Agulhas and Somali Currents Large Marine Ecosystems Project

Capacity Building and Training Component

National Training Plan for

Tanzania

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EXECUTIVE SUMMARY

This project is part of a multi-project, multi-agency Programme (The Programme for the Agulhas and Somali Current Large Marine Ecosystems) to institutionalize cooperative and adaptive management of these LMEs. A phased approach is planned that progressively builds the knowledge base and strengthens technical and management capabilities at the regional scale to address transboundary environmental concerns within the LMEs, builds political will to undertake threat abatement activities and leverages finances proportionate to management needs. The Programme includes two parallel projects, one that addresses land-based sources of pollution (WIO-LaB, implemented by UNEP); and one that builds knowledge for the purposes of managing industrial fisheries (SWIOFP, implemented by the World Bank).

An integral component of the project involves training and capacity building. This document provides a foundation for the Training component of the ASCLME Programme by providing a synthesis of the National training requirements of Tanzania. The aim of the synthesis of the National training requirements is to put in place training programmes which should serve to develop the capacity required in order to effectively implement the various project activities as well as increase the capacity of stakeholders to effectively address the environmental concerns and sustainably manage marine resources and thus maintain the economic, food security and livelihood benefits that can be derived from them.

Three different methods were used to collect information used in evaluating training activities for developing the capacity building and training (CB&T) needs assessment for the ASCLME project in Tanzania. The major source of information was the review of national, regional and international CB&T needs assessments that have been conducted in the past and related to ASCLME Project themes and sectors of concern. Included in this review were also programme need assessment reports prepared by universities and other training institutions prior to launching of long and short-term training programmes related to ASCLME Project thematic areas.

The second major source of information for identification of training needs and capacity for meeting these needs was by the use of questionnaires targeting professionals from different categories of stakeholders including government and academic institutions, private sector, decision makers, and community groups. Respondents were asked to respond to the questions on the general awareness of issues of concern within ASCLME Project thematic areas of fisheries, aquaculture, tourism, ports and harbours, coastal mining, municipal waste water, agriculture and forestry. They were also asked to undertake a self-evaluation for their competencies in project management skills, professional skills, fisheries management skills and technical skills.

The third method of gathering information for this training needs assessment was based on the consultants' observations as well as from personal interviews with some senior staff members from project implementing institutions in Tanzania. These institutions include Fisheries and Aquaculture Divisions in the Ministry of Livestock Development and Fisheries, Marine and Coastal Environment Management programme (MACEMP), Tanzania Fisheries Research Institute (TAFIRI), Marine Parks and Reserve Unit (MPRU), National Environment Management Council (NEMC), Tanzania Coastal Management Programme (TCMP), Fisheries Training Institutes and relevant departments of the University of Dar es Salaam and Sokoine University of Agriculture.

The findings from the three sources of information showed that there are broad ranges of formal education institutions in the country offering courses that are of relevance to the ASCLME Project thematic areas. The awards offered by these institutions range from certificate, diplomas, Bachelors' degree, Masters and Ph.D. These include; Universities, colleges and other technical training institutions. In addition, there are various local, regional and international programmes with TCB components that have organized various short term capacity building activities in Tanzania focusing on training experts on different subjects ranging from broader topics such as ICM and ecosystem approaches to coastal and ocean management to very specialized ones such as nutrient analysis for marine waters and coral reef restoration and remediation. Further, there are several agencies for International Development and Regional projects that support long term postgraduate research programmes of national and regional importance that seeks to contribute to the knowledge and understanding of coastal and marine environment of the region, to raise awareness of coastal and marine issues, and to disseminate information and data for sustainable use of coastal and marine resources.

There are several knowledge gaps and deficiencies in technical expertise on some aspects within the ASCLME Project thematic areas that would have to be addressed through CB&T programmes. Some technical areas where capacity is inadequate include mariculture pond siting (zoning) and approval system, fish taxonomy and collection curation, Geographic Information Systems (GIS) for modeling purposes, environmental auditing, communication gap between researchers and policymakers, coastal circulation and hydrodynamic modelling, marine and coastal governance, and strategic planning. There is need for ASCLME Project to ensure that the training programmes developed are able to impart hands on technical skills to people of different cadres within the society.

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1.0 INTRODUCTION

The Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project is part of a multi-project, multi-agency Programme (The Programme for the Agulhas and Somali Current Large Marine Ecosystems) to institutionalize cooperative and adaptive management of these LMEs. A phased approach is planned that progressively builds the knowledge base and strengthens technical and management capabilities at the regional scale to address transboundary environmental concerns within the LMEs, builds political will to undertake threat abatement activities and leverages finances proportionate to management needs. In addition to the ASCLME Project, the Programme includes two parallel projects, one that addresses land-based sources of pollution (WIO-LaB, implemented by UNEP); and one that builds knowledge for the purposes of managing industrial fisheries (SWIOFP, implemented by the World Bank).

The activities within the ASCLME Project are focused on filling the significant coastal and offshore data and information gaps for these LMEs by capturing essential information relating to the dynamic ocean-atmosphere interface and other interactions that define the LMEs, along with critical data on artisanal fisheries, larval transport and nursery areas along the coast. The overall objective of this data capture will be to deliver national Marine Ecosystem Diagnostic Analyses (MEDAs) within the Western Indian Ocean (WIO) countries that feed into a Transboundary Diagnostic Analysis (TDAs), and a Strategic Action Programmes (SAP). A key output of the programme is that of capacity building and training (CB&T) in relation to the long-term LME monitoring and management process. There is a need to identify institutional, programme and human capacity building requirements and for these to be addressed through training initiatives.

Within this context, the ASCLME Project sub-contracted the CB&T specialist (consultant) in each of the WIO countries (Kenya, Tanzania Mozambique, South Africa Madagascar, Seychelles, Comoro and Mauritius), to undertake a review of national and regional training and capacity building initiatives, identify key gaps, and assist the national CB&T coordinator in producing a draft, comprehensive regional work programme.

The overall aim of this CB&T consultancy was to lead to the development of a Draft Training Plan, based on the outcome of the overview of current and planned national and regional training and capacity building initiatives and needs, and propose start-up training projects (priorities) and activities including a work plan and budget. (Refer to Terms of Reference in Appendix II).

2.0 Covered in previous documents

3.0 METHODOLOGY

Different methods were used to gather information used in evaluating training activities for developing the capacity building and training (CB&T) needs assessment for the ASCLME project in Tanzania. The major source of information was the review of national, regional and international CB&T needs assessments that have been conducted in the past and related to ASCLME Project themes and sectors of concern. The local institutions and programmes whose training needs assessment reports or core/priority training areas documents were consulted include Fisheries and Aquaculture Divisions in the Ministry of Livestock Development and Fisheries, Marine and Coastal Environment Management Programme (MACEMP), Tanzania Fisheries Research Institute (TAFIRI), Marine Parks and Reserve Unit (MPRU), National Environment Management Council (NEMC), Tanzania Coastal Management Programme (TCMP), UNEP/GPA in collaboration with the UNESCO-IHE (i.e. capacity needs in waste water management in Tanzania), and Integrated Coastal Management (capacity in ICM) (Kiambo *et al*. 2001). Programme needs assessment reports prepared by universities and other training institutions prior to launching of long and short-term training programmes related to ASCLME Project themes were also reviewed. These programmes included those offered at the Universities of Dar es Salaam, Sokoine University of Agriculture, University of Dodoma, Ardhi University, Fisheries training institutes (Mbegani and Nyegezi) and Dar es salaam Maritime Training Institute.

The second major source of information for identification of training needs and capacity for meeting these needs was by the use of questionnaires. In the general information section of the questionnaire respondents were asked to name areas they are involved in at their place of work and respond to the questions on the general awareness of issues of concern within ASCLME Project focal areas of fisheries, aquaculture, tourism, ports and harbours, coastal mining, municipal waste water and agriculture and forestry. Part two of the questionnaire was used to evaluate project management skills, professional skills, fisheries management skills and technical skills. Respondents were requested to undertake a self-evaluation indicating whether they considered themselves to be experts, skilled, apprentices, beginners or lacked experience in various areas. In part three respondents were requested to provide a list of training courses and workshops that they have attended in the region as well as to provide a list of colleges and universities that provide training in topics related to the already identified ASCLME target sectors. Part four was used to evaluate the strengths and weaknesses of past courses attended by the respondents. Respondents were also requested to recommend modes of delivery of training courses. The major limitation of the questionnaire survey is the small sample size since many eligible respondents did not fill and return the questionnaires. A total of 32 respondents filled the questionnaire. However, from the responses provided it was clear that similar issues and concerns were raised by most of the respondents therefore making this assessment representative and reflective of the general needs.

The third method of information gathering was based on the consultants' observations as well as from personal interviews with some senior staff members from project implementing institutions in Tanzania. These institutions include Fisheries Division, Marine and Coastal Environment Management programme (MACEMP), Tanzania Fisheries Research Institute (TAFIRI), Marine Parks and Reserve Unit (MPRU), National Environment Management Council (NEMC), Tanzania Coastal Management Programme (TCMP), fisheries training institutes and relevant departments of the University of Dar es Salaam and Sokoine University of Agriculture.

The three sources of information used in this study helped the consultant to identify key gaps in CB&T for each of the priority areas of ASCLME Project and develop a Draft Training Plan to address the gaps.

4.0 INVENTORY OF CURRENT EDUCATIONAL CAPACITY IN TANZANIA

4.1 General

Since independence the education and training system of Tanzania has gone through distinct regimes, primarily influenced by changing political objectives and economic constraints. Tanzania adopted 'Education for Self-Reliance' in 1967 and after 1968 "formal education comprised seven years of primary, four years of 'ordinary' secondary and two years of 'advanced' secondary education", replacing the post Second World War system of 4 years of primary and 4 years of middle school which were then the prelude to secondary schooling (Buchert 1994). The structure of the formal education and training system today is 2-7-4-2-3^{+}, the first 2 years comprise pre-primary education. Other changes made in post 1968 era included the introduction of Swahili as the sole teaching language in primary schools and the setting of a target to achieve Universal Primary Education (U.P.E.) by November 1977. The objective was a transformation into a mass educational system, whereby formal study could end for most after seven years (Ministry of Education 1968).

4.2 Primary education

Primary education is the base of higher education including technical education and training (Figure 1). Primary school is compulsory and enrolment has increased from 3.94 million in 1996 to 8.32 million in 2007 (MoEVT 2009). In 2008 154,895 teachers were teaching the total pupil population of 8,410,094. The T: P ratio sums of 1:54 were well above the norm of 1:45. Remarkable achievements in primary school education in Tanzania were registered following the implementation of Primary Education Development Programme (PEDP: 2002-2007). These include increased number and quality of teachers and classrooms as well as increased supply of books. The transition of pupils from primary to secondary has also increased due to increased secondary education facilities made possible through Secondary Education Development Programme (SEDP: 2004-2009).

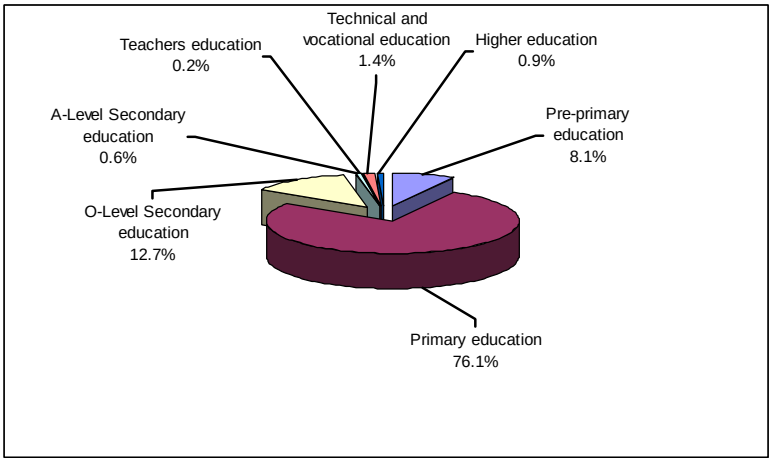

Figure 1: Education enrolment pie chart by level, 2009 (*Source*: MoEVT 2009)

4.3 Secondary education

Secondary education is split into ordinary and advanced level secondary education. The enrolment stood at 1,222,403 in 2008 (compared to 261,951 in 2000) with a teaching force of 32,835 (MoEVT 2009). The teacher pupil ratio increased from 1:23 in 2004 to 1:37 in 2008, while the norm is 1:30. The majority of teachers in Ordinary level secondary schools are diploma holders while those at Advanced level have at least Bachelor degrees. Secondary education enrolment of 20% in Tanzania is among the lowest in the world.

Generally, the contents of primary, secondary and high school curricula have negligible contribution towards imparting marine and coastal knowledge to the pupils.

4.4 Technical and Vocational Education (TVET)

Technical and vocational education and training in Tanzania is offered in three types of programmes: long/basic courses, short courses and outreach programmes for informal sector operators (VETA, 2009). In year 2008 there were 889 vocational training centers, 21 agricultural and natural resources and environment institutions, 22 business and management institutions, 29 engineering and other sciences institutions, 94 health and allied sciences institutions, and 29 planning and welfare institutions offering technical and vocational education and training in Tanzania. A proportion of the agricultural and natural resources vocational training institutions located in coastal areas have curricula specialized in imparting marine and coastal knowledge. Approximately 60% of the 65 instructors employed in two VETA centres located in coastal areas in 2010 were experts in marine and coastal issues. Other marine and coastal related training are offered at Mbegani Fisheries Development Centre, Kunduchi Fisheries Institute and dare s Salaam Maritime Institute as shown in Table 1. Many of TVET institutions offer courses leading to the award of advanced diploma, ordinary diploma or certificate qualifications. To control the quality of TVET the National Council for Technical Education (NACTE) was established in 1997 to accredit and approve curricula for tertiary institutions other than universities.

Table 1: Long term training courses related to priority areas of ASCLME conducted by selected Technical Education Training Institutes in Tanzania in 2010.

INSTITUTE	**NUMBER OF STAFF ON POST**		**COURSES OFFERED**	**TRAINING FACILITIES**
	Total	**Experts in marine & coastal disciplines**		
Kunduchi Fisheries Institute (KFI)	12	12	• Fisheries Biology • Aquaculture • Navigation and Seamanship • Fish processing and quality control • Marine motor mechanics • Fisheries management	A 10 footer research boat with solar powered sea habitat mapping device, computer lab and library
Mbegani Fisheries Development Centre (MFDC)	20	18	• Fish Processing and Quality Control • Fishing Gear Technology • Refrigeration engineering • Marine engineering • Master fisherman • Aquaculture • Conducts periodic MCS training	Trawlers (MV Mafunzo, MV Jodari), purse seine (MV Nguru), 3 canoes for gill net and hand line fishery, computers and a library.

			programme under the sponsorship of EU through MCS Project in SADC countries.	
Dar es Salaam Maritime Institute (DMI)	22	15	• Engineering for Deck Officers • Survival at Sea, Fire Fighting, First Aid at Sea, Efficient Deck Hand, Electronic Navigation Systems, Radio Telephone, Advanced Fire Fighting, Navigational Control and Ship Captain Medical Guide	Radar, Global Positioning Equipment, Computer Aided Simulators, computers, life boat and a training workshop.

4.5 Higher Education

Universities and other higher learning institutions are key players in indigenizing knowledge and diffusing it into the national economy. As frontiers of knowledge and technology rapidly advance and competition between industrial firms and nations becomes fierce, industries have tended to turn to higher learning institutions such as universities for assistance to keep abreast with the frontiers of knowledge. By 2008 Higher education leading to the award of Bachelors, Postgraduate, Masters and Ph.D. degrees in Tanzania was being offered by 11 public and 17 private universities and university colleges. The 2008/09 total student population/enrolment in universities and university colleges is 82,237 (Table 2) with the number of female students constituting 33%.

Table 2: Enrolment in public and private universities and university colleges in 2008/09

INSTITUTIONAL CATEGORY	**DEGREE COURSE**				**TOTAL**
	Undergraduate	**Postgraduate**	**Masters**	**Ph.D.**	
Public Universities	52,440	856	5878	442	**59,616**
Private Universities	22,065	70	481	5	**22,621**
TOTAL	**74,505**	**926**	**6359**	**447**	**82,237**

Source: MoEVT (2009)

Training courses on themes related to the ASCLME project are mainly concentrated at the University of Dar es Salaam where two departments in particular, Aquatic Sciences and Fisheries and the Institute of Marine Sciences, have experts trained nearly in all aspects of coastal and marine sciences. Table 3 lists the undergraduate courses related to coastal and marine sciences run by different departments at the university of Dar es Salaam. These courses impart background knowledge that may then be built upon by short-term training and hands on activities.

Table 3: Training courses related to priority areas of ASCLME conducted by University of Dar es Salaam in 2011

DEPARTMENT	**NUMBER OF ACADEMIC STAFF ON POST**		**COURSES OFFERED**
	Total	**Experts in marine & coastal disciplines**	
Aquatic Sciences and Fisheries (DASF)	20	20	**BSc Courses** • Fisheries Biology and Stock Assessment • Aquaculture

			• Wetland Ecology • Ecology of Coral Reefs • Watershed Management • Oceanography • Aquatic Pollution • Fisheries Economics and Marketing • Law of the Sea and Inland Waters • Plankton Systematics and Ecology **MSc Course** • MSc in Fisheries and Aquaculture **Short course** • Fish taxonomy and collection curation
Institute of Marine Sciences (IMS)	19	19	• MSc in Marine Sciences
Zoology and Wildlife Conservation	26	3	**BSc Courses** • Conservation Biology • Applied Biostatistics • Ichthyology **MSc Course** • MSc in Biodiversity Conservation
Botany	16	4	**BSc Courses** • Algal Ecology and Systematics • Plant Systematics
Geography	24	5	**BA Courses** • Environmental Policy and Planning • Environmental Disaster Management • Natural Resources Management • Urban Transport, Planning and Management • Introduction to Geology and Geomorphology • Tourism and Leisure • GIS and Remote Sensing • Environmental Conservation Education
Institute of Resources Assessment (IRA)	22	6	• MSc in Natural Resource Assessment and Management (NARAM) **Short Courses** • Environmental Impact Assessment • Geographical Information Systems • Communicating Environmental Research to Policy Makers • Environmental Economics and Valuation • Integration of Population Variables in Development Planning • Training on Communicating Environmental Research to Policy Makers
Water Resources Engineering	13	5	• Management of Solid and Hazardous Wastes • Water Pollution Prevention and Control • Operation in Wastewater Treatment • Applied Hydrogeology
Economics	43	4	• Introduction to Microeconomic Analysis • Natural Resources and Environmental Economics

			• Cost-Benefit Analysis
School of Law	22	5	• Natural Resources Law • Environmental Law • Arbitration and Alternative Dispute Resolution
Archaeology Unit	8	1	• Tourism and Tour Guiding
Sociology and Anthropology	34	3	• Advanced methods of Social Science Research • Sociology of Rural Development • Family and Gender Relations

Recent admission trends of the universities and other higher learning institutions have indicated that there is the general decline of interest by the applicants for Science, Engineering and Technology courses (TCU 2009). Increasingly more candidates with science combinations opt to study commerce, law or other non-science disciplines. The basic reasons put forward to explain this trend include some short-term benefits evident from the current dominance of trade over direct science-based production system in the country and erosion of mathematical skills**.** There is thus an urgent need to redress the teaching of science and mathematics in Primary and Secondary Schools. Tanzania ought to address this matter urgently so as to create a critical mass of scientists in order to stimulate a rapid socio-economic development.

Currently, Tanzania is facing challenges of acute shortages of well-qualified workforce including in areas related to the priority areas of the ASCLME project. Apart from expanding the undergraduate enrolments, plans are underway to expand graduate programmes in three public universities - the Universities of Dar es Salaam, Sokoine University of Agriculture and University of Dodoma. Expanded graduate enrolment is aimed at producing a cadre of graduates with the necessary skills to man the key sectors of the economy including the mining industry, fishing industry, tourism and hotel management, and teaching at all levels but mostly in Universities and higher learning institutions.

4.6 Research Institutions

The Science and Technology in use today is an outcome of long-term investment in Research and Development (R&D). While both basic and applied research is important; for a developing country like Tanzania, more resources ought to be directed to applied research since it does provide the required solutions within a short period of time.

The capacity building and training role of research institutions in Tanzania is limited by small budgetary contribution of the government to Science and Technology research and training. Currently the government contribution to Science and Technology (R&D) is 0.18% of the GDP compared to the minimum of 1% recommended. Tanzania was the second country in Africa after Ethiopia to develop a Science and Technology policy (1985) but implementation of its strategic plan has been more elusive due to resource constraints. Efforts are underway to review and develop a Science, Technology and Innovation (STI) systems policy so as to make Science and Technology much more visible to the ordinary Tanzanian.

There are several research institutions dealing with issues within the priority areas of ASCLME project in Tanzania. Significant contribution in the area of coastal and marine sciences comes from the Tanzania Fisheries Research Institute (TAFIRI). Fisheries statistics and fish stock assessment, fish biology, fish diseases, fishery management, fish processing and marketing, water pollution and aquaculture are among the research priorities of TAFIRI. The Institute has 61 Research Scientists trained in coastal and marine sciences of which 5 are Ph.D. holders, 30 M.Sc. holders and 26 B.Sc. holders. The facilities at the Institute include; computers, GIS facility, fishing vessel, library and fishing gears.

4.7 Regional and International NGO's Programmes

Regional and international programmes with TCB components have made remarkable contributions to training and capacity building initiatives and programmes in key areas of the ASCLME project Tanzania. One such programme is the Sustainable Coastal Communities and Ecosystems (SUCCESS) Program funded by USAID. The SUCCESS Tanzania programme is supporting conservation and coastal management efforts by facilitating district action planning and establishment of Collaborative Fisheries Management (CFM) areas in Bagamoyo and Mkuranga districts. The process of developing the CFM area begins with a community participation process to identify fisheries issues and concerns leading to a decision to establish a CFM area. The goal of the Collaborative Fisheries Management Area is to rebuild fish stocks and associated habitats to levels that allow for increased and sustainable fish catches by artisanal fishers, and that result in improved income for artisanal fishers in the districts. When SUCCESS began, it concentrated primarily on mariculture development in the two districts, but as these activities matured, the programme has adopted more conservation related elements, such as establishing no-take areas and initiating monitoring programs that can help in understanding the conservation impacts of the programme.

WWF Tanzania programme is implementing ReCoMaP funded project to promote pearl oyster culture in Mafia and Kilwa Districts, in which the Department of Aquatic Sciences and Fisheries of UDSM is a formal partner, alongside the two district authorities and Mafia island Marine Park. The project, which also includes several postgraduate researches, is aimed at strengthening livelihoods amongst poor coastal communities in the central and southern Tanzania who are dependent on marine natural resources by promoting sustainable artisanal pearl oyster culture.

Various materials and tools have been produced by NGOs in the region through different initiatives. These include: MPA manual (Francis *et al*. 2001a); Toolkit (IUCN 2004); Guidelines on economic tools for MPA management (Emerton 1999); SEACAM guidelines on coastal tourism (Grange and Odendaal 1999), as well as aquaculture (Hambrey *et al*. 2000), coastal mining (CSIR 2003) and a multi-lingual Western Indian Ocean socio-economic manual (SocMon WIO) (Malleret-King *et al*. 2006). These materials and tools have been disseminated through different mechanisms including organization of workshops specifically designed to introduce this material to the relevant practitioners. In addition to the production of the manual, the Socioeconomic Monitoring Network in Western Indian Ocean has conducted a number of site based and refresher trainings that helped to increase the capacity of socio-economic monitoring in the region. Through such training between 2007 and 2008 the number of SocMon resource persons increased from 3 to 14 trainers spread across Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles and Tanzania (SocMon WIO 2009). Locally, NGOs and CBOs that are currently working on issues related to marine conservation in Tanzania include Sea sense, WWF Tanzania Programme office, Lawyers' Environmental Action Team (LEAT), Wildlife Conservation Society of Tanzania (WCST) and Journalists Environmental Association of Tanzania (JET).

4.8 Other Forms of Capacity Building

Other forms of capacity building initiatives in Tanzania have involved several regional organisations and donor agencies. These include the Western Indian Ocean Marine Science Association (WIOMSA), which has provided an active forum for scientific exchange on natural and social science aspects of marine sciences, including fisheries and aquaculture developments. It has also played a key role in promoting coastal zone management and concepts of sustainable use of coastal and fisheries resources throughout the region.

Another regional initiative is a Sida funded marine initiative in East Africa, the Marine Science for Management (MASMA) program, which is coordinated by WIOMSA and the Coastal Management Research Centre (COMREC) of the University College of South Stockholm (Francis and Lundgren 2001). The MASMA program seeks to contribute to the knowledge and understanding of coastal and marine environment of the region, to raise awareness of coastal and marine issues, to conduct and coordinate research activities of national and regional importance, and to disseminate information and data for sustainable use of coastal and marine resources.

Sida also continues to support capacity building through the bilateral marine science programs at the University of Dar es Salaam in Tanzania (UDSM). The program contains a number of different capacity building activities such as research and postgraduate training, staff and student exchange between Tanzania and Sweden, information dissemination through workshops and publications, procurement of books, journals, laboratory and field equipment, rehabilitation and maintenance of research infrastructure. The priority research themes include fish farming, seaweed cultivation, fish ecology, coral reef ecology, disturbance effects on coral reefs, nutrient dynamics, primary productivity studies, pollution studies and research on habitat restoration and conservation.

Another capacity building initiative is implemented through SWIOFP, an ambitious multinational research project with an overall goal that will see the West Indian Ocean's marine resources ecologically managed for sustainable use and benefit by the region's riparian countries. The project forms part of the Large Marine Ecosystem Programme approach (LME) and is supported by the Global Environment Facility (GEF) as a contribution to its international waters programme. Under this project nine countries of the Western Indian Ocean will work together to understand and management better their fisheries through an LME and Ecosystem Based Approach. In 2010 the project funded 1 full-time Tanzanian Masters student in marine and fisheries science: demersal resources and biodiversity. The list of capacity building and training courses/programmes/workshops conducted by local, regional and international programmes in Tanzania are given in Table 4.

Table 4: Capacity building and training courses/workshops related to priority areas of the ASCLME project conducted by Regional and international programmes with TCB components

MAIN TOPICS COVERED	**TYPE OF COURSE / WORKSHOP**	**ORGANIZER/ FUNDING AGENCY**	**VENUE**	**YEAR**
Wetland Dynamics and Integrated Management Techniques	6-Week Training Course	SADC	FAST/ UDSM	2004
Mariculture extension	Training	SUCCESS/WIOMSA	Zanzibar	2005
Biodiversity studies for	Short course	WWF	Dar es Salaam	Periodic

Ecoregions				
Marine turtle conservation techniques	Training workshop	Sea Sense	Dar es Salaam	2006
Fish taxonomy and collection curation	Training course	CIDA (MUN-UDSM)	Dar es Salaam	2006
Indian Ocean Global Ocean Observing System	Workshop	UNESCO-IOC	Zanzibar	2006
Sustainable management of dolphin tourism	Meeting	WIOMSA	Zanzibar	2006
International seagrass biology	Workshop	World Seagrass Association	Zanzibar	2006
Nutrient analysis for marine waters	Training Course	GEF-WIO-Lab	Zanzibar	2006
Shoreline changes	Training Course	Sustainable Management of Land and Environment (SMOLE)	Zanzibar	2007
Effective communication for marine science researchers	Training Course	CRTR	Zanzibar	2007
Computer Modelling applications in coastal waters	Training Course	UNESCO-IOC	IMS	2007
Kisiju Pwani SACCO loan disbursement and accounting training	Training workshop	USAID-TCMP	Zanzibar	2008
Coral Reef Restoration and Remediation	Training Course	Coral Reef Targeted Research (CRTR)/ WIOMSA	IMS	2009
Stakeholder analysis and sensitization on beach erosion	Workshop	UNESCO/ReCoMaP	Zanzibar	2009
Mariculture challenges in the WIO region	Workshop	WIOMSA/IFS	Zanzibar	2009
Business development for pearl farmers and jewellery makers	Training workshop	USAID-TCMP	Zanzibar	2009
Ocean Colour 2009 Africa	Training Workshop	The Global Environmental Monitoring (GEM) of the Institute for Environmental and Sustainability (IES)	Zanzibar	2009
Fisheries of *Euthynnus affinis* and *Scomberomorus commerson* in relation to oceanographic and atmospheric parameters in the coastal waters of Kinondoni, Dar es salaam	M.Sc. Training	CIDA	UDSM	2008
Fish stock assessment in Inshore reefs of Tanga and Pangani Districts.	Ph.D. Training	CIDA	UDSM-DASF	2007
Feasibility of blacklip oysters (*Pinctada margaritifera,* Linnaeus, *1758*) half-pearl culture in Tanzania	M.Sc. Training	SUCCESS-WIOMSA	IMS, Zanzibar	2007
Role of small scale community-based marine no-	M.Sc. Training	SUCCESS-WIOMSA	IMS, Zanzibar	2006

take areas in conservation of *Anadara antiquata* Linnaeus 1758 (Pelecypoda: Arcidae) in Fumba Peninsular, Unguja Island				
The occurrence, distribution and population structure of blacklip pearl oysters (*Pinctada margaritifera)* in Mtwara and Mafia Island, Tanzania.	M.Sc. Training	ReCoMaP	UDSM-DASF	2009
Modelling coral Colarimorpharia Interactions under varying anthropogenic inputs along the coast of Tanzania	M.Sc. Training	Sida-Sarec	IMS	2009

In summary, the previous capacity building initiatives and training courses reflect the diverse capacity building activities conducted in the Tanzania over the years and indicate the existence of general understanding and knowledge in coastal issues. There has been a broad spectrum of both short and long-term courses that cover different aspects of the ASCLME Project thematic areas.

5.0 KNOWLEDGE GAPS, NATIONAL TRAINING NEEDS/PRIORITIES AND CAPACITY FOR MEETING THEM

5.1 Knowledge gaps

The evaluation of training activities has shown that there are a broad range of formal education institutions that are able to impart basic knowledge and skills to students in Tanzania. Also, there have been various capacity building activities that have focused on training personnel to undertake different aspects of project activities. However, several of these short courses focus on training government and project staff with very few aiming to impart similar skills to communities and the different levels of governance. Therefore, it is recommended that the ASCLME project focus on the different strata of society in imparting knowledge within the different thematic areas.

The analysis of the human resources data from a number of research and training Institutions as well as NGOs revealed among others that Marine and/or Fisheries biology are the predominant fields of specialization since they account more than 50% of the individuals surveyed. For example, more than 60% of the staff holding at least a Bachelor degree that were on post at TAFIRI in 2007 (http://www.wiomsa.org/?id=2474) were Marine/Fisheries Biologists (Figure 2). The remaining specializations had only one or two individuals which points to the fact that that multidisciplinary training of marine scientists is far from being adequate. Another important observation under this survey is that individuals with Diploma and few Bachelor degrees in

fisheries sciences hold most of senior fisheries administrative positions at the regional and district levels.

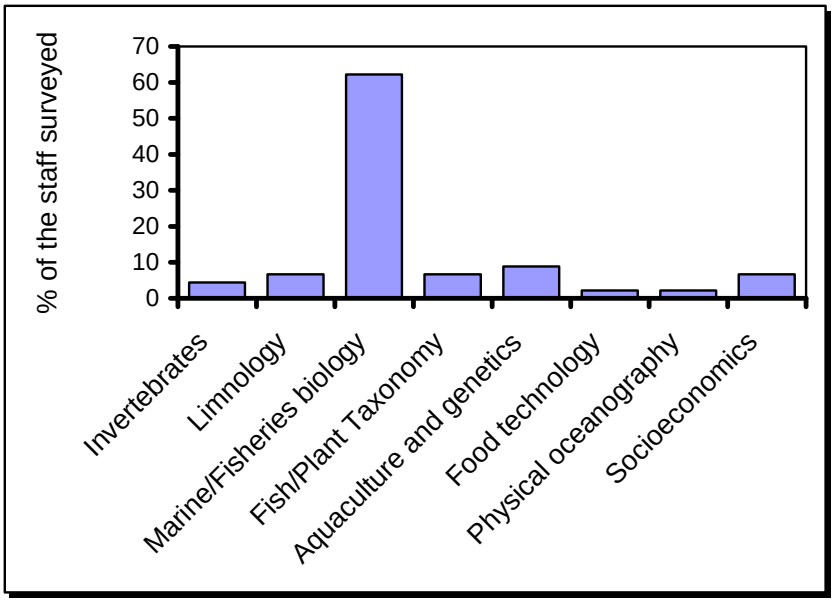

Figure 2: Percent of the staff surveyed according to their fields of specialization

There are still some specializations, which require attention in terms of capacity building. These include:

- Physical oceanography and Hydrography - to model physical, chemical and biological processes governing the dynamics of the coastal waters,
- Sociology - for community consultation and try to understand how people are interacting with vital coastal resources,
- Environmental economics - which among others looks at what those vital coastal resources are worth to local communities and carry out cost benefit analysis of different management options, and
- Legal expertise - which examines the legal framework and its implication on conservation and management of coastal resources.
- Marine and coastal governance – to adapt managers to changing administrative roles and tasks in managing coastal resources and at the same time safe-guarding the ecosystem and its biodiversity.

Although there are many well trained sociologists, economists, and legal experts in the country, few of them are conversant and interested with coastal and marine environmental issues.

The other priority training areas include;

- Remote sensing – which entails the interpretation of the remote sensing data/images and their applications as a decision support system.
- Geographical Information Systems (GIS) – a valuable tool to organizations and researchers in solving planning and management problems in the coastal zone.

In the following sub-sections the major knowledge gaps affecting the implementation of ASCLME project in Tanzania are discussed briefly within each of the project thematic areas and the more detailed account of the gaps is given in Appendix 3. These knowledge gaps will need to be

addressed through several CB&T programmes offered in the country and elsewhere in the region.

5.1.1 Technical Training

The importance of technical education and training to a developing country cannot be overemphasized. It provides the necessary knowledge and skills required to exploit the natural resources of the country through scientific and technical discovery. It enables the material wealth of a nation to be built up. The availability of technical personnel in the right numbers, at the right time, in the right place and with the right balance of technical knowledge and practical skills determine the pace and direction of industrial innovation and socioeconomic development.

Tanzania's National Strategy for Growth and Reduction of Poverty, known by its Kiswahili acronym *Mkukuta,* identifies investments in human capability as the first major source of growth that Tanzania needs to focus on. This includes investing in education in order to develop an internationally competitive labour force that has the knowledge and skills to: solve the society's problems; meet the challenges of development; and contribute to private sector development and increased productivity.

The current training situation in the whole spectrum of technical education and training has not achieved the required manpower balance between the different cadres. Between 1985 and 1994 this ratio remained stagnant at 1:2:14 between engineer/technologists, technicians and craftsmen. This unfortunate situation occurred because training institutions at all levels have not increased their facilities and students intake. This imbalance led to inefficiency in industrial activities as some engineers/technologists have been forced to work as technicians while in other cases technicians have had to assume and perform duties of engineering/technologists. The 1980/90 ratio of 1:2:14 was to be improved to 1:3:18 by 2000 in order to move close to the internationally accepted ratio of 1:5:25 (URT 1996).

The shortage of technicians, engineers and technologists in every sector of the economy create a serious bottleneck in the implementation of the economic development programmes on which the nation depends. There was a shortage of more than 44,200 technicians by the year 2000, but the total students' enrolment in 5 technical colleges and other tertiary institutions in 2008 was only 11,735 (MoEVT 2009). There is a general consensus that the shortage mentioned and its solution lie in technical education and training. For example, within the ASCLME Project thematic areas acute shortage of skills exist in oceanographic and electronic instrumentation, coastal surveying, GIS and remote sensing. The University of Dar es Salaam, Ardhi University, Dar es Salaam Institute of Technology and Sokoine University of Agriculture have a role to play in training of engineers and allied technical professional personnel.

5.1.2 Economics and Socioeconomics

Economics and socioeconomic monitoring are among the critical tools with which, coastal and ocean resource managers can determine the impact and effectiveness of their management programs. It does little good, for example, to understand the health of coral reef and other coastal resources without understanding how people are interacting with those resources or what those resources are worth to local communities.

The socio-economic characteristics of coastal districts of Tanzania are strongly influenced by the availability and patterns of natural resource utilization. Fish and fisheries, coral reefs, mangroves, coastal forests, seagrass beds, coastal wetlands, minerals, oil and gas and coastal

agricultural lands all provide opportunities for extractive use of commercial value and for subsistence. Numerous coastal communities depend on these resources for their livelihoods, particularly for acquisition of food, fuel, shelter and income, while the condition of these resources determines the social and economic status of these communities. Increasing poverty among coastal communities, literacy rates, historical or traditional resource use patterns, the increased cost of living, the rising cost of fuel and the threat of natural disasters, are just some of the variables that impact on how people interact with coastal marine ecosystems in Tanzania. In turn, people's interactions with coastal marine ecosystems determine the development of management strategies and the resources needed to conserve these ecosystems.

Therefore, understanding and taking into account social and economic attributes such as food security and poverty alleviation for fisher folk households is crucial to the success of any coastal resources and fisheries management program. Because of the link between resource management and poverty, coastal management strategies could benefit from addressing poverty issues through a dual objective: (1) enabling the recovery of the local resource base, and (2) promoting economic development activities that will either compensate for a reduced level of extraction of a particular resource or produce parallel incomes through the rational utilization of other resources.

There is acute shortage of economics and socioeconomic experts dealing with issues directly related to management of coastal/marine resources in Tanzania. For example, the alternative economic development activities in coastal communities that will either compensate for a reduced level of extraction of a particular resource or produce parallel incomes through the rational utilization of other resources (i.e. cost-benefit analysis) has been insufficiently researched.

5.1.3 Numerical Expertise

Large-scale coastal dynamics can be well covered using mathematical modelling. The application of numerical data handling and numerical modelling are powerful tools that aids for example in setting clear demarcations on the protected areas, planning and design of ports and harbours, protection of valuable coastal properties, assisting in ecosystem management, environmental impact assessment, economic evaluation and risk assessment.

Tanzania has an inadequate number of numerical experts and numerical modelling professionals, and especially so within the area of marine and coastal areas. Numerical modelling skills that will need to be imparted includes; offshore and near shore wave analysis skills, hydrodynamic modeling of tidal, wind and storm generated currents, long shore sediment transport, sediment spill and dredging impact assessment, coastal geomorphological processes and coastline responses to man-made coastal projects. With regard to fisheries management, there is a shortage of numerical experts in ecosystem modeling (e.g. larval dispersal aggregating sites and nursery grounds, fish migration, stock assessment, linkage between catch and environment, etc.).

5.1.4 Data Management and Information Management Skills

Data management and information management skills are important tools in creating awareness and in decision making on issues dealing with marine and coastal area management. More so, information management skills are applicable in creating necessary links among different sectors such as the academic institutions, NGOs, the public and governmental institutions. Of currently, Tanzania has taken up database management model for ocean and coastal data management

with the aim of assisting a proper management of data within institutions while ensuring a sharing of available information among different institutes (UNESCO 2003).

Tanzania has also taken other initiatives to facilitate harmonized data management and exchange among local and regional institutions. For example, the participation in ODINAFRICA Programme and the Training Course on Management of Marine Data and Information for IOCINCWIO Region. Through ODINAFRICA, Tanzania was able to establish a Tanzania National Oceanographic Data Centre (TzNODC) at the Institute of Marine Sciences in Zanzibar. TzNODC has also been working closely with all relevant authorities in Tanzania coastal districts and has had close collaboration with other key stakeholder institutions such as the Tanzania Meteorology Agency, Tanzania Commission for Sciences and Technology and others through participation in workshops and seminars.

Despite these initiatives it can be generalised that Tanzania has acute shortage of expertise in data management and information management skills; inadequate and poor maintenance of ICT infrastructure; lack of financial and logistical resources to update and sustain the existing ICT facilities; lack of reliable internet access, data storage media and devices and GIS facilities; lack of national and institutional policies for data access and exchange between institutions (Waema 2006). With regard to coastal resources (e.g. fisheries, mangroves, corals reefs and forests) management, data management and information skill gaps include the following:

- Lack of necessary inputs and tools to enable experts collect, process and store data and be able to timely disseminate the information to end-users.
- Lack of well-planned databases for resource assessment and monitoring interfaced with GIS-based information management; and
- Limited assessment of the existing coastal resource databases and formats to allow harmonization of databases and facilitate data sharing and communication.

5.1.5 Legal Expertise

Law is a central and fulfills a number of functions to ASCLME, the Programme that institutionalize cooperative and adaptive management of the LMEs. The legal knowledge base is therefore required to strengthen technical and management capabilities at both national and regional scale to address transboundary environmental concerns within the LMEs. It is critical to understand the distinction between international law and national law, as well as the relationship between these two spheres of law on transboundary issues.

National Environmental Policy 1997, particularly stressed on the need for formulating environmental legislation and sectoral legislation (e.g. Forestry, Wildlife, Fisheries, Mining, Energy, Water, Lands, Local Authorities and Urban Authorities) as an essential component for effective and comprehensive environmental management and improvement of quality of life. To be effective the Policies, Acts and Regulations need to be backed up by competent legal personnel/expertise and understood and treasured by the communities and individuals whom they are aimed to serve. When it comes to coastal area management, Tanzania has shortage of personnel in the legal profession and the general lack of legal and environmental education among the general public.

5.1.6 Language Education

The main feature of Tanzania's education system is the bilingual policy, which requires children in schools to learn both Kiswahili and English. English is taught as a compulsory subject in the primary education whereas at post primary education is the medium of instruction. Likewise,

Kiswahili is the medium of instruction at primary education while at tertiary education is taught as compulsory subject at secondary education and as option at tertiary education (MOEC 1995). The issue of teaching language in Tanzanian education system is quite controversial, with those in favour of English arguing that English is vital for preparing students to compete in a global economy, and those opposed arguing that not teaching in Swahili causes talented students to be left behind and detracts from students concentrating on the subject matter. However, it is a well known fact that when it comes to practice in the classroom, the majority of the learners struggle to learn academic content because of the foreign medium that is used as the language of instruction from secondary school onwards.

The research conducted in Tanzania on language policies and practices (Brock-Utne and Holmarsdottir 2004) shows that whatever the official policies may be the teachers in the classrooms will use whatever language they and their students feel most comfortable with. This has been described as the coping strategies teachers and learners use like translations, code-mixing and code-switching. At the end of the day the learners have to write their exams in English which result in many students to fall even further behind. What seems to be a learning problem or a matter of bad grade, drop out and repetition is really a language problem. In yet another language study conducted in Tanzania, Brock-Utne (2005) reported a clear pattern of higher-prestige jobs tending to employ English speakers and therefore a sharp disadvantage in the job market for Tanzanians compared to similarly educated people from neighboring countries such as Kenya and Uganda who had learned English earlier.

At the University of Dar es Salaam the UDSM Academic Audit (UDSM 1999) published in March 1999 (UDSM 1999:71–73; Point 4.4) discusses "Language as a Medium of Teaching and Learning". The authors of the report mention that from the talks and discussions they held with various groups of students and staff: it was evident that most students have problems with the language medium of instruction (i.e. English). Proficiency in the language is low and leaves much to be desired (UDSM 1999:71).

Currently there is a shortage of English teachers compared to Kiswahili teachers in public Secondary schools in Tanzania. This can be reflected in the 2009/2010 enrolment figures at UDSM for BA (education) students specialising in the two languages (Table 5).

Table 5: Students enrolment in the Kiswahili and English BA programmes at the University of Dar es salaam (2009/2010 academic year).

YEAR OF STUDY	**ENROLMENT BY SUBJECT**	
	Kiswahili	**English**
I	483	240
II	406	170
III	419	86

Source: UDSM Student Admission Bureau

5.1.7 Governance

Governance may be defined as the means by which local, regional, national and international communities organize themselves and subsequently respond to issues of interest to members of those communities. It involves leadership on the part of government and the use of policy and

programs to control and influence activities within communities (Manning 1998). Fisheries governance, for instance, is the sum of the legal, social, economic and political arrangements used to manage fisheries. It has international, national and local dimensions and includes legally binding rules as well as customary social arrangements.

The governance of any geographical area, including marine spaces, is actually the management of stakeholder relationships with regard to spatial-temporal resource use in the pursuit of many sanctioned economic, social, political, and environmental objectives. Good governance is based on recognition of the interests of all stakeholders, and inclusion whenever possible. These interests can be expressed in a variety of ways, for example: sovereignty, jurisdiction, administration, ownership (title), lease, license, permit, quota, customary rights, aboriginal rights, collective rights, community rights, littoral rights, public rights, rights of use, and public good. A hierarchical governance approach, usually practiced by the state or some other governing authority, is usually enacted through policies, laws and regulations and assumes that a top-down approach is always best (Hoogsteden *et al*. 1999).

Several enacted policies, laws and regulations guide the management of fisheries resources in Tanzania. Under the present arrangements the Fisheries Division has the largest share of authority compared to other government and non-government institutions over many issues related to coastal marine resources in mainland Tanzania. Although more stakeholders (such as fishing industries, NGOs, universities, government organizations etc) are now involved in some decision making process of key resource management implementation plans, weak institutional processes and structures that are the basis for planning and decision making continues to affect the sector and is one of the main causes of poor performance of this sector.

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5.1.8 Fisheries Science

Fisheries research within the territorial waters of Tanzania has focused on areas of Fisheries biology (growth, maturity index, feeding habits, reproduction, ecology), Catch Assessment Survey (gear/vessel type, length, weight, effort), Prawns monitoring, socio-economics (employment, income generation, socio-livelihood, revenue), environmental research (rainfall, temperature, waves and tides, pollution, etc), and trawl surveys (weight, length, effort, catch, discards). Kangwe and Budeba (2010) asserts that many of the completed and on-going fisheries researches are short term donor funded projects with low sustainability due to limited sources of funding to support data collection tied to specific projects. When such research projects come to an end, there is no continuity in data collection.

The outstanding issues and major gaps in fisheries science includes; lack of continuous and long-term fisheries data collection for important commercial stocks (e.g. catch-effort statistics and biological data); lack of information on the effect of fishing on habitat destruction and alteration; inadequate collection of important fisheries related oceanographic data; lack of primary productivity and ecosystem modelling skills; lack of sufficient number of trained SCUBA divers to facilitate more researches on coral reefs and other deep water habitats; and lack of fish taxonomists. Other gaps include inadequate fisheries infrastructure such as modern fish landing stations, research laboratories and fishing harbours and limited number of fisheries experts at both Central and local Governments.

Lack of use of fisheries research results by policymakers and planners is another important gap in fisheries science. Every year valuable human and financial resources are spent to produce fisheries and environment research results that fail to reach policymakers and, consequently, are not used to shape policies and programs (i.e. a gap between researchers and policymakers).

5.1.9 Oceanography

The oceanography of Tanzania coastal waters is controlled by a number of factors, including the Northeast and Southeast monsoon wind system, the East African Coastal Current and the influence of the South Equatorial Current, the tidal regime, the water masses originating from four different sources, the Indian Ocean Dipole, the El Niño Southern Oscillation phenomenon, the tropical weather and climate system, the fringing islands and coral reef system, the continental shelf system, shoreline orientation, bottom topography and the coastal estuarine systems (Mahongo 2010).

From the oceanographic perspective, the coastal and marine environment of Tanzania remains relatively unexplored, with only a few surveys carried out by local and international cruises. The R/V 'Dr. Fridtjof Nansen' survey (1982-1983) and R/V 'Prof Metsyesev' survey (1977-1979) are the two most systematic local surveys carried out in the Tanzanian marine waters. Other prior expeditions that covered the coastal waters of Tanzania are the "Valdivia Expedition" (1898-1899), the "Dana Expedition" (1928-30) and the "John Murray Expedition" (1933-1934). Between 2003 and 2004 the African Coelacanth Ecosystem Programme (ACEP) collected oceanographic parameters in coastal waters of Tanzania using R/V 'Algoa'. The research conducted by Harvey (Harvey 1977) using a 10m research boat – *R.V. Pomboo* still remain the most comprehensive of these individual surveys carried out in the coastal waters of Tanzania (Mahongo 2010).

Modelling of the physical, chemical and biological processes governing the dynamics of the coastal waters, which is currently lacking in Tanzania, presents an ideal opportunity for further understanding of the underlying oceanographic conditions. In this regard, plans are underway to establish a satellite receiving station at Tanzania Fisheries Research Institute (TAFIRI) in 2010 under the auspices of the African Monitoring of the Environment Project (AMESD) of the African Union (AU). Under this initiative, satellite data will be archived in high resolution from EUMETSAT, and these will entail SST, winds, currents, altimetry, suspended particle matter, and ocean colour, among others.

The use of modelling tools to better understand coastal processes will require enhancing institutional capacity through training of staff. A networking between/among institutions is both relevant and a prerequisite for a better management of information that can be used for a better management actions. A better understanding of the WIO, east Africa and Tanzanian waters will enhance a better understanding of the regional circulations of ocean currents and their impacts upon the coastal environment and biological productivity.

5.1.10 Coastal Zone Management Including Expertise in GIS and MPA

It is basic to coastal management to recognize how strongly activities on land affect the condition of the sea thereby requiring an Integrated Coastal Management (ICM) approach. The sea is impacted by distant events that occur far inland such as river discharges, various plantations, deforestation and urbanisation - all may affect coastal ecosystems. Conversely, the sea strongly affects the land and intertidal areas; for example, pollution from tanker bilges washings or property destruction from cyclonic storm flooding and wave action. Moreover, the countering "natural defences" of the coastline such as mangroves and coral reefs can be extremely important for protecting shorelines and coastal villages against storm waves and shore erosion.

The overall goal of the ICM-type programme is to ensure optimum sustainable use of coastal natural resources, perpetual maintenance of high levels of biodiversity, and real conservation of critical habitats. Tangible objectives of ICM include, for example, supporting fisheries, protecting the community from storm ravages, attracting tourists, promoting public health, maintaining yields from mangrove forests, preserving coral reefs. A National Integrated Coastal Management Strategy in Tanzania was officially launched in April 2003. It is used as a framework for linking and harmonising different sector's decisions about the management of coastal resources; supports decentralisation and existing initiatives and participatory approaches (Rweyemamu 2003).

Marine Protected Areas (MPAs) should form a complementary and integral part of ICM programmes by complementing and make possible other objectives of ICM such as conserving nursery areas for fisheries production, enhancing tourism revenues and recreational benefits, preserving wilderness values and promoting baseline scientific and management studies. To date Tanzania has eleven MPAs with varying degree of protection as shown in Table 6.

Table 6: Marine Protected Areas in Tanzania

Location	Name	Year
Mainland Tanzania	Mafia Island Marine Park	1995
	Mnazi Bay Ruvuma Estuary Marine Park	2000
	Dar es salaam Marine Reserves Systems (Mbudya Island Marine Reserve, Bongoyo Island Marine Reserve, Fungu Yasin Marine Reserve and Pangavini Island Marine Reserve)	2005
	Inner and Outer Sinda Islands Marine Reserve, Inner and Outer Makatube Islands Marine Reserve and Kendwa Island Marine Reserve	2007
	Nyororo Island Marine Reserve, Shungimbili Island Marine Reserve, and Mbarakuni Island Marine Reserve	2008
	Maziwe Island Marine Reserve	2008
	Tanga Coelacanth Marine Park	2009
Revolutionary Government of Zanzibar	Menai Bay Conservation Area	1997
	Mnemba Island Marine Conservation Area	
	Pemba Channel Conservation Area	
	Chumbe Island Coral Park	

Geographic Information System (GIS), on the other hand, is a data base system in which most of the data are spatially indexed and upon which a set of procedures operates in order to answer queries about the spatial entities in the data base. Thus it is an information system which helps to improve a user's ability to make decision in research, planning and management; a GIS is therefore essentially a management tool (Fedra and Feoli 1998). ICM and MPA, by definition, are spatial management. The increasing use of spatial data and GIS by organizations and researchers is a valuable tool to help solve the planning and management issues in the coastal zone.

Fisheries management and planning, for example, has many spatial components (e.g. movements and migrations of resources, definition of fishing grounds, transportation networks, markets), and many serious issues like habitat loss and environmental degradation have spatial dimensions. Fisheries biologists, aquatic resource managers and decision makers in developing countries have to address issues of great complexity to which GIS can help to clarify the issues and lead to solutions by treating many spatial components simultaneously.

Applications of GIS and spatial models to coastal zone management problems span a wide range of issues in Tanzania. For example, determining the accurate length of the coastline is important for such coastal zone management applications as shoreline classification, erosion, extent of mangrove coverage and zoning, habitat assessment, area of salt pans for conversion into milkfish ponds, and for the planning and response to natural (e.g. storm surges) and man-made disasters (e.g. oil spills). A number of training needs assessments that were consulted by this study identifies GIS as one of the ICM core areas with acute shortage of expertise in Tanzania.

5.1.11 Geology and Geomorphology Including Mineral Extraction

Sedimentary rocks varying in age from Jurassic, Cretaceous to Tertiary and Quaternary characterises the bedrock geology of the coastal belt along the Tanzania mainland (Kent *et al*. 1871). Beach ridges and marine terraces are among the most prominent backshore features along the coast of Tanzania and these distinctive geomorphological features, which help to unlock the late Holocene/Pleistocene sea level fluctuations, have been discussed in detail by many workers (Alexander 1968, 1969 and 1985; Muzuka *et al*. 2004).

According to Shaghude (2010), the information on sea bottom sediment composition, sea bottom sediment distribution and sea bottom morphology is generally scarce apart from the limited studies conducted on the Zanzibar channel and between the Pangani and Wami rivers. Also the problem of shoreline changes, particularly coastal erosion has increasingly been one of the major issues of environmental, ecological and socioeconomic concern and has been a recurrent problem in many parts along the coastal Tanzania, including the islands of Zanzibar. To a large extent, the lack of understanding of the causative factors of the coastal erosion problem has contributed to the use of inappropriate shore mitigation options, resulting to poor management of the shores. Shaghude (2010) cites the most recent systematic study conducted under the auspices of WIOMSA, where a multi-disciplinary methodology for studying coastal erosion problem, its socio-economic impacts and mitigation methods has been developed, using two pilot study sites of Kunduchi in Tanzania and Bamburi in Kenya.

Diverse offshore oil and gas exploration and mining activities are taking place throughout the coast of Tanzania. Training in relevant coastal geology and geomorphology is crucial to the understanding the catchment and coastal management impacts on coastal habitats, shoreline and water quality issues and proposing sustainable mitigation measures.

5.1.12 Aquaculture

Aquaculture is still in its early stage of development in Tanzania and the sub-sector accounted for only about 2 per cent of total fisheries production in 2003. With regard to mariculture, there were approximately 100 ponds for milk fish, mullet, tilapia, and prawn culture in 2009 (TCMP 2009). With some 50,000 hectares of salt flats in the coastal area, the potential for expansion of fish and prawn farming activities is high and growth is likely to continue, contributing to food security, income generation and employment in coastal communities. In addition to pond aquaculture, there has been also an increase in seaweed farming both in Tanzania Zanzibar and the mainland.

Although aquaculture is still poorly developed in the country, it is an emerging sector that could have deleterious impacts on coastal water quality and therefore development of pond mariculture needs to be done in a controlled and thoughtful manner. Pond siting and approval system were identified as priority areas of concern by the inter-agency Mariculture Working

Group constituted by TCMP in the late 1990's. Although mariculture permitting guidelines were developed by this group (TCMP 1999a), to date they have not been proactively applied. More recently, TCMP has developed the district-level Small-Scale Mariculture Zoning and Permitting Procedure (using Mkuranga as a pilot coastal district) to guide a functional, practical, coordinated and decentralized permitting system for small-scale coastal mariculture projects. Potential projects are scrutinized and approved by the District Technical Team (DTT), which needs to be trained in multidisciplinary aquaculture knowledge.

This tremendous increase in aquaculture activity also creates high need for skilled labour on one side and aquaculture knowledge base on the other side. The 2009 draft National Aquaculture Development Strategy (NADS) (URT 2009) identifies lack of adequate trained manpower to manage the fish farms and provide extension services (section 1.2.2 of NADS), lack of quality seed and feeds as among the key gaps hindering aquaculture development in the country.

5.1.13 Coastal Agriculture and Forestry

Agriculture is the backbone of the economy in Tanzania is central to the alleviation of poverty and generation of revenue. Agricultural practices produce elevated levels of four types of pollutant, namely suspended solids (the result of erosion due to inappropriate land use practices), inorganic nutrients (excessive use of fertilizers), pesticides (persistent organic pollutants) and microbial contaminants (typically associated with runoff from livestock rearing areas). Pollutants from agricultural activities usually enter the marine environment through river discharges, although agricultural activities adjacent to coastal areas can directly contaminate coastal waters through surface or sub-surface runoff.

Agriculture is the major threat facing coastal forests. Since the soils of coastal forests are generally poor to support settled agriculture, shifting agriculture is most type of subsistence farming practiced by farmers. Shifting cultivation and plantation agriculture of sisal, coconut and cashew nuts have claimed a considerable area of coastal forests in Tanzania (Dallu 2004). Coastal forest degradation impacts on the marine environment in various ways including reduced plant and faunal diversity, increased soils erosion, low recharge of groundwater aquifers and increased turbidity negatively affect the productivity of critical coastal ecosystems such as mangroves, seagrass beds and coral reefs. The increased demand for fuel wood and charcoal in urban areas is another threat facing coastal forests. Lack of detailed information on cover, species densities and diversity of is one of the major gaps on sustainable management of coastal forests.

5.1.14 Climate Research

Climate research involves predictions and the understanding of human influence on climate through observations, modelling activities and the policy-relevant assessment of climate conditions. It is foreseen that Climate change will aggravate environmental and social problems in the coastal areas of the Indian Ocean basin, with sea level rise as a greatest threat. For example, a 0.5 meters sea level would inundate 247 square kilometers of Tanzania's 800-kilometer coastline (Wong 2010). Besides the direct toll on human lives, there will be impacts on coastal habitats such as coral reefs, lagoons, and mangroves whose destruction further encourage coastal erosion. A rise in sea level would also increase the intrusion of saline water up river mouths thus reducing availability of suitable agricultural land. Fisheries activities are expected to be affected by the global climatic changes through interference with the breeding and migratory habits of most fish. Seemingly, there is therefore a need for a strategic approach towards creating vulnerability analysis and the means to foster adaptive mechanisms.

Networking and coordination of research on marine impacts from climate, climate variability and climate change are necessity among different stakeholder institutions.

Tanzania Meteorological Agency (TMA) is the lead agency for climate related activities in Tanzania, but much of the focus at TMA is on forecasting. Apart from TMA, other institutions that are involved in climate research in Tanzania include IRA and TAFIRI. However, the existing capacity on climate research is mainly through observations and policy-related assessments, with very little being done on modelling due to insufficient number of modelling experts. The capacity to train students in climate research is also not available in Tanzania. Hence resources have to be allocated to expand capacity at TMA and in other institutions through training abroad, from M.Sc. levels to Ph.D. in both observations, modelling and policy-relevant assessments. Other training gaps includes; vulnerability assessment, development of adaptation strategies, climate change, modelling and conservation designs that will maximize resilience of protected areas. Furthermore, there is the need to strengthen observation and monitoring networks that could later on be used to develop policies for integrated coastal zone management.

5.1.15 Microfauna and Meiofauna

There is a lack of information on microfauna and meiofauna within Tanzanian marine water. With only two studies of marine microfauna being conducted in Tanzania (Shilla 2010), there is a pressing need to explore further this area of research. Like microfauna, studies of meiofauna within Tanzania marine waters are rare.

There are huge knowledge gaps in micro and meiofauna studies that can be summarised in two headings: (i) there are extremely few micro and meiofauna experts in Tanzania to carry out research in order to fill the identified knowledge gaps, and as a result, (ii) there is lack of data and information regarding micro and meiofauna, especially on the patterns in meiobenthic diversity and community composition, Use of micro- and meiofauna as bioindicators of marine environmental health, feeding relationship in micro and meiofauna, and effects of changes in physico-chemical parameters on the micro and meiofauna.

5.1.16 Macrofauna – Invertebrates, Fish, Mammals, Reptiles, Birds, Exotics and Invasive Species

Overall, Tanzania has 532 species of fish, 5 species of sea turtle, 1 species of marine snake, and 4 species of marine mammals. Several species of dolphins have been reported in the waters of Tanzania, including the rough-toothed dolphin (*Steno bredanensis*), bottlenose and spinner dolphins (*Stenella longirostris*) and Indo-Pacific humpback (Francis *et al*. 2001b). In addition, there are 976 species of invertebrates, comprised of mollusks (74%), echinoderms (11%), arthropods (6%), corals (5%), and sponges (4%) (Kajuna 2004).

Over fishing and destructive fishing practices have continued to reduce the fish stocks that live on the coral reefs. Tanzania has approximately 60,000 full time fishermen on its coastline (DoF, 2011) and fish resources seem to be overexploited, shown by the decreased in fish landings and catch per unit effort. For example, in the pelagic fisheries of Zanzibar, the catch declined from 600 tons in 1986 to 91 tons in 1997 (Tanzania Coastal Management Partnership 2003). Zanzibari women who collect cockles (*Anadara antiquata),* giant murexes *(Chicoreus ramosus),* conchs *(Pleuroploca trapezium),* and oysters *(Pinctada margaritifera)* in the intertidal have reported that near-shore stocks have been depleted and that they are forced to collect mollusks further off shore (Torell *et al*. 2007). The fact that women now have to walk further in order to collect

enough bivalves indicates that slowly, the collection of wild bivalves may be dangerously depleting the populations. Thus, if collecting continues without some form of management through conservation or zoning policy, the stocks will continue to decline.

5.1.17 Environmental Education, Human Health

Education has a fundamental role to play in solving Tanzania's environmental problems. The 1995 National Education and Training Policy calls for the need to teach environmental education in schools. The government in collaboration with various stakeholders has put emphasis on promoting environmental education and sensitising communities and individual participation as a strategy to invigorate environmental conservation and management. For example, under the Environment Management Act (2004), one of the mandates of NEMC is to enhance environmental education and public awareness; and establish and operate national environmental information system for sound environmental management.

Through its environmental education section NEMC has organized several training programmes for primary, secondary and teacher training colleges between 2003 and 2008, focusing on incorporating environmental problems, issues and indigenous knowledge in training process. Additional training programmes were offered to the National Examination Council of Tanzania in 2005-2006 on how to evaluate environmental education in examinations. Currently, all form four, six and teachers training colleges' examination content incorporates environmental issues that started in 2002.

There are notable weaknesses that have been identified in the implementation of environmental education in Tanzania. These weaknesses include, i) much of the academic enlightenments offered are still not holistic, systematic and experimental. It is still discipline oriented with essential "science-based focus". This makes teachers to mention environmental education ideas or issues instead of teaching them; ii) to date, there are no environmental education policy and environmental education plan of actions. Therefore, there are no clearly stipulated environmental education objectives that could guide its dissemination methods, content to be covered and the extent of materials to be imparted.

Other stakeholders such as WWF Tanzania programme office and the media institutions (radio, TV, press, newspapers) have played a significant role in sensitising and undertaking various education programmes on environmental issues thereby cultivating public / private interest, commitment and awareness on environmental management and conservation aspects.

5.1.18 Coastal Tourism

Tourism relies heavily on the coastal zone, not just for beach sites for development, but for food and as a leisure area for tourists. For example, 20-30% of the tourists who visit Zanzibar annually are attracted by its suitability for SCUBA diving and snorkelling (Westmacott *et al*. 2000). Considerable tourism development is now found on the main Zanzibar island of Unguja, with growing development on the sister island of Pemba as well as on Mafia Island in Mainland Tanzania. Furthermore, since the 1990s there has been tourism expansion in Dar es Salaam, Tanga, Bagamoyo and a few other sites along the coast. Tourism brings in substantial foreign currency and provides important livelihood for the coastal population. It accounts for 16% of the national GDP, and nearly 25% of the total export earnings (Masekesa 2003).

Besides the above management-related issues revolving around tourism, it is well documented that tourism can have significant impacts on the environment. Waste management, water

abstraction, carrying capacity, PADH and other issues all pose challenges for sustainable tourism. A poorly managed coastline, depleted resources and high bacterial content of water are all issues that will shun tourism to the detriment of all. Thus, while tourism does provide significant potential for development, this will not succeed without careful and integrated planning involving governance and stakeholders from the industry. The activities of tourists can affect the marine ecosystem directly, through, for example, boat and anchor damage to coral reefs, and indirectly, for example, by increasing demands for cleared land for development, collection of shells for souvenirs, seafood, and mangrove poles and coral lime for construction.

Inadequate training in this sector has resulted in lack of integrated tourism planning and decision-making, which is necessary tool for sustainable development in coastal tourism.

5.1.19 Training of Inspectors and Observers, Community Involvement (MCS, including pollution)

Even though Tanzania has formed the Deep Sea Fishing Authority (DSFA), a corporate body with the power to regulate and control fishing activities in the country's EEZ, it lacks the effective institutional and financial capability to exercise their jurisdiction. While fish species living in a narrow coastal strip are harvested, the potentially valuable offshore species are left to foreign fishing fleets that rarely pay reasonable "resource rents" for exploitation of the fishery. International fishing fleets operating within the EEZ tend to land fish outside East Africa, and do not assist in management of the resource by sharing data with Tanzanian authorities. The result is that there is: (i) inadequate information on the species composition, quantity of fish taken in the area and the revenue flows from the fisheries, (ii) inadequate information on the threats to the ecosystem as a result of fishing pressure and other activities affecting marine biodiversity, and (iii) neither a national or regional vision or effort to protect biodiversity and the sustainable yield of the region's fish stocks.

Improved knowledge of the resources, and capabilities within monitoring, control and surveillance (MCS) are urgently required to address these issues. Patrols carried out in 2009 under the auspices of SADC that involved South Africa, Mozambique, Tanzania and Kenya managed to seize a commercial trawler, TAWARIQ 1, which was illegally fishing in Tanzania's Exclusive Economic Zone (EEZ) with a haul of 296.3 tonnes of fish (This Day 2009).

In Tanzania MCS training sessions are periodically conducted at Mbegani Fisheries Development Centre under sponsorship of EU through MCS Project in SADC countries. During the period of this project Tanzania has trained two intakes each for Junior and Senior Sea Fisheries Inspectors. About 17 Fisheries staffs from various coastal Districts and Marine Parks have attended the Sea observer course and awarded a Certificate on Fisheries Enforcement. Twenty (20) other Fisheries and Marine Parks Staffs have attended the MCS tailor made course on national Fisheries Enforcement and awarded a Certificate on National Fisheries Enforcement (Fisheries Department 2009). Senior fisheries staff in the Fisheries Department have attended a number of international training courses and workshops on MCS including Strategies to stop Illegal, Unreported and Unregulated (IUU) fishing (Maputo, October 2007), the International Guidelines for the Management of Deep Sea Fisheries in the High Seas held (Italy, February 2008) and Port state measures to combat IUU (Durban and Windhoek, June 2008). Plans are underway to build up a shore-based port and processing facilities at Dar es Salaam, Zanzibar, Mtwara and Tanga (Kangwe and Budeba 2010) to facilitate requirements that catches should be landed and handled in a way that can be monitored more effectively.

At grassroots level the formation of Beach Management Units (BMUs) is considered as an attempt by the government to decentralize fisheries management responsibilities to communities. Fisheries Regulations (2005) No. 104 (Part 4) empowers the BMU to engaging in monitoring, control and surveillance in such a way to reduce the incidence of illegal gears, fishing and fish trading practices within the BMU area.

5.1.20 Trans-Disciplinary Training for Managers Including Ecosystem Approach

Managing a resource or fish stock in isolation from its ecosystem ignores the fact that the very ecosystem that the resource or fish species depends on is being affected by fishing activities and other human activities. Fishing can affect an ecosystem by i) catching unwanted species, ii) causing physical damage to habitats, iii) disrupting food chains, and iv) causing changes in biodiversity. Other human activities unrelated to fishing - such as agriculture, forestry and development can also affect marine ecosystems, including the species that are part of them. The effects of climate change also often exacerbate human impacts on an ecosystem. It is pointless to address the problem of depleted fish stocks merely by placing controls on fishing activities if the key threats to their recovery are related to other human activities and natural factors that cause ecosystem degradation. For these reasons, fisheries authorities are replacing narrow, target species-based fisheries management strategies with a broader approach that attempts to manage fish stocks as components of marine ecosystems. Under the ecosystem approach to fisheries (EAF), the usual concern of fisheries managers (i.e. the sustainability of target species) is extended to address the sustainability of an ecosystem on which a fishery depends, which includes people and fish stocks.

Because of the broad issues involved, fully implementing an EAF requires trans-disciplinary training of managers and collaboration and cooperation between communities and a range of government agencies responsible for managing activities that impact on marine ecosystems. A major fisheries training needs assessments conducted in 2008 (URT 2008) emphasized that training should be an ongoing exercise and there should be a commitment to enhance the capabilities of fisheries staff as they increase their responsibilities. For example, fisheries directors/top administrators were recognized as the department's representatives to the government and require senior level management skills as well as knowledge and ability in the planning and policy side of fisheries and habitat management (i.e. trans-disciplinary training). Subject areas identified for training of officers at this level included: fisheries development and management, convention on the Law of the Sea, donor agency programs, socio and economic analyses, communications skills, legal interpretation, senior management skills including finance and administration, MCS strategy and policy development and implementation, to name just a few.

5.1.21 Fishing Technology, Implementing of Quality Control in Industry

There is considerable worldwide concern about the negative effects that the exploitation of fishing resources is having on the equilibrium of the marine ecosystem. Even though it is not easy to quantify the effect, it certainly does depend, among other things, on the technology or fishing gear used to harvest the resource. The destructive fishing practices, such as the use of dynamite and poison, and small-meshed nets still continue to be used in some places despite being illegal. These results in irreversible damage to aquatic habitats and ecosystem as preliminary research along the coast of Kenya and Tanzania indicates that human activities such as these have reduced fish catches from coral reefs by 30 – 40%. Large proportions of the by-catch (e.g. non-commercial or unwanted species) of shrimp trawlers are juvenile fish. The loss of these immature individuals threatens future fishery resources.

Tanzania is one of the greatest fisheries nations in Africa. Its vast marine and freshwater bodies are home to rich fisheries resources, which are sources of food, employment and income for the local population. Proper management of these resources and good handling practices will enable Tanzania to strengthen and maintain the contribution of the fisheries sector to its national economy. Before mid 1990s fish quality control training in Tanzania focused on the training in fish handling and processing, improvement of artisanal processing technologies (smoking, salting, drying and fermenting) and use of ice. From mid 1960s the Fisheries Division in Tanzania established three training institutes namely Nyegezi Freshwater Fisheries Institute (NFFI), Kunduchi Marine Fisheries Research and Training Institute (KMFRTI) and Mbegani Fisheries Development Centre (MFDC) to train fish processors and refrigeration technicians, among other fisheries specialists. Due to the slow growth of fisheries sector in Tanzania, graduates from these institutes seemed adequate to handle quality control issues in fish processing factories.

The introduction of Hazard Analysis Critical Control Point (HACCP) regulations by major fish importing countries (USA and EU) in mid 1990s threatened promising fish export opportunities for countries such as Tanzania where about 95% of fish landing is from the artisanal sector, which is also composed of illiterate persons. Facing a new challenge, and at the same time wishing to secure and maintain markets, protect and preserve the quality image of its exported products (mainly export of Nile perch), Tanzania requested assistance from international organizations (e.g. FAO, UNIDO and INFOPECHE) to put in new sanitary regulations based on HACCP and set up the competent authorities and construct accredited quality control laboratory. Tanzania is now in the List I of the EU Commission composed of 45 “fully harmonized” countries whose exports are not controlled at the point of arrival in the EU country (http://webcache.googleusercontent.com/search?q=cache:YxpYZxePOfQJ:www.unctad.org/). As a result, there is an identified need to conduct training on HACCP for fish inspectors and industry personnel in order to develop skill and competencies required in HACCP implementation.

5.1.22 Environmental Monitoring, Including Pollution and Remote Sensing

Aquatic ecosystems in Tanzania: lakes, estuaries and coastal areas are increasingly impacted by anthropogenic pollutants from sources such as agriculture, urban and industrial discharges, fishing activities, atmospheric deposition and terrestrial drainage. The coastal area of Tanzania amounts to 1,424 km (TCMP 1999b). Its resources are very rich and significant from both economic and environmental points of view. It is an essential part of the coastal area management to understand the basic physical, chemical, and biological processes that occur in the coastal area. Many of the processes of interest such as pollution occur on a spatial scale such that synoptic data cannot be obtained from ground and ship-borne measurements, so remotely sensed measurements provide the only alternative.

Space observation (e.g. satellite remote sensing technique) has a significant contribution to make routine environment and pollution monitoring. Satellites are capable of measuring a number of oceanographic parameters in the coastal area that provide important information for coastal area management. These include ocean color, chlorophyll-a, suspended sediment, sea surface temperature, sea surface roughness, and sea surface slope, from which other oceanographic parameters can be derived. The main strengths of satellite remote sensing technique lay in the wide, synoptic coverage that provides consistent results over large areas. Repeatability of results also plays a role in ensuring the usefulness of the image data. Mapping coastal area and its resources by ground surveys is costly, time-consuming, and geographically limited. Remote Sensing technique (employing Landsat imagery of 1990 and 2000) has been used to monitor change of mangrove coverage (Wang *et al*. 2003) and Land-Cover change along

the Tanzania Coast. Apart from mangroves and Land-Cover there has been very limited application of remote sensing technique for other coastal resources mapping and data measurements in Tanzania.

5.1.23 Biodiversity

Biodiversity is the variation of life at all levels of biological organization. It refers to plants, animals and microorganisms, the genes they contain, and ecosystems and ecosystem processes they form. It is typically considered at three levels: genetic diversity, species diversity and ecosystem diversity. Marine biodiversity is more than a count of species in the sea, and biodiversity decline is characterised not only by extinctions, but by invasions and hybridisations, populations of species reduced in number, habitats that have been diminished or removed, and ecosystem processes (e.g. cycling of water, nutrients and energy) that have been disrupted. A good understanding of the factors and mechanisms that determine biodiversity is a major scientific challenge and is essential for the development of efficient conservation strategies.

Current trends in the status of Tanzania's marine biodiversity are difficult to determine for several reasons, including lack of information and lack of a nationally coordinated approach to assessing and monitoring marine biodiversity. Despite this lack of comprehensive information on marine biodiversity, expert opinion based on observations of significant decline in some marine species in some areas suggests that there is a continuing decline occurring in Tanzania's marine biodiversity and ecosystems. Main biodiversity issues having a bearing on fisheries include by-catch, habitat damage through fishing, ecosystem effects, sensitive areas, and EAF approach. Sparse biodiversity baseline information for management areas; and the lack of a systematic national-scale approach to monitoring biodiversity trends (i.e. by comparing subsequent studies to the baseline information) were identified as the two major knowledge gaps that hinder management of marine biodiversity. There is a lack of systematic broad-scale sampling of, and taxonomic information on, species and their distribution within the marine environment. Tanzania is facing a critical shortage of expertise in taxonomic identification.
Expertise in areas covering marine and coastal biodiversity is still required in the country. Knowledge gaps that needs to be fulfilled include determining levels of sustainable harvesting of resources particularly mangroves; there is still a lack of information on coral recruitment patterns marine waters of Tanzania, especially so as linked to seasons, directions of dispersion; a better understanding of the extent of the threat of the seagrasses.

5.1.24 Taxonomy and Curation

The need to accurately identify and catalogue the huge diversity of Tanzanian marine species is essential for undertaking meaningful attempts to understand the extent and rate of marine biodiversity decline. While identifying many of the large iconic species like marine mammals, seabirds and fin fishes is reasonably simple, identifying the vast majority of species in Tanzania waters (i.e. invertebrates and marine plants) is quite difficult, as many species are new to science and most are still not yet even formally described.

Marine (animal and plant) taxonomy (requiring both parataxonomists and alphataxonomists) was the domain of an increasingly small number of specialists, who generally worked in Tanzanian museums and scientific institutions in the 1970s and 80s. All of these people have retired and there were no recognized succession plans to replace them. At the University of Dar es Salaam there is, for example, only one Ph.D. graduate on marine algae taxonomy. This problem, also known as the 'taxonomic impediment', was highlighted by the Tanzania Fisheries Research Institute and led to the then Faculty of Aquatic Sciences and Technology in partnership

with Memorial University of Newfoundland to run a two-week intensive Training Course in Fish Taxonomy and Collection Curation held in Dar es Salaam in 2006. It is therefore critical to provide additional formal tertiary courses in marine taxonomy for training the next wave of marine taxonomists, as presently only the University of Dar es Salaam Department of Botany offers an undergraduate course in plant biosystematics.

5.1.25 Pollution from Land and Marine Based Sources

Human activities on land pose a major threat to the health, productivity and biodiversity of the marine environment. Globally, about 80% of marine pollution is generated from land-based activities, including diffuse pollution from urban and agricultural areas, point source emissions and solid wastes (GESAMP 1990). Types of pollution include hydrocarbons, pesticides, other persistent organic pollutants, heavy metals, pathogens, nutrients, sediments and litter. The activities that cause marine pollution generally include shipping, boating (e.g. vessel maintenance activities and littering), oil and gas exploration. Although major oil spills pose serious risks to marine ecosystems, including marine biodiversity, small but frequent operational discharges, such as those from outboard motors, introduce large quantities of oil into the sea on an annual basis. The toxic effects of oil on marine biodiversity can include immuno-suppression, reproductive impairment, developmental or behavioral abnormalities, disease (including tumors) and death.

Untreated sewage from sanitary facilities (septic tanks, pit latrines and malfunctioning wastewater treatment plants) is a major source of marine water quality degradation in Tanzania (Mohammed *et al*. 2006). It is estimated that 37,912 m3/day of municipal wastewater is generated and potentially entering the coastal areas of Tanzania (Kayombo 2007). Estimated loads of organic material (BOD), suspended solids, nitrogen and phosphorus generated from municipal wastewater in coastal areas of Tanzania are in the order of 21,741; 50,413; 10,398 and 1,260 tonnes/year, respectively (Kayombo 2007). Land-based activities and pollutants from land-based sources can adversely impact marine life and ecosystems, and also marine-dependent industries (e.g. tourism, fisheries and mariculture), public health, foreshore stability, recreation and aesthetics. Once in the marine environment, the pollutant are absorbed by marine life, settle in river mouths and on the ocean floor, or follow currents and eddies to distant locations, which may be within a different jurisdiction to the source of the pollutant. More training of researchers and technical experts in sediment and water quality sampling and analysis is necessary.

5.1.26 Environmental Impact Assessment Training

For all developments that potentially have impacts on the biophysical and socioeconomic environment Tanzania has designed guidelines for developers (proponents) outlining appropriate procedures to identify and to address impacts and ensuing mitigation measures. The outcome of this procedure is the environmental and social impact assessment (ESIA). The ESIA provides the environmental authority with a basis to certify the project as being environmentally sound having adequately addressed all potential impacts. The guidelines ensure that the proponent is in line with the environmental legislation i.e. the Environmental Management Act (2004) and the enforcing regulations (EIA and Audit Regulations, 2005 – G.N. No. 349 of 2005).

Several Institutions of higher learning offer training in EIA including the Universities of Dar es Salaam, Ardhi, Sokoine and Dodoma. However, none of the EIA courses being offered in these Institutions has been specifically designed to deal with coastal marine issues. NEMC identifies

expertise in conducting EIA, reviewing EIA reports and carrying out environmental audit for the existing projects as a major gap in the knowledge of EIA in Tanzania (Mchalo pers. com).

5.2 Training priorities and capacity for meeting them

Following the identification of key knowledge gaps hindering effective implementation of ASCLME project in Tanzania various national CB&T priorities and institutions with capacity to offer them have been identified and summarized in Table 7.

The proposed training projects to address existing knowledge gaps should be conducted in a mix of both short and long-term training courses. However, owing to the fact that many long term courses leading to award of a degree (i.e. Ph.D., Masters, or Bachelor) and Diploma already exist with well-developed curriculum, more emphasis should be placed on short training courses/workshops that impart technical skills. Formal education programmes offered by universities and colleges have limitations in that participants have to meet set qualifications whereby for example, a biology student may not qualify to undertake a course in fisheries economics. Furthermore, there is age discrimination, which may not be the case with short courses. Therefore, participants of short courses benefit from the fact that they are able to learn from other participants who have diverse backgrounds, as there is an integration of varied expertise and working experience.

Table 7: **Prioritization of national CB&T needs for ASCLME project in Tanzania.**

KEY:

Level needed/offered: Sc = Short course, Dip = Diploma, Deg = Degree
Expertise/Skills: L = Low, M = Medium, H = High
Priority: L = Low, M = Medium, H = High, VH = Very high
Potential Provider: Abroad = outside Tanzania, UDSM = University of Dar es Salaam, DASF = Department of Aquatic Sciences and Fisheries, IMS = Institute of Marine Sciences, SUA = Sokoine University of Agriculture, NYE = Nyegezi Freshwater Fisheries Institute, MBE = Mbegani Fisheries Development Centre, IRA = Institute of Resources Assessment, CASS = College of Arts and Social Sciences, Geology = Dept. of Geology, Geography = Dept. of Geography, Zoology = Dept. of Zoology, ARDHI = Ardhi University, SAIAB = South African Institute of Aquatic Biodiversity

S/N	TOPIC	CURRENT NEEDS (Level Needed)	CURRENT CAPACITY		PRIORITY	POTENTIAL PROVIDER
			Level Offered	Expertize/Skills Level		
Technical Training						
1.	Oceanographic instrumentation (maintenance & calibration)	Sc, Dip, & Deg	None	L	H	Abroad
2.	Electronic Instrumentation	Sc, Dip, & Deg	Dip, Deg	L	H	UDSM
3.	Coastal/Marine Field surveying	Sc, Dip, & Deg	Sc	L	VH	UDSM (DASF, IMS)
Economics and Socioeconomics						
1.	Fisheries Economics	Sc, Dip, & Deg	Deg	M	H	UDSM-DASF
Numerical Expertise						
1.	Ecosystems Modelling (EAF)	Sc, Dip, & Deg	Deg	L	VH	UDSM-DASF

2.	**Stock Assessment**	Sc, Dip, & Deg	Deg	**L**	**H**	UDSM-DASF
3.	**Acoustics**	Sc, Dip, & Deg	Deg	**L**	**M**	Abroad
Data Management and Information gathering skills						
1.	**Experimental design techniques & Data analysis**	Sc, Dip & Deg	Deg	**M**	**H**	UDSM-DASF
2.	**Data Management**	Sc, Dip, & Deg	Deg	**M**	**H**	UDSM-DASF
Legal Expertise						
1.	**Environmental & Marine Law**	Sc, Dip & Deg	Dip &Deg	**L**	**H**	UDSM
2.	**Arbitration and Alternative Dispute Resolution**	Sc, Dip & Deg	Dip & Deg	**L**	**L**	Abroad
Language Education						
1.	**English as a second Language**	Sc, Dip & Deg	Sc, Dip & Deg	**M**	**M**	UDSM, Private
Governance						
	Policy Development	Sc, Dip & Deg	Deg	**L**	**H**	Abroad
Fisheries Science						
1.	**Ichthyology**	Sc, Dip & Deg	Dip & Deg	**H**	**M**	UDSM (DASF), SUA, NYE
2.	**Fisheries Management**	Sc, Dip & Deg	Dip & Deg	**M**	**M**	UDSM (DASF), NYE
3.	**Fish Identification**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**H**	UDSM-DASF
4.	**Primary productivity (Phytoplankton)**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**VH**	UDSM-DASF
Oceanography						
1.	**Physical oceanography**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**VH**	IMS, DASF
2.	**Chemical and biological Oceanography**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**H**	IMS, DASF
3.	**Coastal ocean modelling**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**VH**	Abroad
Coastal Zone Management (GIS & MPA)						
1.	**GIS & Remote sensing**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**VH**	UDSM (IRA)
2.	**Coastal Engineering**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**H**	Abroad

3.	**MPA**	Sc, Dip & Deg	SC	**L**	**M**	DASF
4.	**Coastal tourism**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**M**	UDSM (CASS), Private
Geology and Geomorphology including mineral extraction						
1.	**Geology & Geomorphology**	Sc, Dip & Deg	Sc & Deg	**L**	**M**	UDSM (Geology, Geography)
2.	**Mineral Extraction**	Sc, Dip & Deg	Sc & Deg	**L**	**H**	Geology
Aquaculture						
1.	**Aquaculture Systems**	Sc, Dip & Deg	Dip & Deg	**L**	**H**	DASF, SUA, NYE, MBE
2.	**Aquaculture production (including seed production)**	Sc, Dip & Deg	Dip & Deg	**L**	**VH**	DASF, SUA, NYE, MBE
3.	**Aquaculture nutrition (including feed formulation)**	Sc, Dip & Deg	Dip & Deg	**L**	**VH**	DASF, SUA, NYE, MBE
4.	**Aquaculture extension**	Sc, Dip & Deg	Dip & Deg	**L**	**H**	DASF, SUA, NYE, MBE
Coastal Agriculture & Forestry						
1.	**Coastal Agriculture & Forestry**	Sc, Dip & Deg	Dip & Deg	**M**	**M**	SUA, Olmotonyi
Climate Research						
1.	**Global Climate Change**	SC, Dip & Deg	Deg	**L**	**H**	UDSM (IRA)
Environmental Education Human Health						
1.	**Health & Safety**	Sc, Dip & Deg		**L**	**M**	
2.	**Environmental Education**	Sc, Dip & Deg	Deg	**M**	**M**	ARDHI, UDSM
3.	**Eco tourism**	Sc, Dip & Deg	Sc, Dip & Deg	**L**	**H**	UDSM, Private
4.	**Public Relations**	Sc, Dip & Deg	Sc, Dip & Deg	**M**	**M**	SJMC, Private

Training of inspectors						
1.	**Fisheries Monitoring, Control & Surveillance (MCS)**	Sc, Dip & Deg	Sc	**L**	**H**	MBE
2.	**Environmental Management (Environmental inspectors**	Sc, Dip & Deg	Sc & Deg	**L**	**H**	ARDHI, UDSM
Trans-disciplinary training of managers						
1.	**Ecosystems approach training**	Sc, Dip & Deg	Deg	**L**	**VH**	UDSM, Abroad
2.	**Ecosystem modelling**	Sc, Dip & Deg	Deg	**L**	**VH**	UDSM, Abroad
Biodiversity						
1.	**Biodiversity**	Sc, Dip & Deg	Sc &Deg	**M**	**H**	Zoology, DASF
2.	**Conservation biology**	Sc, Dip & Deg	Sc, & Deg	**M**	**M**	Zoology, DASF
Taxonomy & Curation						
1.	**Taxonomy**	Sc, Dip & Deg	Sc & Deg	**L**	**VH**	DASF, SAIAB
2.	**Curation**	Sc, Dip & Deg	Sc & Deg	**L**	**VH**	DASF, SAIAB
Pollution						
1.	**Ecotoxicology**	Sc, Dip & Deg	Deg	**L**	**H**	DASF, Abroad
2.	**Environmental pollution monitoring**	Sc, Dip & Deg	Deg	**L**	**H**	DASF, ARDHI
Environmental Impact Assessment (EIA)						
1.	**Environmental Impact Assessment**	Sc, Dip & Deg	Sc & Deg	**L**	**H**	DASF, IRA

6.0 REGIONAL AND INTERNATIONAL LINKAGES AND SUPPORT

There are many national and regional agencies, projects, programmes or institutions active in the Tanzanian marine environment, each with its own mandate, budget, aims and objectives. In overview of the many training activities undertaken by different programmes, there is scope for projects to collaborate and thereby contribute more effectively to the CB&T in areas of common interest.

Within the first four years of the project a number of training courses have been organized by ASCLME and partner projects in Tanzania and elsewhere in the region. A list of completed CB&T activities in which Tanzanian scientists have benefited includes: Two intensive Oceanographic training courses for cruise participants; UCT: 2008, 2009; Training on the use of inshore oceanographic equipment at the Mauritius Oceanographic Institute in April 2010; EAF training in collaboration with FAO; GIS Atlas training; EU-JRC Ocean Color Course; and SAEON/UCT oceanographic modelling course. Cruise participation was not completed as planned due to the problem of piracy along the coastline of Tanzania Kenya and Somalia. Future training activities may include joint courses through the DLIST activity and possible partnerships with the GloBallast Partnership and WWF.

To take advantage of the training courses offered by partner projects, ASCLME-CB&T activities identified in Tanzania would have to be adjusted according to the key partnerships developed. This arrangement will assist in future training activities and at the same time ensure sustainability of the training courses.

7.0 PROPOSED START-UP TRAINING COURSES

7.1 Courses

The proposed start-up training courses were drawn from the skill gaps identified in the various ASCLME Project sub-thematic areas (Section 5, Appendix 1 of this report) and prioritization of national CB&T needs for the project as summarized in Table 7.

The main objective of the proposed training courses is to develop the capacity required to effectively implement the project as well as increase the capacity of stakeholders to effectively and sustainably manage marine resources and thus maintain the economic, food security and livelihood benefits that can be derived from them. Some of the training courses already exist with well-developed curriculum and it is recommended that ASCLME Project use these pre-existing courses. The proposed training courses and their training approaches/methods are summarized in Table 8.

Table 8: Summary of the proposed training courses

Subject	**Attendance**	**Short description**	**Attendance only (e.g. workshops, discussion groups)**	**Diploma**	**Degree**	**Priority** **A - Immediate** **B – Short term** **C - medium term**
Technical training – marine related fields including fisheries and oceanography	10 ocean managers with wide range of formal training (Bachelor and above) and experience (e.g. computer technology, electronics, applied marine science, engineering, operational oceanography, etc.).	**Training course in Oceanographic Instrumentation.** Oceanographic Instrumentation Technicians play an important role in the collection of scientific measurements that allow understanding on how the oceans work and to use the ocean and its resources more safely and wisely. The ocean is a harsh environment, and deploying and maintaining equipment there requires skilled and dedicated professionals. The purpose of this course to provide knowledge for the installation, maintenance, troubleshooting, repair, engineering, and operation of instrumentation and systems used for the collection of oceanic and marine atmospheric observations.		Lecture & Ship board training in oceanographic instruments		A
Economics and socioeconomics	25 Coastal resource managers and personnel with formal training and experience in sociology and Economics.	**Training Course in Socio-economics.** Coastal resource managers realize that coastal resources can no longer be managed from biophysical focus alone. Community attitudes towards, and use of, coastal resources have serious implications on the biophysical health of coastal marine ecosystems. The purpose of this course is to provide resource managers with a methodology to regularly collecting basic socioeconomic data useful for coastal management at the site level; and provide a basis for national and regional systems by which site-level data can feed into national, regional and international databases for comparison.	A series of roundtable/ collegial dialogue organised as retreat.			A
Numerical expertise (statistics, applied mathematics etc)	25 Fisheries scientists, resource managers and personnel with formal training and experience in fisheries biology/ecology.	**Biological and Ecological fisheries modelling.** This course will address unregulated and regulated growth of populations, as this leads to the logistic growth model. The practical application of the concept of carrying capacity (maximum biomass for a stock), the concept of surplus production, maximum sustainable yield (MSY) and the biomass at MSY. Participants will also be introduced to a brief	A combination of plenary, tutorials and small participatory working-group sessions.			B

		descriptive overview of the various mathematical models used to estimate MSY and BMSY. Finally, the use of age or length structured models will be discussed as a further development of the global biomass models.				
Data management and information management skills	15 data managers from fisheries research institutions and national oceanographic data centre	**Training Course in Marine Data Management.** Provide participants with knowledge and skills in basic computer skills; the importance of marine data in general, and particularly within trainees' national and regional environments; how to set up an oceanographic data centre within the IODE System; infrastructure requirements, including hardware and software tools; how to manipulate and analyze the principal types and formats of marine data ; and how to produce ocean data products and to disseminate the products, both over the Internet and by traditional methods.	Participatory working-group sessions.			B
Legal expertise	15 Legal experts, Fisheries officers including those involved in policy formulations	**Introductory Training Course in Fisheries Laws**. To provide review the importance of fisheries laws and the harmonization of local laws at a regional level, while being sensitive to issues of national sovereignty. Trainees cautioned to recognize that fisheries laws at a national level need to be updated to address new challenges; including IUU issues as such updates provide a good opportunity for increased regional consistency. They include, for example, promotion of similar fine amounts and minimum penalties, minimum licensing terms and conditions for foreign fishing vessels, annual renewal and requiring registration on the regional vessel register, use of presumptions and strict liability.	A series of roundtable/ collegial dialogue organised as retreat			B
Language education (general)		**Communication Skills in English** Increase the number of Bachelor of Arts student teachers taking English as a major teaching subject at the existing universities. Conduct periodic refresher courses for secondary and primary school English teachers.	 Workshop		Increase enrolment in existing BA program	C

Governance	30 Professionals working in fisheries (fisheries officers at the Department of Fisheries and Local Government level)	**Transboundary Marine and Coastal Governance.** Enable participants to play an active role in adapting to changing roles and tasks of fisheries managers by strengthening their organizations as change agents in order to effectively contribute to poverty reduction and development and at the same time safe-guarding the ecosystem and its biodiversity. Learn how to bring different stakeholders together and help people to understand each other's perspectives and manage conflict in fisheries (crucial in the formation of fisheries co-management units).	A series of roundtable/ collegial dialogue organised as retreat			A
	20 Researchers, program managers, and others responsible for formulating policies and implementing environmental programs.	**Communicating Environmental Research to Policy Makers.** To provide skills that will help to bridge the communication gap between researchers and policymakers. To understand how to better communicate the fisheries and environment research results, identify the policy and program implications of survey data and research studies, understand how research can influence the policy process, and communicate research findings in simple and compelling formats.	A series of roundtable/ collegial dialogue organised as retreat			C
Fisheries science (e.g. stock assessments, biological/ecological studies)	Fisheries researchers and managers (personnel with formal training and experience in fisheries biology and ecology)	**Fisheries Data Collection and Analyses.** Provide participants with a comprehensive list of the wide variety of data (e.g. fishery independent and dependent) required to conduct effective fisheries management. Survey data on the abundance and distribution of fishery resources allows for the development of relative indices of abundance after a time series of sufficient duration has been developed. The relative indices of abundance also allow the estimation of mortality using catch curve analysis. Finally, survey data of fish abundance and distribution when combined with habitat or environmental information allows for the development of functional relationships between fish distributions and habitat characteristics.	A combination of plenary, tutorials and small participatory working-group sessions.			A
		Taxonomy and Curation To provide skills to accurately identify and catalogue the huge diversity of Tanzanian marine species. While identifying many of the	A combination of plenary, tutorials			B

		large iconic species like marine mammals, seabirds and fin fishes is reasonably simple, identifying the vast majority of species in Tanzania waters (i.e. invertebrates and marine plants) is quite difficult, as many species are new to science and most are still not yet even formally described.	and small participatory working-group sessions.			
Oceanography (Physical, chemical, biological)	10 Physical oceanographers and ocean engineers	**Coastal Circulation and Hydrodynamic Modelling: Addressing Climate Change.** Provide participants with the knowledge and tools necessary to apply numerical models for coastal circulation, tides, waves, wave-current interaction, sediment transport, and in addressing issues of climate change.	A combination of plenary and small participatory working-group sessions.			A
Coastal zone management including expertise in GIS and MPA's	10 Coastal resources managers (personnel with formal Bachelor degree training and experience in any of the ASCLME thematic areas)	**Master of Integrated Coastal Zone Management.** The course should provide an in-depth understanding of the natural and human-induced forcing factors that are responsible for the rapid rates of environmental and climate change, and the types of governance and community based responses required to address the impacts, vulnerabilities and implications of these changes on physical, biological, social, economic and cultural environmental conditions. Provides trainees with practical skills in problem solving as related to adaptive environmental assessment and integrated management systems.			Taught MSc program	B
	20 Researchers, technicians and mid-level managers from various government and non-governmental organizations dealing with coastal resources management and disaster mitigation.	**Remote Sensing and GIS for Coastal Applications.** To build capacity in using remote sensing (e.g. high-resolution satellite data) for coastal zone management and disaster mitigation. Help participants to understand the theoretical aspect of GIS and remote sensing, software usage, use of satellite data for coastal management, use of satellite data for disaster mitigation in a coastal area, integration of remote sensing and GIS, creation of DEM using satellite data and use of GPS for remote sensing and GIS.	A combination of plenary, tutorials and small participatory working-group sessions.			A
Aquaculture	30 Aquaculture extension officers,	**Aquaculture extension training** Milkfish has been practised for several years now but lack of concerted extension activities had	A series of roundtable/			B

	Result demonstrator milkfish farmers and field counterparts,	hampered development and prevented fish farmers from realizing the full potential of their ponds. The participants will learn how to conduct baseline surveys to register profit margins, socio-economic status and annual yields under existing culture practices as well as the technical capacity and ability of farmers to provide the required aquaculture inputs exclusively from their own resources.	collegial dialogue organised as retreat			
Climate research	30 students enrolled annually	**Climate and Human Environment Interactions**. Introduce this as a standalone course to the existing postgraduate degree programme in aquatic sciences, botany, zoology or geography. Trainees will learn techniques for routine collection of data (on temperature, rainfall, soil erosion and other socio-economic data) relevant for reconstruction of the past history of climate change so as to enable prediction of the future.			Taught MSc or MA program	B
Microfauna and Meiofauna	30 students enrolled annually	Introduce Macro- and Meiofauna as standalone course in the existing BSc aquatic sciences degree programmes. Recruit more postgraduate students in Macro- and Meiofauna research at local universities.			Taught BSc program	C
Macrofauna – Invertebrates, fish, mammals, reptiles, birds, exotics and invasive species	30 students enrolled annually	Enrol more students in current BSc programmes that teach Macrofauna (Invertebrates, fish, mammals, reptiles, birds, exotics and invasive species) at local universities.			Taught BSc program	C
Environmental Education, human health	25 Technical experts, Researchers, Community Groups and NGO's.	**Course on Habitat Rehabilitation/Restoration.** To restore and maintain the physical, chemical, and biological conditions necessary to allow the remaining natural habitat (e.g. mangroves, coral reefs, deforested lands, etc) to function and evolve over time. At the end of the course Trainees should be able to quantify different levels of habitat destruction and gain an understanding of methods used to rehabilitate different environments using cost effective techniques. Trainees with skills to impart their knowledge to community groups and peer groups through presentations as well as techniques for the mobilization of large community groups for habitat rehabilitation activities.	A combination of plenary and small participatory working-group sessions.			A
Tourism	20 senior government	**Sustainable Coastal Tourism Development**	A series of			A

	planners and decision-makers, tourism representatives, NGOs, tourism stakeholders and community decision-makers.	To provide decision-makers with the necessary tools to enable them to move towards sustainable tourism development and risk reduction with specific reference to integrated planning and decision-making involving all stakeholders. Participants will develop a holistic appreciation of key issues, including the need to integrate natural hazards and social dimensions, in sustainable tourism planning.	roundtable/ collegial dialogue organised as retreat			
Training of inspectors and observers, community involvement? (MCS, including pollution etc)	20 Fisheries scientists, Fisheries technologists, chemical and physical oceanographers, and Biodiversity professionals	**Fisheries Observer Training Course.** To provide necessary skills and knowledge to observe, record and collect while at sea accurate data relating to the nature of fishing operations, catch and species composition, by-catch mortality, discards, fishing trip details, gears, licences and area(s) fished, vessel specifications, fishing equipment and electronics, searching time, numbers of sets. Successful candidates should be able to board any fishing vessels involved in demersal, crustaceans and/or pelagic fisheries.	A combination of plenary and ship board working sessions			A
Trans-disciplinary training for managers including ecosystem approach	30 Decision makers and senior government officials and managers, particularly those from the sectors such as capture fisheries, aquaculture, coastal mining, etc.	**Training in Ecosystem Approaches to Coastal and Ocean Management, focusing on Ecosystem Based Management.** Building skills to develop and implement ecosystem approaches to the management of coastal and marine environment. Learn how to plan, develop and manage fisheries and other coastal resources in a manner that addresses the multiple needs and desires of society without jeopardizing the options for future generations to benefit from the full range of goods and services provided by the marine ecosystem.	A series of roundtable/ collegial dialogue organised as retreat			A
Fishing technology, implementing of quality control in industry	20 Fish inspectors and fish processing industry personnel	**Training course in Hazard Analysis Critical Control Point** (**HACCP)**. Fish and fishery products are in the forefront of food safety and quality improvement because they are among the most internationally traded food commodities. The course is aimed at developing skills and competencies required in HACCP implementation. Participants will learn skills to identify things that can cause the food to be unsafe (i.e. hazard analysis) and deciding at which place in the production of the food the hazards can best be controlled (i.e. the critical control point for that hazard). They will also acquire skills to examine the relative costs and benefits of producing	A combination of plenary and ship board /factory practical training			B

		seafood, how to create a market incentive, and what does certification mean to the consumer and the producer, the use of branding and eco-labelling as incentive and guidance for moving towards sustainability.				
Environmental monitoring, including pollution and remote sensing	15 Researchers, Technical experts (personnel with formal training and experience in analytical chemistry as well as experience in operation of basic analytical equipment	**Course in Sediment and Water Quality Sampling and Analysis.** Trainees will be equipped with knowledge of how to handle samples for organic contaminants, nutrients and heavy metal analysis. Also have the ability to operate basic equipment for the analysis of these samples. Gain skills in good laboratory practice and result presentation and skills that will enable them to write a strategic plan for the implementation of an institutional monitoring plan.	Plenary and field & Lab based analytical training			B
Biodiversity	15 Fisheries resource managers and personnel with formal training and experience in fishing gear technology. And Diploma trainees in national fisheries training Institutions	**Reducing By-catch and Habitat Alteration through Selective Gear Design (*short 3-weeks for fisheries managers and 1 full academic year for Diploma programme*).** The courses should provide a description of all gears used to harvest fishery resources from the most rudimentary artisanal methods to the most sophisticated methods used in industrial fishing. With each gear type described, specific examples will be provided of recent progress in by-catch reduction and habitat alteration in many fisheries, including these fisheries where additional research remains to be done. Some recent examples of very successful by-catch reduction programs include: dolphin in the tuna purse seine fishery, sea turtles in pound net and shrimp and scallop trawl fisheries, sea birds in long line fisheries, and undersize fish in gillnet, trap, and trawl fisheries.	A combination of plenary and ship board practical training	Taught Gear Technology Diploma program		B
Taxonomy and curation	40 Personnel with formal training and experience in Fisheries biology	**Fish Taxonomy and Curation course.** Current threats to fish biodiversity and losses that have already occurred urgently require better knowledge of fish taxonomy and the distribution and abundance patterns of fishes. In this course trainees will learn basic procedures and acceptable practices involved with natural history collections and gain hands on experience in the practical aspects of making and working with a fish collection and the identification of fishes.	A combination of plenary and small participatory working-group sessions.			A
Pollution: land	25 Researchers,	**Municipal Waste Water**. Learn how to design, construct and manage	A combination of			B

and marine based	Technical experts (personnel that have formal training and experience municipal waste water management)	wetland systems for waste management. Imparting knowledge of quality control parameters, legal aspects of penalty enforcement as well as aspects of strategic planning/management. Trainees will also learn how to assess waste disposal practices of communities and how to educate communities on sanitation issues.	plenary, tutorials and small participatory working-group sessions.			
Environmental Impact Assessment Training	15 trainees who had a previous exposure to EIA training (to become future trainers).	**Training Workshop in EIA.** The training workshop aimed at providing a review on the role of EIA in relation to environmental management for sustainable development, and to effective processes and good practices in its application. The legal and institutional arrangements and capabilities that need to be in place for ensuring the quality of EIA is acceptable will be discussed, and considered how the findings from the EIA process are integrated into project planning and decision-making. Field trips included in the training to provide participants with a real-time example of the scale and complexity of a major near-shore coastal development and an opportunity to discuss different aspects of EIA as it relates to such coastal developments.	A series of roundtable/ collegial dialogue organised as retreat			B

7.2 Budget

Training course/activity	**Total budget (US $)**
Training course in Oceanographic Instrumentation	??
Ecosystem Approaches to Coastal and Ocean Management, focusing on Ecosystem Based Management	129,080
Communicating Environmental Research to Policy Makers	119,678
Transboundary Marine and Coastal Governance	124,765
Coastal Circulation and Hydrodynamic Modelling: Addressing Climate Change	99,320
Remote Sensing and GIS for Coastal Applications	108,000
Fisheries Observer Training Course	161,580
Training Course in Socio-economics	95,234
Biological and Ecological fisheries modelling	99,058
Training Course in Marine Data Management	97,587
Aquaculture extension	102,000
Communication Skills in English	75,000
Introductory Training Course in Fisheries Laws	96,124
Fisheries Data Collection and Analyses	145,300
Master of Integrated Coastal Zone Management	153,842
Climate and Human Environment Interactions	99,480
Course on Habitat Rehabilitation/Restoration	153,000
Training course in Hazard Analysis Critical Control Point (HACCP)	129,845
Sustainable Coastal Tourism Development	85,000
Course in Sediment and Water Quality Sampling and Analysis	108,550
Reducing By-catch and Habitat Alteration through Selective Gear Design	155,410
Fish Taxonomy and Curation course	122,354
Municipal Waste Water	132,904
Training Workshop in EIA	136,270
TOTAL	**2,729,38**

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APPENDICES

Appendix 1:

LIST OF ACRONYMS

ACSEE	Advanced Certificate of Secondary Education Examination
AMESD	African Monitoring of the Environment Project
ASCLME	Aghulas and Somali Current Large Marine Ecosystem
AU	African Union
BMSY	Biomass at Maximum Sustainable Yield
BMUs	Beach Management Units
BRALUP	Bureau of Resource Assessment and Land Use Planning
CASS	College of Arts and Social Sciences
CBO	Community Based Organization
CB&T	Capacity Building and Training
CFMA	Collaborative Fisheries Management Area
CIDA	Canadian International Development Agency
CoET	College of Engineering and Technology
COMREC	Coastal Management Research Centre
CoNAS	College of Natural and Applied Sciences
CSIR	Council for Scientific and Industrial Research
DASF	Department of Aquatic Sciences and Fisheries
DIT	Dar es salaam Institute of Technology
DSFA	Deep Sea Fishing Authority
DTC	Dar es Salaam Technical College
DTT	District Technical Team
EAF	Ecosystem Approach to Fisheries
EAME	East Africa Marine Ecoregion
EEZ	Exclusive Economic zone
EIA	Environmental Impact Assessment
ERB	Economic Research Bureau
ESIA	Environmental and Social Impact Assessment
ESRF	Economic and Social Research Foundation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Products
GEM	Global Environmental Monitoring
GESAMP	Group of Experts on the Scientific Aspects of Marine Pollution
GIS	Geographic Information Systems
HACCP	Hazard Analysis Critical Control Point
HESLB	Higher Education Students Loan Board
ICM	Integrated Coastal Management
ICT	Information and Communication Technology

IES	Institute for Environmental and Sustainability
IMS	Institute of Marine Sciences
IOC	International Oceanographic Commission
IOTC	Indian Ocean Tuna commission
IPS	Image Processing Systems
IRA	Institute of Resource Assessment
IUCN	International Union for the Conservation of Nature
IUU	Illegal, Unreported and Unregulated fishing
JET	Journalists Environmental Association of Tanzania
KICAMP	Kinondoni Integrated Coastal area Management Programme
KMFRTI	Kunduchi Marine Fisheries Research and Training Institute
LEAT	Lawyers' Environmental Action Team
LMEs	Large Marine Ecosystems
MACEMP	Marine and Coastal Environment Management programme
MASMA	Marine Science for Management
MCS	Monitoring Control and Surveillance
MEDA	Marine Ecosystem Diagnostic Analyses
MFDC	Fisheries Development Centre
MNRT	Ministry of Natural Resources and Tourism
MOEC	Ministry of Education and Culture
MoEVT	Ministry of Education and Vocational Training
MPA	Marine Protected Area
MPRU	Marine Parks and Reserve Unit
MSY	Maximum Sustainable Yield
MUN	Memorial University of Newfoundland
NACTE	National Council for Technical Education
NADS	National Aquaculture Development Strategy
NEMC	National Environment Management Council
NFFI	Nyegezi Freshwater Fisheries Institute
NGO	Non Governmental Organization
NQF	National Qualifications Framework
OCSEE	Ordinary Certificate of Secondary Education Examination
ODINAFRICA	Ocean Data and Information Network for Africa
PEDP	Primary Education Development Programme
R&D	Research and Development
ReCoMaP	Regional Programme for the Sustainable Management of Coastal Zones of the Countries in the Indian Ocean
RS	Remote sensing
SADC	South African Development Community
SAP	Strategic Action Programmes
SEACAM	Secretariat for Eastern African Coastal Area Management
SEDP	Secondary Education Development Programme
SMOLE	Sustainable Management of Land and Environment
SocMon-WIO	Socioeconomic Monitoring Network in Western Indian Ocean.
SSR	Staff Student Ratio
STI	Science, Technology and Innovation
SUCCESS	Sustainable Coastal Communities and Ecosystems Program
SWIOFP	South West Indian Ocean Fisheries Project
SWIOP	South West Indian Ocean Project
TAFIRI	Tanzania Fisheries Research Institute
TAFORI	Tanzania Forestry Research Institute

TCMP	Tanzania Coastal Management Programme
TCU	Tanzania Commission for Universities
TDAs	Transboundary Diagnostic Analysis
TEA	Tanzania Education Authority
TMA	Tanzania Meteorological Agency
TVET	Technical and Vocational Education
TzNODC	Tanzania National Oceanographic Data Centre
UDSM	University of Dar es Salaam
UNEP	United Nations Environmental Programme
UNEP/GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (UNEP)
UNESCO	United Nations Scientific and Cultural Organization
UNESCO-IHE	Institute for Water Education
UNIDO	United Nations Industrial Development Organization
URT	United Republic of Tanzania
USAID	United States Agency for International Development
VETA	Vocational Education Training Authority
WCST	Wildlife Conservation Society of Tanzania
WIO	Western Indian Ocean
WIO-LaB	Addressing Land-based Activities in the West Indian Ocean
WIOMSA	Western Indian Ocean Marine Sciences Association
WWF	World Wide Fund for Nature

Appendix 2:

TERMS OF REFERENCE: CAPACITY BUILDING AND TRAINING SPECIALIST

Can be found in the Project document

Appendix 3: Knowledge/information gaps for the ASCLME Project thematic areas in Tanzania

Oceanography	• Lack of models of the physical processes governing the dynamics of the Tanzanian coastal waters (wave analysis and wave tranquillity studies; • Lack of good models for ocean dynamics (e.g., oil spill or pollutant movement, tsunami run-up, storm surges). • Offshore and near shore wave analysis and wave tranquillity studies, tidal, wind and storm generated currents, etc).
Aquaculture	• Inadequate coastal area zoning schemes to cater for pond siting and small-scale mariculture projects approval system; • Insufficient trained manpower to manage the fish farms and provide extension services.
Fisheries Science	• Lack of continuous and long-term fisheries data collection for important commercial stocks; • Scarce or patchy information on the fisheries for majority of fish stocks (i.e. catch and effort statistics and biological data) • Only very basic fisheries information that is inadequate for assessments of stock status or fisheries potential is collected;

	• Insufficient researches and data in key fisheries attributes that yield useful information for management; e.g. optimum effort that produces the maximum sustainable yield. Such information will allow managers to determine total tonnage to be allowed to the foreign fishing vessels, etc. • Inadequate collection of important fisheries related oceanographic data due to limited areal coverage of existing researches; • Inadequate socio-economic researchers; • Limited spatial and temporal extent of the existing data and lack of linkage of fisheries information with environmental information; • Inadequate fisheries infrastructure such as modern fish landing stations, laboratories and fishing harbours along the coast; • Lack of port (landing site) sampling methods; • Inadequate human capacity (fisheries experts) at both the Central and local Governments; • Much of the existing biological research data are related to time-specific postgraduate training; • Decline in commercial fish stocks and non-optimal harvesting of living resources; • Lack of information on the actual use of the retained by-catch, and destiny of discarded by-catch; • Limited assessment of variability in the fishing environment, ecosystem impacts and research aimed at improving predictability of the catches and the environment; • Lack of information on the effect of fishing on habitat destruction and alteration, including inter alia modification of seabed and coastal zone and degradation of coast scapes as well as threat to biodiversity/endangered and vulnerable species; • Inadequate data supporting the view that seabird by-catch is insignificant in tropical waters; • Lack of sufficient number of trained SCUBA divers to facilitate more researches on coral reefs. • Lack of fish taxonomists • Lack of necessary inputs and tools to enable fisheries experts collect, process and store data and be able to timely disseminate the information to end users. • Lack of well-planned databases for fisheries resource assessment and monitoring interfaced with GIS-based information management; • Hotspots (e.g. aggregating sites and nursery grounds) have not been formally identified, registered or protected; • Limited assessment of the existing fisheries databases and the formats to allow harmonization of databases and facilitate data sharing and communication. • Lack of good aquatic ecology models (e.g. larval dispersal, fish migration, stock assessment)
Governance	• Lack of specific fishery-by fishery management plans; • Lacks the resources and the power to control fishing effort; • Limited information on the achievements and problems of the BMUs based on the functions stipulated in the regulations; • Lack of researches on issues related to community-based monitoring of coastal and marine resources; • Insufficient researches on issues related to fishing in general including research on the level of awareness among fishermen on hazards of using illegal fishing gears. • Inadequate communication between resource users, scientists,

	planners and policy makers
Language education	• Inadequate number of English teachers in secondary schools and high schools.
Legal expertise	• Inadequate implementation/enforcement of legal and policy instruments; • Lack of regular updates of fisheries and other environmental laws to address new challenges (e.g. fine amounts and minimum penalties).
Data management and information management skills	• Limited expertise in data management and information management skills to implement effective and consolidated data management systems; • Inadequate and poor maintenance of ICT infrastructure; • Lack of financial and logistical resources to update and sustain the existing ICT facilities; • Lack of reliable internet access, data storage media and devices and GIS facilities; • Lack of national and institutional policies for data access and exchange between institutions.
Numerical expertise	• Inadequate number of numerical experts (e.g. modellers, statisticians, numerical economists, etc).
Socio-economics	• Lack of alternative economic development activities in coastal communities to either compensate for a reduced level of extraction of a particular resource or produce parallel incomes through the rational utilization of other resources.
MCS	• Insufficient researches on the fishing including level of awareness among fishermen on hazards of using illegal fishing gears. • Lack of researches on community-based management /monitoring of coastal and marine resources (e.g. achievements and problems of BMUs). • Insufficient Vehicle Monitoring System (VMS) and regular patrols to monitor fishing activities in the EEZ. • Lack of resources for capacity building and training, equipment (e.g. patrol boats and planes) and monitoring.
MPAs and ICM	• Lack of a wide network of CFMA in coastal area of Tanzania. • Lack of regular reviews of the existing Management Plans and Zoning Schemes for MPAs • Lack of regular reviews of the responsibilities of different government institutions/departments (e.g. forests, fisheries, wildlife, agriculture, ports, surveying of land and issuing of titles, and mineral mining) to harmonize sector policies involved in ICM. • Limited application of spatial data and GIS in ICM; • Limited human and infrastructural capacities in GIS.
Coastal tourism	• Lack of or limited access to beaches as a result of unregulated coastal development particularly hotels. • Lack of tourism information centres. • Inadequate trained staff to man the sector
Exploitation of coastal forests	• Lack of support to alternative energy sources to reduce exploitation of mangroves.
Urbanization	• Lack of current data on the extent of urban sprawling
Geology and Geomorphology	• Limited coverage of the studies on marine and coastal geology and geomorphology (existing studies covers northern part of Tanzania only) • Limited studies of shoreline changes along the coast of Tanzania. • Limited knowledge on causative factors of the problem of coastal erosion and sustainable shore mitigation solutions. • Lack of modelling tools for studying the coastal hydrodynamics (e.g. numerical modelling of waves, currents and sediment transport, coastal

	morphological processes and coastline responses to man-made coastal projects, etc). • Limited information on the ecological and socio-economic impacts of coastal erosion (e.g. effect of sedimentation on mangroves, sea grasses and coral reefs). • Lack of information on the sea bottom morphology (bathymetry) which is an important input for most hydrodynamic models. • Limited drilling density for hydrocarbon exploration which limits hydrocarbon research activities • Limited updating of discharge data for coastal river.
Climate changes	• Limited knowledge on how to analyze the pattern/frequency of extreme climatic events particularly the floods and storm events along the coast of Tanzania. • Lack of climate vulnerability analysis studies and the means to foster adaptive mechanisms to climate changes; • Limited networking and coordination of research on marine impacts from climate, climate variability and climate change among stakeholder institutions. • Insufficient number of modelling experts.
Coastal resources (e.g. mangrove, sea grasses and coral reefs) management	• Lack of long-term projects on restoration or protection of coral reefs. • Lack of information on coral recruitment patterns in Tanzania with respect to seasons, directions of dispersion, and species. • Lack of understanding on the extent of the threat of the seagrasses and corals based on illegal fishing and natural grazers and its link to productivity. • Lack of regular spatial and temporal monitoring studies based on the existing baseline studies on coral reefs, sea grasses and mangroves. • Lack of sufficient number of trained SCUBA divers to facilitate more researches on coral reefs and sea grasses. • Lack of detailed taxonomic work on coral reefs and sea grasses (e.g. identification keys). • Lack of detailed information on cover, species densities and diversity of mangroves, sea grasses and corals reefs along the coast of Tanzania. • Lack of regular interviews of the existing mangrove Management Plans and Zoning Schemes