INTERNATIONAL CLIMATE INITIATIVE (IKI) PROJECT

HYDROLOGICAL RESTORATION OF MANGROVE IN SALTPANS OF JIMBO

Technical Report

Dec 2022

Collaborating Partners **Funding Partner**

This report was prepared by Kenya Marine and Fisheries Research Institute (KMFRI)

Disclaimer; The views expressed in this report are those of the respective authors and do not reflect the views of KMFRI, WWF, KFS, and other partners as institutions.

List of contributors: Nguu J, Mugi L, Kirauni H, Mbaru E and Kairo J.

Recommended Citation: *KMFRI 2022. Technical Report: Hydrological restoration of mangroves in salt pans of Jimbo. Kenya Marine and Fisheries Research Institute. December 2022.Pg14+App*

Copies are available from:

Director
Kenya Marine and Fisheries
Research Institute (KMFRI)
P.O. Box 81615
Mombasa-80100-KENYA
Telephone: +254 41 475151/2/3/4/5
Fax: +254 41 475157
Email: director@kmfri.co.ke
Website: http://www.kmfri.co.ke
Cover photo credit: Pauline Nyambura

Acknowledgment

The project team wishes to thank all who contributed to the success of this project activity. Special thanks go to Dr. James Kairo (Principal Investigator) and Dr. Emmanuel Mbaru (project coordinator) of KMFRI for their continued support and guidance. We are also grateful to our collaborating partners, especially Kenya Forest Service (KFS) and World-Wide Fund for Nature (WWF-Kenya). Appreciation to VAJIKI CFA leadership as well as team members for availing themselves in numbers during the activity implementation. This work was supported through the International Climate Initiative (IKI) under project number 16_IV_076_KE_A_Coastal Forests project granted to Dr. Kairo by WWF Germany, for which we are grateful.

Table of Contents

List of plates

List of Acronyms and Abbreviations

CFA	Community Forest Associations
GoK	Government of Kenya
IKI	International Climate Initiative
KFS	Kenya Forest Service
KMFRI	Kenya Marine and Fisheries Research Institute
PI	Principal Investigator
VBF	Vanga Blue Forest
VAJIKI	Vanga, Jimbo, Kiwegu
WWF	World Wide Fund for nature

1. Background

Mangroves in Kenya occupy some 61,000 ha of the coastal area. At least 40% of mangrove forest is perceived to be in degraded conditions (GoK, 2017). Like in most countries, the loss and degradation of mangroves in Kenya continue largely unabated because of both natural and anthropogenic factors (Hamza et al., 2020; Kairo et al., 2021). More importantly, new infrastructural development, pollution, and climate change – sea level rise are among the looming threats to the survival of remaining mangroves in the future (Bosire et al., 2014). Currently, the degradation observed in the Kenyan mangroves has been illegal harvesting, aquaculture, coastal development, and salt mining in the mangrove areas.

Since 1910, Kenya has been exploiting salt mining from her coastline, with big swaths of salt pans in Ngomeni and Kurawa in the Malindi area. In the 1990s, some salt works were initiated in the Vanga-Jimbo area, occupying an area between 5-10 ha, but did not take up. They had cleared off mangroves to pave way for the salt works but when the initiative failed the area was left barren and with high saline soils.

Presently in Jimbo salt pans, mangroves are observed to be stunted in statute a condition attributed to the high saline soils. Attempt to rehabilitate these salt pans produce little success with most seedlings dying after planting. This has promoted an alternative approach to restoring the area which involves first solving the high saline condition. The approach adopted is that of hydrological restoration whereby the water flow within the pans is corrected by creating a network of channels or dyke breaking. This allows water to uniformly fill the pans and subsequently reduces salt concentration in the raised area that rarely gets inundated.

1.1. Activity objectives

The main objective was to restore hydrological flow in the saltpans within the Jimbo mangrove ecosystems. More specifically, the objectives were to:

a. To train the community on hydrological mangrove restoration
b. To restore hydrological flow in the salt pans within the mangrove of Jimbo
c. To restore the degraded mangrove area of Jimbo

2. Approach

Field-based training of the CFA community on mangrove restoration and creating a network of dug channels. The community of Vanga-Jimbo has been trained on ecological restoration but not on the hydrological approach. To make the hydrological restoration course more understood, the training team opted for fails-based demonstrations. In the field, the observable condition affecting the salt pans; patchy mangrove, stunted mangrove, islands within the pans, at end of pans healthy mangrove, and channels running through the pan's edges were *in situ* analysed. The community agreed that compared to the neighboring mangroves, those in the salt pans were more stressed. Also, it was observed that where water flew adequately like at the edges of the salt pans, the mangroves performed well growth-wise. This therefore baseline information to create channels through which ocean water would freely flow within the pans.

Plate 1. Community field training on hydrological restoration

2.1. Methodology

i. Technical team Desktop planning.

A technical meeting was held at the KMFRI-Gazi office to finalize the field workplan and also checklist field equipment. The map of the area was reviewed to understand the topography of water flow and to help plan the start point of the hydrological channeling. It was agreed that the pans close to the main creek should be the ones prioritized. Once these are dug, those further would then follow but after observing how the water flow in the first pans works.

ii. Problem identification

Salt production along Kenya's coast is produced in mangrove areas. Big swaths of salt pans are found in Ngomeni and Kurawa in the Malindi area. Some attempts were made to explore salt production in the Jimbo area and the process resulted in about 5-10 ha of mangrove being cleared to pave way for the salt works but the initiative failed so the area was left degraded. Because of the changes in the physical and chemical conditions, natural recruitment has not taken up well. Attempts also to artificially restore the area through planting have not been highly successful. This prompts an alternative method of restoring the area.

iii. Purpose of restoration

In this undertaking, the aim is to increase mangrove cover for a carbon offset project. Since other methods of restoring the area have not been highly successful, then a proposed approach is to first correct the water flow in the salt pans. This was informed by the presence of healthy mangroves growing along the edges of the salt pans where ocean water reaches every day. Being that mangroves need to be inundated daily, therefore, then the hydrological approach that would allow the water to flood the pans daily is sought as an appropriate way that would correct for 1) lack of enough water flooding the pans and 2) lower the high salinity in the pans, 3) allowing easily propagule dispersal in the pans leading to natural recruitment.

iv. Area mangrove forest governance

Mangroves in Jimbo fall under the bigger Vanga mangrove ecosystem and are being managed by VAJIKI CFA in collaboration with Kenya Forest Service (KFS). VAJIKI CFA is made up of three villages;

Vanga, Jimbo, and Kiwegu and are actively participating in the area mangrove conservation. It is under this CFA that Vanga Blue Forest, a blue carbon project is housed. It is the mandate of KFS to manage all gazetted forests in Kenya but the Kenya Law allows for co-management with the communities living adjacent to the forest at a radius of 5km.

v. Stakeholder analysis

There are different users of the Vanga mangrove both directly and indirectly. These include fishermen, beekeepers, *dagaa* processers, VBF, and researchers and all depend on the existence of the forest to accomplish their uses.

vi. Community engagement

With the stakeholders identified, through the CFA, the community was informed of the upcoming hydrological activity. Through the village heads, a total of 30 communities participated in the training on hydrological restoration and created a network of water flow channels within the salt pans.

vii. Site assessment

The participant we field trained on how to assess and differentiate sites that require restoration and the appropriate restoration. Where natural recruitment is sufficient, no planting is warranted. Where there is clear-cutting, and no natural recruitment is seen to take, place artificial planting is recommended. Further in such an area, a site must be right and the species planted must match the site condition. In the present case of the salt pan, a different approach of restoring hydrological flow is recommended.

viii. Site preparation

To create a conducive environment to allow for restoration in the salt pans, the flow of water must be restored. To achieve this, the ground within the pans must be at the same level as the existing natural channels that brings water into the pans. Where there are islands, channels with depth equal to the water entry point must be dug. Therefore, using a level machine, channel depths are determined and peged.

2.2. Field Work planning

1. Define tide levels for the period planned to carry out hydrological restoration activity
    a. Tide should be correct to easily identify zero water entry point
    b. The preferred period is during the spring tide period
    c. The hydrological activity should take place during the dry season to avoid channel franks collapsing.
2. Define how much labor is required for hydrological restoration
    a. Depending on the number of channels, their length, and their area, manpower is estimated. The labor should include both genders as it is a learn-as-you-go activity.
    b. Also, important to consider is the budget. A good amount of budget is required both to purchase/ hire field equipment, and compensate the workforce.
3. Hydrological restoration field work tool required
    a. Shovel-10
    b. Panga-3
    c. Jembe-5
    d. Hand lens/magnifying glass-3
    e. Water/soil parameter tool box-1

f. Masking tape-5
g. Marker pens-10
h. Pegs
i. Hammer 3pound hammer
j. Basins/ndoo-15
k. GPS-3
l. Manila/nylon rope-4(50m) rolls red/blue
m. Level machine
n. Construction gloves-10
o. Sacks(50kg)-15, 90kg-5
p. Casuarina poles (3inch diameter)

4. Understanding mangrove area conditions.
    a. Forest condition/seedling recruitment. This is to inform on the structural and health status of the forest. Also, to help decide what type of intervention is required. For low recruitment then restoration is needed. And the species naturally recruiting becomes a guiding principle of species to be restored in the area. Further this information form baseline for monitoring the progress of a restoration intervention
    b. Water flow. Information on how the ocean water flows into the salt pans helps decide where the hydrological channels start and end. Where the water enters freely into the salt pan, that becomes point zero/ reference point for the channels.
    c. Soil conditions-grain size, salinity, Ph. The biophysical data help track changes in the chemical and physical characteristics of an area before and after interventions. The trends of these parameters are used to indicate a return of a normal condition or lack thereof after an intervention. Because different species of mangroves thrive in specific conditions as well as fauna, the changes in the physical-chemical influence biodiversity over time.

3. Field Activity

1. The fieldwork program and objectives were outlined to the participants present in the field meeting:
    a. Participatory planning for hydrological restoration activity
    b. Discuss how many salt pans are to be hydrologically restored
    c. Discuss the method of hydrological water flow restoration
    d. Define the length/depth of the channel to be dug
    e. Discuss how and where dug-out material will be exported
    f. Discuss how much labor is required for hydrological restoration
    g. *Assess the presence of existing pegs and determine to peg*
2. Define how many salts pans are to be hydrologically restored
    a. Those closest to the main creek

Plate 2. Technical team member (Lilian, Edinburgh University) explain to the community the approach of the channel network should start.

3. Define the method of hydrological water flow restoration
   Hydrological Engineer Renson took the participant through the process of hydrological restoration. It was explained that the hydrological flow is intended to allow flooding of the pans with the seawater at the same time. For that to happen the channel starting from the lowest water entry point is dug with depth measurements and systematically branched all over the pan with depths similar to that of the entry point. Other branching channels are also made to fully allow water to flood the pans. Recommended width of the channel is 1m but with sloping flanks to allow free flow of water.
   The dug-out soil materials from the channel should be exported to a nearby terrestrial area or on top of the dykes. This is to prevent creating additional dykes within the pans or forming a barrier on the channel franks.
   It was noted that the dug-out materials are part of the carbon stored in the pans therefore a compromise/tradeoff was agreed upon where some carbon dioxide is allowed to leak out to allow for enhanced restoration. A sample of dugout sediment materials is taken and laboratory analyzed to determine its carbon content for the emission modeling.

4. Assess the presence of existing channel depth pegs
   After assessing the orientation of the pan, the team inspected existing pegs to determine if there was a need for pegging. In some pans, the pegs were still intact while in others they were missing. For the existing pegs, some had visible writing of the channel depth to be dug and others had faded writing. The team then agreed to repeat remarking pegging channel depths.

Plate 3. Community members use the level machine to determine the channel depth

4. Creating a network of hydrological channel

After determining the channel depths using the ground-level machine, participants embarked on digging channels within the salt pans following predefined channel lines marked with labeled pegs. Starting from the Zero mark near the main creek, channel(s) were dug to the defined depth. Using spades and jembes, channels were created. The dugout materials were exported to a hole dug at the edge of the forest and later cover. The export of dug-out materials was to make sure no channel banks were raised that would prevent free overflow of the water once full to the channel capacity. The burial of the dugout materials was to minimize the emission of carbon if they were left in the open.

At the end of the exercise, about 600m of the channel was dug in two salt pans. The created network took the shape of a fish bone where there is the main channel and then subchannels branching from it. Once the channels were created, water was observed to come into the pan freely and overflow through the channel slopes easily. Being the first kind of hydrological restoration in the area, the participant was excited about the approached and gained useful skills that will be utilized in completing the rest of the hydrological work. Some members became equipped with level machine reading skills while others at creating the right angles of the channel slope.

Plate 4. Network of hydrological channels created within the Jimbo salt pans

5. Conclusion

The hydrological restoration approach was successfully started in the salt pans of the Jimbo mangrove. Water was observed to now flow freely within the pans. About 40 participants (including participating institutions personnel) were capacity built on the hydrological restoration methods and moving forward more capacity-building will be done to the community. The activity was observed to be labor intensive therefore a recommendation was given to have more participants in the next phase of channeling. For the next few weeks, monitoring of water flow in and out of the pan through the dug channels will be done in conjunction with the CFA members, and report back the observation for adaptation in the next phase.

6. References

Bosire, J. O., Kaino, J. J., Olagoke, A. O., Mwihaki, L. M., Ogendi, G. M., Kairo, J. G., ... & Macharia, D. (2014). Mangroves in peril: unprecedented degradation rates of peri-urban mangroves in Kenya. *Biogeosciences*, *11*(10), 2623-2634.

GoK (2017), National Mangrove Ecosystem Management Plan. Kenya Forest Service, Nairobi, Kenya

Kairo, J., Mbatha, A., Murithi, M. M., & Mungai, F. (2021). Total ecosystem carbon stocks of mangroves in Lamu, kenya; and their potential contributions to the climate change agenda in the country. *Frontiers in Forests and Global Change*, *4*, 709227.

Hamza, A. J., Esteves, L. S., Cvitanovic, M., & Kairo, J. (2020). Past and present utilization of mangrove resources in Eastern Africa and drivers of change. *Journal of Coastal Research*, *95*(SI), 39-44.

7. Participant list

Name	Institution
Ruwa K Masha	KFS
Hamisi Kirauni	KMFRI
Livingstone Kitawi	KFS
Mwinga Maskati	KFS
Jacob Misyili	KMFRI
Faith Nafula	KMFRI
Eli Idel	St. Lawrence University
Aubrey Burns	St. Lawrence University
Renson Simu	EBROC
Lilian Mwihaki	Edinburgh
Nana Mohammed	KFS
Mwanarusi Mwamfrica	VBF
Hamadi Tunusi	VBF
Mwanamvua Mwinyi	VAJIKI
Mwasiti Kihawa	VAJIKI
Mwanamtama Mohamed	VAJIKI
Mariam Abdi	VAJIKI
Mwanaisha Mwadugu	VAJIKI
Mwanapili Mohamed	VAJIKI
Omar Riko	VAJIKI
Bakari Hasan	VAJIKI
Mwachambi Kai	VAJIKI
Harith Mohamed	VAJIKI
Ibrahim Abdi	VAJIKI
Boy Tsuma	VAJIKI
Ali Abdalla Ali	VAJIKI
Juma Bakari	VAJIKI
Hassan Shee	VAJIKI
Kombo Faki	VAJIKI
Daudi Faki	VAJIKI
Diwani Mwauga	VAJIKI
Said Ali	VAJIKI
Mwanakombo Shee	VAJIKI
Fatuma Shillingi	VAJIKI
Said M Boy	VAJIKI
Mwanamvua Kassim	VAJIKI
Mwanshamba kai	VAJIKI
Mwana Alawi	VAJIKI
Rashid Said	VAJIKI
Kihawa Mohmed	VAJIKI
Mohammed D Mohamed	VAJIKI
Hariri Kai	VAJIKI
Mwantumu Kalama	VAJIKI

8. Pictorial presentation

	Technical team recap meeting
	Field site training and site assessment
	Ground-level profiling and channel path pegging

	Channel digging to predefined depths
	Burial of channel dug-out soil materials
	A network of the hydrological channel created