STATUS REPORTS FROM DIFFERENT REGIONS 4 (10)

Status report Kenya

Dr David Obura
CORDIO-East Africa, P.O. BOX 10135, Bamburi, Kenya

Background

Kenya s coastal population is expected to exceed 2 million people by the year 2000, with an annual growth rate of 3.7%, of which a large proportion is due to migration of people from other parts of Kenya. Increasing economic activity, due to shipping, freight handling and tourism, provides a strong draw for migrant workers, as well as conditions for environmental degradation. Marine resource use is largely unregulated, and the predominant near-shore coral reef activities include subsistence and small-scale commercial fishing and tourism.

The Fisheries Department estimates fisheries statistics for the Kenya coast, though a lack of resources for comprehensive monitoring of the catch makes the estimates unreliable. Marine fish catch rates have been estimated at various levels, from 3 to 13 tons/km^2/yr, with estimated maximum sustainable yields for coral reefs varying between 5 and 10 tons/km^2/yr. The number of subsistence fishermen is currently about 5,000, with close to 35,000 dependents and perhaps another 1,000 people involved in fish distribution and processing. Numbers are continually increasing, even though many reefs are overexploited and severely degraded, and degradation due to fishing is likely to increase in the near future.

Of the 750,000 tourists visiting Kenya during a normal year, 70% spend at least some of their time in coastal hotels, and close to 200,000 stay in hotels adjacent to, or visit, Marine Protected areas. Tourism is one of the principal sources of income for the coastal economy. Both fisheries and tourism depend on coral reefs and the associated ecosystems (seagrasses, mangroves). Any loss of productivity, diversity or integrity of coral reefs could have severe consequences for coastal people and the economy.

Kenya s coral reefs are divided between two main areas: the southern, almost-continuous fringing reef system from Malindi to Shimoni (a distance of approximately 200 km), and more broken up patch and fore reef slopes around the islands of the Bajuni Archipelago, from Lamu and northwards (a distance of approximately 100 km). In both areas, hard substrate patches with coral growth are interspersed between extensive seagrass and algal beds. Within these patches, coral cover is typically about 30%, with over 50 genera and up to 200 common species of coral recorded so far (Obura, unpublished data). Reef complexity and diversity is higher in the south and decreases northwards past Lamu due to increasing influence of the cold-water Somali current system. Fish abundance is typically 1,500-2,000 kg/hectare, though this varies greatly with back reef and fore reef location, the influence of sediment, and the intensity and type of fishing effort (Samoilys, 1988; McClanahan, 1994; 1998).

The bleaching event

The 1997-98 El-Niño Southern Oscillation had severe impacts on the climate of East Africa, with unprecedented rains starting in October 1997 and continuing to July 1998. Sea water temperatures in March and April 1998 rose to an average of 1.5°C above values measured during the same period in 1997, with daytime, low tide highs of over 32°C (Figure 1). Bleaching was first noticed in Kenya around March 15, 1998, and then rose to unprecedented levels of 50-90% of the corals along the entire Kenya coast. Mortality from bleaching appeared to peak about mid-May, and subsequently some bleached corals recovered, while others continued to die up until October.

Following the coral bleaching in 1998, living coral cover decreased significantly on all known reefs in Kenya. Table 1 illustrates the changes in various benthic cover categories on a reef in Malindi that had a stable coral community and normal cover characteristics from 1994–1998. Coral cover then decreased to 40% of pre-bleaching levels, while soft corals decreased to 10% of pre-bleaching levels. As a result of new available substrate, the cover of algal turf increased by 200%. The number and diversity of coral colonies along sample transects decreased by a factor 3 and 2 respectively, with many small colonies remaining compared to the more numerous but larger colonies before bleaching. About ten other sites have been visited by experienced coral reef researchers (including Kiunga, Lamu, Watamu, Vipingo, Kanamai, Mombasa, Galu, and Kisite), all suffering a similar fate, with coral cover at 10–50% of pre-bleaching levels.

Bleaching was observed at all depths (to 20 m), with the highest impact and mortality at depths less than 2–3 m. Bleaching and mortality were highest in shallow habitats and pools, where water stagnation occurs, or where corals are regularly exposed to outflow of shallow (warm) lagoon waters and/or to mangrove and sediment influence. Bleaching and mortality were least in wave-exposed habitats and locations subject to upwelling of cooler deeper water.

Table 1. Changes in benthic community structure as a result of bleaching (in % cover). Example of Malindi Marine National Park. M = mean, st. error = standard error of the mean.

Cover	***Before (1994)***		***After (1999)***	
	mean	*st. error*	*mean*	*st. error*
Coral	35.7	2.46	14.7	4.63
Soft coral	9.6	1.96	1.0	0.42
Other	1.4	0.70	0.1	0.06
Algae				
Turf	31.2	4.58	59.6	7.82
Halimeda	7.0	2.39	5.7	2.61
Macroalgae	1.6	1.24	0.5	0.21
Coralline algae	3.8	1.40	8.7	3.68
Seagrass	0.1	0.07	1.3	0.66
Coral variables				
# Colonies	112.6	12.64	37.0	2.08
# Genera	19.8	1.77	8.7	0.88

Variability in space was a dominant feature observable, with different localized responses to a regionwide and ubiquitous threat. The impact of high temperature stress varied with habitat type and the suite of dominant species – wave zones and back-reef lagoons dominated by arborescent *Acropora* species were the most susceptible, and face loss of ecological function.

Species and higher taxon-specific variability in bleaching was also high, ranging from 0–100% bleaching and mortality. *Pocillopora*, *Stylophora* and arborescent *Acropora* spp. were among the most susceptible corals, with close to 100% bleaching and/or mortality at some sites, even where exposed to high water motion. Other genera exhibited variable levels of bleaching and mortality even within the same species, at some sites low and at others severe. In general, where mortality levels were 50% and greater, sites on a scale of 100–200 m^2 lost up to 50% of their species and genus diversity (Table 1), though at a larger scale of several kilometers the loss of species was lower. The number of coral colonies recorded in transects dramatically decreased by up to 90% (Table 1, Figure 2), showing that the survival of corals following bleaching can be very low; the number of living colonies was lower in January 1999, than that recorded for unbleached corals in April 1998, at the height of bleaching (Figure 1).

Other impacts of bleaching

No data has been collected so far to determine the impact of bleaching on other marine organisms, though extensive historical data exists for gastropods, sea urchins and fish. Similarly, previous socio-economic studies will provide good baselines for assessing the impact of coral bleaching and mortality on coral reef resource users.

Coupled with the severe loss of coral cover and potentially reef vitality, the already high levels of subsistence fishing on many reefs in Kenya (at or above their maximum sustainable yields) suggest that fisheries may become increasingly unsustainable in the short term. The socio-economic impact of the bleaching on other sectors, such as tourism, is harder to predict, but the economic dependence on tourism in Kenya makes this an important sector for investigation. These two areas will comprise the principal focus of socio-economic investigations into the after-effects of the 1998 coral bleaching and mortality.

Monitoring and research relevant to bleaching

Kenya has a relatively well-developed marine research sector, with a number of subtidal and intertidal ecological studies extending from nutrient dynamics to ecological interactions. This summary is restricted to research areas related to corals and the impacts of bleaching.

1. Coral species diversity, abundance, and distribution (Obura, Coral Reef Conservation Project). Biogeographic distribution and ecological zonation of coral species to reveal species-specific variation susceptibility to differences in environmental stress.
2. Benthic community structure (Coral Reef Conservation Project). The effects of fishing (McClanahan) and sediments (Obura) on the benthic community structure of coral reefs, related to management and conservation of reef resources and biodiversity.
3. Coral stress resistance field studies (Obura, Coral Reef Conservation Project). Field surveys on coral condition to examine patterns of stress among coral species with respect to environmental changes. Before, during and after the 1998 bleaching event.
4. Coral genus surveys and levels of bleaching (McClanahan, Coral Reef Conservation Project). Timed surveys of the extent of bleaching during the 1998 bleaching event.
5. Zooxanthellae and chlorophyll concentrations in normal and bleached corals (Mdodo, Moi University/Kenya Marine and Fisheries Research Institute and Obura, CRCP). MSc study on the dynamics of zooxanthellae and chlorophyll in normal and bleached corals, with decreases of on average 80% of both factors in bleached corals compared to healthy ones.

6. Rapid assessment of coral reefs and training of personnel (Kenya Wildlife Service, supported by WWF, UNEP, FAO and IUCN). Training and monitoring programme conducted in the Kiunga Marine Reserve, for repetition at other sites. Recorded the first bleaching observation in Kenya and established baseline benthic and bleaching data for monitoring in northern Kenya.
7. Coral genus reference and display collection (Didham, Kenya Wildlife Service).

References

Gubelman, E. and Kavu, B. 1996. Traditional utilization of natural resources within and around Kiunga Marine and Dodori National Reserves, Kenya: Results of Participatory Rural Appraisal and Recommendations for Integration of local communities into Management Planning for KM&DNRs. World Wide Fund for Nature-East Africa Regional Programme Office, Nairobi.

McClanahan, T.R. 1994. Kenyan coral reef lagoon fish: effects of fishing, substrate complexity, and sea urchins. *Coral Reefs* 13: 231–241.

McClanahan, T.R. 1997. Recovery of fish populations from heavy fishing – does time heal all? *Proceedings of the 8th Coral Reef Symposium* 2: 2033–2038.

McClanahan, T.R., Glaesel, H., Rubens, J. and Kiambo, R. 1997. The effects of traditional fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya. *Environ. Conserv.* 24: 1–16.

McClanahan, T.R. and Muthiga, N.A. 1988. Changes in Kenyan coral reef community structure due to exploitation. *Hydrobiologia* 166: 269–276.

McClanahan, T.R. and Obura, D. 1995. Status of Kenyan coral reefs. *Coast. Manag.* 23: 57–76.

McClanahan, T.R. and Obura, D. 1997. Sediment effects on shallow coral communities in Kenya. *J. Exp. Mar. Biol. Ecol.* 209: 103–122.

McClanahan, T.R. and Shafir, S.H. 1990. Causes and consequences of sea urchin abundance and diversity in Kenyan coral reef lagoons. *Oecologia* 83: 362–370.

Nzioka, R. 1990. Fish yield of Kilifi coral reef in Kenya. *Hydrobiologia* 208: xxx.

Obura, D. 1995. Environmental stress and life history strategies, a case study of corals and river sediment from Malindi, Kenya. PhD thesis, University of Miami.

Obura, D.O., Muthiga, N.A. and Watson, M. (in press). Kenya. In: *Coral Reefs of the Indian Ocean: Their Ecology and Conservation*. Eds: McClanahan, T.R., Sheppard, C.R.C. & Obura, D.O. Oxford University Press.

Samoilys, M. 1988. A survey of the coral, reef fish communities on the Kenyan Coast.

UNEP. 1998. East Africa Atlas of Coastal Resources. 1. Kenya. Nairobi: UNEP.

van Katwijk, M., Meier, N., van Loon, R., van Hove, E., Giesen, W., van der Velde, G. and den Hartog, D. 1993. Sabaki River sediment load and coral stress: correlation between sediments and condition of the Malindi-Watamu reefs in Kenya (Indian Ocean). *Marine Biology* 117: 675–683.

Watson, M., Ormond, R.F.G. and Holliday, L. 1996. The role of Kenya's marine protected areas in artisanal fisheries management. *Proc. 8th Int Coral Reef Symp.*, Panama.

Weru, S. 1991. An appraisal on the Kiunga Marine national Reserve. Kenya Wildlife Service.

Home | **Status report 5**