Kenya Annex VIII. Additional tables

AGULHAS AND SOMALI CURRENT LARGE MARINE ECOSYSTEM (ASCLME) PROJECT

LIST OF DATASETS - KENYA

Contents

Coastal Drainage

Table 1: Main drainage areas in Kenya

	Drainage area	Catchment Area (km^2)	Freshwater Discharge (million m^3 p.a.)	Sediment Discharge (Tonnes p.a.)
1	Tana River	126,828	9,000	6.8('0^6)
2	Athi –Sabaki River	70,000	6,000	9('0^6)
3	Ramisi		6.3	1,500
4	Umba		16	
5	Pemba		9.6	
6	Mwache		2.15	
7	Mkurumuji		1.0	

Water and Sediment Quality

Table 2: Concentrations of Cu, Zn, Cd, Pb (µg g^{-1} dry wt) and Fe (mg g^{-1} dry wt) in sediments

Location (Ref.)	Cu	Zn	Cd	Pb	Fe
Continental slope and coastal zone, Kenya (1)	35 – 40	110 - 130	0.01 - 0.12	12 – 16	60 – 70
Mombasa inshore waters (2)	1.0 - 1177	3.0 – 283	-	1.0 - 427	-
Makupa and Kilindini creeks (3)	5.5 – 114	< 200 - 1429	< 10 - 13	-	< 20 - 27.7
Port Reitz and Kilindini creeks (4)	2.3 - 156	8.8 - 340	ND – 9.3	-	5.0 – 42.7
Makupa and Tudor creeks (5)	-	-	ND – 1.0	0.2 – 58.0	-
Ungwana and Malindi Bays (6)	6.4 – 24.1	69.9 – 294.4	4.0 – 14.8	63.8 – 111.7	10 – 81.3

Table 3: Nutrient concentrations (µmol/l) in surface water in the Malindi Bay (MB) and Sabaki estuary (S)

Stations	Dry season		Wet season	
	Phosphates	Nitrate/Nitrite	Phosphates	Nitrate/Nitrite
MB1	0.17	6.65		
MB2	1.24	8.29	0.10	2.15

MB3	1.03	9.57	0.15	1.64
MB4	1.19	5.35	0.09	2.01
MB5			0.48	2.01
Mean	0.91	7.47	0.20	1.95
Std.	0.50	1.85	0.18	0.22
S1	5.45	16.03	2.36	10.80
S2	4.92	40.96	2.59	33.73
S3	2.17	4.10	2.08	44.71
Mean	4.18	20.37	2.34	29.75
Std.	1.76	18.81	0.26	17.30

Table 4: Cu, Zn, Cd, Pb, Mn (μg g^{-1} dry wt.) and Fe (mg g^{-1}) in epibenthic macroinvertebrates from the continental slope and coastal zone

Species	Cu	Cd	Pb	Mn	Fe
1. Crustaceans					
Penaeidae (prawns)	49 – 90	1.8 – 8.5		6 – 29	
Majidaei (spider crabs)	17 – 33	4.2 – 9.4		30 – 128	
Paguridae (hermit crabs)	66 – 167	1.3 – 5.6		7 – 191	
Portunidae (swimming crabs)	24 – 63	4.6 – 31.1		18 – 41	
2. Cephalopods					
Sepia (cuttlefish)	63	16		4	
3. Echinoderms					
Ophiuroidae (brittle-stars)	1.4	1.0		32	
Regularia (sea-urchins)	3.7 – 10.5	0.1 – 0.2	2.0 – 3.7	251 ± 33	8 - 14

Table 5: Concentrations of heavy metals in fish and penaeid prawns (mg kg^{-1} wet wt.) (Source: Munga and Kamau, 2005)

Location (Ref.)	Cu	Zn	Cd	Pb	Mn	Fe
Makupa, Tudor, Gazi and Mida creeks – fish species (1)			ND – 3.7	ND – 59.3		
Ungwana and Malindi Bays – penaeid prawns (2)	1.5 – 6.3	9.0 – 55.2	0.1 – 0.5	1.1 – 2.4	0.8 – 3.3	10.5 – 35.1

Tides, Tidal regime and waves

Table 6. Some tidal constituents for tide in Kenya inshore area

Constit.	***Period***	***Amplitude***		
		*Tudor_*	*Kilifi*	*Kilindini*
M_2	12.42	1.062	1.051	1.055
S_2	12.00	0.519	0.455	0.521
K_1	23.93	0.224	0.163	0.191
O_1	25.84	0.102	0.092	0.113

Current Status of Marine Resources in Kenya

Table 7: Critical coastal and marine habitats in Kenya

Ecosystem	Area (ha)	Recorded number of species	Important locations
Mangroves	54,000	9	Lamu, Tana River, Mida, Funzi
Coral reefs	63,000	237	Diani-Challe, Kisite-Mpunguti
Seagrass beds	3,400	12	Diani-Chale, Kiunga, Malindi, Mombasa
Coastal forests	139,000	-	Arabuko Sokoke, Shimba hills

Table 8. Causes, impacts, and consequences of degradation and loss of habitats.

Root causes	**Impacts**	**Consequences**
Social drivers - Lack of alternative livelihood - cultural attitudes - increase in prices - lack of education and awareness - increase in population - community alienation/marginalization	- poor regeneration capacity - loss of biomass - increased resource conflict - loss of system productivity - habitat fragmentation	- loss of cultural heritage - Loss of revenue - loss of livelihood - increased poverty
Economic drivers - land transformation for agriculture; salt works etc. - water abstraction - increase market demand - foreign market and international trade	- habitat fragmentation - increased erosion/sedimentation, - Deterioration of water quantity/quality - decline in harvestable resources	- Loss of biotic integrity and threat to biodiversity - invasive species - Outbreak of diseases - loss of revenue - increased poverty

- tourism development	- loss of aesthetic value	
Climate change and natural phenomena - increased Green House Gases Increased sea surface temperature	- Increase rainfall and flooding - Increased drought - Drying of rivers - Diseases - Coral bleaching - loss of tourism opportunities	- Loss of biotic integrity and threat to biodiversity - Reduced biomass - Loss of revenue - Increased poverty
Governance - Little understanding of the values of ecosystem services - Inadequate financial mechanisms and support at all levels - Inappropriate/outdated legislation - Insufficient public involvement - Poor enforcement of legislation - Inadequate data to support sustainable utilization - Inadequate implementation of available regulatory instruments	- unsuitable exploitation of living resources - undervaluation of ecosystem services - Limited ability to think beyond immediate needs - diminishing livelihood	- decline in harvestable resources - decreased revenue - Increased conflicts - Increased poverty

Monitoring Control and Surveillance

Table 9: Estimated recurrent costs of MCS in the SADC region in 1994

	Angola	Mozambique	Namibia	(U.R.)Tanzania	South Africa
Value of landings (million US$)	50	93	333	38	513
Estimated cost of MCS (1 000 US$)	30	282	8 244	103	9 725
MCS as % value of landings	0.10%	0.30%	2.50%	0.30%	1.90%
MCS as % of value of exports	0.10%	0.40%	2.50%	0.70%	3.60%
MCS costs US$ per 1000 km^2 of EEZ	50	501	16 357	463	9 262
MCS costs US$ per km of coastline	18	101	5 496	72	3 377

Table 10: Cost of Hire/wet lease compared to cost of procurement of patrol boats

VESSEL TYPE	PROCUREMENT/ UNIT	COST/DAY		COST/MONTH	
		ltr/hr & hr/day	Cost	Days/Mo	Cost

27 m Steel Hull (twin 500 hp engines)	US$ 3 million	10 hr × 300 ltr @ US$ 0.20/ltr	US$ 609/ day	12	US$7 308
17 m Steel (aluminum) (twin 500 hp engines)	US $ 1.1 million (US$1.25 million)	10 hr × 600 ltr @ US $0.20/ltr	US$ 1218 /day	12	US$1 416
22 m Fiberglass (twin 680 hp engines)	US$ 560 000	12 hr × 240L × $0.20	US$ 576/ day	12	US$6 912
7-9 m Fiberglass (twin 150 hp gasoline engines)	US$ 68 000	5 hr × 36 l @ $0.25	US$45/d ay	20	US$900
Local boats 40 hp diesel	US$4 350	8 hr × 40 l average @ $0.20	US$ 64/d ay	20	US$1 280

Table 11: Quantity and value of Fish Catches to Fishers 2003 to 2005

FRESH WATER	2003		2004		2005	
	M. Tons	000Kshs	M. Tons	000Kshs	M. Tons	000Kshs
L. Victoria	105,866	6,240,298	115,747	6,851,079	133,526	6,675,685
L. Turkana	4,080	69,223	9,069	148,935	2,493	86,471
L. Naivasha	39	2,729	62	2,691	108	4,900
L. Baringo	-	-	63	2,029	43	1,451
L. Jipe/Dams	73	3,959	40	2,268	74	4,171
Tana River Dams	474	18,357	839	33,048	950	34,061
Fish Farming	1,012	100,629	1,035	106,925	1,047	137,020
Other areas	1,176	33,534	845	29,358	785	32,960
TOTAL (Fresh water)	112,720	6,468,729	127,700	7,176,333	139,026	6,976,719
MARINE FISH						
Lamu District	1,502	44,850	1,486	47,270	1,826	57,385
Tana River District	119	5,537	71	4,969	59	3,741
Malindi District	1,219	41,754	1,301	78,377	1,187	72,386
Kilifi District	395	35,836	376	22,673	385	23,982
Mombasa District	1,011	75,018	1,251	90,892	441	34,796
Kwale District	1,573	83,121	1,686	83,329	1,964	113,581
SUB-TOTAL	5,819	286,116	6,171	327,510	5,862	305,871
CRUSTACEA						
Lamu District	187	40,165	200	48,375	159	41,608

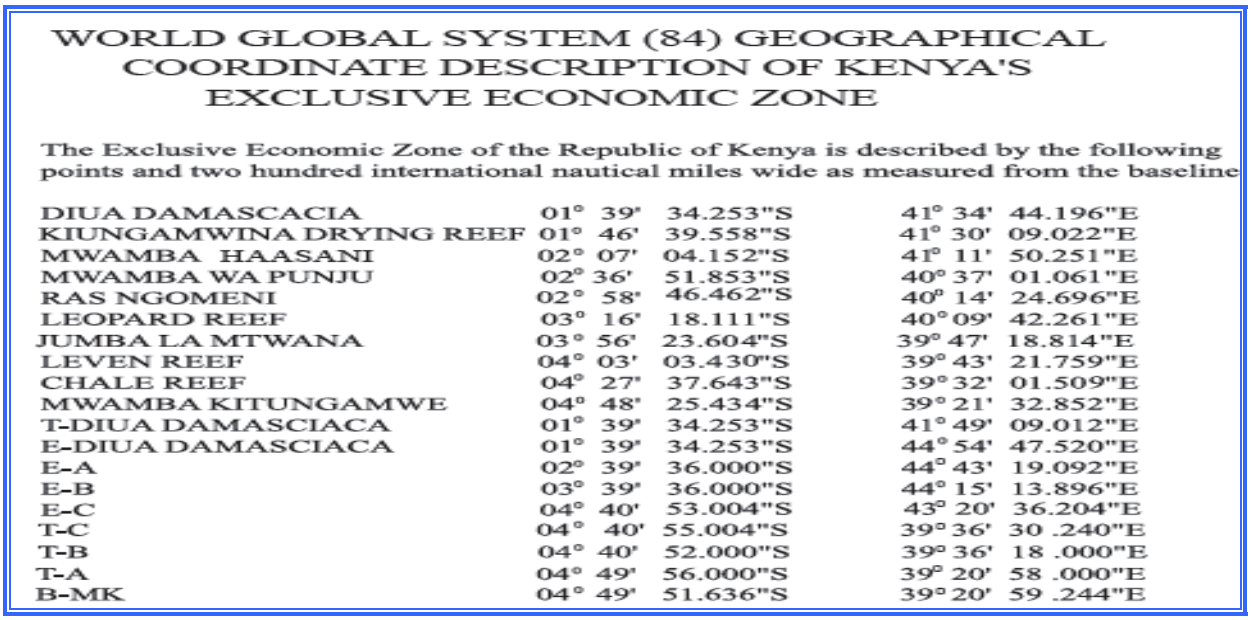
Tana River District	88	25,290	101	33,894	18	7,927	
Malindi District	64	13,308	85	19,426	84	15,305	
Kilifi District	10	1,494	7	1,948	8	2,122	
Mombasa District	324	79,500	738	95,291	89	13,993	
Kwale District	83	16,590	75	22,174	83	18,323	
SUB-TOTAL	756	176,347	1206	221,108	441	99,278	
OTHER MARINE							
Lamu District	4	1,703	12	3,923	42	3,322	
Tana River District	-	-	-	-	*	148	
Malindi District	25	1,717	30	1,624	40	2,911	
Kilifi District	38	2,185	31	1,580	34	1,846	
Mombasa District	31	2,255	36	2,859	35	2,561	
Kwale District	295	17,104	301	19,905	369	28,310	
SUB-TOTAL	393	24,964	410	29,891	520	39,098	
MARINE TOTAL	6,968	487,427	7,787	578,509	6,823	444,247	
GRAND TOTAL	119,688	6,956,156	135,487	7,754,842	145,849	7,420,966	
Landings National Totals by %	%	%	%	%	%	%	%
Fresh Water	94.18	92.99	94.25	92.54	95.32	94.01	93.88
Marine	5.82	7.01	5.75	7.46	4.68	5.99	6.12
							100

Table 12: Sea Patrols carried out in Mombasa District June 2005 to June 2009

Year	**Area**	**Illegal Activity**	**Number arrested and gear confiscated**	**Action Taken**	**Remarks**
2005/06	Tudor Creek	Use of illegal gear (Beach seine), no valid fisherman's license	1 fisherman arrested	Charged in Court of law	Not specified court ruling
	Mkomani	Use of beach seines, and unregistered boat	4 fishermen arrested with 1 beach seine and the boat confiscated	No further action	
2006/07	Tudor Creek	1. Beach seines 2. Unregistered boats	1 beach seine 1 unregistered boat	No further	Not clear what happened to the other 2 beach

				actio n	seines and 2 boats
2007/08	No Patrols made				

Table 13: Kenya's Geographical Coordinates for the EEZ



WORLD GLOBAL SYSTEM (84) GEOGRAPHICAL COORDINATE DESCRIPTION OF KENYA'S EXCLUSIVE ECONOMIC ZONE

The Exclusive Economic Zone of the Republic of Kenya is described by the following points and two hundred international nautical miles wide as measured from the baseline

DIUA DAMASCACIA	01° 39' 34.253"S	41° 34' 44.196"E
KIUNGAMWINA DRYING REEF	01° 46' 39.558"S	41° 30' 09.022"E
MWAMBA HAASANI	02° 07' 04.152"S	41° 11' 50.251"E
MWAMBA WA PUNJU	02° 36' 51.853"S	40° 37' 01.061"E
RAS NGOMENI	02° 58' 46.462"S	40° 14' 24.696"E
LEOPARD REEF	03° 16' 18.111"S	40° 09' 42.261"E
JUMBA LA MTWANA	03° 56' 23.604"S	39° 47' 18.814"E
LEVEN REEF	04° 03' 03.430"S	39° 43' 21.759"E
CHALE REEF	04° 27' 37.643"S	39° 32' 01.509"E
MWAMBA KITUNGAMWE	04° 48' 25.434"S	39° 21' 32.852"E
T-DIUA DAMASCIACA	01° 39' 34.253"S	41° 49' 09.012"E
E-DIUA DAMASCIACA	01° 39' 34.253"S	44° 54' 47.520"E
E-A	02° 39' 36.000"S	44° 43' 19.092"E
E-B	03° 39' 36.000"S	44° 15' 13.896"E
E-C	04° 40' 53.004"S	43° 20' 36.204"E
T-C	04° 40' 55.004"S	39° 36' 30 .240"E
T-B	04° 40' 52.000"S	39° 36' 18 .000"E
T-A	04° 49' 56.000"S	39° 20' 58 .000"E
B-MK	04° 49' 51.636"S	39° 20' 59 .244"E

Coastal management / development plans

Table 14: Land Use Changes Kisauni Division, Mombasa District, 1978-1998

Land use	Area 1978 (ha)	Area 1998 (ha)	% Change 1978-1988
Residential	1,380.0	3,129.0	17.49
Industrial	28.0	40.0	0.12
Educational	146.6	232.5	0.86
Tourism	30.0	105.0	0.75
Public purchase, utility and	40.0	165.0	1.25

roads	15.4	30.5	0.15
Commerce	5,692.0	3,608.0	-20.84
Agricultural, vacant land	109.0	131.0	0.22
Recreational	2,559.0	2,559.0	0
H_2O bodies			
	10,000.0	**10,000.0**	**0**

Table 15: Land use Changes in Diani-Chale, Msambweni District, 1960-2000

Land use Category	**Year**		**% Change**
	1960	**2000**	**1960-2000**
Tourist hotels	4	75	7.63
Permanent Settlements	254	716	49.68
Shopping Complexes	0	3	0.32
Beach Operator Curios	1	7	0.65
Market Centers	4	12	0. 68
Education & other social institutions	4	14	1.21
Road Network	58.5	103	4.78
Total Number	**325.5**	**930**	**65.00**

Table 16. Marine parks and reserves

Table 1
Marine parks and reserves of Kenya (Malindi and Watamu Marine Park and Reserve and Kiunga Marine Reserves were also designated as biosphere reserves in 1979)

Name of the MPA	Size of MPA (km^2)	Legal established
Mombasa Marine Park & Reserve	Reserve: 200 Park: 10	1986
Watamu Marine Park & Reserve	Reserve: 1000 ha includes whole Mida creek 100 ft above high water mark Park: 1000 ha with 92 land base	1968
Malindi Marine Park & Reserve	Reserve: 165 Park: 6.3	Reserve: March 1968 Park: June 1968
Kiunga Marine Reserve	Reserve: 250.	1979
Kisite/Mpunguti Marine Park & Reserve	Reserve: 11 Park: 28	1973 and regazetted in 1978

Human environment

Table 17. Demographic characteristics of the seven districts in coast province in 2005

Demographic profiles	**Mombasa**	**Malindi**	**Lamu**	**Kwale**	**Kilifi**	**T/Taveta**	**T/River**	**Total**
Population Size	650,018	281,552	72,686	496,133	544,303	246,671	180,901	2,487,264
Males	363,552	139,340	37,553	240,764	258,505	123,329	90,613	1,253,656
Females	301,466	142,212	35,133	255,369	285,798	123,342	90,288	1,233,608
Total number of youth (15-25)	186,386	71,489	15,512	119,017	118,304	54,998	45,498	611,204
Population Growth Rate	3.60%	3.90%	-	-	3.05%	1.70%	3.40%	3.5%
Population density (persons per sq km)	2,896	36	12	60	114	14	5	30
No. of households	183,540	52,164	15,006	92,594	90,311	57,635	36,177	527,427
Urban Population	665,018	118,428	17,130	59,786	257,736	101,200	15,947	1,235,245

Source: Republic of Kenya, 2005.

Table 18: List of heritage sites and monuments in coast region

Name of site	Location	Name of site	Location
Alidina Visram School	Mombasa Town	Manda Town Ruins	Manda Island
Anglican Cathedral	Mombasa Town	Mbaraki Pillar	Mombasa Island
Babu Motors	Mombasa Town	Malindi Mosque	Malindi Town
Bwana Bakari Mosque	Pate Town	Mgangani	Malindi Town
Bwana Shali Patani	Faza Town	Mnarani Ruins	Mnarani
Bwana Tamu	Lamu	Mombasa Golf Club	Mombasa Island
Castle Hotel	Mombasa Town	Mosque (unnamed)	Malindi Town
Central Police Station	Mombasa Town	Mrima Sacred Grove	
Chale Sacred Groove	Chale Island	MSA Hospital Dispensary	Mombasa Town
Diani Ruins	Diani	Mtwapa Ruins	Mtwapa
DO's Office, Mombasa	Mombasa Town	Muyu wa Kae, Swahili	Marereni
DO's Office, Malindi	Malindi Town	Mwana	Kipini
Dugumura Hill		National Bank of Kenya	Mombasa Town
Emmanuel Church	Mombasa	Nossa Senhora	Malindi
Faza	Pate Island	Old Law Courts	Mombasa Island
Fort Jesus	Mombasa Island	Old St. Marks A.C.K, Sagala	Sagala
Gede National Monument	Gede	Omwae	Kiunga
Grindlays Bank Intn'l	Mombasa Town	Parcel No.690 Block 1	Lamu
Historic Lamu, Lamu Town	Lamu Town	Pate Ruins	Pate Island
Historic Old Town, MSA	Mombasa Island	Pillar Tomb	Pate
Holy Ghost Cathedral	Mombasa Town	Portuguese Shipreck	Mombasa
Ishakani I	Ishakani	Ras Mtangawanga Mosque	Pate
Ishakani II	Ishakani	Ras Uwani	
Ishakani III	Ishakani	Redoubt	Mombasa Island
Issa Thawar House	Mombasa Town	Riadha Pillar	
Ivory House	Mombasa Town	Ronald Ngala's Tomb	Kaloleni
Jamadra Mosque	Malindi Town	Shaka Ruins	Kipini
Jamia of Siyu	Pate Island	Shanga	Pate Island
Jumaa Mosque		Shatin Tomb	Faza
Jumaa Mtwapa	Mtwapa	Sheikh Mwinyime Shrine	
Jumba la Mtwana Ruins	Mtwapa	Sheikh Othman	Malindi
Kilipwe Island	Malindi	Sheikh Said	Malindi
Kilindini House	Mombasa	Shimoni Cave	Shimoni
Kisauni Bell Tower	Kisauni/Mombasa	Shirazi	Kwale
Khatib Mosque	Malindi	Watamu Mosque	Malindi
Kiunga	Kiunga	Similani Cave	
Kongo Mosque	Diani	Siyu	Pate Island
Kwa Ungwana wa Mashaa	Kipini	Takaungu North	Takaungu
Kwa Wanawali saba	Kipini	Takaungu South	Takaungu
Lamu District Vetenary Office	Lamu	Takwa Milinga Ruins	Manda Island
Lamu Fort	Lamu Town	Tiwi	Ukunda
Lango la Shee of Siyu	Pate Island	Trumpet Ivory	
Leven House	Mombasa	Trumpet Metal	
Luziwa	Kilifi	Tumbe	
Mackinnon market	Mombasa Town	Valentine High School	Mombasa

Mama Ngina Drive	Mombasa Island	Vasco da Gama Pillar	Malindi
Mambore	Kiunga	Vumba Kuu	Vanga
Mambrui	Malindi		
Makupa Fort	Mombasa		

Table 19. Indicators of health services for the seven districts in coast province

Health indicator	**Mombasa**	**Malindi**	**Lamu**	**Kwale**	**Kilifi**	**T/Taveta**	**T/River**
Doctor/patient Ratio (GOK)	1:3,000	1:19,502	1:36,343	1:82,690	1:100,000	1:41,000	1:95,500
No. of health facilities	211	83	5	57	73	44	57
No. of hospitals	9	3	1	1	2	3	2
No. of nursing homes and health centres	19	2	1	5	5	7	5
No. of dispensaries	183	24	4	51	21	22	36
Average walking distance to Health centre (km)	0.5	1.5	5	30	5	10	50

Table 20. Water and sanitation indicators for the seven districts in coast province in 2002

Water and Sanitation	**Mombasa**	**Malindi**	**Lamu**	**Kwale**	**Kilifi**	**T/Taveta**	**T/River**
Total no. of h/holds	183,540	52,164	15,006	92,594	90,311	57,635	36,177
No. of h/holds with access to piped water	163,913	26,822	1,500	23,026	7000	24,000	1,717
No. of h/holds with access to potable piped water	19,627	25,303	1,050	62,286	65,000	26000	9,717
No. of Wells	152	595	380	524	700	131	103
No. of protected springs	1	49	0	67	39	85	0
No of boreholes	61	33	19	-	160	115	27
No. of dams	0	35	19	6	70	13	8
No. of h/holds with roof catchments	409	78	500	641	165	13,400	203
Average distance to nearest potable water point (in Km)	1	3	1	1	7	1	1.22

Production (primary/secondary

Table 21: Taxa of phytoplankton encountered in Shimoni- Vanga systems in 2009

Class	**Genus**
Bacillariophyceae	*Bacillaria sp., Cylindrotheca sp., Fragilariopsis sp, Navicula sp.,*

	[a]*Nitzchia sp., Pleurosigma sp.,* [a]*Pseudo-Nittzchia sp.*
Chlorophycea	*Chlorococcales sp., Pediastrum sp., Scenedesmus sp., Schroederiella sp., Volvocale sp.*
Chrysophyceae	*Dictyocha*
Prymnesiophyceae	[a]*Prymnesium sp., Coccolithophroids sp.*
Coscinodiscophyceae	*Actinoptychus sp., Bacteriastrum sp., Bacterosira sp., Chaetoceros sp.,Corethron sp., Coscinodiscus sp., Ditylum sp., Eucampia sp., Guinardia sp.,Hemiaulus sp., Hemidiscus sp., lauderia., Leptocylindrus sp., Lithodesmium sp., Melosira sp., Odontella sp., Rhizosolenia sp., Skeletonema sp., Stephanopyxis sp., Thalassiosira sp.*
Dinophycea	[a]*Alexandrium sp., Amphisolenia sp., Ceratium sp.,* [a]*Dinophysis sp.,* [a]*Gambierdiscus sp., Goniodoma sp.,* [a]*Gonyaulax sp.,* [a]*Gyrodinium sp., Gymnodinium sp., Noctiluca sp.,* [a]*Ostreopsis sp., Oxytoxum sp., Peridinium sp.,Preperidium sp.,Polykriskos sp.,* [a]*Prorocentrum sp.,* [a]*Protoperidinium sp., Pyrocystis sp., Scrippsiella sp.*
Cyanophyceae	[a]*Anabaena sp., Lyngbya sp.,*[a] *Oscillatoriia sp.*
Fragilariophyceae	*Asterionella sp., Licmophora sp., Striatella sp., Synedropsis sp., Thassiothrix sp., Thalassionema sp.*
Hemiaulaceae	*Cerataulina sp.*
Magnoliopsida	*Cornuta sp.*
Euglenophycea	*Phacus contorts, Trachelomonas grandis, T. bacilifera, T. cylindrica.*
Raphidophyceae	[a]*Chattonella sp.*
Zygnemophyceae	*Cosmarium contractum.*

[a] = HABs

Table 22. List of potentially harmful algal species encountered in Shimoni- Vanga area. (South coast technical report)

Species	**Group**	**Toxins**	**Diseases caused**	**Symptoms**
Ostreopsis spp.	Dinoflagellates	1. Clupeotoxins 2. Palytoxins	Clupeotoxication	Vomiting and diarrhea
Procentrum micans	Dinoflagellates	1. Okadaic acid 2. Diniphysistoxins	Diarrhetic Shellfish poisoning (DSP)	Abdominal pain, diarrhea, Nausea and cramps
Anabaena spp.	Cyanophytes	1. Saxitoxins 2. Neosaxitoxins	Paralytic shellfish poisoning (PSP)	Muscular weakness, respiratory distress and muscular paralysis
Pseudo-nitzchia spp.	Diatoms	1. Domoic acid	Amnesic Shellfish poisoning (ASP)	Nausea, vomiting, diarrhea and neurological effect
Dinophysis spp.	Dinoflagellates	1. Okadaic acid 2. Diniphysistoxins	Diarrhetic Shellfish poisoning (DSP)	Abdominal pain, diarrhea, nausea and cramps

Table 23. Summary of observed and predicted impacts of high CO_2 and ocean acidification on pelagic marine organisms

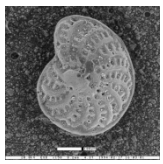
Organism	**Function of $CaCO_3$**	**Observed Impacts of elevated CO_2**	**Observed impacts of low pH**	**Sociological Implications**
Foraminifera  (Image: UCMP)	Mechanical protection	8-14% reduction in shell mass;	Increased abundance of ephemeral algae, filamentous red algae, and foliose red algae	Produce the majority of pelagic $CaCO_3$ on a global basis
Pteropods  (Image: NOAA)	Mechanical protection		Reduced calcification rates in response to decreasing pH.	Loss of food source for key marine predators – Mackerel, Salmon
Coccolithophores  (Image: Celsias)	Structural calcite plates	40% decrease in calcification rates of *Emiliania huxleyi* with increasing pCO_2. Increase in photosynthetic rates in response to pCO_2		Shift in phytoplankton community structure; Blooms support the global albedo effect of by up to 0.13%, reflecting sunlight back into space. Production of Dimethylsulphide reduces the radiative flux to the Earth's surface
Marine Fish and Invertebrates		Disturbance of acid-base status, respiration and blood circulation. Increased energy budget due to acid-base regulation and cardiorespiratory control	Protracted embryonic development.	Juveniles and early development stages more susceptible leading to reduced population size and ecosystem structure changes; Little evidence of respiratory acclimation

Table 24: Zooplankton taxa along the Kenya coast.

Phylum	**Class**	**Genus**	**Ref**
Annelida	Citellata	*Oligochaeta*	South Coast project data, 2009.
	Polychaeta	*Polychaeta*	
Arthropoda (Chelicerata)	Arachnida	*Heteropoda sp., Microthrombidium sp.*	
	Brachiopoda	*Cladocera sp.,*	
	Pycnogonida		
	Diplopoda		Osore *et al*., 2004.
Arthropoda (Uniramia)	Insecta	*Ctenophora sp., Halobates sp., Phyllosoma sp., Water mite.*	South Coast project data, 2009.
Arthropoda (Crustacea)	Malacostraca	*Ampipoda sp., Caridea sp., Cumacea sp., Euphasid sp., Hyperia sp., Isopoda sp., Lucifer ssp., Mysida sp., Sergestidae sp., Tanaidacea ssp., Thalassinidea sp.*	
	Maxillopoda	*Acartia sp., Calanopia sp., Candacia sp., centropagges sp., Cirriped sp., Copillia sp., Coryceaus sp., Eucalanus sp., Euchaeta sp., Harpacticoida sp., labidocera sp., Lucicuta sp., Macrostella sp., Monstrlloid sp., Nauplii (barnacle), Neocalanus sp., Oithonaa sp., Oncaea sp., Paracalanus sp., Parasitic copepod, Pontellina sp., Pontelopsis sp., Pseudodiaptomus ssp., Rhincalanus sp., Sapphirina sp., Temora sp., Tortanus sp., Undiluna sp.*	
	Ostracoda		
Bryozoa			
Chaetognatha			
Chordata	Thalicea	*Thalia dermocratica, Doliolum sp., Doliolid sp., Salpa sp.*	
	Ascidiacea	*Ascidian sp.*	
	Ciliates	*Tintinnid sp.*	
Cnidaria	Hydrozoa		
Echinodermata	Ophiuroidea	*Ophiopluteus sp.*	
Ectoprocta	Gymnolaemata	*Planula larvae*	
Mollusca	Bivalvia	*Bivalve*	

	Cephalopoda		
	Gastropoda	*Cavoliniidae sp, Creseis sp.*	
Nematoda			
Platyhelminthes			
Priapula	Priapulidae	*Priapulida*	
Protozoa	Acantharia		
Rotifera			
Sarcomastigophora	Foraminifera	*Globigerina sp*	Osore et al., 2004
Urochordata	Appendicularia		

Birds

Table 25: Marine IBAs along the Kenyan coast showing important criteria of BirdLife International

Note: ***C*** = Regular congregation of more than 1% of biogeographic population of the species; ***RT*** = Regionally-threatened; ***GT*** = Globally-threatened. (From Bennun and Njoroge, 1999).

IBA site	**Main Site features**	**Important bird species and criteria**	**Bird breeding/ colonial nesting**
Kisite Island	Coral rock and low scrub	1(C)	• Seabirds
Mida Creek, Whale Island, Malindi and Watamu marine parks	Inter-tidal rock; coral reefs; sea-grass beds; sandy beaches; mangrove forests	5 (C) 1(RT)	• Seabird • Shorebirds
Sabaki River estuary	Estuarine sand-banks; mud-banks; fresh and brackish water; sand dunes; freshwater pools; sandy beaches	4 (C) 1(GT) 2 (RT)	• Shorebirds
Kiunga Marine National Reserve	Mangroves, coral islets and platforms; sandy beaches	2 (C)	• Seabirds
Tana River Delta	Fresh and brackish lakes; streams; freshwater and saline grasslands; beaches and mud-flats; dune ridges	1(GT)	• Seabirds • Shorebirds