

RESILIENCE OF MANGROVES TO INDIRECT EFFECTS OF CLIMATE CHANGE

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1. Introduction

- Mangrove forests support the livelihoods of millions of people in the tropics and sub-tropics in terms of fisheries, wood products for fuel-wood and construction and coastal protection from storm surges among other good and services.
- In Kenya, mangroves forests are estimated to occupy 54,000 ha (Doute et al., 1982), with about 70% of the local people along the coast depending on mangroves for fisheries, wood for construction and energy needs among other fundamental services.



Fig. 1. Local fisherman at Mwache setting a fishing trap in the mangroves

- However, these unique forests are threatened by unsustainable harvesting, conversion to other uses (Abuodha and Kairo, 2001) and more recently, by effects of climate change (Kitheka et al. 2002, Bosire et al. 2006).
- As mangroves forests are among the most prominent ecosystems in the low lying coastal areas of the tropics, they are likely to be the first ecosystems to be affected by global climate change.

- While there is no doubt of the global climate change, effects of these changes on mangrove ecosystems remain unclear. A rise in sea level, for instance, is predicated to increase flooding of the low-lying coastal areas and drown mangroves (Field, 1995).
- In 1997/8 and 2006, massive sedimentation due to erosion of terrigenous sediments following extremely heavy rainfall caused mangrove dieback in many areas along the Kenyan coast. Mwache Creek a peri-urban mangrove forest in Mombasa was the most affected, losing close to 500 ha of forest

Objective: The objective this study was to assess recovery of impacted mangroves in terms of vegetation structure and natural regeneration

2. Study site

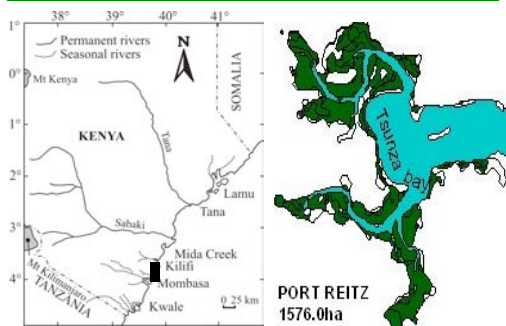


Fig. 2. Map of the Kenyan coastline showing the study area, Port Reitz/Mwache Creek

3. Methods

- Parallel transects were made perpendicular to the shoreline in one of the areas which was extensively impacted.
- Along the transects, plots of 10m x 10m were made at intervals of 20 m and relevant vegetation structural attributes determined
- Tree height (m) and diameter of stems (D_{130} -Brokaw and Thompson 2000) were measured for all trees with a diameter greater than 2.5cm. Trees with diameter of less than 2.5cm were classified as juveniles in three regeneration classes (RCs) i.e. RCI (<40cm height), RCII (>40cm height but less than 1m) and RCIII (>1m height).
- The density and species richness of respective juvenile classes were recorded as a measure of the site's recovery potential (resilience)
- Tree stumps left behind after the die-back were also identified and counted in all the plots above



Fig. 3. Mangrove die-back due to massive sedimentation at Mwache Creek



Fig. 5. Seeding of *Avicennia marina*



Fig. 6. Community mangrove planting at the degraded site.

4. Results

Species	DBH (cm)	Basal area m ² /ha	Height (m)	Density (trees/ha)
<i>Rhizophora mucronata</i>	9.4±1.4	4.0±0.9	1.9±0.3	169±35
<i>Ceriops tagal</i>	1.5±0.8	0.2±0.1	0.4±0.2	9±5

Table 1: Stand structure of the impacted mangroves

- Two species of mangroves were observed in the adult tree canopy in this impacted site with *R. mucronata* being dominant
- The structural data obtained here suggest that the forest was heavily impacted during the mangrove die-back and recovery is still limited 10 years later.
- Natural mangrove stands along the Kenyan coast have much higher tree densities (e.g. S. Coast of Kenya > 1,500 trees/ha), basal areas (e.g. >17.7 m²/ha)
- Data on stumps left after the die-back (Fig 4) indicated that *R. mucronata* was still the dominant species prior to the mangrove die-back and thus suffered most during the massive sedimentation.

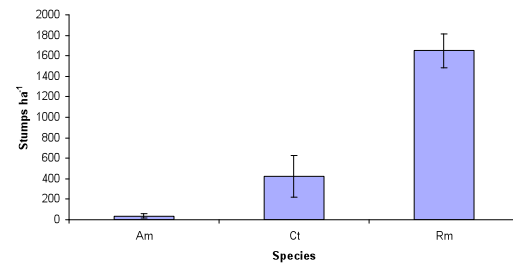


Fig. 4. Stumps of various mangrove species observed at the study site (Am = *Avicennia marina*, Ct = *Ceriops tagal*, Rm = *Rhizophora mucronata*)

Spp	RCI	RCII	RCIII	Total	% Prop
Am	700 ± 198	60 ± 40	0	760 ± 238	34
Ct	0	200 ± 0	360 ± 310	560 ± 310	25
Rm	490 ± 316	140 ± 41	290 ± 82	920 ± 439	41
Total	1190 ± 514	400 ± 81	550 ± 392	2240 ± 987	

Table 2. Density (no/ha) of juveniles at the study site

- Three species of mangrove juveniles were observed at the impacted site (Table 2) with *R. mucronata* leading in percentage proportion. However, the densities observed here are much lower to support effective restocking of the forest and thus ensure recovery.
- Normally a minimum of 2,500 seedlings per ha are required to qualify natural regeneration as being sufficient (Srivastava and Bal 1984).
- On average, 12 parent trees (standards) are required per ha to serve as seed sources for regeneration (FAO 1994). While *R. mucronata* had more than this number and thus presumably able to provide sufficient seeds for regeneration, the site conditions have changed so much such that human intervention is necessary.

5. Conclusions

- Preliminary results obtained here seem to strongly support the original scientific hypotheses proposed i.e. that natural regeneration, and vegetation structure of the impacted site is poor.
- Human intervention will thus be necessary to restore the site. Mangrove nurseries have been established and community based reforestation efforts initiated.
- It will be critical to link upland land-use practices with mangrove conservation downstream to alleviate the serious problem of massive erosion and sedimentation
- Improved soil and water conservation measures in farms contiguous to the mangrove forests will thus reduce the vulnerability of these mangroves to indirect effects of climate change and secure the livelihoods of dependent communities.
- The impact of this mangrove die-back on mangrove associated biodiversity e.g. fisheries, mullooses, decapods etc will be necessary.