Threats and drivers to mangrove and associated resources

The major threats to the mangrove ecosystem are both natural and anthropogenic. Natural threats are associated with climate change, cyclones and storms. Anthropogenic threats include tree cutting for fuelwood and for building material and artificial river runoff. There are evidences that river floods and wave action, due to the storms, are causing infilling and blockage of the mangrove creeks and mangrove roots with sediments, and subsequently causing mangrove tree death. Artificial river runoffs by the dams alter the natural seasonal cycle, causing either reduced or increased amount of water reaching mangrove forests, changing the salinity level of water in the forest, and subsequently causing the death of the mangrove trees.

Policy recommendations and options for sustainable mangrove use

The levels of exploitation of mangrove and associated resources in the delta stills sustain, however, given the actual trends in human growth, there is a potential for negative trends if sustainable exploitation of mangrove trees, fisheries, including crabs is not implemented.

The assessment strongly recommends sustainable mangrove management plan including a harvesting plan consisting of cutting commercially viable trees (7.5 m height, 2.5m perimeter) for charcoal production, at the rate of 13 trees per hectare per month, producing 20 bags of charcoal per hectare per month. One of the major causes of mangrove forest destruction is the demand for building material. In order to reduce pressure on mangrove for building material the study recommends the promotion of alternative building material, which includes bricks, for the Zambezi delta is rich in clay. In addition, the study showed the negative downstream effects of the hydroelectric dams, recommending the regulation of the river flow to mimic natural seasonal cycle through the dam.

The suggested alternative livelihoods are agriculture, rehabilitating the irrigation system of Sombo; fish processing and trade; cage aquaculture; crab fattening and trade; and bee keeping.

MANGROVE AREA

The highest concentration of mangrove is located at the Centre of Mozambique, in the Sofala and Zambezia provinces, corresponding to a total of 71% of the total mangrove area in Mozambique.

CARBON SEQUESTRATION

The mangrove forests have the capacity to capture carbon from the atmosphere and store it in the soil and in dead roots, contributing to the reduction of greenhouse gases in the atmosphere and mitigate climate change.

POPULATION

Approximately 188,206 people live in the Delta area, dependent on agriculture, fishing and timber collection from the mangrove for different uses.

DIVERSITY

There are 9 mangrove species in Zambezi delta, which is considered the mangrove area with the highest diversity at the coat of the East Africa.

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Ecosystem Services Valuation of Mangrove Forests in Zambezi

The Project

The Global Environmental Facility (GEF) Mozambique Blue Forests Project is part of a coordinated international effort to demonstrate methodologies for carbon accounting and ES valuation in blue carbon ecosystems. The focus of the GEF Blue Forests Project small-scale intervention entitled 'Mozambique Blue Forest Project' is the application of blue forests methodologies and approaches for valuing carbon and other ecosystem services (ES). The intervention aims to improve the understanding of ES and carbon sequestration for mangrove ecosystems in Mozambique, and, to develop an improved ecosystem management founded on that understanding.

The project will result in overall improved ecosystem management for the Zambezi Delta allowing an exploration of the valuation of ecosystem services for mangroves in the Delta and promote the sustainable use of mangrove resources in order to meet the needs for the local communities through activities such as beekeeping, crab fattening, the establishment of mangrove harvesting blocks, harvesting mechanisms and community-ecotourism.

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The Delta

The Zambezi Delta is an alluvial triangular shaped plain, about 120 km long towards the coast and 200 km along the coast, covering an area of about 12,000 km2 with several branches and mangrove creeks. The Delta hosts an important rich and diverse ecosystem with endemic fauna and flora. The extensive mangrove creeks and estuaries are a nursery and breeding ground to important fisheries. Approximately 188,206 people live within the delta, mainly depending on agriculture, fisheries and mangrove wood harvesting.

The Mangrove

The estimated area of mangrove in the delta is about 37,034 ha, with an increase rate of 196 ha yr^{-1}. The main mangrove tree species in the Delta are as follows: *Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Heritiera littoralis, Lumnitzera racemosa, Rhizophora mucronata, Sonneratia alba* and *Xylocarpus granatum*. The mangrove density varied on average from 1550 to 26,900 trees per hectare in an old (30 years old) and new (4-5 years old) stand forests, respectively. In an old stand forest over 97% of the trees had heights 10-30 cm and about 55% had diameters between 10-20 cm and 30% were trees with diameter 30-50 cm. In the new stand forest about 95% of the trees had heights less than 3 m, and about 58% had diameters 8-20 cm, about 40% had diameters 20-30 cm. The rate of forest regeneration varied between 6.5% and 99% for old and new stand forest.

Figure 1. Zambezi Delta Location Map, Mozambique. © WWF.

The Mangrove Ecosystems Services Assessment

Aware about the importance of mangroves WWF Mozambique Country office and Superior School of Coastal and Marine Sciences from Quelimane conducted a rapid ecological-economic-livelihood survey to assess the economic value of mangroves. A number of 573 households distributed in 12 villages in the district of Chinde and surroundings were interviewed.

Mangroves in the Delta provide timber, poles and firewood, from which charcoal is produced. The mangrove economic value for sustainable forest exploitation was estimated at US$1,200 ha^{-1} yr^{-1}, if exploited for charcoal, on cycle period of 10 years. Considering the population of the delta, estimated at 188,206, the charcoal production from mangrove would render about US$236 ha^{-1} yr^{-1}, equivalent to the average GDP per capita in Mozambique. If explored sustainably as poles, the cycle period would be 5 years, and would render US$1,040 ha^{-1} yr^{-1}, equivalent to US$204.64 per capita per year, slightly less than if explored as charcoal. It is believed that if explored as timber would render more, however, the cycle period would be 20-30 years.

Figure 2 and 3. Local fisherman in the Zambezi Delta (left) and cut mangrove trees for poles production (right).

The village of Chinde is eroding (Figure 4) at the rate of 30 m^{-1} yr^{-1}, in a section of about 1,500km along the beach. The threatened infrastructures worth US $1,498,312.79. Considering that a strip of mangrove of about 400-500 m width and 1,500 m long would be sufficient to protect the village against erosion; the protective value of mangrove was estimated at US$ 20,000.00 ha^{-1} yr^{-1}.

Figure 4. View of the extent of erosion in Chinde beach, Chinde Village, October 2016.

Figure 5. Mangrove crab collector in a mangrove creek in Chinde, Bairro de Hospital, Chinde, Zambezi Delta, October 2016 (present study).

Mangrove provide breeding, spawning and nursery habitat for several commercial fish species. Some species are endemic in mangrove creeks and estuaries others are either typical of freshwater or typical marine species that live temporarily in the mangrove creeks and estuaries for spawning, breeding, nursing and feeding. The result from the present study indicate that the average fish production yield was 209 kg ha^{-1} yr^{-1}; where the highest production yield was from fish, with 178.6 kg ha^{-1} yr^{-1}, followed by shrimp with 23.8 kg ha^{-1} yr^{-1}, and the overall gross income from fish products was US$600 ha^{-1} yr^{-1}, with the highest contribution from fish with US $419.07 ha-1 yr-1, followed by shrimp with US$152.11 ha^{-1} yr^{-1}, for the entire Sofala Bank.

The estimated rate of carbon sequestration by mangroves in the Zambezi Delta was 463 Mg ha^{-1} yr^{-1}. Considering the average market price of carbon of US$13 per ton of CO2, according to Carbon Planet, the carbon sequestered by the mangroves in the Zambezi Delta would worth US$6,000 per ha^{-1} $year^{-1}$.

Mangrove Value

The overall direct use of mangroves in poles, timber, firewood and charcoal yield was estimated at 1,120 US$ ha^{-1} yr^{-1}; the regulating, habitat and nursery and climate regulation functions were estimated at 20,000 US$ ha^{-1} yr^{-1}, 600 US$ ha^{-1} yr^{-1} and 6,000 US$ ha^{-1} yr^{-1}, respectively.

Considering the total area (37,034 ha) of mangrove in the Delta, the direct use of mangrove worth 41,478,080 US$ yr^{-1} and the indirect use of mangrove worth 985,104,400 US$ yr^{-1} for the entire Zambezi Delta. Thus, the overall mangrove value in the Zambezi delta is estimated at 1,026,582,480 US$ yr^{-1}.

Table (i). Summary of the estimated economic value of the mangrove of the Zambezi Delta.

Provisioning of goods - Direct use of mangroves			Ecological value - Indirect use of mangroves		
Product	Harvesting rate (No of trees ha^{-1} yr^{-1})	Yield (US$ ha^{-1} yr^{-1})	Category	Production rate (kg ha^{-1} yr^{-1})	Yield (US$ ha^{-1} yr^{-1})
Charcoal	156	1,200	Regulating (coastal protection)		20,000
			Habitat and nursery	209	600
Poles	312	1,040	Climate regulation (Carbon sequestration)	463,000	6,000
			Maritime transport (passengers and goods)		264,000

The household interviewed were well aware about the importance of mangrove in ecology and in sustaining livelihood. In the view of the importance of mangrove in their livelihood, nearly 90% of the interviewed said to be willing to contribute in labor for mangrove reforestation.