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## **Proceedings of the Mozambican Marine Ecosystem Forum: Scientific Basis for an Integrated Coastal Zone Management**

**Maputo 17-18 May 2010**



**The Academy of Sciences for the Developing World**  
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Faculdade de Arquitetura, Universidade Eduardo Modlane (UEM), Maputo

**Proceedings of the Mozambican Marine Ecosystem Forum: Scientific Basis for an Integrated Coastal Zone Management, Maputo, Mozambique 17 -18 May.**

**Organized by:**



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**Faculdade de Arquitetura, Universidade Eduardo Modlane (UEM), Maputo**

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To all national and international speakers and presenters for their valuable contributions.

To the chairs of the sessions, especially to Ana Menezes for her useful guiding and inputs

To the KUWUKA JDA and MUSOCO APS collaborators for their hard work and assistance to make the workshop possible, namely: Camilo Nhancale, Herculano Vilanculo, Eduardo Lichuge, Tânia Libanze, Oldemiro Mangaze, Olga Tondo, Gilda Matavel, Mathias Spaliviero, Marzia Piron, Simone Libralato, Stefano Ciavata and others not named here whom contributed.

## **Presentation**

The “Mozambican marine ecosystem forum: scientific basis for an Integrated Coastal Zone Management” was organised in order to provide a new forum of discussion for Mozambican scientists working in the fields of marine biology and ecology, fisheries, aquaculture, oceanography and socio-economic studies applied to the management of marine resources. The purpose of the meeting was to gather scientists working on different aspects of marine ecosystem, to set the basis for placing coherently the different research activities in an integrated framework toward the sustainable use of marine resources of Mozambique.

The “Mozambican marine ecosystem forum: scientific basis for an Integrated Coastal Zone Management” was conceived as an opportunity for:

- discussing methods for assessing the state of marine environments and resources;
- presenting studies regarding the main effects of human activities and natural changes - such as fishing, climate changes, eutrophication - on coastal ecosystems, focusing on the Mozambique coasts ;
- identifying the main structural gaps in the scientific research activity in Mozambique.

This Forum held in May 2010 might represent the first of a series to be continued in the next years, becoming a yearly scientific appointment for local and international students and researchers.

Local and international scientists and experts have been invited as key speakers for providing useful insights on advanced research activities, methods and meaningful examples they have been working on key aspects relevant for the meeting.

Mozambican scientists from the Universities and research Institutes, as well as researchers and experts from other local organizations (co-operatives, environmental associations) were invited to participate and submit their contribution to the Forum.

The participation of both research scientists and experts was intended to assure a balance between high scientific profile and advanced applications of methods, analyses and tools in the framework of the investigation and management of coastal areas.

A relevant aspect of the Forum was to give special emphasis to: *i)* high profile scientific methods that are not “data-hungry”; *ii)* scientific studies and analyses exploiting free/low cost data, and *iii)* analyses based on data collected from Mozambican Institutions and Organizations. These datasets should include, for example, satellite data and fish landing statistics and data collected by scientists and experts in the fields of marine biology and ecology, fisheries, aquaculture, oceanography and socio-economic studies applied to the management of Mozambican marine resources.

The abstract submitted to the Forum were all accepted for oral presentations and 12 talks were organised into four sessions, that are 1) Marine ecology and biology; 2) Fisheries and aquaculture; 3) Pollution and 4) Integrated analyses, gaps and needs for local research development.

The official languages of the forum were English and Portuguese, advantaging the interaction and discussion among local and international participants to the Forum.

## **Program of the meeting**

### **Monday, 17<sup>th</sup> May 2010**

10:00 – 10:20 Introduction and presentation of the meeting by **Camilo Nhancale** (KUWUKA JDA) and **Federico De Filippi** (MUSOCO APS).

#### SESSION 1: MARINE ECOLOGY AND BIOLOGY

**Chaired by: Ana Menezes and Elídio A. Massuanganhe**

10.20 – 11.00 **Stefano Ciavatta:** *Coupling biogeochemical data and models: an useful approach to the investigation of coastal areas.* (keynote invited speaker)

11.00 – 11.30 coffee break

11.30 – 12.00 **Santos Luis Mucave:** *Estado dos recifes de coral e nivel de conhecimentos dos recifes pela população da Ponta de Ouro.*

12.00 – 12.30 **Eduardo J.S. Videira:** *Tartarugas Marinhas em Moçambique: O estado actual de conservação e investigação no sul do país.*

12.30 – 13.00 Plenary discussion on session's arguments

13.00 – 14.20 lunch

SESSION 2: FISHERIES AND AQUACULTURE

**Chaired by: Elidio Massanganhe**

- 14.20– 15.00 **Simone Libralato:** *Evaluating overfishing in an ecosystem context using new simple metrics: evidences from global and local applications.* (keynote invited speaker)
- 15.00 – 15.40 **Ana Menezes:** *Artisanal fisheries: towards poverty alleviation. The case of Mozambique.* (keynote invited speaker)
- 15.40 – 16.10 **Marzia Piron:** *The European Union Common Fisheries Policy (CFP) and the Fisheries Partnership Agreements*
- 16.10 – 16.30 Plenary discussion on session's arguments
- 16.30 – 17.00 coffee break

SESSION 3: POLLUTION

**Chaired by: Helsio Azevedo**

- 17.00 – 17.30 **Federico de Filippi:** *Environmental impact assessment of waste management systems in coastal areas: the life cycle assessment.* (keynote invited speaker)
- 17.30 – 18.00 **Dalila A. Narane:** *Análise quantitativa da poluição por micro- egrânulos plásticos ao longo da costa Moçambicana*
- 18.00 – 18.30 Plenary discussion on session's arguments and closing of the first day meeting (*Camilo Nhancale*).

**Tuesday, 18<sup>th</sup> May 2010**

SESSION 4: INTEGRATED ANALYSES, GAPS AND NEEDS FOR LOCAL RESEARCH  
DEVELOPMENT

**Chaired by: Silvia Dolores**

- 10.00 – 10.30 **Helsio Azevedo:** *Modelo de diagnostico ambiental para elaboracao do plano ambiental do municipio de Inhambane em Moçambique*
- 10.30 – 11.00 **Elídio A. Massanganhe:** *Analise dos sistemas aplicada rumo a efectivacao da gestao integrada da zona costera em Moçambique.*
- 11.00 – 11.15 coffee break
- 11.15 – 11.45 **Marcos Pereira:** *Ciencias marinhas em Moçambique: quo vadis?.*
- 11.45 – 12.15 **Ana Menezes:** *From the Ivory Tower To the Ebony Village*
- 12.15 – 12.30 Plenary discussion on session's arguments

CLOSING SESSION

**Chaired by Ana Menezes and Federico De Filippi**

12.30 – 14.00 Plenary final discussion

14.00 – 14.20 Closing speech by Camilo Nhancale

14.20 – 15.20 Lunch

## **Abstracts**

### SESSION 1: MARINE ECOLOGY AND BIOLOGY

#### **Coupling biogeochemical data and models: an useful approach to the investigation of coastal areas**

Stefano Ciavatta

Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth, PL1 3DH, UK

This talk focuses on a mathematical tool (“Data Assimilation”) that can be usefully applied to couple biogeochemical data collected in coastal areas with mathematical models of their evolution. The talk is motivated by the evidence that monitoring biogeochemical variables in coastal areas is relevant for the investigation and the management of these complex ecosystems. Nevertheless, in coastal areas the data can be poorly representative and highly uncertain due to the complexity of the ecosystem dynamics and the inherent limitations of the measurement procedures.

On the other hand, mathematical models can be useful tools for quantitatively characterizing the spatial and temporal evolution of the biogeochemical variables, and/or for testing our hypothesis on the ecosystem functioning. Nevertheless, the output of models is always uncertain, due to our uncertain knowledge and representation of the biogeochemical variables.

In the framework of coastal system studies, Data Assimilation can be a useful tool because it provides a means to systematically meld the uncertain information provided by theoretical models with the uncertain information present in data, leading in potential improvements in both the model and the observing system.

In order to support these considerations, two case studies are presented. The first, deals with the assimilation of nitrogen data collected in the Venice lagoon (Italy) with a simple time series model. The second case study presents the assimilation of satellite chlorophyll data with a complex physical-ecosystem model of the Western English Channel (United Kingdom).

### **Estado Actual dos recifes de Coral e Nivel de conhecimento dos Corais Pela População da Ponta de Ouro**

Santos Luis Mucave

Universidade Eduardo Mondlane Departamento de Ciências Biológicas;

O presente estudo teve como objectivos avaliar o Estado Actual dos recifes de Coral e o Nível de Conhecimento dos Corais pela População da Ponta de Ouro.

A avaliação do estado do coral inclui a análise da estrutura, diversidade e cobertura do recife de coral, usando método Line Intercept Transect – LIT (Transecto de Linha Interceptada). As amostragens do estado foram realizadas em três recifes da Ponta de Ouro nomeadamente: o Creche, Doodle e Bread Loaf.

A avaliação do conhecimento do coral pela população local realizou-se mediante um inquérito administrado a 35 pessoas residentes na Ponta de Ouro e a 7 instancias turísticas.

Foram encontrado 14 substratos, o maior substrato foi de coral mole e obteve-se no Bread Loaf (62.5%) e Creche com (59.2%), o Doodle que teve por uma maior cobertura de macroalgas (35%). Em termo de diversidade foram 9 famílias e 14 géneros de corais. O recife Bread loaf teve maior número de géneros de coral.

A complexidade dos recifes variou entre 1.75 a 2.49. A similaridade é baixa e variou entre 23 a 33. Estes dados, devem-se ao facto do corais da Ponta de Ouro estarem no limite da ocorrência dos recifes de coral.

O nível de conhecimento dos corais pela população é bom, mas deriva de conversa e dos meios de comunicação social. Poucos elementos da comunidade praticam o mergulho nos corais na Ponta de Ouro. As pessoas com profissões ligadas ao mar são aquelas que têm maiores conhecimentos sobre os recifes de coral.

Os corais da ponta de ouro as principais atracções dos turísticas, foram os peixes esponjas e corais.

### **Tartarugas Marinhas em Moçambique : O estado actual de conservação e investigação no sul do país**

Eduardo J S Videira, Marcos A M Pereira & Dalila A Narane

Associação para Investigação Costeira e Marinha. Maputo – Moçambique.

Na costa Moçambicana ocorrem e nidificam cinco, das sete, espécies de tartarugas marinhas conhecidas no mundo. O estudo destes répteis na nossa costa tem sido, historicamente, muito negligenciado. O primeiro estudo de que se tem conhecimento data de 1971 e desde então, pouco trabalho foi efectuado. No entanto, nos últimos cinco anos, ocorreu um crescimento significativo de actividades relacionadas com estes animais, tais como estudos e programas de conservação. O presente trabalho é uma compilação daquilo que foram os resultados obtidos a partir das diversas actividades efectuadas no sul do país no período 2005 - 2010. Neste período, foi dedicada uma maior atenção a aspectos como a protecção e monitoria das fêmeas e dos ninhos e à marcação de tartarugas. Estima-se que são postos nesta costa mais de 800 ninhos por ano. A maior parte dos

quais (mais de 95%) são postos pelas tartarugas cabeçuda (*Caretta caretta*) e coriácea (*Dermochelys coriacea*). Os cerca de 100 km de praia entre a Ponta do Ouro e a Ilha de Inhaca, constituem a mais importante área de nidificação, pois aqui são postos cerca de 75% de todos os ninhos encontrados. É também nesta extensão de costa, onde se está a efectuar mais intensamente a actividade de marcação de tartarugas, tendo sido marcadas neste período cerca de 90% das tartarugas marcadas no sul do país. A mortalidade de tartarugas marinhas é muito pouco reportada, no entanto surgem todos anos, relatos de tartarugas a serem mortas ao longo toda esta costa. As prioridades e necessidades do programa são discutidas, tendo em conta a necessidade de uma protecção mais eficaz destes animais protegidos tanto a nível nacional como internacional.

## SESSION 2: FISHERIES AND AQUACULTURE

### **Evaluating overfishing in an ecosystem context using new simple metrics: evidences from global and local applications**

Simone Libralato

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS, Sgonico (Trieste), Italia

Ecosystem approach to fisheries is nowadays required worldwide. This requires the development and application of practical tools for ecosystem analysis and evaluation capable of providing insights useful for ecosystem-based fishery management, such as ecosystem models and indicators. Here the decrease in secondary production is proposed as a proxy for quantifying ecosystem effects of fishing, and it is formally defined in a new index of ecosystem overfishing, L (Loss in production) index. From theoretical network analysis, L index formulation is based on properties of catches (Trophic Level and Primary Production Required) and of exploited ecosystems (Primary Production and Transfer Efficiency) and allows estimating the index for mass-balance models and landing data. Application of the index to 51 ecological models of exploited ecosystems, previously classified as overexploited or sustainably exploited, allows associating a probability of being sustainably fished to each index value. Successively, L index, estimated from landing data and outputs of unclassified ecosystem models, allows quantify current level of exploitation, expressed as probability of being sustainably fished, for many marine ecosystems. Moreover, by fixing desired probability levels as reference points (e.g. 75% and 95% probability of being sustainably fished), the corresponding index values provide basis for back-estimating the associated maximum allowable catches. Applications of L index at regional (Mediterranean) and global scales are presented. Moreover, the L index is also applied to outputs of dynamic models of exploited

ecosystems allowing an evaluation of sustainability of fisheries along time for the past fishing history and for future scenarios of alternative management options. Results evidence the usefulness of L index in providing general basis for quantifying the level of disruption for ecosystems subjected to multi-fleet and multi-species target fishing pressures.

**Governance of Artisanal Fisheries in Mozambique: Towards Poverty Alleviation**  
Ana Menezes

This study presents the results of mixed quantitative and qualitative social science research into the factors that have affected economic and social development after a policy shift toward market liberalization in 1987 in Mozambique. Three coastal districts in Nampula Province were studied to see whether these policies improved rural livelihoods and enhancing their sustainability. The study chronicles how fisheries resource management and conflict management processes have changed several times in response to shifting social and political conditions as Mozambique experienced three distinct socio-economic and political periods (Colonial, Socialist-Marxist-post-Independence, and Market Economy-post-structural adjustments).

Participatory Rural Appraisal, household surveys and in-depth interviews were used in this study and the findings suggest that in general socio-economic conditions improved at the household and community level. Most household used diversification as a coping and/ or enabling strategy to minimize risk and for accumulation purposes. The integrated artisanal fisheries development programs implemented since 1995-1996 have played a major role in the creation of an enabling environment that allows households to improve their livelihood, measured with monetary and non-monetary indicators.

While the poorest segments are under-represented in the decision-making process the new policies have promoted the creation of local participatory organizations that have begun to play a role in regulating fishing practices, promoted community development and helped resolve local disputes. Positive results are attributed not only to the adopted policy but particularly to the effective preparation and implementation of the artisanal fisheries development program after the structural adjustments, the inclusive preparation of a new fisheries management plan in 1994 with the involvement of local communities, the leadership of the Mozambican Institute for the Development of Small Scale Fisheries, and to the individual characteristics of the participants. Despite the apparent success of the new institutions, there is no evidence that they are improving the sustainability of the fish stocks. The overall socio-economic results suggest different policy interventions for different income groups, with special focus for social services for the lower income and more complementary services for the higher income.

**Keywords:** Artisanal fisheries, policy, integrated rural development, institutional development, livelihood sustainability, diversification, social cohesion, conflicts;

**The European Union common fisheries policy and the Fisheries Partnership Agreement**

Marzia Piron

The Common Fisheries Policy (CFP) was reformed in 2002 to ensure sustainable exploitation of living aquatic resources. The reform introduced a precautionary approach to protect and conserve living aquatic resources, and to minimize the impact of fishing activities on marine eco-systems. The results of the CFP implementation are:



- the enforcement of new regulations;
- the enforcement of a financial instrument to reduce the size and the impacts of the European fishing fleet;
- the negotiation on behalf of EU countries in international fisheries organizations and with non-EU countries around the world.

This study is devoted to analyze the implementation of the new regulations in the European water of Mediterranean sea and the Fisheries Partnership Agreements between Europe and third Countries.

### SESSION 3: POLLUTION

#### **Environmental impact assessment of waste management systems in coastal areas: the life cycle assessment methodology**

Federico De Filippi

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Waste management is a burning issue in every part of the world: waste is a major source of environmental pollution. In the European Union, the priorities for waste management are set as follows:

- Prevention/reduction of the production of waste
- Reutilization and material recycling
- Utilization/energy recovery
- Disposal.

The Life Cycle Assessment (LCA) is a methodology for the quantitative assessment of environmental impacts of industrial products; EASEWASTE, a model developed by the Danish Technical University, can be applied to monitor waste management systems. The assessment accounts for all resources uses and environmental emissions, aggregates all emissions into potential impact categories (global warming potential, Ecotoxicity, Human Toxicity, etc.).

The LCA, probably a unique method for quantifying the environmental impacts of human activities has though a big limitation: the important uncertainty about the spatial distribution of impacts and emissions.

Examples of environmental impacts of different waste management systems will be presented with particular focus on the waste incineration plant in Venice, near the lagoon and the Adriatic sea.

#### **Análise quantitativa da poluição por micro- e grânulos plásticos ao longo da costa Moçambicana**

Dalila A Narane, Marcos A M Pereira & Eduardo J S Videira

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O efeito deletério dos resíduos plásticos no ambiente marinho são já bem documentados. Estes constituem uma ameaça não só pelo aspecto estético desagradável, como também pelo facto de absorverem, transportarem e libertarem compostos orgânicos perigosos. Pouco se sabe sobre a poluição por plásticos na costa de Moçambique. Para estudar e quantificar a distribuição e abundância de micro-plásticos ao longo da costa moçambicana, foram colhidas amostras de sedimento entre a linha mais alta de maré e a base das dunas em 25 praias. Foram também colectadas amostras de grânulos de resina (ou “resin pellets” - a matéria prima para a fabricação de

objectos de plástico), usando uma metodologia de esforço por unidade de tempo em 19 praias. Um total de 85,336 gr de sedimento foi colectado e filtrado para extracção de micro-plásticos. No total 5,586 grânulos foram colectados. Os resultados mostram que tanto os micro-plásticos (fibras, fragmentos de plástico duro e mole e esponjas), assim como os grânulos encontram-se distribuídos por toda a costa e possuem um tempo de residência no mar relativamente alto. Resultados laboratoriais preliminares, dos grânulos plásticos (principalmente polietileno e polipropileno) colectados em Maputo e Beira, mostram a presença de vários tipos de polímeros policlorinados incluindo PCB (Bifenil policlorinado), DDT (Dicloro-Difenil-Tricloroetano) e HCH (Hexaclorociclohexano), indicando presença destes poluentes orgânicos nestas zonas. As implicações para a saúde pública são discutidas, assim como futuras acções de gestão e investigação nesta área.

#### SESSION 4: INTEGRATED ANALYSES, GAPS AND NEEDS FOR LOCAL RESEARCH DEVELOPMENT

##### **Modelo de diagnóstico ambiental para elaboração do plano ambiental do Município de Inhambane em Moçambique.**

Helsio Azevedo

Universidade Eduardo Mondlane - Escola Superior de Hotelaria e Turismo de Inhambane.

A presente apresentação é resultado de uma dissertação de mestrado e apresenta uma proposta de metodologia para análise da situação ambiental no município de Inhambane em Moçambique, o Diagnóstico Ambiental Municipal - DAM. A metodologia proposta fundamentou-se nas propostas de diversos autores como MOTA (2000), SANTOS (2004), entre outros e organismos públicos e privados como o Ministério do Meio Ambiente do Brasil (2001) e o Programa das Nações Unidas para o Desenvolvimento (1996); o modelo proposto objectiva a criação e aplicação de técnicas de inventariação e sua análise para o planeamento de uma área, no caso a municipal, e fundamentalmente subsidiar as estratégias de gestão ambiental, turística e aspectos relacionados, visando o enquadramento de conhecimento teórico nas acções práticas de planeamento e gestão ambiental, de modo a contribuir para maior sustentabilidade do município. O modelo aqui proposto, após sua aplicação, mostrou que actualmente o município apresenta uma situação fraca de gestão ambiental com as ameaças do ambiente externo a superarem as oportunidades, facto que contribui para o crescimento insustentável de determinadas actividades económicas, neste caso exemplifica-se o turismo, que depende muito de sistema eficiente de gestão ambiental para que possa manter e atrair os turistas que acedem ao município e assim contribuir para o desenvolvimento local. Conclui-se assim que a metodologia proposta mostrou-se viável, pois fornece subsídios para o planeamento e gestão ambiental, contribuindo para a estruturação de uma base de diagnóstico dos componentes ambientais para aplicação em outros municípios moçambicanos no geral e os costeiros e turísticos especificamente.

##### **Análise de Sistemas Aplicada Rumo à Efectivação da Gestão Integrada da Zona Costeira em Moçambique**

Elídio A. Massuanganhe

Departamento de Geologia, Faculdade de Ciências, Universidade Eduardo Mondlane, Bairro Laulane

“Análise de Sistemas” é introduzida neste projecto para analisar a Gestão Integrada de Zonas Costeiras, tomando como exemplo a zona costeira moçambicana. Diferentes variáveis ambientais, processos, bem como as diferentes actividades que ocorrem nas zonas costeiras form agrupadas num diagrama de causa e efeito (Causal Loop Diagram – CLD) com vista a perceber a complexidade do processo de Gestão Integrada de Zonas Costeiras. Actividade turística, pesca, água subterrânea, urbanização, qualidade de vida, catástrofes naturais, e poluição ambiental são algumas das variáveis identificadas para a zona costeira de Moçambique na perspectiva de sistemas. Para este trabalho foi analisada a interação e a interconexão entre as diferentes variáveis no esquema CLD e, baseado também no comportamento de de algumas variáveis foi possível identificar a urbanização e a actividade turística como variáveis chave a serem observadas para o desenvolvimento sustentável para zonas costeiras. Contudo, práticas ambientalmente sãs são recomendadas para a efectivação da Gestão Integrada de Zonas Costeiras em Moçambique.

### **Ciências Marinhas em Moçambique: *Quo vadis?***

Marcos A M Pereira, Eduardo J S Videira & Dalila A Narane

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Moçambique possui uma longa costa marítima (ca. 2700 km) que é de extrema importância histórica, cultural e sócio-económica. No entanto, pouco se sabe sobre o seu actual estado de conservação, quantidade e distribuição de recursos e suas ameaças. Apesar de a investigação científica nas várias disciplinas ligadas ao mar (colectivamente denominadas ciências marinhas) ter se iniciado há pelo menos um Século. No presente trabalho, foi analisada a literatura primária ligada às ciências marinhas, publicada nos últimos cinco anos (de 1 Janeiro 2005 a 30 Abril 2010) em jornais científicos indexados, tendo como base trabalhos feitos em Moçambique. A busca resultou num total de 63 artigos válidos, publicados por 26 cientistas (61.5 % do sexo masculino). Em 76.2 % dos artigos, o autor sénior é estrangeiro e em mais de metade (50.8 %) deles, todos os autores são estrangeiros. Somente dez artigos (15.9%) são totalmente autorados por Moçambicanos e somente 23.8% dos artigos têm como autor sénior um cientista Moçambicano. Um terço dos artigos teve autoria conjunta (autores nacionais e estrangeiros). A maioria dos artigos (58.1%), debruçou-se sobre aspectos relacionados com a ecologia e biologia dos recursos. Outras áreas foram largamente negligenciadas sendo de destacar a Biodiversidade/Taxonomia (9.5%), Conservação/Áreas Protegidas/Políticas (9.5%), Pescarias e Recursos Pesqueiros (4.8%) e outras áreas diversas (representando conjuntamente 19.7%). A maioria dos autores estava afiliado à Universidade Eduardo Mondlane (52.4%) seguido pelo Instituto Nacional de Investigação Pesqueira (9.5%). As causas, implicações e consequências desta fraca produção de conhecimento científico nesta área crucial para o país são discutidas e algumas recomendações são igualmente apresentadas.

### **From the Ivory Tower to the Ebony Village: Poverty Assessments in developing rural communities. Reflections about methodological approaches**

Ana Menezes

This paper reflects on the methodological approaches used in a longitudinal study for a dissertation project that explores theoretical and practical policy issues related to the governance of natural resources in Mozambique, focusing on artisanal fisheries. It consists of retrospective and iterative qualitative and quantitative analysis of data collected during the field work. A combination of research methods was used in this study. Using qualitative and quantitative methods this research project seeks to understand the complexity of the sustainability paradigm in Mozambique and how

policy influenced it. The assumptions are as follows (1.a) income diversification is one strategic mechanism to cope with shocks, (1.b) family and social networks are essential to build resilience and to avoid vulnerability, (1.c) governance of the resources through public participation and participatory decision making models (state/society relations) are central for community development and its sustainability.

Livelihood and sustainability analysis requires the understanding of poverty dimensions in specific environmental, socio-cultural, politico and economic context (Booth et al., 1998, Woolcock, 2001). The combination of research methods is crucial to grasp the complexity of the poverty issues in terms of problems, its causes and potential solutions in a specific setting. Initially the research framework was basically hypothetic-deductive, to test hypotheses based on a general theory, and whose phenomena occurred in a certain physical, social and economic environment; therefore, a specific deductive study. During the first week of the field work, it became evident that to answer to the research questions part of this study would need to incorporate a great deal of an inductive approach into the research design.

This paper reviews literature regarding the use of mixed methods in poverty assessments. It draws some lessons from the use of theory-driven and data-driven research using quantitative and qualitative data derived from household surveys and participatory approaches. It also describes the use of statistical principles and analysis in participatory research, which removes pitfalls commonly identified by many researchers, in qualitative research. At the same time it provides a meaningful context for statistical results, since qualitative participatory methods allows in-depth analysis, difficult to acquire in quantitative analysis alone.

### **The meeting structure and plenary discussions**

The “Mozambican marine ecosystem forum: scientific basis for an Integrated Coastal Zone Management” held at the Faculdade de Arquitetura da Universidade Eduardo Modlane (UEM), MAPUTO 17-18 May 2010, was a successful event.

The two days of meeting have seen the participation of 25 people, with a female/male ratio of approximately 1:1. Participants were affiliated to different departments of the University Eduardo Modlane, research Institutes and associations mainly from Mozambique. The four invited speakers (one Mozambican and three from foreign countries) presented their insightful works that foster discussion. The preferred language of the meeting was Portuguese but also English was adopted whenever necessary with no negative effects on the discussion and interaction among participants. Each presentation was followed by interesting questions, discussions and reasoning that involved all the audience. This outcome highlighted the appreciation of the Forum themes and works presented, and pointed out the need for discussion and interaction forums like the one proposed.

In the following, the main issues raised in the discussions and plenary sessions of the four forum themes are briefly summarized.

#### **1) MARINE ECOLOGY AND BIOLOGY**

The discussion following the presentations highlighted the possibility and usefulness of linking different sources of data in the framework of the investigation and management of Mozambican marine resources, such as remote sensing data (e.g. ocean color) *in situ* data ( e.g. corals and turtles surveys). Nevertheless, it was pointed out that a marked improvement in the quality, quantity and availability of data and information relative the Mozambican marine ecosystems is needed. It was highlighted the need and opportunity of exploiting satellite data freely available on the web, by Mozambican scientists.

#### **2) FISHERIES AND AQUACULTURE**

The participants discussed the relationship between data and model, and, in particular, how an error in the data might propagate into representations and future insights/scenarios. Models were considered with criticism due to the complex fishing activities in the country also characterized by targeting multi-species: the appropriateness of presented studies was discussed. It clearly emerged the importance of data and the general lack of quantitative information in Mozambique, although great attention to the social-economic side was claimed and the social methods for studying fishery sector.

### 3) POLLUTION

The discussion highlighted the need for reducing discharges and wastes, an issue that is common throughout the world. The discussion highlighted the large initial costs for the most recommended waste disposal methods (incinerator): these costs hamper their adoption in the country. Despite Mozambican coasts are not free from pollution, with areas more prone to concentrate industrial and urban pollutants, in general there is no program for waste reduction in Mozambique and in Africa and this was questioned as a critical point to address to managers and policy makers. The current need of monitoring activities aimed to the surveillance of the pollution of the Mozambican marine ecosystem was highlighted.

### 4) INTEGRATED ANALYSES, GAPS AND NEEDS FOR LOCAL RESEARCH DEVELOPMENT.

The presentations stimulated the discussion of methods and tools for the environmental management plans of coastal areas. The planning of tourism and urbanization was highlighted as a crucial point in the safeguard and management of coastal areas. However, the lack of cooperation and dialog among institutions involved in the planning is considered a relevant current gap for an effective management of the Mozambican resources. This lack of communication does not favour the research activities. The latest, are of very high quality but few results are brought to international forums and scientific tools (publications). The lack of available information is widely recognized, but the participants highlighted that the participatory research in social science facilitate a true connection with the real world, where management and policies are to be applied.

### **Final plenary and remarks**

During the meeting and in the final plenary discussion many insights were provided by the audience, with respect to the useful applicability of the works presented at the Forum in the context of coastal zone management and to the current status of scientific research in Mozambique.

It was pointed out, for instance, the need for translating the scientific information into direct social effects. This connection needs to be valued in the evaluation/planning for coastal zone management. The participants highlighted the need of an interdisciplinary view and approach, for including all spheres of influence of management, that is somewhat hampered by the specialization of each scientist and expert. Participants agreed that the investigation and management of coastal areas need an integrated vision and approach. Nevertheless specialized studies are useful in a context of collaboration and sharing of information. In particular, the lack of coordination, interaction and integration among activities carried out by institutions and associations seems affecting negatively the community of local scientists and experts. This issue was considered a critical point for an effective management of the coastal zone and of the other Mozambican environmental resources.

The participants pointed out the need for scientific forums like the “Mozambican marine ecosystem forum: scientific basis for an Integrated Coastal Zone Management”. Indeed, these forums could allow the gathering and the collaboration among researchers, students and experts that are studying and working on the effective analysis and management of the Mozambican natural resources. Moreover, other methods for exchanging information and communicating among scientists and experts were suggested, such as the use of the internet. Thus, the set up of an internet forum was

also suggested as a tool for simplifying the interaction and discussion among local and international scientists and experts.

The Organizing Committee and the participants agreed that the “Mozambican marine ecosystem forum: scientific basis for an Integrated Coastal Zone Management” was a successful event in the framework of the scientific activities and debates in Mozambique. They highlighted the need of iterating the Forum as a periodical event to gather local and international scientist and experts, with the auspice of extending the participation to a higher number of local Research Institutes, Organizations and Authorities.