

**The effects of social-ecological changes on the  
livelihoods of fishing communities in Mafia Island,  
Tanzania**

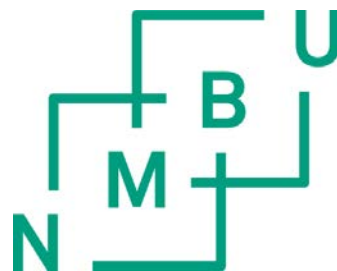
Effekter av sosio-økologiske endringer på livsgrunnlaget for fiskerisamfunn på  
Mafia Island, Tanzania

Philosophiae Doctor (PhD) Thesis

Victoria Hippolite Moshy

Department of International Environment and Development Studies, Noragric  
Faculty of Social Sciences  
Norwegian University of Life Sciences (NMBU)

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## **Abstract**

Changes in social-ecological systems (SESs) may originate in natural environmental processes, conservation interventions, or from the introduction of new economic policies or other social, cultural or political processes. In Tanzania, changes in marine SESs have had profound effects, both on marine resources and on the livelihoods of the communities depending on them for survival. However, there is a lack of in-depth understanding of how such effects have unfolded and affected these communities and the environment, and of how the communities and the resource management bodies have responded to change in order to contribute to the well-being of marine resources and the maintenance of livelihoods.

This study draws upon empirical evidence from the Mafia Island Marine Park (MIMP), Tanzania, to explore how the marine environment is changing over time, and how these changes, together with changes in conservation and economic policies, affect the livelihoods of fishing communities. The study examines how fishing communities and the Park respond to changing social-ecological conditions to enhance the well-being and resilience of marine SESs. In doing so, it draws on both qualitative and quantitative methods of data collection, including key informant interviews, focus group discussions and interviews, informal conversations, direct observations, questionnaire surveys, and anthropometry methodology.

The study confirms that a multiple-evidence approach is applicable towards understanding the changes that occur in the seascape in a local setting. The fishing communities interviewed for the study reported improved coral conditions and increased fish abundance in some areas, an increase in water temperatures and a decrease in sea level, coral cover, and fish abundance in others. They also experienced reduced catch composition, catch quantities, and fish sizes. Various environmental processes, conservation approaches, marketing challenges, and human population dynamics were the key interrelated explanatory factors for the observed changes. This new knowledge of the changing marine environment in the MIMP suggests a weak collaboration between fishing communities and conservation managers, which impairs any efforts to promote adaptive management and support livelihoods.

The livelihoods of the fishing communities included in this study have been adversely affected by changing social-ecological conditions and processes. People's ability to access marine resources, earn an income, and meet household food requirements has decreased, with generational and gender implications. Elderly people and non-fishing households experience

more difficulty earning a living, and the majority (69%) of children, the component of SESs that is usually not adequately considered due to the generalised nature of SES analysis – were found to have poor nutritional status. Women now have to work even harder than previously, while household members tend to seek loans, reduce expenditure, skip meals, and sell their assets in order to meet basic household needs. People also diversify their livelihoods, practice collective fishing, change fishing gear and techniques, abandon fishing activities altogether, or even migrate to distant places. These responses, however, have had little capacity to resolve their livelihood challenges, and in some cases have exacerbated them. For example, by working harder, women substantially reduced the period of breast-feeding, but could not afford nutritious breast-milk substitutes. The resulting poor nutritional status and delayed development of children may have adversely affected their ability to learn and accumulate fishers' knowledge, which will be crucial for utilizing and managing marine resources in the future.

Meanwhile, the Park's responses to the changing social-ecological conditions also did not contribute meaningful improvements to livelihood conditions. These responses were geared mainly towards improving marine environmental conditions, without paying serious attention to human needs. This unbalanced approach, combined with the absence of a legally enabling environment or a common understanding of key issues, and unequal power relations among key actors in Park's SESs, are the key obstacles limiting the implementation of adaptive management in the Park. Expanding the human dimension to address the immediate need for livelihoods and flexible conservation strategies could contribute to cross-scale conservation efforts.

This thesis thus attempts to give a human face to prevailing perspectives on SESs by placing more emphasis on humans, and their needs, struggles, and responses to social-ecological changes as they pursue their livelihoods. It shows that focussing on the needs of fishing communities to have conventional managers and scientists respect traditional ecological knowledge, and to earn their livelihoods under adjustable conservation approaches, would contribute to social-ecological resilience in marine parks. New insights into changing sea levels and temperatures, the inability of fishing communities to resolve existing social-ecological challenges, and cross-scale obstacles to effective adaptive management are among the key contributions that could be made by focussing on the human aspect; and they must be addressed in order to enhance social resilience in the Park. Local and institutional responses

to social-ecological changes may promote resilience that is desired by all actors, if national policies and legislation are changed to create an enabling legal environment. This requires balancing demands for biodiversity conservation, foreign investment, and resilient livelihoods; responding to the changing contextual and global social-ecological conditions; and building the capacity to respond to future uncertainty.



## **Sammendrag (Norwegian summary)**

Forandringer i sosialøkologiske systemer (SØSer) kan skyldes naturlige miljøprosesser, miljøverntiltak, eller introduksjonen av ny økonomiske politikk eller andre sosiale, kulturelle eller politiske prosesser. I Tanzania har forandringer i marine SØSer hatt dyptgående effekter, både på marine ressurser og levevilkårene til samfunnene som er avhengig av dem for sin overlevelse. Imidlertid mangler en dypere forståelse av hvordan slike effekter har utviklet seg og påvirket disse samfunnene og miljøet, og hva samfunnene og institusjonene som administrerer ressursene har gjort for å følge opp forandringen og bidra til en god helsetilstand for de marine ressursene og opprettholde levevilkårene.

Denne studien støtter seg på empiriske bevis fra Mafia Island Marine Park (MIMP), Tanzania, og undersøker hvordan det marine miljøet forandrer seg over tid, og hvordan disse forandringene, sammen med forandringer i miljøvern- og økonomipolitikk, påvirker fiskesamfunnenes levevilkår. Denne studien undersøker hva fiskesamfunnene og parken gjør som følge av endrede sosialøkologiske forhold for å styrke velvære og resiliens i marine SØSer. Studien baserer seg på både kvalitative og kvantitative metoder for datainnsamling, inkludert intervjuer med nøkkelinformanter, fokusgruppediskusjoner og intervjuer, uformelle samtaler, direkte observasjoner, spørreundersøkelser og antropometrisk metodikk, satellittbilder, og geografiske informasjonssystem teknikker.

Studien bekrefter at en flerfoldig bevis tilnærming kan benyttes mot forståelsen av forandringene som skjer i havet lokalt. Fiskesamfunnene som ble intervjuet i studien rapporterte om bedre korallforhold og økt fiskebestand i noen områder, men en økning i vanntemperaturer og lavere havnivå, koralldekning og fiskebestand i andre. De opplevde også en redusert fangstsammensetning, fangstkvantitet og fiskestørrelse. Forskjellige miljøprosesser, miljøverntiltak, markedsføringsutfordringer og menneskelig befolkningsdynamikk var de viktigste sammenhengende forklarende faktorene for de observerte forandringene. Denne nye kunnskapen om forandringen i det marine miljøet i MIMP antyder et svakt samarbeid mellom fiskesamfunnene og miljøverninstitusjoner, noe som svekker alle forsøk på tilpasningsdyktig administrasjon og ivaretagelse av levevilkår.

Levevilkårene til fiskesamfunnene inkludert i denne studien har blitt negativt påvirket av forandringen i sosialøkologiske forhold og prosesser. Tilgangen til marine ressurser har blitt svekket, det samme har folks inntekter og muligheter til å fylle husholdningens matbehov, dette gir også generasjons- og kjønnskonsekvenser. Eldre mennesker og ikke-fiskende

husholdninger finner det vanskeligere å tjene til livets opphold, og majoriteten (69%) av barna, som er den komponenten i SØSer som vanligvis ikke undersøkes nøye nok på grunn av SØS-analysens generelle natur, hadde dårlig ernæringsstatus. Kvinner må jobbe enda hardere enn før, mens husholdninger har en tendens til å ta opp lån, redusere kostnader, hoppe over måltider og selge eiendeler for å dekke sine primærbehov. Folk diversifiserer også levestilene sine, de praktiserer samfiske, forandrer fiskeutstyr og teknikker, slutter helt med fiske eller migrerer til og med til fjerntliggende steder. Disse reaksjonene har imidlertid i liten grad løst levevilkårsutfordringene deres, og i noen tilfeller har de forverret dem. For eksempel reduserte kvinner ammeperioden sin når de jobbet hardere, men hadde ikke råd til næringsrike morsmelkerstatninger. Den påfølgende dårlige ernæringsstatusen og forsinkede utviklingen hos barn kan svekke deres evner til å lære og tilegne seg kunnskap om fiske, noe som vil bli avgjørende for fremtidig bruk og forvaltning av marine ressurser.

Parkens respons bidro heller ikke til forandringen i de sosialøkologiske forholdene til betydningsfulle forbedringer i levevilkårsforholdene. Reaksjonen deres var hovedsakelig rettet mot å forbedre de marine miljøforholdene, uten egentlig å bry seg om menneskelige behov. Denne ubalanserte tilnærmingen kombinert med fraværet av et juridisk tilretteleggende situasjon, eller en felles forståelse for sentrale problemstillinger, og ujevne maktforhold mellom hovedaktørene i parkens SØSer, er de viktigste hindringene for implementeringen av en tilpasningsdyktig forvaltning av parken. Ved å utvide den menneskelige dimensjonen og gripe fatt i det umiddelbare behovet for levevilkår og fleksible miljøvernstrategier kunne man bidra til gjennomgåendemiljøverneffekter.

Denne doktoravhandlingen prøver således å gi gjeldende perspektiver på SØSer et mer menneskelig ansikt ved å legge mer vekt på mennesker, deres behov, problemer og reaksjoner på sosialøkologiske forhold for å forbedresine levevilkår. Den viser at ved å fokusere på fiskesamfunnenes behov for respekt fra vanlige ledere og forskere for tradisjonell økologisk kunnskap, og deres mulighet til å tjene til livets opphold under justerbare miljøverntiltak, vil bidra til sosialøkologisk resiliens i marine verneområder. Ny kunnskap om endring i havnivå og temperaturer, fiskesamfunns manglende evne til å løse eksisterende sosialøkologiske utfordringer, og gjennomgående hindringer for effektiv tilpasningsdyktig forvaltning er noe av det viktigste man kunne oppnå ved å fokusere på det menneskelige aspektet; og dette må gripes fatt i for å styrke sosial resiliens i parken. Lokale og institusjonelle reaksjoner på sosialøkologiske forandringer kan fremme en resiliens alle aktører ønsker, så sant nasjonal

politikk og lovgivning forandres for å skape et tilretteleggende juridisk miljø. Dette krever at man finner en balanse mellom kravene om vern av biologisk mangfold, utenlandske investeringer og resiliente levevilkår; at man responderer til kontekstuelle og globale sosialøkologiske omstendigheter under endring; og bygger opp en kapasitet til å håndtere fremtidig usikkerhet.

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## Thesis outline

This thesis is presented in two main parts. The first provides an extended summary and synthesis of the research. This includes the introduction, rationale, and objectives of the study. It also presents the theoretical and conceptual frameworks that guide the study, before discussing the methodology and synthesis of the results. The first part ends with a presentation of the conclusions and recommendations for future research and policy making. The second part presents the five papers that resulted from carrying out the objectives of this study. The list of these papers is presented below.

1. Moshy, V. H. and Bryceson, I. (2016). Seeing through fishers' lenses: Exploring marine ecological changes within Mafia Island Marine Park, Tanzania. *SAGE Open*, (April-June), 1-18.
2. Moshy, V. H., Bryceson, I. and Mwaipopo, R. (2015). Social-ecological changes, livelihoods and resilience among fishing communities in Mafia Island Marine Park. *Forum for Development Studies*, 42 (3), 529-553.
3. Moshy, V. H., Masenge, T. J. and Bryceson, I. (2013). Undernutrition among under-five children in two fishing communities in Mafia Island Marine Park, Tanzania. *Journal of Sustainable Development*, 6 (6), 1-14.
4. Moshy, V. H. Adaptive management for marine protected areas and prospects for its implementation in the Mafia Island Marine Park, Tanzania. Resubmitted to *Ocean and Coastal Management*.

## **PART ONE: THESIS SUMMARY**

# 1 Introduction

Local communities in most developing countries depend on natural resources for sustaining their livelihoods and achieving development (Ellis, 2000; Allison & Ellis, 2001; Marschke & Berkes, 2006). They interact with the environment in a non-linear and dynamic fashion over time (Berkes & Folke, 1998). Such human–environment interactions are further complicated by the dominance of global neoliberal-driven conservation and market-based economic programs, which often undermine the social dimensions of conservation, fail to involve local communities in a meaningful way, and produce inequalities and underpricing of natural resource products (Mwaipopo, 2008; Fletcher, 2010; Agardy et al., 2011; Fox et al., 2014; Benjaminsen & Bryceson, 2012; Beymer-Farris et al., 2012). These locally and globally driven processes increase uncertainty around supporting livelihoods, achieving social development, and ensuring the sustainability of natural resources.

The need to ensure that natural resources are utilized in a sustainable manner makes natural resource management a necessity. The social-ecological systems (SESs) perspective is increasingly being applied in contemporary natural resource management fields (such as social-ecological resilience) to emphasise the interdependencies and interlinkages between humans (social systems) and the environment (ecological systems) (Berkes & Folke, 1998). Thus, SES focuses on analysing social and ecological systems as one interlinked system constituting the environment, which provides benefits to actors, governance systems that comprise policies, rules and governing activities, and the human actors who interact with the environment (Cox, 2014). These components of linked SESs usually interact in non-linear and unpredictable patterns at various scales and levels<sup>1</sup> with reflective reorganization and evolution (Holling, 2001; Walker et al., 2002; Vervoort et al., 2014). Hence, SESs are complex and dynamic over time (Berkes et al., 2003).

Changes in SESs result mainly from a combination of human and environmental factors, including social, economic, political, cultural, biological, ecological, and climatic processes. Furthermore, the contemporary dominance of neoliberal approaches to economic development and conservation exacerbates changes in SESs (Igoe & Brockington, 2007;

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<sup>1</sup> According to Glaser and Glaeser (2014), there are distinct definitions of the terms ‘scale’ and ‘level’. ‘Scale’ refers to spatial, temporal, ecosystem, jurisdictional, institutional or analytical dimensions for investigating a phenomenon. ‘Level’ simply refers to the units of analysis located within various positions of a scale.



Perry et al., 2011). Neoliberal ideology emphasizes maximizing the role of markets by reducing the role of the state, promoting privatization and attracting foreign investment (Haque, 1999). While neoliberal social and economic policies focus on expanding market forces, enhancing mass production and reducing anti-poverty interventions by the state, neoliberal conservation policies re-regulate nature to create market values that are conducive to market-economy operations (Haque, 1999; Igoe & Brockington, 2007). As a result, business-oriented conservation endeavors in the form of multi-use protected areas are increasingly observed in most developing countries, along with prominent effects on SESs (Brockington et al., 2008; Honey, 2008). In this context, the SESs approach to the management of social and ecological changes for sustainability remains crucial.

Although the SESs perspective in natural resource management entails the analysis of social and ecological systems as one system, much emphasis has until recently been placed on the ecological aspects of SESs. This is understandable because the perspective emerged from the field of ecology (Berkes & Folke, 1998). Nevertheless, efforts to also focus on the social aspects of SESs are increasingly gaining pace (Adger, 2000; Marschke & Berkes, 2006). Analyses of property rights, natural resource-based tenure and knowledge systems, the social effects of foreign investment, and livelihood resilience are examples of such efforts (Berkes & Folke, 1998; Marschke & Berkes, 2006; Beymer-Farris et al., 2012). Additionally, major efforts have been made in the development of the SESs framework, which is useful in analysing social-ecological conditions by identifying the components of SESs and the critical relationships among them (Ostrom, 2007; McGinnis & Ostrom, 2014). While efforts are also being directed towards understanding how small-scale SESs (such as a small-scale fishery) can contribute to understanding large-scale environmental problems and governance (Cox, 2014), it is still crucial to appreciate key aspects relating to resource users, particularly their social conditions and well-being, as central actors in SESs.

In the case of changes in Tanzania's SESs under neoliberal economic development and conservation policies, for example, most natural resource-dependent communities have experienced poor social well-being, while more pressure has been exerted on natural resources for national development. In the marine SES, the government decided to make trial changes to the fisheries policy to allow the export of marine finfish, designate protective-management marine parks, promote tourism, and to allow large-scale commercial prawn farming. These changes have all contributed to the reduced social well-being of fishing

communities and to marine resource degradation, as observed by many authors (Walley, 2004; Bryceson et al., 2006; Benjaminsen & Bryceson, 2012; Beymer-Farris et al., 2012; Kamat, 2014).

While efforts to manage marine fisheries and other marine resources are focused mainly on restricting access and types of fishing gear as a way of maintaining natural resource biodiversity and abundance, as well as the general well-being of ecological systems (URT, 1994; URT, 2011; Benjaminsen & Bryceson, 2012), the social aspects of fisheries management and marine conservation, such as fishers' ecological knowledge and income, the food security of resource-dependent communities, and the management process itself have not as yet been adequately considered (Walley, 2002, 2004; Mwaipopo, 2008; January & Ngowi, 2010; Moshy et al., 2013). Given the extent of human–natural resource interdependencies and interlinkages, a deeper understanding of such social aspects could contribute significantly to contemporary efforts to manage the marine SES for sustainability.

## **1.1 Background to the study**

The United Republic of Tanzania has a coastline of about 1,424 km in length. The livelihoods of coastal communities in the country are highly dependent on fishing and other sea-related activities such as seaweed culture and octopus gleaning (Cinner et al., 2012; Benjaminsen and Bryceson, 2012). In total, about 500,000 coastal dwellers depend on the fishery sector for their livelihoods (URT, 2009). Because the country has a narrow continental shelf (about 15 to 25 km wide), fishing activities are concentrated on inshore areas within territorial waters, covering an area of about 64,000 km<sup>2</sup> (Semesi, 1992; Johnstone et al., 1998). Although Tanzania is among the best-endowed countries on the continent in terms of marine fish biodiversity, finfish landings had until the early 2000s served the needs of the domestic market to support food security (Bryceson et al., 2006; URT, 2010).

In 2002 Tanzania lifted the ban on finfish export on a trial basis in order to widen its exports, increase foreign earnings, and respond to the increase in global demand for finfish (Bryceson et al., 2006; URT, 2010). Given that the trial of finfish export was expected to have considerable effects on marine finfish stock, fish habitats, local livelihoods, fisheries management, and marine conservation efforts, it was necessary for Tanzania to start monitoring such effects. Through cooperation on natural resource management between Tanzania and Norway, under the Management of Natural Resource Programme (MNRP), this

monitoring commitment materialized in 2004, when a mid-term review of the trial was carried out. Responding to the recommendation that there was a need to conduct a study to uncover the effects of lifting the ban on finfish export, the first interdisciplinary study (under the project MNRP-TAN0092) was carried out in 2006. Because the first and largest finfish processing factory (TANPESCA) was established on Mafia Island, the area served as a suitable site for the study to determine the potential for extending developments in finfish export to the rest of coastal Tanzania.

The 2006 study investigated issues related to fisheries science, biodiversity, and any ecological, social, economical, and legal issues that may have resulted from the lifting of the ban on finfish export. The study utilized a social-ecological resilience framework (Berkes & Folke, 1998; Folke et al., 2002; Berkes et al., 2003) in order to attend to the interdisciplinary demands (Bryceson et al., 2006). To operationalize the framework, the study team carried out four interlinked mini-studies. These included a biological-ecological survey and mapping, participatory fisheries stock assessments, quantitative socio-economic assessments, and qualitative socio-cultural assessments.

Based on the interlinked analyses, it was concluded that the lifting of the ban on finfish export on a trial basis had the potential to increase foreign earnings and people's income. However, the 2006 study also pointed to the serious need for continuous and careful investigation into various aspects of marine social-ecological systems. In particular, given that combining different forms of knowledge is key to resilience building (Berkes & Folke, 1998), there was a need for careful investigation of existing traditional ecological knowledge, which is enormously vivid among the people of Mafia (Bryceson et al., 2006). Furthermore, the study pointed to the need to investigate the effects of various livelihood vulnerabilities, with particular emphasis on Jibondo village. These vulnerabilities included unfair market terms and prices for fish and other local produce, lack of viable livelihood options and genuine involvement of local people in marine conservation, insufficient trust among actors, and a lack of appropriate policies for protecting the rights of the people. The current study builds on the 2006 study by utilizing the social-ecological resilience framework, and by mixing both qualitative and quantitative assessments in investigating the key aspects of Mafia Island SESs. In particular, it extends the previous efforts by attempting to carefully investigate how fish catches, fish habitats, people's income, food security, and livelihood

activities have continued to change, and how existing multi-level response mechanisms maintain, enhance, or erode social-ecological resilience in the area.

## **1.2 Rationale of the study**

The livelihoods of local communities on Mafia Island have long depended on coastal and marine resources. The island is among the world's richest marine ecosystems<sup>2</sup> in terms of diversity and productivity (Bryceson et al., 2006; IRG, 2008; Benjaminsen & Bryceson, 2012). The Mafia Island Marine Park (MIMP) was established in 1995 as the first marine park in Tanzania, and is the largest in the western Indian Ocean (URT, 1994; Benjaminsen & Bryceson, 2012). The intention behind the establishment of the MIMP was to conserve marine biodiversity while improving the livelihoods of the local communities that live within its boundaries. To achieve this 'win-win' mission, the Park introduced (and enforced) regulations on fishing areas and gear, implemented a gear-exchange program to phase out unsustainable equipment, implemented education and sensitization programs, and facilitated loans for both fishing and non-fishing activities.

The MIMP also introduced alternative livelihood activities such as seaweed culture, beekeeping, brick-making, and handicraft production. Moreover, the Park began to improve social services within its villages by building water-supply infrastructure, health facilities, and schools, and offered school-fee sponsorships to secondary school children (Walley, 2004; Bryceson et al., 2006; Mwaipopo, 2008). All these interventions were geared towards enhancing the capacity of the local people to engage in non-fishing livelihoods such as tourism-related activities in order to improve their livelihoods.

Although Mafia Island had been a tourist destination since British colonial times (Walley, 2004; IRG, 2008), the establishment of the MIMP in a neoliberal context further attracted tourism investment. The investment was to boost MIMP revenue and improve local livelihoods. During the planning of this study in 2008, there were five large tourist hotels, but now there are 11 such hotels on the island. In addition, the MIMP allocates 20% of its net revenue to supporting various projects such as those mentioned above, as part of a benefit-sharing scheme with the MIMP villages (URT, 2011). Meanwhile, the TANPESCA factory

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<sup>2</sup> Its rich marine fisheries biodiversity ranks on about 380 fish species, 29 species of marine mammals including dugongs, eight species of dolphins, five species of sea turtles, 160 species of sea and shore birds, 45 genera of corals, 12 species of sea grass, eight species of mangroves and natural forest covering some 6,067 hectares, and the island's deep offshore basin is endowed with oil and gas deposits (IRG, 2008).

on the island serves as an important source of revenue for the Mafia District Council. The factory also provides local fishers with the opportunity to sell their fish and octopus catches through factory agents.

Despite such intended ‘win-win’ strategies, the livelihoods of the local communities within the Park boundaries are yet to improve, the district is among the poorest in the country, and marine conservation efficacy has not been adequately achieved (URT, 2007; 2011; Benjaminsen & Bryceson, 2012; Beymer-Farris et al., 2012). Researchers such as Caplan (2002), Walley (2004), Bryceson et al. (2006), Mwaipopo (2008), January & Ngowi (2010), Benjaminsen & Bryceson (2012), and Beymer-Farris et al. (2012) have shown, for example, that rather than benefiting from the above-mentioned initiatives, local fishing communities have increasingly experienced poorer living conditions, and inequalities, marginalization, conflicts over resource use and access, violation of human rights, and environmental destruction from fish-factory operations. All these situations raise questions about the implications of, and responses to, the changing social-ecological conditions across scales, with emphasis on the local scale.

In particular, there is a lack of in-depth analysis of how the people of Mafia Island, especially those living within the MIMP boundaries and having direct or indirect socio-economic relations with fish processing company, respond to the effects of such neoliberal-based interventions to maintain livelihood resilience. Much emphasis has been placed on in-depth analysis of bio-ecological conditions of fisheries and other marine resources at the expense of the social system (Andrews, 1998; Kamukuru et al., 2004; Baker, 2013; Gaspare & Bryceson, 2014). None of these studies has solely employed traditional ecological knowledge of fishers to study changes in fish catches and changes in the marine environment in which they fished or through which they passed.

Because local livelihoods depend mainly on marine resources, and the said interventions have the potential for shaping local resource extraction practices, thereby changing marine social-ecological conditions, there is a crucial need to understand:

- (i) changes in the marine environment as perceived by the fishers themselves,
- (ii) the effects both of environmental changes and of interventions on various social-ecological aspects, and

(iii) the existing multi-level response mechanisms for addressing such effects.

Understanding these factors is an important step towards providing the social-ecological feedback needed for improving social well-being and achieving efficacy in marine biodiversity conservation within MIMP SES. This study, therefore, examines how local communities and the MIMP are being affected by and are responding to neoliberal approaches to economic development and conservation in order to maintain local livelihood security and at the same time contribute towards enhancing social-ecological resilience.

### **1.3 Objectives and research questions**

The overarching objective of this study was to examine the changing nature of the livelihoods of fishing communities on the islands of Chole and Jibondo, and to understand the communities' response mechanisms to the effects of social-ecological changes.

The specific objectives and their respective research questions were as follows:

1. To explore ecological changes in small-scale fisheries and analyse how they have unfolded on the islands of Chole and Jibondo.
  - a) What is the fishers' knowledge of changes in catch types, quantity, and size of commercial fish and octopus, and their habitats?
  - b) What is the fishers' knowledge of the key social-ecological factors influencing changes in catch types, quantity and size of commercial fish and octopus, and their habitats?
2. To examine the implications of social-ecological changes for the livelihoods of fishing communities.
  - a) How have the changes in ecological conditions, conservation practices and trade of the targeted species affected the incomes and food security of fishing communities?
  - b) How have the social-ecological changes influenced participation in fishing activities in terms of age, gender, and wealth status?
  - c) How do fishing communities respond to social-ecological changes in order to enhance their livelihoods and resilience?

3. To examine the interaction between, and the dialectical effects of, changes in management and governance processes in relation to small-scale fisheries.
  - a) What are the conservation-management outcomes and responses in relation to social-ecological changes?
  - b) How do the conservation-management responses to social-ecological changes relate to the principles and processes of adaptive management?

## **2 Theoretical and Conceptual Frameworks**

This thesis embraces the idea that pluralism of analytical approaches is necessary when attempting to understand complex social-ecological issues (Stuart, 2016). Thus, the various theoretical and conceptual frameworks that inform my understanding of social-ecological changes and responses to those changes within the Mafia Island Marine Park, originate both in ecological theories and in social theories. The rest of this section presents the key theoretical and conceptual frameworks that inform this study.

### **2.1 Theoretical perspectives of resilience**

The concept of resilience is steadily emerging as a novel initiative for investigating the dynamics of SESs and understanding the ability of people to respond to perturbations (Berkes & Folke, 1998). Resilience thinking was introduced into the field of ecology as a critique of theories on ecological stability, and emphasises the capacity of ecological systems to persist within multiple stability domains in the face of change (Holling, 1973). Following the growth of the use of the term within the social sciences, Adger (2000, p. 347) defined social resilience as the ‘ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change’. The concept of resilience is also increasingly acknowledged within the growing body of literature that bridges the divide between social and ecological systems by regarding the two systems as interlinked SESs. The concept of SESs emphasizes that humans (as part of social systems, which also include institutions that manage natural resources) are in fact linked to the environment within ecological systems (Berkes & Folke, 1998; Folke et al., 2005; Folke, 2006). This means that both ecological resilience and social resilience are crucial in achieving the resilience of SESs, also known as social-ecological resilience (SER) (Coulthard, 2012).

SER focuses on how SESs deal with change. In particular, SER reflects the ability of SESs to absorb disturbance while remaining in a similar state, the capability of such systems to self-reorganize, and the capacity of such systems to enhance learning (Carpenter & Gunderson, 2001; Folke, 2006). Dealing with change can mean adaptability (changing while remaining on a current development trajectory) or transformability (changing while shifting to a new development trajectory) (Walker et al., 2004). Resilient SESs are those that face changes and still achieve a desirable stable state, either by maintaining their previous state or by developing a new one.

Folke et al. (2003) identified the essential factors for building SER. These are: learning to live with change and uncertainty, nurturing diversity for reorganization and renewal, combining different types of knowledge for learning, and creating opportunities for self-organization. While such factors have been criticized for overlooking various factors that build the resilience of undesirable systems such as poverty and inequality, which are critical problems in SES, they are still useful in building the resilience of desirable systems (Fabinyi et al., 2014). Some recent studies have also shown that factors that erode SER and result in undesirable states in SESs include increased exposure to globalization and implementation of state policies (Wilson, 2012; 2013).

While resilience thinking is receiving increased attention in social-ecological studies, critics perceive its use in research into complex phenomena in social systems as futile (Diprose, 2014). This is because resilience shifts the responsibility for confronting global capitalism and overseeing the implementation of neoliberal-based state policies from the government to the citizens, thereby strengthening the capitalist economy while also instilling inequalities and poverty (Mackinnon & Derickson, 2013; Cretney & Bond, 2014; Diprose, 2014).

Some critics perceive resilience thinking as useful in understanding SER, although its applicability is still debatable (Davidson, 2010). This is partly because transferring the concept of resilience from ecological systems to social systems has proved to be problematic, given the systems' inherent differences in behavior, processes, and structures (Adger, 2000). SER can be regarded as symmetrical, for its potential to pay equal attention to social and ecological components of SESs. However, the framing of most current SER research reflects a tendency to consider ecological dimensions as more influential than social dimensions (Armitage et al., 2012). Meanwhile, a uni-directional concept of humans as stressors of ecological systems continues to dominate (Folke et al., 2005; Perry et al., 2010). Such trends



conform to the argument that perspectives on SER are subject to power imbalances in terms of which scholarly group has more power to produce and frame knowledge regarding SESs' interrelationships, desirable states, and problems (Fabinyi et al., 2014). Although changes in SESs have profound effects on resource-dependent populations, efforts to understand the implications of various social-ecological changes for social aspects of SESs remain scant.

Furthermore, efforts towards addressing the social dimensions of SER still overlook the need to focus on social complexity (in terms of varied people's needs, interests, expectations, and experiences); on social stratification (in terms of gender and age); and on power (in terms of who defines a desirable state and why (Beymer-Faris et al., 2012; Fabinyi et al., 2014). There is a lack of analysis of diverse experiences that different individuals face on a daily basis as a result of changing social-ecological conditions (Christensen & Krogman, 2012). However, effective management for SER and sustainability begs much more analysis of these aspects of social systems, which could provide a nuanced understanding of social processes and mechanisms for resilience.

The marginalization of social aspects in the SER perspective points to a lack of incorporation of social theories into resilience accounts (Beymer-Farris et al., 2012; Coulthard, 2012). Meanwhile, understanding the complexities beneath various components of social systems, social processes, and resilience demands sociological theories (Dwiartama & Rosin, 2014). Because resilience of social systems is indeed fundamental to realizing SER, this thesis focuses on understanding the key social dimensions of SESs. More emphasis is placed on understanding the immediate needs, interests, challenges, and expectations of resource-dependent communities that also shape their well-being status in the face of social-ecological changes. These social aspects and daily experiences can influence human–environment interactions, responses, adaptations, and aid in providing social-ecological feedback to bodies responsible for managing natural resources. In particular, emphasis is placed on human agency in explaining the ability of fishing communities to respond to social-ecological changes by exploring strategies that build or erode resilience (Adger, 2000; Coulthard, 2012). The thesis thus contributes to the efforts to advance resilience thinking as a useful theoretical approach to the understanding of how components of SESs are interrelated and interlinked to enhance or erode SER, and to promote livelihood sustainability (Berkes & Folke, 1998).

## **2.2 Livelihood sustainability in rural fishing communities**

According to Chambers and Conway (1992), 'livelihood' is a concept that denotes requirements for, and the processes involved in, gaining a living, satisfying needs, and improving standards of living. That is to say, it is a means of earning a living. It comprises people, their capabilities, activities, and means of living, including food, income, and assets. The term 'capability' in this context refers to a person's ability to perform various basic functions, based on what he or she is capable of doing and being in the course of living (Chambers & Conway, 1992). Assets that are central in livelihood perspectives are mainly divided into the following categories: (i) physical assets such as fishing gear, (ii) natural assets like fish stock and coconut trees, (iii) human assets including people and their health and education, (iv) financial assets such as savings and credit, and (v) social assets including social networks and associations (Chambers & Conway, 1992; Allison & Ellis, 2001).

'Livelihood sustainability' is a concept that integrates concepts of livelihood and sustainable development. 'Sustainable development' refers to development that ensures that the needs of current generations are met without constraining the ability of future generations to meet theirs (WCED, 1987). This means that livelihood sustainability is the ability to maintain and improve livelihood conditions while also maintaining or enhancing ecosystem productivity and the conditions of local and global assets and capabilities that livelihoods depend on (Chambers & Conway, 1992). It implies that both current and future generations have the ability to meet their needs for food, income and other basic requirements, in spite of any challenges, such as change, stress, shock, and uncertainty that they may face. However, the agency that individuals or the community exert when making choices and pursuing actions that enable them to achieve their basic needs and improve their livelihood is operated within various structures, including geographical, economic, and social structures, which in turn influence the outcome (Coulthard, 2012). It is therefore imperative that the sustainable livelihood perspective focuses on the interactions between individual assets, activities that individuals engage in, and any mediating structures and processes, such as the institutions and regulations governing access to assets and alternative livelihoods (Allison & Ellis, 2001).

Livelihoods in rural coastal areas often depend on fisheries resources, fishing activities and other fisheries and coastal related activities for sustaining the lives and development of its inhabitants (Allison & Ellis, 2001; Marschke & Berkes, 2006). Because this dependency has tended to be regarded as causing fisheries and marine degradation, management approaches

such as marine protected areas have been increasingly advocated for their potential to manage fisheries, conserve marine environment and promote sustainable livelihoods, thereby improving the conditions of the environment and its inhabitants (Allison & Ellis, 2001; Pomeroy et al., 2004). A sustainable livelihood perspective is thus useful in understanding how fishing communities respond to fisheries resource fluctuations and the stresses, shocks and uncertainties that originate from the changing fisheries resources and management structures and processes (Allison & Ellis, 2001).

Analyses of livelihoods in rural areas continue to benefit from the use of the sustainable livelihood approach. However, there are several critiques of its application that arise from experiences gained over two decades of its use in research and development programs, which include the following key concerns: that the approach lacks (i) focus on the human face, existence and rights, (ii) attention to the environment and other complexities and vulnerabilities that people face, (iii) considerations of social structures and power relations, including market, class, gender, and poverty, (iv) attention to historical processes that have led to current institutional structures, (v) attention to the influence of powerful and wealthier individuals, and (vi) foundation in broader theories of social and economic change (Small, 2007; Morse & McNamara, 2013). Because these shortcomings have mainly resulted from the dependence of the approach on international development concepts and values, critics of the approach further argue that incorporating social theories such as the ANT could largely improve the livelihood approach.

Nonetheless, this study acknowledges the usefulness of the sustainable livelihood approach in analysing livelihood conditions in rural areas. Because the survival and development of individuals depend on their capacity to transform assets into livelihood strategies (Chambers & Conway, 1992; DFID, 2000), this study incorporates some aspects of livelihood assets, institutions, and social relations that mediate access to assets and activities (Ellis, 2000). Although the study does not apply the livelihood approach in full, it borrows some conceptual ideas from the approach to analyse the effects of social-ecological changes on coastal livelihood conditions in the context of SES perspectives.

The choice of a SES perspective is driven by (i) the idea that combining livelihood and SES perspectives draws attention to humans and their needs and agency, rather than focussing on their assets (Tanner et al., 2015), (ii) the strength of the SES perspectives in highlighting the

environment and humans, and the interaction between them (Berkes & Folke, 1998), (iii) the growing emphasis on the need for empirical research to contribute to the understanding of the resilience of linked SESs, (iv) the fact that extensive research has already contributed enormous insights to the sustainable livelihood approach since its introduction in the early 1990s, and (v) the argument that other approaches, other than the livelihood one, are needed to provide a nuanced understanding of cross-scale dynamics in marine SESs, which are more dynamic than terrestrial SESs (Ferrol-Schulte et al., 2013).

### **2.3 Livelihoods in the context of rural marine social-ecological systems**

Marine SESs, in comparison with terrestrial SESs, are uniquely dynamic and complex in various ways. Given that the world's oceans cover more than 70% of the globe, the size of marine SESs is indeed larger than the terrestrial ones (Glaser & Glaeser, 2014). The marine SESs also constitute mobile resource units, mobile resource users, and weak governance systems, all of which contribute to their dynamicity and complexity (Ferrol-Schulte et al., 2013). Promotion of marine protected areas may reflect global efforts to improve governance of marine SESs, and to embrace the idea of interlinked SESs through attending to both biodiversity conservation and socio-economic needs. However, the implementation of marine protected areas is increasingly reported as a cause of vulnerabilities and uncertainties for local livelihoods (Walley, 2004; Brockington et al., 2008; Benjaminsen & Bryceson, 2012). Making a living within a marine SES thus entails interacting with the marine environment while also responding to these changing conditions in a non-linear fashion over time (Berkes & Folke, 1998).

Since changes in marine SESs seem to be inevitable, the livelihoods of resource-dependent communities are also increasingly exposed to, and affected by, external shocks and stresses (Berkes & Folke, 1998; Marschke & Berkes, 2006). These perturbations can be a result of three interdependent processes: changing environmental conditions, changing social conditions, and the introduction of policy interventions that control access to and the use and trade of natural resources through science-based management approaches (Marshall et al., 2009; Kolding & Zwieten, 2011; Benjaminsen & Bryceson, 2012). Perturbations can further be complicated by the dominance of global neoliberal-driven, market-based economic programs, which often undermine social dimensions of conservation, lack meaningful involvement of local communities, and produce inequalities and underpricing of natural

resource products (Mwaipopo, 2008; Fletcher, 2010; Agardy et al., 2011; Fox et al., 2014; Benjaminsen & Bryceson, 2012; Beymer-Farris et al., 2012).

An understanding of livelihoods within the context of SESs makes it easier to appreciate the interdependence of humans and the environment, and to make linkages between social and ecological systems (Berkes & Folke, 1998). By depending on the marine resource base for their daily living, fishing communities usually face day-to-day uncertainty regarding their survival (Berkes & Seixas, 2005). Such uncertainty often arises from seasonal fluctuations in resources (Marschke & Berkes, 2006), the effects of global warming (Bunce et al., 2010), restrictive conservation policies that constrain their access to resources (Benjaminsen and Bryceson, 2012), and ecological degradation resulting from industrial aquaculture developments that are based on capital accumulation (Beymer-Farris et al., 2012). Through continuous learning, fishing communities can respond to both social and ecological feedback in order to adjust and adapt in ways that build their capacity to manage current and future uncertainty (Folke et al., 2003; Pinkerton, 2009). Hence, their responses constitute strategies that can enhance livelihood security, which is among the key social determinants of resilience in SESs (Berkes et al., 2003).

The extent to which individuals and households are vulnerable or resilient to various shocks depends on the magnitude of the disturbance and how robust their livelihood options are. For example, changes in fisheries-related regulations as an institution or patterns of marine fishing may constrict or broaden the livelihood options of fishing communities. Institutions (comprising tradition, culture, regulations, procedures for decision making, and programs for defining social conduct and guiding interactions among actors) are key causes of significant changes in SESs (Adger, 2000; Young, 2002; Vatn 2005). In turn, global politics and economies influence formal and informal institutions at all levels, creating new livelihoods or constraining existing ones. Nonetheless, building a robust livelihood system and livelihood security is fundamental to poverty reduction (Ellis, 2000; Allison & Ellis, 2001) and can enhance livelihood resilience.

The concept of livelihood resilience refers to ‘the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social and political disturbances’ (Tanner et al., 2015, p. 23). This includes the ability of households or individuals to respond to social-ecological changes, and to reorganize

themselves to maintain their income, food security<sup>3</sup> and livelihood activities for development (Adger, 2000; Walker et al., 2004; Folke, 2006). Aspects of empowerment, human rights, human agency, and both individual and collective capacity to respond to changes are thus at the centre of livelihood resilience (Tanner et al., 2015). These aspects are crucial in enhancing people's rights to food, housing, and health, and for maintaining basic human dignity among the people who inhabit a particular environment while also facing and dealing with social-ecological changes (Tanner et al., 2015).

Even though the degree of livelihood resilience is not quantifiable, this study (through papers 2 and 3) pays attention to some of the indicators described above, including livelihood activities and opportunities, income, food security, health, well-being, and the agency and ability of people to understand and respond to social-ecological changes. These indicators provide qualitative (and simple quantitative) indications of how well people adapt and reorganize to strengthen their resilience. The four resilience-building factors (Folke et al., 2003) described in Section 2.1 were invoked in analyzing people's response strategies in order to understand the ways in which these response strategies contributed to enhancing their livelihood resilience. The factors capture the complexities of social-ecological interactions and foster the analysis of response strategies, and are useful for assessing social-ecological resilience and livelihood resilience (Berkes & Folke, 1998; Berkes & Seixas, 2005; Marschke & Berkes, 2006). Well-being perspectives are also used to complement livelihood resilience perspectives, in order to understand how people are embedded within complex systems and the processes and structures that influence SER, by uncovering livelihood realities and providing additional variables for resilience building (Marschke & Berkes, 2006; Armitage et al., 2012).

### **2.3.1 Traditional ecological knowledge in marine social-ecological systems**

Combining different types of knowledge for learning is among the key resilience-building factors (Folke et al., 2003; Bohensky & Maru, 2011). Thus, traditional ecological knowledge (TEK) was given priority in this study, in order to contribute empirical evidence about changes in marine environmental conditions from the perspectives of the people who inhabit and interact with the marine environment for making their living. The concept of TEK refers

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<sup>3</sup> According to FAO (2010), people have food security when they have economic, physical and social access to sufficient and nutritional food to meet their dietary and preference needs throughout the year.

to knowledge – comprising practices, insights, beliefs and experiences – that inhabitants of a particular environment have accumulated (by living in, interacting with, and continuously observing that environment) and handed down through generations (Berkes, 1993; Huntington, 2000).

The notion of inhabitants in this study was extended to include a range of people who lived within the MIMP area but did not necessarily fulfill all aspects of the definition of TEK, such as those relating to beliefs and cross-generation knowledge transmission. These inhabitants included visiting fishers, diving instructors working for tourist hotels, and boat captains working for the hotels and the MIMP, for their long experience in operating within the MIMP waters. Nonetheless, TEK production was to a large extent based on the perspectives of fishing communities interacting with the marine environment, through fishing (both gleaning and diving) and seaweed culture, for their livelihoods, whereby they experienced nature and change processes. To a lesser extent, observations of TEK production were also based on my own experience during the course of interacting with ‘inhabitants’ and participating in their social discourses.

TEK provides a nuanced understanding of marine processes, such as the distribution of various marine species and changes in marine SESs, thereby improving the efficacy of conventional science-based conservation initiatives (Drew, 2005; Yasue et al., 2010; Thornton & Scheer, 2012; Tesfamichael et al., 2014). Given the complexities of marine ecological systems highlighted in Section 2.4, and the inefficacy of conventional science-based approaches in dealing with uncertainty surrounding SESs and enhancing resilience and sustainability (Berkes & Folke, 1998; Berkes et al., 2001; Ferrol-Schulte et al., 2013), this study is committed to producing TEK of marine ecological changes (Paper 1) as a contribution to the efforts to improve the management of marine park SESs and enhance resilience.

### **2.3.2 Adaptive management and resilience building in marine SESs**

Adaptive management is increasingly advocated as an ideal approach to achieving effective marine protected areas because of its capacity to decrease uncertainty and deal with unpredictable and dynamic human–environment interactions (Holling, 1978; Pomeroy et al., 2004; Morris & Green, 2014). Adaptive management comprises three major principles (Torell, 2000). First: adjusting management actions and strategies as new information

emerges. This principle is concerned with the ability to make timely and effective changes based on experience gained from implementing previous management actions. Second: enhancing learning by doing and by experimentation. This principle emphasizes treating management policies, programs and practices as experiments to obtain measurable results that can be included in the management process more effectively. Third: ensuring that relevant actors actively participate in the management. This principle requires the active engagement of significant actors in management processes to create and share more knowledge, and to produce appropriate solutions.

Adaptive management principles are operationalized through an iterative process that involves various actors in planning a strategy by defining objectives, goals, and evaluation indicators; implementing the plan; monitoring progress; and evaluating resultant outcomes for adaptation and further refining the initial plan in order to achieve both conservation and development goals (Pomeroy et al., 2004; Allen & Gunderson, 2011). Each management process is treated as an experiment and subjected to assessment in order to generate data for understanding what strategy works and what strategy does not work, and why, as a basis for improving management processes and practices further (Pomeroy et al., 2004; Cumming et al., 2012; Fox et al., 2014). This means that adaptive management blends research data and actions to improve conservation practices (Salafsky et al., 2002). Hence, it allows managers to make informed decisions and changes based on experience obtained from doing scientific research, experimentation, collaborative monitoring, evaluation, and assessment (Williams, 2011). Building an understanding of the extent to which the MIMP has been blending research data and experience gained during years of park implementation into its conservation strategies and actions, was therefore of much interest to this study (Paper 4). This interest derives from the ideas presented in previous sections regarding the influence of conventional science-based conservation strategies, such as marine protected areas, in building or eroding livelihood resilience and ultimately SER.

## **2.4 Analysis of social-ecological systems**

Since the introduction of the concept of linked SESs during the 1990s, there has been a focus on the social mechanisms of institutions embedded within communities (Berkes & Folke, 1998; Folke et al., 2003). In fact, the following decade witnessed intensive research, which resulted in the introduction and modification of a standardized framework for analysing the



components of SESs, and for diagnosing problems in SESs for sustainability (Ostrom, 2005; 2007; 2009; McGinnis & Ostrom, 2014; Cumming et al., 2015). Designed to bring a human face into SESs and SER analyses, the framework identifies four major components of SESs. These are resource units, resource systems, governance systems, and actors, which together constitute about 50 social-ecological variables that guide social-ecological analysis in relation to sustainability (Ostrom, 2007; Cumming et al., 2015). In presenting a human face, the framework focuses on the formal and informal institutions, rules, norms, traditions, regulations, and actions that influence the human–environment interactions involved in addressing the challenges of over-exploitation and the collapse of natural resources as a way to promote sustainability (Ostrom, 2005).

Because the SES perspective originated from ecological perspectives and thus placed much emphasis on ecological aspects (resource units and resource systems), the SES framework originated from economic and institutional perspectives to emphasize social aspects (governance systems and actors). While this remains an important step towards balancing social and ecological aspects in SESs analyses, concerns are increasingly emerging that the framework still focuses on resolving natural resource problems and achieving sustainability of ecological aspects. In so doing, it overlooks the importance of societal needs, and the contributions of social-science perspectives, including political-ecological perspectives, which are useful in analysing power imbalances among different actors across scales (Robbins, 2004; Beymer-Farris et al., 2012; Cumming et al., 2015). These concerns indicate that the process of bringing a human face to SESs frameworks is still ongoing and requires more of a commitment than simply focusing on institutional and governance roles and influences.

In particular, scholars argue increasingly for the need to combine SER perspectives and a SESs framework with other sociological perspectives to improve SESs analyses. Some emphasize the rights of people to access resources and participate in rule making and resource management decisions, and efforts to consider cross-scale linkages (Pinkerton, 2009; Jones et al., 2013; Cumming et al., 2015). Marschke and Berkes (2006) combine resilience and well-being thinking in their analysis of the livelihood challenges of Cambodian fishers. Meanwhile, Folke's work (2006) discusses mainly the important potential for incorporating social processes such as social memory, social learning, and social networks, agents, and actor groups into the SESs framework. Furthermore, Schwarz et al. (2011)

combine resilience indicators in the Solomon Islands with a 360-degree integrated assessment map that has a sub-category of people and livelihoods. Other studies, like the one by Sutton and Tobin (2012), focus on social resilience. Their work examines the relationship between social resilience and fishers' perceptions, and fishers' adaptation to key policy changes in Australia. Although these studies address some social aspects of SESs by focusing mainly on the various social processes that shape human–environment relationships, they still place considerable emphasis on natural resources management and sustainability.

Recent SESs studies have identified a need to consider ecological, economic, and social dimensions of SER in some depth (Jones et al., 2013). The studies have also pointed to the need to introduce social well-being concepts into the resilience discourse to ensure that adaptation strategies do not jeopardize social well-being (Coulthard, 2012). In particular, efforts to investigate human agency and the individual's role in employing various strategies in response to changes are evident (Brown, 2013). Other studies have pointed to the growing need for field-based research to enhance capacity to functionalize resilience concepts on the ground (Schwarz et al., 2011; Sutton and Tobin, 2012), and the need to combine political ecology and resilience approaches in order to understand unequal outcomes of social-ecological relations within imbalanced power relationships (Beymer-Farris et al., 2012; Cumming et al., 2015).

In this regard, Cumming and colleagues (2015) have argued for the potential of unpacking the social aspects of governance to isolate simple variables that can affect the sustainability of SESs. They divide institutional organization into five levels and identify various social-ecological driving forces at each level. In so doing, they extend the SES framework to offer a new proposal for integrating social-ecological feedback and cross-scale effects in the context of SESs in marine protected areas. They emphasize the idea that analysis of the resilience of marine protected areas must recognize protected areas as multi-scale and multi-level SESs with multiple feedbacks. Thus it is argued in this thesis that actors in marine protected areas must also be recognized as operating on multiple scales and levels to shape social-ecological changes and response strategies that eventually enhance or erode SER.

To contribute to efforts to bring a human face both to SER perspectives and to the SES framework, this thesis further extends the SES framework. It does so by unpacking the social aspects of actors to reveal social processes and actions that can affect sustainability. The

thesis unpacks the actors in the SES framework in the context of marine protected areas to uncover the most overlooked aspects of the framework, such as the perceptions and needs of marginalized actors, and to identify categories in terms of interests, perceptions, and capacities of key actors to respond to social-ecological changes to shape SER. About five major types of multi-scale actors are recognised here as having varying degrees of influence on the shaping of SER. These include (i) local inhabitants in their role as small-scale users of natural resources for making a living, (ii) fish factory investors in their role as large-scale users of natural resources running profit-making businesses with local–global linkages, (iii) government officials in their role as conservationists and managers of natural resources, (iv) WWF officials in their role as representatives of an international environmental conservation organization, and (v) researchers in their role as producers and disseminators of knowledge about natural resources. The social processes and relationships among these actors with their very different roles eventually influence social-ecological outcomes and SER.

Although the multi-scale actors discussed above contribute to shaping SER, this thesis places more emphasis on the actors whose perceptions, interests and needs have received scant attention in the SESs framework. These are the marginalized local inhabitants living in local SESs in the least-developed nations, whose needs for livelihoods are yet to be fully attended to in SER perspectives and the SESs framework, in spite of being the main actors and deserving thorough attention (Tanner et al., 2015). It has also been argued that the SESs framework requires extension and adjustments to its scientific and technical focus in order to be meaningful to the daily lives and practices of the ordinary people that inhabit the natural systems (Cannon & Muller-Mahn, 2010; Tanner et al., 2015). Recognizing this need, this thesis contributes not only empirical evidence that brings a more human face to SER perspectives and the SESs framework, but also, more importantly, empirical evidence regarding ordinary people’s daily experiences in satisfying their immediate needs for money, food security, resilient livelihoods, and well-being, all of which are meaningful to the lives of ordinary people inhabiting the natural systems.

Acknowledging that the people inhabiting natural systems are heterogenic in terms of their interests and needs, this thesis recognizes various categories that exist under the ‘inhabitants’ umbrella in order to understand how inhabitants are affected by and respond to social-ecological changes. For example, the categories related to age are useful for comparing various aspects among past, present, and future resource users, whereas those related to

gender are useful for reflecting on gendered livelihood activities, effects, and response mechanisms. Meanwhile, categories related to wealth status are useful for understanding the varied effects and capacity of various inhabitants to respond to change. The role of relatively wealthier inhabitants such as local fish traders and fish-factory agents in shaping changes and response mechanisms is also considered.

## **2.5 Analysis of changes in marine social-ecological systems**

Building on the above key concepts and conceptual challenges surrounding the SESs framework, I developed a conceptual framework for analysing the components of the Mafia Island Marine Park SESs (Figure 1). To understand changes in SESs within the MIMP, I investigated changes both in social components (Paper 2, Paper 3 and Paper 4) and in ecological components (Paper 1). I also investigated the key interrelated factors (environmental, social, economic, political, and cultural) that resulted in such changing conditions. The effects of, and responses to, such social-ecological changes among households in fishing communities living within the MIMP boundaries were then analyzed in the context of linked SESs. The analysis provided important social-ecological feedback that could warrant adaptive adjustments of conventional science-based marine conservation approaches by the MIMP (Paper 4).

In particular, the conceptual framework acknowledges the four interrelated components of the SESs framework (Ostrom, 2005; 2007; 2009; Cumming et al., 2015) but chooses to unpack one component, the actors. In so doing, I place more emphasis on examining the key components among resource users, including (i) their traditional ecological knowledge of the changes in resource units (fish and octopus) and resource systems (e.g. fish abundance, coral cover, sea water conditions), (ii) the livelihood activities, income, food security, and well-being of household members including children, (iii) their perception of, and engagement in, fisheries management and biodiversity conservation. Furthermore, I place some emphasis on actors engaging in fisheries management and biodiversity conservation in order to examine the extent to which institutional learning gained from resource users' knowledge and experiences, park implementation, and research influence the adaptability of conservation strategies. By placing emphasis on the components of resource users, managers, and conservation strategies, my analysis covers the four interrelated components of the SESs framework, and contributes to the current efforts towards enhancing SER and households' ability to satisfy their basic needs and thrive.

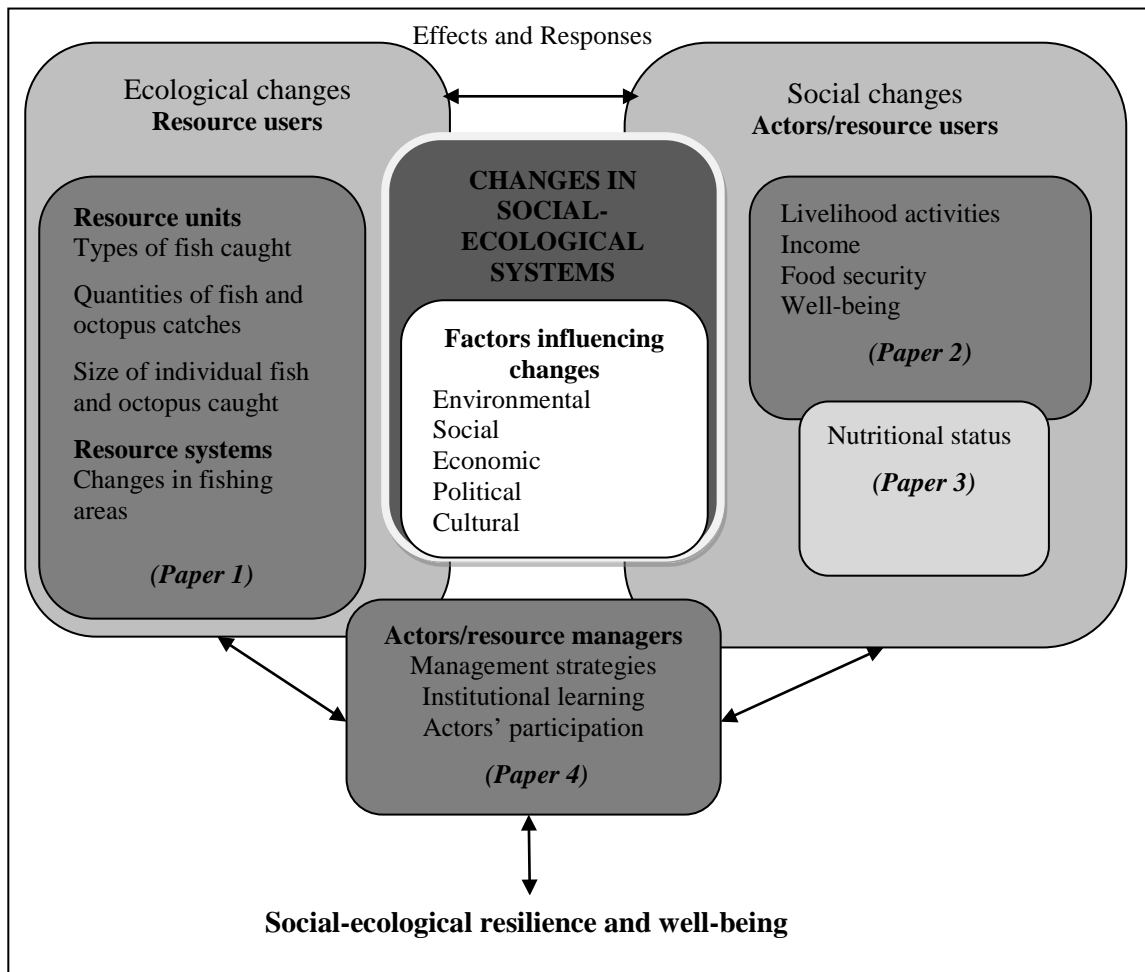


Figure 1: Conceptual framework for understanding the effects of and responses to social-ecological changes for building resilience of the MIMP SES

The analysis of social-ecological changes within the MIMP from resilience perspectives also integrates some aspects of a political-ecology approach. The integration helped me to achieve a more nuanced understanding of how such changes affected various actors differently, given their differential levels of power, how political-economic factors at a higher scale shape actors' actions on the ground, and how historical accounts contributed to the understanding of current social-ecological conditions. Political ecology is an interdisciplinary approach that provides a powerful theoretical basis for understanding local realities as a result of changes in the environment, governance systems for managing natural resources, and the political-economic drivers that operate at higher scales (Blaikie, 1985; Blaikie & Brookfield, 1987; Robbins, 2004; Agrawal, 2005). The approach provides a basis for the analysis of power relations – in particular, matters related to distribution, justice, inequality, exploitation, and marginalization (Walker, 2006) and of actors as they strive to safeguard their interests, resulting in unequal patterns of 'winners' and 'losers' in human–environment relationships

(Robbins, 2004; 2012; Mung'ong'o, 2009). The strengths of this approach thus complemented the shortcomings of the perspectives of SES and resilience, which have already been pointed out.

### **3 Approach and Methodology**

Any scientific research is based on some philosophical assumptions about reality, or what needs to be known (Bryman, 2004; Sumner & Tribe, 2008). Hence, ontological and epistemological perspectives shape the research design and methods chosen (Bryman, 2004). By focusing on the actors, particularly the small, marginalized resource users, the reality and knowledge of changes in, and responses to, marine social-ecological changes, my research rests mainly on a constructivist approach. This means that knowledge production is based on the perspectives of the individuals in the fishing communities, because they have been living in, interacting with, and continuously observing their environment in the course of pursuing their livelihoods. They therefore accumulate insights and experiences regarding nature and change processes. This epistemological stance is also based on my own experience during the course of interacting with the individuals and participating in their social discourses.

These socially constructed realities of changes are also complemented by objective reality based on a positivist approach. I carried out scientific measuring of the nutritional status of children. This study thus adopts middle-ground (both subjective and objective realities) ontological and epistemological positions, because the social-ecological changes and associated effects are not only embedded and shaped within local livelihoods, but also constitute observable aspects that can be measured objectively. Furthermore, the middle-ground stance, better known as the critical realism approach, is important in the current study because, by having different perceptions and interpretations of the changes, effects, and response strategies, the actors produced multiple subjective explanations and realities that were better complemented by objective measurements.

#### **3.1 Study setting and strategy**

This study uses a case study design, since that design is useful for describing subject matter intensively while covering contextual conditions, and relies on various sources of evidence (Yin, 1993; Bryman, 2004). Various methods of data collection were employed in order to ensure that the requirement to use multiple sources of evidence was met. A research strategy, on the other hand, is an orientation or approach used in the collection and analysis of data

(Bryman, 2004; Creswell, 2003). Creswell (2003) defines three research strategies in social research: the qualitative approach, the quantitative approach, and the mixed-method approach. Given the epistemological and ontological stance of this study, I chose the mixed-method approach, which combines both qualitative and quantitative methods. This choice also served as a means of triangulation to ensure the credibility of the results.

### 3.1.1 Study areas

The study was conducted on Mafia Island, a large archipelago that covers about 407 km<sup>2</sup> of dry land and 565 km<sup>2</sup> of water. The Mafia archipelago is about 49 km long, and narrow, with the widest part being 17 km. It is situated off the East African coast, opposite the Rufiji River delta, about 120 km southeast of Dar es Salaam (Figure 2). It comprises various islets, four of which are permanently inhabited. The archipelago forms Mafia District, which is one of the six districts that form the Pwani Region of Tanzania. The district comprises one town and 20 villages, and has a population of 46,438 inhabitants (URT, 2013).

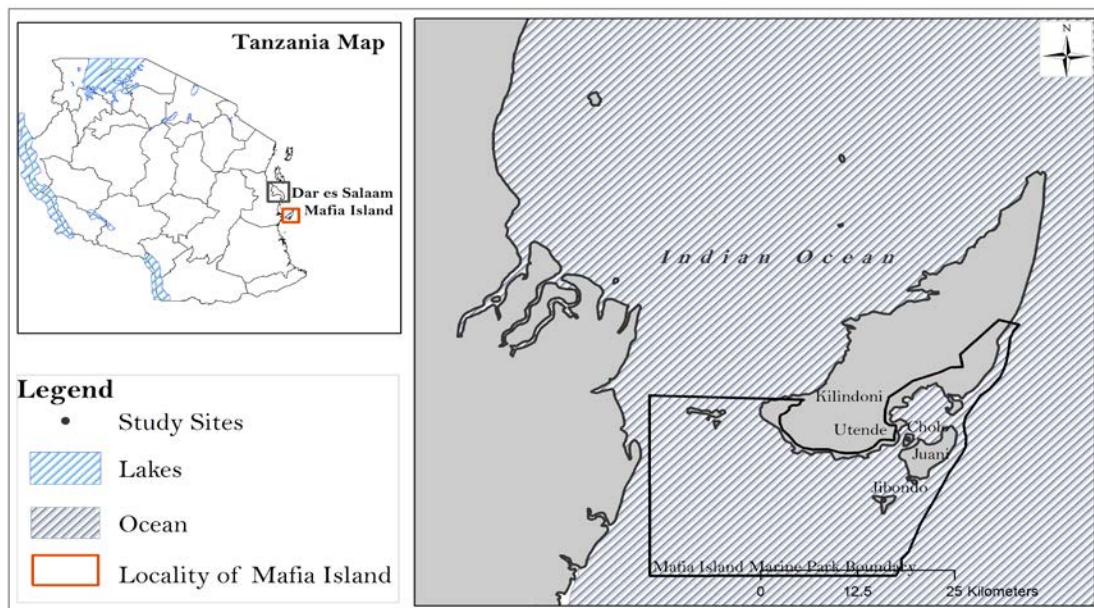


Figure 2: Map of Mafia Island showing study sites and the MIMP boundaries

The Mafia District stretches across the trade wind system, where the northeast monsoon blows from December to April, and the southeast monsoon blows from June to October. These monsoon winds influence climatic and oceanic conditions, including air temperature, which ranges from 20 °C to 32 °C, and sea surface temperature, which ranges from 25 °C to 31 °C (Bryceson et al., 2006). The district has an average annual rainfall of about 2,000 mm, experiencing short rains from October to December, and long rains between March and May.

Although the island has the richest marine biodiversity in the western Indian Ocean (Benjaminen & Bryceson, 2012), it has little soil cover, with most areas dominated by sandy loam and coral rags. (Bryceson et al., 2006).

The biophysical and climatic characteristics described above have both a spatial and a temporal influence on people's ability to pursue their livelihood activities. Because the characteristics also tend to support certain activities at specific locations and times, they tend to expose people to various economic shocks and stresses. People's knowledge of such characteristics often guides the timing of their activities to minimize vulnerabilities. Fishing activities have tended to be dominant among both men and women, although women engage mainly in octopus fishing and seaweed farming (Bryceson et al., 2006; URT, 2007). The people of Mafia Island also engage in agricultural and other economic activities, including livestock keeping, rope making, boat making, handicraft and small business (Walley, 2004; Mwaipopo, 2008).

As highlighted earlier, this study was carried out within the MIMP, which is located south of Mafia Island. The history behind its establishment can be traced back to the 1960s, when Ray (1968) argued for the need to protect Tanzania's marine resources (Andrews, 1998). By 1981, some areas in the southern part of the island had been designated as marine reserve. Despite this designation, marine degradation in Mafia's waters persisted, because fishers, particularly the outsiders, continued to engage in destructive fishing practices, particularly dynamite fishing (Bryceson, 1981; Benjaminen & Bryceson, 2012). The reserves also lacked both financial and human resources, which further hampered their enforcement.

The late 1980s and early 1990s witnessed a series of studies that focused on understanding the physical, biological, and socio-economic statuses that were needed to guide the establishment of the Park from a scientific point of view (Ngoile, 1989). In 1994 the legal framework to guide the establishment and implementation of marine parks and marine reserves in the country, the Marine Parks and Reserves Act of 1994, was put in place. In the same year, the MIMP was established in response to global conservation requirements and local demands to halt dynamite fishing (URT, 1994; Walley, 2004; Benjaminen & Bryceson, 2012). Implementation of the MIMP began in the following year, 1995, and the boundaries to mark its area, which covered about 822 km<sup>2</sup> of land and water, were gazetted in 1996.



Because the MIMP became a multi-use park, the people who were living within the gazetted boundaries were not evicted from the Park. The MIMP thus includes 13 villages inhabited by about 23,000 people, whose livelihood pursuits are regulated (URT, 2011). The inhabitants, through conservation sub-committees, have been engaged in park operations; the cessation of dynamite fishing within Park boundaries since 1998 being their most successful endeavor (Bryceson et al., 2006; Benjaminsen & Bryceson, 2012). The first general-management plan for the Park, based on the Act (1994), was formulated in 2000, and was followed by the enactment of park regulations in 2006 (URT, 1994; 2000; 2006). Although the 2000 management plan was scheduled for revision in 2005, it was not revised until 2011 (Benjaminsen & Bryceson, 2012).

The above documents provide detailed accounts of the MIMP's implementation in terms of the fulfilment of its objectives, which cover issues related to conservation, resource use, participation, tourism, education, cultural heritage, monitoring, research, and sustainable development (URT, 2011). Strategies for dealing with zoning, fishing gear limits, alternative livelihoods, village liaison committees, and patrols were also established (URT, 2000). For example, the zoning strategy designated three zones to guide multiple uses of Park area: a core 'no take' zone (an area with the Park's richest biodiversity); a specified-use zone, and a general-use zone for regulated fishing. Although the Act (1994, p. 10) stipulates that village councils, relevant committees, or representatives 'shall participate fully in all aspects of the development of the regulations, zoning and general management plan', there is increasing evidence that points to inadequate adherence to this stipulation (Walley, 2004; Mwaipopo, 2008; January & Ngowi, 2010; Benjaminsen & Bryceson, 2012).

This study was carried out in two villages within the MIMP, namely Chole and Jibondo, each of which constitutes a small island community (Figure 2). The study sites were chosen to reflect different contextual backgrounds, allowing comparison between the two communities in terms of how they were coping with social-ecological changes. Chole has higher poverty levels than Jibondo (Bryceson et al., 2006), despite the fact that it is a relatively developed and well-organised tourist destination (IRG, 2008) and in close proximity to the main island of Mafia. Jibondo is further from the main island, has poor soil cover, and its community's economic activities are almost entirely limited to fishing, seaweed culture, and boat building.

### **3.1.2 Data collection and analysis**

This study employed mainly qualitative methods of collecting data. The use of such methods allowed a detailed and contextualized understanding of how the two fishing communities interpreted the processes of change in their livelihoods, and how the effects of such changes were dealt with. Quantitative methods of data collection were employed at a later stage in order to provide simple quantitative indications of the reported social-ecological changes. The combination of qualitative and quantitative techniques provided an opportunity for utilizing the strengths of each research technique to yield rich answers to research questions (Bryman, 2004; Creswell, 2003). The following sub-sections provide brief explanations of the methods and techniques that were employed in data collection.

#### ***3.1.2.1 Key-informant interviews***

Interviews conducted with key informants were semi-directive, and aimed at providing room for purposively selected participants to give in-depth explanations of the various processes of change in the livelihoods of the people of Chole and Jibondo villages. A total of 78 interviews were carried out, each lasting between 35 minutes and two and a half hours. The number of interviews conducted was determined by a saturation point that indicated that no new answers would emerge from further interviews. Where consent was granted, a voice recorder was used to record the interview. In most cases, however, informants were not comfortable with the idea of being recorded during interviews, and notes were taken instead.

The interviews were conducted in different locations. At the village level, they were carried out mostly in the homesteads of identified informants. Care was taken to ensure that informants representing different fishing practices and livelihood activities were obtained. Investors or operators of hotels located within the Park were interviewed in Chole and Utende. Informants at the institutional level were interviewed in Utende, Kilindoni, and Dar es Salaam.

#### ***3.1.2.2 Focus group discussions***

A total of 16 focus group discussions were conducted with elderly fishers, young fishers practising pull-net fishing and octopus diving, women octopus fishers and seaweed farmers, and village and religious leaders. These focus group discussions were useful for obtaining different points of view in one setting. Individuals of different ages and genders, engaged in

various fishing practices and livelihood activities, and holding varied perceptions of marine environmental conditions, and conservation practices, were brought together to discuss various social-ecological aspects in an interactive manner. The focus group discussions were conducted either in village office buildings or under the trees where net-mending activities were carried out.

### ***3.1.2.3 Direct observation***

This method of data collection provided a means of confirming some of the information obtained from other methods. I observed and took notes on the types of fishing gear people used, the extent of damage to fishing nets, net-mending activities, the aftermath of confiscation of fishing equipment, fishers' adherence to tidal patterns, duration of daily fishing trips, catch composition and quantity, and catch-collection activities by traders. I also observed variations in housing conditions among various wealth categories. Furthermore, I observed the types of food prepared in households and was sometimes invited to share meals with household members.

I also made observations regarding livelihood diversification among household members. For instance, I observed various activities and events related to farming, including efforts to fence farms, incidences of crop destruction, livestock free grazing, seaweed drying and sorting, and child-care activities by elderly women. On occasions when I saw people on Jibondo digging large pits for dispensary waste disposal, household pit latrines, rain-water storage, or house foundations, I was able to observe the soil profile of the area and confirm the accuracy of the information I had obtained about constraints on crop production in Jibondo.

In addition, I made structured observations throughout the research period of one household at each site, in order to understand how household members engaged in various economic activities, and sometimes I took part in these activities. I also participated in funeral gatherings and village meetings. All these observations and, to some extent, my engagement in community activities, provided important avenues and insights for conducting a series of informal interviews and chats. These were useful in providing a deeper understanding of important aspects of this study.

#### ***3.1.2.4 Seasonal calendars***

Together with participants we drew up seasonal calendars to identify seasonal variations in the livelihood activities undertaken in each village. These calendars enabled me to plan my research activities, but more importantly, improved my understanding of how various socio-economic activities were distributed throughout the year. The calendars also provided an understanding of how the people of Chole and Jibondo dealt with short-term changes such as seasonal variations in rainfall and monsoon winds. For example, the calendars showed how fishers changed fishing areas throughout the year, variations in the types of fish caught, and annual trends in non-fishing activities.

#### ***3.1.2.5 Participatory mapping***

Participatory mapping was useful in providing a greater understanding of declining crop production in Jibondo. A group of villagers, led by a fellow villager talented in drawing, drew a sketch map of Jibondo village to provide visual explanations of why farming activities were declining in the area. The map also showed the distribution of small shops, which were crucial in providing villagers with food and financial support. Since the map was labelled in Swahili, I provided English translations; I also made modifications to improve some of the visual details on the map.

#### ***3.1.2.6 Wealth ranking***

A participatory wealth-ranking exercise was conducted in order to stratify households in the two sites and enable random sampling of questionnaire respondents from each category. Wealth ranking provided a basis for understanding social structures and classes within the two study sites. It improved my understanding of wealth categories from the perspective of local people and of how individuals in each category were affected by, and responded to, various changes in their livelihoods. Participants from each village defined wealth and explained key indicators of each wealth group before wealth ranking was carried out.

#### ***3.1.2.7 Anthropometry***

Anthropometry was used for collecting anthropometric data for children under five years of age. Anthropometric measurements (weight for age) were employed to obtain quantitative data that were then used to assess the nutritional status of under-five children. These

quantitative indications of nutritional status provided the basis for building a better understanding of the age-based effects of social-ecological changes in the study sites.

#### ***3.1.2.8 Questionnaire survey***

Between January and March 2011, towards the end of the data collection period, I administered questionnaires in order to obtain simple systematic quantitative data and/or indications that could not be obtained from qualitative methods of data collection. The questionnaires were designed to complement the qualitative data on changes in fish catches, oceanic conditions, trends in livelihood activities, household income and food status, conservation strategies, and the processes of dealing with such changes. A total of 103 structured, open-ended questionnaires were used to conduct structured interviews with the heads of households.

In terms of size, the sample constituted about 17% of the total households on Chole (226) and Jibondo (364). These figures were provided by village government at the beginning of the data collection period. However, as I was winding up my data collection activities, village authorities, through a government-led exercise, established that the number of households on Chole had increased to 243, while those on Jibondo had increased to 620, meaning that the real sample size had decreased to about 12%.

Respondents were randomly selected from stratified wealth-rank categories in order to obtain representatives of each wealth category and provide an understanding of their responses to various social-ecological effects.

#### ***3.1.2.9 Desk studies***

Desk studies were carried out in various locations in order to review literature on the various contextual conditions relevant to this study. For example, bio-ecological studies conducted within the Park were reviewed at the MIMP offices to build a general understanding of fish-catch collections, fishing practices, and the status of marine environmental conditions over time from conventional science perspectives.

Historical information on previous environmental conditions and socio-economic status was obtained at the National Archive offices Dar es Salaam. Furthermore, I reviewed peer-reviewed publications on the perspectives of resilience in various aspects of social-ecological

systems, including traditional ecological knowledge, adaptive management in marine resource management, and challenges of diversification of livelihood activities. Such reviews were useful in placing the local contextual knowledge into broader perspectives. They also formed a basis for reflecting on the contribution of this study to the existing knowledge of changes in social-ecological systems.

The analysis of qualitative data began while I was in the field. The transcription of the voice-recorded data was progressively carried out throughout the fieldwork and data analysis phases. During the data analysis phase, I recruited and oriented two research assistants (both holding MA degrees in sociology) to assist with the transcription work. The recorded data were listened to repeatedly to foster familiarity with, and develop an understanding of, the data. Re-reading transcriptions and textual data allowed me to identify issues for further probing. These prompted me to carry out continuous discussions about preliminary results with research participants, or ask for clarification on issues that were not clearly understood. This process also helped me to ensure that my understanding of their social processes and conditions was accurate.

Qualitative data were analysed through thematic analysis. First, the data were sorted into broad thematic categories based on research objectives. The categories were further reviewed to identify emerging themes and analytical meanings, which were then related to and integrated into the discussion of broader thematic concepts in the existing knowledge base. After that, the data from structured interviews were summarized, coded, and analysed descriptively using Excel, and presented using percentage distributions, frequencies, and tables. The data from anthropometric measurements were checked for consistency and then analysed descriptively and presented as proportions. Results from anthropometric data were then interpreted using growth charts developed by the World Health Organization (WHO, 2006).

### **3.1.3 Validity and reliability**

To strengthen the validity and reliability of data, I used multiple data collection methods to gather and confirm data. The use of multiple methods ensured that the data obtained was triangulated with other methods. Distortion of data was noted through verification of information that was obtained from different sources collected using different methods. To ensure that conclusions were drawn only from reliable data, I discussed results from my

preliminary analysis with the people of Chole and Jibondo and checked whether or not my understanding of various issues conformed to their understanding. These discussions were conducted as a continuous process throughout the data collection period. Some results were also presented in a feedback workshop, which involved various fisheries management and marine conservation actors, including representatives of the people of Chole and Jibondo villages.

#### **3.1.4 Study limitations**

The major limitation of this study relates to the lack of data on how other actors across the scale were affected by, and dealt with, neoliberal-based social-ecological changes. At the national level, my attempts to obtain data from the Ministry of Livestock and Fisheries Development were unfruitful. This limited my ability to undertake detailed analysis of response mechanisms at a higher level. However, as shown in Paper 4, the use of secondary data related to fisheries management, and primary data obtained at the MIMP and Marine Parks and Reserves Unit headquarters in Dar es Salaam contributed to the analysis of some fisheries management issues.

Obtaining data on catch-collection trends from the finfish processing factory, TANPESCA, an important actor in fisheries and livelihoods development, was also problematic, as I had difficulty securing permission to enter factory premises and obtain data. To address this limitation, I consulted the MIMP authorities to find out whether there were such data in the Park's records. Unfortunately, the MIMP officials had also experienced difficulty in accessing systematic data from the factory. In a further attempt to address such data shortcomings, the responsible factory official directed me to the factory headquarters in Dar es Salaam. There I was able to carry out an interview, but systematic data on catch-collection trends remained inaccessible. I thus decided to rely on the general data obtained from the interview and district records to analyse some of the fisheries management issues.

Furthermore, existing tensions between the villagers and MIMP officials, slowed down the data collection process in both villages considerably, mainly because it was difficult to establish rapport and trust with villagers. Thus, a lot of time was spent explaining the purpose of the study, and it was not possible to adhere to strict guidelines for conducting interviews, focus group discussions, and questionnaire surveys. For example, it was simply impractical to stick to the ideal time limits, or even to limit the size of focus groups, when individuals were

eager to explain issues at length, or to participate in discussions. Furthermore, data collection was slow because a tense research environment made it difficult to introduce new individuals into the study. Thus it was impossible to use research assistants. Consequently, I could not achieve a large sample size during the collection of quantitative data.

It was also impractical to proceed with data collection when the villagers were in a difficult situation, particularly at times when their fishing gear and vessels were being confiscated. During such times, therefore, my trips to the study sites were used specifically for strengthening rapport and trust through my physical presence, and to observe the effects of, and responses, to such confiscations. Given all these limitations in the data collection process, it was unfeasible to complete my fieldwork within the initial one-year period allowed by my research permit, which was valid from August 2009 to August 2010. This limitation was addressed by applying for an extension to the permit, which was granted for a period from August 2010 to April 2011.

Another limitation related to the socio-cultural differences between the villagers and me. The villagers strongly believed that their poor socio-economic conditions stemmed mainly from the fact that Park officials originated from mainland Tanzania, and therefore did not have an adequate understanding of coastal livelihoods in relation to marine environments. Given the fact that I also originated from the mainland, the villagers doubted whether I would represent their conditions effectively. To address this limitation, I assured them that I would spend enough time in the study areas to allow in-depth scrutiny of various issues as part of a learning process that would provide a better understanding of their conditions. I also assured them that I would not change the data obtained. In addition, I discussed the preliminary findings of the study with villagers to ensure that my understanding of the various social-ecological issues, including the various aspects of their socio-economic conditions, was correct. I also explained to them that the difference in our socio-cultural backgrounds was actually one of the strengths of this study, mainly because it minimized subjectivity.

Lastly, understanding social-ecological changes from the perspective of the local communities who had varied experiences of neoliberal-based conservation and development endeavors could be a major source of bias in this study. For this reason, care was taken to encourage participants to provide honest opinions. The use of various tools of data collection was useful in detecting outright false responses; in some cases, a number of participants



admitted that they had given false information, particularly when I started my fieldwork. They later explained that they had feared that the information would be used against them to advance marine conservation, and thought I would not stay long enough to detect such errors. For example, at the beginning of my fieldwork, some pull-net fishers explained that they used three-inch fishing nets without scoop-nets, and that coral soils in Jibondo village hampered *any* crop production. However, they later confessed that these were fabricated explanations, intended to convince outsiders to support their need for the MIMP to reduce restrictions on accessing fisheries resources within the MIMP.

### **3.1.5 Ethical considerations**

In the course of conducting scientific research, researchers are obliged to adhere to ethical principles to ensure that participants are well informed and have the potential to benefit from the proposed study, that they are not exposed to risks, and that their privacy is respected (Creswell, 2003; Bryman, 2004). I obtained permission to undertake this research from the University of Dar es Salaam and other national, district and local village authorities. In addition, informed consent was sought from individual participants before they were involved in this study. Permission from mothers and guardians of under-five children to undertake measurements and record children's information was also requested and granted.

Before involving participants in the data collection process, I explained the purpose of the study to them. Due to existing tensions between villagers and officials from the MIMP, the Mafia District authority, and the TANPESCA factory, the process of explaining the purpose of this study was extremely repetitive. I made it clear that the results of the study would be used only for academic publication, and that they would serve as a source of feedback to the MIMP and other fisheries management authorities. During these introductory sessions, I also guaranteed participants' anonymity and confidentiality in reporting the findings, in order to protect them and respect their privacy. Only two potential participants from Jibondo village declined the invitation to participate in this study on the grounds that previous studies had not resulted in any improvements in their lives, and that information obtained would be used to further tighten resource-use restrictions. In these cases, the decisions of the two individuals were respected. Furthermore, permission from participants to record interviews and focus group discussions was requested, and their decisions were also respected.

### **3.1.6 Fieldwork experiences**

While my fieldwork was ultimately successful, I found it useful to document the difficult experiences I encountered during the data collection period. The tensions among villagers, and between villagers and officials from the MIMP, have turned Jibondo and Chole villages into difficult areas for conducting social research. I first went to Mafia Island in 2008 and was introduced to the study sites, the MIMP, and the district authorities. During the introductions, villagers and officials gave me a warm welcome. A year later, I went back to Mafia Island to begin my fieldwork. I registered my presence with the district authorities and submitted my research permit and introductory letter for conducting research in Chole and Jibondo villages.

During my short interaction with the district officials one official warned me that as a woman, I would not be able to carry out research in Jibondo village because it was a dangerous place with violent villagers. I was then given two options for ensuring my security: either to change the study area, or to carry out the research in Jibondo under police escort. Recalling the friendly expressions of the Jibondo villagers to whom I was introduced in 2008, I decided to trust my instincts and chose neither of the two options provided. Instead, I requested the official to write an introductory letter for me to take to Jibondo village, and explained that I would like to have first-hand experience of Jibondo villagers before deciding between the two options. I was given the introductory letter and asked to report to the district authority whenever I encountered any violent incidents.

For logistical purposes, I chose to base myself at Utende village. The village had secure facilities for handling and storing the research boat, boat engine, fuel, and other equipment. Furthermore, it was easier to alternate field routes to Chole and Jibondo villages from Utende, and to maintain equal treatment of both study sites, especially when villagers in each site assumed and defended their right to host me throughout the fieldwork period. Thus, by settling in Utende, I avoided complaints from villagers regarding my settling in one village permanently or spending too much time on either study site. Furthermore, to avoid unnecessary cultural tensions in either study site, I conformed to gender conventions by adhering to a dress code appropriate to a predominantly Muslim community.

As the fieldwork advanced, I experienced difficulties in developing rapport with the participants in the study areas. The villagers hesitated to interact with me, even after repeated

explanations concerning the nature of my study, because they did not believe that I was not one of the MIMP officials. This was mainly because the research boat had been seen in the MIMP parking lot several times. Immediate measures were taken to shift the research boat to a neutral boat yard at one of the hotels in Utende. After this shift, I gained trust from the villagers at both sites, and data collection proceeded smoothly. Interestingly, the warnings about my security were scaled up to another level. This time, villagers warned me repeatedly of the problems that would emerge between me, the officials at the MIMP, and the district as a result of my undertaking a detailed study of their existing social conditions. At the same time, villagers kept on encouraging me to continue moving forward and remain positive. This constant encouragement gave me the strength to persevere.

As villagers in both sites continued to freely explain in detail their changing social-ecological conditions, tensions between key officials from the MIMP, the district, and me were building up as anticipated. The officials accused me of destroying relationships between villagers and MIMP officials. I was also accused of threatening peace across the villages of Chole and Jibondo. Following these allegations, I was interrogated about my research work several times at the MIMP headquarters and district offices. To a large extent, these interrogations created unpleasant environment for conducting research. Hence, as it turned out, unpleasant fieldwork experiences originated from powerful actors at a higher level than that of the villagers.

## **4 Results and Discussion**

This section presents and discusses the key results that emanate from the study. The main focus of the study was to explore how marine social-ecological changes have unfolded within the Mafia Island Marine Park, and how the Park residents and management have responded to such changes to improve both marine environmental conditions and the well-being of the people that depend upon them.

### **4.1 Making the most of fishers' knowledge of marine ecological changes**

Various studies in the field of social-ecological resilience have demonstrated the importance of nurturing knowledge diversity by combining different kinds of knowledge as an effective way of building resilience (Berkes & Folke, 1998; Folke et al., 2003). For example, a combination of conventional science-based knowledge and traditional ecological knowledge

tends to facilitate the learning process and build a nuanced understanding of the dynamics of various aspects of social-ecological systems. However, there is no specific guidance on how the two kinds of knowledge systems can best be combined in a manner that maximizes their potential strengths. In most cases where the two have been combined, conventional science-based knowledge has received more attention than traditional ecological knowledge.

In this study, because the people of Chole and Jibondo villages depend mostly on marine resources for their livelihoods, their interactions with the marine environment were found to be continuous. They made repeated observations of marine environmental conditions and were in a good position to describe the observed changes. Hence, the first paper (Moshy & Bryceson, 2016) focuses on exploring how fishers, as key users of marine resources, perceive and explain observed fundamental changes in the marine environment within the MIMP.

Some of our results are in accordance with a few subordinate discourses indicating that the establishment of multi-use parks has led to the recovery of fisheries and increased catches, without increased ranges of fishing or additional costs, as observed by Kerwath et al. (2013) and Machumu and Yakupitiyage (2013). However, our results generally resonate better with the dominant discourses on multi-use marine parks which largely indicate decreased catches, increased travel distances and costs for fishing fleets, and a lack of full recovery of targeted fish (Kincaid et al., 2013; Rife et al., 2013; Stevenson et al., 2013; Kamat, 2014).

The first point made in the paper is that while fishers in Jibondo observed that overall fish catches are increasing, the catches by individual fishers are decreasing. The fishers explained these changes by pointing out the dominance of pull-net fishing in the area and increased ranges of fishing. The practice requires them to fish in deeper waters, and in larger groups per vessel than those recorded by Darwall (1996). Although this fishing method enables groups to obtain large catches, in reality it means that each fisher receives a smaller proportion of the catches.

Furthermore, the fishers explained that such changes also resulted from increased dependence on fishing as a major source of income, after marketing strategies shifted from selling dry fish to selling fresh fish. This encouraged people from the increasing population to move from farming activities into fishing. Since they are paid low prices, they tend to fish more (by increasing the number of fishing days and diversifying fishing activities), thereby contributing to the observed changes. Although this response is the one most voiced in this

study, it is contrary to the findings of Barnett and Anderies (2014), who report that the most common response to low prices among fishers in Canada was to store their catches until they could obtain suitable prices.

So while the Park's positive observation generally focused on trends in overall fish catches to explain the well-being of the marine environment following conservation efforts (URT, 2011), it missed the trends of fish catches by individual fishers. The Park could therefore not explain the decreased well-being of the people who make their living by interacting with the marine environment. Hence, fishers' explanations of changes in catch trends in Jibondo are clearly contrary to the assumption that the introduction of new livelihoods and sustainable fishing gear in multi-use marine parks would reduce dependence on fisheries and promote sustainability (URT, 2011). Focussing on understanding trends in people's well-being would have contributed a nuanced appreciation of the various social processes that have contributed to the observed changes in catch trends.

The second point made in Paper 1 concerns the perceptions expressed by the fishers of Chole. Unlike those of Jibondo, the fishers of Chole observed decreasing trends in both overall and individual catches. They attributed these decreasing trends to increased marine protectionism, which had prompted most fishers to rent out their fishing boats and boat engines to fishers in distant areas, abandon fishing altogether, or fish juveniles in shallow waters. Zoning, as a key strategy for marine protection, was also said to have hampered the rotation of fishing activities around traditional fishing grounds. The observed changes in catch trends in Chole therefore imply that the existing generalized information on increasing overall catches within the Park area (URT, 2011) masks the realities of contextual variations of catch trends among the Park villages. The realities of contextual variations are further evident in the reported response strategies that contributed to a decrease in the number of fishers in Chole. Consequently, efforts to transmit traditional knowledge across generations of fishers have also decreased, thereby compromising the availability of such knowledge in the future. This is one example of how implementation of the Park has contributed to effects that could impair the potential for future engagement with fishers' traditional knowledge.

At the same time, the tendency to overlook the importance of tracking people's well-being deprived Park officials of the opportunity to gain a nuanced understanding of contextual variations of the social implications of Park conservation for specific Park villages, and the

opportunity to respond appropriately to such effects. This was, for example, the case with the observed decreasing trends in both overall and individual catches of octopus. Because of increased protectionism and frequent confiscation of fishing nets since the early 2000s, more people have been drawn permanently or temporarily into octopus fishing. The issue of declining octopus catches has therefore emerged as a new governance challenge. This supports the argument by Hinkel et al. (2015) that governance challenges usually originate from a lack of understanding of how multiple uses in SESs are connected. The paper shows that the connection between fish and octopus fisheries, and between fishers and traders, particularly factory agents, has to some extent, been overlooked.

It should be noted that the current decline in octopus fisheries began during the early 1990s, when octopus traders introduced the buying of fresh octopus catches. This had the effect of attracting more people into octopus fishing. Hence, the governance of SESs needs to promote an understanding of system dynamics over time, across various levels, and among various actors (Vervoort et al., 2014). This is important because octopus catches still received low prices that compelled fishers to fish more (Paper 2); and furthermore, the fish processing plant was open to buying octopus catches throughout the year. The plant also bought as many octopus catches as possible, and envisaged venturing into mechanised octopus fishing if the government would grant them a permit (Paper 4). All these factors suggest that the challenge of a decline in octopus catches is likely to persist. Scholars have shown that fishers elsewhere are less concerned about the decline or sustainability of fisheries, and much more concerned about the extent to which large-scale users benefit from fisheries resources and cause the decline and degradation of fisheries, and about who should bear the costs of fisheries and conservation regulations (Fabinyi et al., 2015). Because fishers' complaints about unsustainable practices among large-scale users are evident (papers 1, 2, and 4), Park implementation processes should be required to redirect efforts to respond to the changing marketing strategies and practices of powerful actors (including traders and factories) that collect catches and manufacture unsustainable gear, which are in fact shaping fishers' actions on the ground. This means that the current trend in Park implementation to focus on controlling fishers' actions without directing the same efforts towards regulating the larger forces that influence such actions, is less likely to yield the envisaged conservation outcomes. The trend therefore supports the argument that governance efforts often tend to be directed at one level and miss out other levels at which key processes may play out (Cash et al., 2006; Fabinyi et al., 2015).

Park implementation processes should also redirect efforts to carry out research into changing environmental conditions that shape fishers' actions on the ground. This would contribute to a shift from the single-based factor and linear modes of explaining changing environmental conditions, as was the case with presenting over-exploitation narratives, to an understanding of decreasing fish abundance in fished zones. Fishers' explanations of rising sea temperatures and evidence of falling sea levels provided further understanding of the decreasing trends. These findings support the observations of Silvano and Begossi (2012) on fishers' ability to produce new knowledge that is yet to be reported in conventional science studies of a certain area, and their ability to produce knowledge that concurs with both conventional science and traditional ecological knowledge that is reported elsewhere (Mustelin et al., 2010; Kebede and Nicholls, 2011).

On another note, the fishers' observation that the condition of coral cover had generally improved following the halting of dynamite fishing within the Park area confirms a common understanding among fishers, Park officials, fisheries officers, researchers, and the general public, that dynamite fishing practices are indeed unacceptable, and that collaborative actions that prompted its termination are highly appreciated (Walley, 2004; Benjaminsen & Bryceson, 2012).

However, the fishers' observation that there are patches of disturbed corals resulting from pull-net fishing practices suggests that there is a lack of consensus among actors as to whether or not such practices are indeed destructive, and the extent to which they may be so (Paper 4). This is perhaps a key issue that calls for the Park to redirect its efforts to invest in employing the same collaborative action to build consensus. It is also important because not all the Park's efforts have been effective. For example, the zoning strategy and gear restrictions reduced pressure on some traditional fishing grounds, but resulted in increasing fishing pressure on the few remaining fishing grounds.

Furthermore, previous harvesting-related practices that contributed to the management of octopus fishing are no longer carried out. The weight limit of 500 grams for an individual octopus is no longer observed. Meanwhile, there have been shifts from octopus gleaning to octopus diving, from octopus gleaning during spring tides to continuous octopus diving through the neap tide, and from the three-month closure of the fish processing factory to factory operation throughout the year. Since there are poor relations between Park officials

and fishers (January & Ngowi, 2010; Benjaminsen & Bryceson, 2012), the feedback from the outcomes of the Park's conservation efforts is not effectively communicated, and could further compromise octopus fisheries. This finding supports the argument put forward by Barnett and Anderies (2014) that poor relations between resource users and resource managers usually weaken system feedback, which can then result in the collapse of some fisheries because resource users may modify rules to suit existing social-ecological conditions.

Barnett and Anderies (2014) found that a decline in ground fishing led to the expansion of lobster fishing, and that a decline in lobster income drew fishers back into ground fishing. In this case, however, it would be difficult for fishers to return to fishing finfish when octopus fisheries declined, because most of the Park's conservation efforts are geared towards controlling fishing of finfish. While there have clearly been efforts to advocate set-nets as prescribed fishing gear, the dominance of prohibited pull-nets was evident. Biggs et al. (2015) found that the introduction of new strategies for harvesting marine resources can be successful when there is collaborative work among resource users, managers, and researchers to deal with the challenges that emanate from previous harvesting methods and conservation measures. This points to the fact that collaboration among actors in finfish fishing is crucial for understanding the effectiveness of the prescribed set-nets, and for introducing effective fishing gear that would contribute to balancing the fishing pressure between finfish and octopus fisheries. While this could slow down the observed decline in octopus fisheries, successful restoration thereof would require adaptive strategies that focus on producing knowledge and governing strategies to balance conservation and development needs. Such strategies have proved to be effective in the restoration of coral ecosystems (Frey & Berkes, 2014).

Lastly, the focus on fishers' knowledge empowered the people of Chole and Jibondo to freely share their knowledge and experiences on their own terms; this created an enabling environment for combining traditional ecological knowledge and conventional science knowledge in an equitable manner. It also contributed to the understanding of marine social-ecological changes. Hence, by focusing on fishers' knowledge within its philosophical stance in the future, the MIMP could uncover important observations on the changes that might be overlooked by conventional science-based conservationists. This would also create space for accommodating an adaptive-management approach within marine conservation efforts in a



meaningful way (Paper 4). Efforts to employ fishers' knowledge must therefore be made to ensure that conservationists optimize this knowledge and promote meaningful outcomes for both marine conservation and for livelihood improvements. More importantly, future efforts to engage fishers in conventional science endeavors will need to benefit communities (Moran & Lopez, 2016), unlike the current efforts that focus largely on improving marine environmental conditions.

## **4.2 Social-ecological changes and resilience in small islands**

The main focus of Paper 2 was to investigate the effects that changing marine environmental conditions, marine conservation, and economic development policies have had on the livelihoods of the people of Chole and Jibondo villages. This focus is important because the most common aspects of social systems have been overlooked from the social-ecological systems perspective. Most studies on SESs and resilience thinking have tended to focus on the analysis of ecological aspects, and less attention has been paid to the analysis of social aspects, including social, political and economic processes (Folke et al., 2003; Barnett & Anderies, 2014). In particular, attention has usually been directed towards those aspects of social systems that are closely related to the governance of natural resources, particularly issues of property rights and traditional environmental-management practices (Berkes & Folke, 1998; Ostrom, 2009).

During the 2000s, some social-ecological research began to focus on understanding the ecological, institutional, and livelihood diversity in building the capacity of SESs to deal with social-ecological changes (Folke et al., 2003; Berkes & Seixas, 2005). However, there has been inadequate focus on the aspects of social systems that are closely related to the well-being of the people who depend on natural resources for survival. Hence, the use of a livelihood-resilience lens was ideal for ensuring that aspects of people's lives, rights, and power relations remain central, allowing further improvement of resilience thinking (Tanner et al., 2015).

Results of this study have shown how members of households struggle to maintain their livelihoods under changing marine ecological conditions, increasing neoliberal-based marine protectionism, and market-led economic development policies. Decreasing fish abundance in shallow areas, reduced access to traditional fishing grounds, restrictions on fishing gear, and failure to obtain reasonable prices for local produce, have all contributed to various

household hardships. The ability of households to earn an income, meet food requirements and afford other amenities has decreased. While *maisha magumu* ('tough life') was the most common phrase that the Park residents used to summarize their livelihood conditions during the early 2000s (Walley, 2004), the most common phrase during this study was *maisha yametushinda* ('life has failed us').

The above shift in phraseology affirms the key finding in Paper 2, namely that most participants are experiencing increased poverty compared to previous years. Hence, the assumption that the MIMP conservation strategies have improved local livelihood conditions remains problematic. The findings in this paper are in accordance with the increasing evidence that shows that although various multi-use parks in developing nations seem to be successful in terms of biological conservation, they are overwhelmed by social failure (Brockington et al., 2008; Kamat, 2014). In Tanzania, for example, negative sentiments have been increasingly documented about disrupted or 'squeezed-out' livelihoods, lack of viable alternatives, use of violent action to enforce regulations, and the prevalence of social suffering and misery across park villages (Walley, 2004; Mwaipopo, 2008; January & Ngowi, 2010; Benjaminsen & Bryceson, 2012; Kamat, 2014; Mangora et al., 2014).

As also reflected in Paper 4, the poor social conditions are partly exacerbated by efforts to conserve the marine environment, which focus largely on achieving good marine environmental conditions, but overlook the socio-economic conditions and livelihoods of the people living around the marine environment. Adaptive-capacity studies carried out among residents of marine protected areas elsewhere have shown high levels of poverty and a lack of formal education or training (López-Angarita et al., 2013). However, in the case of the MIMP, the residents' adaptive capacity to deal with various social-ecological changes was affected more noticeably a lack of meaningful action on the part of the Park officials to respond to social outcomes of Park implementation.

Although the results of this study show that household members responded to social-ecological changes by reducing expenditure and seeking loans, skipping meals, selling assets, conducting collective fishing, changing fishing techniques, changing gender roles, diversifying livelihoods, or even migrating to other places, such responses did not result in meaningful improvement to social well-being. In fact, these responses could not resolve the key challenges that constrained their livelihoods. For example, it has been shown in paper 2

that such responses to ongoing marine protectionism did not lessen the extent of protectionism or even influence the Park to modify current conservation strategies in order to bring about livelihood improvements. Response actions among the fishers of Chole, such as abandoning fishing activities, renting fishing equipment to people in distant areas, or even migrating to other places, neither improved their household well-being nor resolved conservation-based constraints. Repeated efforts to resist Park operations, to demonstrate non-conformity to Park regulations (such as the use of scoop nets with a mesh size less than two and a half inches), and to replace confiscated gear, could not resolve such challenges either. In fact, gear replacement worsened families' financial conditions by increasing household debt.

Furthermore, responsive actions among women and some elderly fishermen to shift into seaweed culture did not provide a meaningful solution to declining octopus catches, and seaweed harvest did not provide a daily income in the way that fish and octopus catches had done. Although fishers decided to avoid TANPESCA agents by selling their catches to local traders, such a response could not address the key marketing constraint – low prices. The results show that fishers and producers of other local produce receive lower prices than they had hoped to obtain.

The response of abandoning crop-production activities by focusing on fishing activities, following the emergence of new market opportunities to sell fresh fish and octopus catches, did not improve financial capacity among the people of Jibondo. They could still not purchase sufficient household food supplies to compensate for the food that they would have produced themselves. Likewise, responsive actions among seaweed farmers (including shortening the time between planting and harvesting, and sorting the green algae from the dried seaweed harvest<sup>4</sup>), could not resolve their key challenges, i.e. decaying seaweed from warmer and rougher water conditions, and the invasion of seaweed fields by green algae.

Other responses, such as resorting to fishing in large groups as a way of building capacity to fish in deeper waters, did not bring meaningful improvements for individual fishers because the income from the catch obtained from each vessel was shared by more fishers. Such a

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<sup>4</sup> Seaweed sorting was carried out manually and was laborious and time consuming. For example, observations revealed that 81 kg of dried seaweed harvest took five-and-a-half hours of sorting to obtain 73 kg of seaweed. However, the price of seaweed did not reflect the cost of seaweed production.

response could not solve the key environmental constraint of increasingly warm water conditions in the shallow areas, with resultant decreased fish abundance. While decreasing fish sightings in shallow areas remain a key challenge among fishers in the two sites, Cox (2014) affirms that fish-stock decline is also a large-scale environmental problem that impacts on the well-being of a large number of people in the world. Local responses to dealing with a global environmental problem are likely to remain ineffective, unless efforts are made to harmonize responses across various levels.

Furthermore, because the local responses discussed above could not resolve the key social-ecological challenges, future responses would benefit from people's understanding of the various structures that influenced agency of local people to deal with the challenges (Tanner et al., 2015). Our results have shown that varied wealth status, type of livelihood activity, changes in access rights to resources, unequal sharing of conservation costs and benefits between small and large resource users, proximity and remoteness of the villages to the MIMP headquarters, and peoples' varied social-capital strategies<sup>5</sup> all influence their agency in dealing with the challenges.

The results of this study also show that the effects of, and responses to, social-ecological changes to enhance social well-being are based on age and gender. Elderly men are the most affected because they are too weak to adopt new, labour-intensive fishing techniques. Meanwhile, people of Jibondo who keep free-grazing livestock constrained the elderly men and women from engaging in crop production. The map that resulted from the participatory mapping exercise (Figure 3) indicates that there has been a substantial decrease in the amount of land that is formally used for crop production. This is due to the expansion of residential areas, whereby three additional sub-villages (Kichanga Chui, Juu Maji, and Shinyanga) are now occupying the area that was previously used for crop production (Figure 4). Furthermore, the practice of free grazing of livestock, which began in the late 1980s, has constrained crop-production activities because livestock grazing does not conform to the previous land-use designation. Thus the response actions by the few people who continue to produce crops in Jibondo, such as fencing their farms, do not attend to their key challenge – crop damage by livestock. Women also face an increased responsibility to contribute to

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<sup>5</sup> These include networks and connections among villagers, and among villagers and fish traders, investors, Park officials and researchers.

household income and needs. They work harder to sustain their households, which means that they have less time to carry out their biological responsibilities, including childcare (Paper 3).

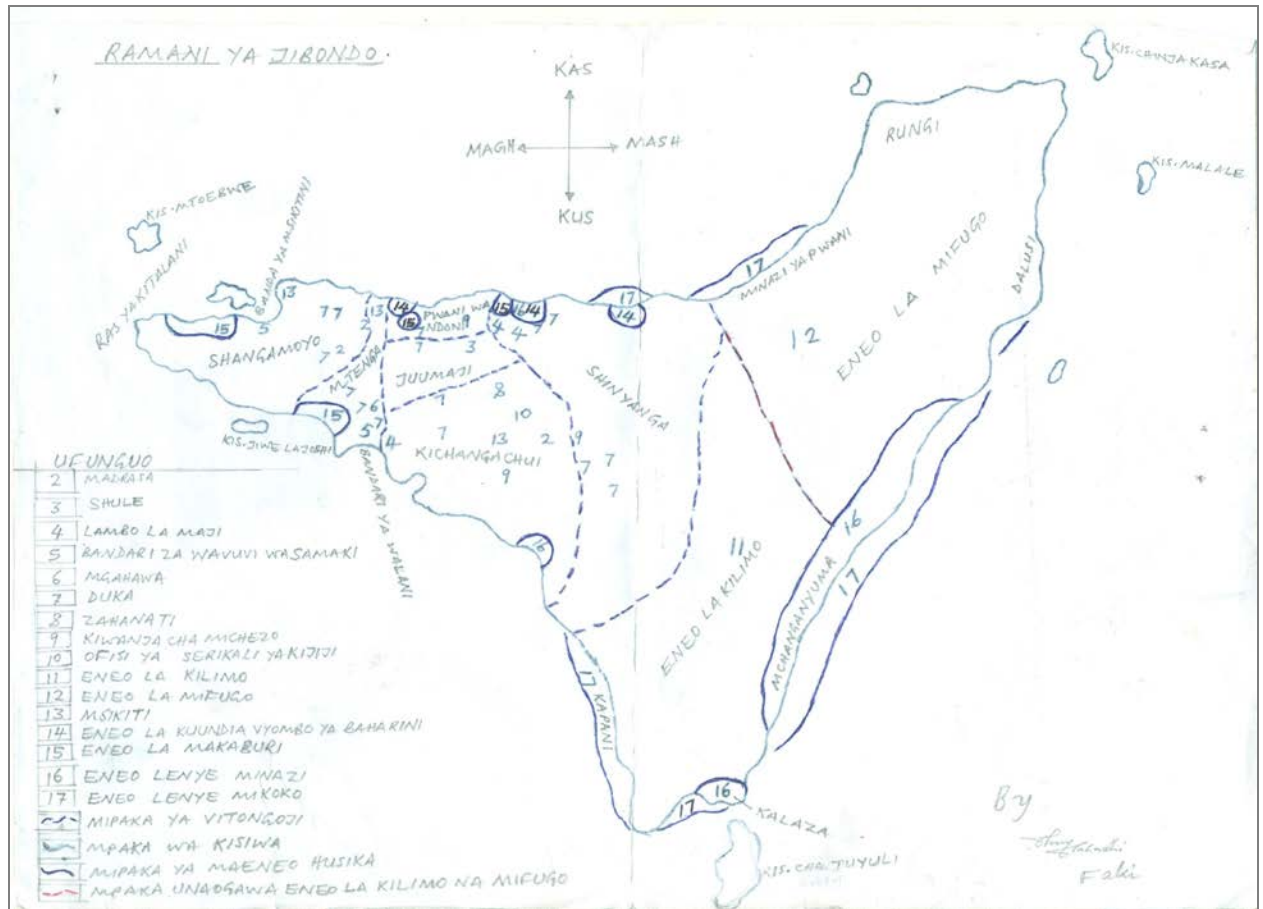


Figure 3: Participatory sketch map of Jibondo village

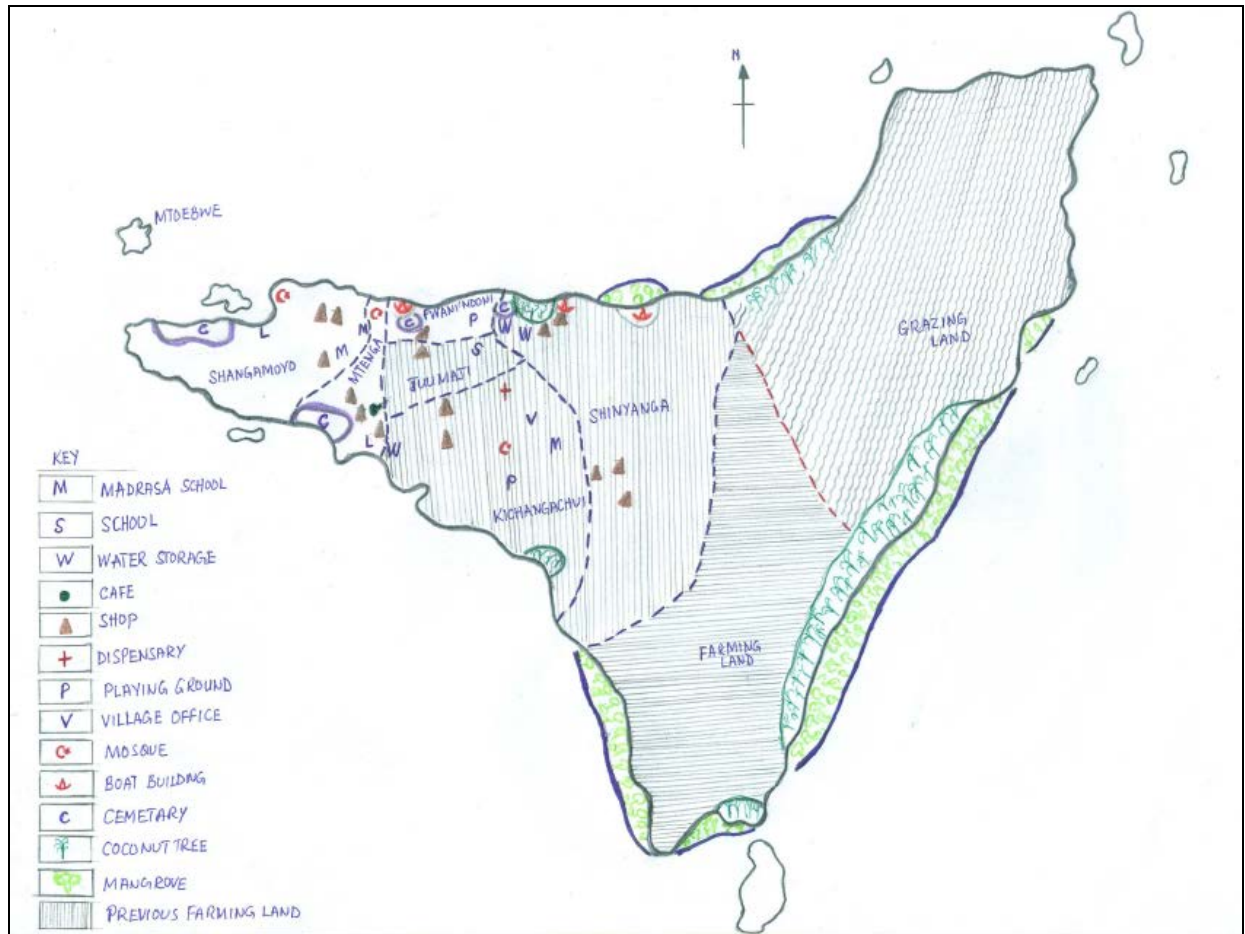


Figure 4: Modified participatory sketch map of Jibondo village, showing decreased size of land for crop production. Note the distribution of small shops across the village, which function as social safety nets in difficult situations.

The results thus indicate that without multi-level efforts to promote an equal focus on the social and ecological aspects of marine biodiversity conservation, the perspectives of social-ecological systems and social-ecological resilience remain impractical in areas like the MIMP. This is because most local responses to improving socio-economic conditions conflict with rigid policies and legal frameworks that prioritize and support marine conservation and foreign investment by powerful actors, without paying much attention to the socio-economic outcomes for marginalized actors. Hence, the results support the argument that rigid institutional environments at higher levels, and the implementation of policies and legislation, tend to constrain people's agency to act adaptively, resulting in less or diminished resilience in social-ecological systems (Ruiz-Mallen & Corbera, 2013; Stokols et al., 2013).

The failure of local responses to improve socio-economic conditions also supports Diprose's (2014) argument that resilience is becoming a means of encouraging powerless people to learn to live with insecurity, because the challenges of the status quo are deemed

insurmountable; and that resilience offers a temporary solution to stress and suffering without focusing on a permanent solution or dealing with actors who manufacture and benefit from the status quo. Hence, if people are to transform from surviving to thriving, resilience would need to work for both the powerful and the powerless, by emphasizing the key obligations of governments to protect and improve livelihoods (Disprose, 2014). In particular, governments should support development of their citizens, and provide an effective legal environment for regulating cross-level powerful actors and preventing them from violating human rights and threatening human dignity (Bryceson et al., 2006; Disprose, 2014; Tanner et al., 2015).

However, the measures necessary to ensure social well-being require a social turnaround that embraces responsive policy actions at various levels across spatial and temporal scales (Cinner et al., 2012). This means that the response actions on a smaller spatial scale, at village level (papers 1, 2, and 3), must be supported by actions on the largest spatial scale, namely at national (Paper 4) and international levels. At the same time, actions at various temporal scales (short-, medium- and long-term) also need to be considered. Based on Cinner et al.'s (2012) idea of cross-scale actions, Table 1 exemplifies actions that could guide the introduction of alternative livelihoods as part of a conservation strategy to enhance social well-being and achieve a balance between conservation demands and human needs within the MIMP.

Table 1: Example of cross-scale actions that could improve multi-level response capacities to deal with constraints that impair social well-being within the MIMP

| Scales | Temporal        |   |  |  |
|--------|-----------------|---|--|--|
|        | Levels          | Short-term  | Medium-term  | Long-term  |
|        | <i>Global</i>   | Initiate a social turn by mobilizing funds to address social dimensions of conservation.  | Mobilize funds to improve infrastructure to support efforts to achieve social well-being.  | Mobilize funds to sustain efforts to balance conservation and social demands.  |
|        | <i>National</i> | Initiate appropriate programs that would enhance social well-being and resilience by ensuring flexibility in policy and legislation, and a balanced legal framework that responds to both conservation and social | Initiate programs that enhance mutual learning between fishers and conventional scientists to build the capacities needed to deal with existing social-ecological challenges, including poor district's infrastructure, that constrain livelihood resilience and | Enhance capacity to monitor and manage practices of both small- and large-scale resource users within MIMP waters and adjacent waters. |

|         |                           |   |   |  |
|---------|---------------------------|---|---|--|
| Spatial | <i>MIMP/<br/>District</i> | demands<br><br>Through mutual learning, experiment with and initiate flexible conservation strategies and context-based new viable-alternative livelihoods.<br><br>Protect livelihoods from exploitative marketing and investment operations. | social well-being.<br><br>Through mutual learning, research and develop monitoring indicators for monitoring conservation strategies, statuses of ecological conditions and new livelihoods, and effective capacities to deal with existing challenges. | Support and confirm new viable livelihood projects as alternative livelihoods that can compensate for the losses from fisheries livelihood in a meaningful way.<br><br>Sustain capacities to monitor the well-being and resilience of the MIMP's social-ecological systems.<br><br>Conduct research into further livelihood options. |
|         | <i>Village</i>            | Experiment with and implement proposed new livelihood activities  | Address existing challenges and monitor status of social-ecological conditions through mutual learning.   | Adopt the new viable-alternative livelihoods that enhance livelihood resilience.<br><br>Experiment with more livelihood options.   |

### 4.3 Child health in the context of social-ecological changes

According to the 2014 Tanzania Human and Development Report (ESRF, 2015), undernutrition is among the largest threats to human development in the country. The extent to which the children's nutritional status in the two sites has been affected by changes in household income, food security status and gender roles (Paper 2) was thus a key focus of the third paper. The focus on under-fives was crucial because analysis of nutritional status among children provided further quantitative indications of social well-being of the two communities (Paper 2). Also, children, despite being future resource users, are the most forgotten age group in the analyses of social-ecological systems. And, finally, the ability of children to effectively acquire traditional ecological knowledge over time, by continuously practicing livelihood activities with their elders, depends on good childhood nutritional status. This is necessary for developing physical stamina, which in turn, is crucial for pursuing rural livelihoods. The results of this study show that up to 69% of the sampled under-five children



have poor nutritional status, partly because their mothers reduced breastfeeding substantially in order to fulfill their increasing contribution to the household's livelihood needs. This means that the new role of women in contributing to the overall well-being of their households has adversely affected their role as mothers, and the well-being of the youngest members of their households.

Folke et al.'s (2010) argument that the process of building resilience in one part of a particular system can be achieved by destroying the resilience of other parts of the system was evident in this case. In particular, our results indicate that the effects of such resilience-building processes are mostly likely to occur within the lowest part of a marine social-ecological system, namely the household. This deviates from what we argued previously about the resilience-building processes that occur at a much higher level in marine social-ecological systems – that is, between livestock-keeping households and the village's food security status (Paper 2).

Meanwhile, given household challenges in meeting income and food requirements, it is impractical for mothers to substitute breast milk with infant formula milk, fresh cow's milk or high-quality nutritional foods. As a result, the poor nutritional status of children is likely to impair their physical and mental development, and the ability of these future resource users to learn and accumulate traditional ecological knowledge. This could further limit the potential use of such knowledge in managing marine resources. Children form the lowest part of the household system and are yet to begin exploiting the marine environment. Thus the current negative effects on their well-being (in the process of building resilience of the overall household), could have serious implications for marine social-ecological systems at various levels in the future.

Simply put, destroying the lowest and most dormant part of the marine social-ecological systems within the Park now, could destroy the well-being of the *whole* system in the future. It is therefore necessary for the Park to consider temporal scales when implementing activities in order to ensure that the capacity to anticipate and respond to the outcomes of current resilience-building processes in various parts of the marine social-ecological systems is enhanced over time.

#### **4.4 Adaptive management as a response strategy to social-ecological changes**

The fourth paper is an attempt to analyse responses to social-ecological changes beyond the household level. The people of Chole and Jibondo face various challenges that have constrained their ability to achieve meaningful development by means of market-led economic and conservation approaches (papers 1 & 2). They face difficulties in improving their livelihoods, although such market-based approaches have contributed to the widening of livelihood opportunities by introducing various alternative livelihood activities, and by expanding the market for local produce through investments in fish processing. Nevertheless, the various household responses to the effects of ecological changes have been incapable of resolving the challenges they face in earning their living. Hence, the fourth paper focusses on the people's need for adaptive marine resource management strategies that actually address the changes they face.

The MIMP was designed to ensure that marine biodiversity conservation blends with tourism operations, research, and the socio-economic development of the communities that live within the Park boundaries. Hence the fourth paper also analyses the potential of the Park to respond to the changing social-ecological conditions as a way of achieving its twin objectives, namely to blend conservation and development using adaptive management as a long-term management approach (URT 2005, 2011; Torell 2000; Pomeroy et al., 2004). As a strategy, adaptive management has proved useful in understanding various social-ecological processes (Biggs et al., 2015). In fact, environment management strategies can demonstrate adaptive capacity when such strategies have the ability to learn and respond to social-ecological changes (Walker et al., 2002; Nelson et al., 2007). An analysis of how adaptive-management principles were implemented in the Park is thus important because various studies had shown that most adaptive-management projects failed to realize the full potential of the adaptive-management approach (Allen & Gunderson, 2011).

The fourth paper shows that, although the Park has been implementing the key principles of adaptive management in its operations, several barriers have compromised the likelihood that the Park would embark on a full process of adaptive management. The key actors in marine conservation lack a common understanding of whether or not the Park is succeeding in achieving the intended goals; whether the current and future focus and plans will yield the intended outcomes; and whether there is adequate assessment of the reasons for non-

conformity to Park regulations. They also gave different explanations of the problems of marine degradation and poor social conditions. For example, Park officials (the leading actors in Park implementation), mainly used overfishing narratives to explain the problems, while the people in the two sites (the least powerful actors), mainly used environmental narratives. This might suggest that some actors tend to overlook the system's interlinkages and behaviors (Cash et al., 2006). It also points to the importance of capacity building among professionals (through participatory approaches) to inform policy makers and implementers who may lack hands-on experience of marine social-ecological processes that play out on the ground (Berkes, 2007; Frey & Berkes, 2014). These differing narratives further point to the importance of analysing MPAs as SESs, which has proved useful in building a nuanced understanding of the key drivers that affect ecological health and social well-being (López-Angarita et al., 2013).

In addition, Park interventions were implemented without giving enough consideration to the emerging outcomes of conservation and other changing conditions over time. For example, following the implementation of the zoning scheme, the number of fishing grounds decreased, while the number of people who depend on marine-related resources on Mafia Island increased over time. For example, Piggott (1941), writing in *Tanganyika Notes and Records* indicated that the 1931 population on Mafia Island was about 7,903 people, while the 2012 population census recorded a population of 46,438 people (URT, 2013). Despite this increase, modifications to the zoning scheme were made by increasing the area under protection. By the time of this study, two more fishing areas, Nyororo and Shungimbili, had been subjected to conservation. This does not reflect the reduced protectionism anticipated by fishers, whereby a temporary zoning scheme would be trialled following satisfactory progress in the recovery of coral-reef conditions from the effects of dynamite fishing.

Furthermore, the implementation of the gear-exchange program and the promotion of prescribed fishing gear proceeded without paying meaningful attention to feedback from fishers who had attempted to adopt the equipment. The envisaged program was therefore not effective, and most fishers did not adopt the prescribed gear, on the grounds that it is not effective in catching fish and in contributing to household income. According to Frey and Berkes (2014), just a few fishers in a community have the power and ability to share new fishing methods and train other fishers if such methods are effective, which can contribute to both conservation and livelihood goals. Hence, it might be fruitful to encourage meaningful

collaboration among actors in designing and advocating more effective fishing gear that responds to existing social-ecological conditions and challenges.

Park interventions were also implemented with the backup of various government authorities, including the police and the army. However, the use of state powers to implement national policies related to conservation was sometimes accompanied by violence, with inadequate adherence to both Park regulations and the Constitution of Tanzania. This use of external power and violence contributed to the loss of social trust, which is a crucial asset for managing bodies dealing with social-ecological dynamics and uncertainty (Biggs et al., 2015). In fact, the use of external power meant that the potential power of resource users to improve ecological conditions (Frey & Berkes 2014) was compromised.

The new general management plan lacked innovative approaches in responding to both current challenges and to potential uncertainties emanating from Park implementation, and to the actions of other actors in Mafia District and elsewhere. At the time of the study, marine conservationists were experiencing an increasing number of challenges and surprises that were yet to be appropriately addressed. Furthermore, there was little evidence to suggest the presence of social capital in terms of the actors' readiness to collaborate in sharing conservation responsibilities as they had done in a Columbian MPA (Lopez-Angarita et al., 2013). In this study the actors also did not show readiness to collaborate in dealing with emerging conservation challenges.

The barriers discussed above suggest that the Park had been implementing the *principles* of adaptive management, but not meeting the requirements of the *process* of adaptive management. Paper 4 thus shows that failures in such projects can originate largely from various contextual conditions that existed before the projects adopt the full process of the adaptive-management approach. In fact, the paper highlights ways in which conservation actors can implement park activities in a manner that will result in failure to transform into success in the long term. In this case, implementation of the Park resulted in outcomes that were likely to limit its ability to successfully follow an adaptive-management process, which had been envisaged as a long-term management approach. More importantly, the paper shows that the Park's responses to the social-ecological changes focused on improving marine ecological conditions, but contributed to poor well-being among the people living within the Park, as detailed in papers 2 and 3.

Poor well-being remains a governance challenge that requires actors to collaborate in addressing barriers that have been reported across various scales and levels (Vervoort et al., 2014). This challenge also requires that the Park should be considered a linked SES. This will provide indications of how the social-ecological indicators change in response to the implementation of conservation measures over time, and reduce the costs of marine conservation for resource-dependent communities (López-Angarita et al., 2013).

## **5 Conclusions and Recommendations**

This study set out to contribute empirical evidence of changes in marine SESs in the richest marine biodiversity area in Tanzania, their effects, and the various efforts put forward to address them. Due to a growing awareness that resilience in SESs may not be achieved without paying more attention to human and social dimensions, this study has built on the SESs framework by unpacking the ‘actor’ component. In doing so, the study has brought to the fore concerns of the marginalized actors about their most overlooked needs. It has highlighted the challenges and complexities of multi-level resilience-building responses, and has provided in-depth descriptions and contextualized understandings of the changes, effects and responses. Hence, the study has contributed useful feedback and insights that can be employed to guide conservation efforts, in order to further improve the well-being of marine environmental conditions, as well as that of the environment-dependent people.

The study’s treatment of fishers’ ecological knowledge, without the restrictions imposed by the modes of analysis used in conventional science, has highlighted the need for conventional science to pay full attention to the enormous extent of knowledge possessed by fishers. This in turn promotes knowledge diversity, a key resilience-building factor. The study has yielded significant knowledge of how marine ecological changes have been unfolding within and around the Mafia Island Marine Park. Contrary to the dominant view that the increasing overall fish catches within the Park are the result of increasing fish abundance due to conservation efforts, fishers’ observations indicate that the increase is due mainly to increasing numbers of fishers and the dominant use of large pull-nets in relatively deep waters.

However, fish catches for individual fishers have decreased because pull-net fishing involves large numbers of fishers per boat, and other fishing practices are carried out in relatively

shallow waters with decreased fish abundance, as a result of increasing water temperatures. Again, fishers' explanations for decreasing fish abundance differ from the dominant explanation that overfishing is the main cause. The declining trends in both overall and individual octopus catches were found to be largely a result of strict Park prescriptions regarding fishing areas and gear, and continuous operations of the TANPESCA factory. Fishers also demonstrated that the sea level in their area is falling due to the uplift of the sea bed, which is contrary to the dominant, conventional science-based explanation that the sea level is rising due to climate change. Hence, by focussing on controlling fishers' actions, the MIMP may continue to overlook other key social-ecological factors that contribute to marine ecological changes in the area. Furthermore, the dominant tendency to consider fishers as destroyers of the marine environment could further impair the MIMP's ability to explore and incorporate fishers' knowledge into Park implementation.

The study has further shown that ignoring the interrelated effects of marine ecological changes, and neoliberal-based conservation and economic development regimes on the socio-economic conditions and well-being of marine resource-dependent communities, may slow down the achievement of the Park's objectives even further. There is little focus on the key aspects of social systems within the host communities, especially their socio-economic conditions, livelihood challenges, and the physical development of their children. The people in the two study villages face restricted access to marine resources, earn low incomes, have debts and low money-saving capacity, and are not able to meet their daily food requirements in terms of nutritional quality, quantity, frequency of eating, and food preferences.

Responses to such livelihood challenges, the study found, are useful for survival but cannot remove the challenges altogether. In fact, some responses, such as skipping meals, reducing fish intake, and increasing women's responsibility to contribute to household income, have had adverse effects on the nutritional status of children. This example shows how various responses to social-ecological challenges could relieve pressure on one level but amplify pressure on another. Hence, the resilience of the Park's SESs may not be realized if human actors lack the capacity to respond effectively to social-ecological challenges in order to meet the basic needs of local communities. In addition, the study has demonstrated how the increasing deterioration of socio-economic conditions compromises the well-being of future resource users.

The study has also shown how current and future marine resource conditions have been, or will be affected by social-ecological changes in various ways. First, there will be a decline in the production of traditional ecological knowledge due to the abandonment of fishing activities by elderly people and those unable to withstand Park restrictions, violent patrolling, and the frequent confiscation of fish catches and fishing equipment.

Second, there has been a decline in the transfer of traditional knowledge from elders to the younger generation, due to current age-based fishing practices which demand good free-diving skills and energy, thus automatically excluding the elderly. Moreover, the undernourishment in children, the future resource users, could result in poor development and physical stamina, and impair the efficacy of physical work, all of which could further compromise their future ability to participate in energy-demanding fishing practices, to manage marine resources, and to accumulate and transfer knowledge across generations.

Third, there has been decreasing adherence to resource management practices based on traditional knowledge, resulting from an increasing number of fishing days, declining alternation in fishing areas, and declining rotation between fishing and farming. Fourth, fishers showed a decreasing willingness to share traditional knowledge with outsiders, including Park officials and researchers, due to the fear of inappropriate use of such knowledge to exacerbate the fishers' impoverished livelihood conditions.

On the other hand, the study has demonstrated that the effects of, and responses to the social-ecological changes have provided enormous amounts of feedback to Park management. The implementation of adaptive-management principles provides further feedback and an excellent avenue for learning and informing management actors about how to adjust their management practices as new information arises. This could enhance the Park's ability to balance conservation and development goals in more adaptive ways. However, this study has highlighted contextual barriers in adopting adaptive-management processes within the Park, which could constrain current conservation efforts to further improve marine ecological conditions and promote development among the people residing within the Park.

Most current management practices are rigidly implemented, regardless of increasing evidence and surfacing of new information about changing social-ecological conditions. In particular, the increasing focus on ecological conditions and minimal focus on sociological

conditions of marine SESs were found to widen the gap, rather than ensuring that interactions between social and ecological systems are dealt with as part of one integrated SES.

In addition, the study has demonstrated that an analysis of failures in adaptive-management projects should be carried out in projects that implement key principles of adaptive management but are yet to adopt the full adaptive-management process. It has shown that the potential failure of adaptive management lies within the failure of key management actors to thoroughly analyse spatial-temporal interrelationships between the environment, the society, and the political economic conditions from a SESs perspective. The study has provided examples of issues that could reduce enthusiasm among local people for conforming to Park regulations. Such issues include the inadequate ability of the Park and other government authorities to control the operations of large-scale commercial fishing fleets and the TANPESCA factory, and inadequate attention being paid to the various concerns raised about the implications of Park implementation for the people residing in the Park.

In general, the evidence resulting from this study has shown that both household and Park responses to marine social-ecological changes have been inadequate in addressing the existing challenges, or bringing about meaningful outcomes that are desirable among various actors. This is partly due to various barriers, some of which are context-specific and some of which are related to broader socio-economic and policy statuses. The biggest challenge, however, is the rigidity of, and loopholes in various national policies and legislative instruments. These are not able to provide the flexibility and legally enabling environments that would allow household members, as well as Park officials, to make meaningful changes at the local level, in responding to the social-ecological challenges that they face in their attempts to achieve the twin goals of conservation and development.

The potential for balancing marine biodiversity conservation and social development under changing social-ecological conditions may yet be realized if efforts are made to promote equal consideration of fishers' ecological knowledge and conventional science. Furthermore, it is important to give equal consideration to social (particularly on the age, gender and well-being dimensions) and ecological systems. In addition, progress would entail making a meaningful review of national policies and legislative instruments that emphasize promoting neoliberal conservation and economic development through foreign investment, without fully monitoring their implementation strategies over time, and without fully considering their



implications for local SESs. In this regard, there is a need for national policies to provide an enabling environment for promoting the effectiveness of responsive strategies, and for facilitating meaningful adjustments of marine resource management practices at the local level in order to balance the conservation–development nexus in the Park area.

Possible future research in this area could focus on:

- (i) using conventional scientific knowledge to understand the extent of long-term changes in sea level and sea temperature and their implications on ecological conditions;
- (ii) understanding the implications of current trends in food consumption for the nutritional status of those aged above five years and the micronutrient status among all age groups in the fishing communities within the Park area;
- (iii) using a multiple-evidence approach to understand and resolve the pull-net controversy;
- (iv) improving the ability of the government to deal adaptively with neoliberal-based policies for economic development and conservation, and shape their outcomes to balance global, national, and local needs, instead of the various fruitless grassroots efforts to respond to their effects;
- (v) developing new policy strategies for dealing with colonial-rooted marginalization of the fisheries sector in the country, and the inadequate ability to manage marine fisheries in both territorial waters and the exclusive economic zone; and
- (vi) developing new adaptive strategies for dealing with long-term environmental changes and addressing the challenges that continue to hamper the adoption of adaptive-management processes in Park implementation.

All these research areas could further contribute to efforts to enhance livelihood sustainability and well-being among the Park residents.

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## **PART TWO: PAPERS**



**Paper 1: Seeing through fishers' lenses: Exploring marine ecological changes within Mafia Island Marine Park, Tanzania.**



# Seeing Through Fishers' Lenses: Exploring Marine Ecological Changes Within Mafia Island Marine Park, Tanzania

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Victoria H. Moshy<sup>1,2</sup> and Ian Bryceson<sup>2</sup>

## Abstract

Insights from traditional ecological knowledge (TEK) of the marine environment are difficult to integrate into conventional science knowledge (CSK) initiatives. Where TEK is integrated into CSK at all, it is usually either marginalized or restricted to CSK modes of interpretation, hence limiting its potential contribution to the understanding of social-ecological systems. This study uses semi-directive interviews, direct observations, and structured open-ended questionnaires ( $n = 103$ ) to explore TEK of marine ecological changes occurring within the Mafia Island Marine Park, Tanzania, and factors contributing to these changes. It illuminates TEK insights that can be valuable in parallel with CSK to provide a more nuanced understanding of ecological changes. In some areas, fishers observed coral reef growth, increased fish abundance, and increased sea temperatures, whereas in others, they reported decreases in sea level, coral cover, fish abundance, catch composition, catch quantities, and fish size. They associated these changes with interrelated factors emanating from environmental processes, conservation outcomes, marketing constraints, population dynamics, and disappearance of cultural traditions. Utilizing TEK without restricting it to CSK modes of interpretation has the potential to improve CSK initiatives by promoting complementarity and mutual enrichment between the two kinds of knowledge, thereby contributing new insights that may enhance adaptive management and resilience in social-ecological systems.

## Keywords

fishers' knowledge, social-ecological systems, marine fisheries, marine ecological changes, marine protected areas

## Introduction

Over the past three decades, traditional ecological knowledge (TEK) has increasingly been recognized in the conventional science knowledge (CSK) community (Bryceson, 1981; Francis & Bryceson, 2001; Haggan, Neis, & Baird, 2007; Johannes, 1989). A great challenge remains, however, on how to achieve meaningful integration of these two knowledge systems (Nadasdy, 1999; Thornton & Scheer, 2012). Not only is there no specific “rule” guiding the integration of TEK into CSK practices, but the integration process has often necessitated processing TEK through statistical analysis and mathematical approaches based on CSK standards and principles of objectivity, precision, testable quantifications, and generalization (Berkes & Berkes, 2009; Haggan et al., 2007; Mackinson & Nøttestad, 1998; Tesfamichael, Pitcher, & Pauly, 2014).

Because neither TEK nor CSK are comprehensive in understanding marine social-ecological systems (SEs), maximizing the potential of each knowledge domain offers benefits for enhancing resilience and sustainability of the

SES (Carr & Heyman, 2012; Daw, Robinson, & Graham, 2011; Haggan et al., 2007). One way in which the potential of TEK can be maximized is through *reframed integration* which holds that the originality, standard and philosophical stances of each knowledge system should be maintained to avoid dilution of either during the integration process (Bohensky & Maru, 2011). Simply put, TEK holders should still be able to identify and understand their knowledge contributions even after the integration process has taken place.

Despite these positive indications, current integration practices have not changed much. Tendencies to “stretch” TEK toward CSK standards prevail. Some CSK holders still fail to integrate TEK into their undertakings because they consider it to be subjective, general, qualitative, and even

<sup>1</sup>University of Dar es Salaam, Tanzania

<sup>2</sup>Norwegian University of Life Sciences (NMBU), Ås, Norway

## Corresponding Author:

Victoria H. Moshy, Institute of Resource Assessment, University of Dar es Salaam, P. O. Box 35097, Dar es Salaam, Tanzania.  
 Email: moshyv@ira.udsm.ac.tz; moshyv2001@yahoo.com



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backward, especially in areas where TEK holders lack formal education (Berkes & Berkes, 2009; Huntington, 2000; Nadasdy, 1999; Walley, 2002). They are not only reluctant to retain TEK standards before incorporating it into CSK but are also often disrespectful to TEK holders, assuming that they hold a more powerful position in knowledge production processes than the TEK holders (Carr & Heyman, 2012; Drew, 2005; Huntington, 2000; Mackinson & Nøttestad, 1998). As a result, these attitudes instill reluctance among TEK holders to share their knowledge.

A recent study that innovates toward retaining TEK originality on a global scale used a multiple-evidence-based approach to combining TEK and CSK by first allowing each knowledge system to “speak for itself,” in its own context (Tengö, Brondizio, Elmqvist, Malmer, & Spierenburg, 2014, p. 6). This approach requires the establishment of equivalent points of departure for the two knowledge systems; that is, TEK should first be established based on its own values, after which equal sharing of the contents of the two systems can be enabled. The resulting enriched picture is then processed with mutual respect for the values of each knowledge system (Tengö et al., 2014). This promising study clearly shows that more empirical studies at smaller geographical scales are needed, to further explore the potential of retaining TEK originality as a way of dealing with current challenges of knowledge integration.

The Mafia Island Marine Park (MIMP) in Tanzania is an example of an area with such knowledge integration challenges. Although the TEK of fishers has been largely ignored since the 1990s (Walley, 2002), Bryceson and colleagues (2006) based their study upon TEK inputs as a way of demonstrating the value of TEK. However, none of the existing studies have solely used fishers’ TEK to study marine ecological changes. This is despite the fact that the MIMP lacks systematic monitoring (United Republic of Tanzania [URT], 2011a), even after Tanzania began to allow the export of marine finfish on a trial basis since 2002 (Bryceson et al., 2006). Such situations can, in the long run, compromise the resilience of the Park’s SES.

Based on the idea of retaining originality and values of TEK (Bohensky & Maru, 2011; Tengö et al., 2014), this article attempts to explore fishers’ TEK of marine ecological changes, including changes in fish and octopus catches, and changes in the fishing areas. We show that retaining TEK originality on a small geographical scale such as the MIMP has the potential for producing new knowledge and insights which can be valued in parallel with CSK to improve the efficacy of conservation efforts in the SES. We neither intend to present TEK in a manner that strictly appeals to scientific principles of specificity, preciseness, and objectivity, nor to compare it explicitly with CSK, because the inherent characteristics of the two systems are quite distinct from each other (Berkes & Berkes, 2009). As such, processing the enriched picture requires mutual engagement of participants from the two knowledge realms, to avoid processing it solely from

CSK perspectives as has been done elsewhere (Daw et al., 2011; Drew, 2005; Tengö et al., 2014; Yasue, Kaufman, & Vincent, 2010). Hence, we focus on fishers’ understandings and estimates of long-term ecological changes, and their causes, without pursuing precise categorization of species and habitats, or precise measurements of the extent of changes as per CSK requirements. Our aim is to contribute context-specific insights, as holistic and as simple as they appear, to the understanding of marine ecological changes, and to relate them with CSK to identify insights that might have the potential to improve conservation efforts under a multiple-evidenced approach.

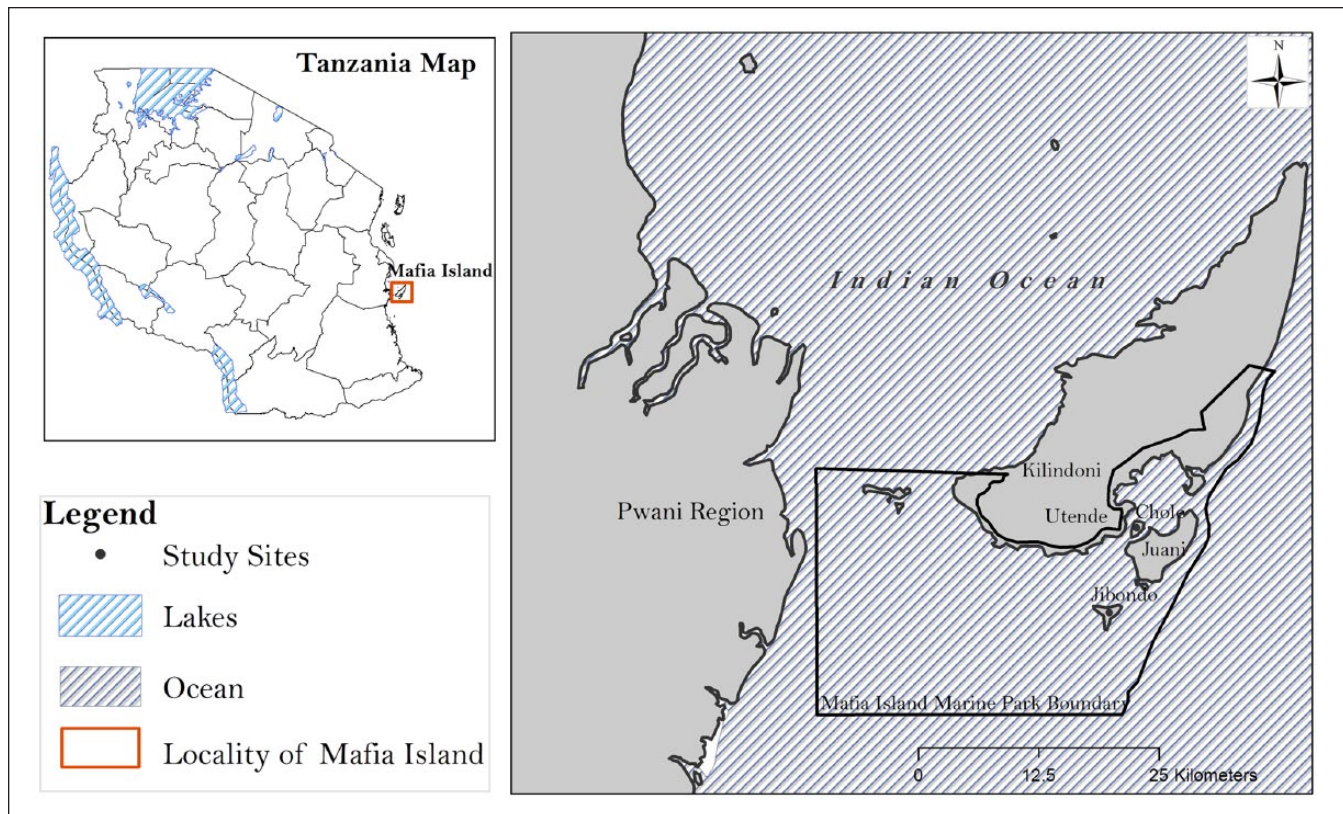
## TEK, CSK, Adaptive Management, and Resilience

We conceptualize TEK as knowledge that comprises practices, insights, and experiences that local and visiting fishers have accumulated by living in, interacting with, and continuously observing their environment (Berkes, 1993; Huntington, 2000). Hence, our epistemological stance on the understanding of marine ecological changes rests on a constructivist approach (Guba & Lincoln, 1994). We base TEK production on the perspectives of fishing communities interacting with the marine environment for their livelihoods whereby they experience nature and change processes; and to a lesser extent, also on our own experience during the course of interacting with them and participating in their social discourses.

Because TEK is centered on real-life experiences through livelihood undertakings, it is rich in its observations (Mackinson & Nøttestad, 1998), context specific (Berkes, Mahon, McConney, Pollnac, & Pomeroy, 2001), practical (Haggan et al., 2007), ethical (Huntington, 2000), holistic (Berkes & Berkes, 2009), up to date (Carr & Heyman, 2012), adaptive (Berkes, Colding, & Folke, 2000), and resembles a monitoring system (Evans, Brown, & Allison, 2011). TEK provides a more nuanced understanding of marine processes such as changes in the marine SES (Teschfamiel et al., 2014; Yasue et al., 2010). Furthermore, TEK contributions foster knowledge diversity, which is a key source of SES resilience (Bohensky & Maru, 2011).

Unlike TEK, CSK is obtained through Western formal education, is relatively new, and is based on positivist approaches that focus on precision, which can sometimes be irrelevant to the real world. CSK often overlooks contextual explanations of the SES in question, and can lead to erroneous conclusions (Berkes & Berkes, 2009; Berkes et al., 2001; Johannes, Freeman, & Hamilton, 2000). The production of CSK remains scarce and costly, and has often not succeeded in building resilience in SESs (Berkes, Colding, & Folke, 2003; Mackinson & Nøttestad, 1998).

We define *resilience* as the capacity of marine SESs to manage changes, learn, and develop, while retaining their



**Figure 1.** Chole and Jibondo villages within the Mafia Island Marine Park area.

functions and structures (Folke et al., 2002; Walker, Holling, Carpenter, & Kinzig, 2004). The concept of resilience includes the ability of systems like the MIMP to anticipate and deal with changes, and plan for the future, while maintaining ecosystem functioning, marine resources sustainability, and progress in community development (Jones, Qiu, & De Santo, 2013; Ruiz-Mallén & Corbera, 2013). As a component of adaptive capacity, resilience can benefit from adaptive management, an approach that recognizes the changing nature of the environment, and requires natural resource management systems to monitor management outcomes and respond to environmental feedback (Berkes & Folke, 1998).

Management bodies generally respond to changes by changing their practices based on comprehensive knowledge obtained through continuous learning among managers, researchers, and TEK holders (Berkes et al., 2001; Carpenter & Gunderson, 2001; McFadden, Hiller, & Tyre, 2011). In so doing, TEK contributes new insights that management bodies can use as a basis for adjusting management practices over time (Berkes et al., 2001). Hence, the integration of TEK into adaptive management serves as a resilience building strategy, because both TEK and adaptive management are able to deal with uncertainty, based on feedback learning, which, in turn, enhances diversity (Berkes et al., 2000).

## Study Area and Method

The MIMP (Figure 1) incorporates part of Mafia Island, a district located 120 km south-east of Dar es Salaam. The MIMP covers 565 km<sup>2</sup> of water and 407 km<sup>2</sup> of land which was inhabited by 46,438 people in 2012 (Bryceson et al., 2006; URT, 2013). Mafia Island stretches across the trade wind system, where the northeast monsoon blows from December to April, and the southeast monsoon blows from June to October. These winds influence climatic and oceanic conditions, including the air temperature that ranges from 20 to 32 °C, and the sea surface temperature that ranges from 25 to 31 °C (Bryceson et al., 2006).

We selected Mafia district as a suitable area to study marine ecological changes, due to the presence of multiple interacting drivers of changes. It is the country's richest marine biodiversity district, contains the highest number of fish landing sites in coastal Tanzania (International Resource Group [IRG], 2008), and has the first, largest, foreign-owned marine finfish and octopus processing factory in the country (TANPESCA Ltd.). The district has octopus-collecting companies (Sea Products Ltd. and Bahari Foods Ltd.), and the first marine park in Tanzania (MIMP). The MIMP was established in 1995, and constitutes 13 villages (URT, 2011a). Two villages, Chole and Jibondo, were selected for this study to reflect contextual variations within the MIMP villages. Chole is located in close proximity to the MIMP headquarters and is



**Table 1.** Local Swahili Names of Fish and Their English and Scientific Family Names.

| Local Swahili names                                     | Common English names             | Scientific family names |
|---|----------------------------------|-------------------------|
| Changu batu <sup>a</sup> /mjibondo <sup>b</sup> /kitawa | Big-eye emperor                  | Lethrinidae             |
| Changu doa mkapa <sup>a</sup> /kiwala <sup>b</sup>      | Thumbprint emperor               | Lethrinidae             |
| Changu tuku   | Sky emperor                      | Lethrinidae             |
| Changu njana  | Yellow-banded emperor            | Lethrinidae             |
| Changu chole  | White-cheek monocle bream        | Lethrinidae             |
| Changu chali <sup>b</sup>                               | Blubberlip snapper               | Lethrinidae             |
| Pono wa madema  | Blue-barred parrotfish           | Scaridae                |
| Pono ng'ombe  | Giant humphead wrasse            | Scaridae                |
| Pono mweupe /paka <sup>a</sup> /mkundaji <sup>b</sup>   | Indian Ocean longnose parrotfish | Scaridae                |
| Pono mtindi   | Seagrass parrotfish              | Scaridae                |
| Chewa   | Grouper                          | Serranidae              |
| Songoro   | Cobia                            | Rachycentridae          |
| Mizira  | Barracuda                        | Sphyrnidae              |
| Vijenga   | —                                | —                       |
| Kolekole  | Jacks                            | Carangidae              |
| Tasi  | Rabbitfish                       | Siganidae               |
| Karambisi   | Trevally                         | Carangidae              |
| Kelea   | Blackspot snapper                | Lutjanidae              |
| Chaa  | Common silver-biddy              | Gerreidae               |
| Msusa   | Black-barred half beak           | Hemiramphidae           |
| Ndwalo  | Swordfish                        | Xiphiidae               |
| Mkundaji  | Goatfish                         | Mullidae                |
| Jodari  | Tuna                             | Scombridae              |
| Nguru   | Kingfish                         | Scombridae              |
| Mwatiko   | Milkfish                         | Channidae               |
| Panji   | —                                | —                       |
| Samsuri   | Marlin                           | Istiophoridae           |
| Joza  | White-spotted guitarfish         | Carharhinidae           |
| Vibua   | Mackerel                         | Scombridae              |
| Vibua mbono   | Fusilier                         | Caesionidae             |
| Vichuje   | Surgeonfish                      | Acanthuridae            |
| Puju  | Unicornfish                      | Acanthuridae            |
| Dagaa   | Sardine                          | Clupidae                |
| Michorocho  | Keeltail needlefish              | Belontiidae             |
| Ngalala   | Needlefish                       | Belontiidae             |
| Kapungu   | Shark                            | Carcharhinidae          |
| Taa   | Ray                              | Dasyatidae              |
| Nguva   | Large mammal dugong              | Dugongidae              |

<sup>a</sup>As known at Chole village.

<sup>b</sup>As known at Jibondo village.

—Name could not be obtained.

considered to be compliant with MIMP regulations (Mahingika, 2007). Jibondo is a typical fishing village located far from the MIMP headquarters, and is considered to be non-compliant with MIMP regulations (McClanahan, Cinner, Kamukuru, Abunge, & Ndagala, 2009).

Data for this study were collected during 8 months between August 2009 and March 2011. Being mainly qualitative, this study draws on methods of collecting TEK data suggested by Huntington (2000), that is, semi-directive interviews, informal interviews, direct observations, and questionnaires. Semi-directive interviews were conducted with

42 individuals and 12 discussion groups. The participants, particularly the elders and fishers who represented each type of fishing gear, were purposively selected to share their knowledge about the changes. The participants were able to freely discuss changes in catch composition, catch quantities, and sizes of individual fish caught. They described changes they had observed in the fishing areas, and were able to surmise why such changes had occurred, without strict direct questions and time limits, as suggested by Huntington (1998, 2000). Although they provided local names of fish in Swahili (Table 1), for simplicity, we present them in this



study in English, based on Food and Agriculture Organization (FAO) species identification sheets (Bianchi, 1985; Bryceson et al., 2006; Lieske & Myers, 2002).

To detect changes in fish and octopus catches from the 1980s to 2010/2011, fishers recalled past and present types of fish caught, average sizes of fish and octopus caught, and estimated catch quantities. They recalled ranges of good and bad catches in spring and neap tides, and during northeast and southeast monsoons. Weight estimates were provided mainly in local units such as the *sado*, a 10-L bucket, which is equivalent to around 25 medium-sized fish. Length estimations were based on parts of their hands, for example, wrist to middle finger tip is equivalent to 6 in., middle forearm to middle finger tip is 12 in., and the *pima*—the length between the ends of two middle fingers when arms are widely stretched sideways—is about 1.8 to 2 m. Local units were then converted to individual numbers or modern units to understand the nature of change. Changes in the types and sizes of fish consumed in households were provided as proxy indicators of changes in catch composition.

To describe changes in areas where they fished, retired and elder fishers recalled characteristics of fishing areas as far back as the 1940s. Fishers below the age of 50 years described current characteristics in comparison with those observed during the 1980s. Their major indicator for detecting changes was the existence of fish and octopus in their fishing areas. We use the term *abundance* to refer to this indicator. Other indicators were types and size of fish sighted, oceanographic conditions (including water depth, speed, warmth, and clarity), and benthic cover characteristics. Time spent in searching for fish and octopus before they actually fished was provided as a proxy indicator.

Toward the end of the fieldwork period, structured questionnaires with open-ended questions were administered to 103 heads of households, about 20% of the total recorded households in Chole (226) and Jibondo (364). This method was useful in obtaining additional insights, triangulating, validating, and obtaining simple quantitative indications of specific changes and their contributing factors that had emerged from the qualitative methods (Huntington, 2000; Tengö et al., 2014). Respondents were selected under stratified random sampling based on the three and six sub-villages in Chole and Jibondo, respectively, to investigate changes in types and sizes of fish consumed in households across the villages and wealth groups; and to find the extent of respondents' relationship to the marine environment. Questions concerning proxy indicators were posed to all respondents, whereas questions concerning specific fishery information were posed to respondents who practice fishing as their primary livelihood activity.

To address possible biases and increase the reliability and validity of TEK data, 19 interviews were conducted with seasonal visiting fishers, fish traders, officials from catch collection companies, tourist hotels engaged in underwater tourism, the MIMP, Mafia district, and the World

Wildlife Fund for Nature (Tanzania Office). The interviews were useful in triangulating fishers' perceptions of trends on overall catch estimates, and their observations of changes in the marine environment. Continuous observation was conducted on catches, fishing gear, number of fishing days, as well as informal interviews and talks throughout the study period, all of which were useful in corroborating the TEK collected.

Qualitative data were analyzed manually by means of thematic analysis. Textual data were read repeatedly to glean a general understanding of the issues at hand. The data on types of changes observed were categorized into general thematic categories, based on research objectives. The data about why such changes occurred were also read repeatedly to identify emerging themes, which were then further reviewed to determine key themes and extract analytical meanings. These meanings were then related and used to develop and discuss major factors of change and the potential for improving CSK initiatives. Quantitative data from questionnaires were entered in Microsoft Office Excel before being summarized, coded, analyzed descriptively, and presented as percentages and frequency distribution tables.

## Results

Fishers' explanations of changes were non-linear and holistic in nature, and all aspects that caused changes in types, quantities, and sizes of fish caught, and in fishing areas, were described in depth. Overall, 36% of respondents were practicing fishing as their primary livelihood activity. Thus, they were able to provide further systematic explanations and quantitative indications of the changes observed. The explanations for changes fall into six major intertwined themes: environmental changes, conservation and management achievements and challenges, changes in fishing practices, marketing constraints, population dynamics, and disappearance of cultural and management traditions. In presenting the reasons for changes, the appropriate themes are interwoven into the following sections on reported changes.

### *Changes in Catch Composition, Quantity, and Size of Fish and Octopus*

*Catch composition.* Fishers mentioned the key types of fish that are most common in current catches, types that are increasing and decreasing, and types that are seldom observed in current catches but have been caught in the past (Table 2). They linked the disappearance and decrease of some types of fish mainly to warmer water conditions. They linked the increase mainly to increasing fishing depths, as explained further in the following sections. Catch composition also depends on the type of fishing gear used. The dominant types in Jibondo are pull nets, shark nets, and basket traps, whereas hand lines, basket traps, set nets, and fence traps are common in Chole.

**Table 2.** Estimates of Changes in Fish Catch Composition, Quantities, and Individual Fish Size Over Time.

| Item  | Examples of changes   |   |
|---|---|---|
|   | 1982-1992   | 2010-2011   |
| Fish catch composition  |   |   |
| Common  | Wide variety of tropical fish including milkfish, giant humphead wrasse, and white-spotted guitarfish | Emperors, parrotfish, jacks, rabbitfish, rays, sharks, goatfish, blackspot snapper, mackerel, common silver-biddy, and trevally |
| Increasing  | —   | Fusilier, rabbitfish, and jacks   |
| Decreasing  | —   | Groupers, emperors, trevally, and blackspot snappers  |
| Rare  | —   | Milkfish, giant humphead wrasse, <i>vjenga</i> , <sup>a</sup> and white-spotted guitarfish                                      |
| Catch composition proxy indicator: Changes in fish types consumed ( <i>n</i> = 103) |   |   |
| Positive change (4%)  | Sardine, needlefish, and keeltail needlefish  | Fusilier, surgeonfish, and parrotfish   |
| Negative change (63%)   | Milkfish, trevally, emperors, and jacks   | Unicornfish, surgeonfish, mackerel, common silver-biddy, sardine, and juvenile fish   |
| Perceptions of changes in catch quantities per vessel/fisher ( <i>n</i> = 37)       |   |   |
| Increased   | —   | 8%  |
| Decreased   | —   | 78%   |
| Same  | —   | 14%   |
| Estimated number of type of fish caught per trip                                    |   |   |
| Big eye emperor   | 5,000-7,500   | 560-1,400   |
| Thumbprint emperor  | 200-300   | 50-60   |
| Sky emperor   | 200   | 100-50  |
| Yellow-banded emperor   | 150-200   | 40-50   |
| White-cheek monocle bream   | 300   | 50-60   |
| Blubberlip snapper  | 10-20   | 1-2   |
| Bluebarred parrotfish   | 2,500-3,000   | 700-840   |
| Giant humphead parrotfish   | 2-5   | 0 in 2008   |
| Indian Ocean longnose parrotfish  | 50-60   | 30-40   |
| Fish size proxy indicator: Fish size consumed ( <i>n</i> = 103)                     |   |   |
| Large; more than 6 in.  | 97%   | —   |
| Small; below (or occasionally slightly more than) 6 in.                             | 2%  | 73%   |
| Small; strictly below 6 in.   | —   | 27%   |
| Absent  | 1%  | —   |

<sup>a</sup>The English name could not be obtained.

The changes in catch composition revealed through proxy indicators are also shown in Table 2. Respondents who consumed better types of fish pointed to an improved marine environment, changes in fishing gear, and increased ranges of fishing. Meanwhile, most respondents consumed inferior types of fish, including juvenile fish locally known at Chole as *visolola*, due to declining fish stocks in shallow waters (25%), constraints imposed by the MIMP (25%), the need for cash (19%), and the lack of fishers in a household (7%). About 16% did not provide reasons and 3% did not know the reasons for such changes. Detailed explanations for declining trends are rooted mainly in environmental changes, and will be provided in the

“Changes in Fishing Areas” subsection. Other explanations are described below.

**Catch quantities.** The least common views during interviews and discussions were that catch quantities per individual fisher or vessel remain the same, or have increased. Data from questionnaires also showed this trend (Table 2). The dominant view in both villages was that individual catches are decreasing in quantity. For example, a pull-net fisher in Jibondo reported decreased fish catch quantities from 180 to 210 buckets in 2005 to 30 to 90 buckets in 2011. Further examples of catch decrease for specific fish types are presented in Table 2.

**Table 3.** Changes in the Catch Quantities and Size of Individual Octopus Per Trip From Four Experienced Fishers.

| Sites and practices | Past catches (1980-1990s) |           | Current catches (2010) |           |
|---------------------|---------------------------|-----------|------------------------|-----------|
|                     | Quantity (n), (kg)        | Size (kg) | Quantity (kg)          | Size (kg) |
| <b>Chole</b>        |                           |           |                        |           |
| Gleaning            | 5-50 octopus              | 1-12      | 0-10                   | 0.5-1     |
| Diving              | 15-27 kg                  | 0.5-5     | 3-12                   | 0.5-2     |
| <b>Jibondo</b>      |                           |           |                        |           |
| Gleaning            | 10-50 octopus             | 0.5-7     | 0.5-25                 | 0.5-3     |
| Diving              | 20-50 kg                  | 1-10      | 0.5-25                 | 0.5-3     |

Overall catches per village were reported to have increased in Jibondo and decreased in Chole, as one elder fisher at Chole expressed,

... the first change is that there are no fish like we used to get ... we used to get lots of fish, even a full vessel in one day. If you sit at that side and I sit this side you won't see me for the fish was plenty ... (Interview [I] No. 7, 2009)

Quantities for octopus catches show decreasing patterns for both individual and overall catches. At Jibondo, women reported a substantial decrease in their catches (Table 3) and were observed to return with about zero to six octopuses each. These fishers' descriptions of the changes in fish and octopus catch quantities confirm traders' observations in the two sites.

Apart from declining abundance, which is further addressed later in this article, fishers explained declining catch quantities as a result of MIMP restrictions. Zoning plans and gear prescriptions have contributed to decreased catches, particularly in Chole. Rich fishing grounds have been permanently closed, which hampers traditional rotation among fishing grounds to allow fishery recovery. As a result, continuous fishing in the few and less-endowed remaining grounds has contributed to decreased catches. An elderly fisher at Chole explained their inability to fish in this way,

... they [the MIMP] have restricted all the [endowed] areas. In the beginning there was slavery; now slavery is back. Blessed be the former slavery for in the evening you would eat at your master's place; in the current slavery you neither eat at your master's, nor are you going to find food for yourself where it is found ... (I No. 30, 2010)

Furthermore, it was argued that the prescribed fishing gear (3-in. set nets and shark nets) contributes to decreased catches because of their ineffectiveness. The set nets have to be operated in shallow areas where there are no fish; some fish species, like the white-cheek monocle bream and black-barred half beak are too small in their natural size to be caught using 3-in. nets; and shark-net material and odor tend to spoil fish catches. Thus, in Jibondo, pull nets dominate, operated in deep waters by means of 11 motorized pull-net fishing boats. Each boat has a pull-net of about 15 to 30

joined pieces of net operated by about 30 fishers, whereas in the past, three sail boats, each containing one to 10 joined pieces of fishing net were operated in shallow waters by about five fishermen.

The dominance of pull nets has contributed to increasing overall fish catches at Jibondo; this is because fishers perform underwater searching to find a large enough school of fish before setting the net, to avoid small catches. However, the large numbers of fishers in each boat have contributed to decreasing catches per individual fishers. Furthermore, pull nets are confiscated by the MIMP, and hence, some pull-net fishers tend to shift to octopus fishing for a while.

The increasing overall fish catches and decreasing octopus catches are further related to marketing constraints and population dynamics. There is an increasing demand for fish and octopus because traders and factory agents, particularly in Jibondo, provide a continuous ready market for low prices for fishers. Thus, fishers need to fish more, just to meet their basic necessities. The market also contributes to the dominance of pull-net fishing, for it guarantees quick and large catch quantities per trip. However, the low income per individual crew member has resulted in the need to spend more time fishing. Because the fish market is a quick source of income, it has contributed to lower crop production at Jibondo, which, in turn, has increased income needs. Prior to the 1970s, villagers produced their own food, and rainy seasons and neap tide days were allocated to farming. Since then, more people<sup>1</sup> have become dependent on fisheries, which has contributed to increased overall catch.

Furthermore, the population increase has contributed to increased numbers of fishers in Jibondo competing for the remaining fishing grounds. Traditionally, fishing in Mafia was practiced only by villagers in Jibondo and Bwejuu, who rotated fishing grounds and camped at various areas. However, villagers from other parts of Mafia have since begun fishing and there are now permanent settlements on previously camped areas.

The population at Chole has also increased, but this was not considered to be a direct factor in the decrease in fish catches. Participants attributed the decrease mainly to the low number of fishers, following out-migration, and the abandonment of fishing activities by most fishers as a result of MIMP restrictions. Six fishers migrated to Kilindoni

**Table 4.** Multiple Responses to the Question “Why Do You Experience a Decrease in Catch Quantities?”

| Factors                                | Types of fishing gear   |                       |                       |                     |                       |                          | Total count<br>(n = 29) |
|--|-------------------------|-----------------------|-----------------------|---------------------|-----------------------|--------------------------|-------------------------|
|  | Basket traps<br>(n = 3) | Shark nets<br>(n = 5) | Hand lines<br>(n = 1) | Set nets<br>(n = 2) | Pull nets<br>(n = 11) | Octopus stick<br>(n = 7) |                         |
| Decreased sea level                    | —                       | 1                     | —                     | 2                   | 6                     | —                        | 9                       |
| Seasonality                            | —                       | —                     | —                     | —                   | 1                     | 4                        | 5                       |
| Decreased fisher knowledge             | —                       | 1                     | —                     | —                   | —                     | —                        | 1                       |
| Mafia Island Marine Park interventions | 1                       | 1                     | 1                     | 1                   | 3                     | —                        | 7                       |
| Increased population                   | 2                       | 2                     | 1                     | 1                   | 7                     | 4                        | 17                      |
| Market constraints                     | —                       | 1                     | —                     | —                   | 1                     | 1                        | 3                       |
| Destructive gear elsewhere             | —                       | 2                     | —                     | —                   | —                     | —                        | 2                       |
| God's will                             | 1                       | 2                     | —                     | —                   | —                     | 1                        | 4                       |

between 2009 and 2010. Some remaining fishers rent out all their boat engines and four boats to distant areas; there remain three net-fishing non-motorized boats (each operated by about six fishers), three sail boats, and 13 canoes. Alternatively, they fish for small fish on foot. Thus, most fish traders and agents have left Chole, and the remaining ones often obtain only small catch quantities that are mostly sold locally.

The dwindling fishing activities in Chole were confirmed by respondents, as the percentage of fishers engaged in fishing as a secondary activity is higher (32%) than those for whom fishing is a primary activity (22%). The decrease was also linked to the disappearance of cultural traditions, including TEK of the marine environment among youth fishers. Because most knowledgeable fishers have now abandoned fishing, youth fishers would go fishing at certain fishing grounds because they previously saw or even fished with elder fishers, not because they knew what type of fish could be caught where, on which lunar day, or at what specific time. The previously mentioned explanatory factors for the decrease in individual catch quantities were also reported by 78% ( $n = 29$ ) of respondent fishers, who reported decreased catches as shown in Table 4.

**Size of fish and octopus caught.** Current catches generally consist of smaller sized fish than in previous years (Tables 2 and 3). Large-sized fish occur in catches only occasionally. However, migrant fishers from Pemba, whom I interviewed, visit Jibondo seasonally and conduct fishing further offshore; they often catch large fish such as tuna, swordfish, kingfish, marlin, sharks, and *panji*. The proxy indicator for decreasing size of fish revealed that the majority of people consume mainly small fish today, in contrast with the 1990s when they consumed large fish.

In the octopus fishery, large octopuses that reached about 15 kg in the past are no longer found (Table 3), as also evidenced by an experienced octopus gleaner in Chole:

. . . mmmh! Now it is very rare (to have large octopus), they are totally finished. I tell you octopus mantle was like this [showing

her head] and then its arms were like this [showing her arm]. But now there is no such octopus, only very small ones . . . (I No. 21, 2010)

There was also consensus among traders and officials from catch collection companies and the MIMP that the sizes of fish and octopus collected have decreased.

### Changes in Fishing Areas

**Oceanic conditions.** A decrease in sea water depths was one of the most prominent changes that fishers observed in the fishing areas. This was attributed to reef growth and the rise of the seabed.<sup>2</sup> Fishers stressed that most intertidal pools have filled up with sediment and that areas which never dried up during spring tide are now doing so, including some parts of Mto Mkuu and Makutani which are now easily accessible on foot. The water depth at Mange (Majambani) was reported to have reduced from 18 m in 2005 to 16 m in 2011; and at Mchanga Nyuma, areas that used to have water up to chest height (about 1.4 m) were only knee deep (about 0.5 m) in 2011.

A more vivid example of decreasing water levels around Jibondo was provided with reference to the Mtowebwe reef (Figure 2). One elderly interviewee explained that

. . . the sea floor has risen. At Rasini coast vessels were not grounded (*pwelewa*) because the water was full all the time and vessels could leave anytime . . . During spring tide Mtowebwe was seen as a cap and more vaguely seen during neap tide. Vessels with captains having little expertise could even knock it. But now Mtowebwe is seen as soon as you leave Utende. It is uncovered now . . . (Group Interview (GI) No. 8, 2010)

Furthermore, fishers observed increased speed of ocean currents, which hampers the setting of passive fishing gear such as shark nets. They added that increasingly rough waves are now causing higher turbidity than five decades ago. Meanwhile, the effects of the 1998 El Niño, prolonged dry seasons, and increased air temperatures are causing warmer conditions in shallow waters. These changes make conditions





**Figure 2.** View of Mtowebwe reef from Jibondo Island.

unfavorable for marine life and fishers, as expressed by an elderly fisher at Chole:

... now the environment is ruined, the ocean has become murky and rough that when you dive you don't see, which is different from the past when it was clear ... this is just because of changes in air conditions because when changes happen very far from here it also changes conditions here. In other days when you pass by, you find fish are just dead. They are harmed when they find such air conditions ... (I No. 16, 2010)

**Abundance of fish and octopus.** The heavy decrease in fish abundance within the shallow inshore areas is another prominent change that was mentioned during interviews. Fishers linked this to three main factors: rising sea temperatures and resultant fish redistribution, uncontrolled industrial scale fisheries, and declining traditional practices.

**Rising sea temperatures.** Fishers explained that increasing warmth is causing large fish like groupers to move into deep cool waters and sea channels. Large mammal dugongs and giant humphead wrasse are no longer sighted in their fishing areas. They also observed a substantial decrease in seagrass parrotfish populations due to their low survival rates in warm shallow waters where they usually lay their eggs. Other relatively small fish, juvenile fish, and sardines are still observed within shallow waters around Chole and Jibondo.

However, fishers have observed relatively large fish in shallow areas during good rainfall seasons which are coupled with decreased warmth. They also observed large fish and increased fish abundance in the areas enclosed by the MIMP; however, they argued that such areas had high abundance even before the establishment of the MIMP, and are relatively deeper. They are also closer to, and have openings to the open sea, which allows the entrance of colder water from the deep sea during the processes of tidal ebb and flow. Hence, such areas remain cooler than others. Officials in the tourist hotels also reported increased abundance and size of

fish in the enclosed areas where they frequently observe schools of parrots, emperors, groupers, and mixed types and sizes of fish, including rays, cobia, barracuda, and the giant humphead wrasse ranging from 0.7 to 1.8 m.

Fish movements into deep waters thus contribute to changes in fishing practices, depth, and time at Jibondo. In the past, fishers successfully fished with set nets to a depth of about 8 m. Currently, they use large pull nets (about 360-560 m in length and 14-40 m wide/deep) in waters that are 20 to 30 m deep. Furthermore, instead of operating gill nets at 12 m and catching fish on the same day, they now need to fish to a depth of between 120 and 200 m, without a guarantee of obtaining catch on the same day. The majority of fisher respondents (65%) also reported spending increased time fishing. About 16% still spend the same amount of time fishing, 11% use less time, and 8% did not provide their perceptions. Moreover, octopus fishers now need to search for octopus for long hours, whereas in the past, octopus were plentiful and easily seen.

**Uncontrolled trawling, long-lining, and purse-seining by large-scale industrial fishers.** Fishers argued that the MIMP does not control trawling, long-lining, and purse-seining practices by large-scale industrial fishers within Tanzania's exclusive economic zone and territorial waters. These fishers extract large quantities of fish, including non-targeted fish, and cause unsettled ocean waters and seabed disturbance, thereby decreasing fish abundance and inflow to shallow waters. Although pull-net fishing is also thought to decrease abundance, major concerns focus on large-scale industrial fishing vessels, as one fisher explained,

... currently, the government allows us to use 2 inch mesh nets, but the same net becomes illegal when it is operated as a pull net. At the same time, about 10 foreign ships fish offshore using 0.25 to 1.5 inch nets pulled by machines. Now their type of fishing, when they fish with one ship for one day, it is equal to the whole of Jibondo fishing for six months ... (GI No. 10, 2011)

Thus, fishers feel unfairly treated because there is maximum control of their small-scale practices, yet minimum control of large-scale industrial fishing. They further argued that the lack of control of practices by investor in processing factory has contributed largely to the decline in octopus abundance. Although the Hellas Company, a previous factory in Mafia, allowed octopus recovery by having 3-month closures each year, the TANPESCA factory operates throughout the year, and offers low prices. Because fishers need to fish continuously to obtain money for survival, the combined effects have eventually contributed to a decline in octopus numbers.

**Declining traditional practices.** Because fishers feel unfairly treated, they have lost morale in attempting to reduce time spent fishing, curtailing pull-net fishing, and maintaining

**Table 5.** Example of Fishers' Observations on Changes in Major Fishing Grounds.

| Fishing areas | Changes noticed   |
|---------------|---|
| Mto wa Baraka | Dead coral from earlier dynamite fishing and El Niño, trampled green seaweed, and decreased water depth |
| Kulawe        | Slow coral recovery and decreased water depth   |
| Utumbi        | Dead coral from earlier dynamite fishing, coral damage from net fishing and decreased water depth       |
| Kinasi pass   | Decreased water depth   |
| Mange         | Coral recovery, patches of coral damage and decreased water depth near reef                             |
| Mwamba Milime | Coral growth  |
| Lwala         | No changes, apart from previous coral breakage for construction   |
| Kitutia       | Coral recovery and coral damage from net fishing  |
| Nyamaliile    | Substantial coral growth  |
| Ufungu        | Trampled and uprooted seaweeds ( <i>mwani mapanga</i> ) and decreased water levels                      |
| Kitoni        | Disturbed/overturned coral  |

cultural traditions in environmental management; consequently, this has contributed to decreased abundance and continuous habitat disturbance. Traditionally, Jibondo fishers had about 15 fishing days per month because tidal patterns determined fishing practices. Elders fished during spring tide days (from the 10th to 17th day of a month and 25th to 1st day of the next month) and used neap tide days (from the 2nd to 9th and 18th to 24th day of a month) for mending nets and farming. They used to fish for 8 months a year, leaving the rainy season (March to June) for farming. Observations reveal that today, pull-net fishers spend about 25 days per month fishing, whereas octopus divers reported that they fish almost throughout the year, regardless of tides and rainy seasons.

Traditionally, fishers would stop fishing whenever there were community events such as burials, initiations, and wedding ceremonies, and on Fridays (prayer day). Presently, some fishers continue fishing on such days, with impunity. Furthermore, octopus fishing through gleaning was traditionally a women's activity practiced in intertidal areas; now, men have begun diving for octopus in deep waters to access factory markets and avoid the Park's fishing gear restrictions, thereby contributing to the decline in octopus numbers. Women traditionally fished on foot in nearby areas from July to September during spring tides, and did not fish during pregnancy and maternity. However, they are now transported in large groups<sup>3</sup> to distant areas by factory agents, and fish for 2 or 3 days in each spring tide throughout the year, because after those days, the chances of returning empty-handed would be high. They now continue to fish until the late stages of pregnancy, and return to fishing just a few weeks after delivery. This reduced adherence to cultural traditions is perceived as being directly linked to decreased abundance of fish and octopus; the people believe that such practices have awakened the wrath of supernatural powers that have now inflicted human suffering through decreased fish abundance.

**Benthic cover.** Fishers observed increasing coral cover in most areas because corals are now recovering from earlier

**Table 6.** Multiple Responses to the Question "What Are the Observed Changes in the Areas That You Fish?"

| Perceived changes   | Counts (n = 22) |
|---------------------|-----------------|
| Decreased abundance | 12              |
| Decreased sea level | 11              |
| Seasonalities       | 4               |
| Increased abundance | 3               |
| Coral growth        | 3               |
| Habitat disturbance | 2               |

dynamite fishing. Breakage of branched and small corals, and decreased coral coverage were observed in some fishing areas. Fishers also reported a decrease in seaweed and sea-grass coverage in a few areas (Table 5).

Fishers further attributed damaged coral and benthic cover to the dominance of pull-net fishing practices which, as explained below, damage the coral and disturb benthic cover by

... dragging branched corals, because the net must be dragged on the seabed to fish blackspot snappers, rabbit fish and emperors. When these corals are trapped on nets, they are bitten to be broken so that they fall off, because sorting them takes up time under water ... but at the same time fishers avoid these corals for their nets will be trapped ... (I No. 19, 2010)

The changes in fishing areas were mentioned by 60% of fisher respondents (Table 6). Five per cent said they had not observed any changes, and the rest (35%) did not know whether there have been changes.

## Discussion

This study has made a case for retaining TEK originality and applying multiple evidence-based approaches to understanding marine ecological changes (Bohensky & Maru, 2011; Tengö et al., 2014). We have related results of the study to the available TEK and CSK<sup>4</sup> literature, to build part of an

enriched picture of the reported changes and identify new knowledge. For simplicity, we have grouped together results that align with CSK, and identified results that require CSK attention because they contradict CSK; we then present new knowledge gained from TEK. Reflections from applying the approach are then provided to affirm its potential for improving marine conservation.

### *TEK That Aligns With CSK*

Fishers' accounts of current catch composition, increasing overall catch quantities, decreasing sizes of individual fish and octopus caught, trends in fish and octopus abundance, and the overall status of coral reefs are closely aligned with CSK. For example, results on types of fish most frequently caught are similar to those reported in CSK of the same area by Machano (2005). His study also aligns well with fishers' observations of increased fusiliers in current catches. Such similarities between the two knowledge systems suggest a common understanding of catch composition, and hence enhance TEK reliability. Thus, the results on types of fish that are no longer common, or are either decreasing or increasing in current catches remain applicable, and can indicate further ecological changes in marine food webs, and/or changes in individual species populations. These results require further CSK vindication to complete the enriched picture in understanding trends in catch composition.

The results on increasing overall catch quantities in Jibondo align well with CSK documentation on increasing trends (Machano, 2005; URT, 2011a). However, this might not suggest an increase in fish abundance per se, but rather, it may reflect changes in fishing gear and practices, increased number of fishers, attempts to fish in deeper waters, and continuous catch collections by traders. A wide range between minimum and maximum catch quantities might reflect increased uncertainty in recent times in obtaining catches following increased protectionism (Benjaminsen & Bryceson, 2012) and difficulties in fishing in deeper waters. This observation aligns well with Machano's (2005) research in the same area finding that 7% of fishing trips resulted in no catches at all. Results on decreasing size of individual fish and octopus caught also align well with both TEK and CSK (Gaspere, Bryceson, & Mgaya, 2015; Kincaid, Rose, & Mahudi, 2013; Machano, 2005). Machano (2005), for example, reported that the majority of fish caught weigh significantly less than 1.2 kg, and 73% of octopus weigh less than 1.5 kg.

Concerning the status of fishing grounds, results on both fish abundance and coral cover variables resonate well with those of CSK. Fishers' observations of decreasing abundance in inshore areas align well with findings reported in CSK, for example, by Kamukuru, Mgaya, and Öhman (2004). Such decreasing trends have also been reported elsewhere by Masalu, Shalli, and Kitula (2010); and by Blythe, Murray, and Flaherty (2013). Observations of increasing

fish abundance in enclosed areas were also vivid among hoteliers and in CSK reports such as Machano (2003); the URT (2011a); Baker (2013); Hemsworth, Jensen, and Gill (2015); and Lewis, Margeriso, Sobkowiak, and Fanning (2011).

Similarly, observations and interpretations of both improved and damaged coral cover are consistent with those from CSK. For example, observations of coral recovery after the effects of dynamite fishing and the 1998 El Niño align well with the documented increase in coral cover from 14% (Garpe & Öhman, 2003) to 52% (Hemsworth et al., 2015). Furthermore, observations of slow recovery of damaged coral are in accord with those of Roberts (2014) that reported dead coral cover of up to 63%. This may affirm the argument that coral reef recovery in protected areas tends to be slower than that in fished areas, partly due to higher initial coral cover (Graham, Nash, & Kool, 2011). Nonetheless, CSK concludes that marine ecosystems within the MIMP are healthy (Lewis et al., 2011; URT, 2011a).

### *TEK That Contradicts CSK*

TEK results showing decreasing catches per fisher and overall catches in Chole reveal contradictions with CSK. Although results reflecting decreasing catches per fisher in both sites is consistent with other TEK within the MIMP and elsewhere (Blythe et al., 2013; Gaspere et al., 2015; Kincaid et al., 2013; Masalu et al., 2010), they contradict CSK which show increasing trends (Machano, 2005). A similar inconsistency is reported in the Mnazi Bay Marine Park, in southern Tanzania, where Machumu and Yakupitiyage (2013) reported increasing catch trends, whereas Kamat (2014) reported decreasing trends. Such inconsistency may reflect variations between qualitative and quantitative methodological approaches in understanding TEK of ecosystems (Mackinson & Nøttestad, 1998). It may also further reflect the importance of multiple evidences, and the need for mutual engagement of TEK and CSK holders in processing the enriched picture about the changing trends in individual catches (Tengö et al., 2014).

However, although decreasing individual catches was a major concern among fishers, this features less in CSK. Furthermore, decreasing overall catches in Chole also contradict CSK (Machano, 2005). This affirms the important need to consider contextual variations, even at local scale (Child & Barnes, 2010), and might indicate reliance on overall catch data in explaining ecological conditions within the MIMP (URT, 2011a). Nonetheless, increased overall catches have shown no substantial positive impact to individual fishers in terms of meeting their livelihood needs. The lack of attention to individual catches and local contextual variations may undermine the ability of MIMP officials in the long run to notice and anticipate ecological changes that may result from efforts by individual fishers to deal with decreasing individual catches.



Our results illuminate some such efforts by local fishers. These include an increase in free-diving fishing practices, increased numbers of fishing days, and increased pressure on the octopus fishery. In 1994, for example, CSK reported that fishers used 12 fishing days per month and that octopus fishers returned with up to 30 octopuses (Hooper, 1996). This is quite different from our results which show that fishers use 25 fishing days per month. Thus, although Darwall (1996) concluded that pull-net fishing in Mafia was within sustainable levels of exploitation, and Guard (2003) considered octopus fishery in Jibondo to be sustainable, joint research between TEK and CSK researchers is required to re-examine the current situation.

### *TEK That Presents New Knowledge and Novel Insights*

Although long-term fishers' observations of falling sea levels, reef growth, and rising sea temperatures present new knowledge as illustrated below, their explanations of the causes of the changes (presented in the "Results" section) yield new insights which require attention from CSK. Such emerging TEK has not been communicated to CSK practitioners due to bureaucracy, increasingly hostile relationships between fishers and MIMP officials, and lack of effective community participation in MIMP undertakings (Benjaminsen & Bryceson, 2012; Mwaipopo, 2008; Walley, 2002, 2004).

*The falling sea level and reef growth.* The observation that the sea level is falling due to reef growth within the MIMP does not feature in CSK. However, the same observations by fishers in other parts of Tanzania are consistent with CSK. In Zanzibar, for example, fishers noted that some fishing grounds are currently reachable on foot, even by children (Mustelin et al., 2010). This concurs with some CSK reporting of a substantial decrease in sea level in parts of the western Indian Ocean, including southern Tanzania and Zanzibar, following changes in subsurface winds and tectonic uplift (Benjaminsen, Bryceson, & Maganga, 2008; Han et al., 2010; Han et al., 2014; Reuter, Piller, Harzhauser, Berning, & Kroh, 2010). According to Kebede and Nicholls (2011), Tanzania's sea level is fairly stable or falling. This is consistent with previous and current findings in other parts of the east African coast that reveal stable or falling sea levels compared to 50 to 30,000 years ago, partly due to long-term reef growth (Mönnner, 2013; Salm, 1983). Although the results of this study show fishers' explanations of falling sea level are based on reef growth, much remains to be established about CSK of the causes and extent of falling sea levels and reef growth to establish multiple pieces of evidence.

Nonetheless, both TEK and CSK of falling sea levels challenge the mainstream narrative of climate change studies, which report sea-level rise in the Indian Ocean (Intergovernmental Panel on Climate Change, 2007; Stammer,

Cazenave, Ponte, & Tamisiea, 2013; Yanda, 2013). Such similarities and differences in observing and interpreting sea-level changes confirm that matching and/or mismatching of findings within and between TEK and CSK are inevitable. This is so because TEK is at small scale, and is based on long-term observations and conceptual interpretation by the people inhabiting a particular geographical setting; whereas CSK can cover large geographical scales, and is based on positivist principles of precision and objective collection, and quantification and interpretation of hard data (Berkes et al., 2001; Mackinson & Nøttestad, 1998; Tesfamichael et al., 2014). Nevertheless, each knowledge system has significant potential for contributing to the enriched picture of understanding changes at a particular scale (Carr & Heyman, 2012; Daw, 2008; Haggan et al., 2007).

*Rising sea temperatures.* Results indicating that sea temperatures are rising also do not feature well in CSK. Bryceson et al. (2006) and URT (2011a), for example, showed that sea temperatures within the MIMP have large seasonal variations, but are fairly stable over periods of many years. Other studies have observed seasonal variations of surface temperatures (Mahongo & Shaghude, 2014) and extreme temperature shifts during the 1998 El Niño, and reported impacts on coral reefs (Garpe & Öhman, 2003; Hemsworth et al., 2015). Thus, CSK of long-term changes in sea temperatures and the impact on fish distribution is required to harmonize and establish multiple evidences, which are crucial for processing the enriched picture. The CSK of temperature trends is crucial, particularly because there is CSK evidence of weak correlation between the percentage of coral cover and fish abundance within the MIMP (Hemsworth et al., 2015). Thus, TEK of rising temperatures and the implications for fish abundance and distribution can be valid. Such TEK also accords well with TEK from Mtwara, on the southernmost coast of Tanzania, where fishers associated increased warmer conditions with fish migration to offshore areas (Bunce, Rosendo, & Brown, 2010). It further accords well with CSK from elsewhere that shows that changes in sea temperatures caused shifts in marine fish abundance and distribution (Brander, 2007; Perry, Low, Ellis, & Reynolds, 2005; Soto, 2002).

*Causes of marine ecological changes.* Fishers' interpretations of the causes of marine ecological changes emphasize the influence of non-linear, multiple, interrelated social-ecological factors. These interpretations indicate fishers' ability to comprehend both proximate causes and underlying forces underpinning the reported changes and fishers' actions (Lambin et al., 2001). Fishers' interpretations are also in accordance with findings that emphasize the importance of TEK-based social-ecological factors in understanding ecological changes, providing critical direction for research, and informing management challenges (Blythe et al., 2013; Evans et al., 2011). However, most CSK within



the MIMP is dominated by proximate causes, with a focus on fishers' actions as the leading cause of changes. A case in point is the persistence of the narratives of overfishing, use of destructive fishing gear, and resultant damaged habitats as major causes of decreases in fish and octopus abundance and catches (Kamukuru et al., 2004; Mahingika, 2007; URT, 2011a).

The argument that there is overfishing in Mafia waters, for example, is problematic because it overlooks the underlying factors, thus narrowing the potential for improving conservation. It is further problematic because suspicions about overfishing are not always accurate (Haggan et al., 2007). This is especially vivid when overfishing is said to occur when overall catches begin to decrease (Kolding & Zwieten, 2011), yet the overall catch numbers within the MIMP are increasing (URT, 2011a). Results in this study show that increased catch numbers relate to the breakdown of traditional management practices, including greater fishing depths, number of fishers and fishing days per month, use of active gear, and diving practices, compared with previous observations (Guard, 2003; Hooper, 1996). Nonetheless, the changing traditions and the resultant increased catches indicate not only fishers' response to economic opportunity (Lambin et al., 2001) but also the effect of low prices for their catches, inefficacy of the MIMP's prescribed fishing gear, falling sea levels, and rising sea temperatures (Bryceson et al., 2006; Moshy, Bryceson, & Mwaipopo, 2015).

One may argue that fishers' attribution of reduced abundance to sea temperatures and depths might suggest what Daw (2008) called "cognitive dissonance," where fishers tend to explain resource decline by pinpointing environmental factors rather than their own actions. However, environmental-related factors also dominated at Chole, where fishing activities are dwindling. Thus, fishers do not deny the effects of their fishing practices on abundance and coral conditions, but they are against the narrow and simplified interpretation of ecological changes that discount the underlying factors (Lambin et al., 2001). Furthermore, some fishers used environmental factors to provide additional interpretations of increasing abundance in enclosed areas, as water movement from the open sea cools the water in such areas, automatically supporting fish existence. This interpretation differs from the dominant interpretation that the MIMP's achievement in halting dynamite fishing is the reason for increased abundance.

Nonetheless, results suggest that the MIMP is a key underlying institutional factor that contributes to decreasing catches and abundance in fished areas. For example, new insights into the decline of TEK transferring across generations in Chole, less overall adherence to former TEK-based conservation strategies, and increased pressure on the octopus fishery at Jibondo, all point to the downside of MIMP undertakings. Fishers linked the decline of transferring TEK to the dwindling fishing activities following MIMP restrictions. Although there were 70 fishers in Chole in 1988 (Howell et al., 1989),

district data show that the number of fishers dropped to 27 in 2009 and only 12 in 2010. This is also reflected in the decrease in the number and types of fishing gear in Chole bay by 38%, with users from Chole accounting for only 10% of all users (Machano, 2005).

Because learning and transferring of TEK depend on the continuous practice of livelihood activities in building up-to-date knowledge (Berkes et al., 2000; Carr & Heyman, 2012; Haggan et al., 2007), it would appear unlikely that future generations will possess TEK about the sea as their predecessors. Thus, by contributing to diminishing TEK, the MIMP has also minimized its own chances of nurturing knowledge diversity (Berkes et al., 2003) to improve conservation outcomes in the future.

Although establishing and transmitting TEK from generation to generation is a lifetime process (Berkes, 1993, 2008), the recent gradual reduction of TEK among the youth in Chole had been witnessed only 16 years after the inception of the MIMP as a relatively rigid management body. Meanwhile, although pull-net fishers in Jibondo are the most knowledgeable about current oceanic conditions, they have a poor relationship with MIMP officials. It has been found that hostile relationships between TEK holders and managers often hamper knowledge acquisition (Drew, 2005). Hence, without building mutual respect to improve such relationships, managers will still fail to acquire TEK and fail to realize its importance (Tengö et al., 2014).

The MIMP has further contributed to decreasing adherence to TEK conservation strategies among fishers, by failing to control companies that continuously buy fish and octopus catches at low prices, and large-scale industrial fishing fleets observed in Mafia waters. The fleets were reported as causes of ecological changes, but they are not as tightly controlled as local fishers who fish for their livelihoods. A recent ministerial report (URT, 2014) has also reflected such concerns. The report shows, for example, that in the fiscal year 2013/2014, a total of 800 man-days of patrols were conducted in Tanzania's marine parks and reserves, whereas the Tanzania Deep Sea Fishing Authority conducted only 8 man-days of patrols in the deep sea off Tanzania's coast (URT, 2014). This reflects fishers' concerns that large-scale industrial fishing fleets invade inshore waters, and scientists' observations that they operate in an unregulated manner (Tamatamah & Bryceson, 2009). Deep sea fishing in Tanzania has increased from 12 fleets in 2002 (Jiddawi & Öhman, 2002) to 72 fleets in 2011 (URT, 2011b). However, current efforts are more focused on controlling small-scale fishing than large-scale industrial fishing, and in promoting the latter rather than controlling it. These tendencies have reduced fishers' willingness to adhere to CSK-based conservation strategies.

Furthermore, the results indicate that the MIMP's zoning scheme contributes to both the breakdown of traditional fishing rotation practices, and increase in fishing pressure in fished zones. As a result, narratives about the reportedly

human-induced coral damage, decreasing individual catches, and octopus decline are likely to persist. Furthermore, octopus decline is often linked to declining fish catches and octopus marketing opportunities (URT, 2011a) rather than the low prices offered, or MIMP actions such as fishing restrictions, violent patrols, and gear confiscations (Benjaminsen & Bryceson, 2012). These circumstances press more people into octopus fishing. This insight into octopus decline within the MIMP has been overlooked, but has the potential for improving the management of octopus fisheries.

Marine protected areas are often incapable of managing larger seascapes (Berkes et al., 2006), do not always succeed in reducing user pressure (Allen, Mourato, & Gulland, 2011), and require marketing operations to contribute toward achieving conservation goals (Jones, 2014). Addressing these issues will require the MIMP to strengthen collaboration with institutions which deal with the licensing and control of foreign investments, trade, and research. This will create new spaces for dealing with the key underlying environmental, economic, and institutional factors that are driving the proximate causes of changes within the MIMP, minimizing their undesired outcomes, and eventually building a sense of equitable treatment and respect, thus restoring trust and local support for conservation.

### *Some Reflections on the Multiple Evidence-Based Approach*

Unlike the previous dominance of CSK within the MIMP (Walley, 2002), the process of exploring ecological changes through TEK has enabled its owners to freely share their knowledge of the sea. The process has produced spaces for enhancing the equal treatment of TEK and CSK by promoting effective participation of TEK holders in knowledge production, before it was considered in parallel with existing CSK (Tengö et al., 2014). However, some TEK owners have been skeptical about sharing their TEK, probably because they feared that it might backfire on them; and in the past, their TEK was undervalued (Walley, 2002), which hampered its meaningful integration into CSK (Bohensky & Maru, 2011; Carr & Heyman, 2012; Cornwall, 2002; Nadasdy, 1999).

The TEK documented in this study reflects how fishers picture and interpret marine ecological changes in their area, and how such picturing is related to CSK. These findings indicate the need for mutual engagement of TEK and CSK holders in processing an enriched picture of a particular phenomenon; and may imply that studies that simultaneously produce TEK and CSK would be likely to succeed. This is because each knowledge system must first have equal chances of “speaking for itself,” on its own terms, and within its own context (Tengö et al., 2014). This entails removing CSK standards from the initial phase of exploring TEK, and using them in the second and third phases (i.e., when producing CSK and in processing the resulting enriched picture of a

particular phenomenon). The involvement of both social and natural scientists who respect TEK remains critical to remove CSK interference from TEK exploration. Such researchers are most likely to present TEK as it appears and can empower TEK owners to participate in processing the enriched picture more effectively. Such an approach could also resolve the failure to integrate TEK in CSK due to social scientists documenting TEK which lacks conventional science standards or overlooks important biological realities (Haggan et al., 2007).

Meanwhile, TEK that contributes new knowledge and insights can facilitate adaptive management for enhancing social-ecological resilience of an area. If practitioners can learn from and react adaptively to sea level and temperature trends and the multiple factors causing marine environmental changes, they will eventually create space to enhance resilience by making practical data-based decisions that consider social-ecological and conservation concerns. In fact, by focusing mainly on local resource use and its effects on the marine ecosystem (URT, 2011a), the MIMP has been overlooking the underlying factors contributing to changes (Lambin et al., 2001). TEK can present new insights into the contexts of marine ecological changes and contribute new priorities in CSK research and monitoring. This is especially so when research within the MIMP “has been sporadic and often without particular research priority” (URT, 2011a, p. 27); furthermore, TEK is important in identifying areas of special concern (Drew, 2005; Haggan et al., 2007).

Such insights also form an important feedback mechanism enabling MIMP officials to detect changes, which may, in turn, increase their potential to learn, and build their ability to anticipate the outcomes of such changes and future changes. However, it is practically worthless to notice such changes without making significant efforts to improve management strategies and create space for designing mechanisms to *deal* with observed changes in adaptive ways. The best potential way to deal with such changes is to adopt a multiple evidence-based approach (Tengö et al., 2014). This implies producing enriched knowledge from equal treatment, empathy, and mutual respect for TEK and CSK values that are embedded in each knowledge system, and confirms the need to diversify knowledge systems as a strategy for building resilience (Berkes et al., 2003; Tengö et al., 2014). It is necessary to combine efforts within relevant institutions to build capacity for dealing with the underlying factors of marine ecological changes (Jones et al., 2013). Such efforts can, in turn, foster rapid and flexible data-based decision making (Carr & Heyman, 2012; Evans et al., 2011; Ruiz-Mallén & Corbera, 2013), and restore respect, trust, equality, and good relationships between fishers and conservationists as a way of renewing local support for conservation. Addressing practical issues, which hamper the realization of social, ecological, and conservation needs, offers the potential for improving resource management and enhancing social-ecological resilience.

## Conclusion

Seeing through the perspective of fishers' knowledge has contributed new insights to understanding marine ecological changes in the MIMP. Fishers provided contextual data to show that sea levels are falling in their area. They also illuminated that environmental factors, conservation outcomes, marketing constraints, population dynamics, and the disappearance of cultural traditions are among the underlying causes of marine ecological changes, besides overexploitation which is a dominant explanation in CSK. For example, the decline in fish abundance in shallow areas within the MIMP is due to decreased water depth and rising sea temperatures, increased fishing pressure after enclosing traditional fishing areas, declining rotational schemes, increasing population, and low prices paid for local catches.

A dominant CSK narrative perceives fishers as a cause of ecological changes and a threat to marine conservation. This study found that increasing efforts to control their actions without dealing with the underlying causes may impair conservation efficacy in marine protected areas, and may not necessarily be the best option for dealing with marine ecological changes. Genuine cross-scale collaborations between TEK and CSK holders can contribute feedback and learning to enhance adaptive management, a key resilience building strategy that can balance the concerns of fishers, conservationists, and researchers. Nonetheless, such collaboration will depend upon the willingness by CSK holders to prioritize multiple evidence-based researches, and upon political willingness to place equal emphasis on conforming to global conservation policies and meeting local social-ecological needs.

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## Notes

1. Apart from the 11 motorized boats, there are also 12 sail boats and 23 canoes.
2. This explanation captures fishers' use of the term *bahari inakua*, meaning that the sea level is decreasing and the sea bed is moving upward as a result of reef growth and the accumulation of sediments and eroded debris.
3. There were three large motorized boats each transporting about 100 women.
4. Due to the scarcity of conventional science knowledge (CSK) data (United Republic of Tanzania, 2011a), CSK reports from non-specialist volunteer researchers from Frontier Tanzania, who have proven to be reliable (Darwall & Dulvy, 1996), and literature covering the Mafia Island Marine Park, form a basis for picturing the changes from the CSK perspective.

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### Author Biographies

**Victoria H. Moshy** is an assistant lecturer at the Institute of Resource Assessment, University of Dar es Salaam - Tanzania. She is currently pursuing her doctoral degree in Development Studies at the Norwegian University of Life Sciences. Her research interests include social dimensions of social-ecological resilience, fisheries and marine conservation.

**Ian Bryceson** is a professor of Ecology at the Department of International Environment and Development Studies, Norwegian University of Life Sciences. He is a marine ecologist with broad interests in fisheries, aquaculture, the struggles of coastal peoples for their rights, and socio-ecological resilience at the interphase of society and environment.

**Paper 2: Social-ecological changes, livelihoods and resilience among fishing communities in Mafia Island Marine Park.**





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Victoria H. Moshy<sup>ab</sup>, Ian Bryceson<sup>a</sup> & Rosemarie Mwaipopo<sup>c</sup>

<sup>a</sup> Department of International Environment and Development Studies, Norwegian University of Life Sciences (NMBU), Norway

<sup>b</sup> Institute of Resource Assessment, University of Dar es Salaam, Dar es Salaam, Tanzania

<sup>c</sup> Department of Sociology and Anthropology, University of Dar es Salaam, Dar es Salaam, Tanzania

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## Social-ecological Changes, Livelihoods and Resilience Among Fishing Communities in Mafia Island Marine Park, Tanzania

Victoria H. Moshy<sup>a,b</sup>, Ian Bryceson<sup>a</sup> and Rosemarie Mwaipopo<sup>c</sup>

*<sup>a</sup>Department of International Environment and Development Studies, Norwegian University of Life Sciences (NMBU), Norway; <sup>b</sup>Institute of Resource Assessment, University of Dar es Salaam, Dar es Salaam, Tanzania; <sup>c</sup>Department of Sociology and Anthropology, University of Dar es Salaam, Dar es Salaam, Tanzania*

Analysis of societal dimensions is increasingly receiving attention in social–ecological resilience research. This study investigates the impacts of neo-liberal marine conservation and economic policies, and environmental changes on the livelihoods of two fishing communities in Mafia Island Marine Park, Tanzania, and their response strategies towards attempting to maintain livelihood resilience. These communities are in similar geographical and administrative settings but differ in their proximity to Park headquarters, conformity to Park regulations and engagement in fish trade. Data were collected through in-depth interviews, focus group discussions, direct observation and questionnaire surveys. Interviewees from both villages reported increasing poverty in terms of reduced capacity to meet their basic needs, and decreases in numbers of meals per day, variety of foods and fish consumption, reduced access to resources, low productivity and prices of local produce. Women experienced raised household responsibilities for food security and meeting other household needs. Their main responses to these changes included loan seeking, reduction of expenditures, skipping meals, selling assets, collective fishing, livelihoods diversification, change of fishing techniques and gears, abandoning of fishing activity and outward migration. Their responses only contributed to survival without resolving the challenges. Paying attention to these societal experiences is therefore necessary, if resilience of social–ecological systems in a marine conservation area is to be maintained or enhanced.

**Keywords:** social–ecological systems; livelihoods; response strategies; resilience; marine protected areas; Tanzania

### Introduction

Perturbations in marine social–ecological systems (SESs) have recently become a major concern of many conservationists in the world. These perturbations can be a result of two interdependent processes: introduction of policy interventions that control the access, use and trade of natural resources among resource-dependent communities; and the changing environmental conditions (Benjaminsen and Bryceson,

2012; Berkes and Folke, 1998; Marschke and Berkes, 2006; Marshall et al., 2009). For example, the introduction of global neo-liberal marine conservation and economic interventions have had mixed effects on local SESs (Mora and Sale, 2011; Kolding and Zwieten, 2011). In Marine Protected Areas (MPAs), it is pointed out that while these MPAs are often effective in conserving biodiversity, they tend to minimize extractive livelihood activities by controlling resource access among actors, and maximize market values of conservation areas in favour of maximizing tourism revenues (Brockington et al., 2008). Meanwhile, market-based production and economic interventions are reported to alter marine resource extraction patterns and provide unequal opportunities among actors (Coulson, 2013; Harvey, 2005). On the other hand, ecosystem processes such as species interactions may transform the environmental conditions, while anthropogenic processes such as livelihood activities, technology advancements and capitalist production exaggerate such environmental transformation (Brockington et al., 2008; Jones, 1992; Kolding and Zwieten, 2011). These interdependent social–ecological processes affect both ecological and social components of marine SESs.

Increased trade and large-scale investment in marine fisheries under the neo-liberal capitalist economy regime fails to provide equal opportunities among actors, and has both ecological and social costs (Berkes, 2003; Harvey, 2005). While such investments are profitable among investors, they reduce fishery productivity, economic gains and fish supply for improved food security among resource-dependent communities, who are often the least powerful actors (Harvey, 2005; Jennings and Polunin, 1996; Perry et al., 2010). Meanwhile, marine conservation efforts to restore declining marine resources may contribute to both increased fish catches and food insecurity in MPAs (Baker, 2013; Benjaminsen and Bryceson, 2012; Mascia et al., 2010). The costs of free market and conservation benefits are thus also distributed unequally between social and ecological components, and among actors with unequal power relationships (Bryant and Bailey, 1997; Christensen and Krogman, 2012).

While conceptualization of ecological components is relatively well established in the marine SESs perspective and conservation pursuits, it is not so for social components (Coulthard, 2012; Fabinyi et al., 2014). The main reason for this is that conceptualization of social components in marine SESs conservation has lacked in-depth analysis of the immediate needs of resource-dependent communities and their well-being status. This article is intended to address this weakness by focusing the analysis of the Mafia Island Marine Park (MIMP) social conditions, with emphasis being placed on their daily experiences and pursuits for income, food, resilient livelihoods and well-being. The goal is to contribute to current efforts of strengthening social perspectives of SESs in resilience thinking by adoption of social–ecological resilience (SER) approaches<sup>1</sup> in the context of a developing country. These social aspects can influence

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<sup>1</sup>Adoption of social-ecological resilience (SER) approaches is increasingly recommended for its potentials to consider both social and ecological components of SESs and minimize adverse

human–environment interactions and responses, and may contribute to providing social–ecological feedback to managing bodies, and thus provide a better understanding of social mechanisms in relation to resilience.

### *Concepts and analytical framework*

This study combines SER and political ecology approaches with some concepts of livelihoods and well-being to investigate implications of key changes experienced in two villages within MIMP and key conditions that strengthen or weaken SER. The concept of SER refers to the ability of SESs to respond to perturbations while retaining their function (Folke et al., 2003; Walker et al., 2004). Thus it guides our analysis of how fishing communities deal with social–ecological changes to maintain their income, food security and living conditions by embracing social learning, nurturing diversity, combining various knowledge types and self-organizing to build SER (Adger, 2000; Folke et al., 2003). While both ecological resilience and social resilience are crucial in obtaining SER (Coulthard, 2012), we attend to the growing need to understand the social aspects of SER.

The applicability of resilience thinking to understand social systems is still debatable (Davidson, 2010). This is partly due to lack of incorporation of social theories in its accounts (Beymer-Farris et al., 2012; Coulthard, 2012) and inherent differences in behaviour, processes and structures between ecological and social systems (Adger, 2000). Resilience also tends to overlook the role of human agency, social stratification, social factors that maintain undesirable states and questions of power relations among actors (Brown, 2013; Fabinyi et al., 2014). Thus a political ecology approach is deemed useful in analysing how neo-liberal conservation, capitalist relations and political economic drivers can result in poverty at the local scale (Blaikie and Brookfield, 1987). In this article, the political-ecological questions are explored in terms of capitalist relations of production linked to non-class factors such as the state-sponsored conservation of the fishery in the MIMP (Bryant and Bailey, 1997). As a critique of the ‘environmental crisis’ narratives that have informed public policy in marine conservation in the MIMP, the article attempts to integrate local concerns and evidence of biophysical change with political economic causes by collecting new place-based data as suggested by Blaikie (1985).

Our understanding of livelihoods follows Chambers and Conway (1992), Ellis (2000) and Allison and Ellis (2001) who broadly define livelihood in terms of requirements for, and processes of gaining a living, satisfying needs and improving standards of living. Meanwhile, our analysis of livelihoods in the context of rural marine SESs is

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social-ecological effects that individuals face on a daily basis in their struggle to survive (Berkes et al., 2003; Christensen and Krogman, 2012). However, due to existing power relationships in SES perspectives, ecological components and institutional aspects of human-environment relations (Berkes and Folke, 1998) are privileged in social-ecological studies whilst social components in terms of diversity of human interests, experiences, complex social processes across scale, and the role power are marginalized (Coulthard, 2012; Fabinyi et al., 2014).

informed by Berkes and Seixas (2005), Marschke and Berkes (2006), Bunce et al. (2010); Benjaminsen and Bryceson (2012); and Beymer-Farris et al. (2012) who show how livelihoods of fishing communities usually encounter uncertainties related to resource fluctuations, foreign investments impacts, and restrictive conservation. Local views of 'good life' are included as a supplement for well-being and resilience.

### **Context and methods**

The MIMP, covering an area of 822 km<sup>2</sup>, is located within Mafia Island, an archipelago forming Mafia District and located about 120 km southeast of Dar es Salaam. The Island has the richest marine biodiversity in the western Indian Ocean and is a globally recognized area for marine biodiversity and conservation (Benjaminsen and Bryceson, 2012). The island has an average annual rainfall of 2000 mm and receives short rains between October and December and long rains from March to May. Air temperatures range from 20°C to 32°C. The Northeast Monsoon occurs from December to April and Southeast Monsoon between June and October. The soils are mainly sandy loam while coral rags dominate in some areas with little soil cover (Bryceson et al., 2006). These biophysical and climatic characteristics have great influence on villagers' choice and focus of livelihood activities over time, but also make villagers vulnerable to economic shocks and stresses. For example, strong winds during the Southerly Monsoon make fishers vulnerable to safety and income shocks.

Livelihoods are also influenced by various political economic factors. Since colonial times, farming was important in Mafia Island, whereas fishing was mainly practised in Jibondo and Bwejuu islands (Caplan, 2002). Following the global slump in demand for copra, increased demand for sea products and local competition from cheap imported cooking oil under neo-liberal economy during 1980s, more villagers were drawn into fishing (Caplan, 2002; 2007). By 1989, the foreign-owned sea products processing factory, Hellas Company Ltd, was established in the Island at Kilindoni. By 2002, Hellas was sold to TANPESCA Ltd, the first and largest marine finfish processing factory in Tanzania, which is recently blamed for offering low prices to fishers while increasing fishing pressure (Bryceson et al., 2006; Caplan, 2002). Marine finfish export has been illegal until 2002, when Tanzania made a trial change in fisheries policy to allow export of finfish from her coastal waters (Bryceson et al., 2006). Meanwhile, the establishment of MIMP in 1995 as a response to dynamite fishing and global biodiversity conservation demands initially gained local support because its initiatives halted dynamite fishing and widened livelihood options (Bryceson et al., 2006; Walley, 2004). However, since 2000s increasing protectionism, restricting fishing gears and access to rich fishing grounds also downplayed societal needs, and limited the extent of local participation, thereby bringing resistance to MIMP operations among Park residents (Benjaminsen and Bryceson, 2012; Mwaipopo, 2008; Walley, 2004).

The Park residents reside in 13 villages, 4 being wholly within the Park boundary. The 13 villages are often grouped as Park villages without much consideration of their contextual differences. This study focuses on villages that are totally located within the Park. Chole and Jibondo villages were selected because they lie within the MIMP but had different contextual characteristics. The villages had populations of 1021 and 1707, respectively (URT, 2011). Chole was closer to the MIMP headquarters, had a foreign-owned tourist hotel, had the highest poverty level and regularly conformed to MIMP regulations (Bryceson et al., 2006; Walley, 2004), whereas Jibondo was further from the MIMP centre, demonstrated non-conformity to MIMP regulations and was a typical fishing village with fish traders and factory agents (Bryceson et al., 2006; Caplan, 2002; McClanahan et al., 2009). Thus, these two villages were chosen to facilitate a deepened understanding of perturbations and response strategies among the people who are often grouped under the label 'Park residents'.

Data used in this article were collected for eight months, between August 2009 and March 2011 using both qualitative and quantitative techniques (Bryman, 2004). For qualitative methods, wealth ranking was conducted to gain an understanding of how various individuals were differentially affected by or responded to social–ecological changes. Three wealth categories (rich, poor and poorest) were identified using villager-identified wealth status indicators (number and quality of assets and meals per day, and ability to work and handling emergencies). Seasonal calendars were used to identify livelihood activities throughout the year, and 48 key informant interviews, which included officials at MIMP and Mafia district authorities, were used to obtain data at household and institutional levels. Other methods used included 13 focus group discussions (FGDs) and collection of life histories of individual fishers. These methods facilitated contextual understanding of the ways in which people interpreted change in their lives and their responses to stress as a result of social–ecological changes. Direct observations were made on catch landing sites, farming plots, food consumption and general living conditions and processes to further understand reported issues.

Structured open-ended questionnaires administered to 37 and 66 heads of households randomly selected from wealth categories in Chole and Jibondo, respectively, complemented qualitative data and provided quantitative indications of changes and responses. To obtain information related to income, respondents were asked to estimate their average income from their activities, from other household members and remittances. We wanted them to specifically show income and expenditure fluctuations depending on types of livelihood activities and frequency of payments. To obtain food-related information, respondents were asked to give variations in the number of meals per day and diet diversity between 1980s/1990 and 2010/2011 periods. They also estimated the number of days without consuming protein foods (fish, pulse, eggs, chicken, beef and milk), and explained why their income, food trends and livelihoods were changing and how they were responding to these changes, before providing their views of 'good life'.

The analysis of data was conducted through coding of interviews, FGDs transcriptions and drawing meanings using thematic analysis. Quantitative data were also coded and analysed to reveal possible trends in percentages. Since it was noticed from both qualitative and quantitative data that income levels and trends were largely influenced by four compounding factors, that is, seasonality, ocean tides, shocks from management interventions and price fluctuations, it became clear that income estimates could obscure their reality of living conditions, since they fluctuated too often. Hence, as also suggested in Narayan and Pritchett (1999), we decided to use daily expenditure<sup>2</sup> estimates to reflect living conditions because expenditures were more stable over time than income.

## **Results and discussion**

People's livelihood situations were observed to have resulted from cumulative impacts and interlinked processes related to social–ecological changes and their responses strategies. As such, people's experiences of the emerging trends of livelihood activities, economic conditions and food security are discussed in relation to responses to changes in strategies of resource management and marketing, and environmental conditions over time.

### *The changing livelihoods situations*

The socio-demographic conditions of respondents influenced their ability to earn and maintain their living, and provided a broad picture of their living conditions. Respondents in Chole were aged between 30 and 75 years (mean age 49) and in Jibondo between 25 and 90 years (mean age 53). About 76 per cent of respondents in Chole had primary education, and only 1 per cent had diploma. In Jibondo, 65 per cent had primary education, and only 1 per cent had secondary education. Average household size was 5 persons in both sites, but household size in Jibondo ranged from 1 to 15 and from 1 to 7 in Chole. About 5 per cent of households in both sites were classified as rich, while 10 per cent in Chole and 5 per cent in Jibondo were grouped as poorest. Respondents in Chole had poorer housing conditions than respondents in Jibondo. In Chole, 60 per cent of their houses had mud floor, 81 per cent had mud-pole walls, only 11 per cent had metal roofing and 35 per cent had banana leaves fence because palm leaves were unaffordable. In Jibondo 48 per cent had mud floor, only 27 per cent had mud-pole walls and about 26 had metal roofing.

### *Changes in livelihood activities*

Livelihood activities have been changing over time. Until the late 1990s, a majority of men in Chole and Jibondo had been mainly engaging in fishing, and subsistence crop production, together with women. Rope-making dominated among women in Chole,

<sup>2</sup>All money values are in USD based on the February, 2011 exchange rate of 1 USD to 1393 TShs.



while in Jibondo octopus-fishing was predominant. During this study, however, most men in Jibondo engaged in fishing and some elderly men joined the women in seaweed culture. In Chole, farming was predominant for both men and women, and a few people were employed at Chole Mjini tourist hotel. Rope-making was still practised by women. Thus, both temporal and gender dimensions to livelihoods are important for understanding livelihoods dynamics.

Diversification of livelihood activities was a key feature among households. Respondents reported other household members to be engaged in seaweed culture (78 per cent) and octopus-fishing (67 per cent) in Jibondo, and farming (57 per cent) and rope-making (51 per cent) in Chole. Livestock keeping, business, petty trade, thatch weaving, handicrafts, casual labour, house construction and vessel building were practised at both sites. The dwindling activities were farming at Jibondo, whereas at Chole, fishing and seaweed culture were in decline. About 27 per cent and 68 per cent of respondents in Chole and Jibondo, respectively, owned seaweed culture ropes. The average number of ropes owned by each respondent was 13 ropes, ranging from 15 to 22, which was lower than 64 ropes, ranging from 10 to 200 at Jibondo. Diversifications within the fishery, and of fishing methods was common in Jibondo but made them temporarily less resilient to maintaining their needs and fishing livelihoods when shocked by sudden actions. For example, the fishing gear confiscation by the MIMP in 2010 caused extreme hardship conditions at Jibondo (Benjaminsen and Bryceson, 2012), but was rather a stress in Chole because people's dependence on fishing was declining. This variation supports Berkes and Folke (1998) argument that a similar event can result to shock into one area and stress into another, depending on their contextual variations. Overall, by diversifying, small cumulative gains from each activity contributed towards maintaining a living, but their general economic situations remain undesired.

### *Economic situations*

Low economic status and mismatch between income and expenditure were reported as key concerns among interviewees because their income did not fulfil household needs. Traditionally, men had the role of earning income and satisfying household needs. However, following their engagement in seaweed culture, middle-aged women at Jibondo were found to be financially stronger than some of the men and the interviewed female household heads revealed that they met their basic needs without assistance. This undermined women's capacity to carry out their role in children's upbringing and well-being, although it may also suggest an important role played by women in sustaining life at Jibondo (Hauzer et al., 2013; Moshy et al., 2013). However, women were cautious to reveal their actual earnings to their spouses, in trying to avoid being made to shoulder household maintenance or in fear of men using their income for personal interests such as paying bride price for another wife. Nonetheless, owing to the traditional gender set-up, men were mostly affected by the dwindling income because of their

declining capabilities to cover household expenses without financial contributions from women or other individuals.

Household expenditure (Table 1) ranged between US\$ 0.7 and 10.7 per day. Respondents living above US\$ 5 a day were 16 per cent and those living below US\$ 2 per day were 14 per cent. During this study, 70 per cent of respondents at Chole and 56 per cent at Jibondo had debts (Table 1), mainly incurred for meeting basic food needs in Chole (88 per cent) and Jibondo (84 per cent); to acquire fishing equipment in Chole (19 per cent) and education in Jibondo (19 per cent). Emergencies such as sickness, or business needs, land purchase, construction and costs for ceremonies also led to debt. Only 4 per cent at Chole and 11 per cent at Jibondo had debts above US\$ 215. Debts were higher in Jibondo than Chole because women covered non-food household expenditure but households also covered expenses for education, replacing confiscated fishing equipments, and food. In Chole, secondary education expenses were covered by Chole Mjini hotel, confiscation incidences were few and most food was locally produced. However, expenses for meeting household needs for fish protein were higher in Chole because fishing had decreased. Although taking debts is common among fishing households, the extent of debts in study areas is higher than would expected. This may concur with the argument that debts reflect desperate coping strategies which usually worsens household conditions (Marschke and Berkes, 2006). Although as Béné (2009) notes, it is necessary not to generalize or assume that fishing communities are inevitably poor; nevertheless, the interviewees of this study have in fact showed increasing both economic vulnerability and impoverishment. Nonetheless, 51 per cent of respondents at Chole and 45 per cent at Jibondo had money savings (Table 1), reflecting some preparedness for uncertainty. Respondents with savings above US\$ 215 were 14 per cent at Chole and 11 per cent at Jibondo. Low savings and convenience considerations meant that most respondents keep their savings at home or in shops.

The small variations in daily expenditure and large variations in the money debts and savings across the wealth categories reflect the likelihood of social–ecological relations to produce unequal outcomes (Beymer-Farris et al., 2012), even among local resource users, and may suggest that not everyone was living in poverty. However, these money-related indicators did not directly appear in villagers' poverty indicators as the indicators related to assets and ability to work did. Although poverty is evident in our study, we also concur with others in questioning the tendency of attributing monetary terms to poor living conditions without considering a wide range of social, cultural and institutional factors (Béné, 2009; Onyango and Jentoft, 2013).

Response strategies to income shortage varied (Table 2). Fund-raising fishing was a unique strategy that assisted most poor villagers at Jibondo to meet education and housing constructions expenses. Thus, outsiders hardly observed poverty gaps among villagers, and judged villagers as high-income earners based on (communally achieved) better housing conditions compared to other villages. Meanwhile, Chole

|                   | Chole<br>Average (range) |                 |                  | Jibondo<br>Average (range) |                   |                   |
|-------------------|--------------------------|-----------------|------------------|----------------------------|-------------------|-------------------|
|                   | Rich                     | Poor            | Poorest          | Rich                       | Poor              | Poorest           |
| Daily expenditure | 4.3 (3.5–5)              | 3.3 (1.4–7.1)   | 2.4 (1.4–4.3)    | 4.2 (2.1–7.1)              | 3.8 (1.7–10.7)    | 2.5 (0.7–3.5)     |
| Debts             | 75.5 (10.7–143.8)        | 59.4 (2.1–228)  | 13.2 (7.1–215.8) | 597.1 (86.3–1438.8)        | 63.2 (0.3–215.8)  | 16.2 (2.1–143.8)  |
| Savings           | 264.3 (21.5–1079.1)      | 200 (3.5–489.2) | 57.5 (7.1–107.9) | 437.4 (35.9–1151)          | 116.4 (3.5–431.6) | 41.9 (10.7–100.7) |

**Table 1: Estimates of expenditure, debts and savings by area of residence and wealth category (in USD).**

residents lacked collective actions to meet their needs, partly because their livelihood activities were mostly performed individually, and had access to full educational scholarships. As Coulthard (2012) asserts, responses for managing change do not automatically lead to well-being improvement. Overall, the household responses were effective for short-term mitigation rather than ending existing challenges altogether.

### *Trends in food security*

Daily struggles to meet food needs were most common, particularly at Jibondo. One interviewee explained that he was fasting throughout the year as if he was in Ramadan because he could only afford one meal a day (elderly man in Jibondo, 82 years old, 2009). Most respondents could afford three meals a day three decades ago, but they reported that they had now lost such ability (Table 2). Respondents who were uncertain about having three meals a day increased from 16 per cent to 59 per cent at Jibondo and 16 per cent to 35 per cent at Chole during the last 30 years. Overall, these changes were attributed to declining income levels, Park operations, drought and decline in food production in Jibondo.

Changes in the varieties of food consumed were more reported at Jibondo (Table 2). Maize-meal, rice and occasionally beans were mostly consumed in both sites. However, the majority at Jibondo hardly had the varieties they consumed in the past, including sorghum, cassava, potatoes, dolichos beans, cowpeas, pigeon peas, bambara groundnuts, pumpkins, cucumbers and pawpaws. In Chole, bananas, cassava, sweet potatoes and yams were still produced and consumed. The changes were attributed to drought (53 per cent) and decreased income (18 per cent). Other reasons included sickness, persistence of coconut tree disease and the effects of coconut tree roots in hindering growth of root crops. In Jibondo, causes were decline of farming (76 per cent), livestock free-grazing (46 per cent) and soil erosion (24 per cent). Other reasons included increased focus in fishing, decreased income, seasonality, old-age and unavailability of food varieties in local shops. Most of these reasons for decreasing food varieties were in fact originating from various response strategies, which are summarised in Tables 2 and 4; thus reflects the tendency of responses to either build or erode resilience (Marschke and Berkes, 2006) to food security.

Although transformation into new activities at lower scale intends to maintain resilience at higher scale of a particular SES (Folke et al., 2010), resorting to livestock keeping appears to build resilience among 'wealthier' individuals, but had worsened the community's resilience in maintaining food supply. This reflects the importance of analysing resilience-building responses at various levels (Magis, 2010; Merschke and Berkes, 2006). Institutional diversity as a key strategy for building SER (Folke et al., 2003; Jones et al., 2013) was relatively impractical in dealing with food insecurity because there was inadequate support from existing managing institutions across scales. This reflects the necessary need for efficient inter-sectoral management approaches in solving food insecurity (Foale et al., 2013).

| Key Indicators   | No. of respondents in percentages |            |
|--|-----------------------------------|------------|
|  | Chole                             | Jibondo    |
| <b>Number of meals per day during (1980s/1990s), (2010/2011)</b>           |                                   |            |
| One  | (0), (0)                          | (0), (3)   |
| One to two   | (0), (0)                          | (0), (2)   |
| Two  | (11), (13)                        | (8), (39)  |
| Two to three   | (5), (22)                         | (8), (15)  |
| Three  | (81), (65)                        | (83), (41) |
| Four   | (3), (0)                          | (1), (0)   |
| <b>Respondents experiencing changes in meal diversity</b>                  | 51                                | 96         |
| <b>Period that respondents stayed without fish protein</b>                 |                                   |            |
| Missed fish during 'neap tide' (about 1 to 5 days)                         | *                                 | 88         |
| Missed fish in the long-term basis (about 7 to 60 days or more)            | 43                                | *          |
| <b>Respondents without food reserves at the time of interview</b>          | 54                                | 65         |
| <b>Respondents experiencing Income-expenditure mismatch</b>                | 94                                | 97         |
| <b>Key response strategies to income and food shortages</b>                |                                   |            |
| Obtained credit from shops, traders and individuals                        | 86                                | 70         |
| Used women's income on non-food household expenses                         | 67                                | 59         |
| Collaborated with household members to meet non-food household needs       | 73                                | 86         |
| Periodic remittances covered household food expenditures                   | 32                                | 50         |
| Reduced expenditure  | 19                                | 17         |
| Harvested crops before time  | 14                                | —          |
| Sought for assistance  | —                                 | 30         |
| Worked harder  | —                                 | 11         |
| Sold household assets  | *                                 | *          |
| Produced own thatch and fishing gear                                       | *                                 | *          |
| Reduced food portions  | *                                 | *          |
| Resorted to casual labour  | *                                 | —          |
| Rented out small vessels temporarily                                       | *                                 | —          |
| Produced own food  | *                                 | —          |
| Fished sardines or juvenile fish in shallow inshore waters for consumption | *                                 | —          |
| Ate plain food (rice, bananas or maize-meal) or with cassava leaves        | *                                 | —          |
| Ensuring food was stocked  | *                                 | —          |
| Used the tips obtained from tourists                                       | *                                 | —          |
| Skipped meals  | —                                 | *          |
| Ate at relatives' households   | —                                 | *          |
| Ate dried fish, also boiled raw pawpaw                                     | —                                 | *          |
| Fishers provided fish to elders and non-fishing households                 | —                                 | *          |
| Sold reserved water  | —                                 | *          |
| Took children to relatives within village and Mafia Island                 | —                                 | *          |

(Continued)

**Table 2: (Continued).**

| Key Indicators  | No. of respondents in percentages |         |
|---|-----------------------------------|---------|
|   | Chole                             | Jibondo |
| Paid school expenses in instalments   | –                                 | *       |
| Obtained collective support through fund-raising fishing, a tradition whereby pull-net fishers organized fishing trips on request and gave the resulting income to a needy individual | –                                 | *       |

**Table 2: Food and income trends, shortages and response strategies at Chole and Jibondo.**

–Response strategy not mentioned at particular study site.

\*Situation/ strategy less mentioned but exists/ practiced.

Interviewees also consumed less fish and some consumed small-sized fish or stayed for long periods without fish protein (Table 2). They expressed this experience as follows:

We used to cook lots of fish . . . say three were cooked in stew, four were fried and eaten as bites, and three others were grilled with spiced coconut sauce. We ate more fish than any other food. Now we only cook two small fish in stew to cover-up inadequacies. Fish grilled with coconut sauce is never available and most people don't even know it now. (Interview with a 73 years old fisher in Jibondo, 2010)

In the past when you went to any household you would find yesterday's fish in the pot. Today, go to any house and you won't find fish. (Interview with a 52 years old former fisher in Jibondo, 2010)

Meanwhile, most respondents had less ability to consume other protein-rich foods (Table 3). Although most respondents (63 per cent) kept chickens, its consumption

| Period without other protein | Percentages of respondents having other protein foods |    |      |    |         |    |      |    |      |    |
|------------------------------|---|----|------|----|---------|----|------|----|------|----|
|                              | Pulse   |    | Eggs |    | Chicken |    | Beef |    | Milk |    |
|                              | C   | J  | C    | J  | C       | J  | C    | J  | C    | J  |
| One to six days              | 21  | 23 | 12   | 11 | –       | –  | –    | 2  | 14   | 11 |
| One to three weeks           | 49  | 37 | 21   | 24 | 21      | 23 | 14   | 2  | 8    | 20 |
| One to six months            | 25  | 35 | 43   | 20 | 52      | 36 | 51   | 34 | 40   | 20 |
| One to three years           | –   | 1  | 16   | 31 | 16      | 32 | 19   | 46 | 17   | 16 |
| Always (cannot afford)       | –   | 1  | 8    | 11 | 8       | 6  | 11   | 14 | 16   | 32 |
| Allergic/sickness            | 5   | 3  | –    | 3  | 3       | 3  | 5    | 2  | 5    | 1  |

**Table 3: Rates of consuming other sources of protein in the two sites.**

Note: C, Chole and J, Jibondo.

was low because chicken were used in traditional rituals, and were assets that were sold during times of crisis. The quality of food had also deteriorated, and vegetables were consumed less frequently. Amounts of food per meals were reported to have decreased and most respondents had no food stocks (Table 2) because they afforded purchasing only enough for immediate consumption.

While skipping meals as a coping strategy has been observed elsewhere (Bunce et al., 2010), the food trends and related responses (such as merely having carbohydrate meals) might suggest increasingly desperate conditions to obtain daily sustenance and can have long-term implications for people's health and resilience. The suggestion by Foale et al. (2013) on including food security programmes in conservation actions in MPAs holds. This is because majority of villagers were incapable of meeting the requirements for food security, and Moshy et al. (2013) reported their children to have poor nutritional status that can have serious implications for their well-being and SER.

Aspects of household food insecurity in terms of quality, quantity, preferences, affordability and availability (FAO, 2010) were vivid. Park operations contributed to food insecurity both directly and indirectly by causing decreased fishing, fish catches, fish consumption, and income for purchasing food, including fish. This is contrary to findings by Darling (2014), showing benefits of MPAs in Kenya neither increase nor decrease food security and by Mascia et al. (2010), showing increased food security within 20 MPAs in 11 countries. The use of catch (production) as a proxy for food security in the latter may partly explain this variation. The variation also highlights the need to consider the access and consumption aspects of food security (Foale et al., 2013) because total catch within MIMP increased from 1394 tonnes in 2002 to 3854 tonnes in 2009 (URT, 2011), and overall catch in Jibondo is reported to increase (Moshy et al., 2012). However, fishers sold most of their catches to buy food. Food security in most island communities is a critical issue due to great reliance on fish for dietary protein and food security, increased fish demands and integrations to global economy, and increasing tensions from conservation (Foale et al., 2013; Hardy et al., 2013; Hauzer et al. 2013).

### *Changes in conservation strategies*

The establishment of the MIMP originally heralded closer collaboration between officials and local communities to halt dynamite fishing. In 2000, the MIMP's General Management Plan (GMP) was put in place and park operations began with emphasis placed on biodiversity conservation and sustainable utilization of natural resources (URT, 2000). Access to fishery resources were regulated through user certification, licensing, limits of fishing gears and restricted fishing areas. MIMP also introduced environmental education and training in entrepreneurship skills; promoted research; and sustainable fishing practices through gear exchange program. Alternative livelihood activities such as seaweed culture and beekeeping; provision of school fees

support for secondary education students; improving health and water facilities; and loans for economic development projects became part of the social development package.

MIMP interventions did not, however, provide equal opportunities to all Park residents. For example, a one-week seaweed culture training course in 1999 involved only 20 Jibondo residents (MIMP official written response, 2011). However, though sharing knowledge, more than 561 women and 12 elderly men were practising seaweed culture during this study. The process of selecting beneficiaries of various projects reflected favouritism rather than equality (Mwaipopo, 2008; Walley, 2004). For example, the gear exchange programme targeted beach-seine fishers, and left out the line and hook fishers.

Data from the interviews showed that MIMP rigidly pursued its operations regardless of their impacts on livelihoods, and people's responses did not resolve their livelihood challenges. The closure of rich fishing grounds reduced number of fishing grounds. Meanwhile, restrictions on fishing gear were problematic. Pull-nets, which were considered to be effective in relative deep water, were prohibited. Prescribed gears such as long lines were expensive, set-nets had bigger mesh size and had to be set in shallow water where fish had decreased, and gill-nets material spoiled catches and had to be set in deep water where strong currents swept them away. Such operations contributed to decreased fish availability and income. In response to Park's operations, most fishers in Chole abandoned fishing, engaged in farming to produce their own food, rented out boats and engines although the payments were low and unreliable. They also fished by sail vessels or on foot, migrated elsewhere and requested for major changes in Park strategies during GMP review in 2011.

Interviewees in Chole estimated that about 50 per cent of fishers abandoned fishing and villagers no longer considered themselves as a fishing community, implying that fishers in Chole were the most affected, as one fisher explained:

MIMP gave us a two weeks training on alternative fishing using gillnets. We went to Kilwa, Somanga and Songosongo for practice but we failed [to obtain catch] and they [MIMP officials] saw that we failed. They tried all their professional fishing and we used our experience but we did not obtain catch with this set-net fishing. People fought to get the nets which were provided, but when they came and set them, they only found mangrove leaves and dry wood. We tell them [MIMP officials] the nets don't fish but they don't want to listen. (Interview with a 33 years old fisher in Chole, 2010)

In Jibondo, fishers resisted Park operations and voted to reject MIMP in 2004 on the grounds that it brought a crisis in their lives. They persisted in pull-net fishing and sun-dried gill-net spoiled catch to reduce loss. They also invested in children's education to widen their future livelihood options, and voted again to reject the MIMP during GMP review. The repeated decision to reject the Park demonstrated that they



sustained their social memory, collectiveness and constant struggle to survive as noted elsewhere by Folke et al., (2003); Magis (2010); Brown and Westaway (2011). One FGD discussant puts it this way:

When they [MIMP officials] stopped us we decided that it was better to die from gun shots instead of letting families die of hunger. You see us like this, but we are as if in a war like the Somalis. We don't know what will come next. We struggle with the beatings so that our children can eat. (Discussant, a 45 years old fisher in Jibondo, 2009)

It was further shown that dialogue between MIMP officials and local people decreased, and violent approaches to enforcement of regulations became applied. Patrols were sometimes armed and involved beatings, harassment, exacting stiff penalties and confiscation of vessels, engines, gear and catches. Fishers were concerned that they could not escape the vicious beatings even if they owned valid fishing licenses. They recalled being physically attacked four times since violent enforcement approaches began in 2006. Although they hid or tried to resist the attacks, they were overpowered and were harassed and whipped. Meanwhile, the confiscation strategy caused repeated losses of fishing equipment and decreased safety at sea because crew members paddled with their sandals for propulsion to return to the coast when there were no sails at times of engine confiscation. Confiscations also decreased fish catches, income and food security. In response to confiscations, fishers opted into octopus fishery and used other gears while arranging loans from fish traders to buy new equipment. Their efforts to replace confiscated equipment suggest that confiscation operations may not necessarily be effective in conservation because the loans compel fishers to increase fishing operations to afford their repayments (Allison and Ellis, 2001; Crona et al., 2010). In fact, it increases ties between fishers and fish traders (Crona et al., 2010), thereby empowering traders to control the fishery and thus further worsening the economic status of fishers and contributing to decreasing presence of fish and octopus in the ocean. Their investments on children's education implies that people had not only come to expect the worst from MIMP in the future, but they had also come to realize their capacity to create opportunities for renewal as discussed elsewhere by Folke et al. (2003). Nonetheless, interviewees emphasized that although in principle they valued conservation initiatives, they condemned the manner in which such a valuable idea was being implemented. They were particularly concerned with the shift from genuine collaborative practices with villagers to rhetorical, authoritarian and violent operations during the past decade (Benjaminsen and Bryceson, 2012). On the positive side, the shift promoted unity among the villagers against an increasingly authoritarian MIMP.

The variations in responses between study sites reflect the heterogeneity in people's actions in responding to changes, as noted elsewhere by Leslie and McCabe (2013). Meanwhile, the adverse MIMP-related effects exemplify the likelihood of social-ecological processes to produce unequal outcomes in SESs that constitute competing resource users (Beymer-Farris et al., 2012). This is because the ecological part of

MIMP SESs is in a relatively good condition (Baker, 2013; URT, 2011), which is desired by conservationists, government and tourism operators, while the social part experience poor and undesired conditions (Benjaminsen and Bryceson, 2012; Moshy et al., 2013; Mwaipopo, 2008; Walley, 2004). Although park authorities are urged to ensure that the needs of resource-dependent communities are met (Marshall et al. 2009), the real challenges of day-to-day life within the MIMP have resulted in increased hardship and poverty. This affirms the argument that transformation into a fundamentally different system that improve future conditions will only occur when actors agree that the current system is dysfunctional (Beymer-Farris et al., 2012; Walker et al., 2004).

### *Changes in marketing strategies*

The neo-liberal economic reforms and capitalist market economy from the 1990s were also seen to have added further livelihood challenges that were difficult to resolve. The shift into selling fresh catches was beneficial because fishers received income immediately after fishing trips. The shift attracted increase in the number of fishers and time allocation for fishing because crop production decreased substantially. Fishers began fishing during neap tides and rainy season, formely left for farming. However, they were not progressing because they lost abilities to receive bulky earnings (from sun-dried catches), save money, stock catches for household consumption and afford food purchase. They were also underpaid, owing to their low bargaining power. For years, Dar es Salaam traders maintained their price at about US\$ 2.1 per basket of around 50 medium-sized fish. In 2006, Jibondo village government replaced external traders with resident traders to improve money circulation within the village, and credit provision during hard times. This reflects the possibility of grassroot institutions to self-organize for enhancing their social security. The traders bought most of the fish catch and guaranteed social security among the villagers because they owned fishing vessel and gears, operated small shops and were present in Jibondo most of their time to provide support. Furthermore, the replacement slightly improved prices for the catches. By 2011 the price of a bucket of about 25 fish had risen to around US\$ 5.7 from resident traders and US\$ 7.8 from independent buyers. The price of each kilogram of fish was US\$ 1.1 from resident traders or US\$ 0.9 from factory agents while each kilogram of octopus fetched about US\$ 1.1 from factory agents and resident traders or US\$ 0.9 direct from the factory. Fishers argued that had they been determining prices by themselves, they would suggest about 2.1–3.5 USD per kilogram of fish or octopus, given their actual costs of living and risks encountered while fishing. Thus fishers had to fish more to afford basic living costs.

On the contrary, the factory agents facilitated fishing vessels to women to obtain most octopus catches at a low price. The agents were also blamed for denying fishers credits during hardships and setting poor market relations. In Jibondo, villagers argued that the factory had not improved the market conditions as envisaged, as evidenced by one discussant:

Market requires knowledge about buying and selling prices . . . Me as a fisher, I don't know market issues. The trader is the one knowing market issues, and is the one benefiting . . . Even when a fisher decides to sell catch direct to the factory, he will then get a lower price than those selling to agents. (Interview with a 45 years old Fisher in Jibondo, 2009)

Respondents at Jibondo also explained that the factory constrained them because it offered low prices over the years (70 per cent); delayed payments (35 per cent); did not re-invest into village development (22 per cent) and contributed to degradation of the octopus fishery (15 per cent). Other constraints included inability to afford quality fish and octopus for consumption, deprivation of credits during hardships, dwindling of dried fish trade, mistreatment of octopus fishers by overloading them in the fishing boats and tampering with the weighing scales by agents. The factory was also blamed for drawing more men into octopus fishery, which decreased women's catches and income substantially. Thus, middle-aged women reduced the time spent in octopus gleaning to three days per springtide and turned to seaweed culture, which earned them bulky payments. Elderly women resorted to farming, pottery, hand-crafting and babysitting. Interviewees also blamed seaweed companies for offering low prices (US\$ 0.3 per kilogram against the expected US\$ 1.4), and tourist investors for excluding them from tourism operations.

Overall, people experienced low prices for most products produced, which also trapped them in poverty. The district's poor economic status, marginalized position within the country and difficult transportation logistics further compounded price challenges. Nonetheless, low prices reflect inadequate capabilities of people to influence the market to operate on their favour. At the same time, village government intervention have not been profitable ventures. The marketing issues may confirm inadequate capacity of resilience thinking to make radical changes, thereby maintaining existing states (Cretney and Bond, 2014), even when such states are undesirable. Capitalist economy has tendencies of shaping uneven ability of communities to respond to changes such that by expecting people to respond to its effect, a resilience approach demonstrates inability to confront global capitalism (Mackinnon and Derickson, 2013). In this case, diversifying institutions (Folke et al., 2003; Merschke and Berkes, 2006), by combining local initiatives with national efforts to oversee trade, and foreign investments are unlikely to work unless national polices and legislatives create an enabling environment for controlling foreign investments' interventions and undertakings on the ground.

### *Changes in environmental conditions*

Apart from the influence of marketing strategies, the changing environmental conditions also pose challenges to people's livelihoods (Table 4). The falling sea level and increasing sea temperatures (Moshly et al., 2012) mostly affected elderly fishers because they could not resort to pull-net and octopus-fishing practices through diving. Most of them resorted to palm weaving, basket-trap making, net-mending, vessel repair and farming, and received low earnings. Few elders were still engaged in pull-net fishery

| Environmental conditions                       | Related processes   | Outcomes   | Response strategies   |
|--|---|--|---|
| Falling sea level; increasing sea temperatures | Reduced fish populations in shallow areas; poor seaweed growth; inability to anchor vessels on traditional areas  | Decreased individual fish catches; women octopus fishers no longer caught fish; decreased seaweed harvests; increased transportation costs | Fished in deeper waters; women contributed household income; alternated seaweed culture location and timing   |
| Increasing wind and speed of ocean currents    | Rougher ocean conditions hampered gill-net setting or swept them away; caused accidents; blew dust onto seaweed and caused decay; blew away seaweed poles | Decreased catches; loss of life, property, and income; Reduced seaweed productivity  | Avoided deeper waters; fished in the same areas to support one-another; reduced seaweed harvesting time from six to three spring tides                                    |
| Increasing climate variability                 | Prolonged dry seasons affect plant growth; livelihoods functioning; fish migration to deeper water  | Decreased fish catches and crop productivity   |   |
| Decreasing soil qualities                      | Constrained farming activities  | Decreased crop productivity  | Chole people farmed on Juani Island; sought extension officers' support   |
| Southerly monsoon winds                        | Winds damaged fishing vessels; constrained fishers to reach outer reefs   | Decreased fish catches   | Fished in inner reefs; focused in octopus-fishing   |
| Northerly monsoon winds                        | Winds blew green algae that invaded octopus caves and seaweed   | Reduced octopus catches and seaweed harvests   | Removed algae manually from the harvest; focused on fish fishery in outer reefs   |
| Rainy season                                   | Inability to: work in the rain, dry fish and seaweed; fall in price for local produce; closure of tourism operations; thatch decomposition                | Slowed down most activities; low productivity  | Resumed activities after rains or season  |
| Dry seasons                                    | Fish migrated further into deep cooler waters; shortages of fresh water and grazing grasses   | Fishing became harder and less productive; crop damage by livestock  | Jibondo people collected water from Utende but lost fishing time; sought extension officers' support; fenced their farms; planted non-grazed crops; abandoned agriculture |

**Table 4: Changes in environmental conditions and their implications on livelihoods.**

to provide their ecological knowledge, wisdom and advice to the fishing group. Through elderly engagement, fishers transformed structural knowledge into functional knowledge (Berkes et al., 2003). They built capacity by learning ecological knowledge and then practised it during fishing to maximize fishing efficiency while also providing opportunities for elders to continue with the fishery without diving.

Pull-nets involved strong able-bodied men diving to search for schools of fish to guarantee availability of catch. Those able-bodied unwilling to operate in groups or to face MIMP patrols opted for octopus-diving. However, diving caused chest pains and ear ruptures due to frequent free diving and breath-holding process. Pull-nets were also operated by about 30 fishers per vessel resulting in low income per individual fisher. The nets were frequently confiscated, and thus trapped fishers in debts. The skills for pull-net and octopus-diving were learnt from visiting fishers from southern Tanzania; reflecting the community's capacity to absorb social learning and/or ability to combine local and external experiences (Folke et al., 2003). However, fishers were also exposed to deep-water gill-net fishing by visiting fishers from Pemba every northern monsoon period but did not adopt it because it was perceived to be risky. This can imply that local fishers traded off potential economic benefits to ensure their safety (Brown and Westaway, 2011; Magis, 2010).

While the challenge of low crop productivity mainly resulted from a prolonged dry season, decreasing soil qualities and abandonment of agriculture, it was further extenuated by extension officers. The officers did not visit fields in Chole to deal with plant diseases or to solve persistent disputes between farmers and livestock keepers in Jibondo, where many farmers abandoned agricultural activities because livestock free-grazing caused recurrence of crop damage, and fencing was laborious and ineffective as livestock keepers often broke the fences and grazed their cattle on the farms. Although most respondents (59 per cent) at Jibondo owned farming plots and 36 per cent owned gardens around their homesteads, district agricultural officials explained that extension services were concentrated in Northern Mafia because Jibondo had been removed from their list after been re-categorized as a fishing village, while Chole was categorized as having little farming.

The decrease in seaweed productivity was a livelihood challenge that was also confirmed by seaweed agents, whose collections per springtide dropped from 25 tonnes during 1999–2006 to 5–10 tonnes since 2007. At the same time, seaweed farmers experienced seaweed decay from warmer oceanic conditions and seasonal turbidity. Hence farmers in Jibondo began to experiment by alternating farming locations and timing. During July to September they farmed in the Kitalani area, in Dongoni during September to November and in Rungi during October to April. Meanwhile, the Pwani Walani area was still under experimentation and was farmed throughout the year to determine suitable months. They innovated by using empty plastic bottles when the buoys became unavailable and farmed seaweed in less than knee depth to minimize injuries. The reduction of harvesting time slightly minimized losses from seaweed decay but removal of green algae from the harvest was, however, laborious and time-demanding.

These responses demonstrate the ability of respondents to combine local experiences with conventional science because seaweed culture training by Zanzibar Agro-Seaweed Company in 1986 and MIMP in 1998 directed villagers to farm at knee depth and harvest after six spring tides. Furthermore, the adjustments to environmental-related changes reflect the nature of human agency in making choices (Brown and Westaway, 2011) and the ability to transform crisis into opportunity to enhance livelihood resilience (Folke et al., 2005). These responses also support the argument by Perry et al. (2010) that emphasize a shift from uni-directional concepts that disregard how environmental processes stress humans (Charles, 2012).

### *Local notions of well-being*

Overall, people experienced stress in their livelihoods such that their current state of being remained undesirable to the majority. Interviewees explained that their responses could not address most pressing challenges effectively hence they mainly experienced hardships rather than good life. This was partly because most of the challenges were influenced by national and global factors which were beyond their control. As such, respondents show cross-scale collaborations remain crucial to foster well-being among Park residents. When respondents were asked what should be done to ensure well-being of both people and environment, they provided multiple responses. In Chole, the top-most frequently mentioned measure was the need for MIMP to revise zoning scheme (49 per cent), whereas in Jibondo, the need for government to support fishers to own advanced fishing vessels and gears (50 per cent) was mostly mentioned. Other mentioned measures were the need for MIMP to provide credits in all fishing practices; substitute forceful beatings with dialogue and education; ensure alternative activities are feasible before stopping fishing; leave protection to local people and provide them with government assistance; foster genuine participation in decision-making; involve fishers in tourism activities; revolve rotational scheme in octopus fishery and to stop dynamite fishing elsewhere.

Furthermore, respondents mentioned the need for government to support fishers to access markets and determine price; invest on non-fishing activities; assess thoroughly on efficacy of fishing gears and well-being of all groups, particularly the elderly; construct fish processing plants in villages; ensure availability of extension officers for providing advice and training; supply water in villages; and separate fisheries management and fishers from politics. They also mentioned the need for fishing communities to ensure fish are available for consumption; establish new fishing groups and improve existing ones; save money instead of getting drunk; avoid damaging corals and extracting juvenile fish; migrate to other places; build better housing and to plant trees to reduce warmer conditions. However, impressions from interviews and FGDs mainly demonstrated little hope for obtaining desirable 'good life'. The mentioned cross-scale attributes of good life or SER imply benefits of responses by interviewees and potentials of adaptive conservation by the MIMP were not fully realized to stop regime shift to

undesired state and to promote societal development as envisaged in resilience thinking (Beymer-Farris et al., 2012; Folke et al., 2005). The shifting livelihood situations into undesirable states in this study include the shifts from engine to sail fishing vessels, large to small/juvenile fish consumption and food production to purchase.

## Conclusions

This article investigates the struggles of fishing communities in an MPA to maintain their living in the face of multiple challenges. Villagers experienced worsened living conditions, reduced capacity to meet their basic needs, changing gender responsibilities, reduced access to key fishing grounds, and low productivity and prices of local produce. Their main responses included reduced expenditure, loan seeking, skipping meals, livelihood diversification, collective fishing, changing or abandoning fishing practices or activities, and outward migration. However, these responses only contributed to survival rather than resolving the challenges or attaining meaningful livelihood improvements.

Some responses and practices either strengthened or weakened people's resilience to social–ecological changes. Elements that strengthened their resilience were social capital and networks, self-organization, collective actions, social learning and transferring of social memory about initial agreements with the MIMP, focus on children's education and ability to retain ecological knowledge while also learning, sharing and experimenting new methods in fishing and seaweed culture. However, changing women responsibilities and increased livestock keeping at Jibondo, and increased farming at Chole strengthened resilience on one level and weakened it on another. Practices that weakened resilience included rigid management approaches that focus on environmental rather than social aspects, unviable livelihood activities, and unequal power relations between: villagers and MIMP officials; fishers and fish traders; livestock owners and farmers; and men octopus divers and women octopus fishers.

Persisting difficulties in fulfilling basic needs despite years of marine finfish export policy trial and MIMP operations means that MIMP's envisaged objective for ensuring park residents share the benefits of park operations (URT, 2000) and strategies for promoting sustainable livelihoods (URT, 2011, p. 38) have not been achieved. It also means household responses to changes in conservation and marketing strategies have failed to overcome MIMP conservation interventions and capitalist market economy forces to ensure their livelihood resilience and achieve desired social well-being. Improving institutional diversity and multi-sectoral collaborations is necessary because villagers face multiple social–ecological constraints. While conservation policies may have the potential for improving local living conditions, this is not achieved unless local vulnerabilities and resilience factors are clearly understood and articulated with respect to conservation interventions. Blind pursuits of conservation goals at the expense of the social, economic and cultural conditions that change in the processes may have negative outcomes on long-term SER as this study has illustrated.

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### Notes on contributors

*Victoria H. Moshy* is a Ph.D. student in Development Studies at the Norwegian University of Life Sciences, and Assistant Lecturer at the University of Dar es Salaam, Tanzania. Her present research interest is on human–environment interactions, focusing on the social aspects of social–ecological resilience and coastal and marine conservation.

*Ian Bryceson* is Professor of Ecology at the Department of International Environment and Development Studies, Norwegian University of Life Sciences. He is a marine ecologist with a research focus on fisheries, aquaculture and the struggles of coastal peoples for their rights. The core of his research focuses on socio-ecological resilience at the interphase of society and environment. He has published widely in international journals and has been actively involved in international public debates on land, coastal resource and human rights.

*Rosemarie Mwaipopo* is a senior lecturer at the Department of Sociology and Anthropology at the University of Dar es Salaam, Tanzania. Her research areas are on gender issues, human–environment interactions with a focus on coastal communities and artisanal and small-scale mining communities. She has published widely in these fields.

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**Paper 3: Undernutrition among under-five children in two fishing communities in Mafia Island Marine Park, Tanzania.**



# Undernutrition Among Under-Five Children in Two Fishing Communities in Mafia Island Marine Park, Tanzania

Victoria Hippolite Moshy<sup>1,2</sup>, Theopista Jacob Masenge<sup>3</sup> & Ian Bryceson<sup>1</sup>

<sup>1</sup> Department of International Environment and Development Studies (Noragric), University of Life Sciences, Norway

<sup>2</sup> Institute of Resource Assessment, University of Dar es Salaam, Dar es Salaam, Tanzania

<sup>3</sup> Department of Paediatrics and Child Health, Muhimbili National Hospital, Dar es Salaam, Tanzania

Correspondence: Victoria H. Moshy, Department of International Environment and Development Studies (Noragric), University of Life Sciences, P. O. Box 5003, NO-1432 Ås, Norway. Tel: 47-4056-7197/255-784-590-921. E-mail: victoria.moshy@umb.no/ moshyv2001@yahoo.com

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## Abstract

Undernutrition and food insecurity are critical problems among under-five children in many developing countries. This study was carried out for eight months between 2009 and 2011. It combined quantitative data (N=156) and qualitative data to explore nutritional status among under-five children in Jibondo and Chole villages within Mafia Island Marine Park in Tanzania. Weight-for-age analysis was performed according to World Health Organization standards to determine the proportion of underweight children among the samples. The prevalence of underweight children was high in both villages, and in Jibondo village it was even higher (69%) than in Chole village (40%). Interviewees attributed the exceptionally high underweight problems in Jibondo to a substantial reduction in breast-feeding frequency. This was because mothers resumed seaweed farming and octopus fishing soon after delivery. Consequently, infants were fed poor-quality nutritional substitute foods at a tender age. Decreased family income, food insecurity, changes in gender roles and increased responsibilities for women were also perceived to be key underlying problems contributing to higher levels of undernutrition among children in the study areas. If healthy generations and sustainable social-ecological systems are to be achieved within the Park in the future, policies that review fishing restrictions, improve fish trading, increase household food security and liberate mother's time for breastfeeding and child-caring activities would be essential to address the current undernutrition among the under-fives.

**Keywords:** undernutrition, food insecurity, under-five children, Mafia Island Marine Park, Tanzania

## 1. Introduction

Undernutrition persists as a major threat to both physical development and health of millions of children below five years of age in the developing countries (Pelletier, Frongillo, Schroeder & Habicht, 1995; World Health Organization (WHO), 2005; United Nations Children's Fund [UNICEF], 2012). It is a critical problem that contributes nearly one third of total deaths among under-five children in the world (UNICEF, 2009). Prevalence of undernutrition is high in most African countries, Somalia being the most affected (UNICEF, 2009, 2012). Undernutrition is thus among the challenges that constrain global efforts to reduce child mortality by two thirds by the year 2015 as part of the United Nations Millennium Development Goals (MDGs) launched in 2000 ([www.un.org/millenniumgoals/](http://www.un.org/millenniumgoals/)). Most developing countries are still far from achieving this goal (de Onis, Blössner, Borghi, Frongilo, & Morris, 2004) as the numbers are projected to remain high even until the year 2020 (Smith & Haddad, 2000). In 2009, Tanzania was reported to be making insufficient progress towards the 2015 target (UNICEF, 2009).

Undernutrition as a form of malnutrition is mostly observed among under-five children in developing countries through failure of physical growth, although micronutrients deficiency diseases are also high among children (Muller & Krawinkel, 2005). According to UNICEF (2009), failure to grow is easily observed through three forms of malnutrition. First, acute malnutrition or wasting, in which cases, children remain thin with low weight for their height. Second, chronic malnutrition or stunting, results in children remaining too short for their age.

Third, either or both acute and chronic malnutrition cause a condition of underweight, whereby children have low weight for their age and might be stunted and/or wasted. Assessment of underweight through weight-for-age analysis is a widely practiced method in evaluating growth patterns and body proportions because it reflects both acute and chronic malnutrition (de Onis, Monteiro, Akre & Glugston, 1993; Shetty, 2003; Nube & Sonneveld, 2005; UNICEF, 2009; Zavoshy, Noroozi, Jahanihashemi, & Kiamiri, 2012).

The factors that contribute to undernutrition among the children under the age of five in developing countries are complex. Immediate causes include diseases, improper breast-feeding practices, and poor or inadequate intake of diet and substitute foods in terms of quality, quantities and frequency (Mahgoub, Nnyepi & Bandeke, 2006; Black et al., 2008; Leach & Kilama, 2009; UNICEF, 2009, 2012; Sunguya et al., 2011). The underlying causes include poverty and shortage of capital including income, and maternal education; household food insecurity; changes in gender relations and roles including increased work load for women; inadequate child care; unfavourable household environmental conditions; inadequate social services; environmental changes and conservation practices; spatial and social inequalities; and the global trends of trade liberalization, financial crises and increases in food prices (Kent, 1997; Black et al., 2008; Mahgoub et al., 2006; Gabriele & Schettino, 2008; UNICEF, 2009; WHO, 2010).

Women and children, particularly the under-fives, are among the most vulnerable groups in areas that experience food insecurity, inadequate diets and undernutrition (Blössner & de Onis, 2005, Nyaruhucha, Msuya, Mamiro, & Kerengi, 2006; United Republic of Tanzania [URT] 2011; UNICEF 2012). Inadequate diet affects under-five children more than other age groups because under-fives grow rapidly, and need more nutrient-rich diet for their growth and development (Blössner & de Onis, 2005). Individuals exposed to childhood undernutrition have been reported to face permanent socioeconomic and health consequences that have a potential to contribute to adverse impacts on their environment in the future. These consequences include: prevalence of metabolic and cardiovascular diseases; reduced learning ability, lowered years of schooling and intellectual performance in adulthood; reduced working ability, productivity and income; poor quality of life and overall poverty that is mostly transferred to the future generations. These conditions have the potential to contribute towards environmental degradation and unsustainable resource use (McGregor et al., 2007; Black et al., 2008; Walton & Allen, 2011; UNICEF, 2012; Zavoshy et al., 2012).

Moreover, children under the age of five continue to receive little attention in social-ecological studies. Most such studies focus on the resilience, vulnerability and sustainability of coupled social-ecological systems, with emphasis on the current resource users, their traditional ecological knowledge, institutions governing their interactions with environment and their response to changes (Berkes & Folke, 1998). The traditional ecological knowledge of a particular environment is increasingly incorporated in the current efforts to understand and manage the ever-changing social-ecological system for resilience and sustainability (Berkes & Folke, 1998; Young et al., 2006). However, traditional ecological knowledge is mainly possessed by resource users who have learnt the knowledge by practicing and have accumulated it through experience over long periods of time, from childhood to adulthood. The ability to learn, practice and accumulate this knowledge requires healthy minds and bodies from the early stages of life.

Most of the causal factors of undernutrition mentioned above and little attention to the under-five children in social-ecological studies are evident in Mafia Island. Poor dietary intake, inability to access fish for household consumption and mothers' worries about the quality of diets for their children are documented in Walley (2004) and Ash, Takala and Latham (2007). Marine environmental changes including damaged corals from past coral bleaching event and dynamite fishing, and reduced depth of sea water have been reported to influence distribution of fish species, amount of catch per individual fisher and household fish consumption (Ohman, Lindahl, & Schelten, 1999; Garpe & Ohman, 2003; Moshy, Bryceson, & Beymer-Farris, 2012). Meanwhile, the establishment of the first marine park in Tanzania and the largest in Africa, Mafia Island Marine Park (MIMP) and its operations have constrained resource dependent communities from accessing rich fishing grounds (Andrews, 1998; Mwaipopo, 2008; Benjaminsen & Bryceson, 2012). These have in turn contributed to decreased income, increased food insecurity and change on gender roles where women are increasingly engaged in economic activities to complement men's decreasing income (Walley, 2004; Bryceson et al., 2006; Benjaminsen & Bryceson, 2012).

Trade liberalization in Mafia Island manifests itself through the presence of first and largest foreign-owned marine fish processing factory in Tanzania (Caplan, 2007). The factory has contributed to decreased income to fishers by giving low prices for their fish and octopus catches such that they fail to meet their household needs, including food (Bryceson et al., 2006). It has further increased food insecurity among fishing communities through continuous collection of octopus (from men octopus divers and women octopus collectors), which were



previously caught by women as their source of household income and food security (Bryceson et al., 2006). Walley (2004) also reports the influence of price increase in other food products on food security whereby fishers sell much of their fish catch in order to buy grains because families can survive without fish protein but not without maize and rice.

Increased investments in tourism in Mafia, particularly in Chole, have contributed to improved social services. Tourism investors in Chole facilitated villagers and built Chole Health Centre to improve maternal health. Chole Kindergarten was also built to provide education, nutritious food and day care to children under the age of five while their mother attended to their economic activities (Walley, 2004). However, the investors have constrained Chole villagers from actively engaging in tourism related activities to obtain income to complement the decreasing income from fishing due to MIMP restrictions (Benjaminsen & Bryceson, 2012).

Although the presence of factors that contribute to undernutrition are vivid in Mafia, there is no study that has yet focussed on the assessment of physical growth among the under-five children. Albonico et al. (2002) remains the only study that has focused on children in Mafia Island, but solely on soil-based infections and treatment among school children. Walley (2004) and Ash et al. (2007) reported increased hardships among the people of Chole in obtaining fish for household consumption and affording nutritional meals, but there is still lack of information that shows the nutritional status of under-five children in Chole and other villages.

To contribute to the challenging efforts to attain resilient and sustainable social-ecological systems, it is argued that studies need to address sustainability in a more diversified manner such that attention is given to both current and future resource users. We consider it equally important to focus on the under-fives, who are also considered in this paper as 'future resource users' currently residing in Mafia Island. The understanding of nutritional status and growth of these future resource users is crucial for maintaining transfer of traditional ecological knowledge across generations. The under-five children also deserve attention because they are the future resource managers, and as such it is crucial to ensure their development in their early stages of life towards better capacities in the future.

Given the above premises, this study investigates the nutritional status of children under the age of five in Jibondo and Chole villages in order to contribute to the understanding of their health and growth status. The study specifically focuses on the assessment of growth among children to determine prevalence of underweight among the studied children and establish descriptions of their nutrition situation and the local perceptions of possible explanations for the underweight prevalence. The study employs weight-for-age as an appropriate measure for underweight as it combines the two aspects of body growth, linear and proportions (Shetty, 2003).

## **2. Methods**

### *2.1 Study Area*

This study was conducted in Mafia Island, a large archipelago that covers 407 km<sup>2</sup> and is about 120 km from south-east of Dar es Salaam (Figure 1). Mafia is among the seven districts forming the Coast Region and has a population of 46 438 people (URT, 2013). Mafia has rich marine biodiversity which contributed to the establishment of the first marine park in the country and the largest in Africa, the MIMP (Benjaminsen & Bryceson, 2012). The rich marine environment supports fishing activities for both men and women, although women mainly engage on octopus fishing and seaweed farming (Bryceson et al., 2006; URT, 2007). Short rains starting from October to December and long rains that begin in March and end in May supports some agricultural activities in most areas. The people of Mafia Island also engage in other economic activities including livestock keeping, rope making, boat making, handcraft and small business (Walley, 2004; Mwaipopo, 2008).

Chole and Jibondo villages are among the inhabited islands of the archipelago that were chosen for this study. According to village records of 2011, Chole had about 243 households while Jibondo had 620. They were selected because each constitutes a small fishing village with inhabitants that heavily depend on fish as a major source of protein but where they are also affected with global processes in different ways. Conservation measures by the MIMP for example, are reported to affect both Chole and Jibondo villagers (Benjaminsen & Bryceson, 2012). Chole was also selected because of the presence of tourism foreign investment and for its reported high level of poverty and substantial decrease of fish intake (Walley, 2004; Bryceson et al., 2006). Jibondo was selected because of its active engagement in small-scale commercial fishing and trade through agents from the fish processing factory and the reported changes in gender roles that compromise food security (Bryceson et al., 2006).

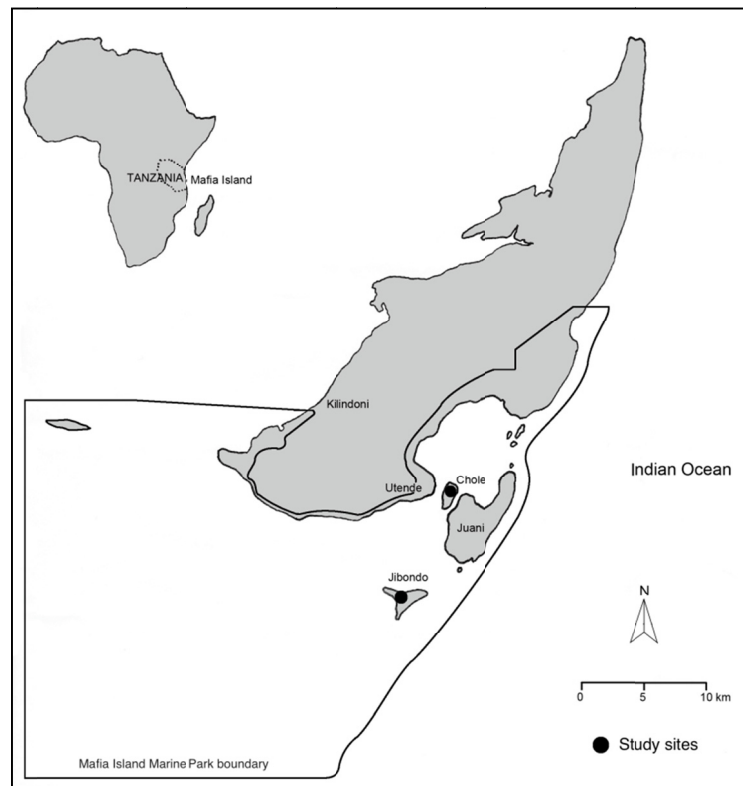


Figure 1. Map of Mafia Island showing study sites

## 2.2 Data Collection

This was a descriptive cross-sectional study conducted for eight months between August 2009 and March 2011 using both quantitative and qualitative data collection methods. It was part of a much wider social-ecological study that was carried out in the two sites to investigate social-ecological changes in the livelihoods of people residing in the sites. Data collected in the wider study included changes in income and food status in terms of number of meals per day, types and amounts of foods consumed, trends in the consumption of fish and other alternative protein-rich foods. Data collection for this study was carried out after being granted research clearance by the University of Dar es Salaam and permission to collect data by the responsible government authorities at regional, district and village levels. Verbal informed consent was obtained from the mothers and guardians of under-five children through the help of village leaders and officials from the kindergarten and dispensaries.

Target population for the study was under-five children residing in Chole and Jibondo villages. This study involved children who were enrolled in Chole Kindergarten and those brought to Reproductive and Child Health (RCH) clinics in Chole and Jibondo villages. Reasons being first, the timing of data collection coincided with school operations such that the under-fives aged above two and a half years from Chole were found at the kindergarten. Second, in Tanzania, all children under the age of five are supposed to attend the RCH clinic once in every month for growth and development monitoring including vaccination. Therefore, quantitative data collection involved under-five children that attended RCH clinic in the month of February 2011 in order to quantify the rate of attendance of under-fives to the RCH clinic for one month. This included the rest of the under-fives from Chole that were not enrolled at the kindergarten but were brought to the clinic during the stated period.

The total number of the under-five children was obtained from Chole and Jibondo dispensaries in the RCH record books. The RCH records showed there were 252 under-five children in Jibondo Island and 77 in Chole Island. A total of 104 and 52 children from Jibondo and Chole respectively were involved in this study. In Jibondo, RCH services for the under-fives were scheduled to take place once every week on Wednesdays whilst in Chole the services were available every working day. Therefore data collection at Jibondo was done only on Wednesdays and other weekdays at Chole while the Wednesdays' data for Chole were obtained from the RCH record book. The health care worker on duty for the day and the first author performed anthropometric

measurements and recorded data on prepared forms. Weight was taken after the participants had removed their shoes and upper garments and was measured to the nearest 0.1 kg using SALTER and ADE weighing scales, which were periodically checked for accuracy and calibrated as necessary. Children's chronologic age was calculated as a decimal age by subtracting the measurement date from the date of birth. At Chole, measurements of the under-five children enrolled at Chole Kindergarten were taken at the dispensary and their birth date records were obtained from RCH records and the rest of under-five data was recorded during clinic services. At Jibondo, data on weight were recorded during clinic services and data on birth date and weight were recorded from child's clinic cards.

Qualitative data collection focused on exploring local perceptions of possible explanations with regard to nutritional status of the under-fives. Data on the topics pertaining to children's upbringing, such as the duration before mothers resumed their income generating activities, particularly seaweed farming and octopus picking, changes in gender roles, breast feeding, introduction of substitute foods, child diet and major causes of morbidity were collected through in-depth interviews and Focus Group Discussions (FGDs). In Chole, ten interviews were held with women, men, kindergarten teacher and healthcare official while four FGDs were conducted, two with women, one with both men and women and the last with kindergarten cooks. In Jibondo, fourteen interviews with women, care givers, men and healthcare official for the village dispensary were held. Five FGDs were conducted, four with women and one with both men and women. Personal observations and informal talks were also useful to complement data obtained from interviews and FGDs.

### *2.3 Data Analysis*

Quantitative data from completed forms were checked for consistency before data entry was conducted. Descriptive analysis was done and the results were presented as proportions. Child's weight for age was interpreted using World Health Organization (WHO) growth charts (2006). These growth charts were used because they are the basis for RCH card number one used in Tanzania for monitoring growth and development in children below the age of five years. Weight for age values falling at the median was taken as normal nutritional status and at -1 standard deviation (-1SD) as mild low weight for age. If the child's weight for age lies between -2 and -3 Standard deviation was reported as moderate low and if below -3SD was taken as severe underweight or very low weight for age. Qualitative data from interviews and FGDs were transcribed and the field notes were organised and reviewed repeatedly to identify emerging themes which were then categorised into major themes for description (Bryman, 2004).

### **3. Results**

Of the 156 children below the age of five years involved in this study, 104 (67%) were from Jibondo Island and 52 (33%) were from Chole Island, representing 41% and 68% of the total under-five children at Jibondo and Chole respectively. Among them males were 81 (52%) and infants (children aged less than 12 months) were 43 (28%) of the studied population. Of the total 252 under-five children at Jibondo, 148 (59%) children did not attend their monthly RCH clinic.

About 40% of the studied population did not suffer from underweight. Most of these children with normal weight for age were infants, accounting for 74% of the studied infants. The rest (60%) of the studied population were underweight. Among the underweight children, 35% had mild, 43% moderate and 22% severe low weight for age. The majority of those with mild to severe low weight for age were those above one year of age (Figure 2).

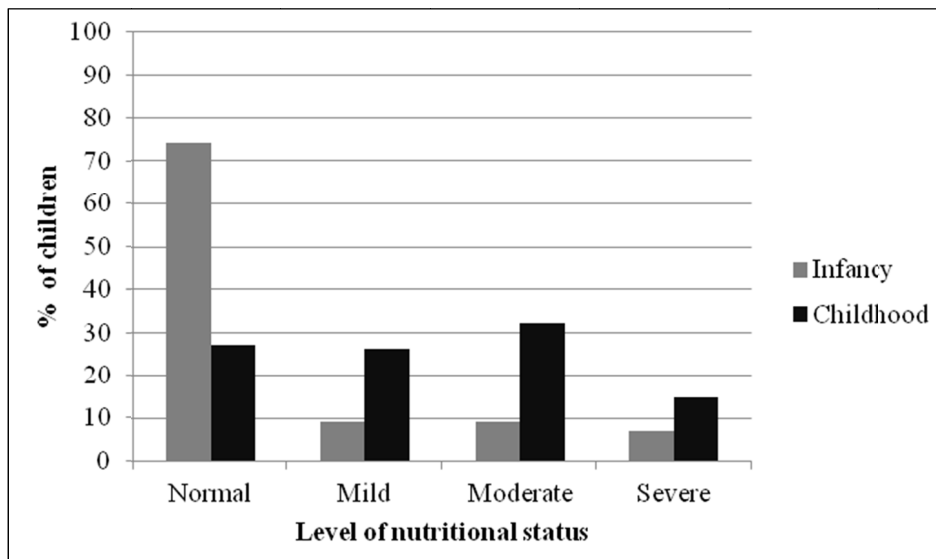


Figure 2. Level of nutritional status (underweight) by age

Infancy = child aged less than 12 months, Childhood= child aged 12 months to 59 months.

The prevalence of underweight children in the two sites differed (see Figure 3). In Chole 40% of the studied children were underweight. In Jibondo the levels of underweight children among the sample were higher (69%). Of the studied children in Jibondo, 20% had mild and 30% had moderate while 19% had severe underweight. In Chole, 17% of the children involved in the study had moderate underweight. All of the severe underweight children of the total studied population were from Jibondo. However, only 8% of the sampled children in Jibondo had low birth weight that was below 2.5 kg.

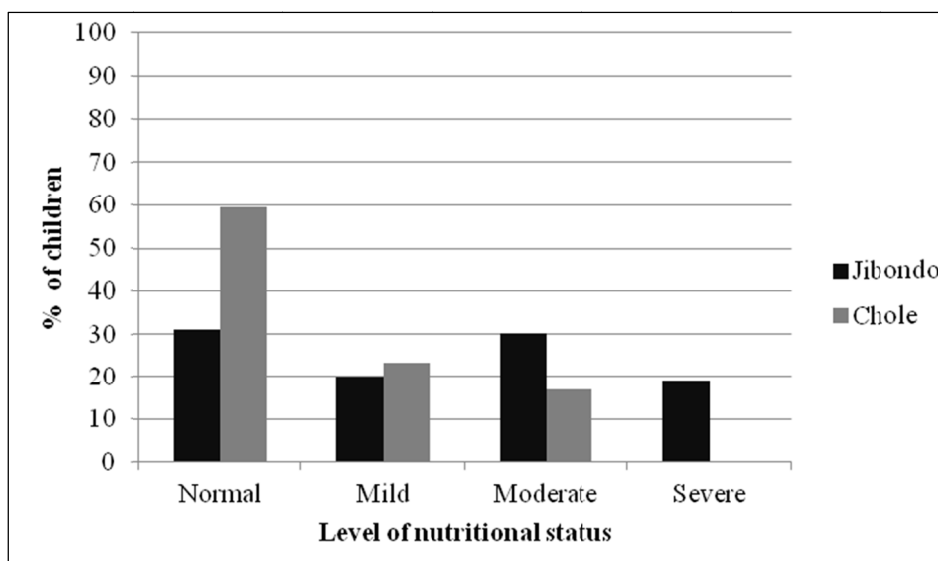


Figure 3. Level of nutritional status (underweight) by area of residency

Qualitative results revealed that most mothers in Chole still breast fed their children as in the past because their important activities for generating income and food production, rope making, handcrafts and farming, took place around their homesteads. Few mothers farmed at the neighbouring island, Juani, during the April-June and November-January farming seasons. They reported that they experienced increased responsibilities for household needs because men faced reduced fish catches and income from fishing restrictions, consequently reducing household nutritious food and fish supply. A 36 year-old man, a father of four children, noted that “...

when I am stuck, I leave in the morning without saying goodbye to my wife, and she attends to the household needs then she claims the money”. (IDI with a man, Chole village, 02/03/2011). However, household expenses were greatly reduced because parents did not cover higher education costs for their children as sponsorships to all children who passed their primary school examinations were provided through an initiative that was introduced by the tourism investors. Women pointed out that most households’ struggles were for obtaining food and other needs, and that their children were not affected much by the increased work-load because Chole women were not such hard workers as those in the neighbouring islands as explained by one woman:

“... We people of Chole are not that active, we are just like that ... maybe because this island was colonized by Arabs. They made as like ‘stay inside only’- a woman is not a person that is supposed to struggle, a woman is a person for keeping inside...” (IDI with a woman, Chole Village, 12/10/2010).

Most of the Chole children were cared for at the kindergarten during working days and were provided with nutritious food. In the mornings, children were fed porridge that was made from nutritional flour, which was a mixture of sorghum, bulrush millet, finger millet, maize and soya beans. For lunch, stiff porridge, rice, bananas, potatoes and pasta were interchangeably served with either beans or small sized fish except on Fridays when either chicken or beef was served. Women who cooked for the 58 children enrolled at the kindergarten at the time of data collection admitted that the quality and varieties of foods provided at the kindergarten contributed much to the nutritional status of their children because such varieties were not available in households. However, they also reported to have reduced portions of both breakfast and lunch due to decreased ability to operate the school.

In Jibondo, the frequency and duration of breast-feeding among the under-fives had reduced substantially because mothers resumed seaweed farming and octopus fishing soon after delivery. Seaweed farming and octopus fishing are important livelihood activities to the majority of women for both household income and food security in the area and are practiced during the two spring tide periods in each month, about sixteen days a month. During these days women usually left at around 7-9 am and returned in the afternoons around 2 pm depending on tides. Mothers resumed breast-feeding when they returned from the ocean. Most mothers resumed their livelihood activities soon after 40 days as evidenced by one woman:

“...women resume going to the ocean soon after *arobaini* (a period of 40 days). It would not pass two months after the *arobaini* before women resume seaweed farming and octopus fishing. There is not enough income from net fishing by children’s fathers such that home provisions drop. We just have to resume early because things don’t go well when women stay grounded for long. Even husbands will not approve of women being grounded for say six months even when the doctor advises them to do so ...” (FGD with women, Jibondo village, 13/01/2011).

Cases were reported of mothers resuming seaweed farming and octopus fishing in less than a month after delivery. An extreme case was reported of one mother who resumed her fishing activities within a week after she had delivered, and the child was found to be underweight. However, there were still some mothers who waited up to eight months before they resumed their activities.

The tendency of mothers to resume livelihood activities soon after delivery was further evidenced by the existence of child caring activities among the elderly women at Jibondo. One elderly woman (above 70 years of age) confirmed that most women resume octopus fishing and seaweed farming after *arobaini* such that she was earning part of her livelihood by taking care of children whose mothers had resumed working in the ocean early after delivery. She fed the children with plain porridge and in few cases milk that was provided by mothers before they left for work. She explained that she cared for about six children every spring tide.

Mothers attributed their early return to income-generating activities to changes in gender roles and increased responsibilities for women in Jibondo. They experienced these changes since the 1980s and stated that they have increased in the preceding two decades. In the past, during spring tides, men engaged in fishing while women practiced octopus fishing and they both engaged in farming on land during neap tides and raining seasons to produce various crops for household consumption such that they did not purchase food. Since 1990s crop production was left to women and started to decline due to destruction by livestock, while men focused on fishing. Women were concerned that these changes and the decrease of governmental assistance in providing health and education services have increased household expenses to the extent that was not manageable by men alone. However, examples were reported that when women earned income to run the households, some men began to provide less for their families and entered into polygamy. These changes in gender roles and responsibilities in Jibondo are reflected in the following quotes from three women:

“... When I was married in 1971, I waited for my husband to provide for both household and my needs. My major responsibilities were to clean the house, wash clothes, cook, reproduce and care for the children. I did not think of business and even when my husband left money for household expenses I returned the surplus to him. Now I cover educational expenses for my children in both secondary and primary school, I used the income I got from my last seaweed harvest to buy cement and built this cement floor that we are sitting on now, I bought 10 goats and my husband has one. Men’s income has dropped because of frequent confiscation of their fishing gear and they have now shifted to octopus diving. In the past octopus was women’s work only and seaweed had no meaning ...” (IDI with a woman, Jibondo village, 02/10/2010)

“... Now most women build houses and feed their families either alone or in co-operation with their husbands. Men have now experienced ease of life because life has knocked them down. They don’t provide household provisions in time and they dodge household expenses so that women would provide ...” (IDI with a woman, Jibondo village, 15/09/2010).

“... In the past women did not hide their money but now they hide it so that the husband don’t see it, because when he sees it he takes it and go to propose marriage to another woman ...” (FGD with women, Jibondo Village, 28/09/2010).

Men admitted to have lost their capacity to fully provide for both their wives’ and households’ needs as they did in the past, and acknowledged the increased workload to women. Most men appreciated women’s support in running the households while some men were not guaranteed support and to others it meant new opportunity to enter polygamy and bare children despite their economic hardships and reduced abilities to care for them. Cases of reduced family care among young fathers were also reported whereby they prioritize their spending on clothing to catch-up to their peers in Kilindoni and the current trends that are seen in televisions at video halls. These phenomena are captured in the following quotes from men.

“... Now we just manage life partly, life is like so. The situation is tough, if we (himself and his wife) don’t help each other, things don’t work out ...” (IDI with a man, Jibondo village, 02/10/2010).

“... Now my income is low although octopus prices are a bit higher. In the past the income was high although the prices were low. Woman’s income is not guaranteed, she hides it because she is married ...” (IDI with a man, Jibondo, 01/10/2010).

“... You can just marry even three wives. Women here feed themselves. But in case of divorce, a man is the one who leaves the house because most houses are mainly built by women ...” (IDI with a man, Jibondo village, 27/09/2010).

“... We are not smart like the elders, you buy a 30,000 TSh [approximately 20 USD] jeans while you have no savings. We are finishing perfumes in shops while the elderly used coconut oil. The youth don’t mend nets, they pay 5,000 TSH [approximately 3.5 USD] per gear to elders or those who want to learn. At what time will they be seen in Kilindoni if they mend nets?” (IDI with a young man, Jibondo, village, 01/10/2010).

The reported increase in earning responsibilities among women contributed to decreased ability for mothers to follow the advice from the clinical officer who urged them to wait to resume their activities until six months after delivery in order to exclusively breastfeed. During this study, it was generally agreed by both women and the clinical officer that there was not a single woman at Jibondo who exclusively breastfed her child for the first six consecutive months. The clinical officer reported requesting mothers to come with the fathers of their babies during their monthly visits to the RCH clinic. This would be an opportunity for the clinical officer to advise both parents on the importance of delaying resumption of income earning activities among mothers so as to breastfeed infants exclusively during the first six months of their babies’ lives. However such plans did not materialize because fathers were reported to fear that they would be tested for HIV infection.

The altered breastfeeding practices at Jibondo entailed early introduction of substitute food among infants during their early stages of life. Most substitute foods were mainly nutrient poor and carbohydrate rich, like maize flour served as a watery porridge. Meanwhile, the rate of supplementing fresh cow’s milk to infants was reported to remain low due to both limited availability and affordability. Children above one year were less breastfed, and were fed on low nutritional substitute foods and family meals containing more carbohydrates and little or no foods that are rich in protein, vitamins and minerals.

Incidences of diarrhea among infants were reported by women and confirmed by the clinical officer, particularly at Jibondo. The officer reported early introduction of substitute foods before the babies’ digestion systems were

ready and poor hygiene as major causes of most diarrhea cases, which further exacerbated cases of underweight in the area. Other causes of morbidity among the under-fives were reported to include malaria, respiratory infections and iron deficiency anaemia, which also affected most women. During their visits to the clinic, mothers were advised to include green vegetables in meals. However, it was reported that households could not afford the vegetables on daily basis.

#### 4. Discussion

Most of the changes experienced by villagers in Chole and Jibondo, including fishing restrictions, reduced income and altered gender roles appear to have negatively affected the nutritional status of the under-five children. As our results show, almost 60% of the studied children below five years were underweight. This is despite the fact that MIMP has a specified obligation to ensure that the wellbeing of the communities residing within the borders of the park is maintained by broadening their income base through new livelihood activities (URT, 2000). The observed percentages of the underweight in this study were almost four times higher than the national standards reported in the 2010 Tanzania Demographic and Health Survey (URT, 2011), which revealed that 16% of Tanzanian under-five children studied during the survey were underweight, with Arusha region having the highest rates (28%). Nyaruhucha et al. (2006) and Abubakar, Uriyo, Msuya, Swai, and Stray-Pedersen (2012) observed high underweight rates in northern Tanzania, in Manyara (31%) and Kilimanjaro (19%) respectively. The percentage of severely underweight children in our study (13%) was more than three times than the national rates (4%) (URT, 2011). This is probably due to low income from fish trade and increased protectionist measures by MIMP (Bryceson et al., 2006; Benjaminsen & Bryceson, 2012).

The degree of underweight in study areas varied across age groups, with children below one year of age being the least affected with underweight problems. This could be partly due to the fact that infants were breastfed. It was observed in this study that women resumed their livelihoods activities soon after delivery but they ensured substitute foods for their infants and continued with breastfeeding when they returned home, and maternal care was probably good for this age group. On the other hand, children above one year were less breastfed, and were fed on low nutritional meals. Early introduction of low quality substitute foods along with poor hygiene has been argued to exacerbate undernutrition problem and increased incidences of diarrhea among under-five children (de Onis, Frongilo, & Blössner, 2000; Bloss, Wainana, & Bailey, 2004; Kumar, Goel, Mitta, & Misra, 2006; Muhimbula & Isa-Zacharia, 2010). About 26% of infants in this study were underweight probably because women did not practice exclusive breast feeding for six months as recommended by WHO (2002) and UNICEF (2011).

Reduced care among the under-fives was also evidenced in Jibondo where more than half of the under-five children in the study site not brought to their monthly clinic. Falls in attendance to clinic by the children above one year were also reported in the study by Matee et al. (1997). Most studies on nutritional status of under-fives have indicated the vulnerable age for undernutrition to be mostly children above six months, a period during which intensification of nutritionally insufficient substitute foods were reported (UNICEF, 1998; Muhimbula & Isa-Zacharia, 2010; URT, 2011; Walton & Allen, 2011).

Jibondo was more affected with undernutrition, although only a few of the sampled children had lower birth weight than the 2.5 kg recommended as normal birth weight by Blössner and de Onis (2005) and URT (2011). This was probably because the nature and dominance of women activities and their household responsibilities in the two sites differed and the women in Jibondo were more engaged in work and were responsible for covering education costs for their elder children. Women in Chole were thus more likely to have more time for child caring than their counterparts in Jibondo. Spatial differences in malnutrition have also been observed by Kandala, Madungu, Emina, Nzita and Cappuccio (2011) and Jesmin, Yamamoto, Malik, & Haque (2011).

Another possible explanation for this variance might be the difference in food security status experienced in the two sites. Chole villagers produced most of their foods but lacked fish protein as also observed by Walley (2004), while in Jibondo poor soils and declining agriculture has increased food insecurity and dependence on purchased food. The increased protectionism by the MIMP and lower prices for fish, octopus and seaweeds (Bryceson et al., 2006; Benjaminsen & Bryceson, 2012) largely reduced income and constrained purchasing power for food. Studies by Alderman, Hoogeveen and Rossi (2006), Evans et al. (2011) and Kandala et al. (2011) have also shown the influence of income on dietary patterns where the amount of income determined the amount that was to be spent on food purchase.

Feeding programs among children have been argued to have potentials for reducing undernutrition cases (Levinger, 1986). The presence of a kindergarten school at Chole is yet another possible explanation of the lower rate of underweight children in the area than those at Jibondo. The presence of the kindergarten also meant that

children at Chole were likely to have more meals per day than children from Jibondo who were mainly left with elderly women when their mothers went to work.

It has been shown in this study that the prevalence of low underweight in both sites has been largely contributed to by the increased burden on women, whereby they spent much time on livelihood activities either to raise income for purchasing food or to produce food directly. The problem of balancing time for child rearing activities and livelihood activities has also been reported in Southern parts of the country in Rukwa Region by Wandel and Holmboe-Ottesen (1992) and in the neighboring country in Kenya by Abubakar, Holding, Mwangome and Maitland (2011). However, Mahgoub et al. (2006) observed significant decrease of underweight cases among the under-fives with increase of household income. This suggests that child malnutrition could have been even worse than what was observed during this study if the mothers had taken more time before they resumed their livelihood activities after delivery. This is because villagers in both sites have been reported to face increased economic hardships (Walley, 2004; Benjaminsen & Bryceson, 2012) and men were already having difficulties in providing household needs without such assistance from their spouses. Women had possibly made hard decisions when they had to resume their activities soon after delivery in order to ensure food requirements for their other elder children and the whole household. By making this choice, women were ultimately struggling to maintain their traditional role - taking care of their children and the entire family whilst also ensuring that food requirements are met (Seebens, 2010).

The argument by Oppong (2001) and Gabriele and Schettino (2008) that past and present macro political and economic trends of global systems contribute to undernutrition problem among children was also evident in this study. The introduction of Structural Adjustment Programmes in Tanzania as a conditionality for foreign aid and loans during the 1980s is widely argued to have affected the poor adversely by causing devaluation of local currency, introducing cost sharing in health and education, increased prices and promoting trade liberalisation (Lugalla, 1995; Walley, 2004; Caplan, 2007). The effects of liberalisation of fish trade on food security and undernutrition by moving fish from where it is most needed due to unaffordability of other protein-rich foods to areas where it less needed at lower prices is also widely documented by Kent (1985, 1997, 2002), Fulgencio (2009) and Allison (2011). These global processes in combination with other local factors, including changes in gender roles, decreased income and devaluation of money appear to have contributed to the underweight problem in this study.

However, in order to understand such contributory explanations with regard to nutritional status of under-fives in the two sites, one must take into consideration major limitations of this study. First, the selection of under-five children into the study by mainly depending on their attendance to the dispensaries implied handling a number of children within the allocated time for RCH clinics. This limited the amount of time spent with individual child and mother; consequently hampered the collection of quantitative data regarding causes of undernutrition from the mothers of the sampled children. Although this limitation was partly addressed by the qualitative explanations provided in this study, it remains unfeasible to generalize such explanations as exact factors that contributed to undernutrition problem among all the under-fives in the two sites. Second, our focus on understanding attendance of under-five children to RCH clinics eliminated more than half of eligible children from participating in this study since they were not brought to the clinics. Even though this study described the nutritional status of the involved children through the small sample size obtained, it is important for future studies to sample participants at household level to avail more time for collecting other quantitative data and obtain larger sample size.

## 5. Conclusions

In line with the limitations mentioned above, several conclusions are made. Most of the under-five children who were involved in this study were underweight, reflecting the failure to meet their nutritional requirements. The problem of underweight was higher in Jibondo than in Chole. The difference that was observed between the two villages in the same district, especially in comparison to national rates, highlights the importance of contextual conditions and demonstrates that the use of national averages may actually obscure the worst scenarios of child undernutrition. The study has also revealed how the situation in Chole and Jibondo is not meeting the stated goals of MIMP's General Management Plan to ensure the wellbeing of the communities within the park, and the United Nations MDGs targets related to child health.

The local perceptions of prevalence of underweight in these cases suggest that underweight was mainly attributed to changes that were happening in the Mafia Island Marine Park. These changes included decreased income among men, increased food insecurity and increased responsibilities and burden among women to contribute to household needs. The important distinctions between women's roles in the two sites had



implications for child-care while the kindergarten meals played important role in improving nutritional status among children in Chole. There is a need for an in-depth multidisciplinary study that includes other anthropometric measures and in-depth epidemiological assessments among the under-fives at Jibondo, Chole and other parts of Mafia. If healthy generations and sustainable social-ecological systems are to be achieved within the Park in the future, interventions that review fishing restrictions, improve fish trading, increase household food security and liberate mother's time for breastfeeding and child-caring activities would be essential to address the current undernutrition among the under-fives.

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**Paper 4: Adaptive management for marine protected areas and prospects for its implementation in the Mafia Island Marine Park, Tanzania.**



## **Adaptive Management for Marine Protected Areas and Prospects for its Implementation in Mafia Island Marine Park, Tanzania**

### **Abstract**

The potential for an adaptive management approach (AM) to achieve both conservation and societal development goals remains hard to achieve in practice. I analyse how the principles of AM are implemented in Mafia Island Marine Park, and then I explore the prospects for a possible attempt to practice AM process for the future. My analysis is based on the data collected between 2009 and 2011 through in depth interviews, focus group discussions, informal interviews, direct observations and open-ended questionnaire survey. The Park has potential to prosper with an AM process. However, existing mismatched perceptions among actors, simplistic conceptualization of key problems, dominance of routine-based practices and coercion, double standards in the interpretation of the law, inappropriate plans to deal with uncertainty, and unattended surprises limit such potential. Conservation-development goals are likely to be achieved through AM approach only if policies are appropriately changed to provide a legal enabling environment, as an adaptive response to contextual and global conditions.

**Key words:** adaptive management, marine protected areas, conservation, social development, Tanzania

## 1. Introduction

Adaptive management (AM) is increasingly being advocated as an ideal approach to achieve effective management of Marine Protected Areas (MPAs) (Pomeroy *et al.*, 2004). Authors like Westgate *et al.* (2013) have actually argued that there is no other approach that is clearly superior to it. AM is advocated for its capacity to decrease uncertainty and to deal with complex cross-scale challenges from unpredictable and dynamic human-environment interactions by implementing three major principles: adjusting management actions and strategies as new information arises, enhancing learning by doing and experimentation, and ensuring relevant actors actively participate in management (Holling, 1978; Torell, 2000; Allen and Gunderson, 2011; Williams, 2011; Williams and Brown, 2013; Morris and Green, 2014).

AM principles are operationalized through an iterative process which involves various actors in assessing the problem and planning a strategy, implementing it, monitoring progress, and evaluating resultant outcomes for adaptation and further refining so as to effectively achieve the intended goals (Nyberg 1999; Pomeroy *et al.*, 2004; Allen and Gunderson, 2011; Williams, 2011). Thus, AM blends research data and actions to enhance flexibility and adaptation to emerging social-ecological issues, and improve conservation practices (Salafsky *et al.*, 2002).

However, some authors have shown that there are difficulties in realizing AM promises on the ground (Walters, 1997; Cumming *et al.*, 2012; Williams and Brown, 2014). It is argued that AM programs often fail partly due to lack of AM understanding and financial resources, inadequate engagement with political economic processes, and poor analysis of power relations among actors. Others include lack of political ecological insights into its theorization, lack of proactive and flexible policies and actions, and lack of organizational commitment to abandon traditional fortress management cultures (Walters, 1997; Allen and Gunderson, 2011; Allen *et al.*, 2011; Beymer-Farris *et al.*, 2012; Cumming *et al.*, 2012; Westgate *et al.*, 2013). Also, there are difficulties in recognizing and reducing uncertainty in AM projects (Williams and Brown, 2014), and AM literature still lacks empirical studies and is dominated by post-implementation analysis of its programs.

Understanding how the principles of AM work, and why its practice often fails, is crucial for improving effectiveness in AM programs (Torell, 2000; Allen and Gunderson, 2011; Westgate *et al.*, 2013). Using the Mafia Island Marine Park (MIMP) as a case study, this



paper explores the potential reasons for failure of AM programmes and looks at the possibilities of ensuring that the benefits of AM practices are realized in MPAs. The MIMP is among the MPAs involved in adopting AM and was already implementing AM principles since late 1990s (Torell, 2000; Pomeroy *et al.*, 2004; Fox *et al.*, 2014)<sup>1</sup>. Hence, this study contributes empirical evidence on how the principles have continued to be implemented so as to show the advantages for analysing the implementation process *before* MIMP attempts to adopt the process full scale. Shifting emphasis from *post*-implementation analysis of AM programmes to *pre*-implementation analysis of potential ones can improve success of AM projects. Pre-analysis of a potential AM project offers early diagnosis of pressing challenges that can cause failure and increase social-ecological uncertainty. It also offers room for improvement before embarking on the actual AM process.

### *1.1. Conceptual framework*

Global conservation regimes such as MPAs are usually inappropriate for local realities (Kolding and Zwieten, 2011). MPAs have been associated with neoliberal thinking in which markets become tools for managing natural resources and promoting development (Adams and Hutton, 2007). As such, MPAs are assigned market values to increase tourism revenues (Brockington *et al.*, 2008). However, market based conservation and economy often undermines social dimensions at the local level and tends to produce inequalities and underpricing of natural resources products (Benjaminsen and Bryceson, 2012; Beymer-Farris *et al.*, 2012). MPAs also face challenges from complex and unpredictable social-ecological interactions and changes which increase uncertainty and reduce ability to adequately achieve the intended goals of biodiversity conservation and social development (Kolding and Zwieten, 2011; Moshy *et al.*, 2015).

Uncertainty about social-ecological processes is a key feature in natural resource management because decisions on management strategies and actions are often made based on inadequate information (Allen *et al.*, 2011; Williams and Brown, 2014). As such, AM is an approach that embraces structured planning and learning for dealing with changes,

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<sup>1</sup> The Strategic Plan prepared to oversee the management of Tanzania's MPAs from 2006 to 2010 envisaged establishment of an AM system to enable regular utilization of research and monitoring of results (URT, 2005). AM is also mentioned in the new Management Plan as a 'long-term strategy' that would oversee MIMP management until 2021 (URT, 2011:57). Moreover, MIMP hosted a regional training course in strategic AM for MPAs in the Western Indian Ocean (November 17 – 22, 2014) as part of efforts towards realizing benefits of AM.

surprise and unpredictable interactions within social-ecological systems. It involves comparing various management approaches through feedback learning to test contextual relevant social-ecological solutions and shape policy (Berkes and Folke, 1998; Cumming *et al.*, 2012). It treats management policies as experiments to build and maintain desired ecosystem states and management results whilst creating more desirable pathways for resilience, development and MPAs effectiveness (Holling, 1978; Pomeroy *et al.*, 2004; Folke *et al.*, 2005).

The six-stage framework of an iterative AM process<sup>2</sup> is modified in this paper to allow analysis of MIMP implementation in the context of AM (Figure 1). Some perspectives of political ecology are also employed to enable critical analysis of human-environment relationships in Park conservation processes (Robbins, 2012). Historical and narrative analysis of actors, social-ecological interrelationships and Park conservation processes were carried out to establish the existing situation and prospects for adopting AM process, and to show how the framing, implementation and outcomes of conservation policies are linked to global economic systems, and flawed by imbalanced power relations and social justice (Blaikie and Brookfield, 1987; Scott, 1998; Walker *et al.*, 2004, Folke 2006; Brockington *et al.*, 2008; Kolding and Zwieten, 2011; Robbins, 2012).

## **2. Study area and methods**

Mafia Island Marine Park (MIMP) is part of Mafia Island, an archipelago forming Mafia District, which is located 120 km south-east of Dar es Salaam (Fig. 2). The MIMP was established in 1995 as a response to global conservation requirements and local demands to halt dynamite fishing (URT, 1994; Walley, 2004; Benjaminsen and Bryceson, 2012). The MIMP is a multi-use park, designed to conserve the marine environment and contribute to social development (URT, 2011). About 23,000 people reside within thirteen villages inside the Park and earn their livelihoods mainly from fishing, seaweed culture, subsistence farming, livestock keeping, and small businesses (Walley, 2004; Mwaipopo, 2008; (URT, 2011).

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<sup>2</sup> i.e. assess, design, implement, monitor, evaluate, and adjust (Nyberg, 1999; Williams and Brown, 2014)

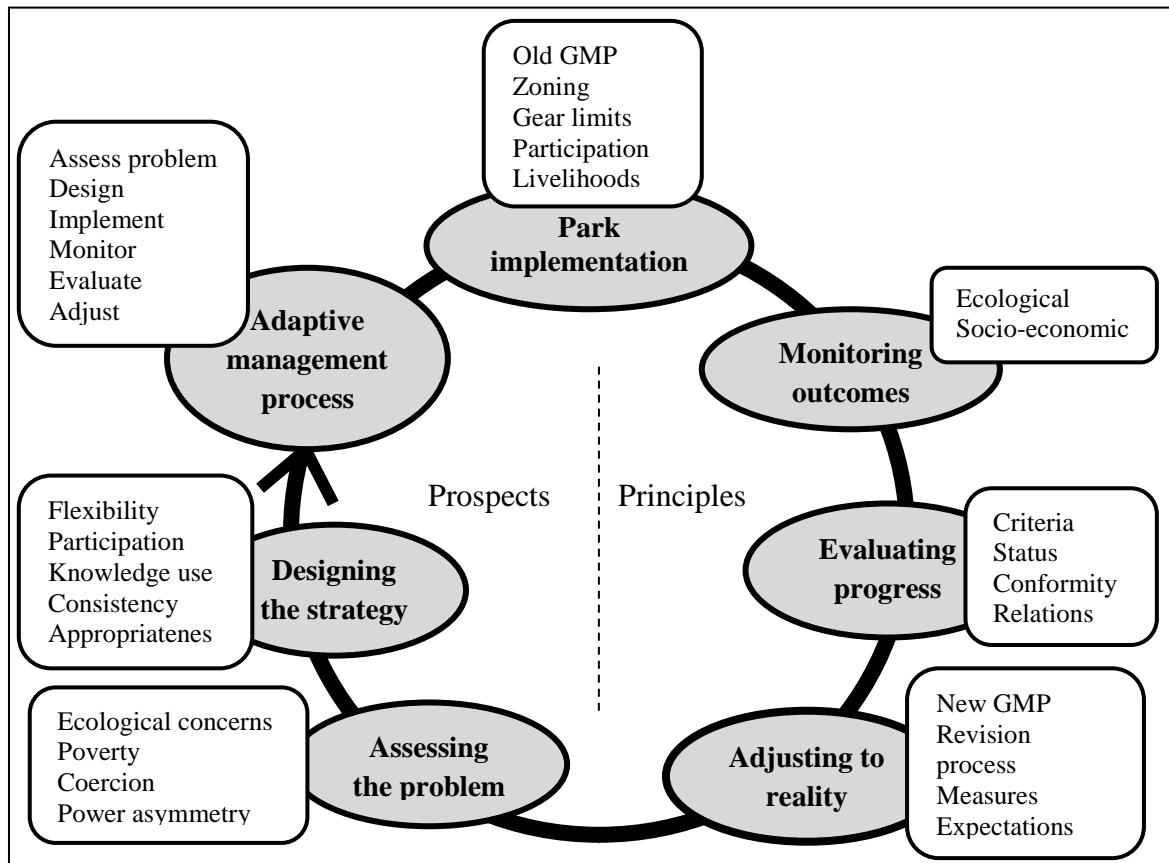


Figure 1: Conceptual framework: transition into full AM process requires analysis of how AM principles feature in Park conservation and how outcomes have been monitored and evaluated to enhance adaptation to emerging realities. Analysis of challenges from conservation, environmental, social, economic, and political environments, and historicity interacts requiring improved strategies to be applied to explore prospects for possible success of an iterative AM process.

Source: Adapted and modified from Nyberg (1999) and Williams and Brown (2014).

The first General Management Plan (GMP) for MIMP was formulated in 2000 and revised in 2011 to guide Park implementation (URT, 2000; 2011). The GMP (2011) provides a detailed account of Park implementation. Generally, Park objectives cover issues related to conservation, resource use, participation, ecotourism, education, cultural heritage, monitoring, research and sustainable development (URT, 2011). Meanwhile, Park strategies such as zoning, gear limits, alternative livelihoods, village liaison committees, and patrols remain essential in MIMP (URT, 2000). For example, the zoning strategy designated three zones to guide undertaking of multiple uses: a core no take zone - an area with the Park's richest biodiversity; a specified-use zone, and a general-use zone for regulated fishing. However, since the extent to which the MIMP applies AM principles in its operations is yet to be properly analysed, the park was chosen as a case study.

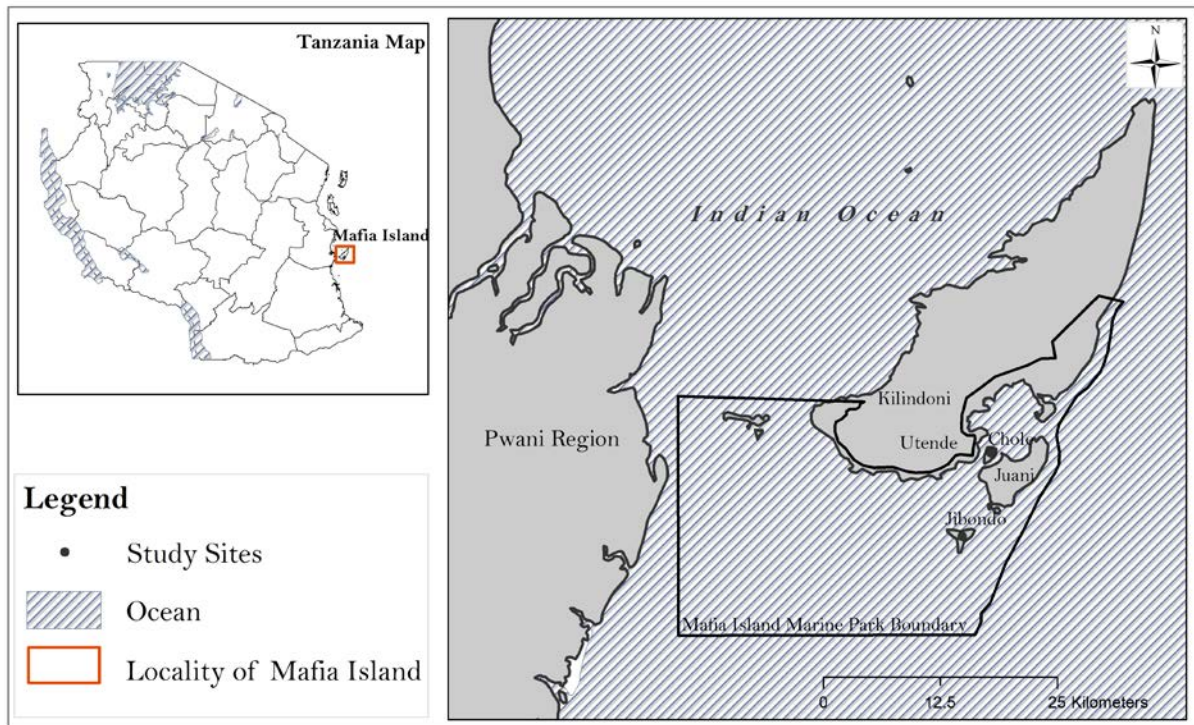


Figure 2: Map of Mafia Island showing study sites

The analysis is based on primary data collected from various actors across scale, including officials at MIMP Headquarters, Mafia District Council offices, WWF Tanzania Office, tourist hotels with dive centres, TANPESCA fish processing factory, Marine Parks and Reserves Unit (MPRU), Tanzania Investment Centre and the people of the villages of Chole and Jibondo. Although the villages lie entirely within MIMP boundaries, Chole is branded by MIMP as a compliant village and Jibondo as a non-compliant village.

Data used in this study were collected between August 2009 and March 2011, using both qualitative and quantitative methods (Bryman, 2004). Qualitative methods included 14 interviews with various officials across the institutional scale. Some institutional interviews were followed by self-administered written responses from officials to obtain temporal data which could not be obtained during face to face interviews. At the village level, 30 interviews, 9 Focus Group Discussions (FGD), and informal interviews were conducted to obtain in-depth descriptions of local understandings of Park implementation processes, success, failure and expectations in fulfilling both conservation and development needs, the nature of power relationships among actors, and the extent of flexibility in conservation measures. Quantitative data were collected following wealth ranking, whereby 103 heads of household were randomly selected and interviewed using a structured open-ended questionnaire. Secondary data were obtained from MIMP and Tanzania National Archives.

Thematic analysis was employed in the analysis of qualitative data. Continuous and repeated review of transcripts, written responses and field notes was done to identify emerging categories. These were further categorized into analytical themes in relation to the modified AM framework. Quantitative data was summarized, coded and analysed using descriptive statistics to obtain systematic quantitative indications of the studied sample.

### **3. Results**

#### *3.1. Park implementation*

##### *3.1.1. Zoning, gear prescriptions and patrolling*

The zoning strategy and the program for exchanging small-mesh sized pull-nets with large-mesh sized set-nets were physically implemented during 2001-2003 and 2004-2008, respectively. Few respondents reported zoning (5%) and gear limits (4%) as being useful in their livelihoods because fishers could no longer use deep water pull-nets in the MIMP, as one villager in Chole explained:

“...In the beginning they [MIMP officials] said their area is core zone and left some areas for us. But now they have taken all the areas, and they confiscate our nets and vessels” (FGD 4, 2009).

Set nets were ineffective hence the exchange program resembled enclosure of all fished zones. MIMP officials confiscated pull-nets because they claimed that fishers had been combining 2.5 inch with 1.5 to 2 inch mesh size nets, which made the whole gear illegal (I 2, 2009). The number of sea patrols per year increased from 19 in 1998/1999 to 187 in 2003/2004, and dropped to 95 in 2009/2010 (after donor funding ceased), and 706 people were arrested and 268 fishing equipment was confiscated (Written response, 2011; I 2, 2009). However, villagers were concerned that they often spotted two to five large trawl industrial fleets around the MIMP, which sometimes destroyed their shark nets but were often left unpunished (FGD 8, 2011). A fisher from Chole had the following to say about dissatisfaction with the patrols:

“Even two days ago fishing fleets came very near but the Park did not arrest them, they only arrest us. It is like welcoming a visitor in my home then I go and sleep outside. We have conserved the ocean for the benefits of people from China and France” (I 27, 2010).

##### *3.1.2. Community participation and development*

Concerns were raised about the decrease and extent of actors' participation in Park implementation. Although a few (17%) of the respondents said they were engaged in various Park programmes, including trainings on sustainable fishing methods and new livelihoods, the majority (97%) said they could not access loans from the Park to improve their livelihood conditions. Furthermore, while fishers reported that they faced difficulties in obtaining fishing permits, the officials claimed that the number of permits issued had dropped from 203 in 1999/2000 to 5 in 2009/2010 following increased environmental awareness and success in alternative livelihood programs (Written response, 2011).

As such, most villagers lost interest in participating in Park conservation because they were tired of its oppressions (I 23, 2010). They considered the losses encountered from the implementation as a surprise because during establishment of the Park, officials only explained about halting dynamite fishing; they did not explain about their long term plans. As one interviewee in Chole said:

“They [officials] came to cheat us. A person can give you a bag and tell you it contains sugar. Then when you get home and look you find there is no sugar and the one who gave you the bag is nowhere to be seen” (I 9, 2009).

### 3.2. *Monitoring social-ecological outcomes*

Following initial studies by Frontier Tanzania during 1989 and 1995, a monitoring program for environmental (2001- 2004) and socio-economic (9-11 February, 2010) issues was established to monitor social-ecological trends (Machano, 2005; Coastal Oceans Research and Development in the Indian Ocean (CORDIO), 2010). Frontier Tanzania and researchers in collaboration with villagers have continued to contribute vast social-ecological knowledge (see for example, Guard, 2003; Bryceson et al., 2006; Barker, 2013; Walley, 2004, Mwaipopo, 2008; Benjaminsen and Bryceson, 2012; Moshy *et al.*, 2015). However, while systematic monitoring of social-ecological conditions remains problematic due to limited funds, TANPESCA officials were reluctant to provide actual data on catches to MIMP, district officials, and researchers (I 1, 2009; I 4, 2009; Personal experience). Officials at the Tanzania Investment Centre actually revealed that:

“it is only under joint venture of Tanzania Investment Centre, Bank of Tanzania and National Bureau of Statistics that the investors are bound by law to provide data” (I 39, 2011).

### 3.3. *Evaluating Park's success*

### 3.3.1. Social-ecological status

While the GMP formed a key basis for assessing Park's success among Park officials, villagers' considered the actual benefits and losses they encountered in their daily lives. Hence, the officials boasted of improved marine environmental conditions and social wellbeing within MIMP. They reported increased catch quantities, income of communities, and ability to afford education, build better houses, use solar panels, mobile phones and satellite dishes (I 1, 2009); and increased involvement in new livelihoods (Table 1). Officials also acknowledged that MIMP had not completely succeeded, among other things, to instil compliance without patrols; eliminate all unsustainable fishing gear; scale up adoption of new activities, maintain good relations with local people; and sustain the revolving loan scheme among MIMP villagers, whereby only 5% of TShs 382 million-loan was returned by 2010.

Table 1: Success trends of new livelihood activities in Mafia Island Marine Park

| Activity         | Year | No. of people involved | Average production | Income received in TSh |
|------------------|------|------------------------|--------------------|------------------------|
| Seaweed culture  | 2000 | 117                    | 38,600 kg          | 4,632,000              |
|                  | 2008 | 1200                   | 136,000 kg         | 40,800,000             |
| Honey production | 2000 | 43                     | 200 kg             | 400,000                |
|                  | 2008 | 155                    | 1000 kg            | 5,000,000              |
| Handicrafts      | 2002 | 50                     | 50 pieces          | 207,000                |
|                  | 2008 | 155                    | 3200 pieces        | 10,300,000             |

Source: Field data, 2011; 1 TSh = 1393 USD (February, 2011)

Thus, the success framing by officials shown in Table 1 masks the realities of the quality of management process and underperformance in such activities as shown in Table 2.

Table 2: Failure trends of new livelihood activities

| Activity         | Year | Average production per individual | Average individual income in TSh |         |
|------------------|------|-----------------------------------|----------------------------------|---------|
|                  |      |                                   | Per year                         | Per day |
| Seaweed farming  | 2000 | 330 kg                            | 39,590                           | 110     |
|                  | 2008 | 113 kg                            | 34,000                           | 94      |
| Honey production | 2000 | 5 kg                              | 9,302                            | 26      |
|                  | 2008 | 6 kg                              | 32,258                           | 90      |
| Handicrafts      | 2002 | 1 piece                           | 4,140                            | 12      |
|                  | 2008 | 21 pieces                         | 66,451                           | 185     |

Source: Developed from Table 1; 1 TSh = 1393 USD (February, 2011)

Although some participants in Chole explained that alternative activities had failed to improve livelihoods due to laziness, (I 11, 2010), the majority were concerned that even widely practiced activities had failed to yield significant income compared to fishery income,

or daily expenditures (FGD 2, 2009). When respondents were asked to assess MIMP success (Table 3), the response rate for successes was lower (38%) than for failures (77%).

Table 3: Summary of multiple responses concerning success and failures of MIMP

| <b>Benefits from MIMP actions</b>   | <b>Losses from MIMP actions</b>  |
|---|--|
| Stopped dynamite fishing  | Provided loans to few villagers who were later perceived as betrayals by non beneficiaries                 |
| Supplied seaweed seedlings; searched for seaweed buyer                      | Enclosed fishing grounds and stopped pull-net fishing hence reduced fish consumption and money circulation |
| Constructed clinic, doctor's house, water harvesting structure; MIMP office | Confiscated fishing vessels, gears and catches   |
| Provided loans for fishing equipment  | Created chaos and harassments during patrols; stopped involving villagers in patrols                       |
| Provided vocational skills in mariculture and brick-making                  | Constrained availability of limestone whilst cement is unaffordable  |
| Supported school fees for secondary education                               | Constrained availability of logs for building vessels  |
| Introduced savings and credit co-operatives                                 | Required loan returns despite restricted use areas, sea accidents and life difficulties                    |
|   | Stopped follow ups to check on villagers conditions  |
|   | Caused poorer relations with villagers   |

Source: Field data

Results revealed cases of extreme dominance of failures. One interviewee in Chole summarized his perceptions of success as 1 benefit out of 1000 losses because MIMP provided fishing nets and vessels and then confiscated them and enclosed the fishing grounds (I 9, 2009). Cases of recognition of benefits but with concerns of their significance dominated. As one discussant in Jibondo puts it, the school fees support of TSh 20,000 by MIMP was only 5% of the total costs for day secondary schools that were only found on the main island of Mafia. He actually had to raise TShs 400,000 through collective fishing to cover for the other expenses, including accommodation expenses (FGD 6, 2010). In general, the dominance of losses from MIMP actions made villagers believe that researchers did not address local realities, as one respondent from Chole insisted:

“Researchers should report the reality so that we get improvements in our lives. But if researchers come and question us on behalf of government interests only, then we will refuse because it will have no meaning. The fate of citizens should be known through researchers” (I 12, 2010).



### *3.3.2. Conformity to regulations and actors relations*

Officials explained that all Park villages had no problem conforming to regulations, except Jibondo where villagers thought MIMP establishment was just empty rhetoric; were reluctant to change due to low education levels; were influenced by fish traders who facilitated fishing equipments to villagers; and were quarrelsome because most of them were migrants from Lindi, Mtwara and Pemba (I 1, 2009; I 15, 2010). This last point was maintained despite the fact that 97% of respondents at Jibondo mentioned Jibondo as their place of birth.

However, the data shows that participants from Chole also had problems in conforming to MIMP regulations (I 27, 2010). Meanwhile, Jibondo villagers said their non-conformity was due to lack of contextual considerations about local conditions by the current regulations, and the tendency of officials to destroy the integrity of villagers by publicizing Jibondo as a violent and unsuitable place to live in<sup>3</sup>, instead of explaining and addressing their key problems (FGD 2, 2009). Hence, MIMP-villagers relationships had worsened, and in fact, a majority of villagers had better relations with the fish traders who usually provided them with support in the aftermath of confiscation of fishing gears (I 29, 2010).

### *3.4. Adjusting to emerging realities*

#### *3.4.1. Processes and measures*

The process of reviewing the old GMP reflects a major attempt to adjust to changes (URT, 2011). Villagers were engaged and shared their experiences, but these were not actually considered to allow appropriate adjustments for improving their livelihoods. Villagers at Jibondo argued that even their ability to participate in the process was infringed. The District People's Militia Advisor (an Army soldier) represented the District Commissioner in a village meeting, which was perceived as a technique to intimidate villagers from expressing their views. However, they raised 14 reasons to justify their only request: to remove Jibondo from Park villages. The remaining Park villages raised 22 concerns for consideration in the new GMP, of which 19 were unique to each village. The most pressing concern raised by six villages was the request to allow local fishers to use 2 to 2.5 inch pull-nets and a 1.5 inch scoop net. However, the MIMP management dismissed all the villagers' proposals because the issues raised were against the Park regulations. Villagers insisted that democracy occurs

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<sup>3</sup> During this study, the officials also proposed removal of Jibondo village from the list of sampled villages.

only at the top, and if it was at lower levels then their concerns could have been heard (I 10, 2009). This was also experienced by a district official who had this to say:

“District fisheries officers under Ministry of Local Government and Regional Administration are like step children. Our suggestions are not considered during meetings, but MIMP suggestions are considered better. Even when Jibondo leaders spoke the truth they were scolded and told that soldiers will come to them. MIMP should not suppress the emerging arguments but should work on them to establish the truth” (I 45, 2011).

#### *3.4.2. Actors’ expectations and future uncertainty*

As the new GMP missed villagers’ expectations, actors’ expectations remain varied. While officials anticipated to increase environmental education, enforcement of MIMP regulations, new livelihoods and areas under MPAs, and to encourage fishers to sell their catches directly to existing markets (I 1, 2009; I 2, 2009; I 15, 2010), villagers anticipated major changes in MIMP regulations to accommodate adverse social effects, as explained by one villager:

“Regulations are not a holy bible. If regulations have been enacted and proven to be harmful to people, it should be withdrawn. But these regulations haven’t changed since 2000 and we are living in unsettled conditions. There are signs that the ocean is required to be left untouched. Recently, Nyororo and Shungimbili, have been subjected into conservation, which means there will be more pressure in the remaining fishing areas” (FGD 9, 2010).

Furthermore, MIMP officials did not consider tourism as a potential economic option for Jibondo villagers (Written response, 2011), but some participants anticipated engaging in tourism projects. Further expectations were revealed when respondents were asked what should be done to ensure that their voices are heard and they engage in their livelihoods undertakings peacefully, 87% of the respondents gave multiple responses. The most mentioned issues were: MIMP should review zoning and fishing gear restrictions (38%); national officials should visit villagers to discuss and listen to their concerns (28%); and that the Park should be removed (12%). When they were asked what should be done to ensure their voices are heard and that they genuinely participate in managing marine resources, dominant responses were: villagers should manage and protect resources by themselves (29%), MIMP ensures genuine participation in every undertaking (27%), and officials stop forceful beatings and use more dialogue (18%). Other responses are summarized in Table 4.

Table 4: Measures to ensure villagers are heard and engage in livelihoods and resource management

| <b>Actors</b>             | <b>Restoring villagers' ability to be heard and develop</b>   | <b>Re-establishing local engagement within MIMP</b>  |
|---------------------------|---|--|
| <b>Villagers</b>          | Adhere to national fisheries regulations; establish fishers' union to handle concerns; respect Government decisions.  | Report dynamite fishing; promote sustainable fishing; transfer traditional knowledge across generations.   |
| <b>MIMP</b>               | Ensure local produce fetch good prices; provide education, training, loans and efficient fishing equipment; ensure genuine participation in every undertaking; research on pull-net fishing; stop forceful beatings; use more dialogue and wisdom; establish and support non-fishers groups; follow up performance of introduced livelihoods; share (equally) conservation benefits and losses with villagers | Provide training, education, and requested permits on time; close zones temporally; maintain previous agreements, decisions made, and frequent communication with villagers; control undertakings of TANPESCA Ltd. |
| <b>National officials</b> |   | Visit and listen to villagers to know exact situations.  |
| <b>Researchers</b>        | Conduct research  | Bring feedback to villagers  |
| <b>Media</b>              | Publicise villagers' concerns   | Publicize villagers' conditions  |

Source: Field data

### 3.5. Assessing the key problems

#### 3.5.1. Environmental concerns

Park officials explained decreasing fish abundance in fished zones, and destruction of marine habitat using overfishing and degradation narratives. They argued, for example, that availability of a good market for fish, and lack of focus on new livelihoods compelled fishers to increase fishing pressure by using pull-nets (I 1, 2009). They maintained that pull-nets destroyed the environment by damaging coral reefs, dragging the seabed and extracting small sized fish (I 2, 2009). However, district fisheries officials argued that pull-nets are not destructive when operated in deep water, and urged MIMP to research and establish the depth of fishing nets and water depth where these nets were operated (I 45, 2011). The data show that some hoteliers agreed that nets were very destructive on the seabed (I 40, 2011); some said nets had little damage (I 41, 2011). Other hoteliers maintained that nets had no problem,

except with large companies with industrial fishing fleets and processing plants, which were the major cause of marine degradation (I 42, 2011; I 44, 2011).

Some villagers, on the other hand, said the nets were destructive on the seabed (FGD 5, 2009; I 12, 2010; I 20, 2010). Some maintained that nets only destroyed scenery for tourists' enjoyment and photo-taking (I 26, 2010). Some insisted that nets were not destructive when operated in depths between 12-30 meters, where they did not reach the seabed. They argued that each net was installed with about six buoys on the top and small stones at the bottom to keep them vertical and off the seabed. Fishers also dived to ensure that nets were not in contact with the corals to avoid damage and net-mending expenses. They further argued that body pulling energy alone was not enough to destroy hard corals; and that scoop nets were not pulled, but were used to scoop the fish into the boats (FGD 1, 2009; FGD 6, 2010).

Furthermore, data from interviews showed that market availability was inadequate for explaining the increase of pull-net fishing. Most fishers had changed their choices of fishing gears up to seven times in their lifetime but market availability was not the only explanatory reason (Table 5). Despite promises of economic gain in pull-net fishing, some fishers avoided it because they lacked energy, and avoided health complications, patrol-related harassments, and disadvantages of group work, such as low individual income.

**Table 5: Summary of purposes for switching fishing gears and practices among fishers in Chole and Jibondo**

| <b>Drivers of change</b> | <b>Purposes for changing fishing gears</b>  |
|--------------------------|---|
| <b>Decision making</b>   | Learn each practice to guide choice of preferred one  |
| <b>Security</b>          | Switch practices according to social-ecological events as safety mechanism to persist in fishing                            |
| <b>Economy</b>           | Practice chosen is perceived to yield highest return  |
| <b>Health</b>            | Avoid practices (e.g. diving and pulling) that cause muscle tightening, chest pain, ear pressure                            |
| <b>Exhaustion</b>        | Rest by switching to another less strenuous practice  |
| <b>Support</b>           | Switch into another practice to help out family members/elderly   |
| <b>Traditions</b>        | A way of life; start learning elders' practices during childhood then join peers' practices afterwards                      |
| <b>Keeping active</b>    | Opt for the simplest practice as 'a last resort' after lacking alternative activity (following age or health complications) |
| <b>Peace keeping</b>     | Opt for practices that are carried out individually to avoid group-related conflicts  |

|                      |   |
|----------------------|---|
| <b>Responsive</b>    | Switch into a practice temporarily to solve a pressing problem  |
| <b>Compliance</b>    | Opt for a practice that complies with MIMP regulations e.g. basket trap fishing                       |
| <b>Adjustment</b>    | Opt for a practice due to inefficacy of previous practices e.g. set nets catching leaves and dry wood |
| <b>Harmonization</b> | Opt for a practice that is compatible with the type of vessel owned                                   |
| <b>Affordability</b> | Opt a practice that is affordable e.g. basket traps   |

Source: Field data

While villagers also perceived actions by large scale fleets and TANPESCA as destructive to marine environment (FGD 3, 2009), a Tanzania Investment Centre official revealed that the centre placed much emphasis in attracting foreign investment, but lacked adequate control of their undertakings to address resulting environmental challenges because there were no representative offices at the district level (I 39, 2011). Meanwhile, TANPESCA efforts were based on capital accumulation philosophy, which may increase environmental challenges. For example, when explaining how TANPESCA coped with global demand, one official said:

“But I don’t think we will fail because of the scarcity of the materials. For example, this time [June-August] it is high season. So we try to collect as much as we can and have our good stock. So after freezing, our products have 2 years shelf life. So we can store our materials. So after 3, 4 or 5 months we get our order and work on that. So we are trying to get maximum materials, we process it and store it...If they [government] will allow mechanized fishery they will allow us to get more materials” (I 13, 2010).

Efforts by district authorities may also compound environmental challenges in the future because fisheries revenue is the key source of the district’s income. Officials may thus not even consider controlling the number of fishing licences issued. The revenue has increased from TShs 8 million in 2004/2005 to TShs 36 million in 2008/2009 due to increased efficiency in issuing fishing licenses (I 4, 2009).

### 3.5.2. *Poverty, coercion and power asymmetry*

Various officials used poverty narratives to explain poor social conditions. The MIMP and district officials perceived that fishers were poor because they were reluctant to adopt sustainable gears and new livelihoods, did not own fishing equipments, and had ‘mental’ poverty which often led them to use their earnings on alcohol and polyandrous relationships

(I 3, 2009; I 4, 2009). A WWF official pointing to the nature of the people had this to say to explain poverty:

“...We gave up to TSh 30 million to the people but the payments are very slow because they are not aggressive in exploring changes. They are used to be living in poverty. They are satisfied with it and they don't allow to be given a base of change...” (I 6, 2009).

Such dominant narratives also existed among some villagers, but they externalized the reasons for being poor. They said they were poor because fishing was marginalized in the country; failure rates among secondary school leavers were high; traders under-priced local produce and over-priced consumables from the mainland; and that fishers lost rich fishing grounds but lacked meaningful opportunities in marine tourism operations (FGD 2, 2009; I 17, 2010, I 18, 2010). Other factors mentioned were frequent changes in specifications of permitted fishing gear, inadequate attention to villagers' concerns, and lack of a processing factory for agricultural products like oranges (FGD 9, 2010).

Thus, villagers were surprised to see themselves in poverty, despite advancement in tourism and market availability. Hence, they also anticipated that the new GMP would likely amplify their poverty levels. Conservation measures were seen as mainly focused on preserving the environment for sustaining tourism industry and fulfilling global interests, rather than sustaining local livelihoods and reducing local social costs (I 27, 2010; I 28, 2010). Some of the participants' sentiments in both sites are as expressed by these respondents:

“...Their [MIMP] objectives are to preserve fish and kill villagers, who are told to fish far in the open sea, where the buoys are not visible anymore due to strong currents. Now what kind of thought is this that values fish more than humans? They [officials] get shocked when they see a dead sea turtle but they don't see a problem when a person fails to get fish in their meals...” (I 26, 2010).

“... The MIMP is not only oppressing us, who can survive a day with just water, but also the children who depend on us, the future generation...” (FGD 7, 2010).

MIMP patrol boats occasionally rammed onto traditional boats and destroyed their engines (I 37, 2011), which endangered the fishers' lives. The joint patrols between MIMP officials and Tanzania army soldiers were more life threatening, as illustrated by these respondents:

“When soldiers come they don’t ask whether you have fishing licence, they just beat, not only in the ocean but also in homes. They break in and start the beating in front of your wife” (FGD 2, 2009).

“Last time, they [soldiers] came and beat even expectant mothers and the school teacher who fainted afterwards” (I 10, 2009).

“MIMP rangers and soldiers should not focus on scaring us with guns and wanting to sink us into the ocean to kill us. They should take us slowly. They should know that they are chasing us from the ocean but we have no food” (I 11, 2010).

While incidences of environments of violence are evident, officials emphasised without compromise that police and soldiers shall continue to be used to enforce the Park regulations (I 15, 2010). Villagers were surprised that MIMP began to use violent approaches although the marine environment had largely recovered from the effects of dynamite fishing. They were also concerned that what is stipulated as law is not always the truth that is to guide the undertakings of powerful actors, who have multiple abilities to abide with, to enforce and to break rules to safeguard personal and institutional goals while leaving the least powerful helpless. To summarise, a villager in Chole simply said: “...the park is government, and government is politics, and politics is truth and lies” (I 27, 2010).

A district official added that what is allowed or not allowed has become a political rather than a regulatory issue (I 4, 2009). For example, the local MP encouraged the use of prohibited fishing nets to please villagers and win their votes (I 2, 2009; I 4, 2009), but, such encouragement was against the law and led to villagers’ punishment during patrols. Villagers also reported that the factory loaded their products at night to avoid paying tax, and no action was taken (FGD 3, 2009).

By being responsible for enforcing park regulations, MIMP is legally a powerful actor with powers to produce knowledge, ‘truths’, influence decision making and influence villagers’ behaviours in manners which maintain Park’s pursuit for biodiversity conservation. Jibondo villagers were also concerned that powerful actors at district level denied development projects in order to maintain control and force people back into membership of the ruling political party (I 10, 2009). They also stopped outsiders from going to the villages to ensure that villagers’ concerns did not reach the national leaders (I 34, 2011). Meanwhile, unequal

power relations between district and national fisheries officials in current governance structure were other concerns, as explained by a district official here below:

“...There is no formal communication system between the Ministry of Livestock and Fisheries Development and the District Council. Directives from the Ministry can be directly given to the District Council for implementation, but there is no direct communication from the District Council to the Ministry, and there is no involvement in making policies and regulations. For example, the new fisheries policy is almost ready, but I was not involved in anything and I don't know its contents. I will read and implement it when it is out” (I 45, 2011).

#### **4. Discussion**

As it has been observed in the results, the shift to pre-implementation analysis of intended AM programs can minimize failures of AM projects because it provides insights for improvement before attempting the adoption of the AM process full scale. In this study the Park implementation processes were interrogated and subjected to scrutiny in the context of AM principles and the process. The results and the prospects for a successful AM process are in summary discussed below.

##### *4.1. Application of Principles of Adaptive Management in MIMP*

Under normal circumstances experiments should promote learning in AM (Nyberg, 1999). During early implementation of the Park, its strategies reflected experimentation and learning (Torell, 2000). However, research so far indicates inadequate learning on and dissatisfactions in the implementation of such strategies as reported by Walley (2004), Mwaipopo (2008) and Moshy *et al.* (2015), among others. For example, actors' participation, which remains the most popular AM principle known to be practised in MIMP to enhance learning and the ability of management processes to adapt to the changing needs (Torell, 2000; Stringer *et al.*, 2006), remains to be unsatisfactory. Villagers' dissatisfactions to the participatory strategy were in this case higher than those reported by Pomeroy *et al.*, (2004) (60%) and CORDIO (2010) (72%). In fact, participation was somewhat effective during the 1990s than in recent times (Walley, 2004; Benjaminsen and Bryceson, 2012).

Torell (2000) reported previous Park's efforts to obtain new information through monitoring, research and trainings. Frontier Tanzania's five year (2010-2015) project to establish a monitoring program for MIMP (Baker *et al.*, 2013), and various research initiatives still



provide new insights that could be used to improve management. However, as reported by Bryceson *et al.*, (2006) difficulties to obtain actual data from TANPESCA, marginalization of fishers' ecological knowledge (Walley, 2004) and less emphasis put into socio-economic aspects (Mwaipopo, 2008) and socio-economic monitoring are serious concerns for monitoring social-ecological outcomes.

It is thus that, although the data shows a halt of dynamite fishing in the Park resulting into improvement in marine environmental conditions (Benjaminsen and Bryceson, 2012; URT, 2011, and Barker *et al.*, 2013), the actors had mismatched perceptions of Park's progress. Framing of a success narrative among officials, for instance, shows that only 6% of the 65 planned activities in 2000 were not implemented by 2011 and the achievement list is longer (26) than the list of challenges (14) (URT, 2011). It is also argued that the framing masked important local realities. Pomeroy *et al.* (2004) argued, for example, that the basis of assessment through input measures was not indicative of management progress. MIMP progress was not adequately reflected in community development and there was input-output divide whereby MIMP efforts seldom matched achievements. It is further argued that framing success in the context of quantities (including number of activities implemented, students supported and patrols undertaken) masked the quality of success and the urgency to respond to current livelihood problems reflected in a failure narrative existing among villagers and in literature (Mwaipopo, 2008; Benjaminsen and Bryceson 2012; and Moshy *et al.*, 2015).

Results further show mismatched perceptions of conformity and actors' relationship statuses. The views of Chole participants conform to observations by Kincaid *et al.* (2013) on problems of conformity to regulations. Meanwhile, the labelling of Jibondo villagers as quarrelsome was reported by Benjaminsen and Bryceson (2012), and has historical roots. In the German colonial period, for example, the people of Mafia stopped working on coconut plantations when they noticed no social advancements were being made from the enterprise. The Germans instead labelled them as lazy and stubborn.<sup>4</sup>

Such labelling weakened villagers' relations with Park officials, and reduced their chances of interacting with researchers and outsiders, therefore constraining knowledge production,

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<sup>4</sup> Piggott (1941:6), however, disagreed with such labelling, arguing: "As long as they [people of Mafia] are neglected no advance can be expected. They will be regarded as backward and truculent people, which I am convinced is not the case".

learning and actors' participation, which is contrary to AM principles. Furthermore, by extending the 5-year span to 10-year span for GMP review (URT, 2011; Benjaminsen and Bryceson, 2012), the Park also prolonged intervals before making adjustments to emerging realities. This suggests the need for specifying potential ideal time limits between implementation and adjustment in the AM process framework.

Weak applications of participatory approach and inadequate learning from new knowledge are key shortcomings of GMP review process. Although the GMP states that the review process was heavily based on: participatory approach; experiences obtained from implementing the old GMP; and the need to adjust the old GMP 'in order to reflect new issues, lessons learnt, or changes in management objectives, adapting the contents according to new information gained' (URT, 2011: vi), there is little evidence to support these claims. The Marine Parks and Reserves Act of 1994 gives villagers the right to participate in all aspects when developing management plans (URT, 1994). However, the incidences of infringement and lack of consideration of concerns raised during GMP review suggest that the claimed participatory approach resembled a blend of consultative and passive participation (Pimbert and Pretty, 1997). Meanwhile, the latest literature cited in the new GMP dates back to 1999, reflecting a lack of learning from newer information.

As such, the GMP missed current expectations, and displayed measures that were inappropriate for responding to existing challenges and future actors' expectations in view of: worsening MIMP-villagers relationships; hegemonic capitalist market economy; MIMP's focus on environmental concerns; and varied actors' mismatches. Hence, the likelihood of achieving desirable socio-ecological outcomes in the future will depend on *how* the MIMP is committed to take meaningful steps towards influencing policy reforms to provide enabling environment for empowering local people economically.

#### *4.2. Prospects for Adaptive Management Process in the MIMP*

Successful AM process requires a clear understanding of the problem at hand (Allen *et al.*, 2011; Williams 2011) and linkages between local social-ecological systems contexts and other broader systems (Stringer *et al.*, 2006), and high controllability of external influences (Gregory *et al.*, 2006). Assessing the key social-ecological problems can thus provide insightful considerations before adopting the process. However, data from this study shows that the dominance of overfishing, degradation, and poverty narratives among officials in explaining social-ecological concerns was simplistic and could not provide meaningful basis

for establishing detailed contexts of degradation and poverty concerns within the MIMP. It overlooked the effects of local variations of coral cover across the MIMP (Benjaminsen and Bryceson, 2012); decreasing sea water depth and increasing warmer water conditions (Moshy *et al.*, 2015); and the impact of both the colonial and capitalist market economies and investments (Coulson, 2013).

Another important issue at this point was the controversy regarding the use of pull-nets within the MIMP. Data from this study show that the use of pull-nets was, in fact, prohibited even before the old GMP (URT, 2000) phased out. However, even though pull-nets raised environmental concerns for many years, their prohibition was partly because of the observed inconsistency in Park documents. While the GMP and the English version of the Marine Parks Regulations (URT, 2006), permitted use of pull-nets with mesh size of 2.5 inch and above in the general-use zone, the Swahili version of Park regulations (MPRU, Undated), and the new GMP (URT, 2011) prohibited the use of *all* pull-nets within the MIMP ostensibly “following successful development of alternative sustainable fishing gears, Park regulations and National regulations” (URT, 2011:59). Hence by basing enforcement on the Swahili version, MIMP denied the rights of fishers who were using pull-nets with 2.5 inch mesh size.

While learning by doing is central in the AM process (Berkes and Folke, 1998; Cumming *et al.*, 2012), the decision to prohibit pull-nets suggests a dominance of routine-based practices, lack of good intentions by MIMP to learn through research and experiments to settle controversies and make informed decisions about them. It also shows an unwillingness to seriously engage in the commencement of the regulation amendment process. It also distorts the meaning of generating new information in collaboration with researchers and local communities, and thus affecting the future willingness of villagers to involve in meaningful creation of new knowledge.

Without clearing up the pull-nets controversies through research, several questions remain unanswered scientifically. For example, if pull-nets and scoop nets were destructive, why had the catch within MIMP increased from 1,394 tonnes in 2002 to 3,854 tonnes in 2009 (URT, 2011)? Secondly, if the nets were kept off the seabed, why did the nets get torn badly? Thirdly, if pull-nets were destructive by having small mesh size, how come ring nets and fence traps were legally allowed despite having smaller mesh sizes? And, finally, if pull-nets accounted for 70% of the total catch within MIMP, was the catch increase really a success from halting dynamite fishing (URT, 2011) or a result of increased fishing depth (Moshy *et al.*

*al.*, 2015)? The decision to prohibit pull-nets could have been more appropriate if catch trends showed a decrease. Without establishing through research the exact depth where fishing was done, how the nets were operated and what exact damages did occur, these questions remain answered.

Meanwhile, market availability per-se was inadequate for explaining overfishing, dominance of pull-nets or choice of fishing gear. While Tanzania pays less attention to monitor investors' operations, investors concentrate on capital accumulation processes that are inimical to environmental sustainability, and can shift investments elsewhere after degrading the current areas (Berkes *et al.*, 2006; Benjaminsen and Bryceson, 2012; Gagern *et al.*, 2013). TANPESCA operations have been proven to be harmful to the environment and social wellbeing of local communities (Beymer-Farris *et al.*, 2012). They have also been reluctant to provide catch collection data such that there has been no full control of what is collected. As such, efforts to retain some elements of State intervention is imperative for ensuring monitoring and right pricing of fishery catches (Jones *et al.*, 2013).

The fishers' perceptions of their marginalization and poverty relate to broader economic, social and political marginalization at the national scale. Marginalization of the fishery sector in Tanzania began during the colonial times when government focused on the agricultural sector, with copra production dominating in Mafia Island. In fact, there was no fisheries staff in the British colonial Tanganyika until 1939 when the first officer was stationed at Lake Rukwa (Hickling, 1949). The visit by the Fishery Advisor in 1946 to examine possibilities for fisheries development in Tanganyika did not even mention Mafia as an intervention area (Revingtone, 1936; Piggott, 1941; Hickling, 1949).

After independence in 1961, Tanganyika maintained the colonial focus on agriculture-led economic growth until the 1990s, when the market economy was adopted, with tourism and mining sectors as leading contributors of economic growth (Coulson, 2013). Following global demands for large land-based investments for food and biofuel production, and national needs to modernise agriculture, Tanzania has renewed her focus on agriculture (Coulson, 2013)<sup>5</sup>.

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<sup>5</sup> For example, through the *Kilimo Kwanza* (Agriculture First) policy since 2009.

Meanwhile, the fishery sector was never developed into a full-fledged Ministry like in other countries (e.g. Kenya, Namibia, Mozambique, Ghana, Somalia, Norway and Canada), but has shifted six times as an appendage of other ministries. For example, since 2008 the sector was placed under the Ministry of Livestock and Fisheries Development where it remains largely marginalised despite having higher contributions than those from the livestock sector. The Ministry's website ([www.mifugouvuvi.co.tz](http://www.mifugouvuvi.co.tz)) is also dominated by livestock information and by March 2014 only 1.4% of the ministerial publications related to fisheries. Furthermore, revenue from freshwater fishery remains significantly higher than marine fishery, reflecting the persistence of the colonial development pathways.

Colonial administration of Mafia also created other forms of marginalization that have had an influence on peoples' poverty today. For example, since the 16<sup>th</sup> century and throughout the periods of German and British colonialism, Mafia Island had been mostly administered from Kilwa, Zanzibar, Rufiji and Dar es Salaam with little advancements being made at the local level (Piggott, 1941). Thus, Mafia has since remained among the poorest districts in the country. Meanwhile, the likelihood of fishers to become rich by fishing in controlled areas; allocating fishing efforts appropriately; and obtaining 'lucky catch', as argued by Gordon (1954:132) remain a pipe dream.

Apart from this unfortunate colonial legacy, dominance of values from certain disciplines is also among the causes of failure in AM programmes (Walters, 1997). The overlooked socio-economic goals and the tendency of describing the marine environment which is surrounded by resource-dependent communities as 'relatively pristine' (URT, 2011:11), for example, demonstrate the dominance of conservation biology in Park management implementation. Conservation biology seldom accommodates sustainable development concerns, excludes human agency from conception of the ecosystem, and depicts humans as destructive agencies of nature (Gordon, 1954; Lee, 1999; Adams and Hutton, 2007). Hence, the Park's efforts have mainly been geared towards safeguarding biodiversity conservation. The importance of actors' collaborations in integrating interdisciplinary knowledge and experiences in AM programs as envisaged by authors like Walters (1997), Pomeroy *et al.* (2004), Stringer *et al.* (2006), and Williams (2011) has yet been able to achieve real success in bridging interdisciplinary gaps. Social concerns remain unattended and conservation practices are becoming more protective, authoritative and violent (Benjaminsen and Bryceson, 2012).

Specifically, concerns with violent patrols suggest use of double standards in the interpretation of law. Despite claims to reject villagers' proposed adjustments for being inconsistent with Park Regulations,<sup>6</sup> the MIMP leadership has been undertaking unlawful actions at odds with both Park regulations and the Constitution of the United Republic of Tanzania (1977). According to the supreme law Article 13 (6), subsection (c) and (d), no person shall be treated as guilty until proven guilty. It further stipulates that neither shall a person be tortured, punished or subjected to inhuman or degraded treatment. Hence, violent actions were contrary to this stipulation and adaptive approach logic; reflecting extension of state control in making villagers support conservation. Powerful actors acted jointly to safeguard regulations and pursue conservation interests while the least powerful were subjected to coercion and poverty. Lack of flexibility to modify regulations dominated partly because practices of governing natural resources treat regulations as complete projects for the populace to abide by, simplifies complex phenomenon to process, and focuses on the techniques to exercise state power (Scott, 1998; Rutherford, 2007). Hence, further research to justify the need for legislation changes will likely be unfruitful unless there is political will to do so (Walters, 1997).

Power imbalances among actors can minimize potentials for democratic management and success in AM (Pomeroy *et al.*, 2004; Stringer *et al.*, 2006; Allen and Gunderson, 2011). By leaving political figures unaccountable for their actions during political campaigns and by only punishing villagers who have been misled by them, MIMP allows powerful political figures to pursue their political ends without accountability. Most Park strategies are centred towards controlling the actions of villagers while little attention is paid to the actions of powerful actors and external factors which actually influence villagers' actions. Meanwhile, the gap between policy makers and implementers not only demonstrates power imbalances among officials, but it also shows lack of experience-based policy formulation.

#### *4.2.1. Designing the appropriate strategies for adaptive management process*

Performance of AM is likely to improve when decision makers stop perceiving it as a threat to existing conservation values and legislations (Walters, 1997); management decisions are agreed among actors based on changing resource status (Williams, 2011); and current shortcomings are embraced as opportunities for institutional learning for improving

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<sup>6</sup> Also given the inconsistencies between the English and Swahili versions of the Regulations,

management strategies and actions without suppressing surprises from social-ecological factors (Walters and Hilborn, 1978; Allen and Gunderson, 2011; Ban *et al.*, 2012; Cumming *et al.*, 2012). Hence, the Park will likely succeed to adopt AM process if social-ecological outcomes of its implementation are seriously considered without ignoring surprises from unintended socio-economic outcomes. The increasing poor socio-economic conditions among Park residents in the villages of Chole and Jibondo (Moshy *et al.*, 2015) suggest that the existing Park strategies were not necessarily the best management options.

As such, designing strategies that are appropriate for addressing the emerging concerns and the requirements for AM process remains crucial. Strategies that will foster flexibility of various national policies, harmonization of social-ecological indicators for monitoring to enhance common understanding of issues among actors (Stringer *et al.*, 2006), are likely to reduce uncertainty. Moreover, genuine actors' participation and application of new knowledge in decision making, consistency in interpretation and enforcement of regulations, and timely adjustments and response to surprise from unexpected outcomes, will surely improve the prospects for AM process in the Park.

## **5. Conclusions**

Understanding the difficulties of realizing promises of AM on the ground offers substantial room for improvement. Using Mafia Island Marine Park as a case, this paper has illustrated how AM-based pre-analysis of potential AM projects can reduce failures of AM projects by providing insightful concerns for consideration before adopting the full process of AM. By applying AM principles, the Park demonstrates chances for adopting the process but the manners of their application can undermine its own ability to embark into a successful AM process. Consequently, existing mismatched perceptions among actors, simplistic conceptualization of key problems, dominance of routine-based practices and coercion, double standards in the interpretation of law, complex set of unattended outcomes, and inappropriate plans to deal with uncertain futures are likely to impede any intention to embark into AM process. Hence, failures of AM programmes are likely created before such programmes even begin.

Potential failures of AM lie within failure to adequately analyse spatial and temporal interrelationships between environment, society and political economic conditions. By delaying the making of informed and adaptive decisions to shift into more appropriate management actions, MIMP magnifies the severity of concerns and increases the likelihood

of failure of prospects for future AM endeavours. Clearest indications of this are the failures to address deteriorating livelihood conditions and maintain genuine participation without coercion, and failure of the 2011-2021 GMP to reflect adjustment of conservation strategies as a response to lessons learnt during the implementation of the 2000-2010 GMP, and by ignoring feedback during its review process.

The MIMP case reveals an inert management body with conventional scientific and fortress approaches that prevent potentials of AM opportunities. The challenge here is how to influence appropriate changes in the national policies and regulations to allow meaningful changes at Park level. Such changes are seriously needed as an adaptive measure for enhancing cross-scale capacity to oversee global-driven conservation-development programs, and foreign investments undertakings; ensure legal grounds provide enabling environment for improving socio-economic wellbeing, and to allow flexibility that enhances the ability of conservation actors to respond to outcomes in relation to their underlying problems and anticipated surprises. These can increase the viability of transitions of conservation efforts into a successful AM process.

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APPENDIX 1: Field photographs



Figure 1: Fence traps at Chole



Figure 2: Fence-trap fishing at Chole



Figure 3: Shark net mending and construction of basket trap at Jibondo



Figure 4: Confiscated fishing vessels and nets at MIMP Office



Figure 5: Fish catch collection at Jibondo



Figure 6: Octopus catch collection at Jibondo





Figure 7: Sun-drying fish at Jibondo



Figure 8: Free livestock grazing at Jibondo



Figure 9: Fenced farming plot, and patches of coral rag at Jibondo



Figure 10: Fenced garden around homesteads at Jibondo



Figure 11: Fenced lemon tree around homestead at Jibondo



Figure 12: Fenced garden around homesteads at Jibondo





Figure 13: Coconut farming at Jibondo



Figure 14: Fenced coconut tree around homestead at Jibondo



Figure 15: Rainwater harvesting infrastructure at Jibondo



Figure 16: Worn out infrastructure at Jibondo that produce rusted water, unsuitable for human consumption



Figure 17: Water fetching at Utende



Figure 18: Empty water reservoir at Jibondo





Figure 19: Pottery making at Jibondo



Figure 20: Fuel reserve for pottery making. Preparations for rainy season



Figure 21: Banana leaves fence at Chole



Figure 22: Boat making at Chole



Figure 23: Fruit bats at Chole



Figure 24: Seaweed collection at Jibondo



