# Nature-Based Solutions: Restoring Mangroves For Shoreline Protection And Other Ecosystem Services At Gazi Bay, Kenya

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## Background

Mangrove forests have a potential role to play in disaster risk reduction and climate change mitigation/adaptations. Mangroves have been known to reduce about 66% of the wave's height over 100 m. The reduced wave energy minimizes shoreline erosion and the risk of flooding to coastal communities that live adjacent to mangroves. In responding to sea-level rise, mangroves are able to accrete sediment thus adapting to rising sea levels. The role of mangroves in coastal protection along with other benefits has prompted widespread restoration efforts to re-establish lost mangrove stands. Unfortunately, the successes of these restoration efforts vary significantly from one project to another. In Kenya, about 40% of mangroves have been lost in the last four decades. Rising sea levels further threaten the remaining mangroves. Low success rates are often attributed to rapid changes in mangrove ecosystems after disturbance. Areas that are exposed to high wave action, debris, and poor soil threaten the survival of mangroves during their early developmental stages. As such, conventional restoration techniques involving the transfer of nursery-raised seedlings or direct planting of propagules are not able to recover the degraded forests, hence the need to pursue enhanced restoration techniques to allow mangrove establishment in such challenging areas.
The overall objective of the project is to return the functionality and productivity of mangroves on an eroding shoreline of Gazi Bay. This will be achieved through mapping to determine eroding areas requiring restoration, systematic characterization of the area for both biological and physical factors to help decide on the best cause of action, and finally replanting of lost mangroves using enhanced planting techniques and monitoring growth performance.

## Method

Natural and socioeconomic suitability were considered in the selection of the project site. On natural suitability, the site was selected on the basis that it previously had mangroves that have been degraded and the area is eroded, exposed to strong waves, currents and winds. Regarding the socio-economic suitability, it is expected that the community will be better protected against coastal hazards such as flooding after mangroves have been rehabilitated.
Mapping: GPS device was used to obtain coordinate points of the project area. Mangroves cover Satellite images, subset to the GPS coordinates were obtained from the United States Geological Survey (USGS) website. Image classification and analysis were conducted on Landsat imagery spanning from 1990-2020 using a hybrid of Iso Cluster Unsupervised and Supervised Maximum Likelihood

Classification algorithm.
Vegetation structural survey: Systematic random sampling was carried out in 39; 10 m by 10 m quadrats laid along 50 m belt transects perpendicular to the waterline. Within each quadrat all structural attributes of the vegetation including stem diameter greater than 2.5 cm, height (m), canopy cover (%), quality class, and regeneration were species-identified insitu, counted, position marked, and recorded.
Tidal regime classification and topographic level measurement: Tidal regime (frequency and duration) was determined through progressive observations of the ocean tides during neap and spring seasons in low and high tides. The water hose technique was employed to determine the topographic level of the reference site.
Experimental design: Replanting adopted systematic Randomized Complete Block Design (RCBD). Rectangular blocks measuring 5.5 m by 7 m were established perpendicular to the shore, not blocking each other. Encasements (different-sized PVC pipes and bamboos) cut into heights corresponding to the ground elevation were randomized separately for each block and installed on the blocks. They were then filled with sufficient mangrove sediments to set the seedling at an elevation consistent with the mean-high-water mark. On each encasement, one seedling was planted.
Monitoring: growth performance is being monitored as per the steps outlined in the "Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean Region".

## Results

The study area consisted of both planted and natural mangrove vegetation, approximately 15ha. Temporal variations and trends in mangroves cover between 1990 and 2020 depicted a significant decrease in cover with 100ha in 1990, 97ha in 2000, and 54ha in 2020.
A number of 20 transects were established from which 39, 10m by 10m plots were surveyed. The most dominant mangrove species was Sonneratia alba (SA) (96.9%) followed by Avicennia marina (AM) (1.7%) and Rhizophora mucronata (RM) (1.4%). SA also had the highest average tree height (5.7m) followed by AM (5.2m). AM recorded the highest average stem diameter (10.9cm) followed by SA (8.6cm). RM being the least dominant recorded the lowest average stem diameter (8.3cm) and tree height (4.2m). The percentage cover in the planted stands of the area ranges between 40-60% while in the natural stands ranges between 20-40%.
Following Watson's (1928) tidal classification, the project site was identified as inundation class 1 as it's flooded by all high tides in both neap and spring seasons. The average topographic level was found to be -1.86m. This being an exclusive zone for Sonneratia alba the topography/ elevation is expected to be higher than -1.86m. This paints a situation in which disturbance, soil erosion, and degradation have occurred. It is therefore wise to elevate respective mangrove seedlings to their normal growing elevations during restoration for higher survival rates.

## Conclusion

The preliminary result of the study confirms that mangrove forests are still being lost despite the widespread restoration efforts and awareness on mangrove protection. Therefore, it's time to embark on innovative/enhanced restoration techniques to change the narrative of mangrove losses. The current project explores the feasibility

of modified restoration tools that have been used in some parts of the world experiencing high wave energies, as is the case in Gazi Bay. The restoration tools are meant to bring in seedlings, sediment, and protection from high energy.