabirds and waders); and
- Marine mammals (e.g., dolphins and possibly the dugong, though recent surveys were not successful in locating this species within the project area [CSA International, Inc., 2007a]).

Socioeconomic elements dependent upon seagrass- and macroalgal-dominated communities within the project area include artisanal and recreational fishing.

Within this grouping the following 3 classes are shown on the map:

- **SAV**: areas continuously covered by the community described above
- **Sand/Sparse SAV**: sand substrate with a discontinuous cover of SAV
- **SAV/Coral/Sand**: areas displaying a mosaic of SAV and Coral on a sandy bottom.

3. **Sand and mud substrates;**

Sand and mud substrates in the project area include diverse soft substrate-dominated habitats such as intertidal sandy beaches, shallow intertidal and subtidal flats, and deeper subtidal sandy or silty areas and channels.

Significant biological resources of sand and mud substrates include the following:

- Infaunal invertebrates (e.g., cnidarians, polychaetes, crustaceans, and mollusks);
- Motile epifaunal invertebrates (e.g., crustaceans, echinoderms, and mollusks);
- Diverse juvenile and adult fishes;
- Sea turtle nests;
- Hatchling, subadult, and adult sea turtles (including nesting females);
- Birds (e.g., seabirds and waders); and
- Marine mammals (e.g., dolphins).

Socioeconomic elements dependent upon sand and mud substrates within the project area include artisanal fishing (e.g., seining and areas used to clean seine nets), recreational fishing over flats, and tourism (e.g., beach utilization and observations of sea turtle nesting).

Within this grouping the following 3 classes are shown on the map:

- **Sandy shores**: intertidal sandy beaches of particular importance for turtle nesting
- **Sand/Barren**: barren shallow intertidal and subtidal sandy flats, and deeper subtidal sandy substrates
- **Mud/Sand/Silt/Turbid**: shallow intertidal and subtidal silty flats, and deeper subtidal muddy and silty substrates and channels

4. **Emergent hard substrate;**

Emergent hard substrates in the project area are defined as subtidal carbonate platforms and terraces, and intertidal and subtidal areas of exposed carbonate and karsted limestone on shorelines. This habitat category encompasses those areas where densities or cover of attached biota are either low or relatively low due to periodic inundation by soft substrates (in subtidal areas) and high wave energy and exposure to air during periods of tidal emergence (in intertidal areas).

Significant biological resources of emergent hard substrates include the following:

- Diverse macroalgae and "turf" algae (a broad category for diverse filamentous algae that typically trap fine sediment, forming a felt-like mat on hard substrate);
- Sessile invertebrates (e.g., sponges, cnidarians, bryozoans, and ascideans);
- Motile epifaunal invertebrates (e.g., crustaceans, echinoderms, and mollusks);
- Diverse juvenile and adult fishes;
- Birds (e.g., seabirds, shorebirds, and waders); and
- Marine mammals (e.g., dolphins).

Socioeconomic elements dependent upon emergent hard substrates within the project area include artisanal fishing.

Within this grouping the following 3 classes are shown on the map:

- **Rocky Bottom**: emergent hard substrates, as described above.
- **Rocky Bottom/sand**: these are hard substrates covered with sand or interspersed by sandy substrates
- **Rocky Bottom/algae**: these are hard substrates with macro algae growing on them.

5. **Shallow and emergent coral communities**

Shallow and emergent coral habitat is defined as hard substrate occurring from the surface (intertidal) to a water depth of 10 m. Hard substrates within this habitat category consist of, or are primarily colonized by, diverse stony coral (Order Scleractinia) and octocoral (Subclass Octocorallia) species. In some areas, stony corals (primarily acroporids) may grow to the sea surface, becoming emergent during extreme low tide conditions.

Significant biological resources of the shallow and emergent corals habitat include the following:

- Stony coral and octocoral species;
- Other sessile invertebrates (e.g., sponges, cnidarians, bryozoans, and ascideans);
- Diverse macroalgae;
- Motile epifaunal invertebrates (e.g., crustaceans, mollusks, and echinoderms);
- Plankton;
- Larval, juvenile, and adult fishes;
- Subadult and adult sea turtles;
- Birds (e.g., shorebirds and seabirds); and
- Marine mammals (e.g., dolphins).

Socioeconomic elements dependent upon shallow and emergent corals habitat within the project area include artisanal fishing (both with lines and by diving [Figure 1]) and tourism (recreational diving and fishing).

Within this grouping the following 3 classes are shown on the map:

- **Coral**: areas continuously covered by shallow or emergent coral communities
- **Coral/Coral fringe/Sand**: dense coral patches on a sandy substrate and fringing coral. The coral cover is dominant.
- **Sand/Sparse Coral**: a sandy substrate with sparse coral heads, or coral communities covered with sand

6. Deep coral communities

Deep water coral community habitat is defined as areas of hard substrate dominated by stony coral and octocoral species below a water depth of 10 m. This habitat was investigated during the CSA habitat groundtruthing study (CSA International, Inc., 2007b). Unfortunately, very little is known about the extent or composition of this habitat within certain areas, such as the deep channels found between several of the outer islands within the project area and within other deep water areas to 200-m water depths.

Significant biological resources of deep water coral communities include the following:

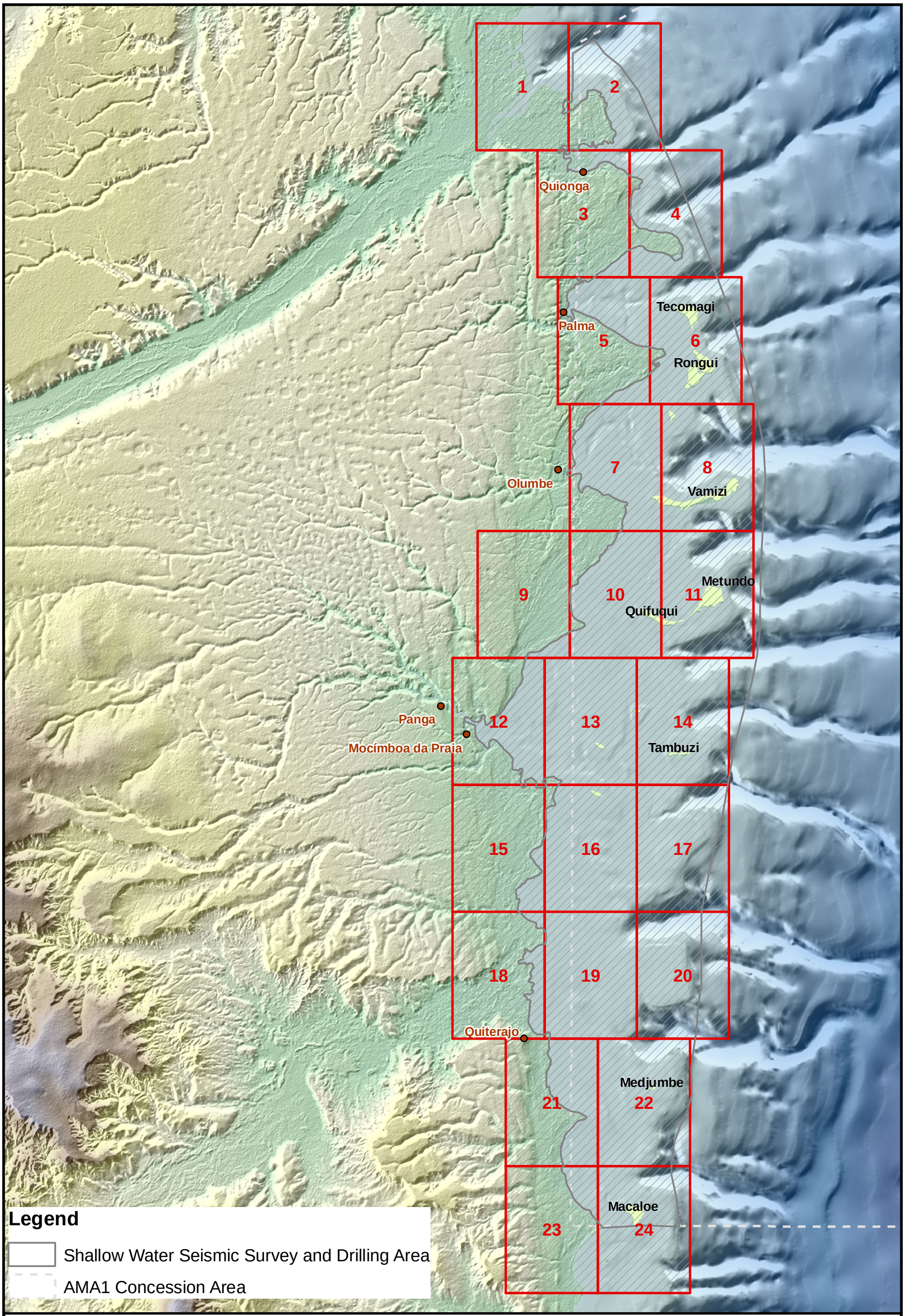
- Stony coral and octocoral species;
- Other sessile invertebrates (e.g., sponges, cnidarians, bryozoans, and ascideans);
- Diverse macroalgae (within photic depths);
- Motile epifaunal invertebrates (e.g., crustaceans, mollusks, and echinoderms);
- Plankton;
- Diverse larval, juvenile, and adult fishes;
- Subadult and adult sea turtles;
- Birds (e.g., seabirds); and
- Marine mammals (e.g., dolphins and whales).

The classes not included in the 6 groups above which were also identified in the classification exercise include:

- **<u>The vegetation classes</u>**
  - **Low sparse Vegetation**: a discontinuous low lying vegetation layer, consisting mainly of herbaceous and graminaceous species close to the ground and bushes less than 0.7m tall
  - **Low Vegetation/Scrub**: a continuous low lying vegetation layer composed of herbaceous and graminaceous species and small bushes.
  - **Mixed Vegetation**: a mix of unidentified bushes and trees 0.7 m-1.5 m tall
  - **Woody Vegetation**: consisting of woody tree species with a thick canopy cover, generally taller than 1.5 m.

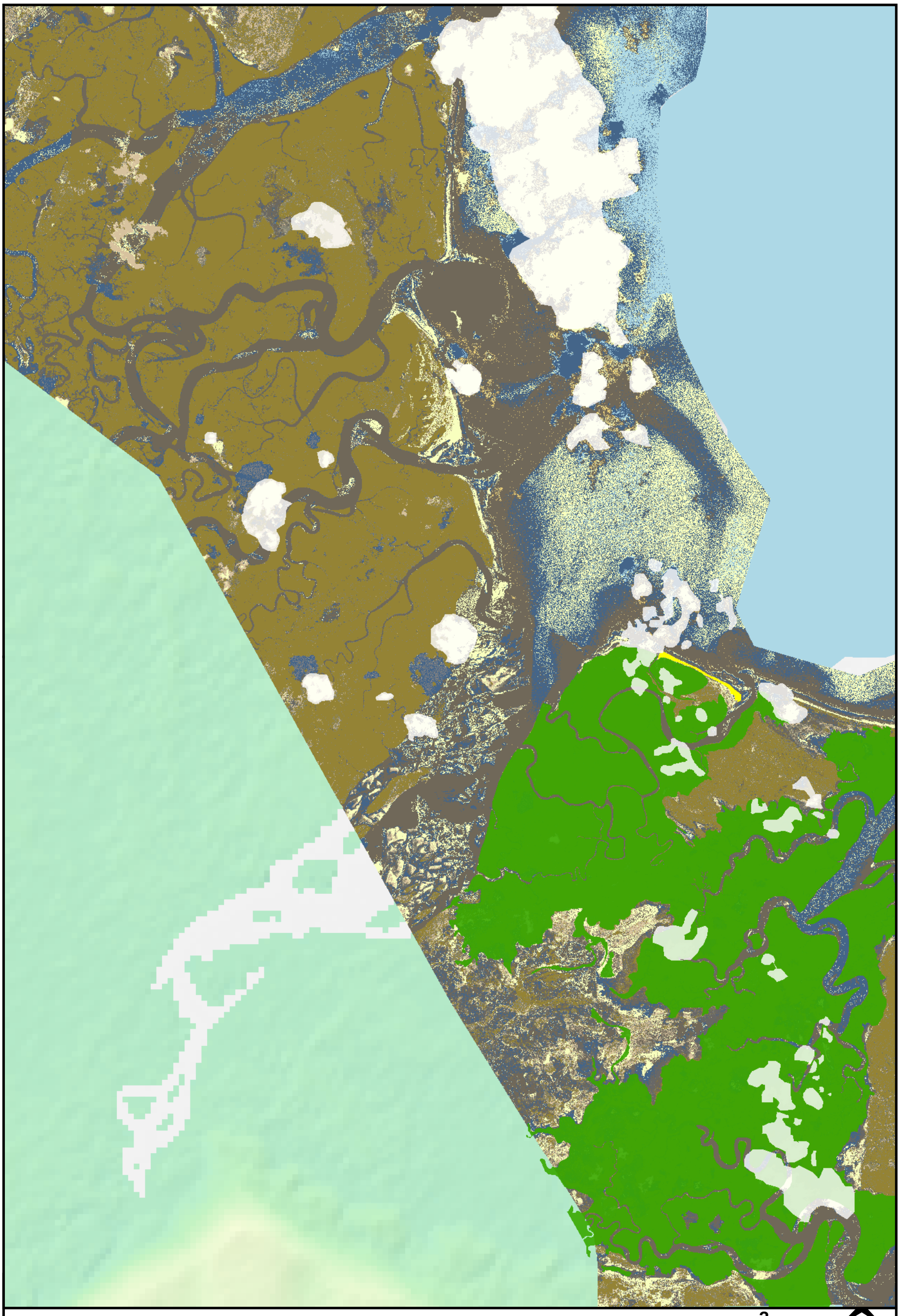
- **<u>The classes where the habitat was unidentifiable</u>**

  - **Deep/Indeterminate (water)**: areas where the water column was too deep to be able to pick-up what king of habitat lies at the bottom
  - **Turbid water**: areas of turbid water, hindering visibility. These are mostly situated around river mouths
  - **Shadow**: shadow areas of trees or buildings



Habitat Maps Overview

Habitat Maps for Shallow Water EIA



Legend

- AMA1 Concession Area
- Clouds
- Coral
- Coral/Coral Fringe/Sand
- Deep Coral
- Low Sparse Vegetation
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- Mangroves
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- Sand/Sparse Coral
- Sand/Sparse SAV
- Sandy Shores
- Turbid Water
- Water
- Woody Vegetation

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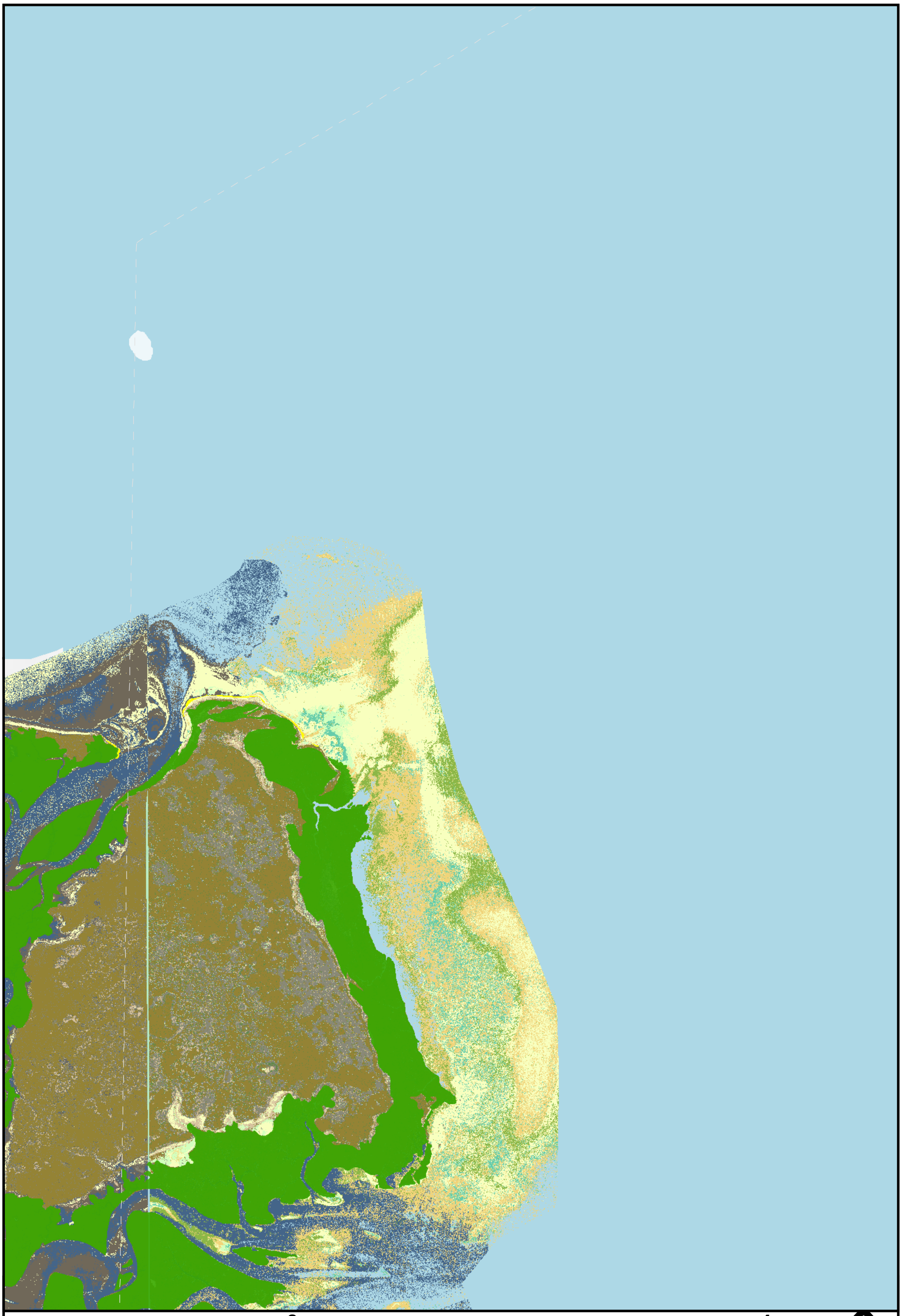

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Habitat Maps for Shallow Water EIA

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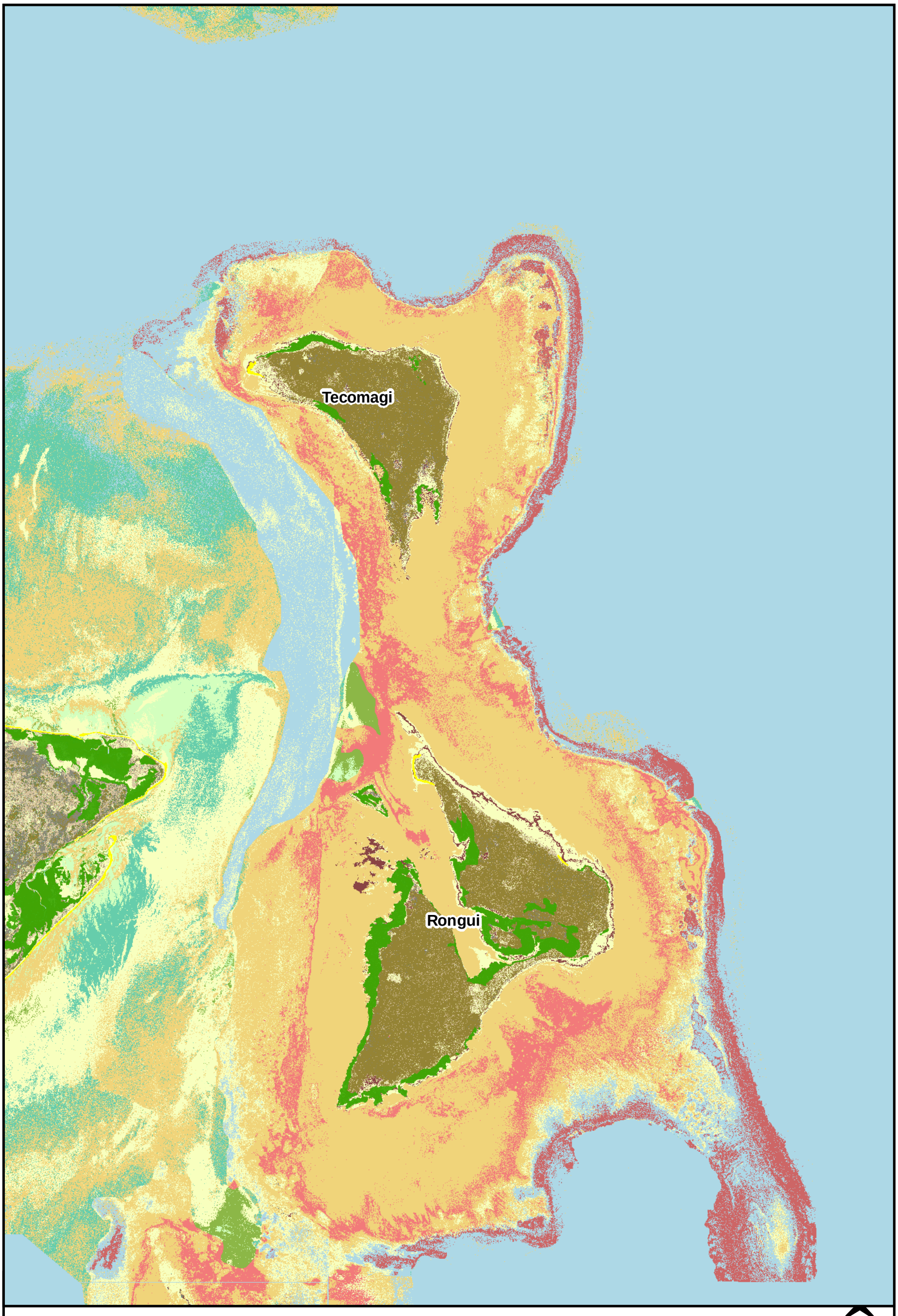

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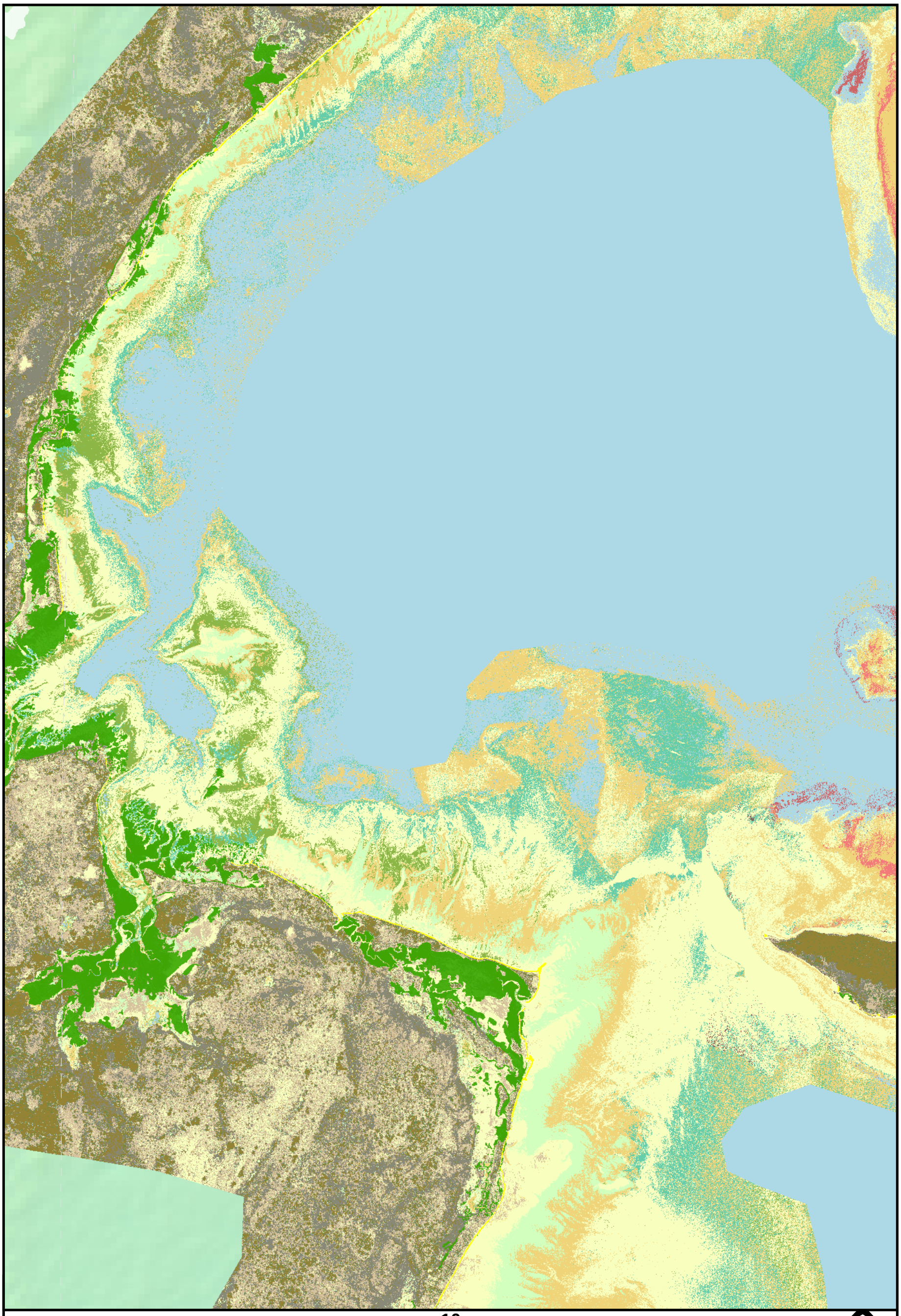

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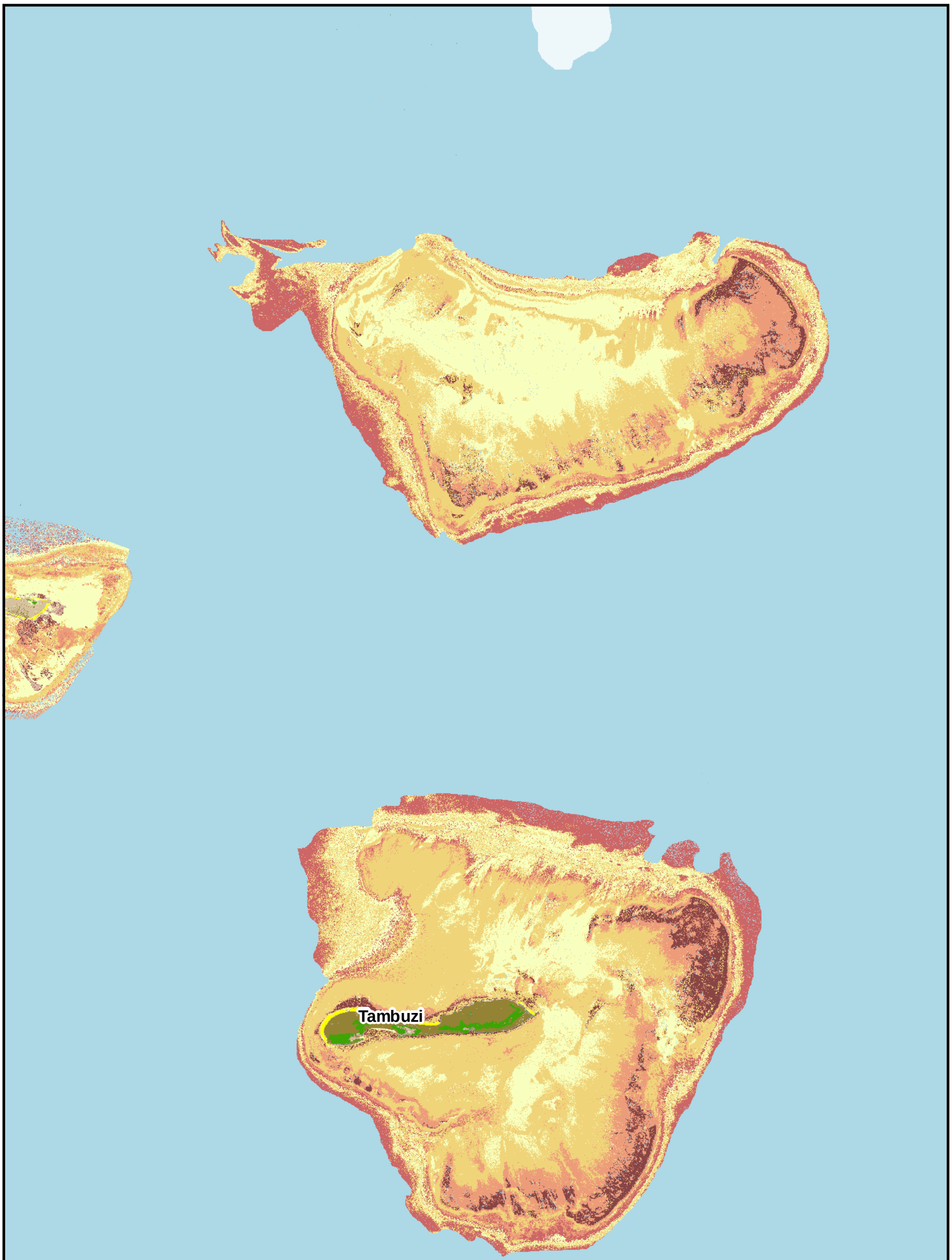

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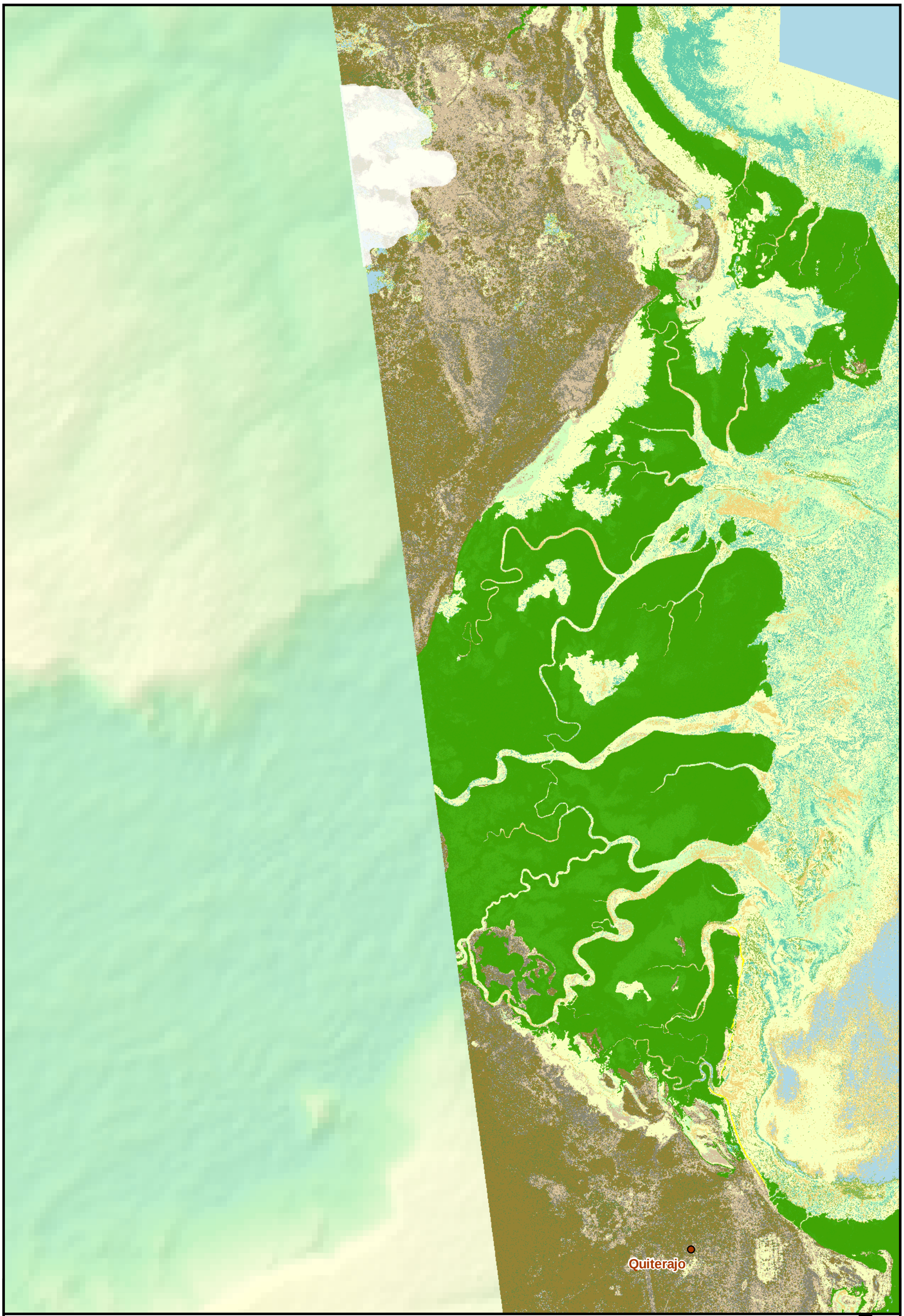

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Vadiazi

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Macaloe

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