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Chapter

Stieglers Gorge Dam Construction: Potential Impacts and Possible Mangrove Restoration Options in the Rufiji Delta, Tanzania

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Abstract

The varied importance of mangroves has long been recognized. And so have been the threats to their existence, leading to various actions taken locally by local communities, national governments, and through international agreements for the protection and integration of human livelihood needs in a manner that balances conservation goals and goals of socio-economic development. In Tanzania the mangrove conservation ethos began during the German colonization of Tanganyika and has been persistent in the age of high globalization. In an effort to deepen our understanding of the dynamics of global, national and local nature conservation, this chapter documents the various strategies and approaches used in mangrove restoration elsewhere in the world generally, and then specifically in the Rufiji Delta. The chapter further unpacks the contrasting socio-political interests behind the efforts to conserve mangroves worldwide and in Tanzania. It does so by looking at three competing narratives, i.e. the mainstream perspective, the neo-liberal perspective, and the local cultural perspective, acting at a number of nested scales from the local grassroots to the national and the global scales.

Keywords: ecosystem goods, ecosystem services, Africa, coastal community, conservation management, socioeconomic

1. Introduction

1.1 Framing the problem

Mangroves have provided critical services to humans and the ecosystems. They have done this well and their ecological, economic, cultural and esthetic importance values have long been recognized. It was not until recently in the Anthropocene when the threats to their existence have been magnified with losses of the habitat of more than 50% reported in some parts of the globe due to their commoditization [1–5]. It is thus that the mangrove conservation ethos has particularly been persistent now than ever before in human history [6].

In an attempt to deepen our understanding of the dynamics of nature conservation reinforced by dominant discourses of the 1990s, neo-liberalism and ecological

modernization, this chapter documents the strategies and approaches used in mangrove restoration in Tanzania, in general, and specifically in the Rufiji Delta. The chapter further unpacks the contrasting interests behind the efforts to conserve mangroves worldwide. This is done by looking at three competing moral narratives operating at nested scales from the grassroots to achieve conservation with social justice through the national, regional to the global and back again [7–9]. The three narratives interrogated here are the mainstream ecological conservation narrative, the neo-liberal economic narrative and the local cultural narrative at the grassroots [10] as discussed later in this chapter.

1.2 Methodology

Data collection for this study involved a desk-based literature search during September–November, 2019. Published and gray literature and secondary sources were purposively sampled using key words in the Google search engine. Key words such as mangroves, restoration, commoditization, ecosystem goods and services, Rufiji Delta, et cetera, were used to create a document set for known mangrove countries in the world.

A qualitative content analysis approach was then used to analyze each of the relevant research categories. Through a directed approach each document was reviewed to identify and collate evidence for each of the research themes and the level at which they operated. Three levels were identified: namely, local factors that operate at the community, village and household level; national factors that operate at the state level; and international factors that operate beyond the level of the state.

Content analysis was then followed by discourse and narrative analyses that have long been a major part of political ecology. While discourse analysis was an epistemological exercise, narrative analysis was important for understanding how environmental knowledge of specific events was communicated [11]. These narratives were deemed important for policymakers as they would make arguments for controlling the actions of certain, often unknowing groups; to achieve desired environmental outcomes. The rest of this chapter is structured according to the results of these latter analyses.

2. Results and discussion

2.1 Defining the mangrove ecosystem

The word “mangrove” refers to trees, families of the plant, and the ecosystem that has adapted to flourish in tidal zones in tropical and sub-tropical regions. Mangroves have been defined variously by many people; but they all agreed that mangroves are salt-tolerant evergreen forests found at sheltered coastlines, shallow-water lagoons, estuaries, rivers or deltas in intertidal areas around the world [12, 13].

They comprise around 73 species covering an area of over 150,000 km² spread in 123 countries [1]. (See also **Figure 1**). Over two-thirds of the mangroves exist in just 12 countries, with Indonesia accounting for over 20% of the global mangrove area. With about 8% of the total mangrove estate, Brazil has the largest contiguous mangrove forest cover. In tropical estuaries of Indonesia and Brazil and deltas like the Rufiji, there grows some of the largest mangrove trees in the world, reaching heights of 30 m or more, with extensive roots penetrating into soft mud deposits. Mangrove trees growing in the sediments of a carbonated shoreline and in arid,



Figure 1. Mangroves are common along tropical and subtropical coastlines around the world, and among the most biologically important systems on earth [12]. **Source:** NASA earth observatory as described by Twilley and Rovai [14].

very salty regions along the Red Sea are so much smaller that they look like stunted “ornamental trees in public parks” [15].

Mangrove forests in mainland Tanzania are categorized as State Forest Reserves by the Forest Act of 2002 [16]. They occur along almost the entire coastline in continuous or fragmented stands [17]. Recent estimates by the National Forest Resources Monitoring and Assessment (NAFORMA) indicate that mangroves cover approximately 158,100 ha, which is about 0.3% of the total forest area in the country [18].

Despite the commercial value of mangroves, “blue” carbon ecosystems are globally being lost twice as fast as tropical rainforests [19]. They are threatened by changing climate, natural impacts such as hurricanes, and human impacts such as deforestation and alterations in freshwater management regimes. Approximately 35% of mangrove trees were lost in this way during the last two decades of the 20th century [20].

Ngongolo *et al* [21] note, for example, that by 2000 the total estimate for mangroves was 137,760 km², representing a decline from 198,000 km² of mangroves in 1980, and 157,630 km² in 1990. These losses represent about 2.0% per year between 1980 and 1990, and 0.7% per year for the period 1990–2000. Hence, the anticipated task of mangrove restoration is immense.

2.2 Mangrove’s ecosystem services

Ecosystem services are the benefits that people get from ecosystems such as mangroves [21, 22]. Forests moderate the amount and type of water we get from a river. It also decreases both the erosion and run-off of a place. They also provide food security as far as the variety of biodiversity they contain and general economic development. The goods and services they provide have the capacity to bring

resilience among smallholder farmers, through diversification of incomes and livelihoods such as fishing.

Ecosystem services are necessary for people’s livelihoods and wellbeing. They include provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain other services (Figure 2). This is from the provisioning of food and water, to disease regulation and maintenance of general conditions of the natural environment. Biodiversity is behind every ecosystem services.

The concept of ecosystem services has been used in diverse ways by different interests to justify different kinds of interventions that at times might be totally opposed. The concept has historically been depicted as a one-way flow of services from ecosystems to people. Jeffers *et al.* [21] argue, however, that this conceptualization is inaccurate. It neglects the reality that humans have often also contributed to the maintenance and enhancement of ecosystems, as evidenced in many traditional and indigenous societies.

Secondly, the ecosystem services idea has mainly been used to justify forest conservation in ways open to critique for its neo-liberalization of nature [25, 26] or disempowerment of communities in some developing countries such as Madagascar. On the other hand, the discourse of ecosystem services has also served the liberating agendas of traditional populations and family farm lobbies in places like the Brazilian Amazon, where the ecosystem services concept has been mobilized by diverse actor interests in real-life situations that have led “to complex, regionally particular and fundamentally political outcomes” [27].

Irrespective of the range of species and forest types, the manifold ecological role of mangrove ecosystems is, economically and socially, highly significant. The international discourse on mangroves hypothesizes that they play an important part in shaping the physical coastline by trapping sediments and stabilizing the coast.

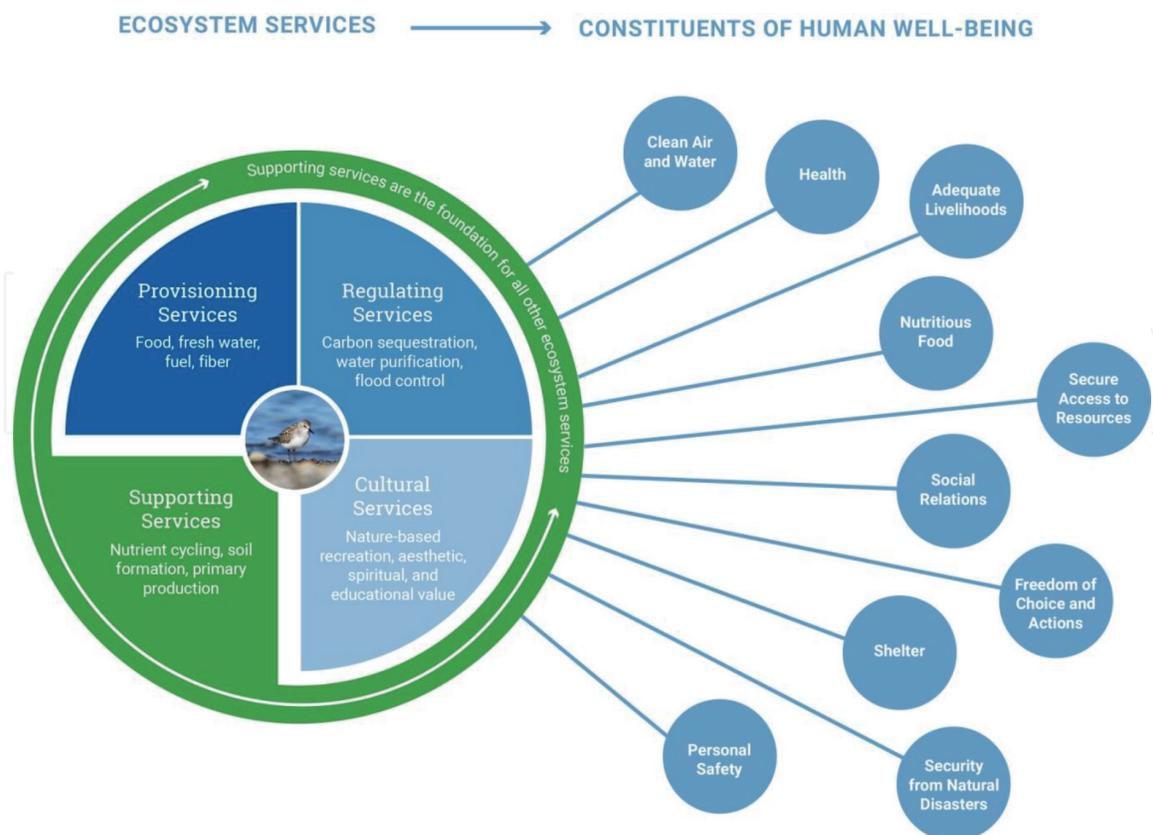


Figure 2. Healthy ecosystems benefit human well-being. Humans have often also contributed to the maintenance and enhancement of ecosystems in a reciprocal fashion [23]. **Source:** Adopted and modified from Chapin *et al.* [24].

Moreover, the mangroves are highly productive ecosystem that can store carbon in sediment for long period; therefore, they have the potential of providing an efficient CO₂ sink [11].

Mangrove plantation provides the possibility of forestation for the Clean Development Mechanism (CDM) project worldwide. Recent studies revealed that mangrove restoration can continue to combat climate change after 25–30 years [28]. Anthropogenic interventions decrease the capacity of ecosystems to provide goods and services as discussed above.

2.3 The mangrove estate of the Rufiji Delta

Located between latitudes 7°50' and 8°03' S and longitudes 39°15' and 32°17' E, the Rufiji Delta is about 200 km south of Dar-es-Salaam (**Figure 3**). The lower Rufiji valley starts upstream from Stiegler's Gorge, some 180 km from the Indian Ocean, and into the Selous Game Reserve. Below the gorge the river fans out into an outer plain with numerous lakes before entering its lower floodplain. This part of the floodplain gradually widens until the river branches out and forms the 23 km wide and 65 km long cobra like hood of the delta [30].

Before reaching the Mafia Channel in the East, the river passes through 20 islands and 31 villages, and supports the largest contiguous block of mangrove

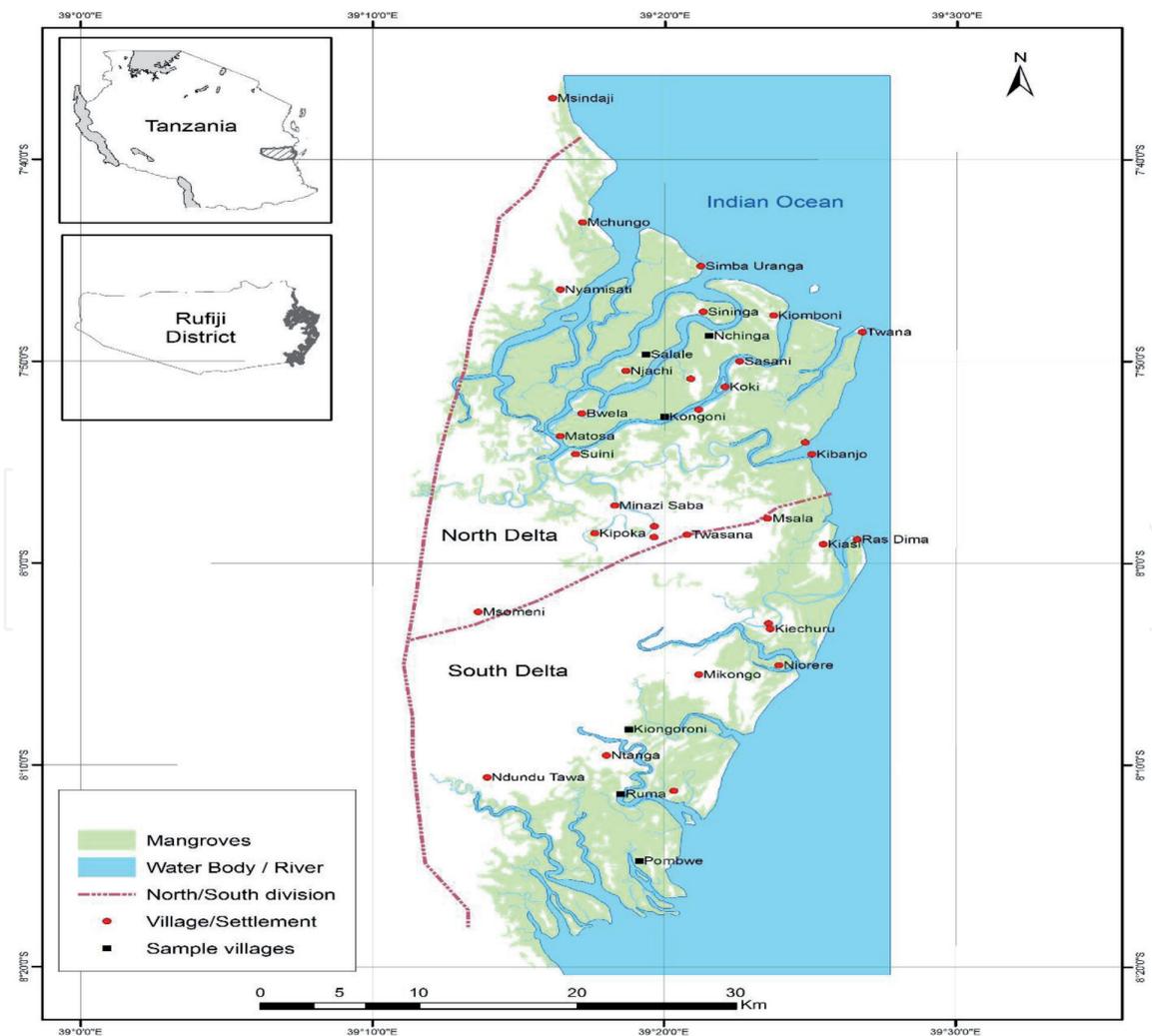


Figure 3. Location of the delta area in Rufiji District, Tanzania. The crescent shaped Rufiji Delta has extensive, estuarine mangrove forests that constitute almost half of Tanzania's mangrove forests (Source: Adopted from Muansasu [29]).

forest (53,255 ha) in East Africa. Eight mangrove species are reported to occur and are well represented in the delta, i.e. *Avicennia marina*, *Sonneratia alba*, *Ceriops tagal*, *Lumnitzera racemosa*, *Bruguiera gymnorrhiza*, *Rhizophora mucronata*, *Xylocarpus granatum* and *Heritiera littoralis* [31]. Two particular species, *Xylocarpus molluccensis* and *Pemphis acidula*, are missing in the delta. These are characteristically rare in the region due to a limited geomorphological niche [17].

In the delta mangroves are cleared mostly for rice farming and timber to feed urban Tanzania, including Zanzibar, and some parts of the United Arab Emirates. Areas dominated by *H. littoralis* are more favored for rice farming while *C. tagal*, *R. mucronata* and *B. gymnorrhiza* are heavily cut for poles. *X. granatum*, and more recently *S. alba*, are logged for timber [32].

Rufiji River is also endowed with the greatest fish potential along Tanzania's coastline, supporting about 80% of all prawn fisheries in the country [33, 34]. With a mean annual flow of approximately 800 m³/s, Rufiji is one of the largest rivers in Africa and drains 20% of mainland Tanzania through three major tributaries, the Great Ruaha, the Kilombero and the Luwegu. Together, the rivers provide approximately 18%, 62% and 15% of Rufiji's annual flow, respectively [35].

The basin is targeted for major socio-economic development over the next two decades as part of the Southern Agricultural Growth Corridor of Tanzania (SAGCOT). Its water resources are central to the development plans. If the plans go on as arranged targets are met, irrigation water demand will increase by 7 billion m³/per year. 2.4 giga watts of new hydropower are expected to be produced from the controversial Stigler's Gorge. Many of these developments will be in the most valued landscapes and ecosystems of Kilombero and Lower Rufiji sub-basins [36].

Coastal sedimentation and siltation of coastal waters due to agricultural expansion on the highlands has always been a blessing rather than a curse. Of primary threat will probably be reduced stream and peak water flows due to the proposed river impoundment for the hydroelectricity power (HEP) station, with the associated trapping of sediments in the proposed dam [37]. This is further expected to have significant consequences with respect to increased salt water intrusion and diminished nutrient availability for agriculture and altered natural vegetation in the floodplain and the delta.

The delta is also an internationally recognized wetland protected under the Ramsar Convention and a system of UNESCO's World Heritage Sites upstream [38]. These aquatic systems have historically provided valuable ecosystem services, including the *mlau* agriculture performed by the Warufiji as discussed elsewhere by Ochieng [30], Duvail and Hamerlynck [35], and others.

2.4 Mangrove restoration initiatives/options

The characteristics of ecosystems, such as species composition, tree cover or growth conditions, modulate the type and magnitude of ecosystem services that can flow to societies. Mangrove restoration is an important strategy for reversing plant decline and rebuilding the ecosystem services lost due to deforestation and degradation. Mangrove restoration has usually been in the form of replants of single species, and has mostly been for silvicultural purposes. More recently replants have, however, also been undertaken to re-create the lost ecosystem functions [17]. The Indian Ocean region, for example, saw the rapid expansion of government and NGO-funded mangrove replants after the 2004 Indian Ocean tsunami to maximize the coastal protection function provided by mangroves.

Large-scale planting projects have, nevertheless, had mixed success. Many causes have contributed to the low success of plantation interventions, including:

i) biological causes such as pest infestations, ii) unsuitable physical locations, and iii) the socio-economic aspects, as elaborated in Section 3.3 below.

In addition, knowledge of the ecological processes has been added in some projects to increase restoration success. One such approach has been the Ecological Mangrove Restoration (EMR), a community based restoration practice that used several ecological principles to support natural decolonization [39]. This approach shifts the emphasis from seedling planting to prior physical site preparation. For example, the hydrology and topography of a site can be restored to allow natural regeneration of selected mangrove species [40].

2.5 Mangroves in the mainstream development narrative

Nested within mainstream values and definitions of development in Tanzania, several assumptions tend to have guided a policy narrative that has supported mangrove forest conservation in the country:

1. assumptions of inefficiency in local resource use and management regimes [28];
2. inadequate perceptions about the socio-economic benefits of local aquaculture production system, and
3. the central government may be seeing mangrove restoration from the angle of ecological services, while local people view mangrove forests as part of their culture and source of livelihoods.

For example, local aquaculture production systems are considered by regional and district officials to be economically inefficient and incongruent with broader national economic development goals for wetlands [21]. Such assumptions and perceptions are even captured in formal policy documents [41].

In contrast, traditional use of common property mangrove resources is not accorded the same economic value in mainstream discourse despite the numerous benefits provided to local communities [42, 43]. Such conceptions of local inefficiencies and the economic productivity of external aquaculture and carbon sequestration for REDD+ situate well within the broader value sets and definitions of “development” and encourage neo-liberal narratives in developing countries like Tanzania [44, 45].

Moreover, in the case of Rufiji study area, values supportive of common property ecosystems held by indigenous groups have been usurped by an influx of different interest groups, including international environmental NGOs with their political agendas and economic modes of production [44, 46, 47].

The practice of mangrove restoration is based on restoration ecology, which aims to help the recovery of resilience and capacity of ecosystems to adapt to degradation and other damage. Since environmental impacts are ongoing, successful restoration of an ecosystem implies not merely to recreate its former condition, but to strengthen its capacity to adapt to change over time [48]. One of these capacities is the management aspects of mangrove conservation.

After the acknowledgement that strict protection of mangroves did not work in Tanzania, experiments have recently been unfolding in the Rufiji Delta and elsewhere in the country. Three different models of community engagement have been tried in the delta with varying degrees of success [49] as discussed below.

3. Managing mangroves by restoration and reserves

Declines in the extent of mangrove forest cover have a long history in the Rufiji Delta [29, 32]. The Rufiji mangrove forest was the first to be declared a forest reserve in Tanzania during the German colonial period in 1898 [45]. The delicate socio-ecological balance was, however, upset during the course of successive German, British, and the national governments.

The British colonial government adopted and expanded a strict protection approach in the 1920s and 1930s [49]. The Forest Ordinance of 1957 allowed for the creation of forest reserves by government decree after considering “any objections” by interested parties to this *de jure* transfer of rights from local communities to the state. The independent state expanded mangrove forest reserves in the 1960s and has repeatedly used its authority over mangrove forests to exert control over the Rufiji Delta communities and resources. In 1987, for instance, the current Tanzania Forest Service (formerly Forestry and Beekeeping Division) declared a ban on the cutting of all mangroves in the northern Rufiji Delta, with forest officers posted to the area to enforce this ban [12].

By creating ‘forest reserves’ for the exclusive use of the government, local communities were effectively excluded from using these socially, culturally, and economically important resources. Meanwhile, various large-scale extractive projects were proposed for the delta, including commercial shrimp harvesting [12]. Elsewhere in the Coast Region and the country a devolution of resource management to local government, in combination with improved road access and the opening-up of the Tanzanian economy, led to increasingly unsustainable use of other forests in general.

Evidence from literature shows that traditional government agencies have not been effective in protecting forest ecosystems, including mangrove forests. Constraints of capacity and the economic position of many district agencies have resulted in few controls on the scale and intensity of mangrove conservation in the delta, despite an increasingly well-established legal framework for forest conservation [29, 32].

Tanzania was the first country in Africa to develop a mangrove management plan [49]. Although it was never implemented, the 1991 National Mangrove Management Plan crafted by the TFS was the first attempt at halting mangrove conversion alongside monitoring and regulating the use of the resource. Strict mangrove protection entailed actively excluding people living in and around mangroves from accessing and using mangroves for their survival, while the government controlled the harvest and export of mangrove products, particularly timber and building poles [13].

Tanzania’s protectionist policies generally achieved limited and short term success in some locations around the country, with general failure in most mangrove areas of the country. At the local level, to the mid-1990s local residents had, from the colonial period, actively resisted state-led protection of forests, including mangroves [49].

As a result, efforts by the government to continue with strict protection approaches, such as establishment of new marine parks in the late 1990s and mangrove forest reserves continued to face serious implementation challenges, including resistance from coastal residents who complained that these forest reserves and marine parks marginalized them from their main livelihoods [46].

Lack of an appropriate institutional framework for the allocation of management rights and responsibilities between the local government and the national state, as well as weak government enforcement capacity at the national level [33, 51] have been the main culprits of this failure. It was because of these weaknesses, for

example, that Wang *et al.* [43] and Mwansasu [29] noted the ambiguous features of the forest reserve in the Delta - that there were legally established village settlements within it which relied on mangroves and the associated marine environment for a range of ecosystem goods and services. Population estimates by then indicated that over 49,000 people lived in and around the delta, directly engaging in rice farming, mangrove cutting for poles and timber, and fishing [32].

This was possible partly because of political influence at the national and local levels. Mshale *et al.* [49] point out that politicians at various levels in the Rufiji Delta had been issuing statements that encouraged unsustainable use of mangrove forests and mangrove clearance for paddy rice farming to gain residents' political support, particularly during election times. Such statements sent confusing messages to the populace. While elective politicians often promoted mangrove clearance when this was pertinent to increase votes, the civil service maintained a strict protectionist approach. Often, the rural poor who depended on mangroves for their subsistence continued to be characterized by the state institutions as culprits of the degradation of the resource [17, 52].

The 1990s can be dubbed the age of policy shifts. Many natural resource management policies were changed during this period. Since then, the approach to mangrove protection changed, with new efforts being more and more directed toward collaborative management of the trees with local communities. This paradigm shift later led to the emergence of what I call "community appeasement forest management" that was seen as an appropriate alternative to state control with its ambiguous institutional arrangement for ensuring management of forest resources, including mangroves. The turn toward community appeasement forest management was motivated by a number of reasons, including conflicts over forest use between local residents and outsiders seeking to use the forests, and political interests at the national and sub-national levels as discussed above [49].

I would argue in this context that mangrove restoration, including replanting, has in fact also been an attempt at community appeasement rather than a forest management practice adopted to regenerate areas that have been seriously degraded. Mangrove restoration has thus been conducted in various parts of the country by the Mangrove Management Programme, as well as in Tanga and Mbwani by local coastal management efforts. In the Rufiji Delta WWF's Rufiji-Mafia-Kilwa Seascape (RUMAKI) programme has invested substantial donor resources since 2005 to help communities in the delta, as well as in Mafia and Kilwa Districts, to secure long-term mangrove co-management rights [8, 53, 54].

The philosophy behind this supposedly "new approach" has arguably been to show local stakeholders that the restoration projects and the protected areas were in fact theirs, providing a range of benefits such as access to carbon financing schemes, eco-tourism revenue and sustainable sale of commercially valuable timber and non-timber products. It has been the carrot side of the Equation [44, 45]. Three different models of community engagement have, therefore, been tried – with varying degrees of success as discussed below.

4. Three models of community engagement

4.1 Individual taungya farming with permits

This is a TFS system whereby individuals are given permits to farm forest plots with the aim of clearing them of weeds. Farmers apply for renewable one-year licenses allowing them to continue farming rice in exchange for facilitating the natural regeneration of mangrove trees on their plots. Once the trees reach a certain

height, their shade renders rice paddies less productive, and farmers must move elsewhere to repeat the process.

This scheme has not fared well though. Farmers have found it one-sided – imposing a lot of conservation responsibility on the farmers in exchange for meager returns. It has also been creating insecurity. People know that once the mangroves have re-grown farmers will be kicked out, so there is a perverse incentive for farmers to intentionally prevent mangrove recovery.

The written contracts have also been problematic. Many people in the delta are illiterate, and they fear anything that is written and requires to be signed. People feel like they are getting tricked. As one respondent in a focus group discussion remarked: *“perhaps there is something written there that we don’t understand...?”* During the introduction phase of one of these projects many communities refused to sign these contracts due to such apprehensions [12]. After so many years of mistrust and harsh policies, people (especially pastoralists and “squatters” around protected areas) do not always trust government’s intentions [49].

4.2 Group rehabilitation

This is another rehabilitation strategy that has been tried for the mangroves in the Rufiji Delta, with the support of the UNDP and UNEP. Local collectives of 15–30 men and women were assigned an area of mangrove forest to rehabilitate, and were paid for each day they used replanting or weeding the young trees. Under this arrangement, small-scale mangrove replanting was undertaken between 2009 and 2010 as a community project by 100–200 community members from 10 villages over about 70 ha of former mangrove habitat, of which around 45 ha were abandoned rice farming plots [12].

Communities initially embraced the project, but as one project official confessed sometime later, some villagers complained about favoritism, saying they felt excluded from the scheme (Mshale, pers. comm.) Even though TFS were emphatic that the project would be expanded to ensure benefits were shared by as many people as possible, the program could not manage to give people a sense of ownership over the forest. As the official later noted:

“These people are providing casual labour, but they don’t have any other rights over the areas that they are replanting. So the moment you stop paying them, they won’t be able to come and work for you.” (Mshale, pers. comm.)

Hence, the future of the program itself was uncertain because it relied heavily upon donor support. Once the funds dried up, the system could not be sustained. And because these schemes also failed to confer long-term management rights or responsibilities on community members, those involved were not incentivized to ensure the trees’ survival and in many cases people returned to farming the areas once the scheme failed.

4.3 Community co-management of mangrove resources, including Joint Forest Management

Community participation as a neo-liberal approach to natural resources management in Tanzania has become the most important approach within the forestry sector following its inclusion in the National Forest Policy of 1998, Land Act of 1999 and the Forest Act of 2002. Nevertheless, the efficacy of the move to designate responsibility of forest management to local communities remains unclear [51, 55].

Building interest in poverty reduction to enhance sustainable resource management and strengthen the rights of communities to access and manage mangrove forests to improve livelihoods and resource conditions is one thing. But, whether this has translated into actual poverty reduction in practice is another thing altogether. So, the dilemma persists in poor countries like Tanzania on account of building a strong synergy of community participation and poverty reduction, *at least in theory* (emphasis added) [56].

The most promising approach, according to CIFOR research, has been the Joint Forest Management (JFM) scheme being tried in the Rufiji Delta as part of the Participatory Forest Management program [49]. By the time of this study TFS had negotiated with individual communities in four (4) Rufiji villages to draw up plans for sharing the costs and benefits of managing the mangrove forest. Though the state retains ultimate ownership of the mangroves, the scheme transfers some decision-making power to the local people.

By the time of the Mshale *et al* [49] study, the communities had embraced the scheme. The JFM system appeared to provide broader rights and benefits than the other two mechanisms. It meant that community members' actions such as harvesting timber, poles, charcoal, firewood and other products were no longer criminalized. What is needed is proper management and making sure that the benefits and costs are equitably and fairly distributed among community members.

In particular, it needs ensuring women's meaningful participation in decision-making in a culture where women are traditionally meant to stay silent during group meetings. That could need providing a separate space for women to debate ideas among themselves, before bringing their concerns to the wider community. However, implementation efforts and tangible evaluation of progress continues to lag behind conceptual development [57].

The proposed mechanism for REDD+ offers significant potential for conserving forests to reduce negative impacts of climate change. Tanzania has been one of nine pilot countries for the United Nations REDD Program, receiving significant funding from the Norwegian, Finnish and German governments. The country is also a participant in the World Bank's Forest Carbon Partnership Facility. In combination, these interventions aim to mitigate GHG emissions, provide an income to rural communities and conserve biodiversity for the market [58].

As already noted above the mangrove plantation is expected to be one of the options of afforestation in the Clean Development Mechanism (CDM) project through its ability to accumulate sequestered carbon below-ground [58]. However, it is the economics of the initiative that is of interest to us here. The establishment of the UN-REDD Program in Tanzania, for example, illustrates the challenges that face many developing countries. As noted by Burgess *et al.* [59], the challenges have included inadequate baseline forestry data sets needed to calculate reference emission levels.

It has also involved inadequate government capacity and insufficient experience of implementing REDD+ type measures at operational levels. In addition, for REDD+ to succeed, current users of forest resources must adopt new practices, including the equitable sharing of benefits that accrue from REDD+ implementation. This challenge is compounded by failure of conservation (as a form of land use) to compete effectively with alternative land uses [60].

For example, it is reported that the annual global economic value of ecosystem services is estimated to be between US\$200,000 - US \$900,000 per hectare [12]. The value of commercial mangrove timber products and poles in the Rufiji mangrove delta and flood plain in Tanzania is around \$771,789 per year, fuel wood extraction \$156,000 per year and honey extraction \$9000 per year [19]. Most of the

latter benefits go straight into the communities' household economy but stand to be foregone under global conservation.

Büscher *et al* [59] provide an interesting thesis on this phenomenon. They note that in the spirit of “ecological modernization”, modern environmental problems and related crises are in fact themselves increasingly becoming conceptualized as opportunities for capitalist expansion rather than vehicles of poverty reduction. In a study that measured the impact of a national community-based conservation and poverty reduction initiative in Tanzania, it was found that from 2007 to 2015, the impacts of Wildlife Management Areas (WMAs) on wealth of the local communities were small and variable, with no clear evidence of widespread poverty reduction [61].

On the other hand, another study using five (5) years of photographic data capture-recapture found greater densities of livestock and lower densities of wildlife inside a WMA. After the management changes, the study documented significantly higher densities of wild ungulate species and lower densities of domestic ungulates in the WMA [62]. Giraffes' survival and population growth rate were both found to have increased in response to the management changes, indicating that the WMAs were effectively providing habitat and protection for wild ungulates while generally excluding domestic livestock [62].

4.4 Mangroves in the neo-liberal perspective

Neo-liberal conservation takes many forms, but more significant it reframes conservation in terms of market mechanisms [63]. Neo-liberal conservation is being defined as the decentralization of environmental governance, or a shift in responsibility for formal resource management from state to local institutions and new forms of commoditization and commercialization of nature that emerge in these contexts in order to fund conservation efforts. Advocates of market-based conservation argue that such markets will increase conservation funding and increase environmental-friendly businesses. People say it will promote participatory conservation and protect native property rights. Others say it promotes environmental consciousness, thus enhancing more effective and efficient conservation [64, 65].

Ever since the first Earth Summit in 1992 which was perceived to be a potential regulatory constraint on the operation of business, corporate interests have struggled to draw the sting out of the regulatory measures that the Summit recommended. States are said to have out-manuevered NGOs around the Convention on Biological Diversity (CBD) to produce a convention which prioritized generating profit from genetic resources over protecting the environment [63]. Business interests have thus enjoyed access to prime slots during Conferences to the Parties of the CBD. Crucial to all these developments has been the formation of a transnational capitalist class fostering alliances and giving business interests the space and support they require [66].

It has been observed that much as conservation NGOs need the capital and legitimacy businesses provide, it has been the corporate interest which has reached out to conservation groups [63]. Corporate interests are seeking to make money out of new opportunities in mangrove restoration and conservation. They are looking for new profits in ecological modernization rather than biodiversity conservation. Although the gains for biodiversity are less clear within conservation organizations, the result of their embrace by commercial interests is that there has been a “near universal conflation of nature and capital [which] has established itself as a dominant view” (*ibid* [67]). See also [25].

Costanza *et al.* [68] assessed the economic value of 17 ecosystem services for 16 different habitats. They found out that the value of the whole biosphere was

approximately US\$16–54 trillion per year or US\$33 trillion per year on average. They note that those figures may probably be higher today. Hence, they insist that drastic measures need to be taken if we are to prevent further widespread and irreversible loss of these ecosystems and *sustain their ability to generate new profit avenues worldwide* [64] (emphasis added). See also [69, 70].

However, market-based conservation has also been observed to lead to primitive accumulation, accumulation by dispossession and green grabbing [64]. All these processes have been proved to have negative impacts on local people's access to natural resources, food security, human rights, and the environment. Mariki [64] reports, for example, that some WMAs in Tanzania have disappointed the local people as people were persuaded to demarcate their land for conservation, take management responsibility and benefit from the resources through tourism. Instead in WMAs like Enduimet the central government has retained the power of strategic decision making over the WMA and only minimal benefits have been realized by the local communities.

4.5 Mangroves from a local cultural perspective

With a grim look on her face, Maimuna (Maimuna Ramadhani, 39-year old lady, Mchungu village) laments over the dwindling number of fish in the area for which she blames the destruction of mangroves. "The trees are harvested without replanting and now even when there is a high tide, it floods our homes," she says. "Why don't you do something about it?" we ask. "Because it is not my place to do so," she says. (Mshale, pers. comm.)

Formal sources specifically linking people and mangroves, in particular their management and tenure regimes are lacking. However, basing on knowledge on linguistic analyses of some of the ancestors' myths and other oral traditions, coupled with the written narratives by European explorers, mangroves seem to the colonizers to have long been wastelands [13]. Nevertheless, to a majority of the local people, the mangrove landscapes were communal territories, inhabited, managed into multiple use systems, governed by access and use rights and controlled by local customs [64].

A second point that can also be surmised from these histories is the diversity of the human establishments in the mangroves and the highly varied forms of customary tenure with their "simple" knowledge of resources, the presence of spirits and supernatural creatures, with which the populations had to negotiate [13].

South of the Rufiji Delta, the island of Kilwa establishes a remarkable evidence of an urban and commercial civilization built in the mangroves dating from 9th to the 16th centuries. The historian Sheriff [71] reports of palaces and mosques, testifying of a glorious past of the sultanate, until the arrival of the Portuguese, who destroyed the estate in 1505 and monopolized the trade of gold, textile, spices, ivory and slaves.

The colonial institutions, then the independent State competed to destroy the former order in the form of traditional institutions [13]. They also tried to marginalize the traditional users. The tragedy of the commons observed elsewhere by Hardin [72] became their explanatory theory. But observers such as McCay and Acheson [73] see a new struggle brewing up by the present generation that is trying to grapple with in the Rufiji Delta and elsewhere in the country.

In general, however, the main image of mangrove swamps, the one that emerges from the narratives of European voyagers and missionaries in the 17th century, echoed throughout the 18th and 19th centuries in the writings of colonial agents, is one of a hostile and impenetrable environment [13]. For hygienic and productivity

aims, mangrove swamps were reclaimed under the control of colonizers, who finally became their landlords.

Thus the first enclosures of mangroves were both public and colonial and aimed at converting mangrove swamps into rice fields. The following more recent enclosures (especially from the years 1970s) joins what certain authors qualified as “green imperialism” and aim at making it world heritages through conservation [13]. Nevertheless, the effectiveness of such protection has been highly variable, with several protected areas failing to halt mangrove decline because they were poorly designed or lacked enforcement.

In Tanzania there were greater mangrove gains between 2009 and 2015 than in other years [40]. This is probably due to conservation projects initiated in the delta in late 1990s and implemented by WWF-Tanzania, the TFS Agency and the Rufiji District Authority aimed to restore the deforested areas [17]. The projects are now promoting Payment for Ecosystem Services (PES) as the most rational approach to environmental management. PES uses the language of economics to convince potentially resistant policymakers, corporate actors and domestic populations, particularly in developing countries, to farther ecological goals such as biodiversity conservation.

Thus, environmental nongovernmental organizations (NGOs), academics and international organizations alike spend considerable effort trying to “translate” the worthiness of the environment into the mutually intelligible language of neoliberal economics, in order to convince policymakers and economic actors of the validity of the conservation actions [9, 74].

Nevertheless, a study on the outcomes of CDM projects in Argentina a few years ago did not give such a hopeful picture at all. The study demonstrated that under the current Argentina’s energy policy framework, the income by the selling of CERs covered less than 6% of the incremental costs for renewable energy projects [75]. A sensitivity analysis to evaluate the impact of CDM in the coverage of incremental costs for renewable energy based on the prices of both the energy in the local market and the CER demonstrated that the best conditions would only cover 15% of those costs. The contribution of CDM to technology transfer in Argentina was minor considering that 45% of the projects qualified as type III where technological learning and capacity building were limited at the level of operation and maintenance of a foreign technology [75].

In another research on REDD+ implementation in two case study villages in Tanzania, Scheba [65] argued that the emergence and nature of market-based conservation are complex and more shaped by structural challenges than is commonly acknowledged. The research identified three important challenges:

1. the politics surrounding the establishment of community-based forest management;
2. the mismatch between formal governance institutions and actual practices on the ground; and
3. the fickleness of income from carbon sales and alternative livelihood opportunities [65].

The challenges were conceptualized not only as teething problems. The results questioned the very fundamental assumptions of market-based conservation. Moreover, adopting neo-liberal approaches like PES may cause problems for the effective management of nature at the local level, and by extension, the implementation of the environmental regimes themselves. According to Scheba [65],

market-based instruments share a common objective of re-framing landscapes as providers of “ecosystem services” and rural communities as latent eco-entrepreneurs, who can cultivate and sell the services as commodities for profit. “Selling nature to save it” is promoted as the best philosophy of achieving sustainable rural livelihoods in the face of mounting environmental crises and persistent poverty.

In fact, some authors (e.g. [67]) even think the commoditization of nature is part of broader project of neo-liberal globalization and encompasses a number of scientific and political techniques meant to bring non-market and non-economic materials, processes and things, including those that are considered part of natural ecosystems and are objects of traditional conservation, into the logics of economics and markets [65, 76–78].

Many indigenous peoples are concerned about the ways in which carbon markets commodify nature [79]. A market-based view prioritizes cost-effective strategies and the commoditization of ecological services, thereby utilizing the same economic tools and logic of capitalism that is also the underlying cause of the climate change problem. It is thus that some observers emphasize that market-based conservation is more complex, contested in practice, with mixed outcomes than is implied in the mainstream narrative [65]. It produces both benefits and risks. It produces benefits in the form of nature protection, political inclusion, and economic opportunities, while risks include physical displacement, loss of livelihoods, increased human–wildlife conflicts, and unequal distribution of benefits to some local community groups.

5. Concluding remarks

Since the late 2010 mangroves have become an important focus of market-based carbon-oriented nature conservation. A lot of work by different conservation organizations has been focused on framing or branding mangroves as particularly charismatic and valuable, but vulnerable, ecosystems. Beyond carbon, conserved mangroves and other coastal ecosystems are framed as untapped resources for ecosystem services, including coastal protection, fisheries, water purification, and conservation of marine and coastal biodiversity.

However, what the neo-liberal approach describes as “effective management” has not always been compatible with effective management of resources. For practical and ethical reasons, practitioners need to be critical of any assumption that neo-liberal economics is always an appropriate framework upon which to base local environmental management. Initiatives like REDD+ just represent the latest in a long line of efforts to tap global markets for conservation finance.

It is thus that current difficulties in the REDD+ mechanism are essentially symptomatic of inherent deficiencies in the market-based conservation in general. The fundamental problem is that conservation markets are intended to counter the conventional extractive markets, which generate profit by externalizing environmental costs.

Conservation markets seek to reverse this by internalizing these costs within the payments they provide to forest managers. Yet to function as market mechanisms, *payments must provide at least as much revenue as the extractive markets they replace* (emphasis added), covering not only opportunity costs of extraction but also the social and environmental costs that this extraction externalizes.

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