Afforestation with mangrove plant to protect land degradation and coastal erosion (Md. Fazlay Arafat)

Afforestation with mangrove plants to protect land degradation (Bangladesh)

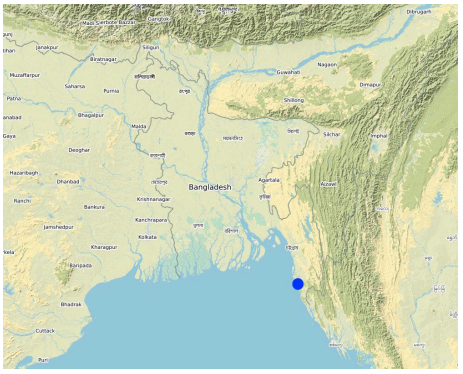
Upokuliyio Bonayon

DESCRIPTION

Mangrove afforestation in newly accreted land along cooastal regions accelerates the process of land stabilization, creates new forest resources, and enriches biodiversity.

Maheshkhali is the only hilly island of Bangladesh and situated in northwest of Cox's Bazar. This island has become a tourist destination for its mangrove plantation and ancient Adinath Temple situated at the hilltop. Historically the island had suffered from coastal erosion and structural measures like building blocks along the coast were implemented in some places to protect the Adinath hill from erosion. The Maheshkhali channel have deposited sediments in the near-shore zone and formed mud banks along the coast. This newly accreted land and other lands were used for mangrove plantations, which stabilized the land and provided protection against coastal erosion, storm damage, flooding, and siltation of adjacent seagrass beds. Mangrove plantations can provide a long-term and cost-effective solution to coastal erosion while at the same time improving the landscape aesthetically and increasing ecological habitats. Before the mangroves were planted, the existing shrub and tree vegetation along the coastline of Maheshkhali was scattered. The barren and exposed coastline is now converted to a green shelter-belt and protecting the soil. Bangladesh Forest Department is the land user and the mangrove plantation was carried out with the support from World Bank through "Forest Resource Management Plan (FRMP)" project in 1997. Later, some new plantation also carried out in 2016 on newly accreted land through "Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP).
The mangrove plant species Baen (Avicennia officinalis) was used to create the plantation. Salinity in coastal regions increased as consequence of global warming and Avicennia officinalis is among the most salt tolerant species that prefer clay soil. The young tree forms a low, dense bushy crown. When it matures, it forms a columnar tree up to 15 m and may grow up to 30 m. The spreading root system of the plant also provides stability in shifting substrates. When planting mangroves, site selection and proper nursery management is crucial. Geo-morphological changes in coastal areas can be rapid and unpredictable, making it difficult to identify suitable sites correctly. Accreted land with grasses and crab burrows indicating a stable site, ideal for planting. The experience of field staff is a key factor in identifying suitable sites. Nursery management is carried out by forest department. Seed collection, site clearing, leveling and fencing, drainage arrangement, bed preparation, making overhead shed, poly-bag preparation, potting seeds, manuring, irrigation and weed control are the major activities of nursery management. Proper care of seedlings needs to be ensured while transporting from nursery to plantation site thorough boat. Gunny bags can be used to carry the seedlings while transporting. The spacing between each plant was 1.5m x 1.5m and 4444 seedlings/ha were planted in the visited site. Compost fertilizer was used both in nursery and while planting in pit. After planting, each seedling was tied up with a bamboo stick for support and to prevent from washing away in tides. The plantation activities were carried out by the staff of forest department. As mangrove afforestation is carried out in unstable environments, there is always a risk of losing some plantation during the time it takes for trees to reach maturity.
Coastal afforestation accelerates the process of land stabilization, and by creating new forest land it enriches biodiversity and natural resources. It also protects the lives and property of the coastal population against cyclones and tidal surges. The plantation develops suitable habitats for wildlife, fish and other estuarine and marine fauna. It produces timber for fuelwood and industrial uses. However, the local community people can only collect fuelwood and other non-timber forest products like honey, crabs and fishes from this plantation site. The mangrove plantation increased the aesthetic beauty of the area and also create employment opportunities for remote rural communities through eco-tourism.

LOCATION



Location: Moheskhali, Cox's Bazar, Chittagong division, Bangladesh

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 91.97735, 21.52738
- 91.97843, 21.52174
- 91.97616, 21.52149
- 91.97864, 21.52992
- 91.97671, 21.52621

Spread of the Technology: evenly spread over an area (approx. 1-10 km2)

In a permanently protected area?: Nee

Date of implementation: 10-50 years ago

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Plantation of Avicennia officinalis (Baen) (Md. Fazlay Arafat)

Plantation of mangrove species that protect land degradation (Md. Fazlay Arafat)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: Nee

Forest/ woodlands

- Tree plantation, afforestation. Varieties: Monoculture local variety

Tree types (evergreen): n.a.
Products and services: Timber, Fuelwood, Fruits and nuts, Other forest products, Nature conservation/ protection, Recreation/ tourism, Protection against natural hazards

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wc: coastal erosion

SLM group

- forest plantation management
- windbreak/ shelterbelt
- ecosystem-based disaster risk reduction

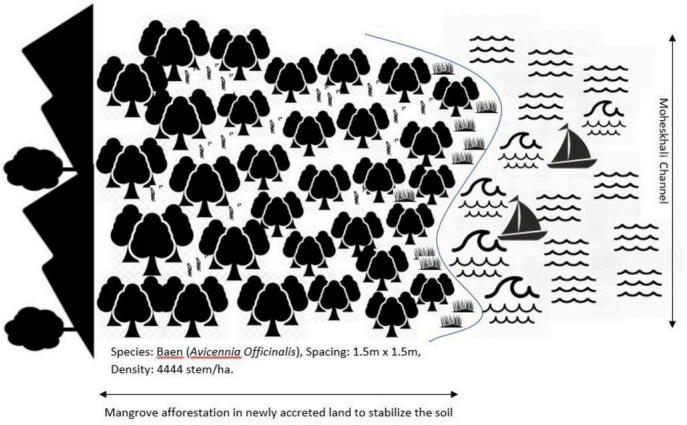
SLM measures

vegetative measures - V1: Tree and shrub cover

TECHNICAL DRAWING

Technical specifications

Planted species: Baen (Avicennia officinalis)
Soil condition: Accreted land with grasses indicated a stable site and suitable for planting Baen plant.
Spacing: 1.5m X 1.5m
Density: 4444 stem/ha.
Vacancy filling: 3 consecutive years after plantation



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ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 ha**; conversion factor to one hectare: **1 ha = 2.47 acres**)
- Currency used for cost calculation: **BDT**
- Exchange rate (to USD): 1 USD = 84.0 BDT
- Average wage cost of hired labour per day: BDT 500

Most important factors affecting the costs

Labor cost

Establishment activities

1. Nursery preparation (seed collection, site clearing, leveling and fencing, drainage arrangement, bed preparation, making overhead shed, poly-bag preparation, potting seeds, manuring, irrigation, weed control) (Timing/ frequency: March-April)
2. Survey plantation site and prepare site map (Timing/ frequency: August)
3. Transportation of seedlings (Timing/ frequency: September-October)
4. Plantation (Timing/ frequency: September-October)

Establishment inputs and costs (per 1 ha)

Specify input	Unit	Quantity	Costs per Unit (BDT)	Total costs per input (BDT)	% of costs borne by land users
Labour					
Nursery preparation (seed collection, site clearing, leveling and fencing, drainage arrangement, bed preparation, making overhead shed, poly-bag preparation, potting seeds, manuring, irrigation, weed control)	person-days	20.0	500.0	10000.0	
Plantation site survey	person-days	1.0	500.0	500.0	
Transportation of seedlings	person-days	4.0	500.0	2000.0	
Plantation	person-days	10.0	500.0	5000.0	
Equipment					
Boat rent for seedlings transportation	lump-sum	1.0	2500.0	2500.0	
Poly bags	pieces	4500.0	1.0	4500.0	
Rope for tying up seedlings with bamboo stick	lump-sum	1.0	1500.0	1500.0	
Gunny bags (to carry seedlings to the plantation pit)	lump-sum	1.0	400.0	400.0	
Plant material					
Bamboo sticks to support seedlings	pieces	4500.0	2.0	9000.0	
Fertilizers and biocides					
Compost fertilizer (to apply in pit)	kg	50.0	10.0	500.0	
Total costs for establishment of the Technology				**35'900.0**	
Total costs for establishment of the Technology in USD				*427.38*	

Maintenance activities

1. 1 year old plantation replanting nursery 40% (2 bed/ha) (Timing/ frequency: March-April)
2. 2 year old plantation replanting nursery 30% (2 bed/ha) (Timing/ frequency: March-April)
3. 3 year old plantation- replanting nursery 20% (1 bed/Ha.) (Timing/ frequency: March-April)
4. 1 year old plantation- replanting (VF) 40% (1777 seedling/Ha.) (Timing/ frequency: September-October)
5. 2 year old plantation- replanting (VF) 30% (1333 seedling/Ha.) (Timing/ frequency: September-October)
6. 3 year old plantation- replanting (VF) 20% (888 seedling/Ha.) (Timing/ frequency: September-October)

Maintenance inputs and costs (per 1 ha)

Specify input	Unit	Quantity	Costs per Unit (BDT)	Total costs per input (BDT)	% of costs borne by land users
Labour					
Nursery work	person-day	18.0	500.0	9000.0	100.0

Replanting work	person-day	10.0	500.0	5000.0	100.0
Equipment					
Boat rent for seedlings transportation	Lump-sum	1.0	6000.0	6000.0	100.0
Fertilizers and biocides					
Compost fertilizer	kg	25.0	10.0	250.0	100.0
Total costs for maintenance of the Technology				**20'250.0**	
Total costs for maintenance of the Technology in USD				*241.07*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [x] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 3700.0
Name of the meteorological station: Cox's Bazar
Mean annual temperature is 25.6 °C

Slope
- [x] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [x] footslopes
- [ ] valley floors

Altitude
- [x] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [x] excess
- [ ] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [x] unusable

Water quality refers to: surface water

Is salinity a problem?
- [x] Ja
- [ ] Nee

Occurrence of flooding
- [x] Ja
- [ ] Nee

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [x] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [x] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [x] 5-15 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled

Land use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

- [x] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

- [ ] individual, titled

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	good
education	poor	good
technical assistance	poor	good
employment (e.g. off-farm)	poor	good
markets	poor	good
energy	poor	good
roads and transport	poor	good
drinking water and sanitation	poor	good
financial services	poor	good

IMPACTS

Socio-economic impacts

wood production	decreased	increased	
forest/ woodland quality	decreased	increased	
non-wood forest production	decreased	increased	Honey, fish and crab production increased
risk of production failure	increased	decreased	
product diversity	decreased	increased	The mangrove plantation support production of timber, fuel wood, crabs, fruits for wildlife, honey, etc.
production area (new land under cultivation/ use)	decreased	increased	
land management	hindered	simplified	
diversity of income sources	decreased	increased	Promote alternate income through ecotourism

Socio-cultural impacts

cultural opportunities (eg spiritual, aesthetic, others)	reduced	improved	The mangrove plantation saved one ancient temple (Adinath Mondir) of Hindu religion from destruction by land degradation.
recreational opportunities	reduced	improved	The mangrove forest now become a tourist place
SLM/ land degradation knowledge	reduced	improved	Forest department now replicating the practice in other degraded areas

Ecological impacts

surface runoff	increased	decreased	surface runoff decreased due to canopy coverage and accretion of sediments in plantation site
soil accumulation	decreased	increased	soil accumulation increased as the plantation promote soil accretion during tides
nutrient cycling/ recharge	decreased	increased	
soil organic matter/ below ground C	decreased	increased	
vegetation cover	decreased	increased	
biomass/ above ground C	decreased	increased	
animal diversity	decreased	increased	the plantation site support habitats for birds and crabs
beneficial species (predators, earthworms, pollinators)	decreased	increased	Honey bee and various birds living here and add benefits in pollination and pest control
habitat diversity	decreased	increased	The plantation develops suitable habitats for wildlife and fish
flood impacts	increased	decreased	
landslides/ debris flows	increased	decreased	The plantation protect the debris flows of Adinath hill from washed away in water. The Adinath hill is on the edge of coast and now protected from bank erosion.

impacts of cyclones, rain storms — increased ✓ decreased
emission of carbon and greenhouse gases — increased ✓ decreased
wind velocity — increased ✓ decreased

Off-site impacts

buffering/ filtering capacity (by soil, vegetation, wetlands) — reduced ✓ improved

The plantation act as a buffer to reduce the saline water flow of high tide towards terrestrial land

impact of greenhouse gases — increased ✓ reduced

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative ✓ very positive
Long-term returns — very negative ✓ very positive

Benefits compared with maintenance costs

Short-term returns — very negative ✓ very positive
Long-term returns — very negative ✓ very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all ✓ very well
seasonal rainfall increase — not well at all ✓ very well
Season: wet/ rainy season
water salinity in coastal areas due to global warming increase — not well at all ✓ very well

Climate-related extremes (disasters)

tropical storm — not well at all ✓ very well
local thunderstorm — not well at all ✓ very well
storm surge/ coastal flood — not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [x] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- [ ] Ja
- [x] Nee

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Protect the lives and property of the coastal population against cyclones and tidal surges.
- Conserve and stabilize newly accreted lands and protect from land degradation
- Produce fuel wood for local people

Strengths: compiler's or other key resource person's view

- Develop ecotourism facility for local communities
- Develop suitable habitats for wildlife, fish and other estuarine and marine fauna

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Vulnerable to natural calamities specially in initial stage Proper management and vacancy filling

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Risk of low production due to unstable environment for plantation Proper monitoring and management of plantation

REFERENCES

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Date of documentation: Jan. 6, 2019

Last update: Mei 4, 2020

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Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_4300/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- Bangladesh Forest Department (Bangladesh Forest Department) - Bangladesh
- FAO Bangladesh (FAO Bangladesh) - Bangladesh

Project
- Decision Support for Mainstreaming and Scaling out Sustainable Land Management (GEF-FAO / DS-SLM)

Key references

- Macintosh, D.J., Mahindapala, R., Markopoulos, M. (eds) (2012). Sharing Lessons on Mangrove Restoration. Bangkok, Thailand: Mangroves for the Future and Gland, Switzerland: IUCN. ISBN: 978-2-8317-1558-2: www.mangrovesforthefuture.org

Links to relevant information which is available online
- Mangroves for the Future: www.mangrovesforthefuture.org

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