

Coastal Ecology Series No.1

Environmental  
Management, Research  
and Training in Coast  
Province, Kenya.

Jan Hoorweg

Editor

Malindi

Mombasa

Moi University, Eldoret  
School of Environmental Studies

Shimoni

**ENVIRONMENTAL MANAGEMENT, RESEARCH AND  
TRAINING IN COAST PROVINCE, KENYA**

### **Coastal Ecology Series**

1. Environmental Management, Research and Training in Coast Province.
2. MUSES Coast Environment Research Priorities.
3. Dunes, Groundwater, Mangroves and Birdlife: MUSES Coast Research 1994-96.

**Coastal Ecology Series No.1**

**ENVIRONMENTAL MANAGEMENT,  
RESEARCH AND TRAINING IN  
COAST PROVINCE, KENYA**

**JAN HOORWEG  
(editor)**

**Moi University, Eldoret  
School of Environmental Studies**

**1997**

© Moi University, Eldoret, 1997

Published in Kenya by ACTS Press  
African Centre for Technology Studies  
P.O. Box 45917, Nairobi  
Tel.: (254-2) 565173, 569986; Fax: 573002

Printed by English Press Ltd.  
P.O. Box 30127, Nairobi, Kenya

**Cataloguing in Publication Data**

Environmental Management, Research and Training in Coast Province,  
Kenya/Jan Hoorweg.—Nairobi, Kenya: ACTS Press, 1997.

(Coastal Ecology Series No. 1)

Cover Design: Andrew Akhonya

ISBN 9966-41-098-8

## CONTENTS

Acknowledgements	vi
Acronyms	vii
1. Introduction <i>Jan Hoorweg &amp; Ton Dietz</i>	1
2. District Environment Management <i>Henry Munga'sia</i>	7
3. Coast Development Authority <i>Bonfance Mwandotto</i>	11
4. Maritime Research Priorities for Kenya Marine and Fisheries Research Institute <i>Enock Wakwabi</i>	17
5. Kenya Wildlife Service, Marine Programs <i>Nyawira Mubiga</i>	21
6. Kenya Wildlife Service, Wetlands Conservation Project <i>Els Martens</i>	27
7. Small Fisheries Research in Kwale District <i>Anthony King &amp; Delphine Malleret-King</i>	31
8. Priorities in Botanical Research in Coastal Kenya <i>S.Ann Robertson</i>	35
9. Kaya Forest Conservation on the Kenya Coast <i>Anthony Gitbito</i>	45
10. Wasteland Rehabilitation: The Case of Baobab Farm <i>Sabine Baer</i>	49
11. International Centre of Insect Physiology and Ecology <i>Srinivasan Sithanantbam &amp; Z.Ngalo Otieno</i>	53
12. Kenya Agricultural Research Institute <i>Geoffrey Kamau</i>	57
13. Coral Reef Conservation Project <i>Nyawira Mubiga &amp; Tim McClanahan</i>	61
14. Training Course for Tropical Coastal Ecology, Management and Conservation <i>Nanette Daro</i>	65
Authors	69

## **Acknowledgements**

This publication and the study day which it reports were made possible by a grant under the NUFFIC-MHO programme, no.KE/7/931301. The editor also wants to thank the student rapporteurs who took notes on the individual contributions: Ms. Winnie Musila, Stephen Anyango, Frances Kamau, Paul Matiku, Thomas Munyao, Jason Mzuga and Evans Ouko.

## **Acronyms**

CDA	Coast Development Authority
CERS	Coast Environment Research Station
CFCU	Coastal Forest Conservation Unit
CRCP	Coral Reef Conservation Project,
DDC	District Development Committee
DEMC	District Environment Management Committee
DEO	District Environment Officer
FD	Forest Department
FR	Forest Reserve
GoK	Government of Kenya
ICIPE	International Centre of Insect Physiology and Ecology
IPR	Institute for Primate Research
KAHC	Kenya Association of Hotelkeepers and Caterers
KARI	Kenya Agricultural Research Institute
KEFRI	Kenya Forestry Research Institute
KENRIK	Kenya Resource Centre for Indigenous Knowledge
KESCOM	Kenya Sea Turtle Committee
KETRI	Kenya Trypanosomiasis Research Institute
KIFCON	Kenya Indigenous Forest Conservation Project
KMFRI	Kenya Marine and Fisheries Research Institute
KWS	Kenya Wildlife Service
MU	Moi University
MUSES	Moi University, School of Environmental Studies
NMK	National Museums of Kenya
NUFFIC	Netherlands University Foundation for International Cooperation
PCP	Plant Conservation Project
RRC	Regional Research Centre (KARI)
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature



\*\*\*\*\*

# 1

## INTRODUCTION

JAN HOORWEG & TON DIETZ

### **Introduction**

The Kenya Coast offers a mix of topographical and agro-ecological zones quite different from those of the highland areas. The Indian ocean, the reefs, the creeks and the beaches form the first and most characteristic habitat. This is part of the coastal strip, an area extending 15-20 km. inland with a rich cultural history, long having had contacts with the East and under the rule of the Sultan of Zanzibar from 1831 till 1963. The rest of the coastal plain goes up to 30 km land inward; followed by the foot plateau and

the coastal range rising to 200-300 m. altitude, and finally the Nyika plateau, the dry hinterland. Different agro-ecological zones alternate over relatively short distances. The coconut-cassava zone is generally near to the coastline, followed by the cashewnut-cassava zone and the livestock millet zone in the hinterland. Together with small and large forests and the wetlands of the Tana Delta this gives Coast Province a unique and rich differentiation in habitats augmented by great ethnic and cultural variations among the population.

Coast Province is the third area of population concentration in Kenya, after the Central and Western regions of the country. Kwale, Kilifi, Mombasa, the lower part of Tana River and the sparsely populated Lamu District form the coastal region as such. Taita-Taveta and the upper part of Tana River are situated inland. The economic development of the region has not kept pace with that of other parts of Kenya. Coast Province scores comparatively low on accepted development indicators such as child mortality, childhood malnutrition and literacy rate. The living conditions of the population in large parts of the province are harsh and estimates place the incidence of rural poverty at forty per cent which is higher than in Kenya as a whole.<sup>1</sup> The past decade has shown increased environmental and social science interest in the region.

Ecology wise this part of the country therefore has important characteristics. The sea front and beaches, the fringing reefs, the mangrove forests but also the remnants of terrestrial forests (half of Kenya's rare plants occur at the coast) and many historical sites and monuments. Because of this combination the region attracts heavy tourism which in itself places a heavy burden on the environment. Over sixty percent of tourists visiting Kenya, visit the coast and this figure is projected to increase over the years.

Most tourism is limited to the seaside and coastal strip.

The ecology of the Kenya Coast is threatened in many ways. Coral reefs are deteriorating, mangrove forests are overexploited, fish catches are going down, forest reserves are threatened, salt and sand mining threatens groundwater; unrestricted surface mining leads to erosion; ground water is increasingly saline and contaminated. The reasons behind these worrisome developments are several: increasing population pressure and economic activities; growth of tourism and resulting expansion of tourist facilities. It is unclear to what extent damages follow from naturally occurring geophysical processes, increased subsistence needs or from growing commercial exploitation. However, if current trends of exploitation continue unchecked many aspects of coastal ecology will suffer irreparable damage.

This concern has also been expressed in the national environment plan which has listed a series of coastal and marine issues.<sup>2</sup> These include fresh water supply; salination of groundwater; domestic and industrial pollution; sewage and waste disposal; overexploitation of reef fisheries; silt and sewage threats to reefs; and overharvesting of mangrove trees.

### **School of Environmental Studies**

Moi University, School of Environmental Studies (MUSES) has had a national

1 Hoorweg J, Foeken D & Klaver W (1995) *Seasons and Nutrition at the Kenya Coast*. ASC Research Series No.7. Oxford: Avebury.

2. MENR (1994). *The Kenya National Environment Action Plan: Report*. Nairobi: Ministry of Environment and Natural Resources.

mandate since 1984 to teach and to do research on sustainable resources in Kenya and to assist in policy formulation that encourages friendly exploitation of resources. At the time, a national need was perceived to improve environmental management in the country which until then had received insufficient intellectual and scholarly backing. Environmental studies were given a place at the new Moi University with the objective to place Kenya in the forefront of environmental knowledge and practice.

The School offers post-graduate programmes for Diploma, Master and Doctor of Philosophy in Environmental Studies offered in eight divisions: Biological Sciences; Environmental Economics; Environmental Health; Environmental Law; Environmental Information Systems; Environmental Planning & Management; Human Ecology and, finally, Physical Sciences.

In the initial phase, from 1989-96, the emphasis was on postgraduate teaching at M.Phil. level with 10-20 students admitted each year. Students were taken who had already acquired bachelor degrees in other disciplines and they were given further environmental training of a broad nature. In the first year the emphasis is on course work and field trips concluding with a three-week course on Environmental Impact Assessment. In the second year the emphasis is on individual research projects with fieldwork and thesis writing.

In 1991, MUSES entered on a pro-

gramme of collaboration with the University of Amsterdam and, through them, with other Dutch Universities. This collaboration entails staff development, support for the M.Phil. and D.Phil. programmes, the Environmental Information Centre, the development of laboratories, field research centres and staff research. The collaboration also includes joint research of Kenyan and Dutch staff and students. The programme is funded by the Netherlands University Foundation for International Co-operation (NUFFIC) under its MHO programme with support from the Netherlands Ministry of Development Co-operation. In principle, the programme is scheduled to continue until the year 2006.

In 1995 a phase of expansion started consisting of the following elements

- M.Phil. programme to be increased to 60 admissions yearly;
- D.Phil. programme with graduation at Moi University;
- Diploma and certificate courses, scheduled to start in 1997;
- Research activities with focus on three areas (i) Moi University campus surroundings, south of Eldoret; (ii) Homa Hills Field Research Centre near Lake Victoria; (iii) Coast Environment Research Station in Malindi .

#### **Coast Environment Research Station**

The Coast Environment Research Station (CERS) started in January 1996 when staff, consisting of a co-ordinator and ad-

ministrator, were permanently stationed in Malindi. Malindi was selected as basis for activities for several reasons. Firstly, because of the environmental richness of the Malindi area with in the near vicinity: Malindi & Watamu National Park with extensive coral reef formations; the Sabaki River estuary including the Mambui sand dunes; the Arabuko-Sokoke forest harbouring unique plant and animal species; the Mida Creek reserve with extensive mangrove forests. Secondly, Malindi is situated at the edge of the fertile and populated coastal strip and the drier north stretching to Formosa Bay and the Tana River giving easy access to different habitats. Thirdly, Moi University has been allocated a plot of land at the southern mouth of the Sabaki River. This land has a varied habitat consisting of dunes, mangroves swamp, low lying riverside and higher lying coral rock. Plans are in progress for a field station that will provide accommodation for visiting scholars together with modest laboratory and lecture facilities.

CERS serves various functions notably to create a presence of MUSES in the Coast and liaise with other coastal organisations concerned with environmental issues, to create a documentation centre, and to assist researchers and students with (thesis) studies regarding Coast Province. CERS currently has temporary offices in Malindi town with communication and transport facilities (including a dinghy with outboard engine). The first priority was to introduce the MUSES ini-

tiative to the civil authorities and to the main environmental organisations and explore possibilities for collaboration. A start has also been made with the documentation centre that apart from international environmental publications on the Kenya Coast, will particularly try to collect papers and reports that have not been internationally distributed and will also compile press clippings on coastal environment issues. A start will further be made with the publication of a Coastal Ecology Series.

From August 7-15, 1996, a workshop was organised by MUSES, actually consisting of four smaller workshops. The first consisted of a study day with presentations by coastal organisations concerning their activities and research priorities. The second workshop concerned the identification of MUSES environmental research priorities in Coast Province and the formulation of a programme that can serve as framework for staff research, student thesis projects, academic cooperation and funding requests.<sup>3</sup> The third workshop served to draft an interdisciplinary proposal on mangrove research.<sup>4</sup> During the final workshop, former and current MUSES students were given an

3 MUSES (1997) *Coast Environment Research Priorities*. Coastal Ecology Series No.2. Eldoret: Moi University, School of Environmental Studies.

4 MUSES (1996) Sustainable management of mangrove forests in Kenya: An ecological, socio-economic and policy research project. Research proposal. Moi University, School of Environmental Studies.

opportunity to present papers based on their thesis research.<sup>5</sup>

The presentations during the study day were concerned with environmental management, environmental research and environmental training. Speakers were requested to describe their organisation's environmental activities and to indicate urgent research priorities in their field of interest. These are the presentations included in this report. Two are concerned with practical environmental management by district administration and regional development organisation (Chapter 2-3) and two with training in coastal ecology (Chapter 13-

14). Four papers are concerned with marine research (Chapters 4-7), three papers with research on forest and fauna including wasteland rehabilitation (Chapters 8-10). In addition there are two papers on the environmental concerns of two national research organisations (Chapters 11-12).<sup>6</sup> Δ

5. Hoorweg J ed (1997) *Dunes, groundwater, mangroves and birdlife: MUSES coast research, 1994-96*. Coastal Ecology Series No.3. Nairobi: ACTS (In preparation).
6. While this volume was being prepared the new Malindi District was split off from Kilifi District. The text of some of the presentations has to be read with this administrative change in mind.



\*\*\*\*\*

## 2

### DISTRICT ENVIRONMENT MANAGEMENT

HENRY MUNG'ASIA

#### **Introduction**

The Permanent Presidential Commission on Soil Conservation was established in 1981 to oversee and co-ordinate all conservation activities in the country. It was soon realised that the commission, operating at the national level, was leaving a vacuum at the provincial and district levels. Subsequently, in 1988, the Government of Kenya (GoK) instituted the Office of the District Environment Officer (DEO) to co-ordinate not only conservation activities but the broad spectrum of environmental protection and manage-

ment in the districts. To demonstrate the GoK's commitment to environmental conservation, DEO's are recruited from the Provincial Administration Department of the Office of the President.

#### **Functions**

The DEO acts as co-ordinator of environmental matters at district level and is concerned with a wide range of concrete environmental issues as evinced below:

- Environmental protection and conservation;
- Surveillance of gazetted forests to

- protect water catchment areas;
- Promote farm forestry to ease pressure on government forests;
- Reduction and prevention of water pollution;
- Promotion of water harvesting techniques and conservation especially in the arid and semi-arid areas;
- Improvements in land use for higher productivity in conjunction with measures to prevent soil loss and degradation;
- Protection of coastal ecosystems;
- Create environmental awareness through training and public meetings;
- Promote afforestation;
- Control of air and noise pollution;
- Ensure environmental impact assessment of new industries.

The main function of the DEO is the co-ordination of all actors involved in environmental conservation and management. These may be GoK ministries or departments, non-governmental organisations, individuals and various interest groups. This part of the DEO's responsibilities entails: (i) co-ordination of environmental protection and conservation programmes in the district; (ii) initiation of new policies and strategies from grass-root level; (iii) promotion of participatory approaches to conservation down to the grassroots. And most important of all, co-ordinating adequate and timely action on existing environmental problems e.g. preservation and protection of forested catchment areas or checking on indus-

trial air and water pollution.

Since large numbers of institutions are currently implementing environmental management programmes in the District, the DEO is required to co-ordinate and promote collaborative linkages among all these players. Co-operation at the planning and implementation stages can prevent overlap, confusion and misapplication of meagre resources.

The DEO also acts as secretary to the District Environment Management Committee (DEMC). These committees were established as subcommittees of the District Development Committee. The DEMC is chaired by the District Commissioner and members are drawn from all government departments that implement development projects, local authorities, NGO's and individuals with special knowledge in environmental matters. The DEMC's are concerned with environmental management. The DEO is charged with the responsibility of organising the activities of the committee, follow-up of recommendations and reporting on action taken.

District Environment Officers usually head technical teams during inspection of eroded sites, conservation areas, related afforestation zones, river banks, dams, endangered wetlands, roadworks, water pollution cases, waste management and industrial pollution sites. These teams usually make recommendations for action by specific institutions, more investigation or further discussion in the DEMC or elsewhere.

District Environment Officers are also expected to be heavily involved in publicity, public education and mobilisation of the general public in environmental conservation.

### **The Kilifi Experience**

Kilifi District being a coastal district it experiences environmental conservation problems that are rather unique as described below.

#### *Land Tenure*

Land adjudication has not been completed in all parts of the district. This has led to destruction of forests, particularly on so-called trust lands because they are not gazetted as forests reserves. The DEMC has recommended that such forests yet be gazetted so that those cutting down trees indiscriminately can be prosecuted.

#### *Sand and Salt Harvesting*

Sand harvesting in some parts of the district has led to severe environmental degradation. The entrepreneurs who harvest sand usually leave behind open pits and do not care to plant trees for soil conservation and rehabilitation. (The same applies to iron ore, lead and limestone mines). Efforts are being made to have the miners rehabilitate the mines.

Salt harvesting has also had an adverse effect on the environment especially in Magarini Division. The process of harvesting salt involves the opening of lagoons to sea water which results in the drying up of vegetation in the surrounding ar-

reas. This has negative effects on mangrove forests in the area.

#### *Soil Erosion*

Some farmers in the district do not have soil conservation structures on their farms and this has led to soil erosion. However through the catchment approach to soil and water conservation some positive results are being realised.

#### *Air Pollution*

Complaints have been received from Mariakani area that factories in the area are emitting gases that are harmful to human health. The DEMC makes regular spot-checks on these factories and recommends remedial action by the factory owners.

#### *Beach Pollution*

The District is a major tourist destination with quite a number of hotels located on beaches. Through the local authorities and the concerned GoK departments action is taken to ensure that hotels do not dump waste on the beaches.

The Committee also ensures that coastal and marine areas are protected. The beaches are gazetted for protection by the Kenya Wildlife Service and anyone found violating provisions of the gazette notice can be prosecuted.

*Solid Waste Management in Urban Areas.* This is the responsibility of the local authorities. However, in the recent past, many local authorities have not been able to effectively manage the solid

waste in their areas of jurisdiction. The DEMC has embarked on an awareness campaign so that local residents are involved in keeping their towns clean to supplement the efforts of the local authorities.

**Conclusion**

The Office of the District Environment Officer is ill equipped. Lack of transport,

in particular, makes it difficult to monitor environmental activities in the district. With the many environmental problems highlighted above, it is necessary that research and advisory services are provided to assist the DEO in managing the environment more effectively while, at the same time, maintaining economic development. ▲

\*\*\*\*\*

# 3

## COAST DEVELOPMENT AUTHORITY

BONFANCE MWANDOTTO

### **Introduction**

The Coast Development Authority (CDA) is a regional development corporation constituted by an Act of Parliament in 1992. The Authority is charged with the responsibility of facilitating and co-ordinating sustainable development activities in an area which embraces all administrative districts within Coast Province, the southern half of Garissa District and the Exclusive Economic Zone off shore.

### **Functions**

Specifically, CDA is charged with the following functions:

- Design a long-term development plan for the area;
- Plan, design and initiate related development projects;
- Initiate studies and surveys as may be considered necessary by the government or the Authority;

- Effect monitoring and evaluation of the development projects with a view to improve performance and future planning;
- Co-ordinate the present extraction and use of natural resources, especially water, and to set up monitoring of extraction and usage;
- Effect the construction of works necessary for the protection and utilisation of water and soils including hydropower development;
- Ensure that landowners undertake all the measures required to protect the water and soils;
- Identify, collect, collate and correlate data on all natural resources and economic and related activities for the efficient forward planning of the area;
- Maintain a liaison between the government, the private sector and other development agencies to limit the duplication of effort and make best use of available technical resources;
- Plan and liaise with the relevant agencies concerning the exploration and development of the extensive fishing and marine activities, especially in the Exclusive Economic Zone.

### **Goals and Strategies**

The development efforts of the authority are geared towards attaining four major goals:

- **Food self sufficiency:** To improve the food production system to ensure that the coastal population will be able to feed itself;

- **Income generation:** To promote income generation activities by the population;
- **Employment creation:** To promote agricultural and industrial activities, particularly with a view to provide employment to the youth;
- **Wealth creation:** To promote large enterprises by institution or the people aimed at generating wealth for the region

Development projects have to be need driven and can only be sustainable when sensitive to environmental support systems. CDA development strategies endeavour to:

- Identify projects from people's desires and felt needs through the District Development Committees (DDC);
- Adopt an integrated approach in project design and implementation;
- Implement projects that have a sound scientific, socio-cultural and economic basis;
- Facilitate development activities by other institutions;
- Mobilise people to participate fully in development.

### **Environmental Activities**

Since its inception, CDA has made a number of environmental matters part of its agenda:

#### **CONSERVATION**

- **Encroachment into Funzi Mangrove Forest.** Following complaints by the local people of Funzi on destructive

activities in the nearby mangrove forests; CDA together with the Forestry and Geology Departments visited the site and compiled a technical report on the subject. This matter is now a subject of the court which awaits the technical report as evidence and as a guide to arrest the problem;

- *Management of Indigenous Forests on Trust Lands.* The management of indigenous forests on trust lands in Kwale and Kilifi District is a subject of major concern. This matter has been taken up with the respective county councils and gazettelement of these forest lands has been proposed. For the local people, who are living on these lands, the wider issue of land ownership and land tenure remains largely unaddressed;
- *Water Catchment Areas.* There is a problem of loss of water catchment areas to various development activities, particularly as a consequence of poor agricultural practices and population pressure. There is also loss because of private developers, particularly in Kwale District. Modalities are in place to arrest this problem but the private developers prove the most difficult to tackle;
- *Sand Harvesting.* This is an acute problem throughout most of the coast. The authority addresses this problem through the District Environmental Management Committees. Cases in point include sand mining near Tim-

boni Water Wells in Gongoni, Kilifi, and beach sand mining in Diani. Extension of salt lagoons at Gongoni is being addressed simultaneously since it has a direct impact on the quality of water in the wells;

- *Turtles and Dugongs.* To conserve these endangered species a multi-sectoral team has been formed for their survival. Incentive schemes, to be funded by KWS, are being developed for the villages in turtle and dugong areas, Ngomeni, Kipini and Kizingitini;
- *Marine Environment Day.* CDA sits on the planning committee for the annual Coast Schools Marine Environment Day. This committee plans for activities that involve school youth in awareness campaigns for marine conservation;
- *Integrated Coastal Zone Management.* A team under auspices of CDA and consisting of relevant government organisations has now developed a strategy document based on issues identified for the Nyali-Bamburi-Shanzu site (see appendix, p.22). Implementation of the strategies for this area is now being undertaken by various technical working groups under the Coastal Management Steering Committee.

#### SANITATION

- *Relocation of Kibarani Dump Site.* The dump site at Kibarani, Mombasa, has always been an eyesore. CDA has

taken the matter to the DDC for consideration. The District Environmental Management Committee (DEMC) has identified Nguu Tatu as an alternative dump site. This site has been approved but agreement is still needed from the Directorate of Civil Aviation;

- *Marine Pollution Studies.* A multi-departmental team that is studying marine pollution in the Marine Parks and Reserves. The team is headed by CDA, the secretariat is held by KWS-Netherlands Wetlands Project who are the financiers. The studies are done by the Government Chemist and KMFRI, looking at the biological quality of the water and the presence of toxic metals in the said areas;
- *Clean Lamu.* Action is supported to enhance the efforts of Lamu population in the clean-up of the town. CDA officers visited Lamu and attended a meeting organised by the Lamu self-help cleanliness committee. Modalities are being worked out to advance this effort;
- *Annual International Coastal Clean-Up.* The main activity here is the removal of debris from the shoreline, waterways and beaches. In 1995, 4,012 tonnes of debris was removed. This year, 1996, CDA sits on the planning committee and makes transport and manpower available;
- *Malaria Control.* Through the DEMC Mombasa, CDA participates in sub-committees chaired by the Municipal Public Health Department to clear

bushes around industrial and residential dwellings.

#### CHALLENGES

A number of challenges have been emerging over the past years thus:

- Migration of people to arid and semi-arid lands. Associated with this movement is the unplanned clearing of range lands for settlement activities including charcoal burning in these otherwise ungazetted 'forests';
- Utilisation of hill tops and steep slopes in trust lands; particularly Taita-Taveta District for agricultural cultivation;
- Introduction of beach management programme in the South Coast;
- Inadequately planned resurfacing of tarmac roads, without proper drains, in Malindi Town;
- Rehabilitation of Chaani Gully;
- Land degradation through mining at Kaloleni;
- The present aqua culture development to increase protein production requires the environmental evaluation of the pond construction and cage settings in various water bodies;
- Plans exist for an Export Processing Zone, Free Port and Ferry Bypass from the airport to South Coast. All these mega-projects will necessitate a strong environmental impact assessment in their feasibility studies.

#### PRIORITY AREAS

- Since only 40% of Mombasa is connected to the municipal sewage system, this problem has to be addressed

- both for the town and the hotels in the North and South Coast and should also entail rehabilitation of the present sewer systems. An associated problem is that of borehole water in Mombasa and Lamu which is not fit for human consumption unless treated. Awareness to this effect should be enhanced;
- Municipalities will have to change their bylaws to allow construction of storage tanks to capture rainwater in towns. Environmental implications in this new approach should also be attached;
  - The Indian crow menace in Mombasa should receive full attention;
  - Environmental impact assessment standards for the coastal area need to be developed;
  - Land-ocean interactions need to be documented as to the environmental effects occurring in inland lakes that will touch on the international water bodies (e.g. Lake Jipe, Lake Chala and Uмба River );
  - Environmental impact assessment of the Lake Chala Water Resources Development project is also of immediate concern and urgently in order to present the final project to possible investors;
  - Mombasa gets most of its water from the Kilimanjaro catchment, which is shared with Tanzania. It is necessary to assess the long-term environmental and human effects on this catchment area as an agreement regarding its mutual use is prepared.

△

Appendix  
**Coastal Management Issues with Possible Causes in Bamburi-Nyali-Shanzu Site**<sup>6</sup>

*Urbanisation*

- inadequate public services (water supply, waste disposal);
- encroachment of tourism and industry;
- lack of public access to shorefront.

*Decline in fisheries production*

- lack of boat and gear ownership by fishermen;
- relocation of original fishing villages;
- distance between fishing villages and shorefront;
- distance between landing sites and fishing grounds
- availability of more lucrative, tourism-related employment opportunities;
- government restrictions on gear and catch size;
- lack of offshore fishery;
- habitat degradation.

*Decline in water quality*

- contamination from sewage, stormwater runoff, solid waste, industrial effluent, seawater intrusion, and sporadic oil spills;
- limestone geology exacerbates seepage;
- illegal dumping of sludge;
- absence of any regulations on septic system design and standards, and discharge of industrial and wastewater effluents into public water bodies;
- discharge of waste water from hotels to reef area.

*Erosion of the shoreline*

- seawall and individual protection works construction;
- lack of protection due to reef damage;
- accelerated sea level rise;
- sand and beach vegetation removal;
- lack of beach nourishment;
- natural causes.

*Degradation of coastal ecosystems*

- dumping of sewage, toxic wastes, and oil spills contribute to mangrove loss;
- overharvesting and clear-felling of mangroves;
- poor farming techniques encourage soil erosion leading to sediment build-up in mangrove stands;
- improper oyster harvesting may result in mangrove roots being cut;
- overfishing and excessive sea urchin population, siltation from dredge spoils, damage from tourists and boats, and land-based sources of pollution all contribute to reef degradation;
- loss of sea turtle nesting areas on beaches due to tourism encroachment.

*User conflicts*

- displacement of traditional users due to lack of public access and on-water recreation ;
- harassment of tourists by service providers;
- cultural differences between tourists and local community;
- competition between hotel-based and independent boat operators.

---

6 Source: CDA (1996) *Towards Integrated Management and Sustainable Development of Kenya's Coast: Findings and recommendations for an action strategy in the Nyali-Bamburi-Shanzu area*. Mombasa: Coast Development Authority.

\*\*\*\*\*

## 4

# MARINE RESEARCH PRIORITIES FOR KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

ENOCK WAKWABI

### **Introduction**

The sea is a source of food, and a major transport route. Kenya Marine and Fisheries Research Institute (KMFRI) considers the sea as a laboratory, source for food, recreational site and a home for many species. The driving force behind the research activities of KMFRI is the need to provide marine food supplies to the Kenyan public.

Following a workshop held in 1982, the institute has developed, advanced and executed research programmes singly and jointly with others in accor-

dance with the research priorities and strategies developed during the workshop. In the marine sector, these have centred on (i) identification of marine organisms and estimation of harvestable production; (ii) identification of cultivable marine organisms; (iii) monitoring of marine environmental health; (iv) monitoring and estimation of marine production; (v) identification of and experimentation with marine bio-products; and (vi) conservation and management of marine biodiversity.

### **Mandate**

The mandate of the institute is wide, it covers both marine and inland water systems. Specifically, KMFRI was established by an act of parliament to undertake research and advise on the state of the aquatic resources (e.g. fisheries), and environment. The institute has focused her research activities on the following:

- Assessment of existing fish stock;
- Assessment of levels and mechanisms of exploitation of these stocks;
- Determination of sustainable exploitation levels;
- Evaluation of the state of the marine environment as a resource and a home to species of economic as well as ecological importance;
- Identification and determination of the sustainability of resources other than fish in the coastal and marine waters;
- Identification of organisms and appropriate technology for farming them and evaluation of the applicability of the technology to local conditions (for instance, oyster farming and cultivation of brine shrimps in saltwater ponds);
- Identification and recommendation for conservation management of species and biotopes critical to the ecological set-up.

### **Research Activities**

Research activities are carried out in the form of projects addressing specific topics. Such projects are developed either

singly by KMFRI staff or jointly with other institutions or departments who share areas of interest. Examples are:

- Kenya-Belgium Research Projects in Marine Sciences between KMFRI and Free University of Brussels. Several sub-projects have been undertaken with immediate or long-term effects. The oyster farm and mangrove reforestation programmes in Gazi Bay on the South Coast are results of this collaboration. A number of publications has appeared in the form of university thesis at local and external universities, local reports and papers in international scientific journals;
- Fish stock assessments have been carried out under unilateral and joint programmes between KMFRI and the Fisheries Department with support from the Government of Kenya and UN-organisations, such as FAO and UNESCO. Results of these studies are also used in the licensing and controls of fishing by the trawler fleet and by the artisanal fleets;
- Integrated Coastal Zone Management with support from FAO, USAID and URI in joint effort with Coast Development Authority, Kenya Wildlife Services, Fisheries Department, Forest Department, Municipal Council of Mombasa and the public, with special attention for the long-term impact of tourism on the environment. The results of these programmes will be seen or felt from the active role CDA is playing in the management of coastal de-

velopment. Tourism is one of the country's largest economic sectors and number one foreign exchange earner, yet, if developed haphazardly, can lead to manifold problems to human communities as well as the natural environment;

- Coastal pollution is a major scare to the public. Mombasa is a major port and Kenya's Exclusive Economic Zone contains a major sea route between the Eastern African countries in the Western Indian Ocean area and the rest of the world. As a sea route, the coastal waters are prone to oil and other maritime pollution from transit vessels both offshore and in port. Such pollution may be accidental or deliberate. KMFRI, in conjunction with the Kenya Wildlife Services, monitors coastal waters for any such eventuality. Monitoring programs also test for other sources of pollution e.g. municipal waste and up-country farming. Levels of chemical and biological pollution are checked against international (WHO) standards;
- In joint effort with KWS and support from the Netherlands' Government; KMFRI is undertaking research programmes on biodiversity, in this case of the coastal zone;
- With support from Michigan University, US, and IOC/UNESCO, tide gauges have been set up in Mombasa and Lamu to monitor sea level changes. This puts KMFRI among the few institutions with capability to give

accurate and immediate sea level measurements to monitor the effects of global warming and sea level rise. The tide gauges in Mombasa and Lamu have direct links with the satellite which puts the Kenyan coast under constant comparison with other areas of the same juxtaposition in the world.

### **Research Capacity**

At inception in 1979, KMFRI had a handful of researchers most of them inherited from the defunct East African Marine Fisheries Research Organisation, East African Freshwater Fisheries Research Organisation; and from the Department of Fisheries. The institute embarked on a staff development programme and over the years has established eight research centres: at Mombasa (Headquarters) for marine and coastal waters; Kisumu on Lake Victoria; Sangoro on River Miriu; Kalokol on Lake Turkana, Naivasha on Lake Naivasha; Baringo on Lake Baringo; Kegati on River Kuja and Nairobi for research programmes centred on Central Kenya as well as administrative services. The siting of these centres took into consideration the various problems facing the country in regard to fish, fisheries and the aquatic environment. The Mombasa Centre is responsible for developing research projects and programmes to tackle issues of marine and coastal resources and environment.

As the number of centres grew, so did the size of the research force. Training has however been the main limiting fac-

tor. To date, KMFRI has 53 marine scientists with qualifications as follows: 2 Ph.D., 10 Ph.D. trainees, 22 M.Sc., 15 B.Sc. and 4 B.A.. This team is backed by a well trained technical staff.

### **Priority Areas**

To achieve its goals, KMFRI operates through specific need driven research projects. Demands for research come from:

- University requirements (e.g. M.Sc./ Ph.D. thesis);
- Requests from GoK departments, institutes, or organisations (e.g. KWS, Fisheries Department, CDA);
- International organisations (e.g. programmes on subjects that have international implications like global warming, sea level rise, marine pollution and fisheries stocks);
- As a result of interaction between researchers and public.

### **Ongoing Research Projects at the Mombasa Research Centre**

- Assessment of pollution in the Mombasa Marine Park and Makupa Creek in collaboration with KWS;
- Assessment studies on biodiversity of Mida Creek in collaboration with KWS;
- Fish community studies on Gazi Bay; in collaboration with University of Ghent

and Catholic University of Leuven, Belgium;

- Sea level changes, global warming effects and tidal currents along the Kenya coast in collaboration with Michigan University, US; IOC/UNESCO and University of Gothenberg, Sweden;
- Integrated Coastal Zone Management in collaboration with other government departments and institutions with interest in the coastal zone;
- Aqua culture development in the coastal area; focusing on the artemia, oysters, seaweeds and fish farming;
- Experimental re-afforestation of clear fell mangrove areas in Gazi Bay, south coast;
- Environmental geology of the coastal area;
- Prospecting for pharmacological extracts from marine organisms;
- Survey and assessment of the diversity of marine birds on the Kenya coast;
- Socio-economic assessment of the marine and coastal resources in Kenya;
- Regional project on interlinkages of marine and coastal ecosystems in East Africa.;
- Atlas and database of Eastern Africa coastal and marine resources and environment;
- Ecological studies on specific marine organisms and specific biotopes. ▲

\*\*\*\*\*

## 5

### **KENYA WILDLIFE SERVICE MARINE PROGRAMS**

**NYAWIRA MUTHIGA**

#### **Introduction**

Kenya Wildlife Service (KWS) has had a terrestrial research unit since the '70's but most of the research that has been carried out on marine protected areas has not been initiated by KWS. This research has included expeditions and studies by local or international institutions and individuals although the primary research objectives of these groups had to be approved by KWS before research clearance could be granted. Neverthe-

less, the park management was rarely involved in designing these projects hence recommendations from the research findings were rarely implemented. In order to avoid this problem and to ensure that research was geared towards management problems, KWS has instituted a marine research unit with the objective of developing and co-ordinating basic and applied research. Following meetings with park managers the following broad objectives were formulated:

- Mapping and compiling resource inventories of coral reefs, seagrass beds and mangroves and developing a database of this information;
- Study endangered species, including the sea turtles and dugong, and develop survival strategies;
- Long-term monitoring of changes in the main biotopes i.e. coral reefs, seagrass beds and mangrove forests in the parks and reserves or adjacent to parks and reserves;
- Monitoring the water quality within the marine parks and reserves with a view to identifying sources and effects of pollution;
- Study tourist activities at the different marine parks and reserves in order to assess tourist damage;
- Study the fishing activities and socio-economic status of local communities utilising marine reserves to assess the status of the fisheries sector, its future and assess possible alternatives i.e. aqua culture;
- Follow socio-economic developments in the coastal region, in particular land use practices, and their impacts on the marine environment.

Using the above broad objectives several research programs have been designed. These programs have been given the highest priority by the park management and are carried out jointly with other government institutions and international organisations. There are eight programs, described below, and a number of affiliated projects.

### **Marine Resource Inventory and Monitoring.**

Survey of coral reef habitats, seagrass beds and mangroves. The community structure of these habitats is studied including species composition, percentage cover of different substrates and abundance and distribution of the dominant organisms. To date, the following sub-projects are under way:

- Inventory of coral reef, seagrass and mangrove habitats. Investigators: Muthiga (KWS), Oyieke (NMK), Ruwa (KMFRI) and McClanahan (CRCP). Research funded by ROSTA/UNESCO-IOC. Output will include an annotated species lists and a collection of reference materials to be kept at NMK and the KWS Marine Resource Center, Malindi. A survey of gastropods, echinoids and hard corals for 10 sites along the Kenyan coast has been carried out and check lists compiled;
- Community structure and distribution of scleractinian coral along the Kenyan coast. Investigators: Muthiga (KWS) and monitoring team in marine parks. A comprehensive survey of Kenya's reefs and training of rangers in coral reef monitoring techniques. Currently rangers have been trained in diving, and several have taken marine ecology courses at the Naivasha Training Institute.
- Ecological Survey of Mida Creek. Principal investigators: Moragwa, Mwatha and other scientists from KMFRI. This multi-disciplinary project includes studies on mangrove regeneration,

birdlife, dissolved inorganic nutrients and plankton, macro algae and sea-grass, fish stocks, hydrology and water circulation and sedimentological dynamics.

### **Endangered Species Program**

- An aerial survey of marine turtles and mammals has been completed that gives baseline information on abundance and distribution of turtles and marine mammals along the Kenya coast. The report is in the final stage of preparation;
- Sea turtle conservation programs in Kenya. Principal investigators: Wamukoya (KWS), Mbendo (Fisheries Dept.) and the Kenya Sea Turtle Committee (KESCOM). The objective is to collect data on the status of turtles in Kenya, including biological data, identify threats and develop a national strategy for their conservation. Surveys of the nesting grounds of turtles as well as reports of turtle deaths are compiled from information continuously gathered along the Kenya coast. A draft of a national strategy for sea turtle conservation is currently under review;
- The dugong (*Dugong Dugon* (Muller)) in the seagrass system of Northern Kenya. Principal investigators: Wamukoya, Mbendo and KESCOM. A detailed aerial survey of the Lamu area identified as the main dugong habitat in Kenya. Additionally the seagrass beds of this area were also surveyed.

### **Pollution Monitoring**

- An assessment of marine pollution of the Mombasa Marine Park and Reserve. Investigators: Mwangi, Yobe (KMFRI) and Njoya (Govt. Chemist). The study includes measurements of water quality including nutrients, chlorophyll, bacteriology and heavy metals as well as measurements of physical factors like temperature, salinity and currents. The effect of seasonality on these parameters is also assessed. Output to include a long-term monitoring program of the water quality within marine parks and reserves;
- Marine pollution in Makupa Creek. Investigators: Mwangi, Yobe, Abuodha (KMFRI) and Njoya (Govt. Chemist). This study aims to assess the accumulation of heavy metals and organochlorines in water, sediments, animal and plant material collected from the Makupa Creek.

**Impact of Visitor Activities in Protected Areas.** A project to assess the impact of visitors in marine parks and reserves has been initiated at Kisite Marine Park. Transects were used to study the coral community structure and natural and anthropogenic damage to corals. The findings of this study were presented at the 8th International Coral Reef symposium.

### **Socio-Economic Studies**

- A socio-economic survey of the mangrove exploitation in the Mida Creek

- Marine Reserve: Principal investigator: Onyango (independent researcher). A survey of the communities of Mida Creek is complete and a report is under review;
- Socio-economic aspects of mangrove systems and alternatives to traditional mangrove area land use in the south coast of Kenya. Investigators: Radull and Ochiewo (KMFRI);
  - Village based larviculture and stock enhancement of sea cucumbers (Echinodermata: Holothuroidea) on the Kenyan coast. Investigators: Muthiga (KWS), Radull (KMFRI) and Mwadzaya (KWS). A proposal submitted to Biodiversity Support Program has been accepted for funding pending country mission concurrence.

**Environmental Impact Assessment (EAI).** EAI of seagrass removal project. Investigators: Ochieng (KMFRI) and Erftemeijer. Many hotels along the Kenyan coast remove beach casts which they perceive as an eyesore for their visitors. The effects of this removal is not known and this study aims to provide useful information on these effects and make recommendations for the management of these removal activities.

#### **Mangrove Stem Borer Study**

In recent times, a stem borer has caused the death of large areas of mangrove. A joint team consisting of Kipepeo, NMK and KEFRI is carrying out taxonomic, life-cycle and natural predator studies of this

pest. An important output of this study will be the development of a simple low cost program to monitor the incidence and spread of the stem borer in mangrove systems using Mida Creek as a case study.

#### **Marine Resource Database**

A bibliography of information on marine parks and reserves and other information relevant to the management of protected areas of Kenya has been compiled and is continuously updated. A collection of reprints, reports and manuscripts of studies relevant to marine resources and conservation has been started. Additionally, a coral reef database will be compiled using the REEFbase program developed by ICLARM, as well as a wetlands database appropriate to Kenyan wetlands which is currently underway.

#### **Affiliated Projects**

These research projects are carried out by scientists jointly with KWS marine section or by students usually supervised by KWS and include:

- Integrated Coastal Zone Management: Multi-disciplinary team from CDA, KWS, Fisheries, Mombasa Municipal Council, KAHC and many other government departments. Funded by USAID through the Integrated Coastal Zone Management Center of University of Rhode Island. This project compiled information on the coastal zone problems of Kenya coast using Bamburi as a pilot area. KWS was involved

- from the onset and participates actively in the newly formed Coastal Management Steering Committee;
- Global Biodiversity Study: University of Plymouth. Part of a global experiment involving artificial substratum units which act as settlement substrates for planktonic organisms. Units were developed at Kisite in November, 1995, and retrieved in April, 1996;
  - Coral Reef Conservation Project: jointly with WCS and KMFRI. This project has been carrying out a long-term monitoring of Kenya's marine protected and unprotected reefs. Monitoring of fish, urchins, shells and substrate at Malindi, Watamu, Mombasa marine parks and reserve and Diani, Kanamai and Vipingo has been ongoing for 4 years;
  - Western Indian Ocean Climate Study: Rice University, Texas, US. This project aims to use coral cores to get long-term temperature data in this region. Coral cores have been collected at Mombasa, Malindi, Kisite and Lamu. Ongoing;
  - Student studies: local and foreign students do carry out studies either in protected areas or attached to ongoing KWS programs. Some studies are part of undergraduate and graduate requirements at local and international universities. These students have their own funds and KWS helps with transport when possible and information, supervision or boats.
- \*\* Karanja F, M.Sc., Moi University. An ecological study of the mangrove forests and adjacent salt ponds at Ungwana bay. Field work is complete and thesis submitted;
  - \*\* Gleisel H, Ph.D., University of Wisconsin, US. Coastal fisheries and marine conservation; in the process of final write-up;
  - \*\* Westerink B, M.Sc., Wageningen Agricultural University, Netherlands. Local participation in tourism and attitudes towards conservation: A case study of the Malindi Marine National Park. Has completed fieldwork and thesis has been submitted ;
  - \*\* King D, Ph.D., University of Warwick, U.K. Socio-economic study of the fisher-farmer community of Kinondo. Data collection continues;
  - \*\* Ruben J, M.Sc., University of Newcastle U.K. Economic model of coral reef related resource use in Diani. Field work completed; in write-up stage;
  - \*\* Samyn Y, M.Sc., Free University of Brussels, Belgium. Reproduction of two non-commercial sea urchins (Echinodermata: Echinoidea) in the Mombasa Marine National Park, Kenya. Thesis submitted and defended;
  - \*\* Gilbrane L, School of International Training, US. Tourism and the coral reef of the Malindi Park. Short study completed in December, 1995; a report submitted to KWS;
  - \*\* Watson M, Ph.D., University of York, U.K. The effects of fishing on the coral

- reef fish of Shimoni, Kenya. In stage of writing up;
- \*\* Campillo and Vallespir. Manchester Metropolitan University, UK. Fish survey at Uyombo, Mida Creek, Kenya. A short survey of the fish landings at Uyombo. Report submitted to KWS.
  - \*\* Morris J, Manchester Metropolitan University, UK. The mangroves of Mida Creek: Regeneration and planting. Short study; report submitted to KWS;
  - \*\* Brown C, St Lawrence University, US. Erosion of the Kenya coast: The effects of development on the coastal zone. Fieldwork completed and a report submitted to KWS.
  - \*\* Sharlow S, St.Lawrence University, US. KWS sea turtle and dugong projects: The southern coast of Kenya. Field work completed and a report submitted to KWS;
  - \*\* Pye S, St Andrew University, U.K. A study of the distribution and zonation of marine molluscs in the mangrove ecosystem of Kiwayu island. Field

work completed and a report submitted to KWS.

### **Support and Funding**

All research projects are carried out jointly with other government institutions including KMFRI, Fisheries Department, CDA, Forestry Department, Government Chemist and NMK, among others, and therefore contributions by these institutions must be recognized. NGO's including Baobab Trust, Eden Wildlife Trust, KIPEPEO are also involved. As well as international organisations like Wildlife Conservation Society, IUCN, WWF, UNEP make contributions especially in funding workshops and participation to workshops. Local and international universities (i.e. University of York and University of Rhode Island) and students are involved in various phases of the programs. Currently most of the direct funding for research comes from the Wetlands Conservation and Training Project (KWS/Netherlands). Other sources of funds include the Biodiversity Support Fund. ▲

\*\*\*\*\*

# 6

## KWS COASTAL WETLANDS CONSERVATION PROJECT

ELS MARTENS

### **Introduction**

Along the coast, tidal conditions and the presence of a fringing reef and many bays and creeks create a prime environment for mangrove, mudflat and seagrass communities. The coastal wetlands support abundant marine life, are a refuge for rare or threatened species and are crucial resting and feeding grounds for resident and migratory birds. Mangrove forests provide habitats and nurseries for many fish and crustaceans and form a buffer protecting the coastline from ero-

sion and the neighbouring biotopes from sediment run-off. Intertidal seagrass beds are critically important habitats for marine turtles and dugongs. Coral reefs are the most biodiverse and complex marine systems.

These three main coastal wetland biotopes have important ecological and biological interrelationships which are the basis of their biodiversity. They are not only the centre of social, subsistence and recreational activity for local communities, they also add to the economy

through tourism, fisheries, and forest products.

Since coastal wetlands are inextricably linked to the surrounding systems, their conservation and management must be pursued in the context of an integrated approach to environmental conservation and ecologically sustainable development.

The Netherlands Government funds the Wetlands Conservation and Training Programme which includes the Coastal-Marine Wetlands Project based at the KWS Coast HQ, Mombasa; Inland Wetlands Project based at KWS Nairobi HQ; and the Training Project based at the Naivasha Training Institute.

The Coastal Wetlands Project supports conservation and management activities in the Marine Parks and Reserves along the coast, while special attention is given to the conservation of endangered species, e.g. turtles and dugongs, and to the mangroves within and outside protected areas.

### Objectives

The main objective of the programme is to promote and facilitate conservation and integrated management of marine protected areas and coastal wetlands to safeguard the biodiversity and integrity of ecosystems and their productivity. The overall objective follows the three main goals of KWS: Biodiversity Conservation, Partnership and Nature Tourism and it is pursued through:

- Policy development for the wise use of

wetlands;

- Creating awareness among the population and among policy makers about wetland conservation issues;
- Strengthening institutions in the field of wetland conservation;
- Contribution to the improvement of actual management of protected wetland areas.

The specific programme objectives are summarised under the following topics:

- *Inventory*. Determine the location and the biotic and physical characteristics of the major wetland systems;
- *Values*. Identify and quantify the functions and services provided by these wetlands, as well as current uses and the potential for future utilisation;
- *Threats*. Identify and quantify current and potential threats to these wetlands;
- *Review*. Identify the short- and long-term costs and benefits of wetland loss, and in particular the geographical and social distribution of these costs and benefits, that resulted from previous wetland development activities in Kenya;
- *Environmental Impact Assessment*. Provide KWS with the technical capacity to effect initial environmental assessments of proposed development activities that affect wetlands;
- *National Wetlands Policy*. Promote and contribute to the development of a national policy for the conservation and sustainable utilisation of Kenya's

wetlands, on the basis of the information collected in pursuit of the above objectives;

- *Tana Delta*. Assist in the creation of a wetlands reserve in the Tana Delta in terms of inventories, management planning, and implementation of a management plan as a pilot project of the KWS wetland programme;
- *Awareness*. Build governmental and public awareness and understanding of the importance of wetlands, and of the economic and social benefits of their environmentally sound management, by means of appropriate educational activities;
- *Management*. Improve the planning and management of wetlands within and outside parks and reserves.

### Activities

Main activities<sup>7</sup> under the programme are:

- Compilation of scientific data and information on coastal biotopes to collect sound information for development of management strategies: Inventories, monitoring and specific research studies of ecological, biological and physical characteristics, threats and user impacts (data bases, mapping, reference library);
- Identification and quantification functions, services and uses provided by coastal wetlands, socio-economic surveys;
- Support management planning and implementation: Upgrading of infrastructure, facilitate implementation of MoU's, facilitate involvement of community groups and stakeholders so as to promote institutional co-operation and integrated cross-sectoral approach;
- Community participation and extension programmes, set-up of alternative uses or resources and income generating projects;
- Education and awareness programmes for public, schools, user groups, tourism sector, policy makers;
- Ecotourism/nature tourism development: Snorkelling and diving sites, nature trails, board walks, training of guides including community members;
- Training and capacity building: Joint training of staff from KWS and institutions such as Forestry and Fisheries Departments, KMFRI.

▲

<sup>7</sup> See also the contribution by N.Muthiga on KWS Marine Programs, p.21.



## SMALL FISHERIES RESEARCH IN KWALE DISTRICT

ANTHONY KING & DELPHINE MALLERET-KING

### **Introduction**

This presentation concerns a twin Ph.D. project on small-scale fisheries and coastal zone management. The first study focuses on fishing/farming production systems; the second study on governance and resource management. The research is in an early stage and this paper presents a basic understanding of the issues, the result of interviews with members of the community.

The study location is a Digo community on the South Coast, Kinondo location, with a majority of fishing house-

holds. Focus has been brought on the area through the recent gazetting of the Diani Marine Reserve and through developments relating to local forests and Kayas. In this area there are also seasonal farmers from upcountry and a migrant fishing group from Tanzania. The community is on the fringe of heavy tourism development. Communities of this sort depend on the common pool resources of the marine and terrestrial environments for their existence. From discussions with local people and our own observations it is clear that the area has suf-

ferred significant environmental degradation, particularly over the last ten years, which among other things, is illustrated by reduced fish catches and lost forest. The result of this degradation to the indigenous community is threatened livelihoods and greater pressure on the remaining resources.

### **Resource Management**

Historically the community had a traditional form of fisheries management, although not understood as such. The customs, social pressures, ethics and consensus decision making created a management regime which can be termed communal governance. With the introduction of the colonial administration the traditional management regime began to change, particularly with the introduction of chiefs who replaced the groups of elders as the primary decision makers. Further change occurred in the 1920s with the conversion to Islam of rural Digo communities, creating another new structure of authority. Little by little the traditional regimes have been undermined and the responsibility for their activities has shifted away from the community, both physically and socially. Thus the management regime changed from communal governance to state governance, in which the government has the central role with respect to common pool resources and traditional initiatives are considered regressive.

In fact, the government departments responsible for the management of the

marine environment were ineffective, due to among other things lack of funds, and with no communal responsibility for local common pool resources the management regime became one of *laissez-faire*. There was therefore virtually no governance. In this *laissez-faire* regime illegal and nonselective fishing methods have been widely used, particularly by migrant fishermen from Tanzania, and other marine organisms have been over exploited for the tourist industry. As has been seen in other fisheries, it is often the absence of communal control that has caused the collapse of resources. The fish catches have dropped dramatically and evidence suggests that the nature of the ecosystem has been changed. The collapse of the fish resources has had serious repercussions in the community, particularly in terms of food and livelihood security. More time and effort is now spent fishing for fewer fish which detracts from the time that was previously spent cultivating subsistence crops, and the few fish caught do not provide sufficient income to make up for the reduced food crop production. As with most subsistence societies, this community directs its efforts at satisfying its need for food before anything else. Lack of food presents the greatest and most direct threat to the equilibrium between the human species and the environment.

### **Marine Reserve**

New technical rules and conservation measures for the surrounding marine en-

vironment were proposed by the government in the form of a marine reserve to be managed by the Kenya Wildlife Service. The management regime remained one of state governance, but the possibility of enforcement improved.

However the community reacted violently against the marine reserve proposal despite the fact that the conservation measures and the needs of the community seemed to be convergent. In the early stages of implementing the reserve the KWS had communicated with members of the fishing community and the initial response to the reserve proposal was positive. Later on in the process a number of powerful secondary influences began to change the minds of the fishermen. Although difficult to identify, the sources of these influences were politically and economically motivated, and it is arguable that they had the interests of the fishing community at heart. Nevertheless they turned the community. In addition the fishermen had a genuine fear that the implementation of a marine reserve was the first step to a marine park which would eliminate their only source of livelihood. The KWS were forced to withdraw.

The level of community participation is a good indicator of how likely technical rules and conservation measures are to succeed. In this situation the level of community participation can be categorised as informing, where the participants listened and the government agency talked via hearings and meetings,

but there was little effort made to bring the participants into any planning. This is only one level up from state intervention and is many levels down from co-management. It was the interaction between the government and the community that was critical for successful governance, and with no partnership between the government and the local community the initiative failed although the reserve remains gazetted. Once again this left a management vacuum and the uncontrolled exploitation continued, to the detriment of the environment and people.

#### **Fishermen Committee**

At the suggestion of the District Commissioner the fishermen formed a committee to present their interests. The meetings held by KWS in their consultation phase probably helped in this process. Up until the marine reserve issue there had not been a sufficiently urgent threat to bring people together. For the first time the fishing community had been given government sanction to organise themselves.

Six months after the withdrawal of KWS the Galu Fishermen's Committee was formed. The threat this time was the fishing activities of migrant Tanzanian fishermen who had been able to use beach seines with undersized meshes for a long time. In fact, the Tanzanians had been using this fishing method in the area for decades, but recently their activities had increased. Where in the past the

concerns of the fishermen about the beach seine crews had never got beyond the local chief, the sanctioned committee was able to carry the issue to higher levels of authority in the hope that action would be taken. Thus the level of community participation in the governance of the fishery looked to have improved. In reality there was only first-level consultation, where the fishermen demanded to be heard but the government preferred not to listen. At every stage the committee were faced with obstacles. A public meeting was called by the District Officer and the District Fisheries Officer to discuss the fishermen's concerns, to which about 150 fishermen attended but not a single government representative turned up. The committee were then prevented from meeting unless a government representative was present. It was when the local political party became involved that the fishermen found they could take the issue to the District Commissioner, a higher level of authority.

### Conclusion

The interaction between the community and the government is a key factor influ

encing both the natural and human components of ecosystems and the impact on the natural environment. Because of the political nature the issue has taken on in the meantime (which involves questions of immigration and dubious acquisition of identity cards by the Tanzanians), the profile of fishermen's concerns are being heard. Whether any enforcement of environmental and fisheries legislation will take place is another matter.  $\Delta$

### References

- King, A., 1996. *The resource use patterns and socio-political relationships of a coastal fishing community in Kenya*. Background report for Ph.D. study.
- Malleret-King, D., 1996. *Les systemes de productions des agriculteurs pecheurs de Biga, petite communaute de pecheurs. (District de Kwale, Province Cotiere, Kenya)*. M.Sc. dissertation for the IEDES INA-PG, La Sorbonne.
- McGlade, J., 1995. Integrating social and economic factors into fisheries management in the European Union - An issue of governance. *Environmental Management Review of 1994 and future trends*, 2, 15, 77-80.

## 8

### PRIORITIES IN BOTANICAL RESEARCH IN COASTAL KENYA

S. ANN ROBERTSON

#### Introduction

This presentation concerns recent and ongoing botanical research in coastal Kenya.<sup>8</sup> It covers firstly the work on forests and forest monitoring but also covers other topics such as the charcoal production inland. An outline of research at Centre for Biodiversity and the Institute of Primate Research of the National

Museums of Kenya (NMK) is given. The paper also mentions other needs for research and monitoring, that could help to solve a wider range of environmental issues at the coast.

#### Coast Forest Survey

In 1987 a survey was carried out of the Kayas on behalf of the National Museums of Kenya.<sup>9</sup> Next, from 1988 to 1991,

---

8 I wish to thank colleagues at NMK for providing some of the information but the paper reflects my personal views and experience and does not necessarily represent NMK policy and priority plans for research.

---

9 Robertson SA (1987) *Preliminary Floristic Survey of Kaya Forests of Coastal Kenya. Report to NMK & WWF-I.* Nairobi: National Museums of Kenya.

most of the forested areas in coastal Kenya were surveyed (Kwale, Mombasa, Kilifi, Tana River as far inland as Bura, Lamu Districts).<sup>10</sup> Both these projects were funded by WWF-I. The latter report contains a preliminary checklist of the higher plants and ferns showing that there are over 3,000 taxa at the coast. There are also preliminary checklists for certain forests, and others are available from the database kept at NMK and by the Coast Forest Conservation Unit (CFCU). The report also contains a comprehensive bibliography of references to work done in coastal Kenya. The main recommendations for forest conservation contained in the report were reiterated in early 1996 at a workshop of the newly formed Coastal Forests Ecosystems Task Force. They are listed in the Appendix. The original report also listed a number of botanical research priorities as follows:

- Revision of the 'Flora of Tropical East Africa'<sup>11</sup> with volumes covering Kenya alone, particularly dealing with important plant families in the coast. Recently P.S.Masinde of Kenyatta University and NMK worked on *Cissus* (*Vitaceae*) for his M.Sc. and is now studying *Ceropegia* (*Asclepiadaceae*) for his Ph.D. thesis;

- Newly discovered taxa should be researched and documented. This is being done for *Saintpaulia* (African violets) as a Ph.D. study by S.Simiyu, of the Plant Conservation Programme at NMK. The genetics of *Saintpaulia* are being studied by a student in the Genetics Dept at NMK under Dr Rashid Anan;
- A field guide to the plants of the coast is urgently needed. The woody flora is covered by Beentje<sup>12</sup> but a guide to 'Lowland Kenya Wild Flowers' is needed to complement the existing book on book on upland flora.<sup>13</sup> Marine algae have been covered in the 'Seaweeds of the Kenya Coast'<sup>14</sup>, but there is very little information available on other lower plants, such as the Bryophytes, Fungi and Lichens;
- Existing checklists of flowering plants for the coast, and for individual forests, need to be expanded. There are many more areas – outside the forests – which need intensive plant collecting to come up with checklists and to identify the priority areas for plant diversity conservation. The Plant Conservation Programme of the Museums is planning to study some of the areas

10 Robertson S A & Luke W R Q (1993). *Kenya Coastal Forests. Report of the NMK/WWF Coast Forest Survey*. Nairobi; National Museums of Kenya and World Wide Fund for Nature International.

11 Polhill R M ed. (1952 onwards). *Flora of Tropical East Africa*. London: HMSO & Netherlands: Balkema.

12 Beentje H J (1994) *Kenya Trees, Shrubs and Lianas*. Nairobi: National Museums of Kenya.

13 Agnew A D Q & Agnew S (1994) *Upland Kenya Wild Flowers*. 2nd ed. Nairobi: East Africa Natural History Society.

14 Moorjani S & Simpson B (1988). *Seaweeds of the Kenya Coast*. Nairobi: Oxford University Press.

with high plant biodiversity. CFCU is adding to the knowledge of the plants of the Kayas (recently a preliminary list has been compiled for Kasigau Mt.) and has started a herbarium at Ukunda;

- A herbarium for the coast was planned by NMK and KWS as part of a coast resource centre, but funds have not been sufficient. Perhaps, this could be a joint project between NMK, KWS and MUSES, particularly as Malindi is central to the whole coast;
- There is need for a centrally held bibliography (or library) of references on coastal biodiversity and environmental matters. There is a library at Fort Jesus, dealing mainly with historical documents, and many researchers have built up project collections of coast reference material.<sup>15</sup>

### Ecological Monitoring

Apart from strictly botanical studies, far more information is needed on the ecology and dynamism of the forests, and other natural ecosystems (such as woodland, wetlands, grasslands etc.), to assist in management decisions for sustainable use. In order to do this Permanent Sam-

ple Plots have to be set up in different ecosystems, but particularly in the forests, to establish the growth rates of the trees used for timber and poles. KEFRI, in 1993, did set up 21 plots in the Nature Reserve in Arabuko-Sokoke, and these need to be followed up. KIFCON did some transects in Arabuko-Sokoke and Shimba Hills forests which could be made permanent. The Forest Department (FD) has some data from inventories, but there is urgent need to know, for example, how many poles, of favoured hard wood shrubs and trees, can be cut in a year from Arabuko-Sokoke Forest on a sustainable basis. Certainly, the harvesting of *mububu* at present rates is not sustainable and there are hardly any mature trees left in the forest. More studies need to be done in Tana River and Lamu Districts, although this will be more difficult because of logistical and security reasons. The GTZ projects at Mpeketoni and Witu have been promoting forest conservation and indigenous tree planting and are an important source of information. At Gede National Monument a small forest restoration project has been funded by the Netherlands Government to monitor the trees planted from 1991 to 1995 with a view to providing information on ease of propagation, and suitability for habitat restoration of many coastal trees.

### Arid and Semi-Arid Lands

The coast is not just the high potential area along the 'coastal strip', blessed with

<sup>15</sup> Mr Rodwell at Mtwapa has an extremely valuable private library on coastal matters. The CFCU Project Executant, Q.Luke, has a list of rare and endangered plants of the coast about which little is known. Also, J. Ash, who was for many years the Curator of the snake park at the Nairobi Museum, and now runs a snake farm at Watamu, has a wealth of knowledge on the reptiles and amphibia of the coast.

wetlands and forests. There are also the low potential semi-arid areas of the coast that are increasingly used for subsistence agriculture and charcoal production. There is certainly need to learn more about the impact of the enormous demand for charcoal on the semi-arid woodlands as evinced by the innumerable bags of charcoal for sale along the Mombasa-Nairobi trunk road. In a recent environmental meeting it was reported that there are very few charcoal burners in Kaloleni Division now, the assumption being there is little left to cut and burn, but hard data are few. There is very little information available to policy makers on the extent of this industry, and presently there is no management for sustainability. This could be a fertile topic for many postgraduate students.<sup>16</sup>

### Indigenous Knowledge

Although a fashionable research topic by now, much of this knowledge is still undocumented from coastal Kenya. CFCU is building up information on traditional uses of plants of the Kayas. The Kenya Resource Centre for Indigenous Knowledge (KENRIK), based at NMK, is to study the carving industry in Kenya and

the use of *mububu* (*Brachylaena builensis*), *mpingo* (*Dalbergia melanoxylon*) and *mgurure* (*Combretum schumannii*). The 'Indigenous Food Plants Programme' also at NMK has built up a database and will be publishing a book on food plants.

### Research

Below follow brief reviews of recent, ongoing and planned research at the coast by the Centre for Biodiversity.

#### Botany

- The work of the Coast Forest Survey, and the work at Gede, has already been described;
- Vegetation surveys were done in Arabuko-Sokoke and Shimba Hills through the KIFCON programme. Later the plant ecology team was absorbed into the Plant Conservation Programme (PCP) and they hope to follow up with intensive surveys in 1997 with particular concern for plant biodiversity protection;
- Other PCP staff are looking at endangered plant groups such as cycads, orchids and Saintpaulia, with many more to study;
- Work on the Flora of Tropical East Africa in cooperation with Royal Botanic Gardens, Kew, UK, is going on all the time. The latest volumes to appear are on *Lauraceae* (containing the infamous Neem hemi-parasite, *Cassytha filiformis*) and *Hyacinthaceae*, part of the old *Liliaceae* family.

<sup>16</sup> For example, such questions as how many trees does each bag of charcoal represent, how long would it take for that tree to grow again, can it grow again, or is the environment now unsuitable for woodland growth, need an answer. Also, how much will it cost to restore these degraded areas, can charcoal burning of natural woodlands be sustainable, does the charcoal industry benefit the local people as it is carried out on trust lands?

### Ornithology

- J.H.Fanshawe, D.Phil. thesis (Un. Oxford, UK), 'The effects of selective logging on the bird community of Arabuko-Sokoke Forest Kenya' was circulated early in 1996. This showed that forest degradation had a clear effect on bird communities, with population of forest dependent, insectivorous species reduced and foraging niches altered;
- M.Virani, M.Sc. thesis (Leicester Un., UK), 'Ecology of the endangered Sokoke Scops Owl (*Otus irenae*)', was circulated earlier this year, and provided some insights into population and distribution of this highly endangered bird;
- E.Waiyaki, M.Sc. thesis (Un.Kent, UK), 'The effects of forest fragmentation, isolation and structure on the richness and abundance of bird communities in major coastal forests south of Mombasa' from 1993 to 1994 showed that threatened and endemic coastal birds have patchy distributions compared to other species, and forest structure is the most important factor determining species presence;
- P.Matiku (Moi University; M.Sc.thesis) and Dr.E.Nemeth (Konrad Lorenz Institute, Austria) have been involved in 'Ecological studies of the threatened East Coast Akalat in Arabuko-Sokoke, Shimba Hills and the East Usambaras (in Tanzania)', from 1995 to 1996. Arabuko-Sokoke is a crucially important site for this species because of the

large size of the forest;<sup>17</sup>

- O.Nasurwa and others, in 1995, surveyed the waterbirds on the southern Kenya coast, from Vanga to the Sabaki River. Several new 'Important Bird Areas' were recognised including, Sabaki river mouth, Malindi Marine Park, Mida Creek and Vanga Creek;
- Important Bird Area surveys are planned for the coast north of the Sabaki River in October/November 1996. Monitoring data on bird population of the plots established during the KIFCON surveys in 1992 will take place when funds permit.

### Entomology

- W.Ayiemba studied the butterflies of Arabuko-Sokoke for his M.Sc. thesis (Nairobi Un., Kenya) and through KIFEPEO there is ongoing data collection on the butterflies and their food plants. For instance, W.A.Reid on the distribution of *Charaxes* butterflies of Arabuko-Sokoke Forest;<sup>18</sup>
- A proposal has been presented to SAREC to study the wax moth problem in bee keeping at the coast;
- There are plans to study some groups of insects, butterflies and grasshoppers in the Shimba Hills as indicators of forest degradation (P.Kahumbu, KWS)

17 Nemeth E (1996) *Distribution, habitat selection and behaviour of the East Coast Akalat (Sheppardia gunningi)*. Vienna, Austria: Konrad Lorenz Institute.

18 Reid A (1996) A study of the distribution of *Charaxes* butterflies in the Arabuko-Sokoke Forest. *EANHS Bulletin*, 26 (1), 5-8.

and the butterflies of the Kayas (Nathan).

#### *Mammalogy:*

- NMK is engaged in producing a mammal atlas for Kenya;
- J.G.Mwangi studied 'The importance of animals in the survival of a canopy tree, pod mahogany (*Azelia quanzen-sis*) in Arabuko-Sokoke Forest' for his 1992 M.Sc. thesis (Nairobi Un.);
- E.Kanga is trying to find out if Ader's Duiker still exists in the Arabuko-Sokoke Forest. Indications are that this very rare antelope does still exist but in very low numbers. Trapping in Arabuko-Sokoke is drastically reducing the numbers of small antelopes;
- I.Aggundey is continuing his surveys of bats in coastal Kenya.

#### *Herpetology*

- R.M.Chira did an 'Ecological study of the herpetofauna in Arabuko-Sokoke and Gede coastal forests of Kenya' for his 1993 M.Sc. thesis (Nairobi Un., Kenya);
- Prof.R.C.Drewes of the California Academy of Sciences has been studying frogs at the Kenya coast for many years and recently produced a guide to the frogs of Arabuko-Sokoke.<sup>19</sup>

#### *Miscellaneous*

- P.Muoria is studying human-wildlife conflict in and around Arabuko-Sokoke for his Ph.D. thesis, focusing on baboons and elephants;
- Studies of elephants have been done Arabuko-Sokoke (A.Gesicho) and are being done in Shimba Hills (P.Kahumbu, K.Mwathé);
- N.Moinde is monitoring a group of Sykes Monkeys which has been translocated from Watamu to Arabuko-Sokoke Forest. This to gain experience in handling and releasing forest monkeys, in case a more threatened species, such as De Brazza's, or Tana Red Colobus, has to be translocated in the future. In the meantime valuable information on the Sykes, a poorly studied primate, is being gathered. A short study on the Sykes Monkey was done by A.Balletto at Gede National Monument under the auspices of IPR in 1994;
- Most of the research in Tana River Primate National Reserve has been on two endangered primates (Tana Red Colobus and Tana Crested Mangabey) and the gallery forest which supports them. Ph.D. theses have been written on the Colobus (B.Decker; Emory Un., US), the Mangabeys (M.Kinnaird; Un. Florida, US), and the riverine vegetation (K.Medley; Michigan State Un., US), (A.Njue; Un.California, US). P.Kahumbu studied the use of trees for canoes in her M.Sc.thesis (Un.Florida, US). T.Butynski has been organis-

<sup>19</sup> Drewes R C (1992) *Amphibian species of the Gedi and Arabuko-Sokoke Forests, Kenya*. Unpublished report submitted to the ICBP/NMK Arabuko-Sokoke Conservation Project, Nairobi.

ing the monitoring of the primate population dynamics along the lower Tana, and work has also been done on the feeding behaviour of, and competition between, the primates, including baboons. Much of the work was reviewed during a conservation assessment workshop in 1991.<sup>20</sup> The long awaited KWS/NMK project to promote the conservation of the primates will start soon and will include forest restoration and monitoring, community participation, development of ecotourism and education awareness.

### Other Environmental Concerns

In the hinterland of the coast there is a great deal of subsistence farming on the semi-arid lands which are more suitable for ranching and wildlife production. There is need to learn more about the impact of the resource poor farmer on these fragile lands, why this is happening and how the farmers can be assisted. Although there is opportunity for small scale irrigation near the Sabaki/Galana river, many people may in the future be dependent on famine relief. This leads to the inevitable conclusion that more paid employment has to be created for coastal people, in conventional industry as well as in the tourist industry. But industry can be very damaging to the environ-

ment as was made clear by Schoorl & Visser.<sup>21</sup> There is need and ample opportunity for studies on present and future industries at the coast, for example the Athi River Mining Company at Kaloleni (cement factory), and Kenya Calcium Products at Waa; not to stop these factories operating, but to assist the management to make them less damaging to the environment. All hotels should be encouraged to deal wisely with waste (composting, recycling sewage and grey water etc.), housing for their staff, energy saving etc. Basic data are needed as well as practical research and pilot projects initiated to show what can be done.

### Conclusion

Many opportunities for research studies exist to help solve environmental problems at the coast and increase our understanding of the coastal ecosystems. It is imperative that MUSES collaborates with other institutions with research programmes in coastal Kenya, such as NMK, KEFRI, KMFRI and CDA, and with other Universities, such as Un. of Nairobi which has a coast facility at Diani and Egerton which is planning a coast facility at Mpeketoni in Lamu District to set up joint projects and eliminate competition for funds. Whatever research topics are chosen, it is equally important to find out what has been done before, to avoid du-

20 Seal U S et al (1991). *Tana River Primate Reserve Conservation Assessment Workshop Report*. Captive Breeding Specialist Group (CBSG/SSC/IUCN) in collaboration with KWS, Nairobi.

21 Schoorl J & Visser N (1991) *Towards sustainable coastal tourism: Environmental impacts of tourism on the Kenya Coast*. Nairobi: Netherlands Embassy, Agriculture Section.

plication of effort and waste resources.

Finally, to formulate a few personal suggestions, from among the many priorities that have been mentioned up to now:

- Establish a coast environmental resource base (library, including maps and aerial photos, and possibly a herbarium) for use of researchers;
- Establish an administrative centre to co-ordinate a network of experts who can respond to the need for Environmental Impact Assessment and monitoring teams to care for the coastal environment;
- Promote long term forest monitoring. For instance, encourage students to participate in data gathering on permanent sample plots under supervision; they will learn in the process as well as contribute to long term understanding of the ecosystem;
- Lobby for environmental impact assessments for any hotel coming up on the coast;
- Last, but not least, investigations into the charcoal industry are an absolute necessity.

▲

#### Appendix

#### **Coastal Forests Ecosystems Task Force Workshop, 23-24 May 1996.**

The main recommendations of the report on Kenya Coastal Forests <sup>22</sup> are still valid.:

- 1 Sacred Kaya forest should all be gazetted as National Monuments and cared for by the Coastal Forest Conservation Unit of the NMK;
- 2 Mangua Hill should become a Forest Reserve;
- 3 Kilibasi Hill should be totally protected, as a strict Nature Reserve within a Forest Reserve, or as a National Park;
- 4 Tana Delta should be protected as a National Wetlands Reserve;
- 5 Ras Tenewi Coastal Zone proposed National Reserve should be gazetted;
- 6 Tana River gallery forests should be protected;
- 7 Limestone outcrops of Cha Simba, Mwarakaya, Pangani and Kambe Rocks, and limestone gorges on the Rare, Njora, Ndzovuni Lwandani and Kobeni Rivers should be strictly protected to conserve the flora and prevent uncontrolled quarrying;
- 8 The *Brachystegia* Woodlands of North Kilifi District should become Forest Reserves;
- 9 Lunghi and Boni proposed Forest Reserves should be gazetted;
- 10 All major industries using wood from indigenous trees as raw material, or as fuel, should be required by law to be self sufficient in wood supplies, by growing trees to fulfil their needs. New industries should have to establish plantations before they are licensed to begin operations;
- 11 A realistic value should be placed on all indigenous wood products. Hardwood timber, used in the carving and

<sup>22</sup> Robertson S A & Luke W R Q (1993). *Kenya Coastal Forests, Report of the NMK/WWF Coast Forest Survey*. Nairobi; National Museums of Kenya and World Wide Fund for Nature International.

- furniture trade, should be sustainably harvested by FD itself from the FRs, using techniques which do not damage the forest structure. The wood should be auctioned at the Forest Stations to the highest bidder. Saw millers should not be allowed to harvest timber themselves in the FRs. Commercial or bulk fuel wood extraction from any indigenous forest should be phased out. More FRs should eventually become totally protected and managed jointly with KWS to generate income from tourism and recreation;
- 12 The optimum management of mangroves should be encouraged as this productive source of pole and fuelwood has been mismanaged and could relieve pressure on the terrestrial wood sources;
  - 13 The environmentally damaging production of charcoal from trees of the semi-arid hinterland should be phased out and fuel obtained from plantations or from alternative energy sources. Farmers near towns with high fuel and polewood demand should be encouraged, perhaps with tax relief, to grow trees as a crop;
  - 14 A Botanic Garden should be established at the coast, linked to a regional herbarium and biodiversity resource centre under NMK, to create public awareness of the value of the coastal flora and to support research;
  - 15 New protective categories should be created in Kenyan Law along the lines of National Monuments, to protect sites of environmental importance, and areas of high biodiversity. These categories would protect sites on private or public land.
- In addition, further recommendations were formulated during the 1996 workshop as follows:
- In view of the demand for hardwood timber at the coast (for carving, furniture, and building), the FD, in collaboration with the local authorities, should control the cutting of indigenous hardwood throughout the coast, not just from Forest Reserves. There are still many areas of forest in coastal Kenya, both privately owned and in the Trustlands, where uncontrolled cutting is taking place, and the nation's valuable resource is being squandered. The species that may be cut, and the quantity cut should be limited. Movement Permits should only be issued by District Forest Officers up to a total volume laid down by the annual Licensing Committee;
  - The Movement Permit system should be revised and tightened. Presently there is much abuse of this system as Foresters are often unable, due to lack of transport, to visit the areas where timber is being cut. They have to rely on the information given by the transporter, which may be purposely misleading;
  - The FD Nurseries should be phased out, or leased for commercial production. Local farmers could be contracted to provide the seedlings needed for the plantations. This would release FD staff for forest management. Similarly, the FD Plantations should be leased for commercial production, or managed under the shamba system.



\*\*\*\*\*

## 9

### KAYA FOREST CONSERVATION ON THE KENYA COAST

ANTHONY GITHITHO

#### **Introduction**

The Kaya forests are found mainly in Kilifi and Kwale districts of Coast Province. They are residual patches of the once extensive lowland forests of Eastern Africa. Varying from a few hectares to over 400 hectares, they owe their existence today directly to the history and traditions of the Mijikenda ethnic groups of the coast. The forest patches sheltered small fortified villages of the various groups since their first settlement more than three centuries ago up to the last century (Kaya means homestead). Gradually as condi-

tions became more secure communities left the forest refuge and began to clear and cultivate the areas around. However the small forested sites of the original Kayas were protected by the local elders as sacred places and burial grounds. Fines were imposed in cases where any individual broke the rules. For these reasons the Kayas are probably the best examples of 'people's forests' in Kenya because of the direct effect of human values, beliefs and activities on their management and conservation.

Apart from their social, cultural and

historical importance, these small forests are biologically very diverse and have a high conservation value which is recognised both locally and internationally. They are remnants of the Zanzibar Inhambane forest system whose complexity and diversity has been explained as due to refuge occurrence, differential extinctions, genetic isolation, and instability and change in climatic conditions.<sup>23</sup> More than half of Kenya's rare plants occur at the coast with many of them being found within the Kayas as established by a number of botanical surveys.<sup>24</sup> At present over 40 of the forest patches have been identified in Kilifi and Kwale District.

An increasing disregard and poor knowledge of the forests and their significance combined with rising demand for land and forest products has led to degradation and destruction of these forests in recent years and many have almost disappeared. This is especially so with an ever expanding population around the Kayas in need of more land. There has also been a threat from hotel development particularly to beach Kayas in Kwale District. Because of their unique, but endangered status, the Kayas started attracting the interest of botanical researchers and conservationists from the '60s. In the early '90s comprehensive

surveys revealed widespread deforestation, encroachment and logging.

There was widespread concern about this development among local communities, conservationists and scientists resulting in the start of the gazettement of Kayas as National Monuments. Twenty-three have been gazetted to date in a continuing process. This protection mechanism has been necessary due to the diminishing appreciation of the forests among the local population and the fact that community management could not be fully relied on.

#### **Coastal Forest Conservation Unit**

As a result of these concerns the World Wide Fund for Nature initiated a forest support project with the National Museums of Kenya, known as the Coastal Forest Conservation Unit (CFCU). This unit has the specific task of looking after the Kayas in consultation with the local communities for both their conservation and cultural values. It is also mandated to promote the conservation of coastal forests in general. The objectives of the project include:

- Strengthening the National Museums capacity to conserve the Kaya Forests and sacred groves of Kwale and Kilifi districts in collaboration with the local communities;
- Boundary surveys and gazettement of the Kaya forests and sacred groves as National Monuments;
- Strengthening the social base of traditional cultural values for conserving

23 Robertson S A & Luke W R Q (1993) *Kenya Coastal Forests. Report of the NMK/WWF Coast Forest Survey*. Nairobi: National Museums of Kenya and World Wide Fund for Nature International.

24 Beentje H J (1994) *Kenya Trees, Shrubs and Lianas*. Nairobi: National Museums of Kenya.

- the sacred forests through a public awareness and education programme;
- Alleviating the pressures causing coastal forest destruction by promoting feasible alternatives to over exploitation in collaboration with the Forestry Department;
- Collection of biological, socio-economic and other relevant information on coastal forests in order to develop effective strategies and practices;
- Revision of the Antiquities and Monuments Act of the laws of Kenya in order to facilitate conservation of sites of cultural and conservation importance such as the Kayas;

Specific activities include:

- Strengthening and supporting the day to day activities of the traditional Kaya committees through regular contact and consultations and helping to record customs and institutions;
- Funding the deployment of guards or watchers from local communities;
- Boundary demarcation and survey activities;
- Gazettement procedures for the Kayas;
- Mobilising the relevant law-enforcement departments to curb serious encroachment or destruction;
- Environmental education activities for communities, groups, schools and institutions to increase awareness of Kaya conservation;
- Supporting forestry extension by the Forestry Department to enable communities to develop alternative wood

resources;

- Supporting multidisciplinary research and surveys on Kayas and coastal forest conservation;
- Facilitation of legal review process to culminate with a revision of relevant laws.

### **Research Priorities for Kayas and Coastal Forests.**

CFCU gives priority to research of various kinds which will improve our knowledge of the Kayas and coastal forests in general, both in terms of resource values and socio-economic or cultural contexts. The important subject areas that need research relate to the dual importance of the Kaya forests as centres of biodiversity and other resources and as traditional and cultural entities.

#### *Socio-Economic and Cultural Research*

- Traditional management institutions; elements of their development, responses to change and viability for the future;
- Forest uses, values and attitudes;
- Compatibility of religious and ritual uses of forests with other objectives and mechanisms;
- Impact of external pressure relieving interventions e.g. the effect of rural development on forest uses, values etc.

#### *Resource Management and Ecological Research*

- Distribution and rarity status of shrubs, lianas and non-woody plants;

- Fragmentation effects. The demographic and genetic viability of isolated plant species populations in forest patches;
- The preservation and protection of rare species populations including reproduction, regeneration, economic feasibility;
- Dynamics of natural regeneration of different coastal forest types. Implications for rehabilitation;
- Selection and identification of tree species with economic potential and other features such as high growth rates;
- Growth rates of economic indigenous trees for wider application in production forestry;
- Basic entomological research and studies;
- Basic mycological research and studies.

#### *Research Collaboration*

The Kayas offer opportunities for research on indigenous forests which have become increasingly rare ecosystems in Kenya. There is still a great deal of comprehensive research required for a better understanding of both the ecosystem and

the biology of single species. CFCU welcomes collaborative efforts and encourages student research. It also provides a few fellowships to facilitate research on coastal forest conservation. The following needs mention in this respect:

- A centralised data base is being developed. There is also a small herbarium and nursery for rare plants and plants with potential economic benefits. This provides an accessible information centre for interested parties;
- Shimba Hills should form the initial focus of any botanical research. CFCU welcomes collaboration on this front;
- CFCU, in collaboration with the Forest Department, is working towards the establishment of alternative sources of wood by the introduction of new useful species in consultation with local communities;
- The Kayas harbour a number of herbal medicines, but little scientific research has been undertaken in this regard.;
- Specific management techniques might be necessary in Kaya forest conservation, for example in large mammals control.

▲

\*\*\*\*\*

## 10

### WASTELAND REHABILITATION: BAOBAB FARM

SABINE BAER

#### **Introduction**

The Kenya Coast has extensive coral limestone deposits resulting from a fringing coral reef that fell dry when the sea level receded some 30,000 years ago. In the Bamburi area the deposits are commercially viable and the limestone is excavated and processed by Bamburi Cement Ltd. Bamburi's concession comprises a total of some 10 km<sup>2</sup> (approx. 3 km<sup>2</sup> around the factory, other plots are situated behind Kiembeni, at Kikambala

and Vipingo). Baobab Farm, a subsidiary of the cement factory, has successfully rehabilitated disused quarries with a combination of reforestation and an ingenious system of integrated economic activities.

#### **Rehabilitation.**

After excavation the remaining floor of the quarry consists of hard coral rock without soil and without organic substance. The ground water is about 50 cm.

below floor level. It has a fresh upper stratum and a saline lower stratum. The saline stratum is connected to the sea (at a distance of about 1 km) through the porous limestone rock and the tidal fluctuations are passed on to the ground water. Evaporating ground water leaves a layer of salt on the disused quarry floor.

The first attempt at rehabilitation of the ugly, barren quarries commenced in 1971. It involved the planting of 26 tree species, of which only casuarina, conocarpus and coconut palm trees survived at the end of 6 months. Casuarina was found to be ideal for the prevailing conditions because it is salt tolerant and can adapt to absence of topsoil. It is drought tolerant, and has economic value as building timber, fence poles and drop-pers. It can supplement mangroves in the building industry and produces good quality charcoal. Casuarina seedlings were obtained from nursery grounds with poor substrate conditions (90% silica and 10% inoculum – leaf litter from old casuarina plantation). The seedlings were planted in grounds that had been ripped open with the help of a bulldozer. Humus production from leaf litter was speeded up by the introduction of the red-legged millipede, *Epibolus pulchripes*. At the end of the first five-year period 45 ha. had been planted. After about 10 years, the casuarina trees had grown to a level at which, due to its cover, a new micro climate had been formed, where evaporation of ground water and formation of salt layer had ceased. By

now, a multi-species forest has evolved out of a monoculture tree plantation comprising a diverse forest system together with ground flora and fauna. Some species were brought in by birds, bats and small mammals, many of the indigenous forest species were actively introduced.

### **Diversification**

The rehabilitation created the conditions for the next stage namely a diversification programme that successively introduced aquaculture, game farming and tourism.

### *Aquaculture*

After 10 years of prior experimentation with fish culture in ponds and tanks, the Baobab Tilapia farms was started in 1980. An important reason for the choice of fish cultivation was the fast economic returns that could be expected which, in turn, could be used for the ongoing reforestation. The main tilapia species is *Oreochromis niloticus* of which 35 tons are harvested each year and sold locally. Ground water is pumped into the tanks after which it is recirculated by removing particulate and dissolved wastes. This is done by passing the water through rice paddies as sedimentation ponds, and through ponds overgrown with Nile cabbage (*Pistia stratiotes*) to remove the respective wastes. Experiments are going on to develop different aeration systems as oxygen is the limiting factor, currently being supplied only by gravity in the form of a cascade system.

Together with the fish farm and the rice paddies, crocodiles make up the rest of the integrated aqua culture system. Initially, a few crocodiles were kept to make use of animal offal from sheep, goats, cattle, poultry and fish on the farm. The objective was to turn wastes into money by later selling crocodile meat and skins. This part of the farm is becoming more intensive with increased numbers of crocodiles.

#### *Game Farming*

The reserve land of the cement factory is bush land that is infected with tsetse fly and ticks and is unsuitable for conventional livestock. In 1977, the first indigenous antelopes were introduced here, namely eland (browsers) and oryx (grazers) who have resistance to local wildlife diseases. The aim was not only to utilise the reserve land but also to utilise the vegetation coming up in the quarries, to fertilise the quarries slowly with faeces, promote seed dispersal in quarries by herding alternating in bush land and quarry; and to eventually sell game meat. The current stocks are 70 eland in 4 herds, and 107 oryx in 3 herds. In 1995, a total of 17 animals was culled, in 1996 some 20 animals, and the meat sold locally.

An ostrich farm was started in 1995 on a poor grassland area in the reserve. Almost 100 birds were introduced and have since started laying eggs.

#### *Tourism*

The Bamburi Quarry Nature Park was opened to the public in 1984. It offers guided walks through the man-made ecosystem in the rehabilitated quarry. Guides have been trained to explain the history of the park as well as the ecosystem approach that led to this result. In 1995 the Bamburi Park was visited by some 100,000 paying visitors, of whom about 55% were local visitors and school parties. A network of paths for leisure activities such as walking, jogging, and cycling is being introduced in the North Quarry. Tourism has become an important income source for Baobab Farm, supporting new developments and research.

#### **Research**

Research priorities for the Baobab farm focus mainly on the ecological aspects of forest ecosystems, with fungi and insect succession within the ecosystems as priority areas. The economic aspects of ecosystems conservation practices involving local communities is another priority. Baobab farm is also in the process of diversifying the forest composition by replacing pioneer casuarinas with indigenous forest vegetation. The casuarinas are cut down and sold and a second generation of trees are planted in their place. More than 200 species have already been planted in the rehabilitated quarry, including the *mvule* tree (hardwood) and the *neem* tree (medicinal), to decide which species are suitable

for these conditions. Apart from giving research results, the exercise ultimately aims at creating an ecologically and economically viable indigenous coastal forest. Selection of tree species to be planted is based on origin (coastal indigenous), potential economic value (valuable timber trees), conservation aspects (protection endangered species), and biodiversity values (increasing biodiversity through attracting other organisms by providing food, habitat, breeding ground, etc.).

Other attempts are being made at agroforestry, involving interplanting banana plantations with timber trees, and mangrove plantation with other species suitable for areas close to the water level.

### **Conclusion**

Baobab Farm is a commercial enterprise that has to pay for itself. Any new developments or research have to be funded from the income from commercial activities. It is therefore a unique combination of ecology and economy, described in more detail in Haller & Baer (1995).<sup>25</sup> In 1987, UNEP awarded Rene Haller, the originator and manager of Baobab Farm, an international prize in recognition of his effort. ▲

25. Haller R & Baer S (1995). *From wasteland to paradise: The breath-taking success story of a unique ecological experiment on the Kenya Coast*. (english edition). Germany: Koschany.

\*\*\*\*\*

# 11

## INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY (ICIPE)

SRINIVASAN SITHANANTHAM & Z. NGALO OTIENO

### **Introduction**

ICIPE is focusing its research in sustainable management of harmful as well as beneficial insects, largely through development of environment friendly strategies. In Coastal Kenya, ICIPE's research base at Muhaka, Kwale District, supports ecological research on crop insect problems – especially pests of food crops and vegetables. The major thrust at present is in areas of classical biological control and ecology of locally occurring beneficials,

especially parasitoids, predators and pollinators. Research on ecology of the tsetse, with special focus on wild reservoir hosts, and their implications for management of trypanosomiasis in the livestock at farm level, is another major research theme at this base. Biodiversity research with focus on indicator species, as well as ecological adaptation and economic utilisation of two beneficial insects – honey bees and silkworms – are also being initiated.

### Research Priorities

Coastal Kenya offers a fascinating mix of challenges and opportunities for insect science research and its application for sustainable management of insects. The warm and humid climate, the bimodal rainfall, and the diverse ecozones, provide a varying range of agro-ecologies, in which insects often flourish and dominate the farming systems. The challenges in managing the harmful insects – crop pests and disease vectors – are the relatively favourable agroclimatic and diverse habitat conditions for their activities, especially breeding and dispersal. The opportunities, nevertheless, are also substantial, towards utilising the natural enemies of pest insects, as well as the scope for sustainable farming with productive insects, like honeybees and silkworms.

ICIPE has been focusing its ecological research on developing environment-friendly strategies for the management of crop pests and vector insects of cattle (and human) diseases. One of the thrust areas in this research is biological control i.e. utilising the predators, parasitoids and pathogens for controlling pestiferous insects, especially on food crops. More recently, ICIPE has initiated research and development activities in ecological adaptation of honeybees and silkworm, so as to help generate additional income for the rural poor.

ICIPE has established a research station at Muhaka, Kwale District, near Di-ani. The station comprises farmland (6 ha.) with supplementary irrigation to en-

able cultivation of food and vegetable crops. There are field laboratories, ICIPE has also access to the on-site Kaya forests which offer an ideal site for biodiversity and ecology studies.

### Ecological Research on Insect Pests of Crops.

During the last ten years, substantial research input has gone into the ecological aspects of the stemborer *Chilo* spp. (Pyralidae: Lepidoptera), which are the key pests of the main cereals – maize and sorghum – largely in collaboration with the Kenya Agricultural Research Institute and Wageningen Agricultural University. Some of the ongoing/recently completed ecological research topics of ICIPE in coastal Kenya are listed below.

#### *Stemborers on cereal crops*

The specific thrusts in the ecology of stemborers are as follows:

- Population patterns of stemborer species;
- Seasonality of parasitoids on stemborers;
- Wild hosts plants as refugia for stemborer parasitoids;
- Pheromone-baited traps as tools for monitoring adult stemborer populations;
- Dynamics of predatory arthropods in cereal crop systems.

*Environment-friendly control options for stemborers.* Some environment friendly control options have been tested in the region:

- Importation and establishment of ex-

otic parasitoids, (*Cotesia flavipes*), for controlling the exotic stemborer species (*Chilo partellus*);

- Local adaptation of stalkborer resistant /tolerant genotypes of maize/sorghum;
- Potential of the insect pathogen, *Bacillus thuringiensis*, in controlling stemborers;
- Intercropping/strip cropping with non-host crops for reducing the severity of stemborers on cereal crops;
- Evaluation of neem for the control of stemborers.

#### *Non-target effects of crop pest control*

- Effects of spraying of neem on nontarget beneficial arthropods in cowpea ecosystem;
- Effect of different host plants on the survival of stemborer parasitoids.

Some of the specific topics covered above have been supported under species projects funded by Rockefeller Foundation, Gatsby Foundation and FINNIDA/UNEP among others.

**Arthropod Vectors of Cattle and Human Diseases.** The Disease Vector's Management Programme focuses on three major target areas:

- Tsetse (Vector of Trypanosomiasis);
- Ticks (Vector of East Coast Fever);
- Mosquitoes (Vector of Malaria).

Considerable interest has been ongoing in monitoring & trapping the tsetse species – *Glossina brevipalpis*, *G. pallidipes* and *G. austeni*, especially in Kwale District. One important feature of tsetse

research is the close linkage of the vector, with the wild animals in the Shimba Hills Game Park. Collaboration is being sought with Kenya Wildlife Service (KWS) and Coast Development Authority (CDA), besides other interested partners including KETRI/KARI.

#### **Biodiversity and Sustainable Utilisation of Beneficial Arthropods.**

The arthropod biodiversity, conservation and utilisation programme of ICIPE is undertaking several initiatives in partnership with the National Museums of Kenya, and the Ministry of Agriculture, Livestock Development and Marketing. These include:

- Biodiversity of indicator species;
- Biodiversity of fruitflies;
- Adaptation of honey bees and their utilisation;
- Silkworms: Adaptation and utilisation.

#### **Conclusion**

ICIPE is very keen to collaborate with partners in the different areas of ecological research in coastal Kenya. The Coastal Research Station at Muhaka is available for collaboration in areas of ecological interest to Moi University and its partners. In addition to applied ecological research, ICIPE's social scientists, biomathematicians, applied ecologists, behavioural and chemical ecologists, molecular biologists and biosystematics specialists will be available to collaborate and provide backstopping in appropriate areas of research. ▲



\*\*\*\*\*

## 12

### **KENYA AGRICULTURAL RESEARCH INSTITUTE (KARI)**

**GEOFFREY KAMAU**

#### **Coast Province**

The Coast Province covers an area of approximately 84,000 km<sup>2</sup> comprising six administrative districts: Kilifi, Kwale, Lamu, Mombasa, Taita-Taveta and Tana River. The Province has a bimodal rainfall with annual average ranging from 1200 mm at the Coast to less than 400 mm in the hinterland. Mean annual temperature ranges from 22°C to 32°C in the lowlands and from 12<sup>o</sup>-21<sup>o</sup>C in the Taita Highlands.

Constraints to farming in Coast Province have been identified by several

surveys and include:

- Low and unreliable rainfall;
- Low and declining soil fertility especially under continuous cultivation;
- Pests and diseases both in crops and livestock;
- Direct damage to crops from wild animals especially in the areas around National Parks in Kwale, Taita-Taveta, and Lamu Districts;
- Poor infrastructure and long distances to market centres;
- Salinization of land due to poor

drainage and uncontrolled water management;

- Rapid urbanisation, especially in Mombasa District, leading to competition with agricultural land uses.

### **Regional Research Centre Mtwapa**

The Regional Research Centre (RRC) Mtwapa is situated 20 km north of Mombasa in Kilifi District in agro-ecological zone CL3. Research is carried out on the station, and sub-centres in Matuga (CL4) in Kwale District; Msabaha (CL4) and Mariakani (CL5) in Kilifi District; Mpeketoni (CL4) in Lamu District; and Ngerenyi (UM4) in Taita/Taveta District, as well as on farmers plots.

RRC Mtwapa is one of the thirty one centres of the Kenya Agricultural Research Institute (KARI) throughout the country. It addresses the constraints in farming under the agro-ecological and socio-economic conditions of Coast Province. The mandate of RRC-Mtwapa is to increase agricultural productivity through development of suitable crop varieties and livestock breeds, improved soil management practices, and sustainable use of natural resources.

The total number of staff working at RRC Mtwapa is 144 persons of whom 23 are research officers with Master Degrees and two with Ph.D. qualifications.

The regional research programme focuses on five themes:

- Improvement of food crop production in semi-humid and semi-arid zones;
- Development of mixed crop-livestock

systems;

- Improvement of production and marketing of cash crops;
- Soil fertility management;
- Socio-economic surveys and feasibility studies.

### **Research-Extension Linkages**

Linkages between research and agricultural extension staff have existed since the Agricultural Research Division was in the Ministry of Agriculture about ten years ago. Several efforts have been undertaken to strengthen the existing linkages, which include joint activities, under T&V Extension programme, District Farming Systems Teams and Research-Extension clusters. A Memorandum of Understanding between the Ministry of Research and the Ministry of Agriculture and Livestock Development further strengthened these linkages, through joint field visits, field days, demonstrations, workshops, meetings and seminars.

### **Achievements**

Key research achievements over the years are summarised below:

#### *Cereals*

- Pwani Hybrid 1, released in 1989;
- A new maize hybrid H89P2, released in 1995;
- Two varieties MTVC 9045 and MTAP5, both streak tolerant in advanced testing stages;
- A wide variety of germplasm have been evaluated and crosses of the

promising ones have been done;

- Recommendations on density and fertiliser for Pwani Hybrid 1;
- Recommendations on land preparation, time of planting, weed control, time and method of fertiliser application;
- A new sorghum variety KARI Mtama 1 released in 1994 has been evaluated;
- Sorghum growing technology packages have been tested on station and on farm.

#### *Root and tuber crops*

- Determination of appropriate planting methods and spacing, time of weeding and frequencies;
- Determination of optimal times for planting and harvesting cassava; livestock feed rations which include cassava roots and leaves; and rapid multiplication technology.

#### *Horticulture*

- Recommendations for manure application in amaranthus;
- Production of indigenous vegetable seed for long-term storage at the gene bank and for use by farmers is in progress;
- Bananas and papaw germplasm established;
- Development of a package for growing yellow passion;
- Identification of Cal J and M82 as suitable tomato varieties for the coastal lowlands.

#### *Oil Crops*

The following oil crop varieties have been identified as outstanding:

- Sunflower: S-400, S-430, S-412, S-455, and S-515;
- Soybean: TGX 1448-1E, TGX 1448-2E, TGX 1458-1D;
- Simsim: Bar 0002, Bar 0004, E and MUB 010;
- Groundnut: ICGV 87009, ICGV 87079, Red Valencia and ICGV 86040;

#### *Sugar Cane*

Many Mtwapa-bred clones (KEN series) have been tested in preliminary yield trials in various environments since 1982 and the following clones are promising in various zones: KEN 82-216, KEN 82-237, KEN 82-247 and KEN 82-401.

#### *Livestock*

- Identification of suitable high yielding forage species;
- Tests of promising forage species on-farm;
- Development of agronomic practises for growing Napier and Leucaena in alley farming system;
- Recommendations for intercropping maize, Leucaena and grain legumes;
- Development of low cost dairy cattle ration as the basal diet, based on leguminous forage and Napier grass;
- Study of the epidemiology of ECF and trypanosomiasis, the two most prevalent diseases in the region and their control methods.  $\Delta$



\*\*\*\*\*

# 13

## CORAL REEF CONSERVATION PROJECT

NYAWIRA MUTHIGA & TIM McCLANAHAN

### **Introduction**

Coral reefs are among the earth's most diverse ecological systems and may serve as important biological laboratories for determining impacts on the small scale of human resource use to larger scale environmental factors of global warming. Yet, without sufficient local expertise and manpower to understand these ecosystems through monitoring, experimentation, and modelling the opportunity for wise management is being lost.

The objective of the Coral Reef Conservation Project (CRCP) is to study the impact of human activities on coral reefs in Kenya, and the East Africa region in general. It has the following components:

- Monitoring the status of coral reefs in relation to human resource use;
- Creating opportunities to study specific aspects of reef ecosystems;
- Training regionally based scientists in methods of coral reef monitoring, experimentation, environmental assessment, and modelling.

CRCP is supported financially by the Wildlife Conservation Society, Food and Health Foundation, the Rockefeller Foundation and USAID. CRCP is affiliated to Kenya Wildlife Service and Kenya Marine and Fisheries Research Institute.

### **Research**

Within the Western Indian Ocean the greatest concentration of scientific research has been based on Kenya's fringing reef where coral reefs experience two extremes of resource use; several marine parks are juxtaposed against heavily utilised reefs. This creates a natural laboratory for studying human resource use and for distinguishing these influences from natural or human induced environmental variation.

Coral reef lagoons in Malindi, Watamu, Kisite and Mombasa receive total protection from fishing, shell, and coral collection. The parks vary in size from 6 to 10 km<sup>2</sup> and represent a little less than 5% of Kenya's reef area located within a kilometre from shore. Unprotected reef lagoons are exposed to largely unregulated resource extraction, which principally involves fishing and shell and coral collection.

Studies of impacts on coral reefs include surveys on finfish, sea urchins, substrate cover, shell abundance and diversity, river discharge and eutrophication. Tourist damage has also been reported. Heavy use of snorkelling sites in marine parks and in unprotected reefs adjacent

to tourist accommodations results in varying degrees of physical damage due to standing on and kicking corals.

### **Training**

The long-term success of reef monitoring will depend on a regional association of nationally-based marine scientists who can exchange ideas and learn and compare field methodologies. Formal and informal relationships will assist in developing a regional database in environmental and biological characteristics of Indian Ocean and Red Sea coral reefs as well as studying comparative biogeography, human impacts and experimental management. Professional development through meeting other regionally-based scientists, project staff, associates and park managers is important.

CRCP offers an internship program in collaboration with the following institutions: Moi University and KMFRI (Kenya), Fisheries Research Institute (Tanzania), and Department of Environment (Eritrea). The internship program offers internships of 3 to 6 months and is open to nationals of African coastal countries (i.e. Kenya, Tanzania, Mozambique, Madagascar, Somalia, Djibouti, Eritrea, Sudan and Egypt) and Western Indian Ocean countries (i.e. Maldives, Seychelles, Mauritius and Zanzibar and associated islands). Intern's travel, living stipend, and equipment are paid by the Wildlife Conservation Society jointly through funds from various sources.

**Recommendations**

Kenya's marine parks continue to be a haven for fish, corals, gastropods, and many other unstudied organisms. These areas should continue to receive protection, if only because they earn considerably more income than fishing per unit area basis. The following research topics require priority:

- Study of the factors that affect topographic complexity of the reefs such as increase in sea urchin abundance, coral breakage by tourists, sedimentation, coral predators, and coral community composition;
- Comprehensive research and monitoring to study the impact of sediment discharge from the Sabaki River on Malindi's coral reefs;
- Research on management of reserve areas with a focus on developing fishing practices with sustainable yields and that are non-destructive to the coral reef ecology;
- Experiments to determine the impact that removal of the large-bodied sea urchin will have on the reefs substrate and fish fauna.

▲



\*\*\*\*\*

# 14

## TRAINING COURSE FOR TROPICAL COASTAL ECOLOGY, MANAGEMENT AND CONSERVATION

NANETTE DARO

### **Introduction**

The Intergovernmental Oceanographic Commission, Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, which met in Mauritius, December 1992, strongly emphasised the urgent need for training in marine sciences for the people from the region. This was further emphasised in the recommendations of the conference on large marine ecosystems, held in Mombasa, March 1993.

Since 1985, the Belgian government has initiated bilateral projects in marine sciences with the Government of Kenya, many hosted at the Kenya Marine Fisheries Institute in Mombasa. In 1985, an international M.Sc. course on Fundamental and Applied Marine Ecology (FAME) was started at the Free University of Brussels. A central objective of this course is the education of young scientists from developing countries.

Experience with the above activities,

has learned that Kenyan scientists generally have a good theoretical foundation, but often lack practical training, particularly in one of the fields of most concern to them: tropical ecology.

Advance plans are now in the making for an intensive training in tropical coastal ecology, management and conservation, with particular emphasis on experimental field work. The Belgian Ministry for Development and Co-operation has approved the project and the course will first start in July-August 1997. The allocated funding is US\$ 500,000 for two years. Information on the planned course organisation and course content follows below.

### **Course Organisation**

The training course will be organised in the framework of existing M.Sc.'s in aquatic sciences in the different participating universities. The designated partners are the University of Nairobi and the Free University of Brussels

The course will be held for a period of 10 weeks, yearly, in 1997 and 1998. The locality will be at the Kenyan coast. Existing facilities of KMFRI (Mombasa) will be used.

At the start, ten M.Sc. students from East African countries, specialising in marine ecology, will be accepted per batch. Scholarships for this training course will be available, as well as additional funds to allow the students to do their M.Sc. thesis in this context.

### **Course Content**

There is a growing interest in comparative research on the human impact on marine ecosystems. The course will concentrate on stressed ecosystems such as mangroves, coral reefs, seaweed and seagrass beds, estuaries, and beaches and the utilisation of these tropical coastal zone systems. For the moment the course will offer six subject areas.

#### *Food chains and eutrophication*

Training in laboratory techniques for nutrient analysis, bacteriology, zooplankton and phytoplankton biomass, respiration and production.

#### *Management of the intertidal zone*

Inventarization of benthic flora and fauna and seagrass fields as a buffer between the open sea and the beach. Assessment of the diversity, the biomass of algae, the influence of predators, the presence of juvenile organisms in the sea grass field.

#### *Marine agroforestry*

Instruction in the zonation of different mangrove trees, their production, and their biomass. Study of the bottom (nutrient exchanges), the surrounding water and other organisms (crustaceans, oysters).

#### *Human impact on coral reefs*

General insight in the diversity of coral reef ecosystems, demonstration of the trophic relationships in the community, to assess the importance of light and transparency in the functioning of the corals.

*Production of benthic systems*

Techniques of sampling benthos, nutrient analysis, oxygen content, number of bacteria, and benthic fauna, at different depths.

*Artisanal fisheries.*

Assessment of sizes and species of fishes in mangrove and reef habitats.

**Conclusion**

For the moment, the course topics cover a fraction of marine sciences or oceanog-

raphy. This start, with a limited number of topics is considered a pilot experiment. If successful, the training course can be expanded in the future with other modules, such as physical oceanography, chemical oceanography, and pollution. The intention also is to expand the programme to twenty students in the future. In addition, there will be opportunity for outstanding students to pursue Ph.D. training through the European School for Tropical Aquatic Sciences which is presently being developed. ▲



**Authors***Daro, Nanette*

Director, FAME, Ecology and Systemics Laboratory, Free University of Brussels, Pleinlaan 2, B 1050 Brussels, Belgium.

*Dietz, Ton*

Faculty of Environmental Sciences, University of Amsterdam, Nieuwe Prinsengracht 130, Amsterdam 1018 VZ, Netherlands  
Tel. 31.20.5254147. Fax 31.20.5254051.

*Gitbitbo, Anthony*

Coordinator, Coastal Forest Conservation Unit, National Museums of Kenya, P.O.Box 596, Kilifi. Tel.0125.22140.

*Hoorweg, Jan*

Coordinator, Coast Environment Research Station, Moi University, P.O.Box 710, Malindi. Tel.0123.30093; Fax 0123.30173.

*Kamau, Geoffrey*

Regional Research Centre Mtwapa, Kenya Agricultural Research Intsitute, P.O.Box 16, Mtwapa. Tel.011.485839; Fax 011.486207.

*King, Anthony*

Ecosystems Analysis & Management Group, Department of Biological Sciences, University of Warwick, Coventry CV4 7AL, UK.

*Malleret-King, Delphine*

Ecosystems Analysis & Management Group, Department of Biological Sciences, University of Warwick, Coventry CV4 7AL, UK.

*Martens, Els*

KWS-Netherlands Coastal Wetlands Programme, Kenya Wildlife Service Coast HQ, P.O.Box 81244, Mombasa. Tel.011.312744/5; Fx.011.227774.

*McClanaban, Tim*

Director, Coral Reef Conservation Project, P.O.Box 99470, Mombasa. Tel.011.486549; Fax.011.472215.

*Mung'asia, Henry*

District Environment Officer, P.O.Box 29, Kilifi. Tel.0125.22727; Fax 0125.22474.

*Mubiga, Nyawira.*

Senior Marine Scientist, Kenya Wildlife Service Coast HQ,  
P.O.Box 82144, Mombasa. Tel.011.312744/5; Fax 011.227774.

*Mwandotto, Bonfance*

Chief Research Officer, Coast Development Authority,  
P.O.Box 1322, Mombasa. Tel.011.311119; Fax 011.224411.

*Otieno, Z.Ngalo*

Research Associate, ICIPE-Muhaka Feld Station,  
P.O.Box 1462, Ukunda. Tel. 0127.3413; Fax 0127.2306.

*Robertson, S.Ann*

Biodiversity Liaison Officer(Coast), National Museums of Kenya,  
P.O.Box 162, Malindi. Tel.0123.21156.

*Sithanantbam S*

Scientist-in-Charge, ICIPE-Muhaka Feld Station,  
P.O.Box 1462, Ukunda. Tel. 0127.3413; Fax 0127.2306.

*Wakwabi, Enock*

Principal Research Officer; Kenya Marine and Fisheries Research Institute,  
P.O.Box 81651, Mombasa. Tel.011.475151/2; Fax.011.472215.

# ENVIRONMENTAL MANAGEMENT, RESEARCH AND TRAINING IN COAST PROVINCE, KENYA

Jan Hoorweg, ed.

---

The natural environment of the Kenyan Coast is threatened in many ways. Coral reefs are deteriorating, mangrove forests are overexploited, forest reserves are threatened, salt and sand mining threatens ground water, unrestricted surface mining leads to erosion; ground water is increasingly saline and contaminated. The reasons behind these worrisome developments are several: increasing population pressure and economic activities, growth of tourism and resulting expansion of tourists facilities. It is unclear to what extent damages follow from naturally occurring geophysical processes, increased subsistence needs or from growing commercial exploitation. However, if current trends of exploitation continue unchecked many aspects of coastal ecology will suffer irreparable damage.

A study day was organized on August 7, 1996, by the School of Environmental Studies, Moi University, with presentations on the respective activities and research priorities of organizations concerned with coastal environment issues. Participants included the Coast Development Authority, Kenya Marine and Fisheries Research Institute, Kenya Wildlife Service, National Museums of Kenya and others. This report contains thirteen of the presentations; two concerned with practical environmental management, two with training in coastal ecology, the rest concerned with research in marine topics, forest, fauna, agriculture and entomology.

Jan Hoorweg is senior researcher at the African Studies Centre, Leiden and Visiting Professor at Moi University. Formerly Director of the National Food and Nutrition Studies Programme. He is currently co-ordinator of the Coast Environment Research Station.

**ACTS** PRESS

P.O. Box 45917  
Nairobi, Kenya

Tel: (254-2) 565173; 569986  
ISBN 9966-41-098-8