





KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

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1.0 PREAMBLE

KMFRI undertakes a multidisciplinary Programme approach in research that is based on six research Programmes namely, Fisheries, Aquaculture research and development, environment and ecology, natural products and post harvest technology, socio-economics and information and data management. Two of these Programmes namely fisheries and aquaculture are core Programmes of the institute. Each Programme is headed by a coordinator (PC), while the Division is headed by a Deputy Director. An Assistant Director is responsible for the day to day running and coordination of all research activities at the Division.

Deputy Director - Dr Renison Ruwa
Assistant Director - Dr Jared Bosire

	Research Programme	**Programme Coordinator**
1.	Fisheries	Dr Edward Kimani
2.	Aquaculture	Dr Betty Nyonje
3.	Natural Products & Post. Harv. Tech.	Mr. Peter Odotte
4.	Socio-economics	Mr Jacob Ochiewo
5.	Information and Data Management	Mr Harrison Onganda
6.	Marine Ecology and Environment	Mr Patrick Gwada

This Annual report for the various programmes' activities covers the 2008/9 FY i.e. from July 2008 – June 2009. The Report covers both GoK and donor funded projects undertaken during the period under consideration. The mode of presentation of the various research activities follows the format captured in the performance contract where various research activities are captured under respective thematic areas herein referred to as work packages.

2.0 WORK PACKAGE 1: Undertake stock assessment surveys for new and existing fishing grounds for the marine and fresh water bodies

WORK PACKAGE OVERVIEW

This report covers the Fishery Research Program in the Coastal and Marine Research Division during the 2008/9 Government Contracting year. The Fisheries Research Program conducts fisheries and multidisciplinary research, in coastal, inshore and marine fisheries in Kenya in corroboration with other research programs at KMFRI, and other government agencies and projects conducted by CBOs and NGOs as well as the fishery industry. During the 2008/9 contracting period, Fishery Program continued to participate in three KMFRI seed projects: the Malindi-Ungwana bay fishery project, the Catch Assessment project and the South Coast Project. The Malindi-Ungwana bay project was able to conduct two excursions in December and in May 2009 adding more data on catch composition of fish as well as crustaceans. The South Coast fishery project was able to conduct four field surveys, two in Msambweni area and two in the Shimoni and Vanga areas. Two draft publications, the first on Cephalopod fishery and the second or reproductive biology of groupers were prepared. The exercise provided data to determine the composition of the catches as well as compare the impacts of fishing gear of the fishery. Catch assessment data continued to be collected in a few sites where KMFRI staff still remain. The data was used to provide landing estimates for South Coast. In addition, the Fishery Program was able to get three donor funded projects this year. These are two projects, one on ornamental fishery and the second on spawning aggregations, funded a MASMA, while the third is on coral culture funded by NCST. Two MARG I projects were also funded within the program. On training, the Fishery Program got three new Masters Degrees (Simon Agembe, Cosmas Munga and Christopher Aura). The projects and other research activities are described below.

2.1. PROJECT 1: Malindi-Ungwana-bay; Status of the Artisanal Fishery

Participating institutions: KMFRI, FD

Scientific team members: Edward Kimani, C. Munga and S. Agembe and C. Aura

Source of funds: GOK

Duration: 2007-2012

Research Problem

The Malindi Ungwana bay fishery has been characterized by conflicts between the trawlers on one hand, the small scale artisanal fishers and conservation agencies on the other hand. The main issues surround the contravention of the Fisheries Act, which limits trawling only beyond 5 nm offshore, destruction of fishing gears of small scale fishers by the trawlers, wastage of fish by-catch and killing of non-target species especially the turtles. Trawling has been going on using until August 2006 when the Fishery Department (FD) enforced the Fishery Act and trawlers were removed from within the

5nm offshore limit. Consequently, KMFRI initiated a program to monitor to the artisanal fishery and the economy, perceptions and opinions of the fisher community to guide the implement of management interventions, and to address the sources of conflict within the fishery. Landing and effort data and biological information has been collected at Malindi, Ngomeni and Kipini approximately every 3 months from June 2007 to June 2009. This report describes the artisan fishery, including prawns, as well as other crustaceans (lobsters and crabs) and fish within the Malindi-Ungwana bay area.

Objectives

- to determine CPUE of fish and prawns,
- to determine the species composition and
- to determine the population structure of the main commercial fish and prawn species

Activities

- Planning of field activities
- Data collection in Malindi, Kipini and Ngomeni
- Data analysis and report write up

Main findings and conclusion

The Malindi-Ungwana bay is important in the marine fishery production in Kenya due to the shallow bathymetric formation and the freshwater, nutrients input by Rivers Tana and Sabaki. The two river deltas are the only parts of the Kenya coast that can be trawled. Four semi-industrial trawlers have been landing between 300 and 600 tones of prawns between 1998 and 2002. However, prawn trawling has been characterized by conflicts mainly between the prawn trawlers and the artisanal fishers, conservation organizations and other stake holders, culminating in stoppage of trawling in September 2006 by the government, to protect the ecosystem, fishery and artisanal fishery. Consequently, a need to assess the status of the fishery and monitor fish production, fishing activities and associated changes in the social status of the fishing communities, to inform future management interventions, was realized.

Information available on the artisanal fishery so far, from Fishery Department statistics landing, landings records of several fishers in Malindi, as well as data collected during KMFRI field expeditions at landing beaches between June 2007 and June 2009 are examide to provide insights into the status of the fishery. Fishery Department statistics for Malindi, Ngomeni and Kipini show no remarkable change in prawn landings after removal of the trawlers in 2006. Biological data show that the bulk of prawns in the artisanal fishery were juveniles and were smaller during the SEM than during the NEM.

Field data collection on fish identified over 240 species in 84 families, dominated by siganidae, scombridae, lutjanidae, lethrinidae, clupeidae and mugilida during the study period. Among the common fishing gears, troll lines and hook & lines selected larger fish, over 60cm mean size, *jerife* basket traps selected medium size fish with mean 40-60cm, whereas gillnets, monofilament seine nets and beach seines caught fish with mean size of about 20cm. Daily fish landing were approximately 10Kg for canoes using gillnets as well as hook & lines, and 40-50Kgs for *ngalawa* and

mashua using gillnets as well as hook & line. Examination of fish landing records taken by fishers between 2004 and 2008 show catch per unit effort has decline of between 70-80% in 5 years. Monitoring of fish landings, fishing effort and gear use, as well as examination of biological data to determine changes in the resource, provide production estimates and evaluate changes in the fishery is recommended.

Challenges

- Funding was only available for two excursions this financial year: December 2008 and June 2000 instead of the 4 excursions planned.
- The anticipated KCPD prawn trawl sampling did not come online as expected. There is therefore no comparative data between artisanal and trawler landing data to determine if the two fisheries depend on the same stocks.

2.2 PROJECT 2: Artisanal Fisheries Catch Assessment along the Kenya Coast

Participating institutions: KMFRI

Scientific team members: Gladys Okemwa, E. Fondo, E. Kimani, P. Loki, N. Gichuru

Source of funds: GOK

Duration: 5 years

Research Problem

It has been well documented that artisanal fisheries yield have been declining. KMFRI initiated a catch assessment monitoring programme in September 2001 to assess trends in fish landings. This project was initiated to provide continuous feedback on the status and utilization of fisheries resources in order to provide a basis for effective fisheries management.

Objectives

The main aim of the project is to assess exploitation of fisheries resources by artisanal fishermen and determine the variability in gear use and productivity based on catch assessment surveys conducted on selected landing beaches

Activities

During the year, main activities involved collection of data by KMFRI data enumerators, data entry and analysis. In addition, 6 measuring boards were fabricated for use in the field.

Brief site description and methodology

The research is based on daily fish landing data collected by KMFRI enumerators. The enumerators randomly interview fishermen at the auction sites in the designated landing beaches. During the interview, a questionnaire is completed for each individual fishing trip where information on the fishing activity is collected. This includes type of gears used, nominal catches (kgs), fishing effort (number of crew), fishing grounds visited, composition of species groups and fish sizes is collected. The information is then filed and processed onto a database for further analysis. The landing data is used to characterize annual and seasonal variations in the selected fisheries by focusing analyses on estimation of gear variations in catch (kg vessel $^{-1}$ trip^{-1}), catch per unit effort (kg fisherman^{-1}, day^{-1}).

Main findings and conclusion

This report provides an overview of Kenya's coastal artisanal fisheries based on catch assessment surveys conducted by the Kenya Marine and Fisheries Research Institute in selected landing sites in Vanga, Shimoni, Msambweni, Gazi, Diani and Lamu from 2001 to 2008. Fish landings were recorded, and fisher interviews conducted to monitor seasonal and annual changes in catches. Monsoon seasons were a major driver of seasonal differences in landings, which were higher during the northeast monsoon than during the southeast season. The mean catches also exhibited high variability between fishing grounds which were also influenced by the gear and vessel types used. Catch Per Unit Effort CPUE) from lema traps at Msambweni, Vanga, Diani show no changes during the study period whereas, catch per unit effort from gill nets increased in Shimoni, Vanga, and Msambweni. Fishers in Lamu using handlines landed significantly higher catches compared to those fishing in the southcoast of Kenya. Annual CPUE data also varied from place to place. Fishing effort data was used to estimation of total landings. Distinct management initiatives through ongoing co-management measures are encouraged due to the unique biophysical and socioeconomic characteristics of the different fishing grounds. The information provided here gives a framework for a rapid assessment of artisanal fisheries dynamics at the Kenya coast.

Challenges

Administration and Staffing

- The number of staff working for the project drastically reduced from 18 to 5 enumerators since with some sites only having one enumerator. The reduced capacity in enumerators has drastically affected the data quality and coverage resulting in data gaps.

- The accessibility of some landing sites also affected data collection. It was recommended that enumerators be facilitated with bicycles to ease daily commuting to far off landing sites in Diani and Msambweni.

2.3 PROJECT 3: Cephalopod Fishery in the South Coast of Kenya

Participating institutions: KMFRI

Scientific team members: KMFRI- SOUTH COAST PROJECT

Source of funds: GoK

Duration: 1 year

Research Problem

There has been increasing attention on 'non-conventional' marine resources which include cephalopods. The south coast of Kenya is one of the areas where Cephalopod fishery is active. In

Kenya, there is limited information on Cephalopod fishery and this information is important in the management of the fishery.

Objectives

- To assess the exploitation trends of Cephalopod in the area
- To analyze the Cephalopod landings and effort
- To analyze the population structure and morphometric parameters

Activities

- Field survey
- Field sampling and data collection
- Data analysis and writing

Brief site description and methodology

This study was conducted in the South coast area of Kenya in Vanga and Shimoni. Data on landings of Octopus and Squids was collected from the Fisheries Department Office in Vanga and Shimoni. Information on cephalopod fishery in the area was collected by conducting interviews with the cephalopod fishers and agents of companies exporting seafood. Samples of octopus were taken and the total length measured, and weight of individual octopus taken. The annual total landings and the mean monthly landings were plotted for both areas. The length-frequency distribution and total length-weight relationship were done using Excel.

Main findings and conclusion

Cephalopod fishery is very active in the south coast of Kenya. Some women are also involved in the fishery in Shimoni area. The main gears for fishing octopus are spearguns and pointed sticks. Squids are mostly caught as by catch in fishing nets. Landings are seasonal with high landings during the north east monsoon and low catches in the south east monsoon period. The rough waters and poor visibility during the south east monsoon season contribute to the low catches. Some of the fishers go fishing on foot, to fish in the shallow areas, while the majority goes as crew in motor boats owned by the fishing companies or agents. Sail boats, outriggers and canoes are also used.

Trends show that there has been a general increase in Octopus and squid landings over the recent years. The CPUE in Vanga ranged from 5.33 to 6.52 Kg/fisher while that in Shimoni ranged from 4.80 to 6.04 kg/fisher. The length-frequency distribution for Octopus showed a peak at 60-69.5 cm total length.

There has been a gradual increase in the octopus landings in Vanga, up to 75 tonnes in 2007. In Shimoni, octopus landings were high in 2002 (140 tonnes) but dropped from 2003. Considering that the fishermen from Vanga and Shimoni share common fishing grounds it is likely that octopus landings from 2003 shifted from Shimoni to Vanga where there was a sudden increase in octopus landings in 2003 and have remained high compared to Shimoni. A similar pattern was also exhibited by the squid landings, with a drastic decrease in 2003 in Shimoni, but an increase in Vanga in the same year. Generally, squid landings exhibited fluctuations especially in Vanga.

2.4 PROJECT 4: Incorporating reef fish spawning aggregations into optimal designs for no-take fishery reserves: Strengthening fisheries management and coral reef resilience in the Western Indian Ocean

Participating institutions: KMFRI, CORDIO, SFA AND IMS

Scientific team members: Mr. Jan Robinson, Dr. Melita Samoilys, Dr. Narriman Jiddawi, Mr. Simon Agembe

Funding: WIOMSA
Duration: 2 YRS

Research Problem
Certain biological and ecological information for the key fishery species, including an understanding of the mobility that results from spawning migrations, is required for designing the size, location and other attributes of MPAs. This information is largely lacking in the WIO. However, existing knowledge of spawning aggregations of two key taxa that are important subsistence and artisanal fisheries in Seychelles and Kenya, the rabbit fish and groupers, provides a significant starting point for designing fishery reserves.

Objectives

(1) Define the spatio-temporal dynamics of spawning behaviour of key fishery species that form spawning aggregations;

(2) Determine management requirements for spawning aggregations with a focus on optimal designs for no-take fishery reserves and to assess the role of MPAs in managing species that aggregate to spawn;

(3) Raise awareness and develop policy advice relating to the management of reef fish spawning aggregations at national, regional and global levels.

Activities
Activities have generally proceeded according to the plans given in the full proposal. Here, I summarise the activities conducted to date by work programme (WP)

Biological and Fisheries Studies

Fisher knowledge (FK) and creel surveys

Spawning aggregation verification and dynamics

No-take Reserve Design and Assessment

Brief site description and methodology
Based at 5 study locations in Kenya, Seychelles and Zanzibar, the project focuses on 3 species of groupers (*Epinephelus fuscoguttatus, E. lanceolatus and E. polyphekadion*) and a rabbitfish (*Siganus sutor*) which are fished at the study locations. In Msambweni, Kenya Key question(s): Is there a need

for collaborative management of the rabbitfish trap fishery in the Msambweni area through protecting spawning aggregations of S. sutor?

Main findings and conclusion

The *E. fuscoguttatus* gonads collected in March were all fully hydrated and indicate that spawning occurred in that month. *Siganus sutor* were found spawning in the months February and March while in April most of the fishes were found spent.There are still some difficulties with identifying *Siganus sutor* and *Siganus canaliculatus*. We are hoping to validate our identifications with genetic analyses through another CORDIO project (Dr Visram). We are developing a photographic id key for field recorders. We have progressed with developing a conceptual management model for spawning aggregations which consolidates the objectives and project activities at site level and defines an approach to *optimising* management of these vulnerable life history stages and critical habitats in the WIO. The project aims to finish the preparation of two scientific papers for submission to peer reviewed journals

3.0 WORK PACKAGE 2: Assess the potential and develop adaptive aquaculture technology

3.1 PROJECT I: Experimental scale culture of finfish and crustaceans: a systems development for community aquaculture on the Kenya south coast

Participating Institutions: KMFRI**,** Fisheries Department

Scientific Team Members

Scientific Team: Betty Mindraa Nyonje, Charles Gatune (Fisheries Department), James Mwaluma

Technical team: Dan Odiwuor, Nora Magangi, Mwendwa Mbaluka

Source of Funds: GOK Seed Fund

Duration: 1 year

Research Problem:

The decline in capture fisheries which is a world wide problem has had a negative impact on the livelihoods of the fisher communities in the South Coast of Kenya. The fishermen have reduced income due to fewer landings of fish, and in some cases switched to alternative ways of income generation and their families have less fish to eat as well. While it is an indisputable fact that coastal aquaculture has the potential to offer diverse benefits to resident communities, the development of aquaculture into a viable industry is yet to be realized in Kenya. The aquaculture component of the South coast project was initiated to partly offer some answers by way of supplementing fish production through community efforts.

Objectives

The two principle objectives of the study where

1. Identification of suitable site, communities and local species for development of systems for community aquaculture
2. Transfer of appropriate technology to local communities

Activities

1. Site selection
2. Survey of sites selected for pond construction
3. Pond construction
4. Stocking of ponds with fish
5. Monitoring of growth of fish
6. Harvesting

Methodology

A survey was carried out and five sites visited in the South Coast, three potentially for mariculture and two for brackishwater/freshwater aquaculture. One site on the Western creek (Gazi) was chosen for mariculture and Madongoni village on Maumba river was chosen for freshwater aquaculture. The selected sites were surveyed in respect to the elevations for pond construction. Pond construction on both the marine and freshwater sites were carried out with intimate involvement of the communities from start to finish. On the marine site, pond construction was not completed due to unforeseen circumstances. On the freshwater site after completion the ponds were limed, fertilized with manure and stocked with catfish fingerling at a stocking density of 10-20 fish/square meter. The fish were fed a combination of chicken mash and maize germ and their growth monitored on weekly basis.

Main findings and conclusion

The primary objectives of this study were realized at least in the fresh water site in Madongoni village. The enthusiasm with which the residents of this village received this new venture was translated into the effort they put in learning the new technology. On the other hand the strong relationship established between the scientific team and the community will go a long way in aquaculture development in this area (South Coast of Kenya). By the time of completion of the ponds, there were already several requests from other village elders and individuals who had land which they wanted converted to fish farms with the technical assistance from the scientific team.

This positive impact on one community even before the actual harvesting of fish has been achieved is a good indicator for future prospects of spurring aquaculture development in Kenya through community groups.

The average cost for the construction of a fish pond of approximately 200 sq. meters during this venture totaled about Ksh. 60,000. The labor for this community ponds at the construction level has been factored within the cost of pond construction. For maintenance of these ponds during grow out period labour could be costed at 2,500 per month, which totals Ksh.15,000 for six months (the period for rearing one crop of fish) . Feeds to be used for this type of community fish ponds for the long term are planned to be formulated from cheap ingredients like agricultural wastes that should not bear heavily on the production cost for the communities.

For high density stocking rate of catfish at 20 fish per sq. meter the cost of fingerling would be Ksh. 20,000, the production in such a pond can reach up to 600 – 800 kg if the fish are grown to a size of 150 – 200 g. With such a scenario, considering an average cost of Ksh. 120 / kg, a pond of size 200 sq meters should be able earn about Ksh. 70,000 per crop of fish harvested and a farm the size of the Madongoni community farm could fetch a gross income amount of Ksh. 150,000 to 200,000.per crop. The earnings for this type of farm would be Ksh. 300,000 to 400,000 if two crops are reared in one year. A remarkable growth rate of 1.5-2.0% Bw/d was recorded in the catfish stocked. However there were some serious challenges attributed bad quality seed that was obtained from one of the government seed production centers that led to substantial (up to 80%) loss of the fingerlings due to cannibalism. The second serious challenge the project faced was the drying up of the river for the first time as attested by the residents of the area. The drought the preceding year was unprecedented. A well was sunk to remedy the situation until the rains for the next season came.

However rains failed again for the second year in this particular area. As such the project could not be revived this during the last fiscal year. The Mombasa station had embarked on production of its own seed of catfish to stock these community ponds; however this project was also faced with several challenges including shortage of water, inadequate fish holding units and high larval mortality. A borehole was recently sunk for to ensure a reliable water supply for aquaculture activities within the wet laboratory. Experiments that were started after an adequate and reliable water supply are already showing more promising results. The community project will be resumed once the water supply challenge has been overcome, in order to achieve its other objectives

The study though not fully accomplished so far shows that communities could be mobilized and introduced to fish farming as an alternative livelihood activity. It thus gives a good indication for aquaculture development through coastal communities. The main setback currently is the unprecedented drought that has afflicted the area, and many parts of the country which raises concerns about the sustainability of inland aquaculture with respect to the current global climatic change. More critical analyses of future inland projects are required.

On the marine site in Gazi, the project did not resume due to the fact that there was originally a suggestion to merge it with a UNDP funded community project. The community however declined the offer for a combined project and preferred a separate one. Plans for an EIA for this community mariculture project are underway. Once funds are available this project will resume. This mariculture project is the more sustainable of the two community finfish projects as seawater is reliable and available throughout.

3.2 PROJECT 2: Development of a seed production capacity at the Mombasa wet laboratory

Participating Institutions: KMFRI

Scientific Team: Betty Mindraa Nyonje, Mark-Kyenze Mutuku, Kobingi Nyakeya

Technical Team: Dan Odiwuor, Nora Magangi, Johnson Nyamari, Mwendwa Mbaluka

Source of Funds: GOK Seed Fund

Research Problem

Seed production capacity: The capacity to produce quality seed in quantities that are sufficient and reliable to promote culture of diverse marine and freshwater organisms is grossly inadequate within the coastal region. Capacity under this factor can further be broken down into infrastructural capacity, inadequate technical knowledge to cover different species that present potential in this field, and funding. Although fish production through aquaculture on the global scale has averaged close to an impressive 50%, Kenya's contribution in the sector has remained largely insignificant; producing a meagre 4,250 mt of farmed fish which accounts for about 3% of its total annual fish production. One of the greatest limitations to the development of fish farming in Kenya has been the lack of good quality seed in reliable supply. One of KMFRI's Aquaculture Research Program's main focus is therefore to develop the capacity to produce good quality seed.

Objectives

1. To produce seed (fingerlings) for Tilapia and Catfish
2. To conduct experimental spawning of marine finfish
3. To establish the availability of wild marine finfish seed in the targeted locations

Methodology

During this fiscal year efforts were devoted to production of catfish seed. Catfish broodstock were obtained from KMFRI's selective breeding program in the Sangoro Aquaculture Research Station. Gravid females were conditioned for one to two weeks and there after induced to spawn using fresh catfish pituitary extract. Females were stripped after about 12 hours and eggs were fertilized using milt from sacrificed males. Hatching started after 12 hours at an average temperature 27 – 28^{o}C and was complete within 36 hours. The larvae were kept in glass aquaria and fed Artemia nauplii for two weeks before being transferred to nursery

Main findings and conclusion

Up to 10,000 larvae were obtained from five successful induction experiments. However only one of the experiments successfully produced 1,500 juveniles that were trnaferred to the nursery pond. In this experiment up to 80% survival rate was obtained within the first two weeks. Survival rate dropped with age/time and by the week 8 only 50% of the original larvae were surviving. During the subsequent experiments success rate dropped drastically due to a major challenge of lack of reliable water supply. Experiments started on a number of occasions failed simply because the water taps ran dry. Two other great challenges as identified from the beginning with respect to larval survival was cannibalism and the right weaner feed. Currently there is no feed available for weaning the catfish young from live feeds on which they are feed during the first week of feeding. Quality control of the hatchery conditions is another challenge since a recirculation system to provide for a biofiltration of culture water is still not in place. Space was also limited for the nursery stage catfish. A borehole has been sunk to remedy the water shortage problem and 20 (2,000 l capacity) plastic tanks have been procured to alleviate the fish holding space problem. Experiments conducted after a reliable supply of water was ensured seem more promising. Substantial funds are needed to fix the hatchery into appropriate working condition with a recirculation system having both a biofiltration nad UV disinfection unit. Only then can we ensure proper conditions for larval handling but more importantly start work on marine species.

3.3 PROJECT 3: Formulation of nutritionally sufficient and affordable feeds for aquaculture

Scientific Team Members

Scientific Team: Betty Mindraa Nyonje, Mark-Kyenze Mutuku, Kobingi Nyakeya

Technical Team: Dan Odiwuor, Nora Magangi, Johnson Nyamari, Joseph Omondo

Mwendwa Mbaluka

Source of Funds: GOK Seed Fund

Duration: 1 year

Research Problem

50% of the cost of production in fish farming being attributed to feeds, mainly because of the use of animal protein particularly fish meal.The use of fish meal for fish feed formulae is also controversial due to the high demand of fish for human consumption. It is therefore vitally important to find means of producing feeds that would make fish farming profitable by producing feeds from locally available cheap ingredients. Currently there are no readily available and affordable feeds for fish farmers in Kenya. Research into appropriate and low cost feeds or feeding regimes is therefore paramount for aquaculture development. Another issue in respect of availability of affordable feed is the inadequacy of both human and infrastructural capacity to conduct research as well as to mass produce feeds needed for aquaculture development.

Objectives

1. Establish nutritional content of locally available and cheap feed ingredients through proximate analysis
2. Formulate feed for target species using cheap local ingredients
3. Conduct experimental testing of feeds

Methodology

The project focuses on locally available by-products particularly agricultural wastes. Feed formulation process involves quantification of the amounts of ingredients needed to form a single uniform diet in a proportion necessary to provide the organism with proper amount of nutrients. The feed formulae is based on the target protein level required by a particular species. Protein levels are determined by the standard micro-Kjedahl Nitrogen methos or by extraction in a Soxhlet extractor. Growout diet consisting of 30% protein and a starter diet of 35% protein have been formulated from *Caridina niloticus,* cotton seed cake and wheat bran/maize germ. The Pearson's Square method was used for calculation of the quantities of the different ingredients. For the starter diets the feed ingredients were sieved using fine mesh while for growout diets the particles sizes were relatively large. The ingredients were weighed according to the quantified amounts and mixed to get a uniform feed. This was then either fed to the fish directly or pelletized and dried.

Main findings and conclusion

The diets formulated are already being used for feeding catfish and goldfish within Mombasa laboratory. The pelletized and dried feeds are more convenient to use and store than the originally used agricultural by-products. It is also cheaper than buying or procuring feeds from inland stations. Feed testing experiments are yet to be carried out for these and other diets that are under formulation. The main challenges faced here are

1. The equipment for proximate analysis need repair
2. Expansion of fish holding units but ideally establishment of a mariculture research station to be able to establish laboratories and have enough pond and tank space for different experimental set-ups
3. Funding

3.4 PROJECT 4: Development of a demonstration/experimental seaweed nursery for *Kappaphycus alvarezi* (cottonii) and *Eucheuma denticulatum* (spinosum) in the South Coast of Kenya

Participating Institutions: KMFRI, South Coast CBOs, FMC (A seaweed buying company)

Source of Funds: ReCoMaP

Duration: 1 Year

Research Problem

Seaweed farming has benefited coastal communities in many parts of SE Asia and is well developed in Zanzibar and Pemba, neighbors of Kenya. KMFRI established experimental farms in Gazi & Shimoni in the South Coast for two species of seaweeds; *Kappaphycus* (cottonii) and *Eucheuma* (spinosum) and a remarkable achievement was made in the evaluation of the technical feasibility of farming these species in the two sites, but the same effort was never translated into a viable commercial seaweed industry due to the lack of a market link. The current project endeavors to develop a community seaweed nursery with the establishment of a market link with a seaweed buying company which assures a ready market for the expected products.

Objectives

1. To develop a seaweed nursery/small scale demonstration farm for *Kappaphycus alvarezi* (cottonii) *and Eucheuma denticulatum* (spinosum)
2. Establish growth rates for assessing commercial viability
3. Assess the effect of shocks during a 12 month natural cycle

Brief site description and methodology

Four potential sites have been identified for the development of the seaweed nurseries in the South Coast of Kenya. Kibuyuni, Mkwiro, Funzi and Gazi bays which lie within the Msambweni – Vanga area between latitude: 4°30'- 4°35'S and longitude 39°22' - 39°22'E. Within this area lies the Wasini Channel and Majoreni-Vanga bay complex, covering an area of about 150 $km^{2.}$ The study area is basically a low-lying coastal plain submergent complex dominated by an extensive cover of mangrove forest, intertidal areas covered with seagrass beds and shallow water lagoons harbouring the coral reef.

Gazi has a good potential for both spinosum and cottoni. Funzi Island has a good potential for spinosum and is expected to be the best place for cottoni. The socio-economic aspects are promising; preceding commercial trials left 30-50 trained women. Kibuyuni village with about 500 people has a good potential for both spinosum and cottoni. There is an existing Filipino strain spinosum left over from experimental work done by KMFRI. Mkwiro village in Wasini Island with a population of around 1,500 people has a good potential for cottoni and spinosum. The socio-economic prospects are promising in all these villages. The broadcasting, net (LAG) and off bottom methods are the farming techniques chosen for this demonstration. The off-bottom technique is applied in the shallow areas in the intertidal zone which are often exposed during low tide. Cultivation lines of about 50 m long are strung between mangrove stakes pegged into the substrate. Seedlings of 50-100gm are tied to the ropes 20cm apart. The LAG method involves the use of a large net which is staked out on the bottom. Seedlings are placed under the net at a density of 25/sq meter. The broadcasting technique uses fist sized limestone rocks to which seedlings are attached using rubber bands. In all cases community sensitization is to be conducted through public Barazas before the on set of the project. For Kibuyuni and Mkwiro villages such community workshops have been held. In Kibuyuni, three model demonstration farms have been set using the three methods mentioned above. A 1,500 meter long nursery of the off-bottom, 600 m^2 farm of the LAG and a model farm with 15,000 seedlings using the broadcasting method have been set with the participation of four community groups. The planted seedlings in each demonstration farm are left to grow for six to eight weeks and then harvested by picking them off the rocks, nets or ropes respectively, leaving behind some attachment to re-grow. The set-up of the three nurseries has just been completed in the month of July, an experiment for assessment of growth and shocks for a twelve month period during every spring low tide is underway. An Environmental impact Assessment has also been carried out for the areas targeted for seaweed farming in the four sites and stakeholders views on the project has been gathered.

Main findings and conclusion

The response of the communities in Kibuyuni, Mkwiro and Funzi during the sensitization barazas, and training workshop for Kibuyuni and Mkwiro as well as stakeholders workshops in respect of the Environmental Impact Assessment was very encouraging. From the attendance of the Baraza, the community showed great interest in the project. Participation in the Barazas and training workshop included the whole spectrum of the community from the youth, women and the men. All issues were discussed and ample time was availed for all members of the community to raise their concerns and any other issue pertaining to the project.

Seaweed farming is considered a relatively benign activity compared to other mariculture activities. The potential impacts of seaweed farming include changes in patterns of sedimentation and water movement, erosion, depletion of nutrients and alteration of natural habitat prior to planting. The relatively small-scale farming activities at the nursery are expected to have minimal environmental impacts. On the other hand, commercialization of the project will entail expansion of the area under seaweed which has the potential of increasing the extent of environmental impacts in space and time. Overall, the development of commercial seaweed farming will entail trade-offs and adaptation with respect to ecological effects and socio-economic impacts.

The start of the actual nursery in Kibuyuni went beyond expectation. Originally only one nursery of 500 meters was planned to be set up. But due to the response from the community three nurseries of 500 meters each were set instead. The nurseries are co-managed by four community groups participating in the exercise and the scientific team from KMFRI. Three main harvesting exercises and several minor ones have been carried out. A small percentage of these harvests have been dried but the majority of the harvested crops have been used as seed for planting the Lag and the broadcasting farms. Scientific monitoring of growth and environmental parameters as well as the assessment of the effect of shocks including pest species, herbivory, freshwater runoff and spikes in seawater temperature were not carried out during this first phase of the set-up of the nurseries due to a number of challenges ranging from the lack of the appropriate equipment to the fact that the time scheduled for the completion of the nurseries was surpassed partly due to logistical problems but also due to the fact that during several spring tides the water level was too high to permit work on the LAG and broadcasting methods. The joint venture with the four community groups in Kibuyuni is meant to empower members of these groups in such a way that they would be able to operate as individual farmers by the time of the maturity of the demonstration farms. The project is expected to be a precursor to the establishment of a commercial seaweed industry. A collaborative proposal has been developed between KMFRI and a local NGO to support the development of commercial farms within these communities. The seaweed farming initiative is also enlisted for support in two other major projects; the Kenya Coastal Development Project (KCDP) and the Kenya Coastal Mariculture Development Project are expected to start within one year. A manual for seaweed farming as well as Guidelines for Cultivation Seaweed in Kenya are being developed.

4.0 WORK PACKAGE 3: Developing techniques for reducing post-harvest losses

4.1 PROJECT 1: Solar drying technology for fish drying in the Tana delta region

Participating institutions: KMFRI & JKUAT

Scientific team members: Peter Michael Oduor-Odote-KMFRI, Prof. Douglas Shitanda- JKUAT

Source of funds: GoK

Duration: 2 years

Research Problem

One of the main methods of choice for traditional fish preservation in the Tana delta region is sun drying. Such drying methods are slow, require high labour intensity especially during unpredictable weather where fish has to be brought inside, insect infestation is high during drying, bird and rodent attack is common and contamination from other animal wastes are unavoidable. All this leads to lower quality dried fish that fetch lower market price hence low income to the fisher-folk, food insecurity and survival in a perennial poverty cycle. The introduction of improved drying technology by using a solar tunnel dryer in Moa village on a pilot basis for fish drying provides an opportunity for fish to dry faster to lower moisture levels hence longer shelf life, no insect infestation or rodent and bird attack during drying and no contamination by any other animal waste. The fish shall be of better quality, fetch a better price in the market hence better income to the fisher-folk, better food security and contribute towards poverty alleviation. The dryer shall also be used to dry other farm produce for the market.

Objectives

To develop and test a functional solar tunnel dryer for drying fish in Moa in the Tana delta region

Activities

a) Preliminary discussions with Moa BMU members on site selection
b) Discussion on design of the solar tunnel dryer and contractual terms for construction

Brief site description and methodology

Moa village which is in the common borders of Tana River /Lamu District lies 4 km off the Garsen-Witu road on your way to Lamu. It is an area made up of a fishing village within which exist several mini fishing villages in homestead clusters based on common ethnic backgrounds. The fish commonly landed are freshwater catfish, mudfish, Tilapia and marine catfish. The fabricated sand base solar powered dryer shall be composed of a collector, a drying cabinet and the power source. The collector shall be well insulated to prevent heat loss using coconut fibre and shall be composed of the inlet chute and the collector tunnel. It shall be covered at the top with UV treated polythene to facilitate the penetration of heat into the collector chamber. The bottom of the collector shall be painted black to convert solar radiation into heat energy. To facilitate the movement of heat energy into the drying cabinet, the collector inlet chute shall be fitted with a fan to blow air across the hot plate.

At the end of the solar collector shall be a drying cabinet, which shall be used as the actual drying chamber. The drying cabinet shall have a 150 kg drying capacity. It shall be fitted with mild steel trays that are the receptacles for fish drying. At the exit of the drying cabinet shall be an exhaust chute, which removes the moisture laden exhaust air from the dryer. This exhaust chute like the inlet chute shall also be fitted with an exhaust fan to suck air out of the drying cabinet. The dryer cabinet shall be covered at the top with glass to facilitate easy penetration of solar radiation for fish drying. The walls of the cabinet shall be modified into doors for ease of loading and unloading of the dryer during each drying session.

The power source for the two fans, which induce forced convection in the drying system for the purpose of fish drying shall be composed of a 100W solar module connected to a charge controller and a deep cycle battery of 80 Ah. The two fans, the inlet and the exhaust fan shall be connected in parallel to the solar module and the battery. Hence, from such a connection configuration, the panel and the battery shall power the fans either individually or in a combined mode.

Main findings and conclusion
Construction work is to continue in year 2 of this project. Currently the preparations have reached the contractual stage and the contracts have been signed by both KMFRI and JKUAT. A down payment of commencement of work has been issued.

4.2 PROJECT 2: Improved fish smoking in the Tana – Delta region

PARTICIPATING INSTITUTIONS: KMFRI

SCIENTIFIC TEAM MEMBERS: Peter Michael Oduor-Odote-KMFRI

SOURCE OF FUNDS: GoK

DURATION:

3 years

Research Problem
The fishing communities in Tana Delta/ Lamu Districts mainly use sun drying and fish smoking as a means of fish preservation and to reduce post harvest losses. Traditional fish smoking ovens used consume higher wood fuel posing a threat to wood forest cover, they have low smoking capacity and the fish smokers incur higher wood fuel costs. The women involved in fish smoking with children tied to their backs experience lots of smoke in their eyes, suffer burnt fingers, inhale a lot of smoke and are therefore at a health risk. The final moisture content in the fish is high after smoking leading to shorter storage times. The smoking process is labour intensive (does not appeal to the youth). A lower quality fish with limited market circulation and low income generation is produced. The introduction of a few *clay- walled* double door improved fish smoking ovens in the area by KMFRI with some partners supporting research like WIOMSA on a pilot basis has stimulated interest in the ovens.

This is because the improved fish smoking ovens reduced wood fuel costs and wood fuel consumption by about 60%, had a greater fish smoking capacity, were more hygienic and produced better quality fish for the market with longer shelf life among other advantages. The demand for these ovens is high in the villages among the community members.

Objectives
Strategize on how to get funds for construction of more fish smoking ovens

Activities
Organize 2 workshops on strategies for fund raising for construction of more ovens

Brief site description and methodology
Moa village which is in the common borders of Tana River /Lamu District lies 4 km off the Garsen-Witu road on your way to Lamu. It is an area made up of a fishing village within which exist several mini fishing villages in homestead clusters based on common ethnic backgrounds The Luo, Luhya (Manyala), Wasanya Ormas and Pokomo dominate the fishing villages. It is an area also home to many wild animals like hippos, buffalos, worthogs etc. The fishing area is one of the ox -bow lakes

along Tana River. The fish commonly landed are freshwater catfish, mudfish, Tilapia and marine catfish. Through the letters of appeal and brainstorming workshops with stakeholders organized by KMFRI in Garsen to seek further funding, the stage was set for responses from potential donors.

Main findings and conclusion

After the introduction of the first improved fish smoking oven in Moa in 2005 by KMFRI, there has been a growing demand for more such ovens in the region

The original demand for improved fish smoking ovens in the Moa area stood at 300 though this was reduced to clusters of 13 each containing 6 *block-walled* ovens each that are to be shared. KMFRI alone however could not meet the demand for construction hence the appeal to partners in the private sector to join and assist in construction of more improved smoking ovens in Moa.

In response to such demands, The ***Safaricom foundation*** in true **private public sector partnership** accepted to sponsor construction of a cluster of 6 improved double door *block-walled* ovens in Moa. This was as a result of strategy meetings and 2 workshops held to request for funding.

This was also a unique opportunity for funding a direct technology transfer from KMFRI to the community. The outcome is a showcase of direct improved livelihoods for local communities. KMFRI is now able to address technology transfer to the local communities using improved fish smoking technologies that to help ameliorate poverty, food security and contribute towards environment conservation.

4.3 PROJECT 3: To develop and test efficiency of a Dome dryer in Vanga

PARTICIPATING INSTITUTIONS: KMFRI & JKUAT

SCIENTIFIC TEAM MEMBERS: Peter Michael Oduor-Odote-KMFRI

SOURCE OF FUNDS: GoK

DURATION: 3 years

Research Problem

The fish that are dried using traditional methods in Vanga include shark, rays and sardines among others. The methods however yield low quality products. The sharks obtained fresh, gutted, salted, wrapped in nylon and buried in the soil for 3 days. Upon removal from the soil it is washed in seawater to remove salt and dried in the sun for 2-3 days when they are attacked by maggots. Fish that travel in shoals like sardines pause a challenge during processing as they appear once in large numbers and if not processed quickly lose quality and go to waste.

The local community fish processors involved in fish drying however complained that the time taken to process the fish till drying is long. During poor weather conditions especially when it is wet, they complain of slow drying rates, insect infestation if the fish is not well dried and strong odour from

some fish like “Kole Kole” and Kingfish irritate the throat. There is also lack of space for drying when there is a bumper harvest. They no longer want to dry fish on the ground.
Proper methods of curing like solar drying would therefore play an important role in converting the fresh perishable fish into relatively shelf stable products that enjoy high demand.

Objectives
To develop and compare performance of 2 dome dryers of different sizes and a drying rack in Vanga

Activities
Study drying characteristics of selected sardine species

Brief site description and methodology
The study site was in Jasini village in Vanga. The village lies 5 km off the Lunga-Lunga Vanga road and along the Kenyan-Tanzania border. Marine sardines were purchased in Jasini village in Vanga. One of the local fishermen who fish at night was contracted to land fresh sardines. They were given two Coleman ice boxes of one hundred litre volume each containing crushed ice and were instructed to transfer a suitable quantity of sardines immediately upon hauling out of water into the ice boxes with ice to maintain freshness.

One third each of the salted and unsalted *Sardines* was placed in clearly demarcated areas in the big dome dryer, small dome dryer and rack taken from one of the dome dryers. They were labelled as salted sardines Vanga Big dryer (SSVBD); salted sardines Vanga small dryer (SSVSD) salted sardines Vanga Rack (SSVR); unsalted sardines Vanga Big dryer (USVBD); unsalted sardines Vanga small dryer (USVSD) unsalted sardines Vanga Rack (USVR)

From each batch of fish being dried, 6 fish were identified at random and their weight and thickness determined at the start of drying. Weight loss was measured every 2 hours and thickness after every 4^{th} hour from the fish. *These fish were returned back to the same position each time after weighing.* The measurements were stopped when no further change in weight were observed in 3 consecutive readings. The final product was removed, allowed to cool for 1 hour in unused tray then wrapped in aluminium foil, placed in polythene bags, labelled clearly, put in ice and transported to KMFRI then placed in a freezer till moisture analysis. Drying characteristics and storage characteristics like moisture evolution were determined.

Main findings and conclusion
Data analysis is still continuing to evaluate difference in drying characteristics of the fish under the set conditions. Optimization of production conditions for value added dried sardine products is still to continue for one more year.

4.4 PROJECT 4: Up scaling of Improved Fish Processing by Smoking and Solar Drying to Shimoni in the Kenyan south coast for Food Security, Poverty Alleviation and Biodiversity Conservation (PHASE III)

PARTICIPATING INSTITUTIONS: KMFRI & JKUAT

SCIENTIFIC TEAM MEMBERS: Peter Michael Oduor-Odote-KMFRI

SOURCE OF FUNDS: Lighthouse Foundation

DURATION: 2 years

Research Problem

Traditional fish harvests can suffer periods of excess harvest or glut, particularly during the peak fishing seasons.

Because most fishing communities do not have ice- storage facilities, the daily catch is either sold fresh to middlemen at exploitative prices or traditionally cured before it spoils.

Shimoni has a fish banda and freezers and serves all the other fishing centers around as a collection point. Power blackouts are however a problem.

During periods of high landings, the weather is hot and ideal for drying. The individuals involved in fish drying for external market concentrate on sharks that once dried are collected by their known agents. The process of drying however leads to poor quality fish. To help traditional fish preservation in Shimoni, a smoking oven was introduced though there is a very big demand for a solar tunnel dryer by the local community members. There was therefore need to replicate the improved fish processing system at Gazi by solar drying and smoking in Shimoni.

Objectives

To produce high quality smoked and solar dried fish for the local and wider national and international markets

Activities

a) Consultative meetings with the local community on site selection
b) Discussion on design of the solar tunnel dryer and contractual terms for construction
c) Smoking trials of marine fish using selected tree species and tree products

Brief site description and methodology

Shimoni is in the South coast of Kenya and lies about 19 km off the Mombasa-Lunga Lunga road. It is the second major fish landing site after Vanga. It is a multi-cultural area with Digos as the main tribe and a few settlers like Bajuni, waduruma and wapemba. The other landing beaches are Kibuyuni, Mkwiro, Kijiweni and Anzwani.

The construction of the dryer is at design stage. Smoking of Siganids was carried out using mangrove stumps, coconut husks, sawdust, Mathenge (*Prosopis*), *Acacia* and Neem tree. Parameters determined included drying rate, organoleptic evaluation, insect infestation, mould infestation and biochemical changes during shelf storage

Main findings and conclusion

On solar tunnel dryer onstruction, there is still nothing to report until construction works are completed 2009-2010 financial year. On fish smoking, data is still being analysed and shall be reported fully in 2009-2010 financial year.

4.5 PROJECT 5: Optimal use of different trees or tree products for smoking African and marine catfish to improve quality and conserve aquatic resources in Kipini and Tana-delta areas of Kenya

PARTICIPATING INSTITUTIONS: KMFRI & JKUAT

SCIENTIFIC TEAM MEMBERS: Peter Michael Oduor-Odote-KMFRI, Prof. Douglas Shitanda - JKUAT

SOURCE OF FUNDS: The Commission of Higher Education (CHE)

DURATION: 2 years

Research Problem

Fish smoking in Moa in the Tana delta region is used as a means not only for preservation but also for flavour and colour addition. Preservation of fish by smoking using improved *block-walled fish smoking kilns* introduced for the first time in Moa helps during periods of long rains which are accompanied by heavy landings of fish and during any other period when there is glut.

The coastal fishing communities face a period of fish glut between the months of November and March with excess catches going to waste and in some cases heavy landings is experienced at the beginning of the rainy season. They can easily adapt improved fish smoking methods to preserve their catches during such periods. When there is glut, fish storage is a problem due to lack of refrigeration and storage facilities for cured fish. Insect infestation becomes a problem within this period during storage. What is worse is even if storage facilities for cured fish exist in some cases, the period of April to July is when the cured stored fish would be required most so that people could rely on the stored excess fish. However, this is the time again that the weather is dump and insect infestation causes post harvest losses by attacking the stored fish. This makes fisher-folk resort to desperate control methods by indiscriminately using pesticides. Insects attack stored fish at all levels and all times during storage reducing quality. Incorporating wood –smoke from Neem tree in fish could probably be one way of introducing the insect repellant into the fish and by extension control insect infestation. Currently there is a lot of hue and cry on indiscriminate use of pesticides especially near food for human consumption. Use of bio-safe insect repelling products could provide an answer. Since the Neem tree has insect repellents, storage trials after smoking fish with its fuel wood to repel insects during storage is justified. Fish that is commonly smoked in the Tana River area is the African catfish. Landings of marine fish are also quite high in the neighbouring Kipini area and in Tana River area itself. Marine catfish is considered a low value fish and often discarded in Kipini area. Protein deficiency is evident in such areas and in Kenya in general. Utilizing a fish like the marine catfish that is considered of low value and adding value to it by improved fish smoking provides a chance of increasing protein availability and intake in the diet and introducing a new product in the market.

Objectives

a) To evaluate the fuel wood quality of some selected tree species or tree products

b) To evaluate quality of African and marine catfish fillet after smoking with the selected trees/ tree products

c) To evaluate Neem smoke in controlling insect infestation during storage of the smoked African and marine catfish fillet.

Activities

a) Consultative meetings with community members on construction site

b) Construction of block-walled improved smoking ovens

c) Evaluation of properties of selected wood fuel

d) Smoking trials of African and marine catfish fillet using selected tree species and tree products in block-walled ovens

e) Evaluation of shelf life of smoked fish fillet stored under field conditions

Brief site description and methodology

Moa village which is in the common borders of Tana River /Lamu District lies 4 km off the Garsen-Witu road on your way to Lamu. It is an area made up of a fishing village within which exist several mini fishing villages in homestead clusters based on common ethnic backgrounds The Luo, Luhya (Manyala), Wasanya Ormas and Pokomo dominate the fishing villages. Six *block-walled* improved double door fish smoking ovens were constructed based on recommended specifications. Marine and freshwater catfish were purchased and filleted washed, drained and distributed on 4 fish smoking trays corresponding with 4 tree products to be smoked and smoking commenced on the ovens. The fish fillets on each of the trays were labeled as follows- MCAF –(Marine catfish *Acacia* Fillet); MCPF –(Marine catfish *Prosopis* Fillet); MCNF- (Marine catfish Neem Fillet); MCCF- (Marine catfish coconut Fillet); (FCAF- (Freshwater catfish –*Acacia* Fillet); FCPF- (Freshwater catfish fish-*Prosopis* Fillet*)*; FCNF (Freshwater Catfish-Neem Fillet); and FCCF (Freshwater Catfish Coconut Fillet). At the end of smoking, the fillets were removed from the kilns and exposed to air to cool for 2 to 3 hours. The fillets were packed in labeled plastic open sided milk crates and transported for storage in the open on benches in KMFRI lab Mombasa (350 km away) for proximate composition, colour, and organolepic analysis. The tree samples were sent to KEFRI for quality analysis

Main findings and conclusion

This study is still continuing though some preliminary conclusions may be drawn. The tree commonly used for fish smoking in the Tana delta is *Acacia*. The performance of *Prosopis,* Neem and Coconut husks is commendable especially in terms of organoleptic properties like taste, texture, appearance and overall acceptability. There was no difference in taste and overall acceptability of the fish fillets smoked using the different trees. Freshwater catfish is commonly smoked in the North coast of Kenya while the marine catfish is sun dried. Introducing their smoked fillets as new value added products stand a chance in the market as they were organoleptically acceptable. The shelf stability is good considering that moisture levels were between 8 to 11% when stored for over 70 days. Thus they could be stored effectively under ambient conditions for over to 12 weeks before being rejected. All the fuel materials had burning and energy properties that were within acceptable ranges and the quantity of material required for smoking was not significantly different. Thus the abundant Coconut husks would be a convenient source of fuel for fish smoking. A progress report for the half year has been submitted

4.6 PROJECT 6: Development of an integrated solar tunnel dryer for fish drying along Lake Victoria

PARTICIPATING INSTITUTIONS: KMFRI, JKUAT, Sokoine University Agriculture, 2000 NETWORK UGANDA

SCIENTIFIC TEAM MEMBERS: Peter Michael Oduor-Odote-KMFRI, Prof. Douglas Shitanda – JKUAT, Prof. V.C. K Shilayo, Joy Bongyereire

SOURCE OF FUNDS: VIC RES

DURATION: 3 years

Research Problem

Traditional fish harvests in East Africa can suffer periods of excess harvest or glut, particularly during the peak fishing seasons. There is a long lapse in time from the point of catch to the fish landing points causing deterioration of the fish. There are high ambient temperatures at the lake, deficient access roads to the fishing villages and most fishing communities do not have ice- storage facilities. This means that the conditions allow the fish to spoil rapidly and the fish dealers are left with no options but to sell their daily catch fresh to middlemen at exploitative prices. The traditional processing methods like sun drying or smoking where applicable are no match for the occasional heavy landings. Traditional fish smoking can be wasteful of wood fuel raising environmental concerns and produce poor quality products. During traditional sun drying, insects deposit their eggs that hatch to larvae on the fish that in turn feed on the muscle. This leads to reduction in meat quantity as well as reduction in appearance and overall quality of the fish. The drying time is also prolonged, birds can contaminate the fish and any time it rains the fish have to be transferred inside where there is no adequate holding space and there is exposure to rodents, etcetera. Improved sun drying by using more efficient devices to collect the solar energy and to dry the fish in an enclosed drying cabinet and at higher temperatures than ambient leads to no insect infestation and shorter drying times and less labour in put among others. Estimated loss of food products due to insect infestation can reach up to 30 to 50%. This is quite high for a low income deficient country like Kenya where 60% of the population live below 1 $ a day with not much change expected in the near future.
The research project on fish drying using solar driers was incepted in order to solve the many problems in the conventional/traditional drying of fish, which have consequently marginalized the fish post harvest sector. Such problems include but not limited to inadequate reduction of moisture in a reasonable amount of time, quality hazards and safety hazards, which are derived from the designs of dryers and methodologies used. Use of solar driers for drying fish is expected to significantly reduce dependency on wood and charcoal thus contributing positively to the environment apart from improving household income

Objectives

a) Develop integrated solar driers which use solar energy indirectly to dry fish.
b) Generate sufficient information required to provide a strong background for drying system design and development in the appropriate environment.
c) Develop value added *Omena* fish products for communities and the national market

Activities

a) Consultative meetings & sensitization of community members on the technology, construction and site selection
b) Design, construct and test efficiency of low cost dryers
c) Conduct drying trials and develop value added *Omena* products
d) Evaluate post harvest shelf life of stored value added *Omena* products under field and laboratory conditions

Brief site description and methodology

The project is being conducted in Kenya, Uganda and Tanzania. The second phase of the project involved training of fishermen in Uganda, construction of trial driers in Tanzania and Kenya and performance analysis of prototype tunnel drier in Kenya at the Jomo Kenyatta University of Agriculture and Technology. Considering the need for high capacity solar drying system, the tent solar drier was adopted as a simple drying system compared to the tent drier. Trial driers have been constructed at Sokoine University in Tanzania, and at Kichinjio in Kisumu, Kenya and at Jasini in Vanga, Kenya. Preliminary tests of the driers show that they are able to achieve high temperatures of 40-50 °C. However, the challenge has been the high relative humidity resulting in low drying rate. This problem has been overcome through installation of the eco-vent which increases natural air flow rate thus reducing humidity and increasing drying rate. Comprehensive testing and dissemination of the driers is to be done in the 3rd phase. Construction of the tunnel drier in Uganda is to commence in October 2008 followed by preliminary testing. Training of the fishermen has however already been carried out on the social economic aspects of fish drying.

Main findings and conclusion

The concept of solar fish drying has been received very well in Kenya since the Minister of Fisheries and Development has personally taken interest in the technology and promised to support the project. Already some funds have been allocated for the construction of a solar tunnel drier at Moa in Kenya. Based on the preliminary results, a fish drying model has been developed. The model shall be very useful in the design and construction of fish solar driers. The solar drier can also be used for other materials especially fruits, vegetables and herbal medicines. Data analysis for the drying characteristics and organoleptic properties of the selected fish is continuing and further product development shall be conluded by 2009-2010

The main challenge however was the rapid increases in material prices thus adversely eroding the value of the finances allocated. It also took almost one year for the funds to be released after submitting the final report. This adversely affected the project implementation resulting in very poor off take in the second phase. Up to now some collaborators are yet to make any significant movement forward. Some collaborating fishermen have also gotten fatigued with waiting thus developing negative attitude towards the project. Progress report for the 2nd year was submitted.

5.0 WORK PACKAGE 4: Undertake biophysical studies in relation to fisheries

5.1 PROJECT 1: Shoreline Changes in Kenya and Tanzania, their Socio Economic Impact and Mitigation Options

Participating Institutions: KMFRI, CDA and IMS.

Scientific Team Members: Dr. Yohana Shagude, Dr. N. Nyandwi, Dr. Charles Magori, Dr. Jaqueline Uku, Eng. Wainaina Mburu, Mr. Jacob Ochiewo.

Source of Funds: MASMA-WIOMSA (US$ 150,000)

Duration: September 2006 – August 2009

Research Problem

The problem of shoreline changes along the coast of the Eastern African region is one of the least understood subjects. Shoreline changes particularly coastal erosion has been and is still one of the major socio-economic issues of concern in the mainland states of Eastern African region. The socio-economic issues of concern due to the problem of shoreline changes include the anticipated loss or damage of coastal properties or infrastructures, displacements of local coastal communities, loss of arable or buildable land, etc.

Currently, although the extent of shoreline changes in the region is relatively well documented, but the underlying drivers are generally least understood. Although it is generally believed that both the natural and human – induced factors have a contribution to the observed erosion problem in many parts of the Eastern African region, very little is known on the relative contribution of the different factors. There is also no consensus on whether all of the factors should really be considered of importance or not. This has been mainly due to the lack of comprehensive scientific datasets to

study the causes of shoreline changes. Most of the previous findings on the underlying drivers of shoreline changes are therefore unreliable or inconclusive.

This study intends to bridge that gap as it will be both comprehensive and multi-disciplinary in nature.

Objectives

- Establish the rate and pattern of shoreline changes and the most important natural and anthropogenic causes of shoreline changes by systematic monitoring over 2 years with reference to existing hydrodynamic, meteorological and geological datasets in combination with other historical datasets (such as aerial photos/ satellite images, meteorological, oceanographic etc.).
- Establish the sources, transport paths and relative importance of beach and platform sediments, including those derived from rivers and streams, from coastal erosion and those produced by calcium carbonate-fixing marine animal and plant biota.
- Determine the relationship between shoreline changes and coastal communities' livelihood patterns including tourism; these include the impacts of human activities on shoreline change and vice versa.
- Based on the findings of the three objectives above, forecast the impacts of climate change and its anticipated sea-level rise on these coastal sections.
- Examine the existing mitigation measures in relation to their effectiveness (functional and cost) and efficiency and recommend appropriate options.
- Examine the existing institutional framework (policies and legal mechanisms) in relation to their effectiveness in shore management and recommend appropriate options.

Activities

- Survey of beaches to ascertain seasonal and long-term morphological changes.
- Interviews with local communities to examine the socio-economic pressures affecting sand supplies from the hinterland at the study sites.
- Investigate incidence and variability of extreme wind/wave events by reference to meteorological records.
- Preparation of a draft manuscript on Monsoonal forcing as a driver of shoreline change.
- Re-submission of Sand Supply Manuscript to Western Indian Ocean Journal of Marine Sciences.
- Drafting a manual on mitigation and adaptation strategies for shoreline changes in Tanzania and Kenya.
- Defense of Shoreline change project at the Seventh Meeting of the Marine Science for Management (MASMA) Grantees: Monitoring the Performance of the Approved Projects. The meeting took place in Mombasa, 24-26 October 2008.
- Submission of Manuscript on the role of monsoonal forcing on shoreline change: change: The cases of Bamburi, Kenya and Kunduchi, Tanzania to Western Indian Ocean Journal of Marine Sciences.

Brief site description and methodology

The study will be implemented in two coastal sections of the two Eastern African countries (Tanzania and Kenya), namely, the Kunduchi coastal section, in Tanzania and Shanzu Bamburi coastal section in Kenya. These areas are both experiencing shoreline erosion/accretion, high investments in tourism, pressure from proximity to major urban centres (Mombasa & Dar es Salaam), dependence on fisheries by a large section of the coastal community. Further both areas have beautiful coral reefs and sea-grass beds.

Methods applied in the study include monitoring beach profiles at selected locations in the study site during both the NEM and SEM, analysis of sediment samples for grain size, mineralogy, monitoring tidal currents and sediment concentrations at river mouths as well as interviewing fishermen, hoteliers and other stakeholders using structured and open ended questionnaires. Compiling and analysing historical and current wind data (for Mombasa and Dar es Salaam) as a driver of shoreline change and drafting of a manuscript.

Main findings and conclusion

Field observations at the Bamburi shore revealed that there was ebb-dominant sand bedload transport in the Tudor Creek which is considered to be the principal pathway of the siliciclastic sand from the hinterland to the southern end of the Bamburi site, near Nyali. On the other hand the flood tides were observed as principal pathways of sand transport at Mtopanga where landward spillage of sediments from the sea was evident. A reverse process was observed to happen whenever the river flooded. All the sand earlier accumulated at the mouth of the river is washed into the sea forming the sand fan.

Analyses of the biogenic sediment composition in the lagoon and reef habitats of the Kenyan study site revealed that coral fragments were the dominant biogenic group in the sediments (both in the lagoon and the reef habitats). Other common groups (but relatively less important than corals) were mollusks, Halimeda, foraminifera and siliciclastic sand. The minor biogenic groups in the sediments were echinoderms, crustaceans, ostracods and coralline algae. It is interesting to note that there was significant proportion of siliciclastic sediments in both the lagoon and reef habitats. It is also interesting to note that, although the calcareous algae *Halimeda* spp. are abundant in the study area, the corals were the most dominant biogenic group in the sediments.

Longshore transport of the sediments along the Kenyan study site is influenced by the monsoon seasonal cycles, where cycles of accretion and erosion could be easily observable along the shore. Here also there was an overall transport of sediments from south to north during the SE monsoon. One could easily distinguish between depositional features due to swell waves against those due to local waves. The swell waves tend to be shore parallel and they are generally the principal backshore

erosion agents in extreme conditions. The local waves tend to be oblique and are effective longshore transporting agents.

There are no groyne barriers along the Kenyan study site. The common mitigation structures observed along the Kenyan study site were the seawalls and timber defences. These structures do not obstruct the longshore sediment transport but the seawalls disrupt the supply of backshore sands to the beach wherever they occur

Wind regime analysis in the context of coastal alignment is a key tool in the assessment of risk in respect of shoreline change and coastal erosion. On the Bamburi shore, the NE and SE monsoons appear to be more evenly balanced, but with strong reversals of drift with the change of season. While there are periodic erosion events on that shore, these may be naturally repaired by subsequent beach accretion. There are no indications of long-term losses of sand from the Bamburi shore. While sand may be lost from the system at Shanzu during the SE Monsoon, there is potential for natural recharge there during the NE Monsoon.

Within this period, the shoreline change project has progressed fairly well and on planned schedule without any major hitches. The project is now on the winding-up stage. A closing meeting is planned where the scientific results of the project (and draft recommendations) will be presented to stakeholders' to get their views. A final report will be prepared and submitted to the donor of the project (WIOMSA).

5.2 PROJECT 2: Receptor binding assay for harmful algal toxins

Participating Institutions: AFRA member states

Scientific Team Members: Okuku, Mwangi

Source of Funds: IAEA and GoK

Duration: 3 years

Research Problem

One of the more serious and visible problems facing coastal waters and the local economies relying on them relates to the phenomena commonly known as "red tides" or "harmful algal blooms" (HABs). These events are caused by the growth and accumulation of microscopic algae in marine or brackish waters that can cause massive fish kills, contaminate seafood with potentially lethal toxins,

and alter ecosystems or coastal aesthetics in many ways. HABs constitute a public health problem because of their unpredictability and the rapidity with which concentrations of toxins may develop.

Objectives

- To assess algal toxin dynamics as a function of physicochemical changes in the water column and develop predictive models for bloom toxicity
- To monitor algal toxins in seafood products to ensure they meet the recommended limits
- To monitor water toxin levels thereby providing an early warning to avoid possibilities of aquatic contamination and related ecosystem effects

Activities

- Receiving consignment from the IAEA
- Setting up of the radioisotopes laboratory
- Capacity building

Brief site description and methodology

This project will be adjourned to the south coast and Ungwana bay water quality work while Mombasa and its environs will be sampled under a separate arrangement. Water quality parameters will be determined to give a prediction of the timing and causes of algal blooms. Phytoplankton and shellfish samples will be collected for the determination of levels of toxins and possibilities of trophic transfer.

Main findings and conclusion

We have managed to collect water, shellfish, bivalves, fish and phytoplankton samples during the last three sampling campaigns. Once we receive trited standards, the samples analysis will be carried out.

5.3 PROJECT 3: Biochemical effects of sewage, a story from the fish side.

Participating Institutions: KMFRI

Scientific Team Members: Okuku Eric

Source of Funds: WIOMSA

Duration: 1 year

Research Problem

Discharge of untreated wastewater is a major source of marine pollution, and perhaps the most serious problem within the framework of the GPA. Globally, in spite of action, the problem is growing worse, mainly because of growth in population and rapid urbanization. One method frequently used to assess the ecological effects of pollution in aquatic systems is the abundance and species composition of fauna that is usually complemented with the concept of sensitive and

tolerant taxa. However, these higher levels are usually less sensitive and the effects are only evident after irreversible effects have already occurred. *There is an urgent need to develop sensitive, reliable and broadly applicable indicators of ocean health* inorder to effectively safeguard these sensitive ecosystems from land-based pollution activities.

Objectives

- To determine the levels of pollutants in water (nutrients and heavy metals) and fish (heavy metals) in the polluted area along a pollution gradient and compare it with the results from relatively pristine area.
- To determine the biochemical effects of contaminants (nutrients and heavy metals) on different species of fish.
- To develop a simple model that can be used to attribute the observed pollutants effects on biota to the measured exposure in the water compartment.

Activities

- Field exposure and sampling
- Laboratory analysis

Brief site description and methodology

When a fish is residing in a polluted area, part of its energy in spent in homeostasis, this energy could have otherwise been used for growth or accumulated as energy reserves. Living in polluted waters therefore results into tissue wastage. The study approach involves collection of live samples of fish and exposing them in areas receiving sewage in Tudor creek and in an area perceived to be receiving no sewage (Gazi). The fish energy reserves are measured before and after exposure to give a measure of the effects of sewage exposure.

Main findings and conclusion

Preliminary analysis of the water quality parameters in Gazi and Mikindani confirmed that Mikindani was more polluted than Gazi. Fish exposure experiments were conducted at both the sites. However abnormal mortalities were recorded in both the sites giving an indication that the mortalities were not related to pollution but some other factors which could be the low levels of DO in the stagnant pools and high salinity levels elevated by the net evaporation. Based on these finding, it was decided to carryout an ecotoxicological test in the laboratory where serial dilutions were made and fish exposed in the various treatment aquariums. Statistical analysis of the various water parameter showed that the different level (treatments) differed from each other statistically and could be used as different treatments. Three exposure experiments have been carried out. Water samples have been analysed while the fish samples have been stored at -80°C for further energy reserves analysis

5.4 PROJECT 4: A Constructed Wetland System for Wastewater Management at Shimo La Tewa Prison, Mombasa, Kenya

Participating Institutions: KMFRI, CDA, Prisons, MoR&PW

Scientific Team Members: Okuku Eric, Mwangi Steve, Dr. Munga

Source of Funds: WIOLab- GEF

Duration: 1 year

Research Problem

Pollution of aquatic ecosystems is increasing rapidly in and around Mombasa City. For instance, sewage discharge into Mtwapa creek has increased in the recent past to a level that is threatening the sustainability of its ecosystem and its ability to provide ecological and socio-economic services. Land use changes around the creek, particularly the rapid urbanization occurring in the Shanzu area in the neighborhood of the Shimo la Tewa Prison and Mtwapa Urban Centre have resulted into the release of untreated wastewater and sewage into the sea.

Objectives

- Monitor wastewater and seawater quality prior to construction of the treatment facility to establish the baseline conditions.
- Monitor wastewater and seawater quality after commissioning of the treatment facility to determine the impact of the project.
- Monitor the efficiency of the treatment systems by sampling and analyzing the water quality at the inlet and out-let

Activities

- Field sampling
- Laboratory analysis
- Biannual water quality monitoring

Brief site description and methodology

Water quality assessment is important in determining whether the effluent from CW is safe for reuse in aquaculture and agriculture. Water Quality team of KMFRI carries out frequent monitoring of this system. The parameters that are monitored include pH, temperature, salinity, dissolved oxygen, BOD, COD, suspended particulate matter, particulate organic carbon and inorganic dissolved nutrients (ammonia, nitrates, nitrites and orthophosphate) and microbial indicators (coliform and *E. coli*). Samples for the determination of these parameters are usually collected at the entry point to the CW, in the CW, at the exit of CW and Mtwapa creek.

Main findings and conclusion

The differences in phosphate and ammonia concentrations in the various sampling (Figure 1) were statistically insignificant (P>0.05, $F_{(3,8)}$=0.217) and (Ammonia: $F_{(3,8)}$ = 0.823, P>0.05) whereas the differences in nitrates concentrations in the various sampling were statistically significant $F_{(3,8)}$ = 6.23, p <0.05). From the more or less even distribution of nutrients in the creek (Figure 1), it is evident that tides and most probably currents play an important role in the distribution of nutrients. With the flooding favouring distribution of nutrients towards Mtwapa ferry while ebbs favours the distribution towards Mtwapa ferry. This indicate that even though the sewage is usually discharge at the MPE station, the impacts of the sewage discharge could be having far reaching effects extending beyond the discharge point due to water dynamics. Water turbidity of the three stations were 1.3, 1.4 and 1.1 for Mtwapa ferry, effluent and bridge respectively. Chl a content in the various stations were statistically indifferent from each other $F_{(3,8)}$ = 2.22, p = >0.05).

Ammonia levels in the sewage effluent were found to be above the allowed maximum level for discharge as contained in water quality regulation 2006. Though it is casually expected that the elevated levels of nutrient in Mtwapa creek would promote primary production, this was not the case in this study. Correlation of Chl a pigment with the various nutrients showed very weak relationships that were not statistically significant (Table 1). At least one more field campaigns should be carried-out to provide more baseline data and show temporal variability in contaminants concentration before the commissioning of the constructed wetland.

5.5. PROJECT 5: Enhancing Regional Capability for the Assessment of Contamination in the Marine Environment

Participating Institutions: AFRA Member States

Scientific Team Members: Okuku, Mwangi, Munga

Source of Funds: IAEA and GOK

Duration: 3 Years

Research Problem

Pollution is a growing problem in most of the developing countries partly due to increasing population, industrial activities and urbanization. Currently, pollution is being blamed for declining fish catches. This projects aims to address pollution problems, seafood safety and trans-boundary conflicts emanating from pollution issues.

Objectives

- To improve regional capabilities for using nuclear techniques to assess contamination of the marine environment around the African continent, with a view to promoting its sustainable management.
- To address food safety and trans-boundary pollution issues

Activities

- Receiving consignment from the IAEA
- Setting up of pollution laboratory
- Capacity building
- Samples collection and monitoring

Brief site description and methodology

This project will be form part of the south coast and Ungwana bay water quality work while Mombasa and its environs will be sampled under a separate arrangement. Water quality parameters will be determined in order to delineate areas to be included in the monitoring programme and to come up with baseline data for areas least studied.

Main findings and conclusion

We have managed to collect water samples for south coast and selected location in Mombasa areas. Sediments samples for radio nuclear analysis have been collected and will be transported to Egypt for gamma analysis.

5.6 Project 6: GoK Funded Couth Coast Multidisciplinary Project

Participating institutions: Fishery Department, Kenya Meteorological Department, Kenya Forest Services, Moi University

MEEP Scientific team members: Dr. Nguli, Dr D. Munga, Dr C. Magori, P. Gwada, J. Okondo, S.Mwangi, B. Ohowa, Dr J. Bosire dr. J. Kairo and E. Okuku

Source of funds: KMFRI

Duration: 2008 – 2009 (1 Year)

Introduction

Multi-disciplinary research is a key to understanding the coastal environmental and its aquatic resources. Knowledge from such research is important for sound management of the resources. Within the last two years KMFRI focused such research in Msabweni-Vanga area which is its second largest fishing ground on Kenya's continental shelf and which is located near Pemba Channel and is part of the shared cross-border ecosystems of Moa Bay and Umba River. The aim of the research was to establish the status of fisheries, critical habitats, water quality and oceanography. The study was executed in two phases (Phase I & II) in 2007 and 2008, and it provided general characteristics of the environment and current status of fisheries. There is need; however, to deepen our understanding of the linkages between the ecosystems, in order to advise on good management of the resources. For this reason it was necessary to plan for Phase III.

Sub-thematic Research Areas

Theme I: Water quality, productivity and hydrodynamics

Sub-Project 1a: Joint Hydrodynamic Modeling of Shimoni-Vanga area

Dr Munga, Dr Magori & Dr Nguli

Brief description

Hydrodynamic modeling is important enhancing understanding of a complex coastal, and are good management tools. There is no model work in Kenya coastal waters. However, in the last two years, KMFRI, has been developing capacity in modeling, by having its staff participate in both local and international hydrographic and modeling advanced courses where single beam and multi-beam echo sounders (SBES & MBES) data has been used in surveys. In one of recent training held in the country preliminary modeling initiatives were made using bathymetric data, oceanographic data as well as meteorological data from Ungwana Bay which incorporated bathymetry, sea level and other oceanographic data.

The success on the training is the result of interest to carry out modeling in Shimoni-Vanga area (Moa Bay) so as to explain better the links between environmental processes and fisheries.

Objectives

- To use hydrodynamic model in describing process in Moa Bay

Tasks/Activities

- carry out bathymetric survey of the entire Moa Bay in order to have sufficient data for the model
- collect data on freshwater discharge of Umba River, Mwena River and Pogwe River
- Carry meteorological measurement
- collect time series data currents, sea level and temperature Deploy Rapid current meters(RCMS) and Doppler current meters to get boundary conditions and fluxes

Sub-Project 1b: Investigation of Density-driven Circulation Near Sii and Wasini Islands: *extent of low density water in a major tidal channel*

Leaders Dr Nguli M & S.Mwangi

Objectives

- To investigate salinity intrusion in Umba River estuary
- To measure tide, currents (using drifters and current meters) in order to determine circulation, and water exchange between the mangrove-estuarine-creek waters and the ocean through the Wasini Channel.
- To investigate salinity and temperature variations between the mouth of Umba River and the Wasini Channel in order to understand the extent of secondary circulation.
- To investigate the extend of turbidity and level of eutrophication and the relationship between low salinity water, and nutrient, fish larvae and plankton distributions between the river mouth and the Wasini Channel entrance (note four key oceanographic stations will be occupied where salinity, temperature, nutrients, planktons etc.,) will be measured.

Theme II: Critical habitats:

Sub-Project-1: investigations of sea grass-coral-sponge beds and associated fish and surface invertebrate communities

Leader: Mr. Gwada Patrick

Members [2] Anthony Nzioka, Charles Muthama, Alex Kimanthi, Samuel Ndirangu, Lydia Nguti, Dixon Odongo and Masudi Zamu

Introduction

The project focuses more on the sea grass and surface benthic communities in 30 different sites along Wasini Channel and the discrete several coral head island complexes of Shimoni-Vanga in an effort to find out the habitat conditions and the related invertebrates and fisheries which are dependent on these habitats. The study also investigated the relative importance of these structures to certain assemblages of fish and fauna.

Project Details

Research Problem(s)

a) What's the biophysical environmental attributes (seagrass-coral-sponge beds specific) that exists in Shimoni Vanga area that corresponds to decline in fisheries, including aquarium fish resources?
b) What are the structural habitat attributes (seagrass-coral-sponge beds specific) that are coupled to habitat degradation (lower habitat complexities) and / or sea-urchin explosions?
c) Are indicators of ecosystem services of breeding, nursery, feeding, protection, etc., well offered by local seagrass-coral-benthic beds?
d) What socio-economic / management data [profile of socio-economic activities undertaken here (e.g., recreation areas, protection areas, fishing areas, effort, vessels, etc), including resource use conflicts] exists in Shimoni Vanga area that corresponds to decline in fisheries, including aquarium fish resources?

Objectives

a) Qualitative environmental description at selected study sites;
b) Qualitative and quantitative description of the benthic conditions (seagrass, coral, sponges, bare sites, etc) at selected study sites;
c) Qualitative and quantitative description of the associated biodiversity (species composition and abundance, trophic structure) at selected study sites;
d) Linkages with socio-economic and oceanographic characteristics;
e) Recommendations for intervention based on data and gaps.

Activities

a) Sampling on seagrass–dominated study sites (30 sites sampled): Key parameters: seagrass structure, other benthic structures (including corals and sponges where present) and faunal composition;
b) Analysis of data by habitat types, faunal groups assemblages (macros, surface inverts, sessile fauna, fish);
c) Gap analysis and recommendations for further research and / or management intervention.

Brief site description and methodology

Sampling was conducted on 30 sites distributed as shown in Figure 1. Seagrass sampling sites approximated a radius of 25m. Some sites were not always homogenous but were occasionally interrupted with small bare patch areas or overgrown with other substratum life forms and these were noted. Field data collection took place quarterly for 2 years and covered the north east monsoon (NEM) period and the south-east monsoon (SEM) period. Key parameters assessed included seagrasses structure, benthic structures (including corals and sponges where present), and faunal species composition and abundance. In particular, underwater visual census (UVC) techniques were used to characterize faunal structure (SPC, 2002). Sampling was carried out during low tides (2 – 3 hours from either side of the low tide).

For seagrass structural studies, quadrat sampling (50 x 50cm quadrats) were used along transect lines (each of 25m length). Species composition (line intercept), stem lengths (in-situ measurements of 10 shoots per quadrat), canopy height (in-situ measurements of 10 shoots per quadrat), shoot density and percentage cover (in-situ assessments as per seagrass research methods – Phillips & Meñez 1988 and Phillips & McRoy 1990) were made. Assessments were also made of the sizes and area extent of within-bed bare locations (sand or rubble) and the composition and sizes (percentage cover) of other non-seagrass substaratum structures.

Faunal assessments were done by in-situ visual observations (Phillips & Meñez 1988 and Phillips & McRoy 1990; Halford &Thompson; 1994; SPC, 2002). At each site, 4 transect lines (each 25m long) were set and two experienced divers snorkeled along on each side of transect line and counting all visible benthic and slow moving fauna within 2m from transect line. Water-proof checklist guides (with colour pictures of fish and macrofauna) were used for confirmation of specimen where true identity was not clear to observer. At each site, the 4 faunal transect of 25m and 4 m wide translates into 400m^2 area observations. Unfamiliar species were identified to the known taxon using guide books and checklist guides.

Basic analysis of plants structural information (species composition, abundance, cover, density, biomass relations) and faunal (species composition and abundance) were done on spreadsheets. Interaction effects and associations/similarities in the data sets were analyzed according to Primer (Primer-5 Software; Primer-E Ltd, 2005). The degree of similarity was calculated using the Bray-Curtis Index.

Main findings and conclusion

a) Invertebrate and fish species composition differs for the different benthic habitat sites: seagrass, coral, sponge;
b) Population structure of surface macrobenthos differs for the different benthic habitat sites. This could be a response to habitat degradation leading to:
    - Population structure anomaly
    - Trophic structure anomaly
    - Other forcing factors (hydrodynamics, seasonality, life-stage histories, etc)
c) Population structure-1: surface macrobenthos were dominated by sea-urchins and mollusks. This has
    - Structural and functioning implications
    - Socio-economic implications
d) Population structure-2: Inverted pyramid of numbers. This could be a response to
    - Degraded habitat conditions
    - Selective removal of herbivores
    - Fishing down trophic chains
    - Insufficient data
e) Literature information indicative of
    - habitats degradation conditions (e.g., Levitan,1989)
    - Selective over fishing of certain keystone species. *Echinometra methaii* in particular is a gregarious feeder of corals, (compare with CORDIO-KWS, WCS, Sport-fishing data)

f) The study recommends
   - Further investigations to relate findings to greater environmental variability in time and/or space and to reference conditions (such as exists in MPA's like in the adjacent Kisite-Mpunguti Marine Park and Reserve).
   - Management interventions to control further environ deterioration

Project 2: Ecological-sociological study of *Vibrio cholerae* in the WIO Region

Participating Institutions: KMFRI, University of Dar es Salaam, Muhimbili University of Health and Allied Sciences

Scientific Team Members: *Stephen Mwangi, Jacob Ochiewo and Jane Ndungu*

Source of Funds:WIOMSA (MASMA)

Duration: 2 years

Project Details

Goals and Objectives

The goal of the proposed project is to investigate the link between different environmental factors (biotic and abiotic) and socio-economic factors with cholera epidemicity in the coastal region for improved disease control. The following objectives will be undertaken:

1. To identify and characterize both isolated and uncultured *V. cholerae* O1 and O139 from selected aquatic environments along the coastal region of Tanzania and Kenya
2. To compare *V. cholerae* isolated from aquatic environments with clinical isolates
3. To determine environmental factors and fecal bacterial contamination indicators associated with *V. cholerae* prevalence in aquatic environments
4. To assess the social and economic factors which contribute to cholera outbreaks near coastal aquatic environments in Kenya and Tanzania coastal regions

Activities

1. Monthly sampling in marine environment, estuarine environment and fresh water reservoir to determine the various ecological and microbiological parameters.

2. Socioeconomic assessments in Shimoni-Vanga area using a combination of participatory assessment techniques.

3. Organization of stakeholder meetings for assessments and dissemination

Brief site description and methodology

This project is being carried out in Shimoni-Vanga area as one of the representative of the coastal regions of East Africa. The study areas have been chosen because they experience frequent cholera outbreaks. In each study area, three sampling stations will be established; the first one in the marine environment, the second in an estuarine environment and the third station in a fresh water reservoir. At each station, triplicate samples will be collected once a month for one year to determine the various ecological and microbiological parameters. Socioeconomic assessments will be carried out using a combination of participatory assessment techniques.

Main findings and conclusion

Inception workshop was held in Tanga in May 2009 and the sampling campaign has started

6.0 WORK PACKAGE 5: Information and data management (IDM)

6.1 PROJECT 1: South West Indian Ocean Fisheries Project – data management component

PARTICIPATING INSTITUTIONS: KMFRI-KENYA, TAFIRI-TANZANIA, IIP-MOZAMBIQUE, ORI-SOUTH AFRICA, COMOROS, MADAGASCAR, IRD-FRANCE, ALBION-MAURITIUS, SFA-SEYCHELLES

Scientific team members: Nominees from the above institutions

Source of funds: GEF – WORLD BANK

Duration: 5 years

Research Problem

There has been little attempt to aggregate existing data, and little attention has been paid to ensuring the ready accessibility of data by end users to facilitate joint management efforts. There is a major unmet need, identified during project preparation, to repatriate data that has been gathered over many years in the SWIO by foreign fishing fleets and research vessels.. A data and information workshop convened by the ASCLMEs project and attended by SWIOFP clearly showed that existing programs and institutions do not possess cross-cutting information at regional scale. Information systems at both national and regional scale are fragmented, poorly described, lacking in synthesis, and generally unavailable to managers even at national scale. What little integrated regional information that there is exists in incompatible formats, is not centrally stored, not synthesized and thus not readily accessible to decision-makers and stakeholders.

Objectives

To promote the environmentally sustainable use of fish resources through adoption by SWIO-riparian countries of an LME-based ecosystem approach to fisheries management in the Agulhas and Somali LMEs that recognizes the importance of preserving biodiversity.

Activities of component 1

i) Develop protocols that define how fisheries data are to be used and shared between SWIOFP countries. Once these are in place, each country will inventorize, collect and submit copies of all relevant written output and raw data describing shared fisheries resources to the overall SWIOFP regional database system;

ii) Collect data describing regional fisheries held outside of Africa by public and private institutions and commercial fishing fleets.

iii) Each country will analyze data relevant to components in which it will participate and identify specific gaps in existing data that would collectively form the gap analysis that underpins the primary data collection activities of SWIOFP;

iv) Workshop consisting of all SWIOFP countries will be held at which a conceptual, harmonized, data gap analyses by type of fishery will be undertaken. The data gap analysis will form the basis of annual work plans for years two and three of the project when ship cruises will be undertaken to collect new data;

Outputs

i) Regional statistical database is being prepared. As a first step all the participating countries are progressing with standardisation of nomenclatures used in various countries to achieve a uniform data integration

ii) Based on data and information in various countries a regional gap analysis has been carried out for the following components: crustaceans and demersal fishes. As a result these components have an idea of the existing data gaps that need to addressed in the ship based assessment program to follow

6.2 PROJECT 2: Nairobi convention information clearinghouse system

PARTICIPATING INSTITUTIONS: KMFRI-KENYA, TAFIRI-TANZANIA, IIP-MOZAMBIQUE, ORI-SOUTH AFRICA, COMOROS, MADAGASCAR, IRD-FRANCE, ALBION-MAURITIUS, SFA-SEYCHELLES

Scientific team members: Nominees from the above institutions

Source of funds: UNEP

Duration: 1.5 years

Research Problem

In 2003, a meeting of the Nairobi Convention national focal points recommended that the Convention should make efforts to develop outreach information, networking and public awareness for an effective management approach.

The goal of the Clearinghouse mechanism is to improve the coordination and participation of the Western Indian Ocean countries in the management of their coastal and marine resources. The clearinghouse is designed to enable the Nairobi Convention develop a comprehensive information base and access services to quickly provide information to decision makers.

Objectives

i) Development of human resource capacities and appropriate information infrastructure to enable countries fully participate in national and cross-border activities and benefit from lessons learned,
ii) Development of an enabling environment for assessment through advocacy of standards necessary to acquire, process, store, distribute and improve utilisation of essential data in the region, and
iii) Ready access to scientific, technical, environmental, legal and policy level information essential for the sustainable development of the coastal and marine environment.

Activities

Establishment of a national working group

KMFRI is the focal institution for Kenya. Members of the working group were chosen from diverse institutions to facilitate collation of a wide range of existing information

Search and collation of existing data and information

A wide range of information has been proposed for inclusion into the portal (see details in the 1st planning meeting report)

Quality control on data and metadata standards

Quality control for all editors and data records is done by the Administrator who is enabled by a special password

The regional and national clearinghouse information system

The Kenyan portal is linked to the UNEP-DEWA portal which is the entry point for all the other regional portals

PROJECT 3: KMFRI Library

Objectives:

To be a one stop centre to retrieve and disseminate information effectively to her clientele

Activities

Creation of Library Document Delivery database for statistical purposes

The database has 86 records with 148 requests received and processed

Data entries

Samaki Database is updated regularly records were added from the various ones of 7062 records now the database has 7111

Binding and Repair of Library documents

Several documents were bound for the Institute and Library document repair

250 document s were bound and 100 worn out books repaired

Weblis Software

Training was carried out on how to use the software. Records were subsequently entered in the SWIOPF database with 509 records done so far, to support the data gap analyses.

New contents

New contents/publications are continuously updated and information circulated to scientists via email

7.0 WORK PACKAGE 6: Investigate the demographic and cultural characteristics of the fisher families in order to understand the relationship between the aquatic resources and the rising human induced pressures

7.1 PROJECT 1: Assessment of the social and economic features of the sea cucumber fishery in the coast of Kenya.

The study will determine the national marine resource use patterns, the social and economic characteristics of the fisher communities and the contribution of sea cucumbers to the national economy and local livelihoods of the coastal areas. Resource management systems will also be analyzed to establish possibilities of improvement. A final project report will be produced.

Participating institutions: KMFRI, WCS

Scientific team members: Jacob Ochiewo – Project Coordinator

Fridah Munyi – Assitant Research Officer

Charles Muthama – Research assistant (Technologist)

Richard Angwenyi - Research assistant (Technician)

Source of funds: WIOMSA – MASMA Project

Duration: Began in 2006. The project has come to an end.

Research Problem

Sea cucumbers are a poorly understood coastal resource, despite their long history of consumption by oriental populations. Although the high demand for sea cucumbers has resulted in overexploitation in the main producing nations there remains a high demand for this product worldwide, leading to expansion into new fishing grounds as well as the development of aquaculture. Some studies on sea cucumbers have been conducted in several countries in the WIO, but there has been limited analysis of information relevant for fisheries management in individual countries and no attempt at a regional level analysis. There has been some basic analysis of the sea cucumber fisheries and management systems in some countries of the region that indicate rapidly developing and unregulated fisheries with some showing signs of over-exploitation. Catches have been declining over the last 10 years and fishers are catching smaller and reproductively immature individuals of at least two commercial species (*H. fuscogilva* and *H. scabra*) at the main landing sites in Kenya

Objectives

The main objectives of this study are (1) to determine the sea cucumber fishing patterns, the social and economic characteristics of fisher communities and the contribution of sea cucumbers to the

local livelihoods, and (2) to assess marine resource management systems to provide a baseline for planning management and future improvements.

Activities

- Data analysis and validation
- Preparation of a manuscript for publication
- A final stakeholders' meeting

Brief site description and methodology

Site description

The study was conducted in four sites in the Kenyan south coast namely Vanga, Majoreni, Shimoni and Gazi. These are important sea cucumber fishing villages where sea cucumbers are landed on a daily basis and regular records are maintained. In 2003, these sites (i.e. the former Kwale district) produced more than 80% of the sea cucumber catch in Kenya. Each of the sites has its own unique characteristics. Vanga is a typical fishing village with high levels of sea cucumber harvesting. Majoreni is a rural village that depends on both fishing and peasant farming. Shimoni is a rural settlement adjacent to a Marine Protected Area (Kisite-Mpunguti Marine Park and Reserve). Gazi is a rural fishing village located in the Gazi bay about 60km south of Mombasa city.

Methodology

Primary data was collected using a combination of four techniques namely questionnaires, semi-structured interviews, key informant interviews, and focus group discussions. A summary of the application of these techniques is presented below. Three categories of respondents were identified before primary data collection began namely sea cucumber fishers, first level middlemen who are based at specific sea cucumber landing beaches, and second level middlemen and exporters who are based in the major town of Mombasa.

Main findings and conclusion

The results have shown that *Holothuria scabra* is more dominant in the sea cucumber catch while the catches of the other high commercial value species, *Holothuria fuscogilva,* has declined over the years, a sign of over-harvesting. This species may be threatened with depletion if control measures are not put in place urgently. Collection of the previously low value species and small-size sea cucumbers is increasing due to high demand in the Asian market. There is demand for different grades of processed sea cucumbers, grade 1 (the biggest size sea cucumbers), grade 2 (the medium size sea cucumbers) and grade 3 (the small-size sea cucumbers). Grade 3 sea cucumbers include low value species and juvenile sea cucumber catches. The demand for grade 3 sea cucumbers may result into increased fishing of juveniles and may consequently affect the fishing stocks since the juveniles may not be allowed time to mature and reproduce. It is therefore important to put in place size

limits for the sea cucumbers that enter the market. The size limit could be enforced by checking the length and with of processed sea cucumbers.

There are strong indications that the fishers are exploited by local level middlemen since they often do not have a say over the prices given to them and the time to process their catch themselves. It is therefore important to provide training to the fishers on sea cucumber processing so that those who are ready to process their catch can do so. It will also be useful for the sea cucumber fishers to form an association that can market their catch. The association can negotiate competitive prices with the buyers and can undertake sea cucumber processing on behalf of the members when necessary. If these are done, their dependence relationship with the middlemen will be broken.

7.2 PROJECT 2: Vulnerability of coastal habitats and dependent livelihoods to climate change - Land Use patterns and socio-economic impacts of the mangrove die-back on the livelihoods of the local people

Participating institutions: KMFRI
Scientific team members: Jacob Ochiewo – Principal investigator (Socio-economics
Fridah Munyi – Assitant Research Officer
Charles Muthama – Research assistant (Technologist)
Richard Angwenyi - Research assistant (Technician)

Source of funds: START International

Duration: Began in 2007. The project has come to an end.

Research Problem

Coastal communities in Kenya depend on mangroves for wood for timber, construction poles, fuelwood and fishing. Ecologically these shoreline forests help in controlling soil erosion, protecting farmlands against sea storms and as a sink for carbon and landbased pollutants which would otherwise affect adjacent ecosystems and provides a habitat to many groups of fauna e.g fish, crabs and molluscs. However, the integiry of these mangroves is threatened by both human pressure and natural threats e.g. direct and indirect effects of global climate change.

Objectives

The aims of this study are to assess the land use patterns and the socio-economic impacts of the mangrove die-back on the livelihoods of the local people, and to provide a range of information on the socio-economic characteristics of the communities that depend on the resources of Mwache creek.

Activities

- Data analysis and validation
- Preparation of final technical report

Site description

The study was conducted in three villages around Mwache Creek namely Bonje, Chongongwe and Ziwani. Mwache creek ($4^0$3.01' S & 39.06^{0}38.06'E) is located 20 km Northwest of Mombasa city in Coast Province. The rate of sediment production within Mwache River basin reaches a high of 3,000 tons yr^{-1} due to poor land-use activities such as overgrazing, shifting cultivation, cultivation on steep slopes without the application of soil conservation measures, high rainfall intensity during the rainy season and steep land gradient among others

Methodology

Socio-economic assessments were conducted in the three villages around Mwache Creek. A total of 199 people were interviewed around Mwache Creek. A combination of techniques was used to establish the land use patterns and socio-economic impacts of the mangrove die-back. The techniques used included transect walks undertaken to establish the land use practices and patterns that promote soil erosion in the area. Key informant interviews were conducted to determine the impact of mangrove destruction on the livelihoods of local people. Semi-structured interviews were conducted to establish socio-economic characteristics of the local people.

Main findings and conclusion

The project has yielded data which indicates how human activities have exacerbated the effects of global change, making ecosystems vulnerable thus compromising livelihoods. The area is inhabited mainly by one ethnic group, the Duruma community, and their traditions and cultural practices could be tapped in co-managing the mangrove and other natural resources in the area. Low literacy levels and widespread poverty characterize the area. This has resulted in low adaptive capacity to the impacts of climate change. The area is dominated by traditional peasant farming practices that involve cultivation on steep slopes without any soil conservation measures thus accelerating soil erosion. Farming is mainly done by women. It is therefore important to sensitize the local people to embrace soil conservation while engaging in farming activities. In particular, women should be trained on appropriate soil conservation measures. In addition, since this area has both mangrove and terrestrial forests, it can support alternative livelihoods such as bee-keeping, butterfly farming, etc. that are environmentally friendly.

For long mangrove forests and adjacent farmlands and/or terrestrial forests have been managed as independent ecosystems without appreciating the link between these systems. Poor husbandry practices and deforestation upstream have accelerated soil erosion causing massive sedimentation downstream, which has led to degradation of mangrove forests in many areas more especially during catastrophic events like El Nino. An integrated approach is thus necessary in order to address

resource management issues around these important ecosystems. The socio-economics data has highlighted the impact of poor husbandry practices and deforestation upstream on the integrity of mangrove forests. It is also important to improve road infrastructure in order to improve livelihoods in the area.

8.0 RESEARCH OUTPUTS

8.1 Publications

- Raburu P. O, Masese F. O., and **Mulanda, C.A.** 2009. Macroinvertebrate Index of Biotic Integrity (M-IBI) for monitoring rivers in the upper catchment of Lake Victoria Basin, Kenya. *Aquatic Ecosystem Health & Management*, **12** (2):197-205.
- **Kimani EN, G. Okemwa, J. Kazungu**. 2009. South West Indian Ocean Fisheries: Trends, Management and Transnational Challenges. Simpson Center Transnational Challenges Publications. Washington. pp 3-17.
- **Fulanda B., C Munga**, J. Ohtomi, Osore, M. Mugo, R. Hossain Y. 2009. Structure and evolution of migrant fishers in Kenya. Ocean and Coastal Management. (Accepted)
- Kairo, James G., Wanjiru, Caroline and **Ochiewo, Jacob.** 2009. Net Pay: Economic Analysis of a Replanted Mangrove Plantation in Kenya. Journal of Sustainable Forestry, 28:3,395 — 414.
- Crona, B. I., Ronnback, P., Jiddawi, N., **Ochiewo, J.**, Maghimbi, S., Bandeira, S. 2009. Murky water: Analyzing risk perception and stakeholder vulnerability related to sewage impacts in mangroves of East Africa. *Global Environmental Change, 19 (2009) 227–239.*
- Clerici, M., Hoepffner, N., Diop, M., Ka, A., Kirugara, D. and **Ndungu, J**.(2009)'SST derivation from MSG for PUMA Pilot Projects in Fisheries', International Journal of Remote Sensing, 30:8,1941 — 1959
- M. Clerici; N. Hoepffner; M. Diop; A. Ka; **D. Kirugara; J. Ndungu**: SST derivation from MSG for PUMA Pilot Projects in Fisheries. International Journal of Remote Sensing; Vol. 30, No. 8, 20 April 2009, 1941–1959
- Rudy P. van der Elst, Johan C. Groeneveld, Ana Paula Baloi, Francis Marsac, Kaitira I. Katonda, **Renison K. Ruwa**, William L. Lane. Nine nations, one ocean: A benchmark appraisal of the South Western Indian Ocean Fisheries Project (2008–2012). in R.P. van der Elst et al. / Ocean & Coastal Management 52 (2009) 258–267
- **J. Nyunja**, M. Ntiba, J. Onyari, K. Mavuti, K. Soetaert, S. Bouillon. Carbon sources supporting a diverse fish community in a tropical coastal ecosystem (Gazi Bay, Kenya). Estuarine, Coastal and Shelf Science 83 (2009) 333–341
- **Oduor-Odote, P.M** and M Obiero **(2009).** Lipid and organoleptic response during shelf storage of some smoked marine fish in Kenya. African Journal of Food Agriculture Nutrition and Development. Vol 9 No. 3 885-900
- **Oduor-Odote, P.M** and Kazungu J.M. **(2008).** *The Body Composition of Low Value Fish and their Preparation into a Higher Value Snack Food.* Western Indian Ocean Journal of Marine Sciences. Vol 7 No 1 pp 111-117
- **Cyprian, A.O**.; Sveinsdottir K.; Magnusson, H.; Mattinsdottir, E **(2008).** Application of Quality Index Method Scheme and Effects of Short-time Temperature abuse in Shelf-life study of Freshwater Arctic charr *Salvelinus alpines*. Journal of Aquatic Food Product Technology Vol 17 (3) 303-321
- **Dzeha, T**; K. Wende; M. Harms; J. Wilson; J. Kohen; S. Vemulpad; J. Jamie; U. Lindequist **(2008).** Phytochemical characterization of the Australian (Aboriginal) medicinal plant

Dolichandrone heterophylla (R.Br.) F. Muell. and influence of selected isolated compounds on human keratinocytes. *Natural Prodroduct Communications*. Vol 3 Issue 9 1385-1387

- **Oduor-Odote, P.M. ; Ohowa, B.O. ; Obiero, M. (2008).** Performance of Improved and Traditional Fish Smoking Kilns Introduced in the Tana Delta Area of Kenya. Samaki News. Vol. V No 1 p23-28

- Kobingi, N., Raburu,. P O., Gichuki, J. and Masese, F. O., (2009). Assessment of Pollution Impacts on the Ecological Integrity of the Kisian and Kisat Rivers in Lake Victoria Drainage Basin, Kenya, ***African Journal of Environment and Technology*, 3 (4), pp. 097-107.**

- Boaz Kaunda-Arara, James M. Mwaluma, Gameo A. Locham, Vidar Øresland and Melckzedec K. Osore (2009). Temporal variability in fish larval supply to Malindi Marine Park,coastal Kenya. ***Aquatic Conserv: Mar. Freshw. Ecosyst. 19: S10–S18 (2009)***

8.2 Book Chapters: Under Review

8.3 Submitted manuscripts

- Kundu, R., M. Muchiri, M. Njiru, **C. Aura** & J.E. Ojuok (2008). The Agony of Fishing at Lake Naivasha, Kenya. Is community participation in management the solution? Submitted to Journal of Lakes and Reservoirs: Research and Management.

- Kalama, M.T., Manyala, J.O., **Aura, C.M.** and K. E. Mbaru (2009). Phytoplankton Abundance and Composition in Relation to Physico-chemical Characteristics in Chepkanga Dam, Eldoret, Kenya. Submitted to Journal of Lakes and Reservoirs: Research and Management.

- **Aura, M.C.,** Raburu, P.O., Herrmann, J. and Kaka, A. (2009). The Effect of Nutrient Levels on Macroinvertebrates in Rivers Kipkaren and Sosiani, River Nzoia Basin, Kenya. Submitted to the African Journal of Ecology.

- **Aura, M.C.,** Raburu, P.O. Herrmann, J. and Becha, H. (2009). Macroinvertebrate Index of Biotic Integrity for Assessing the Water Quality of Rivers Kipkaren and Sosiani, Nzoia River Basin, Kenya. Submitted to the African Journal of Eology.

- Agembe, S.W., Raburu, P.O. and Aura, C.M. (2009). The Effects of Point and Non-Point Sources of Pollution on Fish Abundance and Diversity in River Mbogo, Nyando River Basin, Kenya. Submitted to the African Journal of Ecology.

- **Aura, M.C.,** Ngugi, C.C., Nyonje, B. & Mbaru, E. (2009). Effects of Three Different Feed Types on Growth Performance of African Catfish fry, *Clarias gariepinus*. Submitted to Journal of Aquaculture Economics and Management.

- **Ochiewo, J.**, de la-Torre Castro, M., Muthama, C., Munyi, F., Nthuta, J.M. (In press). Socio-economic Features of the Sea Cucumber Fishery in Southern Coast of Kenya. *Ocean and Coastal Management.*

- Shaghude Y.W., Mburu J. W, Uku J., Nyandwi N**., Magori C**., Ochiewo J., Mwaipopo R., Sanga I., Arthurton R.S. (2008): Sand Supply to Kenyan and Tanzanian Beaches, *Re-submitted to Western Indian Ocean Journal of Marine Science*.

- **Ndungu J.,** Maathius B., And Salama M., (2009) Real-time monitoring of total suspended sediments using SEVIRI (Spinning Enhanced Visible and InfraRed Imager) instrument on Board Meteosat Second Generation satellite (TRES-PAP-2009-0346*)(Submitted).*

- **Bosire J. O., Kairo J. G. ,** Langat J. **, Kirui B. ,** Onduso G. , Obinga A. , Orwenyi M. , Mangee F. Are current management regimes supporting sustainable utilization of mangroves in the Southern coast of Kenya? Submitted to Aquatic Conservation and currently under review

- **James G. Kairo, J. Bosire, J.** Langat, B**. Kirui**. Allometry and Biomass Partitioning in Replanted Mangroves. Submitted to Aquatic Conservation and currently under review of Kenya

- Shaghude Y.W., Mburu J. W, Uku J., Nyandwi N., **Magori C**., Ochiewo J., Mwaipopo R., Sanga I., Arthurton R.S. (2008): Sand Supply to Kenyan and Tanzanian Beaches, Re-submitted to Western Indian Ocean Journal of Marine Science.

- **Charles Magori** – The role of monsoonal forcing on shoreline change: The cases of Bamburi, Kenya and Kunduchi, Tanzania. Manuscript submitted to WIOMSA Journal of Marine Science.

- **B. O. Ohowa, E. Okuku, S. Mwangi, D. Munga, M. M. Nguli, J. N. Kamau**, V. W. Wayayi, J. Gatagwu, J. Kilonzo, P. Okumu, M. Mkonu, J. Kilonzi.(20??). Hydrodynamics, temporal and spatial dynamics of nutrients and plankton biomass in Funzi Bay – Shimoni-Vanga area, Southern coast of Kenya.

- **Oduor-Odote P.M**., Shitanda D., Kituu G & Obiero M. (2009). Comparative Drying Performance of Mackerel (*Rastrelliger kanagurta*) in a Solar Tunnel Dryer and an Open-air Raised Drying Rack. Submitted to Western Indian Ocean Journal of Marine Sciences

- **Oduor-Odote, P.M**.; Maurice Obiero.; Cyprian Odoli **(2009).** Influence of 4 tree species on organoleptic characteristics, insect and mould infestation of smoked marine catfish (*Galeichthys feliceps*) and African catfish (*Clarias gariepinus*) in Kenya. Submitted to Turkish Journal of Fisheries and Aquaculture

- Kituu, G.M,; Shitanda, D,; Kanali, C.L.; Mailutha J.T.; Njoronge C.K.; Wainaina, J.K.; **Oduor-Odote, P.M.;** Silayo, V**(2008**). A Simulation Model for Optimizing the Design and Performancce of a Solar Tunnel Fish Dryer. Submitted to Journal of Food Engineering.

- Kituu, G.M,; Shitanda, D,; Kanali, C.L.; Mailutha J.T.; Njoronge C.K.; Wainaina, J.K.; Silayo, V.; **Oduor-Odote, P.M**.; **(2008).** Influence of Brining on the Drying Parameters of Tilapia *(Oreochromis Niloticus)* in a Glass-covered Solar Tunnel Dryer. Submitted to Nigerian Food Journal.

- Badii, F.;**Oduor**-**Odote P.M,** J. Kazungu, L. Abbey, R. Kandando, B. Shamasundar, C.S. Cheow & N.K. Howell, (**2007)** Composition and nutritional analysis of under-utilised fish species in Africa and Asia. *J. Food Biochemistry*. Accepted.

8.4 Technical Reports

- Gladys Okemwa and E. Kimani. 2008. Dynamics of the Shimoni - Vanga Fishery. KMFRI Technical Report. July 2008.

- Edward Kimani, J. Ochiewo, P. Loki, N. Gichuru. 2008. Malindi-Ungwana bay artisanal fisheries and socio-economic report. KMFRI annual Report.

- Gladys Okemwa and E. Fondo. 2008. Fisheries Catch Assessment Monitoring at the Southcoast of Kenya. KMFRI Technical Report. July 2008.

- Cosmus Munga and D. Odingo. 2009. Development of a demonstration/experimental seaweed nursery for *Kappaphycus alvarezi* (Cottonii) and *Eucheuma denticulatum* (Spinosum) in the south coast of Kenya. Findings of fisheries information for Environmental Impact Analysis of the proposed seaweed project.

- Jan Robinson, Melita Samoilys, Simon Agembe & Narriman Jiddawi. 2009. Incorporating reef fish spawning aggregations into optimal designs for no-take fishery reserves: Strengthening fisheries management and coral reef resilience in the Western Indian Ocean. MASMA Progress Report. June 2009

- The social and economic features of the sea cucumber fishery in the coast of Kenya.

- Land Use patterns and socio-economic impacts of the mangrove die-back on the livelihoods of the local people

- **Oduor-Odote, P.M.(2008)** "Emerging Issues on Improved Fish Processing by Smoking and Solar Drying for Food Security and Environment Conservation". STATUS REPORT. KMFRI, P.O. Box 81651, Mombasa, Kenya. Submitted to Lighthouse Foundation. July 2008.

- Shitanda, D; Shilayo, V.; **Oduor-Odote**, P.M; Bonjoyereire, J **(2008).** Development of an integrated solar tunnel dryer for fish drying along Lake Victoria.Year II TECHNICAL REPORT. Submitted to VIC RES, P.O. Box 7110, KAMPALA UGANDA.Nov 2008
- **Oduor-Odote, P.M. (2008)** "Influence of Locally Available Trees or Tree Products (Acacia, Prosopis, Neem and Coconut husks) on Quality and Post Harvest Losses of Smoked Marine and African catfish in Kipini and Tana-Delta areas of Kenya". A TECHNICAL REPORT submitted to WIOMSA. Dec 2008

8.5 Research Proposals submitted:

- 2 research proposals were submitted during the period. One was submitted to MASMA for consideration while the other was submitted to OSSREA for consideration(SOCECON)
- Mailutha T.J.; Shitanda D; **Oduor-Odote P.M** & Kituu G**. (2009)** Solar Tunnel Fish Dryer Technology Improvement and Dissemination. Submitted to JKUAT Inovation Fund (SOCECON)
- **Oduor-Odote *et a*l (2008)** Bioactive Fish Products Using Improved Drying and Fermentation Processes in Africa and Asia (Kenya Component). Submitted to Project coordinator (Prof. Nazlin Howell, University of Surrey, UK) for review for transmission to the EU as part of EU INCO for Funding (Natural products)
- **Oduor-Odote, P.M (2009).** A hybrid solar tunnel dryer and windmill system for fish drying at Kipini in the North coast of Kenya Submitted to the National Council for Science and Technology, Nairobi. (Natural products)
- Ndungu: Application of remote sensing in Spatial Temporal Assessment of the stability and resource use efficiency in Natural Phytoplankton communities: Case study of the Kenyan coast (Awaiting feedback) (MEEP)
- Ndungu: Real-time monitoring of total suspended sediments using meteosat second generation satellite (awaiting feedback) (MEEP)
- Ndungu: Application of Remote Sensing in Assessment of the Effects of Climate Change on Marine and Coastal Productivity(MEEP)
- Nguli: Participation in creation of a pre-proposal (>US$ 6,000,000) on PIRE, prepared and submitted-University of Dar Eslaam (Tanzania), Univerity of Makerere (Uganda); University of Nairobi(Kenya), KMFRI, University of Minnesota(USA), and University of Stony Brook NY, USA(MEEP)
- Development of Management Plan for Nyali-Bamburi-Shanzu beaches with special focus on Jomo Kenyatta Public Beach-Awaiting review(MEEP)
- Spatial Resource Inventory (SRI) for integrated management of Marine protected areas in Kenya.-unsuccessful(MEEP)
- The influence of climate change on water quality and implications on public health: A case study of Ramisi-Shimoni-Vanga area(MEEP)
- Suitability mapping for aquaculture – submitted to the National Task Force on Aquaculture (IDM)

- Small scale aquaculture as an alternative livelihood initiative for coastal communities in Kenya. Collaborators; ECO ETHICS Kenya, FiD. ***Concept accepted by ReCoMaP: Full proposal submitted May, 2009***. (AQUA)
-
- Pond culture of finfish as an alternative livelihood initiative for coastal communities in Kenya. ***Proposal submitted to NCST, March 2009 (Final Response not received)***.
- Guidelines for cultivation of seaweeds in Kenya. ***Concept accepted by ReCoMaP. Full proposal submitted June, 2009***(AQUA)
-
- Management of Food Security Climate Risks through Integrated Aquaculture for Local Communities in the Kenyan Coast. ***Submitted to development Market Place***
- Improvement of living standards of rural communities in Kenya through Artemia production in coastal saltworks. ***Submitted, to Vlir-Belgum: Concept Accepted.*** (AQUA)
-
- Quality assessment and ecology of Artemia population found in Malindi saltworks-Kenya**.** ***Submitted to IFS; May 2009.*** (AQUA)
-
- Developing and expanding mariculture using economically viable and environmentally sustainable innovation in the coast of Kenya. ***Submitted to KAAP, March 2009 (Final Response not received)*** (AQUA)

8.6 Research Proposals funded

- Distribution of the pathogenic *Vibrio cholerae* strains in aquatic environments in coastal areas of the western Indian Ocean: case study of Tanzania and implication to cholera outbreaks and control(MEEP& SOCECON)
- An assessment of the socioeconomic impacts of environmental degradation caused by climate change: a case study of Faza Island, Lamu District – Kenya. (SOCECON)
- Development of an integrated solar tunnel dryer for fish drying along Lake Victoria- **VIC RES $ 9,444 (Natural products)**
- Up scaling of Improved Fish Processing by Smoking and Solar Drying to Shimoni in the Kenyan south coast for Food Security, Poverty Alleviation and Biodiversity Conservation (PHASE III) . Lighthouse Foundation **EU 28,400(Natural products)**
- Construction of more Improved Fish Smoking Ovens at Moa In Tana Delta- Lamu Area by Peter M. **Oduor-Odote** (**2009**) Funded by Safaricom Foundation **Ksh300,000/=(Natural products)**
- Optimal use of Locally Available Trees or Tree Products for Smoking of African and Marine catfish to prevent Post Harvest Losses and Improve Quality as a Measure for Conservation of Aquatic Resources in Kipini and Tana-Delta Areas of Kenya. By Peter M**. Oduor-Odote** and

Prof. Douglas Shitanda (JKUAT) **Funded by** Commission for Higher Education, **(2008**) **through JKUAT (Natural products)**

- Ndungu: The use of MERIS for management of optically complex waters(Funded) (MEEP)

- Munga: Magori, Nguli, Gwada and Steve: Hydrodynamic Modeling Partnership Project for Kenyan Coastal Waters – Submitted to IOC of UNESCO. Proposal Funded – US$ 10,000 (MEEP)

- Integrated Salt-Artemia production and Mariculture in a mangrove wetland in the Kenya Coast, submitted to the Commission for Higher Education (CHE). (AQUA)

- **Integrated culture of the mud crab, S*cylla serrata*, within Mida creek mangroves, coastal Kenya (CHE)** (AQUA)

- Development of a demonstration/experimental seaweed nursery for *Kappaphycus alvarezi* (cottonii) *and Eucheuma denticulatum* (spinosum) in the South Coast of Kenya. (ReCoMaP) (AQUA)

8.7 Value added documents

- IDM Program brochure

- Nairobi Convention Information Clearinghouse System poster
- MEEP Biannual report 2008
- Environmental Impact Assessment for the proposed seaweed farming areas in South Coast Kenya, April 2009. 96pp
- Environmental Impact Assessment for the proposed seaweed farming areas in south coast Kenya, april 2009. 96pp
- **Oduor-Odote P.M. (2008)** Process line for hot smoked marine fish. A User's guide .**DVD.** Funded by Lighthouse foundation

- **Oduor-Odote, P.M (2008)**. Mfumo wa ukaushaji samaki kwa kutumia kuni ama makaa. Toleo la watumiaji. Kimetayarishwa kwa manufaa ya Mashirika ya huduma kwa jamii mashinani. **DVD**. Mradi umefadhiliwa na Lighthouse foundation

- **Oduor-Odote**, P.M (2008) Process line for solar dried marine fish for the local market-A user's guide **DVD**. Prepared for Community based groups- Funded by Lighthouse foundation

- **Oduor-Odote**, P.M **(2008)** Mfumo wa ukaushaji samaki kwa kutumia nguvu za jua. Toleo la watumiaji. Kimetayarishwa kwa manufaa ya Mashirika ya huduma kwa jamii mashinani. **A DVD**. Mradi umefadhiliwa na Lighthouse foundation

- **Oduor-Odote, P.M (2008)** Ukaushaji samaki kwa kutumia kuni ama nguvu za jua. Toleo la watumiaji. **DVD** Kimetayarishwa kwa manufaa ya Mashirika ya huduma kwa jamii mashinani. Mradi umefadhiliwa na Lighthouse foundation.

- **Oduor-Odote**, P.M **(2008**). A guide for dried and hot smoked marine fish**. DVD.** Prepared for Community based groups. Funded by Lighthouse Foundation.

- Aquaculture Research program Brochure

- Ornamental Fish production brochure

- Guidelines for seaweed cultivation in Kenya (Draft)

8.8 Trainings attended

- Christopher Aura. Master of Philosophy in aquatic sciences, Moi University.
- Esther Fondo. Fisheries Data collection and analysis. 29th September-17th October, 2008.Wagningen International. The Netherlands.
- Edward Kimani is a member of the technical team for the preparation of Ungwana-bay Prawn Fishery management plan
- Edward Kimani is member of the WWF/FD lobster certification process
- Miss Fridah Munyi has trained under the CAMARV project on the application of GIS to address socio-economic issues.
- GEOMETCast Training April 2009, at Regional Centre for Mapping and Surveying, Kasarani, Nairobi (Dr. Nguli)
- AMESD training on Physical Oceanography and Remote Sensing-8-20 June 2009, Mauritius (Dr. Nguli)
- Seaweed Nursery technical report

- Training workshop in Physical oceanography and Ocean Remote Sensing, June 7 – 22, 2009 at Quatre bornes- Mauritius (Jane Ndungu)
- Regioanal training on overview of nuclear applications related to marine contamination 24th May- 4th June 2009, Cairo, Egypt
- ISO – QMS Auditors training workshop at KMFRI Mombasa MARCH 23 – 26TH 2009(Gwada, Dr. Munga,);
- Enhancing regional capability for the assessment of contamination in Marine Environment, Monaco, 1-3 December 2008
- Capacity building workshop for national agricultural research system 13th October-2nd November 2008, Embu staff training college
- Regioanal training on overview of nuclear applications related to marine contamination 24th May- 4th June 2009, Cairo, Egypt
- GOK training on performance management conducted by the Public Sector Reforms and Performance Contracting Secretariat (under Office of Prime Minister) at the Utali college, Nairobi, from 19th – 21st march 2009 (Gwada).

- Community Meeting-1: seaweed EIA stakeholder induction meeting at Funzi and Shimoni on 11th June 2009 (Mwangi, Dr. Munga, Gwada)
- **Mr. Cyprian Odoli** has returned after completing his Msc training in Iceland on fish processing and handling. **Thomas Dzeha** completed his PhD studies in Australia

- Fish nutrition training for KMFRI's Aquaculture team. 30th March – 3rd April 2009. KMFRI, Mombasa.
- Training on construction and assemblage of glass aquaria for ornamental fish marketing, 15th – 19th June 2009. KMFRI, Mombasa

8.9 Conferences/workshops

- Kimani E. N. Third South West Indian Ocean Fisheries Commission Scientific Committee (SWIOFC) Meeting. Maputo, Mozambique, 16-19 September 2008.
- WIOFISH workshop. 2nd -3rd March 2009, Panari Hotel, Nairobi, Kenya
- Simon Agembe. Forth International Conference 22-26 September 2008, Addis Ababa, Ethiopia.
- Kimani E. N. and G. Okemwa. KCDP proposal development meeting, 2nd -15 June 2009, Mombasa Kenya.
- Kimani, E. N., and C. Munga. SWIOF crustacean fisheries information and data gap analysis meeting. 20-22 April 2009, Durban, South Africa.
- Kimani E. N. and G. Okemwa. Fishery Department KCDP Stake holder meeting for North Coast. May 6, 2009 Aden Rock Hotel, Malindi.
- Kimani, E. N., G. Okemwa- Kenya Coast Development Project (KCDP) preparation retreat. 15-19 May, 2009. Sun and sand Hotel, Mombasa.
- Prawn Fishery Management Plan technical committee meeting, December 23-24 2008, Mombasa.
- Kimani, E. N.-STIMSON Research Centre Workshop on Climate Change in the Indian Ocean, Colombo Sri-Lanka 18-19 March 2009.
- Kimani E. N., G. Okemwa, E. Fondo-Coastal Fisheries Information Forum organised by the Fisheries Department and funded by ReCoMap, Nyali Beach Hotel, 3 – 4t March 2009.
- ASCLME regional meeting of Technical Coordination Groups, **Mauritius**. From **27/09/08** to **4/10/08**
- Oil Spill Training on Thur 11 Dec 08 at Royal Court Hotel
- ASCLME regional meeting of Information & Data Management Coordinators, Grahamstown, South Africa, 7/2/2009 – 14/2/2009
- National Meeting for Launching the Coordinating Group (GOG) UNDP-GEF Project on Agulhas and Somali Current Large Marine Ecosystem (ASCLME), Mombasa, 29 August 2008.
- ASCLME Regional meeting of Technical Coordinating Groups, La Plantation, Mauritius, 29 September – 1 October 2008.
- Agulhas and Somali Current Large Marine Ecosystem (ASCLME) Regional Project Coordination Forum, 2-4 October 2008, La Plantation, Mauritius.
- The Seventh Meeting of the Marine Science for Management (MASMA) Grantees: Monitoring the Performance of the Approved Projects, 26-26 October 2008, Mombasa, Kenya.

- WIOMSA/UNESCO/KMFRI/KMD Workshop on Numerical Modeling, 24 November – 5 December 2008, Nairobi, Kenya.
- Second Meeting of the Working Group of the San Marco Project on the Establishment of the Regional Centre for Earth Observation, Nairobi, 10 February 2009.
- National Environment Action Plan (NEAP) Meeting, Nairobi, 26 February, 2009.
- Coordinators' workshop on addressing national priorities through nuclear science and technology: 4-5 August 2008, KICC, Nairobi
- Coordinators' workshop on review of progress of IAEA funded projects on 14th November 2008, NCST, Nairobi
- The dispersant use policy presentation seminar to be held at KMFRI headquarters on 9 December 2008- Made a presentation on oil dispersants toxicity testing
- National taskforce on development of pollution control and prevention guidelines 24th May 2009, Mombasa beach Hotel
- IAEA Funded Projects' Coordinators Workshop, 6- 7th April 2009, KEBS, Nairobi
- Mangorove policy workshop, 4th July 2009
- National stakeholder's workshop on marine contamination, Nyali Beach Hotel, 24th March 2009
- KCDP Stakeholders workshop at Nyali Beach November 2008 (Mwangi, Dr. Bosire, Dr. Uku, Dr. Kairo, Dr. Kirui, Gwada)
- Worlds of the Indian Ocean Scientific Conference at National Museums of Kenya organized by the Aga Khan University from 17th – 23rd February 2009. (Gwada);
- KCDP workshops (Mwangi, Dr. Bosire, Dr. Uku, Dr. Kairo, Dr. Kirui, Gwada)
- Workshop on Precision Observations of Vertical Land Motion at Tide Gauges, 11-12 May 2009, Paris, France (Dr. Magori)
- Eleventh session of the Group of Experts on the Global Sea Level Observing System (GLOSS), 13-15 May 2009, Paris, France (Dr. Magori)
- Sixth Session of Indian Ocean Panel (IOP-6) Meeting, 3- 5 June 2009, La Reunion, France (Dr. Magori)
- Inception Workshop on the Project 'Distribution of pathogenic *Vibrio cholerae* strains in aquatic environments in coastal areas of East Africa' held at Panori hotel, Tanga, on 23/05/2009
- Twenty Third Greater Horn of Africa Climate Outlook Forum was attended on 2-4 March 2009, Travelers Beach Hotel, Mombasa
- Kenya Coastal Development Project Workshop. Nyali Beach Hotel. **20th -21st** November **2008**. A project of the World Bank.
- The marine and coastal research retreat workshop for Mombasa Centre. Mnarani Club, 18th - 25th July **2008 . Funded by KMFRI.**
- Kenya Coastal Development Project Workshop. Held at Sun n Sand April 2009
- Kenya Coastal Development Project Workshop. World Bank Mission Meeting. Held at KMFRI 8th to 19th June 2009

- Second Agricultural Sector Conference, Safari Park Hotel Nairobi 10th – 12th November 2008
- Sea cucumber regional project final workshop; Sai Rock Hotel Mombasa; 28th – 30th October 2008
- Vietnam Fisheries Network Aquaculture International Conference Hanoi Vietnam December 8th – 9th 2008
- Kenya Coastal Development Project (KCDP) stakeholders workshop, Nyali Beach Hotel; Mombasa; November 2008
- Community Baraza for project appraisal and training workshop for two new methods (LAG and broadcasting) of seaweed farming; Kibuyuni (South coast) 26th – 27th February 2009.
- World Bank Mission for appraisal of the Kenya Agricultural Productivity Project 24th March – 6th April 2009. KARI Headquarters; Nairobi.
- Kenya Coastal Development Project (KCDP) pre-appraisal workshop held at KMFRI, 8th – 19th June 2009
- National Aquaculture Working Group Workshop to develop the National Aquaculture Development Strategy for Kenya, 18th - 26th April 2009; Nakuru.
- Policy makers workshop organised by Kwetu training centre for CDTF advocacy project held at Kanamai conference hall (Mtwapa) on 8th May 2009
- Gazi UNDP project initiative workshop held on 17th April 2009 at Diani Resort-Ukunda
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8.10 Workshop Coordination

- Kenya Coastal Development Project (KCDP) stakeholders workshop, Nyali Beach Hotel; Mombasa; November 2008
- Kenya Coastal Development Project (KCDP) component leaders meeting, KMFRI 28th October; 2008
- Kenya Coastal Development Project (KCDP) 2nd World Bank Mission, KMFRI 18th – 27th November 2008
- Kenya Coastal Development Project (KCDP) stakeholders workshop, KMFRI; Mombasa; 27TH February 2009
- Kenya Coastal Development Project (KCDP) stakeholders workshop, Sun N Sand; Kilifi; 15th - 19th May 2009
- KCDP Preappraisal Workshop in Mombasa from 8th – 19th June 2009
- Coordinators' workshop on review of progress of IAEA funded projects on 14th November 2008, NCST, Nairobi
- Community baraza for project appraisal and training workshop on seaweed farming in Kibuyuni-26-27 February 2009.

8.11 Professional contributions

- Edward Kimani is a member of the technical team for the preparation of Ungwana-bay Prawn Fishery management plan
- Edward Kimani is member of the WWF/FD lobster certification process
- Socio-economics expert in the State of the Coast Report for Kenya

- Socio-economics expert in the WIO-Lab project's Transboundary Diagnostic Analysis (TDA).
- I am a member of a task force for the development of prawn fishery management plan.
- I am a member of a committee established to identify, evaluate and recommend areas that the proposed KMFRI business wing should focus on.
- Oil Dispersant Use Policy for Kenya
- *NEMA-ICAM-DANIDA Task force on information management*
- *Dra*ft Information management policy for KCDP
- Member of Shoreline Management Task Force.
- Resource Person at the Numerical Modeling Workshop that was held at the Kenya Meteorological Department (KMD) in Nairobi (24 November – 5 December 2008) with funding from WIOMSA and IOC/UNESCO.
- Assisting in the drafting of the National Environment Action Plan (NEAP).
- Development of oil dispersant use contingency plan
- Chair, National taskforce on development of pollution control and prevention guidelines
- Focal point contact: coordination and activation of IUCN Activities in Eastern and Southern Africa region (Gwada)
- Focal point contact: WWF – EAME Activities in Eastern Africa Marine eco-region (Gwada)
- Focal point contact: coordination and activation of WIOMSA Activities in Kenya (Dr. Uku)
- Member IUCN Commission for Ecosystem management (Dr. Bosire)
- Chair Project Implementation Committee of Kwetu Mangrove Project funded by CDTF (Dr. Bosire)
- Project Manager, KCDP: Overall coordination and Component 6 on Capacity building, monitoring and evaluation and project management (Dr. Bosire)
- Cruise Coordinator for Kenya in the Implementation of the regional ASCLME Project (Dr. Magori)
- Member of Shoreline Management Task Force (Dr. Magori)
- GLOSS Regional Coordinator and coordination of sea level activities in Kenya as well as WIO region (Dr. Magori).
- Member of KMFRI Sub-Committee tasked with reviewing Environmental Impact Assessment (EIA) Project reports for NEMA (Ohowa).
- Development of oil dispersant use contingency plan (Okuku)
- Member National Aquaculture Development Working Group

8.12 Community Workshops

- Community Meeting-1: seaweed farming stakeholder induction meeting at Shimoni on 4th December 2008 together with aquaculture team
- Community Meeting-1: seaweed EIA stakeholder induction meeting at Funzi and Shimoni on 11th June 2009

- KCDP Stakeholders workshop at malindi (Mwangi, , Dr. Uku,)
- Launch of the oceans and fisheries policy on april 6th 2009 at Mkomani public beach, English point, Mombasa, presided by the Prime Minister of Kenya, Rt. Hon. Raila Odinga
- 1 final stakeholders workshop was organized to conclude the MASMA sea cucumber project
- Training workshop on improved fish processing by smoking held in Shimoni with the Fisher-folk group at KWS centre on 30th April, 2009.
- 3rd workshop on strategy to fund construction of more improved fish smoking ovens in Tana delta region held in Garsen at Carita's on 23rd April 2009
- 4th workshop on strategy to fund construction of more improved fish smoking ovens in Tana delta region held in Garsen at Carita's on 20th June 2009
- Gazi community consultative meeting on UNDP small grants project. Gazi, 12th February 2009.
- Community Baraza on new initiative for seaweed farming; Kibuyuni (South coast) 4th December 2008
- Community Baraza for project appraisal and training workshop for two new methods (LAG and broadcasting) of seaweed farming; Kibuyuni (South coast) 26th – 27th February 2009.
- KCDP Fisheries stakeholders meeting held in Eden Roc Hotel 5th June 2009.

8.13 Student Supervision

- 2 Bachelor of Science students, one from Maseno University and the other from the University of Nairobi have been supervised during the period.(Mr Ochiewo)
- 1 MSc student from Stockholm University was supervised during her field work in Kenya between November and December 2008 (Mr. Ochiewo)
- Co-Supervisor Nairobi University MSc (Aquaculture) student (Dr. Betty Nyonje)

9.0 Challenges