The role of place-based local knowledge in supporting integrated coastal and marine spatial planning in Zanzibar, Tanzania

Keywords: Participatory GIS; Geospatial Data; Community Mapping; Socio-Ecological System; Sustainable Development

1. Introduction

Coastal spaces provide multiple human values, activities and uses. Pollution, uncontrolled development, overfishing and the extraction of seabed materials threaten the environmental quality of many coastal areas (Jiddawi & Öhman 2002, MEA 2005, Dennison 2008, CEC 2012, Long et al. 2015). Consequently, local residents, who depend on healthy ecosystems, are at risk of losing their livelihoods. Coastal areas can be understood as tightly coupled socioecological systems (Ostrom 2009, Martin-Lopes et al. 2017). Management problems are usually most severe when both local and external actors misuse or overuse marine and coastal ecosystems (Rockloff et al. 2004). Especially in developing countries, fundamental issues such as population growth, limited livelihood alternatives and poverty are increasing the pressures on these resources. However, the conflicts arising from external forces' lack of consideration for traditional coastal uses are becoming more common (Masalu 2000).

The expansion of tourism is an external factor that is dramatically changing coastal areas all over the world. Tourism modifies coastal spaces not only physically but also (and especially) socially and culturally (Othman et al. 2012, Kuvan 2010). When tourism infrastructure penetrates a previously traditional coastal set-up, a dramatic change starts; in this process, the traditional ways of using coastal and marine spaces conflict with vacationers' expectations and needs. Tourism attracts businesses and actors with varied interests to the area. These additions bring economic growth to the area but often do not meet local communities' needs; thus, locals do not really benefit from tourism-related growth and development (Lange 2015). Amidst these contradictory developments, the marine and coastal environment often degrades due to a lack of proper attention, which highlights the complex realities of the socioecological system. These multifaceted coastal challenges are difficult to change into positive courses of development. This creates a vicious circle in which coastal spaces play host to power conflicts and competing interests, thus rapidly (and usually conclusively) changing those spaces' characteristics.

Integrated coastal-zone management (ICZM) (Hopkins & Bailly 2013, Khakzad et al. 2015) and marine spatial planning (MSP) are international frameworks that are meant to promote responses to these socioecological challenges and to resolve the conflicts that arise from overlapping or

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incompatible coastal uses (Douvere et al. 2007, Shipman & Stojanovic 2007, Ehler & Douvere 2009, Douvere & Maes 2010). Donors and bilateral international organisations often pressure developing countries to apply ICZM practices, but because these efforts are donor-funded, the donors often seize control of these efforts once the projects end (Christie et al. 2005, Isager 2008). Owing to ICZM's implementation modalities, its principles and goals are thus seldom achievable in developing countries (Christie et al. 2005, White et al. 2005, Baine et al. 2007, Heylings & Bravo 2007).

One of the big challenges related to sustainable coastal management is that coastal space is not widely understood or respected as a place of multiple values, needs and uses; this leads to a lack of appropriate solutions (Fagerholm & Käyhkö 2009). New developments take place without the actors properly understanding either how the local communities have valued and used these spaces over the generations or how these traditions can be linked to improved means of development. As long as this gap in knowledge and commitment exists, failure is a notable risk in the planning of development for coastal areas, the execution of nature-protection efforts, and all other collaborative forms of coastal management (Lopes & Videira 2013).

Stakeholder participation is imperative to ensure sustainable resource management and proper spatial planning (Reed 2008); it can also improve information quality, increase ownership and commitment, and altogether shift the focus of planning towards transdisciplinary practices in which local and expert knowledge are equally integrated into the decision-making process (Blackstock et al. 2007, Tippett et al. 2007, Jankowski 2009). Thus, solutions are needed that empower and motivate local institutions to implement ICZM practices and that ensure strong participation from the local communities. Participatory geospatial (PGIS) methodologies offer an opportunity to incorporate a community's place-based spatial knowledge into the planning process (Ryan 2011, Pánek 2016). PGIS approaches have particular benefits in the contexts of data-scarce developing countries, which often lack both formal participatory practices and explicit spatial data regarding coastal uses and activities (Rambaldi 2006, Pagella et al. 2014). PGIS provides opportunities for the in situ mapping of marine and coastal values (Painho et al. 2013, Strickland-Munro et al. 2016, Blake et al. 2017), for conflict estimation (Moore et al. 2017) and for the evaluation of ecosystem services (Klain & Chan 2012, Ruiz-Frau et al. 2013, Brown & Hausner 2017).

In this paper, we examined how place-based local knowledge—when collected through PGIS approaches—supported integrated spatial planning for coastal and marine areas in Unguja (Zanzibar) Island, Tanzania. The coastal areas of this island are increasingly under human pressures, drivers such as rapid population growth and the extraction of the natural resources are combining with massive tourism development to create infrastructure changes (Makame & Boon 2008, Mustelin et al. 2010, Anderson et al. 2011, Gustavsson et al. 2014, Khamis et al. 2017). The well-being of Zanzibar's coastal ecosystems (across the ecological, social and cultural dimensions)

is threatened due to uncontrolled changes and the rapid deterioration of environments (Masalu 2000, Khamis et al. 2017). One objective of this research is to study how participatory mapping that includes both local residents and planning experts can support the establishment of place-based knowledge regarding coastal activities, including their associated values, opportunities and threats. Another objective is to determine how this place-based knowledge—when put in map form—helps to identify the demands and drivers of Zanzibar's complex coastal socioecological system and thus aids leaders in making better coastal-management decisions.

2. Data and Methods

2.1 Study Area

Over the last 20 years, largely due to the economic reforms of the 1980s Zanzibar has experienced a socioeconomic transformation. Tourism facilities now occupy the majority of the north-eastern coastline (Anderson et al. 2011, Tobisson 2013, Gustavsson et al. 2014). As part of this transition, the local environments have changed from traditional fishing villages to modern tourism destinations. However, the local residents have largely been left out of these developments in terms of employment, services and general economic growth (Gustavsson et al. 2014, Rotarou 2014). Amongst many other issues, the local residents' access to sea resources, sandy beaches and land for housing and agriculture have become limited (Tobisson 2013, Khamis et al. 2017). Only in recent years have hotel companies and the government invested in social services for the villages; however, due to very low income levels and a dependence on subsistence economies, only a minority of local residents can access these improved services (Gustavsson et al. 2014). Explicit spatial knowledge regarding the uses and values of Zanzibar's coastal space is lacking, so management solutions are difficult to identify in practice.

In 2015, Zanzibar's government renewed its National Land-Use Planning System and established a National Spatial Development Strategy to ensure controlled and sustainable growth of the islands; since then, Zanzibar's Department of Urban and Rural Planning (DoURP) has implemented this strategy for both growth centres and urban centres using regional and local land-use plans (DoURP 2015). Unlike the region's previous spatial-planning processes, the North-East Special Area Planning (NESAP) is intended to integrate terrestrial, marine and coastal areas. It is an integrated planning process for terrestrial and marine coastal areas based on the principles of MSP and Ecosystem Based Management. Our study focuses on the growth centres of the north-east coast of Unguja Island, Zanzibar, where NESAP is in development, with nine local administrative units (*shehia*) from Mnemba in the north to Chwaka Bay in the south (**Figure 1**).

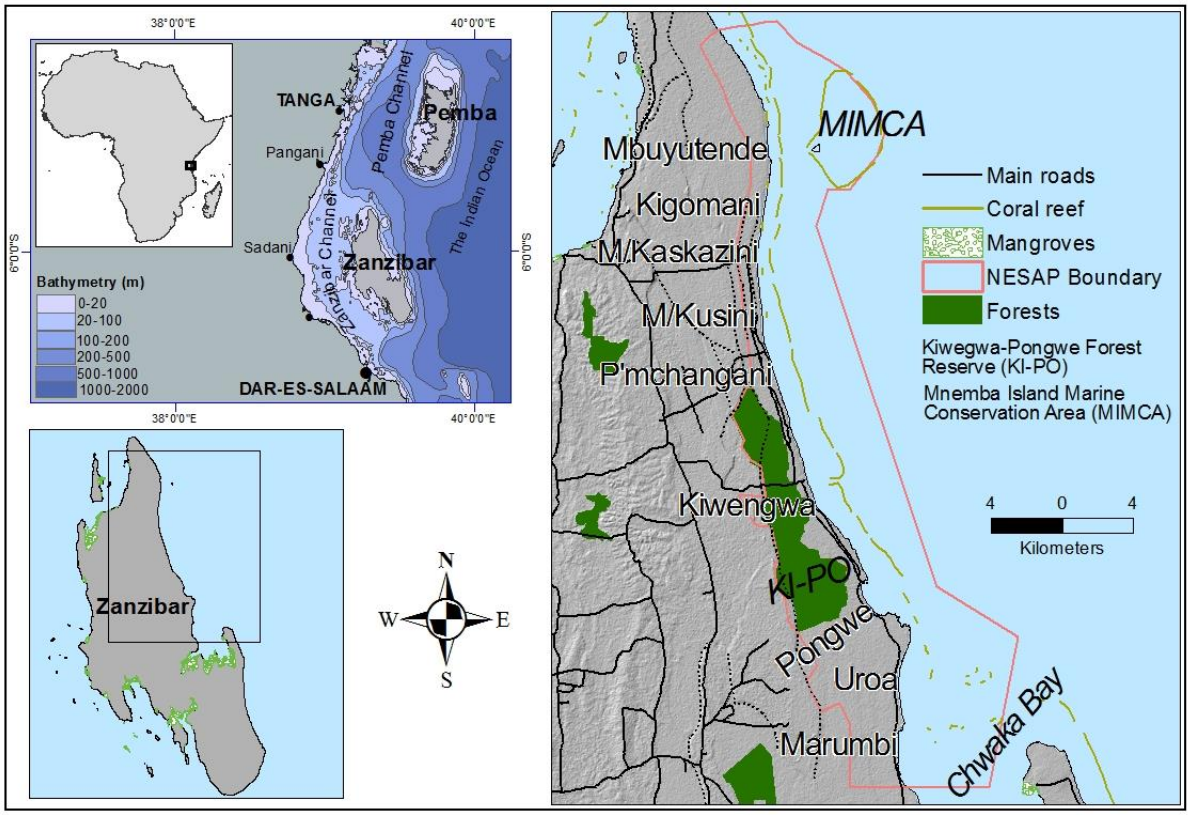

Figure 1. NESAP extends from Mnemba to Chwaka Bay. The planning area covers 330 km^2, and extends 1-6 km inland and 2-7 km to the sea with nine local villages of Mbuyutende, Kigomani, Matemwe Kaskazini, Matemwe Kusini, Pwani-Mchangani, Kiwengwa, Uroa, Pongwe and Marumbi.

The vegetation of the north-eastern coast is predominantly coral rag, with deteriorated scrubland and patchy farmland, as well as some forest remnants in the Kiwengwa-Pongwe Forest Reserve (Käyhkö et al. 2011). Amongst local residents, the small-scale farming of maize, wheat, pumpkins, millet and beans is typical, as is animal husbandry involving goat and cows. The villagers' main protein sources are marine products such as fish, crustaceans, bivalves and octopi. Residents practice artisanal fishing with traditional equipment such as bucket traps, fencing and drag nets (Jiddawi et al. 2002, Jiddawi & Öhman 2002). Seafood collection is limited to the intertidal zone (the area between the shore and the reef) and along the reef. Such seafood-collection activities are mostly done in the reefs and the seagrass meadows (Nordlund 2012, la Torre-Castro et al. 2014). Seaweed farming, mainly in the shallow coastal waters, began in the 1990s as an alternative coastal livelihood (Msuya 2012); most of those who practice it are women. Traditional and modern activities coexist in competition rather than in a harmonised fashion, which creates conflicts between coastal-resource users and other actors (Masalu 2000, Khamis et al. 2017). The coral reef fringe, which is located 1-2 km offshore, shelters the shoreline from the waves of the Indian Ocean. Live coral exists sporadically in many places along this fringing reef and is more abundant in the Mnemba Island Marine Conservation Area (MIMCA), in the Kiwengwa Sea, and at the mouth of

Chwaka Bay. The coastal bathymetry indicates that the sea is shallow (1-5 meters deep) in the intertidal area between the shore and the reef. The water depth increases gradually beyond the reef (5 to 15 meters) before dropping to hundreds of meters after the fault-scape of the continental shelf. The intertidal zone is mosaicked with coral rag platforms and interrupted by sand substrates, patches of coral and seagrass meadows. The shoreline of the north-east coast is devoid of mangrove vegetation and features long stretches of sandy beaches (Khamis et al. 2017).

2.2 Participatory mapping

In March 2017, in cooperation with the DoURP (the government institution that is responsible for spatial planning and development in Zanzibar), we organised two PGIS campaigns. The first was held in conjunction with the NESAP kick-off workshop and included representatives that DoURP had invited from the government, nongovernmental organisations and universities. The second campaign consisted of nine local workshops that were held in the villages of the NESAP area so as to capture local knowledge in map form. Later, in November 2017, feedback campaign were organized and we visited the villages again with the intention of showing residents the results of the mapping process and validating those results.

The kick-off workshop included 27 experts in environmental management, ICZM, urban and regional planning, economics, forestry and wildlife management, agriculture, heritage, water resource management, energy, urban and social development, and architecture. The planners gave presentations to raise stakeholder awareness regarding the ongoing government initiatives related to spatial planning in the growth zone. Following these presentations was a discussion on the important issues that need to be considered during NESAP, such as establishing a common understanding and developing solutions to existing conflicts between stakeholders; these actions are at the core of ICZM and MSP.

As part of the kick-off workshop, we organised a participatory mapping campaign to collect experts' views regarding the existing opportunities and threats in the north-eastern coast region. We presented the experts with a high-resolution satellite image and asked them to place point markers representing threats and opportunities using the web-based Maptionnaire PGIS platform (https://maptionnaire.com/; **Figures 2a and b**). To facilitate this task, we categorised the point markers using 12 themes: cultural and religious value, biological and natural value, public services and education, housing, recreation, beautiful landscapes or landmarks, economic value from tourism, economic value from trade and commerce, economic value from fishing and aquaculture, economic value from agriculture and forestry, other economic value, and infrastructure. The workshop facilitators assisted the experts in completing the web-mapping questionnaire, which consisted of a page with a greeting and instructions, a page for the respondents' background information, and a page for mapping the categorised coastal uses and values using point markers. When an expert placed a point marker on the image, a pop-up window appeared; this allowed the

participants to add textual descriptions regarding the mapped site's importance, opportunities and threats.

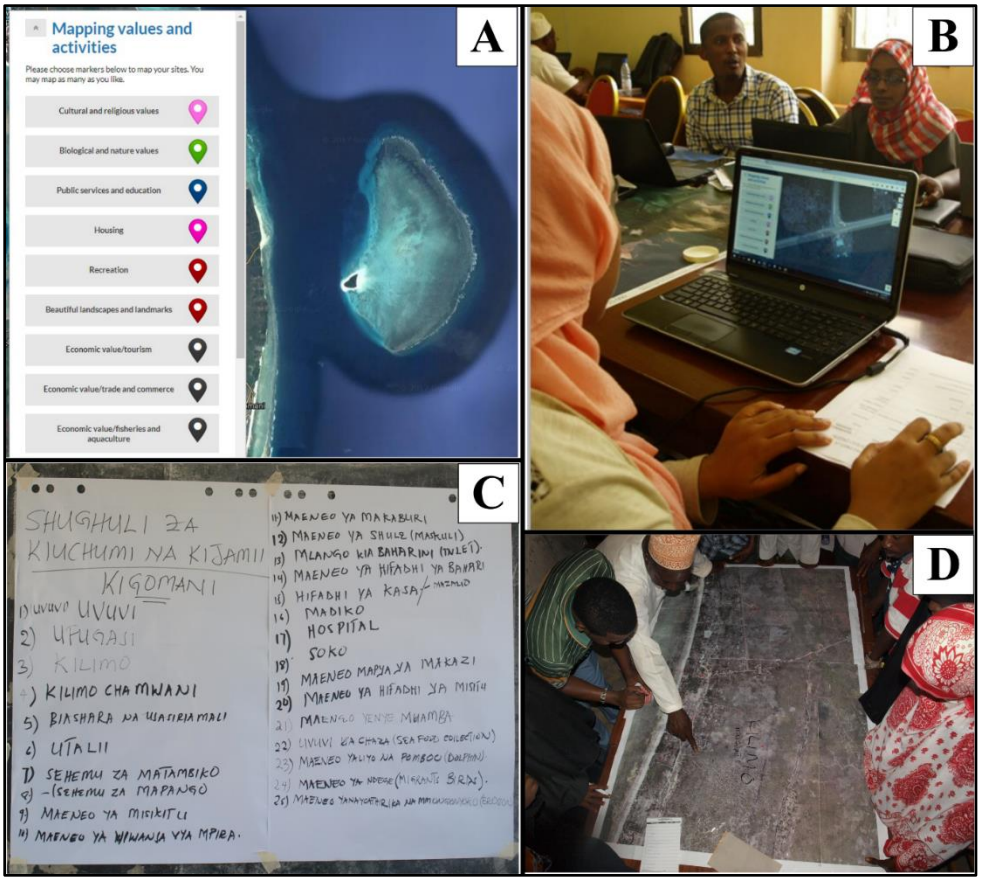

Figure 2. The data collection process in the NESAP process: A) 12 categories of coastal uses and values in a web-based PGIS platform (Maptionnaire), B) Participatory mapping of experts' visions of the existing opportunities and threats related to the coastal uses and values, C) Villagers' listed their activities and values on the land and at sea for participatory mapping, and D) Participatory mapping of activities and values in groups.

We also held mapping campaigns in each of the nine villages of the NESAP area; these campaigns were executed jointly with DoURP planners and with researchers from the University of Turku (Finland) and the State University of Zanzibar. The workshop participants were members of the village committees, which were established as part of the 1995 Integrated Coastal Area Management Project (DoE 1996, UNEP/FAO/PAP 2000). Each committee includes village leaders and two members who represent each local coastal activity (e.g. fishing, seaweed farming and agriculture). The workshop groups were composed of 10 to 30 participants per village, both men and women; in all, 218 local residents participated in this process.

Prior to the actual mapping exercises, we held a discussion on the existing challenges related to spatial planning and development. Subsequently, we helped the participants to collectively identify

and list all existing land-based and sea-based activities in the villages, as well as the values of those activities. We displayed this list on the wall as a guiding reference for the mapping process and used numerical codes for each activity (**Figure 2c**). We provided two sets of maps for the mapping exercise. One, a drone image provided by the DoURP (from 2016, scale 1:7,000), was used to map land-based activities (mainly via points placed on the image). The other was a high-resolution satellite image from Google, as the drone imagery did not cover the sea areas. The Google map had a 2.5-meter spatial resolution and was compiled from images taken in 2006-2016; it was then printed at a scale of 1:15,000.

We covered both images with transparent plastic so that participants could map the land-related and sea-related activities with markers and coded stickers (Figure 2d). We divided the participants into two groups of mixed gender and various livelihoods and then assigned each group one of the two images. We helped the participants to orient themselves on the maps by marking common features from the villages (road junctions, playgrounds, etc.). These mapping exercises were interactive and allowed the participants to share knowledge and build consensus.

2.3 Data processing, analyses and validation

We analysed the spatial point-data that we had collected using Maptionnaire in the first campaign to gain an understanding of how the Zanzibari experts viewed opportunities and threats in relation to various coastal activities and uses. We then recategorised the initial 12 mapped themes into six broader themes so as to facilitate the overall interpretation of the results: (1) local resource uses (e.g. fishing, aquaculture and agriculture); (2) tourism and recreation; (3) ecology, conservation and nature (including forestry and biological or natural value); (4) housing and infrastructure; (5) public services, trade and commerce; and (6) cultural and social values.

We then converted the spatial data that the villagers added to the maps during the second campaign into digital form. After a village's mapping exercise was completed, we vertically photographed the resulting drawings and imported those images into ArcMap for georeferencing. We manually digitised any delineations from the images as polygons, lines or points according to the original form of the mapped feature. After the digitalisation and coding, we recategorised the polygons, lines and points into 18 consistent themes for further analysis (**Table 1**). We presented the results for these 18 themes as thematic maps and used the mapped themes' frequencies to produce charts for an overall comparison of the villages.

USES/VALUES	DESCRIPTION
(1) Fishing and Seafood collection *(Uvuvi na Uvuvi wa miguu)*	Fishing areas, using nets, lines and traps; seafood collection areas on shallow water areas or areas accessible during low tides, but also relatively deep water areas for Octopi harvesting

(2) Agriculture and Animal keeping *(Kilimo na Ufugaji wa wanyama)*	Agriculture areas (mainly coral rag agriculture), animal husbandry and grazing.
(3) Aquaculture or Mariculture *(Kilimo cha baharini)*	Areas of mariculture and aquaculture (mainly seaweed farming). The areas are mainly covered by soft substrates, but in some villages the farming is also conducted on the hard substrates through braking the rocky substrate
(4) Religion and Traditions *(Dini na Mila)*	Areas of religious and traditional practices (Mosque, Quran schools, grave yards, caves and sacred places)
(5) Social activities *(Shughuli za kijamii)*	Areas of social activities (social gathering, meeting places, playgrounds, market places)
(6) Tourism *(Utalii)*	Tourism areas (hotels, snorkelling, diving sites etc.
(7) Quarrying, Mining and light industries *(Machimbo ya mawe)*	Stone/coral quarrying, mining and light industries (e.g. brick-making industries)
(8) Nature Reserve and Conservation *(Hifadhi za Mali Asili)*	Areas designated for reserves and conservation (marine conservation areas, forest reserves, community forests)
(9) Marine habitats *(Makaazi ya viumbe vya Baharini)*	Marine habitats (seagrass meadows, coral reefs, mangroves, dolphin location, turtle nesting areas etc.)
(10) Marine hydrodynamics *(Mikondoo ya maji ya Bahari)*	Marine hydrodynamics, mainly local sea currents
(11) Observed Erosion area *(Maeneo yenye mmong'onyoko)*	Identified erosion areas, and areas at erosion risk (mainly coastal erosion)
(12) Physical feature *(Vitu vya kimaumbile)*	Physical features, such as caves, beaches, sand bars and alike
(13) Public Services *(Huduma za kijamii)*	Social service (schools, banks, hospitals, veterinary and government institutions etc.)
(14) Utilities and Infrastructure *(Huduma za matumizi na miundo mbinu)*	Utilities and infrastructures such as roads, parking lots, landing sites, damp sites and telephone towers
(15) Settlements *(Makaazi)*	Village settlements with mixed land uses
(16) Water sources (Vyanzo vya maji)	Water sources for the village communities (caves, wells and public taps)

(17) Shehia Boundaries and Place names *(Mipaka ya Shehia na majina ya maeneo)*	Shehia boundaries and common place names
(18) Mixed uses *(Matumizi mchanganyiko)*	Areas with land uses (usually not explicitly mapped)

Table 1. Local communities mapped 18 values and activities the participatory mapping campaign.

Lastly, we combined the expert-identified threats and opportunities with the community-based values and activities so as to identify the key characteristics of the coastal and marine socioecological systems (including spatial dynamics), following the methodologies of Palomo et al. (2013) and Wu and Tsai (2014). Explicitly spatially mapping the villages' values and activities across the NESAP area allowed us to understand the patterns and gradients of human pressures on the coastal ecosystems—both on land and at sea.

Along with DoURP, we revisited all the villages in November 2017 to share the resulting maps with the participants of the village mapping campaigns and to validate the results. Preceding this process, we held discussions on the issues related the region's integrated (coastal and marine) spatial planning. These discussions focused on the spatial-planning challenges within the NESAP area and the solutions for the coastal uses and values. After the discussions, we provided the participants with the maps from the PGIS campaign as a validation exercise. Across all villages, 181 individuals (99 of them women) participated in the follow-up discussions and validation exercises.

3. Results

3.1 Coastal opportunities and threats identified by the planning experts

Planning experts marked 117 points on the satellite images in the Maptionnaire survey during the exercise. A majority of these points (87 of 117) were placed on the land areas in the vicinity of the coastline. The mapped themes most abundantly address issues of tourism, culture and religion, public services, biology and nature, housing and recreation (more than 10 mapped points each) (**Table 2**).

THEME	OPPORTUNITIES	THREATS

(1) Local resources uses (Matumizi ya kienyeji)	-Available market for local products (market from tourism sector) -Available manpower and know-how -Existing potential areas for uses (e.g. potential fishing ground)	-Encroachment from tourism developments -Over-extraction of resources due to increasing demands -Lack of local involvement -Conflicts -Uses of destructive methods in resource extraction
(2) Tourism and recreation (*Utalii na Vivutio*)	-Presence of beautiful landscape and seascape -Existence of conservation areas and biodiversity -Availability of both land and sea for recreation -Available open spaces for hotel constructions -Presence of tourism attractions -Availability of fish and seafood -Existence of tourism hotels	-Increasing demands and conflicts -Overwhelming pressures on natural resources -Extinction of biodiversity and species -Erosion and degradation of environment & the landscape -Climate change and Sea level rise -Poor waste management -Settlement expansion & land use changes
(3) Ecology, conservation and nature (*Ikolojia, Hifadhi na Asili*)	-Presence of tourism sector -Presence of good biodiversity	-Encroachment from tourism and other developments -Loss of biodiversity -Over-extraction of resources -Increasing demands from the population -Ad hoc tourism activities -Poor waste management
(4) Housing and infrastructures (*Makaazi na Miundombinu*)	-Presence of tourism developments -Presence of road networks -Presence of untouched land for future planning (the land is not suitable for other uses than housing) -Cultural tourism -Increasing demands from the population -Economic growth	-Encroachment from tourism developments -Environmental hazards -Conflicts -Destruction of the infrastructures
(5) Public services, trade and commerce (Huduma za kijamii, Biashara na Uchumi)	-Increasing demand due to population growth -increasing demand due to tourism sector	-Disturbance from tourism activities -Lack of local involvement -Informal settlement expansion
(6) Culture and social values (*Mila/Utamaduni na Mambo ya kijamii)*	-Presence of tourism sector -Existence of rich culture and traditions -Existence of heritage sites (e.g. Sultan resting place in Chwaka) -Good accessibility	-Encroachment from tourism developments -Lack of maintenance for heritage sites -Conflicts

Table 2. Planning experts identified opportunities and threats of the six mapped themes in the NESAP kick-off workshop on March 15th, 2017.

Tourism and recreation are seen as major opportunities for the area due to the presence of beautiful landscapes and seascapes, conservation areas, hotels, available land for new hotel establishments, availability of local seafood and various recreation possibilities on the land and in the sea. In addition to numerous opportunities, several threats related to tourism and recreation were also identified. These include the pressures on natural resources caused by increasing demands from tourists and the population in general, the extinction of flora and fauna, the degradation of the environment and landscape, climate change, sea-level rise, conflicts over the use of coastal resources, inadequate facilities and poor waste management.

According to the experts, ecological and nature values related to the conservation areas bring opportunities for the development of the region's tourism and recreation, but these are threatened by the over-extraction of natural resources due to the ad-hoc type of tourism development and poor waste management. Experts also consider the local resources to be opportunities for development in the form of increased harvesting (e.g. fishing grounds), a market for the local produce, expertise (know-how) and labour. In this respect, the main demand comes from the tourism sector and from the urban development associated with it. However, experts have been concerned about resource over-extraction, the encroachment of tourism development, resource use conflicts, the use of destructive methods in resource extraction and the overall lack of local people's involvement in resource management.

The increasing population and tourism development were identified as opportunities for the development of public services, trade and commerce. However, experts have been concerned with the informal settlement expansion and inadequate local participation in planning and management processes. Also, they consider the presence of the tourism sector in the area to be a threat to public services, such as schools, as tourism may cause disturbance to such services. Housing and infrastructure development are considered a major opportunity due to the overall population growth, presence and growth of tourism, better road network, available undeveloped land suitable for housing development and economic growth in general. Communities in the north-east coast have a rich cultural and social environment, which the experts have recognised by stating that there are valuable and well-accessible opportunities related to the traditional practices, religion, history and heritage sites in the area. Experts have identified tourism as an opportunity with respect to these values. On the other hand, tourism is also considered a threat to the maintenance of these traditions and cultural heritage in general and as a possible source of conflict.

3.2 Coastal activities and values in the local communities

Local residents marked 236 points, 186 polygons and 21 lines on the images. Local coastal space consists of multiple economically, socially, culturally and ecologically important activities and values. The most abundantly mapped activities included religious and social activities (69), fishing

and seafood collection (56), physical features (48) and marine habitats (39) (**Figure 3**). Local villages have very similar values and activities in the coastal zone, but there are differences in the abundance of sea-related activities, religious and social activities and public services, for example (**Figure 4**). These differences are governed by the vicinity of the marine protected areas (MPAs) and the level of urbanisation in the village. For example, in urban Kiwengwa, public services were more abundantly mapped, and residents identified rather few religious, social and marine livelihood-related activities as important elements of their daily lives.

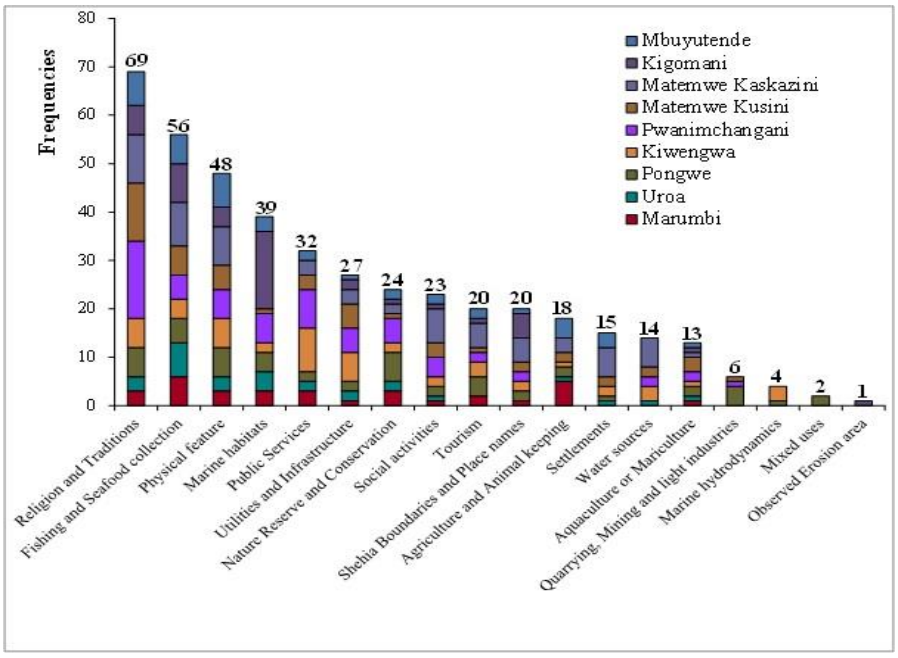

Figure 3. Total frequencies of the mapped values and activities in the nine study villages.

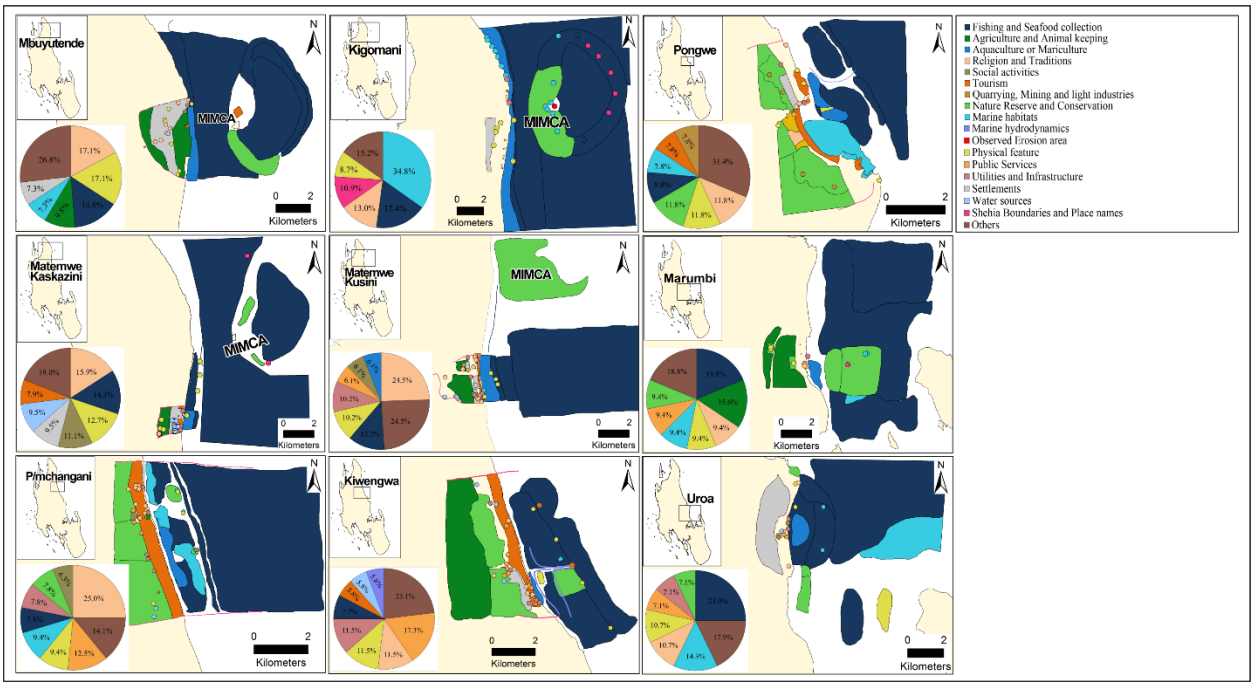

Figure 4. Values and activities and their relative proportions in the nine study villages.

Local residents living along the north-eastern coast access provisional services, such as fishing, seafood collection, aquaculture and seaweed farming from the marine environment (**Figure 5a-b**). Fishing and seafood collection are spatially the most extensive local activity in the area. Whereas seafood collection is practiced in the shallow water areas of the intertidal zone on the seagrass meadows and coral reefs, fishing is practiced both along the intertidal zone and in the deep sea. The hotspot sites for fishing (areas where several communities practice fishing) include Mnemba Island with its coral reef and the Uroa-Chwaka Bay area. The intertidal area is a hotspot for multiple marine-related livelihoods. Seaweed farming and aquaculture are common practices amongst women in the villages. Some of the seaweed farms are located relatively far from the villages and can be accessed by foot during the spring low tides, but they require boat transport during neap low tides.

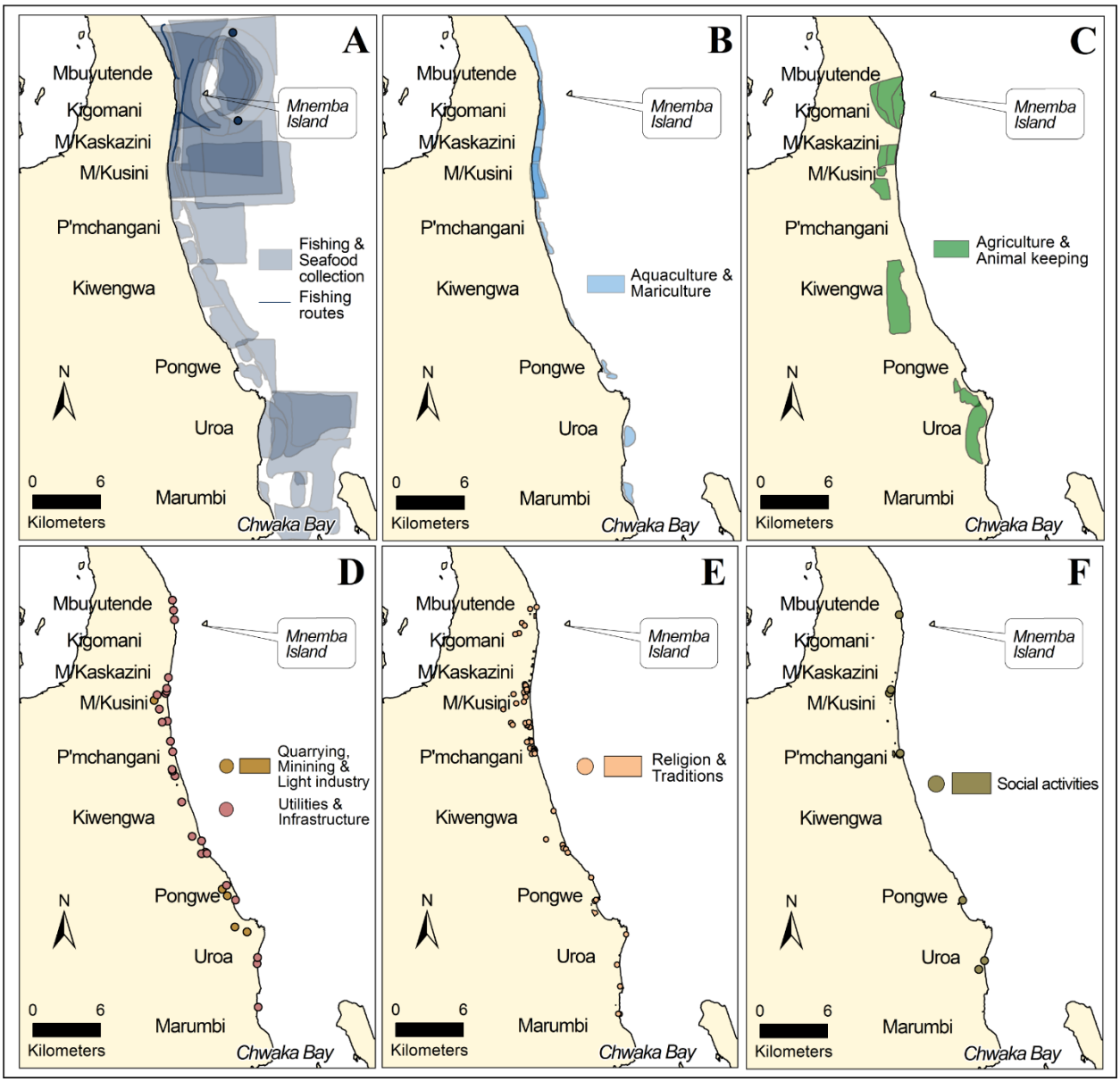

Figure 5. The mapped values and activities consist of fishing and seafood collection sites and areas (a), areas of aquaculture and mariculture (b), sites of agriculture and animal keeping (c), quarrying and light industries (d), religion and traditional sites (e) and sites of social activities (f).

From the land, local communities obtain farming and animal husbandry products, as well as extract building materials, such as coral rock (**Figure 5c-d**). These are mainly for subsistence use, but small-scale businesses are also based on some of the products. The coral rag soil supports limited agricultural activities in the area. Nowadays, most of the agricultural fields are located around 3 km inland. In Kiwengwa and Pongwe, agriculture is practiced bordering the Kiwengwa-Pongwe Forest Reserve. Livestock is kept within the settlement areas, mainly for subsistence (goats and cows). Quarrying and the small-scale industries related to it can be found in the village of Pwani-

Mchangani and at Pongwe, Uroa and Matemwe Kusini. The activities are located in the outskirts of the village settlements.

Religious, cultural and social values and practices were abundantly mapped (**Figure 5e-f**). Most of these values are tied to the surroundings of the local settlements (meeting places, public services, mosques, sacred areas etc.). Religious places such as mosques, Quran schools and graveyards are located within the settlements. Traditions, including rituals and spiritual practices, are commonly conducted in the caves within close proximity to settlements and agricultural fields. Locals normally gather in some areas within the settlements for discussions, games, shopping and other leisure activities, such as walking on the beach. Common social places include football grounds, playgrounds and outdoor gathering sites (*maskani* or *baraza* in Kiswahili) that are located near the boat-landing sites along the beaches, amongst other places. All the social activities mapped are on land.

A substantial amount of local benefits are related to the existence of valuable biophysical environments and features (**Figure 6a-c**), which provide supporting services in the form of livelihood security for the communities (including water) and social and cultural services in terms of sacred and historical places. Within the designated nature-conservation area (MIMCA), there are rich coral habitats. A community marine conservation area exists in Marumbi village where fishing is only allowed through the use of specific fishing gears. Destructive fishing gears are prohibited in the area, including small-mesh nets and dynamite. The Kiwengwa-Pongwe Forest Reserve is managed jointly by the surrounding villages and the Department of Forestry and Non-renewable Natural Resources. Limited activities are allowed within the forest with special permission. The biophysical environment, especially the protected sea and forest areas, healthy corals and other marine habitats and natural features in the sea and on the land (caves, large Baobab trees, corals, mangroves, seagrasses, sand bars, reef openings), maintain various provisioning and supporting ecosystem services. Caves were mapped as important sources of freshwater for the villagers in addition to wells and government taps. Sand banks are used for seafood collection, and reef openings are favoured for high marine biodiversity. Sea turtle nesting areas were identified along the beach in the northern part of Mbuyutende and on Mnemba Island. Dolphins and other marine species are commonly spotted around Mnemba Island. The mangrove patches provide shelters to a number of small marine species such as crabs.

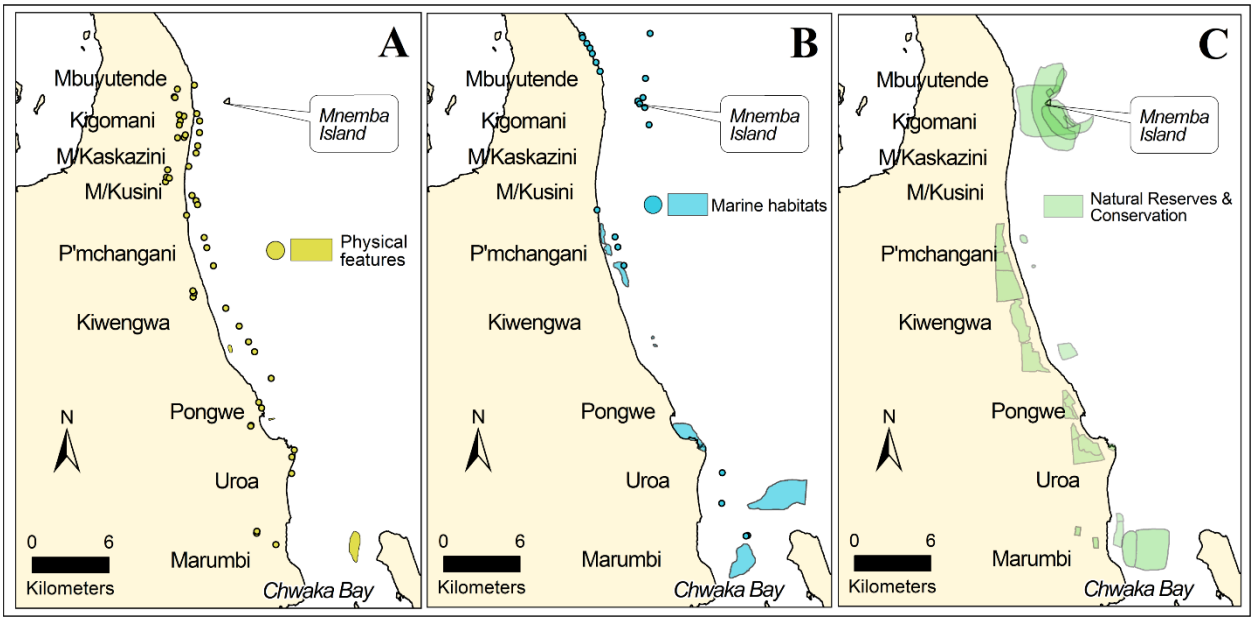

Figure 6. Mapped sites of biophysical environments (a), marine habitats (b) and, natural reserves and conservation (c).

Village informants also marked several sites of tourism and public services on the maps. However, tourism does not provide much direct benefit to locals. Large-scale tourism infrastructures were seen as barriers to local communities rather than opportunities. However, public services, which have come along with the tourism infrastructure, benefit local communities and include places such as schools, hospitals, clinics, bank services, police station and shops. These are found in most urban villages of Kiwengwa and Pwani-Mchangani in particular.

When revisiting the villages with these maps, residents did not make any significant suggestions on the mapped activities and values. Most of the village participants confirmed the validity of the maps. However, some small additions were made by adding the location of firewood collection areas, areas for light industries and conservation areas for forests, for example. In the subsequent discussions, spatial planning-related issues were raised to DoURP. The main concern during the discussion was the land grabbing by tourism investors, which resulted in the loss of agricultural areas and graveyards among other valuable land in the villages. Also amongst the important aspects discussed by the participants were poor government accountability and support, as well as a lack of law enforcement for the designated conservation areas and land-use planning. Furthermore, the villagers discussed major and frequent conflicts within the areas. The profound conflicts are argued to emanate from the tourism sector, as hotel construction limits the locals from accessing the shoreline and beaches. Also, tourism is argued to cause environmental and cultural destruction in the areas. Villagers are concerned with the establishment of damping areas for waste disposal because litter from tourism hotels and settlements is badly polluting the environment in the areas. The conflicts between neighbouring villages regarding the border disputes, on the uses

of coastal resources and the over-extraction of the resources (poaching for forest and marine resources), were also present in all of the villagers' discussions. Additionally, the villagers complained about the little benefits obtained from the marine conservation area of MIMCA that hence create conflicts between villagers and the government.

3.3 Socioecological dynamics in the north-eastern coast

The NESAP area is a rural but rapidly urbanising coastline where tourism is proliferating and population growth is rapid. Settlements are sparsely distributed along the coast with the interruption of walled tourism hotels. The rapid population increase, coupled with the rapid growth of tourism developments and services, is the major demand generating drivers in the area (**Figure 7**).

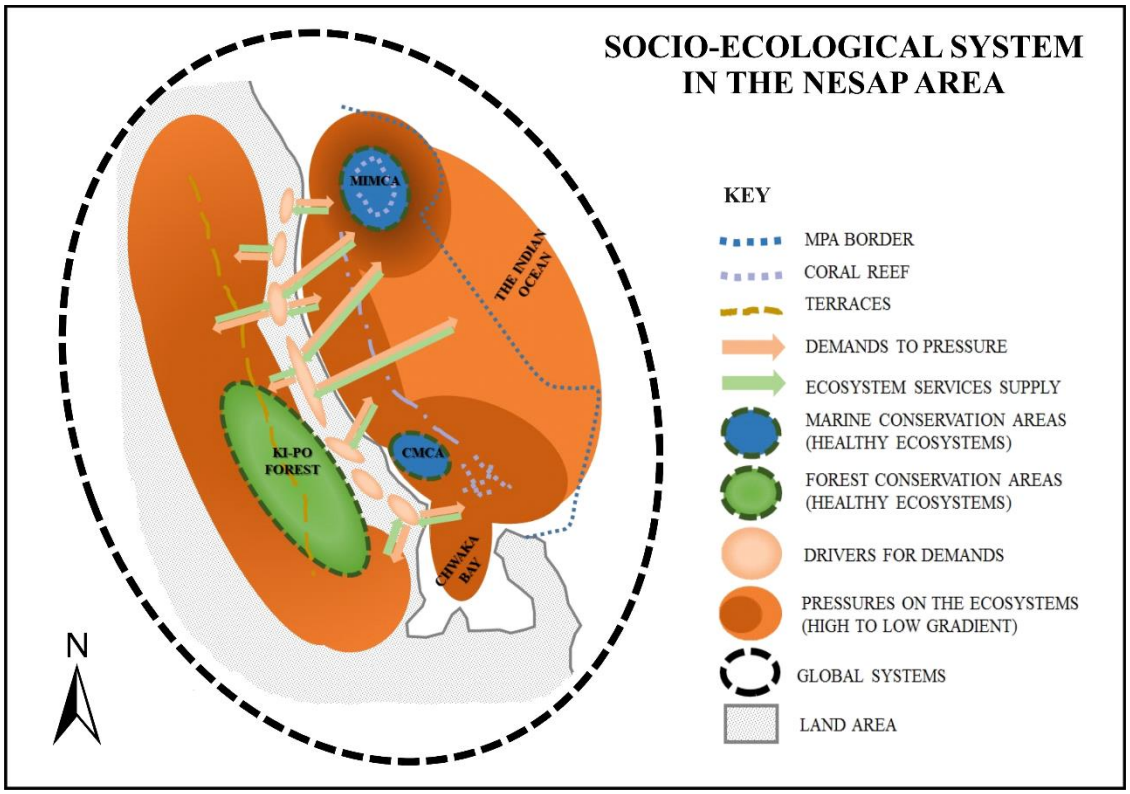

Figure 7. Socioecological system in the north-east coast of Zanzibar. Values and activities are relatively confined in the areas with high biodiversity and the intertidal, whereas social values and activities are in the vicinity of the settlement areas.

Demands for housing, food, income, construction materials, cooking energy and other sources of well-being have resulted in pressures on the coastal ecosystems on land and in the sea. Pressures are specifically high on native coral rag vegetation, seagrass meadows and coral reefs. The gradient of pressure gradually decreases from those ecosystems that are healthier towards those where the

status of the ecosystems is poor. Protected areas, such as MIMCA, Marumbi Community Marine Conservation Area and Kiwengwa-Pongwe Forest Reserve, have considerable value but are also disturbed by tourists and locals alike. Human pressures are also intensive in the intertidal areas, which are very dynamic but important for the coastal livelihoods. Most of the coastal activities aggregate in the intertidal area. Human pressures are also high in areas covered by seagrass meadows, mangroves and coral reefs, which are areas of potential fishing grounds. The pressures gradually decrease towards the open sea, merely because artisanal fishing is predominant in the area and does not enable deep sea fishing. Pressures from agriculture, livestock keeping and settlements have degraded most of the coastal land into a very weak state (see also Staehr et al. 2018). Only in the Kiwengwa-Pongwe Area do the coral rag forests have biodiversity potential.

On top of the pressures identified in this research, climate change and changes in the global weather patterns exert additional pressures on the coastal ecosystems. The rising sea level threatens coasts with inundation and saltwater intrusion, and extreme weather events are becoming more frequent. Furthermore, the rising sea level, together with increases in seawater temperatures and changes in seawater chemistry (changes in global ocean circulation), has recently resulted in coral bleaching around the Zanzibar islands (Mohammed et al. 2000, Muhando & Mohammed 2002, Muhando et al. 2012, Obura et al. 2017).

Protected areas and their surroundings are the service provisioning hotspots, which supply a number of services to meet the demands generated from the drivers in the service benefit areas. Fish and seafood products, and currently seaweeds, are the main provisional products obtained from marine coastal ecosystems in the NESAP areas, whereas land-based coastal ecosystems provide various food and construction materials and cooking energy, for example. Apart from converting demands to pressures, human activities are also the medium of transporting services from provisioning hotspots to benefit areas. In addition to provisioning services, coastal ecosystems also provide regulatory services such as carbon sequestration and coastline protection. Mangrove forests, seagrass meadows and terrestrial forests generate regulatory services in the form of blue and green carbon sequestration (Bauer et al. 2013). Finally, both conservation areas and their surroundings provide a multitude of cultural services to the NESAP area communities.

4. Discussion

Our results from the participatory geospatial mapping campaigns in the villages have shown how diverse the local values and activities along the north-eastern coast of Zanzibar are, as well as how rich of a socioecological system they represent with various material and immaterial human benefits. Livelihoods that gain direct benefits from the land and the sea in the vicinity of the coastline are the foundation of the subsistence economies and daily nutrition intake, and places of social gatherings and religious practices are vital shared spaces for the overall well-being of the

community. Together, these establish multifunctional local coastal spaces that support the communities' overall well-being.

Both local communities and Zanzibari planning experts identify tourism as a contradictory element of change. Opportunities and threats related to tourism meet and conflict along the intertidal and coastal fringe, where these multifunctional spaces coexist. Through the participatory mapping methodology, these areas were depicted in the form of a map and thus can be used explicitly to identify sensitive areas for sustainable development from the community perspective. In the absence of spatially explicit local knowledge, planners have discussed the correct challenges with the stakeholders but without being able to explicitly target possible conflict resolutions in the area. In the case of the north-eastern coast of Zanzibar, local communities' multifunctional areas should be the primary focus for conflict resolutions because, in the case of successful resolutions, these areas would bring co-benefits and sustainable growth for both local inhabitants and the tourism industry. However, Zanzibar coasts are particularly sensitive geographical areas to plan in a co-creative manner due to the already existing severe conflicts between local communities and the tourism industry over many decades (see, e.g., Masalu 2000, Fagerholm & Käyhkö 2009, Mustelin et al. 2010, Lange 2015). Overly intensive and large-scale tourism developments have mainly brought restrictions rather than opportunities for local coastal uses, and this circle of development should be redirected towards multiple livelihood and economic benefits for the local residents in the future.

Another important management implication from the participatory mapping was the identification of sea and land areas, which hold shared, strategic benefits for many communities along the north-eastern coast. These regionally important shared spaces, which the PGIS method was able to capture, are another important target of sustainable planning and management because they are sources of spatial conflicts not only between local communities and other actors in the region but also between village communities. For example, MPAs are hotspots of marine resources for all the local communities but are also key areas for the preservation of healthy marine environments and the target of marine tourism. International literature shows that MPAs can sustain a higher population size, larger biomass and more individuals of various taxa, as well as support higher biodiversity and food web complexity (Halpern & Warner 2002, Lester & Halpern 2008, Lester et al. 2009). Previous researchers have also indicated that MPAs have positive impacts on coastal societies in terms of food security, resource rights, employment and residents' livelihoods (Cinner et al. 2005, Lundquist & Granek 2005, Cinner 2007, Voyer et al. 2012). Unfortunately, these types of co-benefits have not been successfully met in Zanzibar, where the sustainable management of MPAs has suffered from the lack of genuine cooperation, livelihood benefits for locals and trust between local communities, tourism operators and the government. MPAs in Zanzibar demonstrate extensive miss-management of opportunities, and based on this study, we have been able to more explicitly identify where and why such sources of conflicts exist. At the same time that the overall resource base has depleted along the north-eastern coast, MPAs have become crucial areas with

key marine benefits to many actors on the coast. It has been impossible to identify a shared vision and participatory action plans in the MPAs without knowing these benefits; thus, opportunities for co-benefits have not been realised.

The combination of participatory mapping with integrated spatial planning offers several opportunities for improved decision-making in coastal area, where possibilities for co-benefits are threatened by various risks between multiple actors and their interests. In a situation where the explicit spatial data of coastal resources and uses are limited, using local knowledge is a very useful method to collect information within a map and improve planners' understanding of the local coastal realities. Mapping offers an indirect way to obtain information of potentially important resource sites in a situation where hardly any data exist. It is vital to consider what additional information is needed after locals have mapped their preferences and whether these maps assist planners in targeting their additional data collection to specific sites. In this case study, we used locally collected data to draft the NESAP ICZM plan where buffer zones in the multifunctional local areas and sites of special protection were identified (NESAP 2017). Furthermore, as these locally produced geospatial data were also shared with the local communities as thematic maps, local communities were able to convey their opinions of the coastal resource management and planning challenges to the DoURP planners during the revisit campaigns.

One of the technical advantages of the participatory mapping method is that local knowledge can be depicted in a geospatial form; thus, planners are able to compare the data in GIS with existing spatial information (mainly land cover, roads and houses), especially with remote-sensing data. Zanzibar has just recently been covered with high-resolution drone imagery, and these data, combined with locally generated data, are a very good resource base for integrated coastal zone planning and management to follow (see details of the Zanzibar Mapping Initiative at http://www.zanzibarmapping.com/). Although participatory mapping data are technically comparable in GIS with other "scientifically" produced layers of geospatial information, it is essential to understand that they primarily reflect the values and perceptions of the local residents who participated. Thus, the data are not a depiction of the physical environment, nor are they necessarily a solid representation of all the activities and values present in the landscape. The data are a timely expression of the most essential values and activity locations that local participants considered important. However, value-laden qualitative data allow planners to establish more explicit understanding of how coastal space is transformed into local benefits for people and how the dynamic and interwoven socioecological system is at local scales. This type of knowledge is vital in fostering understanding of various stakeholders' place-based needs in relation to resource management problems and the identification of positive development synergies (Palomo et al. 2013, Wu and Tsai 2014).

To develop socially acceptable planning solutions, robust methodology, a comprehensive framework to facilitate community participation and local-level decision-making are required for ICZM and MSP processes. For decades, community participation in developing spatial planning in Zanzibar has remained on the lower levels of the citizen participation ladder (cf. Lawrence 2006). Also, the central shortcomings of MSP have included the lack of social data and domination of top-down approaches from which participative platforms are disconnected (Jones et al. 2016, Moore et al. 2017). Coastal management requires thorough understanding of the complex and dynamic socioecological systems operating in the coastal and marine areas, as well as necessitates the creation of a governance system capable of addressing these complexities. However, developing a coastal and marine governance system that can operationally address such complexities is challenging (Dutra et al. 2015). This is particularly challenging in developing countries where the social system is entangled with environmental injustice, poverty, poor democracy, lack of social capital, weak legal instruments, poor institutional capacity and accountability and poor adherence to the rule of law (see also Torell 2000, Christie et al. 2005, Isager 2008, Rambaree 2011).

In conclusion, to support the sustainable use of coastal and marine resources, various actors should understand and consider their impact on the marine ecosystem's health, as it supports their local livelihoods (Portman et al. 2012, la Torre-Castro 2006). The lack of spatial knowledge regarding marine and coastal environments and their sociocultural values hinders the integration of a multitude of different marine activities within the spatial planning decision-making. In data-poor areas, where the knowledge of marine ecosystems is lacking or is outdated, novel methods for gathering information on marine activities and values are needed, and we demonstrated in this study how the participation of local and planning experts may facilitate that goal.

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References

Anderson W & S. Juma (2011). Linkages at Tourism Destinations: Challenges in Zanzibar, Journal of Tourism Research 3, 27–41.
http://www.arajournal.net/html/ang/arajournoftouriresea31_linkattouridestichallinzanzi.html

571 Baine M, Howard M, Kerr S, Edgar G & V Toral (2007). Coastal and Marine Resource
572 Management in the Galapagos Islands and the Archipelago of San Andres: Issues, Problems and
573 Opportunities. Ocean & Coastal Management 50: 148–73.
574 https://doi.org/https://doi.org/10.1016/j.ocecoaman.2006.04.001.
575 Bauer JE, Cai WJ, Raymond, PA, Bianchi TS, Hopkinson CS & PAG Regnier (2013). The
576 Changing Carbon Cycle of the Coastal Ocean. Nature 504, 61–70.
577 http://dx.doi.org/10.1038/nature12857.
578 Blackstock KL, GJ Kelly & BL Horsey (2007). Developing and Applying a Framework to Evaluate
579 Participatory Research for Sustainability. Ecological Economics 60, 726–42.
580 https://doi.org/https://doi.org/10.1016/j.ecolecon.2006.05.014.
581 Blake D, Augé AA & K Sherren (2017). Participatory Mapping to Elicit Cultural Coastal Values for
582 Marine Spatial Planning in a Remote Archipelago. Ocean & Coastal Management 148, 195–203.
583 https://doi.org/https://doi.org/10.1016/j.ocecoaman.2017.08.010.
584 Brown B & VH Hausner (2017). An Empirical Analysis of Cultural Ecosystem Values in Coastal
585 Landscapes. Ocean & Coastal Management 142, 49–60.
586 https://doi.org/https://doi.org/10.1016/j.ocecoaman.2017.03.019.
587 CEC (2012). Blue Growth Opportunities for Marine and Maritime Sustainable Growth. Brussels.
588 https://www.eea.europa.eu/policy-documents/com-2012-494-final-blue.
589 Christie P, Lowry K, White AT, Oracion EG, Sievanen L, Pomeroy RS, Pollnac RB, Patlis JM &
590 Eisma RLV (2005). Key Findings from a Multidisciplinary Examination of Integrated Coastal
591 Management Process Sustainability. Ocean & Coastal Management 48, 468–83.
592 https://doi.org/https://doi.org/10.1016/j.ocecoaman.2005.04.006.
593 Cinner JE, Marnane MJ & TR McClanahan (2005). Conservation and Community Benefits from
594 Traditional Coral Reef Management at Ahus Island, Papua New Guinea. Conservation Biology
595 19, 1714-23. https://doi.org/10.1111/j.1523-1739.2005.00209.x-i1.
596 Cinner JE (2007). Designing Marine Reserves to Reflect Local Socioeconomic Conditions: Lessons
597 from Long-Enduring Customary Management Systems. Coral Reefs 26, 1035–45.
598 https://doi.org/10.1007/s00338-007-0213-2.
599 De la Torre-Castro M (2006). Humans and Seagrasses in East Africa: A Social-Ecological System
600 Approach. Stockholm University. http://su.diva-
601 portal.org/smash/get/diva2:189345/FULLTEXT01.pdf.

602 Dennison WC (2008). Environmental Problem Solving in Coastal Ecosystems: A Paradigm Shift to
603 Sustainability. Estuarine, Coastal and Shelf Science 77, 185–96.
604 https://doi.org/https://doi.org/10.1016/j.ecss.2007.09.031.
605 DoE (1996). Towards Integrated Management and Sustainable Development of Zanzibar's Coast:
606 Initial Findings for an Action Strategy in the Chwaka Bay-Paje Area, Zanzibar. Government of
607 Zanzibar. 1–64. http://www.crc.uri.edu/download/ZAN_0056.pdf
608 DoURP (2015). Enabling Transformation of Zanzibar. National Spatial Development Strategy.
609 Zanzibar. Government of Zanzibar. 1–88.
610 Douvere F, Maes F, Vanhulle A & J Schrijvers (2007). The Role of Marine Spatial Planning in Sea
611 Use Management: The Belgian Case. Marine Policy 31, 182-191.
612 https://doi.org/10.1016/j.marpol.2006.07.003.
613 Douvere F & F Maes (2010). 2 The Contribution of Marine Spatial Planning to Implementing
614 Integrated Coastal Zone Management. Coastal Zone Management, 13–30. Thomas Telford Ltd.
615 https://doi.org/doi:10.1680/czm.35164.0002.
616 Dutra LXC, Thébaud O, Boschetti F, Smith ADM & CM Dichmont (2015). Key Issues and Drivers
617 Affecting Coastal and Marine Resource Decisions: Participatory Management Strategy
618 Evaluation to Support Adaptive Management. Ocean & Coastal Management 116, 382–95.
619 https://doi.org/https://doi.org/10.1016/j.ocecoaman.2015.08.011.
620 Ehler C, Douvere F (2009). Marine spatial Planning: a Step-by-step Approach toward Ecosystem-
621 based Management. Intergovernmental Oceanographic Commission and Man and the Biosphere
622 Programme. UNESCO, Paris.
623 Fagerholm, N & N Käyhkö (2009). Participatory mapping and geographical patterns of the social
624 landscape values of rural communities in Zanzibar, Tanzania. Fennia 187, 43–60.
625 https://fennia.journal.fi/article/download/3703/3491/
626 Gustavsson M, Lindström L, Jiddawi NJ & M de la Torre-Castro (2014). Procedural and
627 Distributive Justice in a Community-Based Managed Marine Protected Area in Zanzibar,
628 Tanzania. Marine Policy 46, 91–100. https://doi.org/10.1016/j.marpol.2014.01.005.
629 Halpern BS & RR Warner (2002). Marine Reserves Have Rapid and Lasting Effects. Ecology
630 Letters 5, 361–66. https://doi.org/10.1046/j.1461-0248.2002.00326.x.

631 Heylings P & M Bravo (2007). Evaluating Governance: A Process for Understanding How Co-
632 Management Is Functioning, and Why, in the Galapagos Marine Reserve. Ocean & Coastal
633 Management 50, 174–208. https://doi.org/https://doi.org/10.1016/j.ocecoaman.2006.09.003.
634 Hopkins T & D Bailly (2013). The role of science in the transition to sustainability: the systems
635 approach framework for integrated coastal zone management. In Moksness E, Dahl E & Stottrup
636 J (Eds.), Global Challenges in Integrated Coastal Zone Management, 1st ed. John Wiley & Sons,
637 Ltd, West Sussex.
638 Isager L (2008). Coastal Zone Management in Developing Countries with Kenya as a Particular
639 Example. Final Report, Copenhagen. http://geocenter.dk/xpdf/2008_coastal_zone.pdf.
640 Jankowski P (2009). Towards Participatory Geographic Information Systems for Community-Based
641 Environmental Decision Making. Journal of Environmental Management 90, 1966–71.
642 https://doi.org/https://doi.org/10.1016/j.jenvman.2007.08.028.
643 Jiddawi NS, Stanley RD & AR Kronlund (2002). Estimating Fishery Statistics in the Artisanal
644 Fishery of Zanzibar, Tanzania: How Big Sample Size Is Required? Western Indian Ocean J.
645 Mar. Sci. 1, 19–33. https://www.oceandocs.org/handle/1834/23
646 Jiddawi NS & MC Öhman (2002). "Marine Fisheries in Tanzania." AMBIO: A Journal of the
647 Human Environment 31, 518–27. https://doi.org/10.1579/0044-7447-31.7.518.
648 Jones P, Lieberknecht LM & W Qiu (2016). Marine Spatial Planning in Reality: Introduction to
649 Case Studies and Discussion of Findings. Marine Policy 71, 256-264.
650 https://doi.org/10.1016/j.marpol.2016.04.026.
651 Käyhkö N, Fagerholm N, Asseid BS & AJ Mzee (2011). Dynamic Land Use and Land Cover
652 Changes and Their Effect on Forest Resources in a Coastal Village of Matemwe, Zanzibar,
653 Tanzania. Land Use Policy 28, 26–37.
654 https://doi.org/https://doi.org/10.1016/j.landusepol.2010.04.006.
655 Khakzad, Sorna, Marnix Pieters, and Koenraad Van Balen. 2015. "Coastal Cultural Heritage: A
656 Resource to Be Included in Integrated Coastal Zone Management." Ocean & Coastal
657 Management 118:110–28. https://doi.org/https://doi.org/10.1016/j.ocecoaman.2015.07.032.
658 Khamis ZA, Kalliola R & N Käyhkö (2017). Geographical Characterization of the Zanzibar Coastal
659 Zone and Its Management Perspectives. Ocean and Coastal Management 149, 116-134.
660 https://doi.org/10.1016/j.ocecoaman.2017.10.003.

661 Klain, SC & KMA Chan (2012). Navigating Coastal Values: Participatory Mapping of Ecosystem
662 Services for Spatial Planning. Ecological Economics 82, 104–13.
663 https://doi.org/https://doi.org/10.1016/j.ecolecon.2012.07.008.
664 Kuvan Y (2010). Mass Tourism Development and Deforestation in Turkey. Anatolia 21, 155–68.
665 https://doi.org/10.1080/13032917.2010.9687096.
666 De la Torre-Castro M, Di Carlo G & NS Jiddawi (2014). Seagrass Importance for a Small-Scale
667 Fishery in the Tropics: The Need for Seascape Management. Marine Pollution Bulletin 83, 398–
668 407. https://doi.org/https://doi.org/10.1016/j.marpolbul.2014.03.034.
669 Lange, G-M (2015). Tourism in Zanzibar: Incentives for Sustainable Management of the Coastal
670 Environment. Ecosystem Services 11, 5–11.
671 https://doi.org/https://doi.org/10.1016/j.ecoser.2014.11.009.
672 Lawrence A (2006). No Personal Motive? Volunteers, Biodiversity, and the False Dichotomies of
673 Participation. Ethics, Place & Environment 9, 279–98.
674 https://doi.org/10.1080/13668790600893319.
675 Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, Gaines SD, Airamé S, and
676 RR Warner (2009). Biological Effects within No-Take Marine Reserves: A Global Synthesis.
677 Marine Ecology Progress Series 384, 33–46. http://www.int-res.com/abstracts/meps/v384/p33-
678 46/.
679 Lester SE & BS Halpern (2008). Biological Responses in Marine No-Take Reserves versus
680 Partially Protected Areas. Marine Ecology Progress Series 367, 49–56. http://www.int-
681 res.com/abstracts/meps/v367/p49-56/.
682 Long RD, Charles A & RL Stephenson. 2015. Key Principles of Marine Ecosystem-Based
683 Management. Marine Policy 57, 53–60.
684 https://doi.org/https://doi.org/10.1016/j.marpol.2015.01.013.
685 Lopes R & N Videira (2013). Valuing Marine and Coastal Ecosystem Services: An Integrated
686 Participatory Framework. Ocean & Coastal Management 84, 153–62.
687 https://doi.org/https://doi.org/10.1016/j.ocecoaman.2013.08.001.
688 Lundquist CJ & EF Granek (2005). Strategies for Successful Marine Conservation: Integrating
689 Socioeconomic, Political, and Scientific Factors. Conservation Biology 19, 1771–78.
690 https://doi.org/10.1111/j.1523-1739.2005.00279.x.

691 Makame MK & EK Boon (2008). Sustainable Tourism and Benefit-Sharing in Zanzibar: The Case
692 of Kiwengwa-Pongwe Forest Reserve. Journal of Human Ecology 24, 93–109.
693 https://doi.org/10.1080/09709274.2008.11906105.
694 Martín-López B, Palomo I, García-Llorente M., Iniesta-Arandia I, Castro AJ., García Del Amo, D,
695 Gómez-Baggethun E. & C Montes (2017). Delineating boundaries of social-ecological systems
696 for landscape planning: A comprehensive spatial approach. Land Use Policy 66, 90-104.
697 https://doi.org/10.1016/j.landusepol.2017.04.040
698 Masalu DCP (2000). Coastal and Marine Resource Use Conflicts and Sustainable Development in
699 Tanzania. Ocean & Coastal Management 43, 475–94.
700 https://doi.org/https://doi.org/10.1016/S0964-5691(00)00039-9.
701 MEA (2005). Ecosystems and Human Well-Being: Synthesis. Washington DC, Island Press.
702 https://www.millenniumassessment.org/documents/document.356.aspx.pdf.
703 Mohammed, MS, Muhando CA & H Machano (2000). Assessment of Coral Reef Degradation in
704 Tanzania: Results of Coral Reef Monitoring–1999. IUCN.
705 https://www.iucn.org/backup_iucn/cmsdata.iucn.org/downloads/cordio_status_report_2000.pdf#
706 page=35
707 Moore SA, Brown G, Kobryn H & J Strickland-Munro (2017). Identifying Conflict Potential in a
708 Coastal and Marine Environment Using Participatory Mapping. Journal of Environmental
709 Management 197, 706–18. https://doi.org/https://doi.org/10.1016/j.jenvman.2016.12.026.
710 Msuya FE (2012). A Study of Working Conditions in the Zanzibar Seaweed Farming Industry.
711 WIEGO. http://www.wiego.org/sites/default/files/publications/files/Msuya-Zanzibar-Seaweed-
712 Farming-OHS-2012.pdf.
713 Muhando, CA & M Mohammed (2002). Coral Reef Benthos and Fisheries in Tanzania before and
714 after the 1998 Bleaching and Mortality Event.
715 http://repository.udsm.ac.tz:8080/xmlui/handle/123456789/416.
716 Muhando CA & MS Mohammed (2012). Coral Reefs in Chwaka Bay and Adjacent Areas. In: De la
717 Torre-Castro M & TJ Lyimo (Eds.): People, Nature and Research in Chwaka Bay, Zanzibar,
718 Tanzania, pp. 111–24. Zanzibar Town. WIOMSA.
719 Mustelin J, Klein RG, Asseid B, Sitari T, Khamis M, Mzee A & T Haji (2010). Understanding
720 Current and Future Vulnerability in Coastal Settings: Community Perceptions and Preferences

721 for Adaptation in Zanzibar, Tanzania. Population and Environment 31, 371–98.
722 https://doi.org/10.1007/s11111-010-0107-z.
723 Nordlund LM (2012). People and the Intertidal - Human Induced Changes, Biodiversity Loss,
724 Livelihood Implications and Management in the Western Indian Ocean. PhD thesis. Åbo
725 Akademi University. https://trove.nla.gov.au/version/194577875.
726 Obura D, Gudka M, Rabi FA, Gian SB, Bijoux J, Freed S, Maharavo J, Mwaura J, Porter S, Sola E,
727 Wickel J, Yahya S & S Ahamada (2017). Coral Reef Status Report for the Western Indian
728 Ocean. Global Coral Reef Monitoring Network (GCRMN)/International Coral Reef Initiative
729 (ICRI), 144.
730 Ostrom E (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems.
731 Science 325, 419-422. DOI: 10.1126/science.1172133.
732 Othman, Norasmah, Suzana Mohamed, and Farlizawati Khairia Aziz. 2012. "Tourism Activities
733 and Its Impact on Environmental Sustainability in Coastal Areas." In 2012 2nd International
734 Conference on Economics, Trade and Development. Singapore: IACSIT Press.
735 Pagella TF & FL Sinclair (2014). Development and Use of a Typology of Mapping Tools to Assess
736 Their Fitness for Supporting Management of Ecosystem Service Provision. Landscape Ecology
737 29, 383–99. https://doi.org/10.1007/s10980-013-9983-9.
738 Painho MOT & TH Oliveira (2013). Governance of Marine Protected Areas: An Approach Using
739 Public Participation Geographic Information Systems – The MARGov Project. Journal of
740 Environmental Science and Engineering 2, 25–35.
741 https://research.unl.pt/en/publications/governance-of-marine-protected-areas-an-approach-using-
742 public-participation-geographic-information-systems--the-margov-project(38954e1f-6722-414a-
743 8cd6-eee0c2cfa259)/export.html.
744 Palomo I, Martín-López B, Potschin M, Haines-Young R & C Montes (2013). National Parks,
745 Buffer Zones and Surrounding Lands: Mapping Ecosystem Service Flows. Ecosystem Services
746 4, 104–16. https://doi.org/https://doi.org/10.1016/j.ecoser.2012.09.001.
747 Pánek J (2016). From Mental Maps to GeoParticipation. The Cartographic Journal 53, 300–307.
748 https://doi.org/10.1080/00087041.2016.1243862.
749 Portman ME, Esteves LS, Le XQ & AZ Khan (2012). Improving Integration for Integrated Coastal
750 Zone Management: An Eight Country Study. Science of The Total Environment 439, 194–201.
751 https://doi.org/https://doi.org/10.1016/j.scitotenv.2012.09.016.

752 Rambaldi G, Kyem PAK, McCall M & D Weiner (2006). Participatory spatial information
753 management and communication in developing countries. Electronic Journal of Information
754 Systems in Developing Countries 25, 1–9. DOI: 10.1002/j.1681-4835.2006.tb00162.x.
755 Rambaree K (2011). Community participation within integrated coastal zone management in
756 Western Indian Ocean countries: a factor analysis of perceived benefits and barriers. Journal of
757 Environmental Research and Development 6, 147–154.
758 Reed MS (2008). Stakeholder Participation for Environmental Management: A Literature Review.
759 Biological Conservation 141, 2417–31.
760 https://doi.org/https://doi.org/10.1016/j.biocon.2008.07.014.
761 Rockloff SF, Lockie S & FT Pinto (2004). Participatory Tools for Coastal Zone Management: Use
762 of Stakeholder Analysis and Social Mapping in Australia. Journal of Coastal Conservation 10,
763 81–92. https://doi.org/10.1652/1400-0350(2004)010[0081:PTFCZM]2.0.CO;2.
764 Rotarou E (2014). Tourism in Zanzibar: Challenges for pro-Poor Growth. Caderno Virtual de
765 Turismo 14, 250–64.
766 Ruiz-Frau A, Hinz H, Edwards-Jones G & MJ Kaiser (2013). Spatially Explicit Economic
767 Assessment of Cultural Ecosystem Services: Non-Extractive Recreational Uses of the Coastal
768 Environment Related to Marine Biodiversity. Marine Policy 38, 90–98.
769 https://doi.org/https://doi.org/10.1016/j.marpol.2012.05.023.
770 Ryan, Robert L. 2011. "The Social Landscape of Planning: Integrating Social and Perceptual
771 Research with Spatial Planning Information." Landscape and Urban Planning 100 (4):361–63.
772 https://doi.org/https://doi.org/10.1016/j.landurbplan.2011.01.015.
773 Shipman B & T Stojanovic (2007). Facts, Fictions, and Failures of Integrated Coastal Zone
774 Management in Europe. Coastal Management 35, 375–98
775 https://doi.org/10.1080/08920750601169659.
776 Staehr PA, Sheikh M, Rashid R, Ussi A, Suleiman M, Kloiber U, Dahl K, Tairova Z, Strand J,
777 Kuguru B & C Muhando (2018). Managing Human Pressures to Restore Ecosystem Health of
778 Zanzibar Coastal Waters. J. Aquac Mar Biol. 7, 59–70.
779 https://doi.org/10.15406/jamb.2018.07.00185.
780 Strickland-Munro J, Kobryn H, Brown G & SA Moore (2016). Marine Spatial Planning for the
781 Future: Using Public Participation GIS (PPGIS) to Inform the Human Dimension for Large

782 Marine Parks. Marine Policy 73, 15–26.
783 https://doi.org/https://doi.org/10.1016/j.marpol.2016.07.011.
784 Tippett J, Handley JF & J Ravetz (2007). Meeting the Challenges of Sustainable Development—A
785 Conceptual Appraisal of a New Methodology for Participatory Ecological Planning. Progress in
786 Planning. PROG PLANN 67, 9-98. https://doi.org/10.1016/j.progress.2006.12.004.
787 Tobisson E (2013). Consequences and Challenges of Tourism and Seaweed Farming : A Narrative
788 on a Coastal Community in Zanzibar. Western Indian Ocean Journal of Marine Science 12, 169–
789 84. http://www.ajol.info/index.php/wiojms/article/view/79928.
790 Torell E (2000). Adaptation and Learning in Coastal Management: The Experience of Five East
791 African Initiatives. Coastal Management 28, 353–63.
792 https://doi.org/10.1080/08920750050133601.
793 UNEP, FAO & PAP (2000). Progress in Integrated Coastal Management for Sustainable
794 Development of Zanzibar's Coast: Unguja Island Coastal Profile and Management Strategy.
795 Zanzibar. 1–133.
796 Voyer, M, Gladstone W & H Goodall (2012). Methods of Social Assessment in Marine Protected
797 Area Planning: Is Public Participation Enough? Marine Policy 36, 432–39.
798 https://doi.org/https://doi.org/10.1016/j.marpol.2011.08.002.
799 White A, Deguit E, Jatulan W & L Eisma-Osorio (2006). Integrated Coastal Management in
800 Philippine Local Governance: Evolution and Benefits. Coastal Management 34, 287–302.
801 https://doi.org/10.1080/08920750600686687.
802 Wu C-C & H-M Tsai (2014). A Capital-Based Framework for Assessing Coastal and Marine
803 Social–ecological Dynamics and Natural Resource Management: A Case Study of Penghu
804 Archipelago. Journal of Marine and Island Cultures 3, 60–68.
805 https://doi.org/10.1016/J.IMIC.2014.10.001.