

# **Understanding Fast and Slow Variables as a Means to Effectively Manage Implications of Rapid Change in Karimunjawa National Park, Indonesia**

by

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## **AUTHOR'S DECLARATION**

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## ABSTRACT

This research examined social-ecological regime shifts (SERS), in Karimunjawa National Park, in Indonesia, which is home to primarily small-scale fishers. This study largely followed a conceptual understanding of critical slow variables that are often formed over multiple years within a complex social-ecological system. Such slow forming variables including wealth and infrastructure, and fish biomass and biodiversity are important because they determine system functions and interact with fast variables such as local income and fishing efforts to form feedback interactions. Frequent system changes amongst fast variables can cause unpredictable and irreversible change in slow variables, that usually take years and decades to manifest. Local coastal communities are often forced to adapt to ecological changes when the continuity of their natural resource dependent livelihoods, that are extractive and exploitive, is deemed unsustainable. This research used a qualitative and inductive approach, to understand interactions among fast and slow variables to determine any indications of a social-ecological regime shift. Data collection methods included semi-structured interviews with key informants (n=60), surveys (n=27), and focus groups. The main objectives that guided this research are: 1) examining fast and slow changing variables within the social and ecological subsystems of Karimunjawa National Park in order to understand the phenomenon of rapid change; 2) identifying local responses to social-ecological change in order to assess local adaptive capacity; and 3) determining governance implications associated with the interactions and outcomes of fast and critical slow variables in Karimunjawa National Park. The results indicated that understanding feedback interactions amongst fast and slow variables can provide insights on dual directionality of drivers of change with implications on targeted management of critical slow variables. In a social-ecological system, local autonomy and empowerment with appropriate monitoring efforts can be found to enhance the management of slow forming variables and foster resilience.

**Keywords:** adaptive capacity, adaptive management, fast variables, feedback interaction, social-ecological regime shift, social-ecological systems, slow variables, vulnerability

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# Chapter 1

## Introduction

### 1.1 Background

Coastal changes such as sea level rise and increasing populations have accelerated globally in the past century (Ferrara et al., 2016; Chapin et al., 2006). Concepts such as social-ecological systems and regime shifts are emerging in natural resource management literature to help understand the implications of these changes (Bennett et al., 2016; Sugiarto et al., 2015; Pollnac et al., 2010). We are now in what can be described as the Anthropocene (Folke et al., 2010), in which humans and the natural world are connected, and rate of development in coastal communities has been unprecedented. Human activities are increasingly impacting ecological subsystems and are causing fundamental shifts in their structures and functions (Kittinger et al., 2012).

Coastal communities are often considered marginalized and vulnerable due to their heavy dependence on ecological services such as biodiversity and fish abundance (Bennett et al., 2016; Walker et al., 2012). Resource dependency in the context of coastal communities is especially complex due to the high natural productivity of tropical coastal ecosystems (Bailey and Pomeroy, 1996). Local coastal communities are often forced to adapt to ecological changes when the continuity of their natural resource dependent livelihoods, that are extractive and exploitive, is deemed unsustainable. Adaptation can take on many forms and is dependent on factors such as individual skills, allocation of available resources, and individual preferences.

Like many coastal states, Indonesia is also currently facing the impacts of rising anthropogenic activities, creating a need to protect and conserve marine resources (Bennett et al., 2016). Indonesia is home to seven marine national parks, established for maintaining functions of protecting life support systems, preserving diversity of plant and animal species, as well as the sustainable use of biological natural resources and their ecosystems. One of these seven marine national parks is Karimunjawa National Park (KNP), which belongs to the sub-district of Karimunjawa Regency of Jepara Central, Java Province, and serves as the study location for this research. The prominent means

for livelihoods for the communities living in Karimunjawa National Park consist of fishing and farming. With constantly rising populations and limited livelihood options available, the dependence on open access to fisheries and coastal marine resources is on the rise (Campbell et al., 2012). It is important for the ecosystem managers to be able to first identify the changes and then take action either to prevent further change, or support the social-ecological system transition into a new state with as little negative impacts as possible.

A suitable course of action, to manage and respond to change, requires a clear understanding of levels and scales of ongoing change. One way of forming an understanding of change at various levels is by identifying and distinguishing between slow forming, and fast changing variables within a social-ecological system. Slow variables are usually a limited number of controlling variables that tend to remain constant over multiple years to decades, and are critical in determining the pathways of the fast variables within a system (Walker et al., 2012; Crépin, 2007; Chapin et al., 2006). Examples of slow or controlling variables include fish biomass and biodiversity, and culture, norms, and long standing institutions.

Fast variables can be defined as variables within a system that is of primary concern to ecosystem users such as income generated from fish resources (Walker et al., 2012). These variables form a feedback loop along with the institutional responses that pave the way to rapid change in a social-ecological system (Crépin, 2007; Chapin et al., 2006). With human actors at the center of this system combining ecological and social subsystems, it is important to identify patterns in adaptive responses that could potentially lead to further changes within a system. Slow variables often form the parameters in which an ecosystem is studied, however immediate and ongoing management efforts often focus on more visible and fast variables (Carpenter et al., 2001).

One such management effort often used around the world to manage fisheries and marine resources is the use of Marine Protected Areas (MPA). Karimunjawa National Park was officially declared as a Marine Protected Area to preserve its biodiversity and fish stocks in 2001. Dudley (2008) defines an MPA as “a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and

cultural values”. The purpose of an MPA as described by the Indonesian Ministry of Marine Affairs and Fisheries (MOMAF) is to “protect, preserve, and utilize fish resources, including the ecosystems, types, and genetics to ensure the existence, availability, and continuity by maintaining and increasing of quality of value and variety of fish resources” (2004). MPAs are seldom fully accepted by the local communities who depend on the resources such as fisheries, for their livelihoods sometimes creating issues in terms of equity and justice (McClanahan et al., 2006). This thesis aims to use an understanding of critical slow variables, and its complex feedback interactions with fast variables, to respond to any ongoing social-ecological changes.

## **1.2 Problem Statement and Research Objectives**

This study focuses on identifying ongoing change on various scales, from a lens of social-ecological systems, and its implications on local adaptive responses and governance. Specifically, this research uses Karimunjawa National Park as a case study to identify change, local adaptive responses, and examine the importance of identifying critical slow variables in governing rapid change. The following objectives guide this research:

- 1) To examine fast and slow changing variables within the social and ecological subsystems of Karimunjawa National Park in order to understand the phenomenon of rapid change;
- 2) To identify local responses to social-ecological change in order to assess local adaptive capacity; and
- 3) To determine governance implications associated with the interactions and outcomes of fast and critical slow variables in Karimunjawa National Park.

In coastal communities there are “slow” variables such as fish biomass and biodiversity, or distinct cultures affiliated with fisheries that are formed and change over a large temporal and spatial scale (Crépin, 2007). Slow forming variables are also sometimes referred to as “controlling” variable, as any change or shift in these variables can potentially trigger irreversible changes within a social-ecological system (Ferrara et al., 2016). “Fast” variables within a system such as household income have a capacity to fluctuate more often than the slow variables. Fast variables are formed and change over a

short temporal and spatial scale and are often dependent on the slow variables (Crépin, 2007).

Any persistent changes in the fast variables cause patterns of disruption and reorganizing amongst the slow variables, for example changes in local income could affect the slow forming culture and institutions (Armitage and Johnson, 2006). This relationship between fast and slow variables using a social-ecological systems perspective is limited in current literature (Bennett et al., 2016; Sugiarto et al., 2015). A focus on feedback interactions within the social-ecological system of Karimunjawa could lead to information regarding anticipation of rapid, irreversible change. Furthermore, exploring the adaptive capacity and policy implications of understanding crucial slow variables could lead to insights on effectively responding to any ongoing change.

### **1.3 Literature Review**

Relevant areas of literature are discussed in chapters 3 to 5. This section includes a synthesis of all relevant literature, in order to justify a conceptual understanding used in this thesis. The three areas of literature that guide this thesis are stated as following:

- 1) Social-Ecological Regime Shifts and rapid change;
- 2) Vulnerability, adaptive capacity, and resilience;
- 3) Adaptive governance and role of policy.

#### **1.3.1 Understanding Social-Ecological Systems**

Social-ecological systems are comprised of biophysical systems and human societies interconnected in a two-way feedback relationship (Berkes, 2012). To understand the context within which potential changes are taking place, an understanding of social-ecological systems is used (Chapin et al., 2006). A social-ecological system can be defined as ‘a coupled human-environment system; a multi-scale pattern of resource use around which humans have organized themselves in a particular social structure (distribution of people, resource management, consumption patterns, and associated norms and rules)’ (Briassoulis, 2015). Table 1.1 lists key features that define social-ecological systems.

Table 0.1 Key features defining social-ecological systems	
SES Key Feature	Description
Subsystems	Social-ecological systems consist of coupled social and ecological subsystems that exist in an interactive, interdependent, and self-organizing manner (Virapongse et al., 2016)
Complex linkages	The role that human actors play in responding to changes and variability within a SES that could potentially lead to multiple possible outcomes is one reason for why a SES can be described as a complex system (Kittinger et al., 2012; McGinnis and Ostrom, 2014; Ferrara et al., 2016).
Nestedness	Social-ecological systems are structured in a way wherein hierarchal arrangements oversee all interactions. Various political and cultural forces within a SES influence institutions and management of ecological resources. (Nayak and Armitage, 2018).
Feedback	Social and ecological subsystems interact in feedbacks that either keeps the SES within certain thresholds, or with persistent and drastic changes transform the system into new regimes. Other important factors that impact feedbacks include the occurrence of a legacy effects and potential time lags between impact and responses within a SES (Chapin et al., 2006).
Levels and Scales	One important aspect of a social-ecological system is its recognition of changes taking place at various levels and scales, allowing multiple levels of analysis and possible realities (Nayak and Armitage, 2018).
Drivers of change	Social-ecological systems have many drivers that interact in different ways causing a wide array of sometimes-unpredictable impacts creating uncertain system dynamics (McGinnis and Ostrom, 2014). These drivers can be natural or human-induced and cause direct or indirect change (MEA 2003, 2005).

A social-ecological system is highly interdependent and self-organizing (Levin, 1999). Social and ecological subsystems are linked in a mutual feedback that holds the system in a constantly changing state. One implication of this interactive nature is that both social and ecological processes define the nature of changes. A shift in ecological dynamics could lead to a change in its corresponding social subsystem and vice versa (Nayak, 2014). Social and ecological subsystems interact in feedbacks that either maintains the SES within certain thresholds, or with persistent and drastic changes transform the system into new regimes (Miller et al., 2012). Other important factors that impact feedback interactions include the occurrence of a legacy effects and potential time lags between impact and responses within a SES. Acknowledging the interactions on various spatial and temporal scales play an important role in understanding the attributes that makes up a social-ecological system.



To understand and respond to any changes, it is better to analyze a social-ecological system as a coupled system rather than two separate systems (Ludwig et al., 2001; Westley et al., 2002; Nayak, 2014). Responding to change effectively, involves understanding or acknowledging the drivers and impacts of change on various levels and scales (Davidson, 2010; Ferrara et al., 2016). Drivers of change interact in different ways causing a wide array of sometimes-unpredictable impacts creating uncertain system dynamics (McGinnis and Ostrom, 2014). These drivers can be natural or human-induced and cause direct or indirect change (MEA 2003, 2005).

The first literature area used for this thesis builds on the understanding that social and ecological subsystems are interconnected, and that separation or isolation of the two subsystems is arbitrary (Berkes et al., 2006). The focus dives deeper into rapid changes and the six dimensions of Social-Ecological Regime Shifts as identified by Nayak and Armitage (2018). The six dimensions provide an organized structure for understanding change and potential points of intervention, and include differentiating drivers, levels and scale, equity and social justice concerns, power dynamics and politics, social-ecological units or context of regime shift, and governance to navigate regime shift.

The second literature area comprising of vulnerability, adaptive capacity, and resilience allows for a specific focus on the social subsystem's capacity to respond to, or deal with change given its available resources. Adaptive capacity of the local communities often depends on factors such as response diversity, collaborative capacity, connectivity, reserves, and learning capacity (Kerner and Thomas, 2014). It is based on this adaptive capacity that a system can either foster resilience or push boundaries and transform into another stable state.

The third literature area comprises of understanding adaptive governance and understanding the role of policy in responding to any identified changes in Karimunjawa National Park. There is dispersed discussion on politics (power relations between private actors), and polity (forms of governance identified in community, associations, and networks) throughout this thesis. However, there is a focused discussion on the third realm of governance, namely policy (Treib et al., 2007) (Chapter 5). The three literature topics help form a flow of logic and discussion throughout this thesis (Figure 1.1).

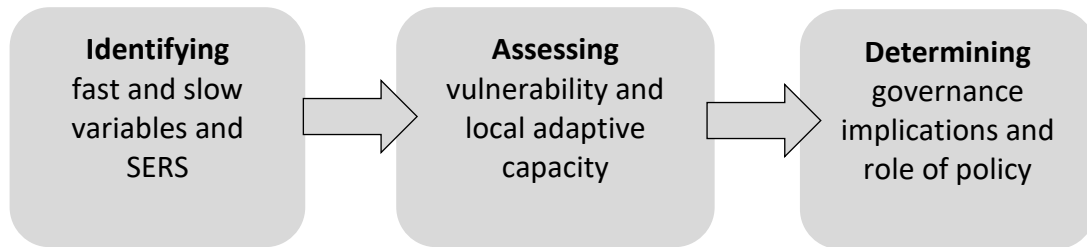


Figure 0.1 Framework representing the flow of logic and discussion followed for this thesis

## 1.4 Study Area

This descriptive qualitative research uses a case study approach to study any potential changes taking place in the social-ecological system of Karimunjawa. Established in 1991, Karimunjawa National Park is home to various marine and coastal resources and is managed by the Karimunjawa National Park Authority (KNPA). It is situated 120 km north of Semarang in Central Java, Indonesia (Figure 1.2). Karimunjawa National Park is made up of 27 islands out of which 22 are located within the national park covering an area of 111,625 ha (Figure 1.3). Within Karimunjawa National Park, five islands are inhabited namely, Karimunjawa, Kemujan, Parang, Genting, and Nyamuk. The National Park can be reached by air as well as by sea from ports in Semarang or Jepara. Since the latest amendments to the zonation, there are nine zones within Karimunjawa National Park as listed below (BTNKJ, 2017):

1. Core Zone (444,629 Ha);
2. Jungle Zone (1.451,767 Ha);
3. Maritime Protection Zone (2.599,770 Ha);
4. Land Use Zones (55,933 Ha);
5. Maritime Tourism Utilization Zone (2.733,735 Ha);
6. Maritime Cultivation Zone (1.370,729 Ha);
7. Zones of Religion, Culture and History (859 Ha);
8. Rehabilitation Zone (68,329 Ha);
9. Traditional Fishing Zones (102.899,249 Ha).



Figure 0.2 Location of Karimunjawa National Park on a map of Indonesia zoomed in to depict zoning in boundaries in the following map.

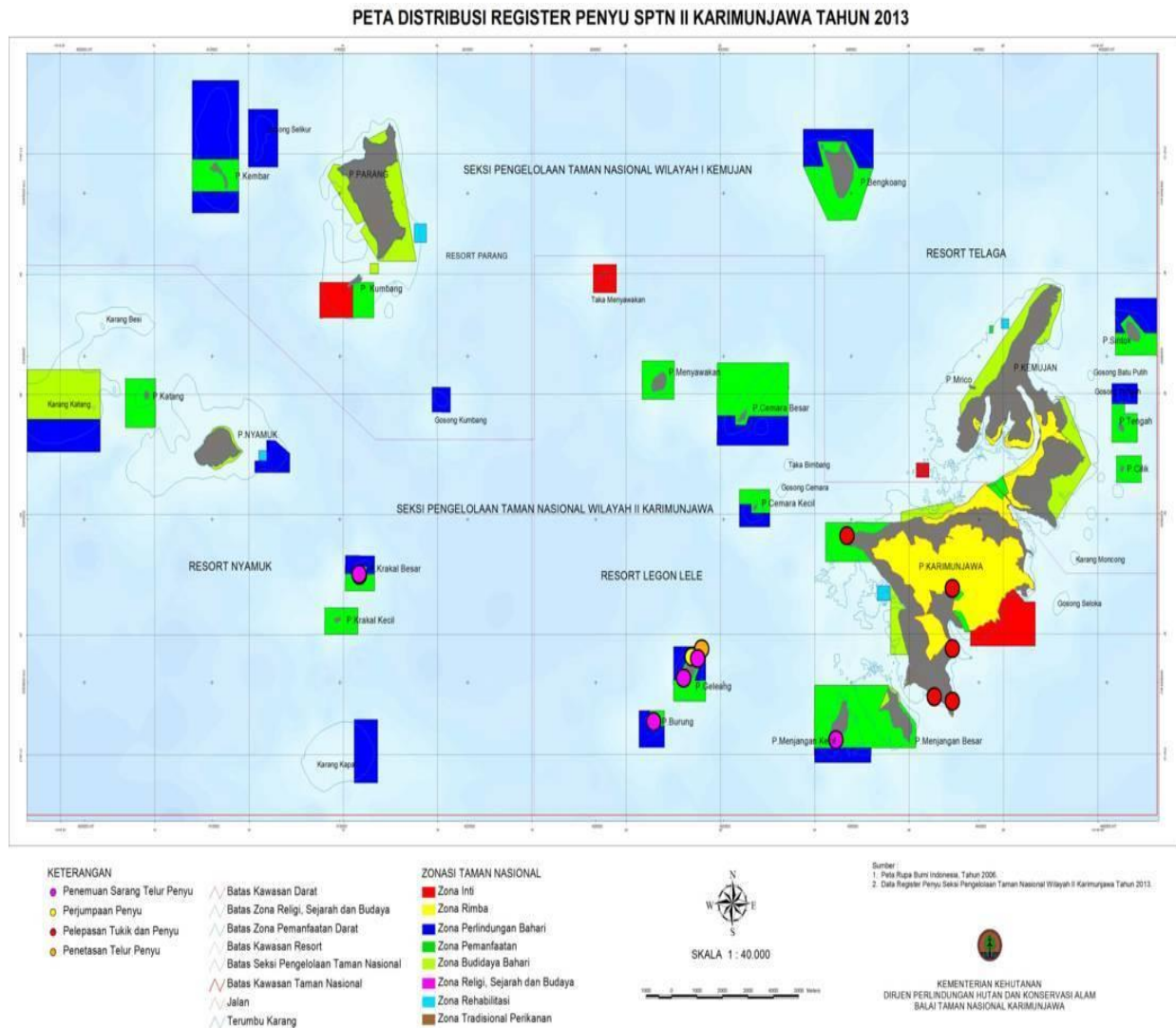


Figure 0.3 Map of Karimunjawa National Park depicting zoning in boundaries

Marine and coastal ecosystems in Karimunjawa National Park can be categorized under the following categories: coral reef, sea grass and seaweed, mangrove forest, coastal forest and low land tropical rainforest, open and deep sea (Yulianto et al., 2010). These ecosystems are rich in services that sustain communities and provide them a mean of livelihoods. The core zone is designated for the protection of ecosystems, and preservation of the unique flora and fauna and their habitats. Activities permitted are limited to protection and security activities, inventory and monitoring purposes, research and development of science, and support for cultivation. The “jungle zone” and “maritime protection zone” serves purposes like that of the core zone, in addition to tolerance for limited ecotourism, and utilization of environmental services. Land use zones and maritime tourism utilization zones were developed for the sake of tourism activities both marine and other ecotourism.

It also supports other activities such as utilization of environmental services, education, research and development. These zones allow for construction of facilities and infrastructure for management and potential tourist attractions. Maritime cultivation zone supports the interests of aquaculture such as seaweed cultivation, floating net cages etc. by the local communities while also focusing on the conservation aspects. Zones of Religion, Culture and History intend to protect the values of the work of culture, history, archeology, and religion, as a vehicle for research, education and natural tourism in history, archeology, and religion. The rehabilitation zone is designated or restoring the condition of coral reef ecosystems that have suffered damage ( $\geq 75\%$ ). The traditional fishing zone is designated for fishing purposes, as fishing practices using sustainable, environmentally friendly fishing techniques has been going on for generations.

#### **1.4.1 Defining Karimunjawa National Park as a Complex Social-Ecological System**

One of the key features of social-ecological systems is the linkage between the human systems and the environmental/ biophysical system (Table 1.1). Marine and coastal ecosystem within Karimunjawa National Park can be categorized under the following categories: coral reef ecosystems, sea grass ecosystems, mangrove forests, coastal forests, and low land tropical rainforests (BTNKJ, 2017; Yulianto et al., 2010). Local communities depend on these ecosystems for their livelihoods. Primary means of

livelihood for the people of Karimunjawa National Park includes, fishing, farming, seaweed cultivation and opportunities in tourism (BTNKJ, 2017). There have been documented impacts of human activities on the ecosystem functions especially in the realm of fish biomass, and coral reef and shallow water ecosystems (Kerner and Thomas, 2014). Activities including harvesting coral and excessive use of destructive fishing methods such as potassium bombs are examples of human activities impacting the ecological subsystem (Setiawan et al., 2017).

The local communities of Karimunjawa have organized themselves in a particular social structure based on their interactions with the ecosystems. The local communities of Karimunjawa work within a hierarchy of power and status earned either through success within their means of livelihood denoted by higher than average income, or political status within the community. One informant stated that “*the amount of fish a person catches is dependent on each person’s luck and fortune, and whoever catches the most fish is the king of the community and his opinion matters the most*”. There is a strong sense of identity amongst the communities as most informants identified themselves as fishers even if they were working as full time tour guides at the time of the interviews. Religion, traditions, and culture play an important role as it defines and guides the changes in livelihood and growth in tourism within Karimunjawa National Park. The growing tourism sector is also heavily reliant on the ecological systems in the form of need for pristine beaches, and availability of coral and fisheries to support marine tourism. The ecological and social subsystems are highly interconnected within Karimunjawa National Park.

Another important attribute of a SES is its “nestedness” and hierarchal arrangements that influence all interactions. Political and cultural forces within a SES influence institutions and management of coastal marine resources. Local livelihoods and perception also play an important role in the outcome of the local institutions (Levine et al., 2015). Within the SES of Karimunjawa, natural resource management actors are connected both horizontally and vertically, hence being connected in a form of a nested enterprise (Plummer et al., 2012). Vertical linkages exist in the form of various jurisdictional levels of management. There are four hierarchies of governance claiming authority of marine resources: national, provincial, district, and city. Local and provincial

governments are responsible for managing coastal resources and enforcing regulations, administrative affairs, participation in security and sovereignty (within their jurisdiction). The province itself holds authority over cross-jurisdictional districts (Wever et al., 2012).

The Karimunjawa National Park Office is a technical implementation unit under the Ministry of Forestry that has the main task of carrying out national park ecosystem management. Karimunjawa in the context of conservation of biological natural resources and their ecosystems is based on applicable laws and regulations. The range of area management activities includes protection, preservation, and utilization. The management effort needs to be distributed to regional stakeholders both related institutions and the wider community. Under the Minister of Forestry Regulation No. P.03 / Menhut-II / 2007, functions of Karimunjawa National Park Office are:

- 1) Zoning arrangement, compilation of activity reports, monitoring and evaluation of national park management,
2. Management of national parks,
3. Investigation, protection, and security of national park areas,
4. Control of forest fires,
5. Promotion, information on the conservation of the living natural resources and its ecosystem,
6. Developing the development of natural love and counseling on resource conservation the natural world and its ecosystem,
7. Cooperation in the development of conservation of biological natural resources and its ecosystem and the development of partnerships,
8. Empowering communities around the national park area,
9. Development and utilization of environmental services and natural tourism,
10. Implementation of administrative and household affairs.

There are also horizontal linkages present within this system in the form of connected communities and villages (Cox et al., 2010). There are associations and local community members in leadership roles such as area heads and small area heads that are often used as a means of disseminating new information.

An important attribute of social-ecological systems is the feedback interaction that takes place between the social and ecological subsystems. The interaction between the

local communities (including natural resource users and managers) and the functions of ecosystems forms a two-way feedback relationship that fosters a self-organizing tendency within a social-ecological system (McGinnis and Ostrom, 2014; Walker et al., 2004). An understanding of feedback interactions often leads to an insight on understanding slow variables that defines a SES (Chapin et al., 2006). The responses and interactions within this feedback cycle affect the scope, intensity, and nature of change. Given this feedback effect, the linkages between social and ecological system are dynamic and hence, the SES of Karimunjawa National Park is best viewed as a complex system (Armitage et al., 2012).

The interactions between different variables and social and ecological subsystems take place on varying scales and levels, which is another important attribute of a social-ecological system, that adds to the complexity within the system (Chapin et al., 2006; Berkes, 2012). For example, the small-scale fishers of Karimunjawa are highly dependent on the fisheries, however given the ongoing competition with the regional fishers of Jepara and Semarang, who possess sophisticated fishing equipment, the local communities are at a disadvantage. In response, the local communities, resort to increased efforts in fisheries leading to a further decline in fish biomass. One of the informants mentioned, *“fishers’ behavior is competitive. The motivation to catch more and more fish becomes bigger as other fishers with more fish are seen as competition”*. Added complexity became more prevalent as Karimunjawa National Park was established as a Marine Protected Area (MPA) in 2001. The Indonesian government used this approach of establishing an MPA as means to facilitate recovery of fisheries and stabilize reef ecosystem. However due to the lack of focus on livelihood management efforts and heavy focus on restricting access to resource, the MPA was not as successful as anticipated. This display of misunderstanding is one of many points of interaction that adds to the uncertain nature of a SES (McClanahan et al., 2006).

Understanding feedback interactions as one of the attributes of social-ecological systems, allows for a focus on managing underlying slow variables such as infrastructure and wealth. Focusing on controlling slow variables could potentially lead to poverty reduction and effective resource management. Lack of intervention in regard to issues such as poverty reduction, could lead to mismanagement or “quick fixes”, that interact in

a feedback with other components of a system to create ongoing change over a larger temporal scale.

An example of when Karimunjawa successfully managed an aspect of slow variable is in the form of increased socialization and awareness efforts towards educating the local people on the importance of preserving and appropriately managing the functions of Karimunjawa's mangrove ecosystems (BTNKJ, 2017). The socialization took place after Karimunjawa was established as an MPA to raise awareness and inform local communities about the importance of conservation. The local communities had been using mangroves that also served as breeding grounds for fish to build fish traps. After socialization, the local communities understood the value of protecting the mangroves and hence slowly altered their resource use patterns. One informant stated that, *“after Karimunjawa became a National Park and the community members received socialization and education on the importance of mangroves, we stopped setting up fish traps there and the overall condition of the mangroves improved”*.

Identifying a limited number of crucial slow variables within a SES is challenging. However, it is possible to identify such variables based on previous studies conducted within coastal social-ecological systems and based on identifying changes as understood and experienced by the local communities. Exploring such changes leads to insights on variables such as distribution of people, resource management, consumption patterns, and associated norms and rules that interact with the ecosystem services to form a complex SES (Briassoulis, 2015).

#### **1.4.2 Karimunjawa National Park Village profiles**

Research participants were selected from all four villages located within Karimunjawa National Park (Karimun, Kemujan, Parang, Nyamuk). Residents, as a way of earning livelihoods work as fishers, look for shells (gleaning), aquaculture, sell marine products, work as farmers (primarily tree crops such as rubber, coffee, coconut), work as paid employees (public/private) and other jobs such as construction workers, carpentry, tourism operators (Yulianto et al., 2010). Most residents depend on natural resources around them for their livelihoods. Fishing gear commonly used by Karimunjawa



fishermen include hand fishing, shallow water nets, deep water nets, spears, spearguns / arrows and traps (Yulianto et al., 2010).

The average level of education for Karimunjawa National Park is not / not yet graduated from elementary school and graduated from elementary school. The level of education is classified as low because school-age children often work a lot to help their parents, and due to low awareness. In Karimunjawa sub-district there are 14 elementary schools, one senior school on Karimunjawa Island, and one Vocational Seaweed Senior School also on Karimunjawa Island. The majority of Karimunjawa residents are Muslim, but there are also those who embrace Christianity and Catholicism. In Karimunjawa Village there are four mosques, 21 prayer rooms and one church. Residents are composed of several ethnic origins, namely Javanese, Madurese, Bugis, Mandar, Bajau, Munak and Luwu. There is one medical health center on Karimunjawa Island, one medical health center in Kemujan, one medical health center in Parang and a mobile medical ship that regularly serves the community.

After initial observation, it was concluded that each village is in various stages of development and infrastructure. The main harbors in Parang and Nyamuk need renovations, and island roads are either partially paved dirt roads or cemented (Figure 1.4). Kemujan Island contains a newly constructed harbor and asphalt roads that have a slow turnaround for road repairs if needed. Karimunjawa, the village with the most tourism services, contains asphalt roads that have a quick turnaround for repairs (Figure 1.4). There are two fully functioning ports with ferries scheduled to arrive and leave the island every day. Potential ongoing changes, and its impacts on natural subsystems are not witnessed in equal capacities across the villages of Karimunjawa National Park. A series of consultations and interviews with key stakeholders provides insights on responding to the three objectives (as stated in section 1.2) that guides this thesis.



Figure 0.4 Images depicting road conditions of the four inhabited villages of KNP. A) Nyamuk Village B) Parang Village C) Kemujan Village D) Karimunjawa Village (photographs by author)

## 1.7 Research Design and Methodology

This thesis uses a case study approach using primarily qualitative methods. Specifically, in-depth semi-structured interviews, surveys, and focus groups were conducted to gather relevant data for this research. Results were analyzed using a descriptive-interpretive approach. The literature review has been ongoing since October 2017, and on site data was collected during the months of August and September 2018. The research methodology is further described in chapter 2 of this thesis.

## 1.8 Thesis Organization

This thesis strives to respond to the three main objectives set out for this research. Chapter 1 of this thesis contains theoretical background, the study's objectives, and significance of the issues it is trying to address. It also introduces the study area, and a synthesis of literature review conducted for this research, in addition to an introduction of the research design and methodology used. Chapter 2 contains research methodology, and

data collection methods used to obtain primary data and to conduct this study. From chapters 3 to 5, each chapter contains literature review, data, analysis, discussion, and main conclusions relevant to objective 1, 2 and 3, respectively. Chapter 6 concludes the thesis by highlighting key points, recommendations, and presents propositions for any future potential research in the realm of SERSs.

## **Chapter 2**

### **Methodology**

#### **2.1 Summary of Research Approach**

This chapter defines the methodology and data collection methods employed to execute the research study including the role of the researcher and types of sampling used. Details regarding justifications and limitations in research methods are also included. This research will use qualitative methods to tackle the objectives stated for this thesis. The initial phase of the research involves scoping and observing the study location, followed by conducting semi-structured interviews, surveys, and focus group discussions. The findings will be triangulated to ensure accuracy.

A descriptive-interpretive research design was chosen for a qualitative analysis since the study is focused on understanding rapid change as a phenomenon and forming trends in adaptive responses. A descriptive-interpretive research design follows an analytical and inductive approach that allows for a focus on various characteristics of a phenomenon, the frequency with which it occurs, and how it changes over time (Elliott and Timulak, 2005). Some quantitative analysis was also conducted through tallying of results; see the subsequent sections for further description.

##### **2.1.1 Case Study Approach**

A case study is “a research approach used to generate an in-depth, multi-faceted understanding of complex issues in its real-life context” (Crowe et al., 2011). Case studies can be used to explain, describe, or explore phenomena in the everyday contexts in which they occur, as compared to setting up an experimental design to reach conclusions (Yin, 2009). A case study approach allows the researcher to capture explanatory information such as answers to the “how”, “what”, and “why” questions. In the context of this research, the focus is on “how” social and ecological changes are perceived by the local communities and governance actors, “why” critical slow variables are important in managing complex feedbacks in social-ecological systems, and “what” is the role various actors in responding to and adapting to social and ecological changes.

The case study approach is especially useful for this research aims to identify critical variables within the social-ecological system of Karimunjawa National Park, and its importance in the realm of adaptation and governance. There is a natural focus on understanding the interconnectedness and feedback amongst variables to prescribe to the explanatory nature of a case study approach (Thomas, 2011).

The epistemological approach adopted for this case study research is interpretative as it places a high value on understanding meanings and contexts as perceived from different perspectives, primarily focusing on theory building. As compared to critical and positivist approaches, that either places the researcher in a privileged position in terms of power relations, or it doesn't take into account the role of researcher and how they might influence findings (Yin, 2009; Howcroft and Trauth, 2005).

Selecting Karimunjawa National Park as a case study for this research was primarily based on the ability of the researcher to investigate a potential phenomenon of rapid change or regime shift based on social and ecological changes documented in the form of rising population, decreasing fish catch, and rise in tourism activities (Setiawan et al., 2017; Taruc, 2011, Purwanti, 2001). Based on this understanding, Karimunjawa National Park presented itself as an instrumental case study to study changes, adaptation, and governance implications (Crowe et al., 2011).

## **2.2 Qualitative Research Design**

The methodological approach chosen for this study was primarily qualitative. Qualitative research design often “rely on linguistic rather than numerical data and employ meaning-based rather than statistical forms of data analysis” (Elliott and Timulak, 2005). It was chosen because of its applicability for the study objectives to form trends in ongoing changes and understand patterns of adaptation.

This research follows a descriptive-interpretive research method. A descriptive method allows the researcher to focus on various characteristics of a phenomenon and the frequency with which it occurs. Additionally, a descriptive-interpretive research method also allows an understanding of why the phenomenon occurs and how it changes over time (Elliott and Timulak, 2005). This study aims to understand the nature of change in

Karimunjawa, in its defined social-ecological system, with a focus on fast and slow changing variables interacting in a feedback cycle. Furthermore, trends are formed in adaptive responses to the identified changes, followed by governance implications of understanding and identifying fast and slow changing variables in the realm of policy. Formation of such trends and understanding requires incorporating a lens of interpretive research method.

Prescribing to a descriptive-interpretive research method is justified for this research, as descriptive research design strives to provide a “comprehensive summarization, in everyday terms, of specific events experienced by individuals or groups of individuals” (Lambert and Lambert, 2012). While interpretive qualitative research is in many ways is “integrated into the core qualitative inquiry” (Creswell, 2007).

This inductive research assumes an emergence of Anthropocene in which nature and humans are linked together. In this complex, linked system, humans are perceived to have an upper hand and are constantly changing the course of variables of both ecological and social subsystems. In this research, critical realism paradigm plays an important role. The research takes on a realist’s and idealist’s approach to better understanding and describing social science concepts such as rapid change and the concepts of resiliency vs. adaptability. Since this research holds various transactional views and its findings are expected to be value mediated, the epistemological assumptions are subjective.

## **2.3 Data Collection Methods**

Methods including literature review, scoping and participant observation, semi-structured interviews, and surveys were used to collect relevant data for understanding and identifying prominent slow variables, ongoing changes, and its impacts.

### **2.3.1 Literature Review**

Examining available knowledge and theory, including up to date information about the relevant topic, is common in both quantitative and qualitative research (Elliott and Timulak, 2005). A preliminary literature review was conducted to obtain a conceptual and theoretical understanding of previous research conducted on three main areas of interest namely Social-ecological regime shifts, adaptation, and governance

implications. The literature review deliberates scholarly articles, books, thesis dissertations, and other secondary sources relevant to the three areas of research. It allowed for a structured theoretical understanding, which allowed the researcher to practice gap spotting, and problematization to justify the need for further research. A combination historical and theoretical review was conducted to allow a split in focus on determining when concepts such as regime shifts first appeared in literature and the appropriateness of various theories surrounding it.

A literature review allowed for a thorough understanding of existing theories related to rapid change, its impacts, and its responses. The literature review was conducted with the help of Zotero reference management software (Figure 2.1).

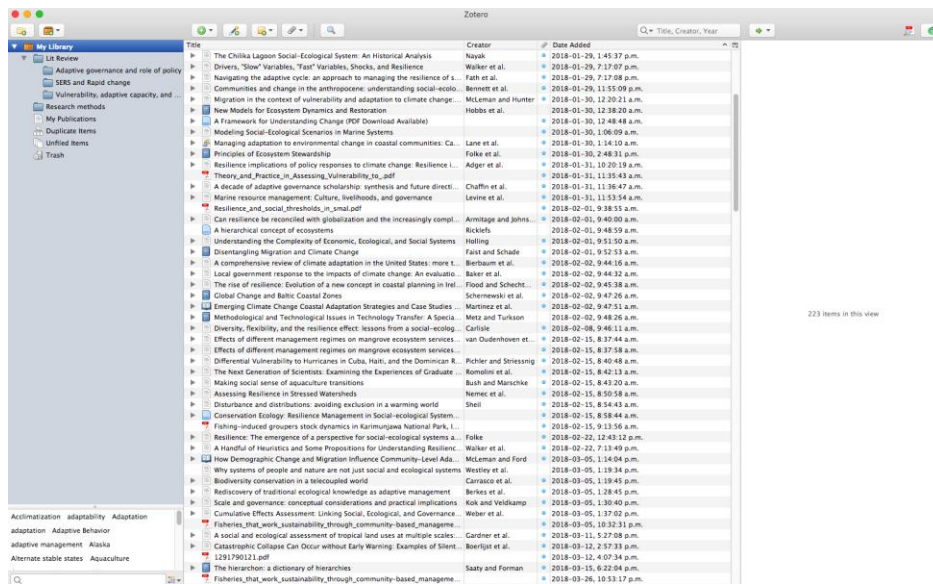


Figure 2.1 Use of Zotero reference management software to organize secondary sources for the literature review

Zotero provides features such as web browser and word processor integration, in addition to the generation of in-text citations, and bibliographies. There were 223 research materials added and organized based on the three research areas, and the research methods use.

### **2.3.2 Scoping and Participant Observation**

As Aagaard and Matthiesen (2016) describe it, “participant observation involves watching, sensing, feeling, and being present with people and things”. By engaging in interviews and participant observation, a researcher minimizes the risk of a “humanist bias” by oscillating between analytical concepts of *meaning* and *presence* (Aagaard and Matthiesen, 2016; Roehl, 2012). In other words, it encourages increased sensitivity between meanings presumed by the researcher versus the understanding amongst the participants. Participant observation in some ways is an imperative supplement to the verbal responses of the interview subjects (Aagaard and Matthiesen, 2016).

The initial stage in scoping involved of engaging with the local communities and identifying relevant stakeholders for this research. The initial stage of scoping for this research took place in late August 2018. This preliminary understanding of local communities, institutions and policies helped create and build rapport with the community. All observations were documented in a journal and organized by date and no name or identifiers were recorded. Notes included details of the living conditions of the local communities, dependence on the natural resources, colloquial terms and other cultural nuances, and key emerging analytical ideas. Using a preliminary understanding of the study site, the researcher proceeded with the other research methods to meet the three objectives.

The observation regarding the reserves such as house material, roof material, and facilities and appliances available to the residents were made to determine social reserves within the place.

### **2.3.3 Semi-structured Interviews**

Semi-structured interviews are often used in qualitative research as they allow the interviewer some discretion regarding the questions asked and topics covered in the interview (Harrell and Bradley, 2009). Semi-structured interviews were used to gain a richer understanding of any change taking place within the social-ecological system as perceived by the local communities; recognizing specific fast and slow variables, local community’s adaptive responses to ecological change and institutional change and the future trajectory of Karimunjawa National Park as perceived by the local communities.



Interviews took place in two rounds allowing for streamlining the interview process. The first round of interviews took place in August 2018, and the second round of interviews took place in late September and early October 2018.

Participants in this study included community members and government officials from 4 out of the 5 inhabited islands of Karimunjawa National Park. Local communities of Karimunjawa, Kemujan, Parang, and Nyamuk were approached for research participation. The fifth inhabited island, Genting Island, was excluded given the lack of accessibility based on the non-existent convenient mode of transportation to the island. However, given the limited population living in Genting Island (less than 100 households), it is considered a part of Karimunjawa village rather than a separate village entity.

Common characteristics of research participants included those knowledgeable about the ecological and social conditions of Karimunjawa over a scope of multiple years and were 18 years of age or older. In qualitative research, the primary consideration in the selection of participants is to ensure representation of important elements of the research questions (Sargeant, 2012). Hence, for data to be optimal and credible, participants who best represented or were knowledgeable regarding the thesis topic were included.

Recruitment was conducted using the snowball technique, where existing interviewees were asked to suggest other potential candidates for interviews based on the criteria stated by the researcher (Bolderston, 2012). Snowball technique worked well in the field as certain community members and fishers were recommended who were born in Karimunjawa National Park or had been living there for a majority of their life and held knowledge regarding long-term changes and drivers of change. Government officials were interviewed for their knowledge on information dissemination, perception of change, and adaptive responses. To meet the research objectives 60 interviews were conducted with key informants within the community at a household and governance level. Table 2.1 contains the details of participant distribution based on livelihood categories (Kaplan-Hallam et al., 2017).

Livelihood Category	Example	% of informants
Fishing	Fishers, fish buyers/middlemen	45
Tourism and Hospitality	Resort owner	2
Agriculture	Farmers	3
Municipal	Village heads, head of tour guide association	4
Provincial	Karimunjawa sub-district head, Provincial Government employee	2
Industry	Banking, power plant workers	2
Other	Carpenter, Mechanic	2
TOTAL		60

Potential participants, especially community members, were approached throughout the day. Mornings (9:00 am to 11:00 am) and evenings (6:00 pm to 10:00 pm) were the most productive based on the availability of the local community members. Locations such as docks, ports, local homes, and central markets were chosen as those were the most active parts of the community to recruit the intended participants for research. The interviews were conducted in a manner that would strive to be the most convenient for the participants. For instance, potential participants were approached when they were outside their homes socializing, or working on maintaining their boats/ wishing gears, or if they were returning from their fishing trips. Interviews with government officials were scheduled ahead of time with the help of the local student translator.

The informants from the local community were asked an array of questions in a semi-structured format including general questions in regards to their day-to-day activities, their involvement with the local environment and resources, any changes that they noticed taking place in both their social and ecological subsystems and their responses to those changes including any adaptive strategies implemented.

Four areas of questions were categorized as following: 1) general questions to build rapport; 2) local community members' perception of changes on various scales within Karimunjawa National Park (Pertains to objective 1); 3) Assessing adaptive capacity of the local community (Pertains to objective 2); 4) type of governance in place for the prominent variables, and the extent to which it strengthens livelihoods of local

resource dependent communities (Pertains to objective 3). Questions were adjusted slightly for key informants' contexts as deemed necessary.

In a SES, there are many stakeholders involved that act as both drivers and impacts of rapid change, hence it is important to engage in a conversational and an in-depth dialogue with the stakeholders (Jamshed, 2014). The data collected through the interviews will be used to compare various perceptions on slow and fast changes as described by the local community and local government officials. The data collected will also be used to form trends for various adaptive responses in place in local communities for ecological and social changes taking place. Semi-structured interviews were ideal for this research for another reason, which is that it allowed interviewees to add to the conversation in addition to adhering to the questions asked.

#### **2.3.4 Focus Group Activities**

Focus groups can be defined as a form of group interview or a discussion aimed at gathering information or data on a specific topic (Hughes and DuMont, 1993; Kreuger, 1998). In this research, focus groups played an important role as they minimized individual biases and helped form a more robust understanding of how the local communities perceive various factors, such as ongoing changes and local governance, in their system. Focus group discussion included recognizing fast vs. slow changes within KNP, and a discussion on how such distinction can lead to novel governance approaches. Core population targeted for the focus groups was composed of the local community members of KNP (Smithson, 2000). Two focus group discussions took place. Initial focus group discussion took place in the beginning stages of field research to gather information on ongoing changes in both social and ecological subsystems. The discussion composed of five traditional fishermen from Kemujan. participant recruitment for the first focus group involved the researcher approaching a group of fishers taking a break in the afternoon near the docks in Kemujan.

The second focus group discussion took place near the end of field research after surveys and interviews were conducted. This second focus group, made up of nine participants, included local fishers and tour guides. The discussion took place at the designated night security guard post location in Karimunjawa, where local community

members hold voluntary shifts to guide night traffic (mainly tourists). Local members and participants were recruited using word of mouth. The purpose of the second focus group was to discuss preliminary results from the surveys and interviews conducted. A timeline of ongoing changes in both social and ecological subsystem and assumed future direction of change was also discussed. To facilitate this discussion, materials such as posters and markers were used. A timeline was made to document the chronological order of ongoing changes within Karimunjawa National Park. It should be noted that there was a translator present to assist with the questions and translations when required.

### 2.3.5 Survey

The SERSs survey was created to quantify various variables of environmental and social changes within Karimunjawa. It was designed and segregated based on the six-dimension framework as defined by Nayak and Armitage (2018). Respondents for the SERS survey were chosen based on similar grounds as the selection criteria for informants for the semi-structured interviews. Respondents represented communities of Karimunjawa Village, Kemujan Village, Parang, and Nyamuk. The surveys were conducted in September 2018. Common characteristics of respondents included those knowledgeable about the ecological and social conditions of Karimunjawa over a scope of multiple years and were 18 years of age or older. Recruitment was conducted using the snowball technique, where existing respondents were asked to suggest other potential candidates for the surveys based on the criteria stated by the researcher (Bolderston, 2012). Total of 27 respondents participated in the survey. Livelihood category for the local respondents was primarily related to fishing (Table 2.2).

Livelihood Category	Example	# of respondents
Fishing	Traditional fishers, middlemen, fish buyers	25
Governance	Karimunjawa sub-district head, provincial government employee	2
<b>TOTAL</b>		<b>27</b>

Survey results were especially useful in discussing the integration of social and ecological subsystems In Karimunjawa. The results were also used to triangulate relevant findings from semi-structured interviews such as changes, drivers, and impacts of change.

This survey was conducted in coastal communities in India, China, and Mexico by student researchers at the same time. A comparative analysis of the results can be conducted to generalize the effectiveness of using the six dimensions to respond to and understand the overlap between social and ecological systems.

## **2.4 Data Analysis**

This section explains how the data collected using the methods described in previous sections was analysed. Qualitative data analysis is a “dynamic, intuitive and creative process of inductive reasoning, thinking, and theorizing” (Basit, 2003). Researchers often draw on their first-hand experience with the local settings and informants to interpret the data collected.

### **2.4.1 Semi-structured Interviews Analysis**

To find meaning within qualitative data, researchers often use coding as the first step towards analysing textual data and information (Blair, 2015). Data coding techniques for qualitative analysis often depend on specific needs and objectives of the research. Generally, coding consists of labelling and identifying patterns in the data, and the relationship between them, followed by linking the findings with the research objectives. This form of qualitative analysis provides structure to a pool of unorganized information.

The first step in analysing the qualitative data gathered through in-depth interviews was to perform a thematic analysis using qualitative coding. Data was analysed and coded using a qualitative analytical software (ATLAS.ti). ATLAS.ti is a data analysis software that can be used to investigate large amounts of qualitative or textual data, in this case semi-structured interviews, to draw patterns or codes in the collected data. All data was compiled into documents and uploaded to the software, which were then used to create encodings (open, selective, and organized) through the code manager. SERS survey and semi-structured interviews had some common themes of questions related to ongoing change and scale of change. Since different participants were

selected for semi-structured interviews and SERS survey, there was some overlap of responses. Results from the survey were also uploaded to the software to compile all data gathered from overlapping inquiries. The program allowed naming the codes that allowed the researcher freedom to identify and create subcategories to follow a more organized structure throughout the stages of coding. The process of coding led to humanizing the data collected in this qualitative analysis and descriptive-interpretive interpretation research.

Stage one of the coding process was composed of open coding, in which category codes were formed from emerging themes in the data, relationship between different aspects, and frequent keywords used by informants. This stage of the coding process was primarily guided by the literature review conducted to support each objective of the thesis. Similar coding process was followed for subsequent objectives where data was coded to form trends and draw conclusions based on the literature review conducted. Selective coding was conducted in stage two, where coding categories were eliminated, combined, or subdivided based on specific research objectives (Nyumba et al., 2017).

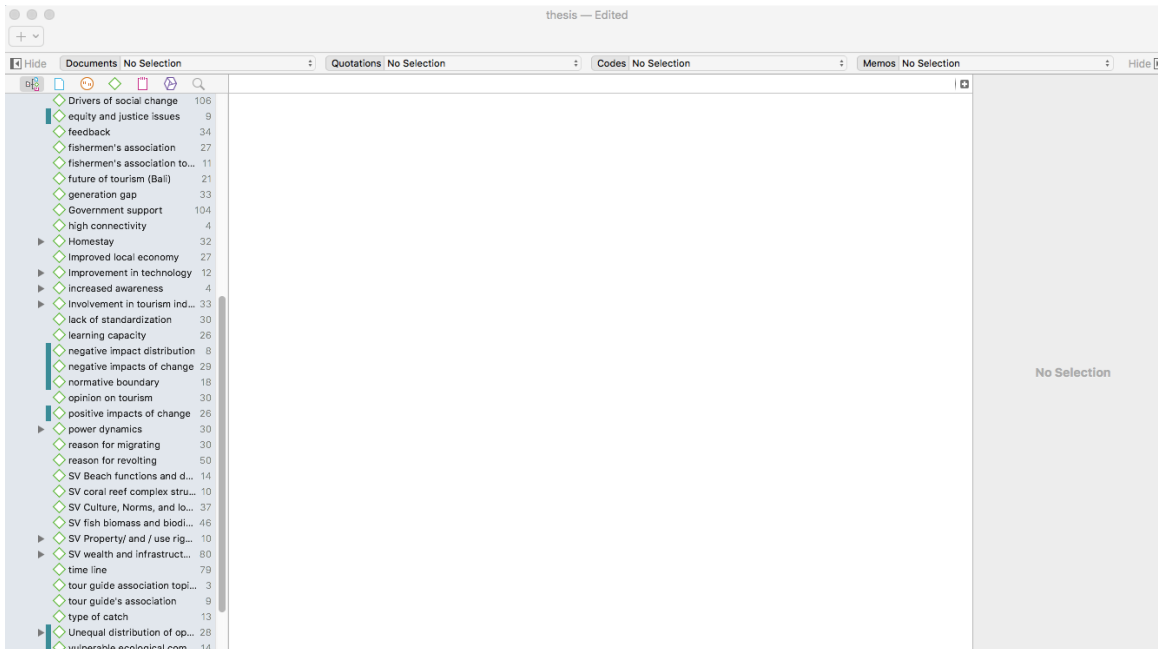


Figure 2.2 A screenshot from the data analysis program ATLAS.ti, used to code the interview transcripts for this research

Data collected on social and ecological changes were coded based on criteria identified to define critical slow variables (see table 3.1). The criteria include identification of time-scale of change (daily, seasonal, interannual, multiple years to decades etc.), and the role of a variable in feedback interactions within the social-ecological system of Karimunjawa (see the literature review section of chapter 3). The second round of coding included identifying a list of predetermined slow variables based on relevant literature, and initial observation. The list of slow variables:

- Culture, norms, and long standing institutions (Mellado et al., 2014)
- Property and use rights (Coulthard et al., 2011)
- Wealth and infrastructure (Wilkinson, 2008)
- Fish biomass and Biodiversity (Hafsaridevi et al., 2018)
- Beach functions and conditions (Enriquez-Acevedo et al., 2018)
- Coral reef structural complexity (Baskara et al., 2017)

The network feature of ATLAS.ti provided a visual depiction of inductive coding used to identify controlling slow variables within the SES of Karimunjawa (Figure 2.3). Data on the percentage of respondents and informants who identified the predetermined slow variables based on timescale and/or feedback interaction is presented in chapter 3. Chapter 3 further contains discussions on each slow variable and its role in maintaining system functions based on identified changes. It also defines each slow variable based on the predetermined criteria in the on-going changes.

The final list of codes is depicted in figure 2.2. ATLAS.ti served as an organizational platform, in which codes and their subsequent quotations were easily accessible. Furthermore, Microsoft Excel was used to quantify numerical data such as types of drivers, change, and impacts, collected in semi-structured interviews.

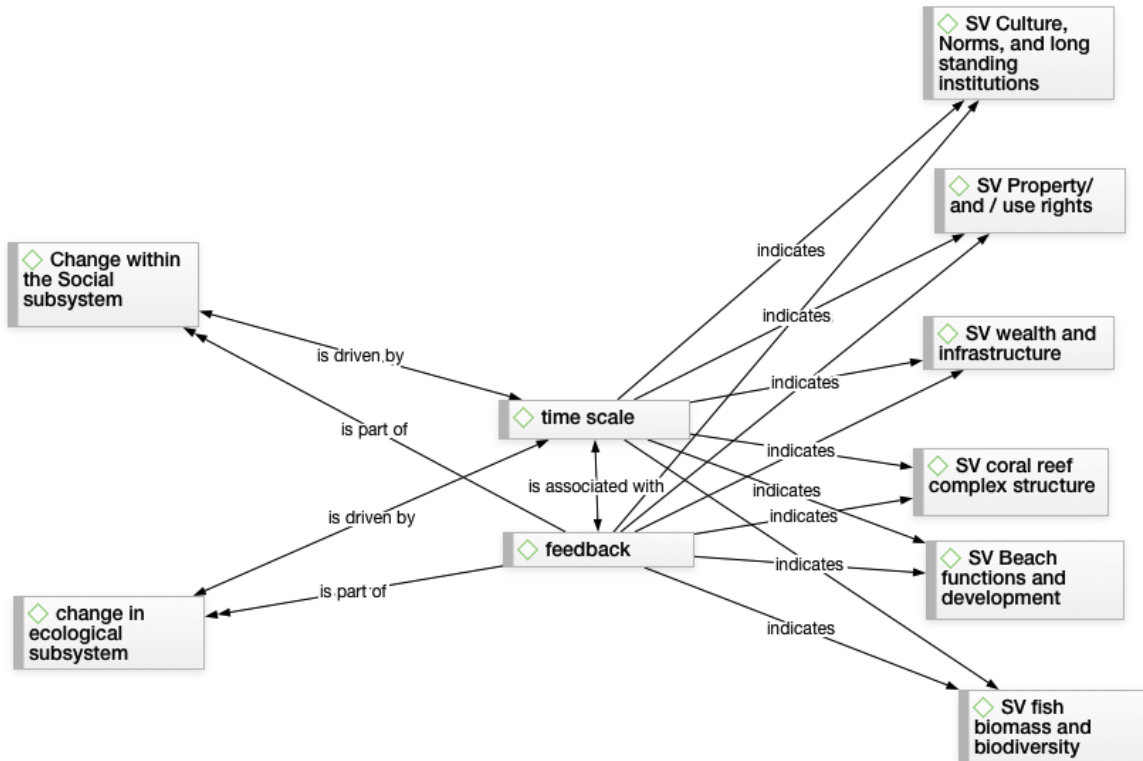


Figure 2.3 A visual depiction of inductive coding used to identify controlling slow variables using the network feature of ATLAS.ti

## 2.4.2 Focus Group Analysis

The focus group activities were analysed using the visual outputs that resulted from the session included a timeline of changes, frequency of change, and the future direction of change (specifically referring to the adaptive responses and governance responses to change).

For the analysis, the frequency of comments, nature of comments, and extensiveness of discussion were noted to form conclusions regarding the future direction of Karimunjawa. The results triangulated the findings from the interviews and surveys results adding validity to the data collection methods



### **2.4.3 Survey Analysis**

Survey data results were organized using Microsoft Excel spreadsheet. The SERS survey represented opinions of individuals aged 18 years and above, comprising of people whose main occupation was related to fisheries and marine resources. A total of 25 respondents were randomly selected from the communities of Karimunjawa, Nyamuk, and Parang. The response rate was 100% as all respondents voluntarily participated in the questionnaire interview session, which consisted of male respondents (100%). Age-wise, the adult group (above 20 years old, 96%) was higher than the youth group (ranging from 18 years -20 years old, 4%). There were some difficulties in obtaining a representative ratio of gender and age groups relative to the available demographic data, present due to interviews being plausible during the daytime. The age/gender matrix was also influenced by the varying working schedule of individuals and households.

Opinions represented in the surveys are contingent on the size of the population sampled. Since respondents were selected from four villages of Karimunjawa National Park, some inter- and intra-community comparisons are possible, however, given the small sample size of the surveys, comparisons are not fully explored in survey analysis.

Survey results provided descriptive statistics regarding dimensions of SERS, which were then used to analyze the feedback interactions taking place in the social-ecological system of Karimunjawa. Conducting the survey added a quantitative element to this research leading to depth and validity of the results gathers from in-depth interviews.

### **2.5 Limitations**

The limitations of this study include generalizability, sampling, biases, and other limitations of qualitative techniques. This case study research could potentially limit generalizability as data collection took place primarily in the main tourist village of Karimunjawa, where the impacts of social change were most prominent (Setiawan et al., 2017). The communities residing in the villages of Parang and Nyamuk had yet to feel impacts of social changes, or the impacts were not widespread. Similarly, impacts of ecological changes associated with fish biomass, biodiversity, and coral reef degradation were also context specific to each village depending on factors such as level of

development, awareness, and learning capacity. Hence on a wide scale, generalizability is potentially impacted because this research concerning local adaptation to changes amongst critical slow variables is limited to one case study in one country. Hence, the generalizability could potentially be limited as unique combination of factors could make analysis and recommendations heavily case/context specific.

In qualitative research wherein study-specific questions are used for in-depth interviews, the interviewer becomes an instrument through which data for their studies are collected or generated (Poggenpoel and Myburgh, 2003). This could lead to a researcher bias where the researcher or the interviewer conducting the interviews possibly influences the results. This bias is especially prevalent where the researcher holds a strong affinity for the participants being studied or is a member of the population (Chenail, 2011).

In this research, triangulation was conducted to mitigate any effects of researcher bias using focus groups, and surveys. On the other hand, the researcher not being from the local communities or not speaking the same language also poses a limitation for the study. There is a potential for the disconnection between the researcher and the research participant leading to lack of depth. This lack of depth could also be connected to the researcher's status as a "foreign researcher", as some community members assumed lack of inaction despite their diligent participation in the research process.

Karimunjawa National Park is a common research/ study site for local students (Diponegoro University, Universitas Negeri Yogyakarta), researching marine sciences, fisheries, tourism etc., the community is also aware of the lack of reciprocity regarding benefits to the local communities despite their ongoing cooperation with research efforts. Response bias is another limitation that factors in the use of semi-structured interviews. Participants may have deceived or misled the researcher based on expected answers rather than giving their authentic response. To combat such biases, the researcher went through a phase of initial scoping and observation to build a relationship with the local community.

## **2.7 Ethics**

This research project received full ethics clearance from the University of Waterloo Office of Research Ethics under ORE # 23165 on July 27, 2018 (Appendix D). A modification was requested while the researcher was on the field to include questions related to the adaptive capacity of the local community during ongoing change.

## Chapter 3

# Identifying Changes: Slow and Fast Variables within Karimunjawa National Park

### 3.1 Introduction

Scientific evidence suggests that human activities are exacerbating natural changes in social-ecological systems with the possibility for adverse impacts on marginalized groups such as coastal communities (Kittinger et al., 2012; Samonte et al., 2010). One such example is that of Karimunjawa National Park in Indonesia, which also serves as the study location for this thesis. Despite the rise in adoption of a social-ecological systems (SES) perspective, that views social and ecological subsystems as an integrated system rather than as two separate systems, in current literature, there has been an overwhelming focus on the ecological subsystem and a lack of focus within the social subsystem (Crépin, 2007; Kittinger et al., 2012; Samonte et al., 2010; Ferrara et al., 2016). Moreover, based on the analysis done by Stojanovic et al. (2016), there is little evidence supporting the comprehensive representation of changes taking place amongst the emergent features of culture and society such as local norms.

Using the concept of fast and slow variables adds to the comprehensiveness of assessing changes within a SES. Within an interconnected social-ecological system, there are many drivers of change that interact with each other to create impacts at various scales and levels (Nayak and Armitage, 2018; Kittinger et al., 2012). It is important to identify and understand human activities and responses as more than just drivers of change. The interconnections of drivers and impacts with institutional responses form the basis for a complex and interactive social-ecological system, in which humans and ecosystems are coupled. In these systems, decisions made by institutions, ecosystem managers and societies form feedback responses, indicating the system's thresholds. Given the rising disturbances, managing such feedbacks and slow variables could support effective management of implications of change. Hence, it is important to identify and manage slow variables in coupled social-ecological systems in coastal areas undergoing any potential rapid change as perceived by the local communities such as the ones in Karimunjawa National Park.

This chapter aims to establish an understanding of fast and slow changing variables, within the social-ecological system of Karimunjawa National Park to understand the phenomenon of rapid change. To do so, the first objective is to define slow variables in social and ecological subsystems based on the local perception of change. The second objective is to establish the nature of change and a baseline understanding of changes taking place in the social-ecological system and its impacts, based on the six dimensions of Social-Ecological Regime Shifts (SERS) using the data collected through the SERS survey. This objective focuses on the intersection of the two subsystems, and its drivers and impacts as it dictates the future trajectory of Karimunjawa National Park. The third objective is to combine an understanding of critical slow variables and the six dimensions of social-ecological regime shift to respond to rapid change.

### **3.2 Understanding Slow and Fast Variables, and Feedback Interactions Within Social-Ecological Systems**

This section contains literature review conducted in order to determine the criteria used to define fast and slow variables in a social-ecological system. It further explores the importance of differentiating between fast and slow variables. A conceptual framework is presented to identify interactions amongst the social and ecological subsystems and human actors (including local community members and system managers). Lastly, a definition of social-ecological regime shifts (SERS), along with its six dimensions is identified. Overall, the literature provided in this section facilitates the identification of critical slow variables and ongoing changes in Karimunjawa National Park; a discussion on intersecting social and ecological subsystems using the six dimensions of SERS; and a discussion on applying an understanding of regime shifts to the feedback interactions between fast and slow variables within the study site.

## **3.2.1 Slow and Fast Variables Within Social-Ecological Systems**

### **3.2.1.1 Defining Slow and Fast Variables**

In a social-ecological system, changes occur at various temporal and spatial scales and can range from short term or gradual change, and sudden or permanent change, hence making intervention or addressing change a complex subject (Kinzig et al., 2006; Armitage and Johnson, 2006; Walker et al., 2012; Conversi et al., 2015). There exists a spectrum of controls that operates on various scales and levels that are grouped as fast variables and slow variables in current literature (Chapin et al., 2006; Crépin, 2007; Walker et al., 2012).

There are a few critical slow variables that strongly influence ecosystems while remaining constant over multiple years to decades (Kinzig et al., 2006). Slow variables are also known as “controlling” variables, as they shape the dynamics of fast variables within a system at the same spatial scale (Crépin, 2007; Walker et al., 2012). Fast variables can be defined as variables within a system that is of primary concern to ecosystem users such as income generated from fish resources (Walker et al., 2012). These fast variables change on daily, seasonal, and interannual time scales.

Table 3.1 contains the criteria used to define slow and fast variables for this thesis. The stable state or the “equilibrium level” for the fast variables, in relation to slow variables, depends on their interactions with external drivers (Crépin, 2007). Drivers operating at various scales have an impact on all sectors in the form of cascading effects (Nayak, 2014; Kinzig et al., 2006). These cascading effects tend to potentially alter the underlying slow variables in an irreversible way also leading to the crossing of other critical thresholds (Kinzig et al., 2006; Ferrara et al., 2016). Such changes require human actors (local communities and resource managers) to then respond in the form of adaptation or transformation (Kinzig et al., 2006; Chapin et al., 2006).

Table 3.1 Criteria defining slow and fast variables

Criteria	Slow Variable	Fast Variable
Nature	<ul style="list-style-type: none"> <li>• Slow variables are typically “controlling” and change slowly (Crépin, 2007; Walker et al., 2012).</li> <li>• Slow variables within a social-ecological system are composed of a predominant history, culture, economy, and governance system that has been formed and devised over the years providing pathways for future trajectories in face of change. (Chapin et al., 2006)</li> </ul>	<ul style="list-style-type: none"> <li>• Fast variables are typically those that are of primary concern to ecosystem users and often depend on the slow variables for its outcome (e.g. ecosystem goods and services) (Walker et al., 2012).</li> <li>• Frequency of change/ and occurrence of fast variables provide novelty for experimentation upon which adaptation depends (Ruitenbeek and Cartier, 2001; Armitage and Johnson, 2006).</li> </ul>
Time Scale	<ul style="list-style-type: none"> <li>• Slow variables are constant over multiple years to decades (Walker et al., 2012)</li> </ul>	<ul style="list-style-type: none"> <li>• Fast variables can potentially change on a daily, seasonal, and interannual time scales (Walker et al., 2012)</li> </ul>
Feedback interactions	<ul style="list-style-type: none"> <li>• Slow variables tend to accumulate and contain a memory connection among nested adaptive cycles that provides conditions of renewal and stability within a social-ecological system (Armitage and Johnson, 2006)</li> <li>• External or exogenous drivers can cause a change in slow variables by crossing thresholds, which can push the system across a threshold into an alternative stable domain. (Chapin et al., 2006)</li> <li>• Changes in slow variables can come across as shocks, or sudden change in the system, which cause the fast-moving variables in the system to fluctuate more (Ferrara et al., 2016)</li> </ul>	<ul style="list-style-type: none"> <li>• Fast variable holds the capacity for possibility overwhelming slower variables, thus creating disruption and driving a need for an eventual reorganization.</li> <li>• Ongoing and persistent human impacts on fast variables over long time periods can propagate upward and impact slow variables even regional controls such as climate and regional biota that were once considered constant parameters (Chapin et al., 2006; Steffen et al., 2004)</li> </ul>

Understanding the distinction between fast and slow variables allows for better understanding of the critical linkages among ecological systems and the people’s knowledge, established local institutions and rules and norms that dictate local responses in the face of rapid change (Ostrom, 2005; Ferrara et al., 2016). Identifying slow variables can minimize uncertainty and lag between drastic changes and institutional or governance response. For example, community responses to drastic changes can be explained and predicted by better understanding the underlying slow variable of culture

and norm dictating the community's collective actions and responses (Armitage et al., 2012; Lew, 2014). Disruptive changes amongst slow variables that are formed over a larger temporal and spatial scale could potentially lead to the functions of a SES crossing threshold into new systems (Crépin, 2007).

Slow variables exist in both social and ecological subsystems, even though the focus is usually within the ecological subsystem (Béné, 2005; Chapin et al., 2006). This thesis will assess critical slow variables discussed in the current literature. Slow variables within the social subsystems of coastal communities include culture, norms and long standing institutions, property and use rights, and wealth and infrastructure (Mellado et al., 2014; Coulthard et al., 2011; Wilkinson, 2008). Slow variables within the ecological subsystem include fish biomass and biodiversity, beach functions and conditions, and coral reef structural complexity (Hafsaridevi et al., 2018; Enriquez-Acevedo et al., 2018; Baskara et al., 2017). Relevant fast variables will be identified and discussed based on the criteria (Table 3.1) and the changes as described by the local informants.

### **3.2.1.2 Conceptual Framework**

The conceptual framework implemented for understanding fast and slow variables in this chapter is adopted from Chapin et al. (2006). Within the dotted box is the visualization of a social-ecological system, in which the two subsystems form feedback loops with human actors in the center. As depicted in the framework (figure 3.1), human actors are involved in responding to ongoing change in the form of institutional response that feeds into the fast and slow variables. Within the dotted box, the shaded region depicts the lens of local knowledge and perception that will be applied in this research to identify the prominent fast and slow variables in Karimunjawa National Park. These variables will be analyzed to understand its importance and implications for change identified by the local community. Following the arrows in the framework, change in any variable in one subsystem could lead to a change in the other. A clearer understanding of this feedback between the variables can be gained by studying the scale and levels of drivers and impacts of change.



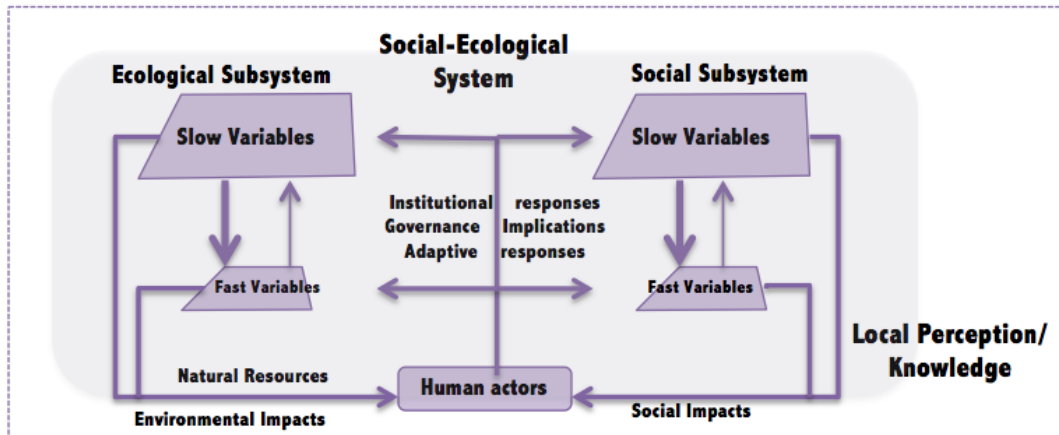


Figure 3.1 Conceptual framework used to understand fast and slow variables within a social-ecological system (Chapin et al., 2006)

The role of human actors is mainly categorized under institutional responses to change as they have the power to affect local governance by organizing and directing social behavior that drives other changes within a social-ecological system. The institutions set up by human actors are depicted to have a direct impact on the ecological subsystem and an indirect impact on the social subsystem (Chapin et al., 2006). There is partiality between the two subsystems regarding simplification of drivers and impacts of change within a social-ecological system (Bouska et al., 2018; Walker et al., 2012). This bias leads to factoring out individual responses to changes on a household level based on factors such as availability of resources, individual skill sets and exposure to learning (Walker et al., 2012; Chapin et al., 2006). These individual responses often define fast variables within the social subsystem such as income. This further leads to undermining the value of identifying and analyzing slow variables within a system such as cultural ties to the land (Chapin et al., 2006, Schlüter et al., 2012). The social dimension of understanding fast and slow variables is only partially theorized; ecological dimension is more influential in understanding fast and slow variables of SES (Crépin, 2007; Kittinger et al., 2012; Samonte et al., 2010; Ferrara et al., 2016).

Since coastal-marine systems are inhabited by societies dependent on their ecosystem services, there are social implications such as loss of livelihood and loss of culture resulting from an ecological change such as a decrease in fish biomass (Folke et al., 2010). Some of these internal slow variables, or “controlling” variables such as social

norms, culture and institutions have a huge impact on the so-called fast variables such as community income and population density (Walker et al., 2012, Chapin et al., 2004, Kinzig et al., 2006). Both fast and slow variables in a social subsystem can impact ecological processes (Costanza and Folke, 1996). Human societies do not only act as a driver of change for ecological systems but also adapt their behaviors to the ecological changes as they are also impacted by changes (Folke et al., 2010; Schlüter et al., 2012).

A feedback loop can be understood here as an underlying mechanism that exists between the fast and slow variables within the social-ecological systems, that maintains systems resilience or pushes a system to cross thresholds into new regimes (Crépin et al., 2012; Biggs et al., 2012). During ongoing disturbances within the social-ecological system, interactions amongst the variables can either be destabilizing or amplifying (Chapin et al., 2006). Certain dominant feedbacks can alter the state of slow variables leading a system into a new regime. For example, within a coastal social-ecological system, local livelihoods often depend on the ecosystem services provided by the slow variables in the ecological subsystem such as fish biomass. Drivers of change such as global warming, destructive fishing methods, and increasing anthropogenic pressures could affect fish biomass, which inherently impacts the local livelihoods. Assuming the lack of alternatives in livelihoods, local communities respond by adopting intense destructive practises and behaviors that provide them with the highest yield, resulting in the further degraded state of natural ecosystems. Hence, analysing feedbacks can shed light on the dynamic of variable interactions with one another and the role that the local community members and decision-makers can play in dealing with and responding to the disruptions (Biggs et al., 2012).

With rising disturbances, managing feedbacks, with a focus on underlying controlling, slow variables is of vital importance to manage dependent fast variables (Chapin et al., 2006). Analysing the feedback could lead to insights regarding the responses to these changes have the potential to either dampen or strengthen the feedback within a system. If a system crosses the threshold into a different configuration or regime, it can be extremely difficult to reverse (Holling, 1973; Walker and Meyers, 2004). Analyzing the interaction of fast and slow variables within a SES may lead to new revelations regarding the nature of change and ways in which its implications can be

effectively managed (Horan, 2011; Kittinger et al., 2012).

For example, an understanding of how various components interact with one another may allow the resource managers to proactively assign possible trajectories during ongoing change. Identifying certain attributes of the feedback such as the time lag and memory effect minimizes uncertainty. Without a focus on an understanding of feedbacks, any rapid change within a social-ecological system is unexpected and sudden. While anticipating change is a challenging task for resource managers and local communities, an understanding of controlling slow variables can lead to better predictability hence towards prevention of long terms drastic change (Chapin et al., 2006). If given the scale and magnitude of rapid change prevention is an impossible task, resource managers may use an understanding of rapid changes, critical slow variables, thresholds and feedbacks in order to guide the social-ecological system into the new regime with minimal negative impacts (Berkers, 2012).

Identifying critical slow variables within the social subsystem could also lead to clarification regarding behaviors, processes, and functions within the social domain. Understanding slow variables could lead to an insight into the capacity of the social system to self-reflect, consciously act, and learn from previous actions, hence going beyond identifying social systems with collective responses and local rules. To dynamically link social and ecological subsystems the focus in past research has prominently been on variables that are easily quantified (Stojanovic et al., 2016). However subjective and qualitative, slow variables such as local norms, values, and behaviors, play an important role in providing a wholesome understanding of changes and response within a defined social-ecological system. Furthermore, focusing on assigning changes under the categories of fast and slow variables categories could provide clarification and insights on the pathologies caused by interactions of ecological, social, cultural, and economic realms (Sugiarto et al., 2015).

### 3.2.2 Defining Change and Dimensions of a Social-Ecological Regime Shift

There is evidence that links rapid changes in social-ecological systems to the rising anthropogenic activities around the world, especially in coastal communities (Lade et al., 2017; Walker et al., 2012, Sugiarto et al., 2015). Changes to these coastal-marine systems that are highly interactive, can lead to social-ecological regime shifts (SERS), where in its extremes, there is diminishing social cooperation and deteriorating state of ecological resources (Sugiarto et al., 2015). Nayak et al. (2016) define Social-Ecological Regime Shifts (SERS) as “*abrupt, long-term and significant changes in linked systems of people and nature with uncertain implications for ecosystem services and human wellbeing*”.

Nayak and Armitage (2018) identify six core dimensions of SERS that minimizes the gaps that exist in understanding changes within the social-ecological system. The dimensions consist of differentiating drivers, levels and scales, equity and social justice concerns, power dynamics and politics, social-ecological units or context of regime shift, and governance to navigate regime shift (figure 3.2). The dimensions are conceptualized to focus on the integrations of social and ecological subsystems. These dimensions also provide an analytical framework to help local resource users and managers better anticipate and navigate rapid change.

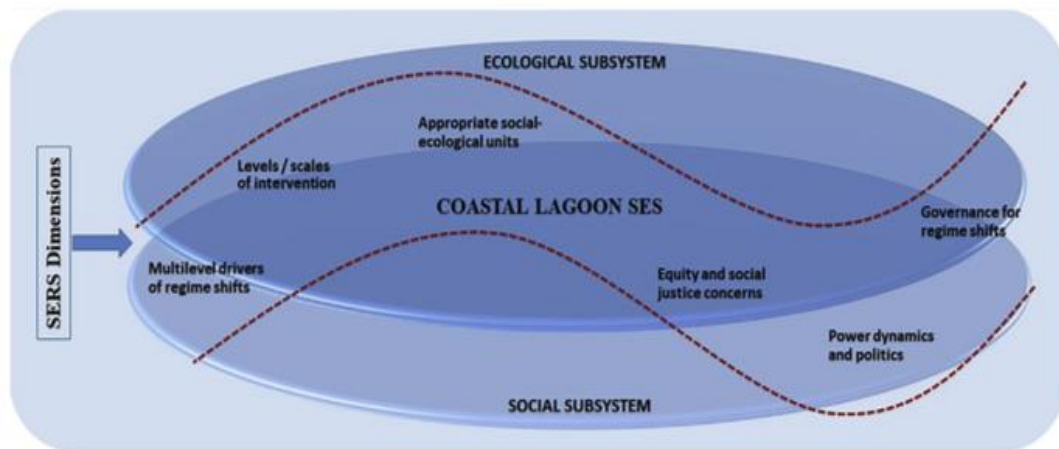


Figure 3.2 A framework outlining key dimensions of Social-ecological regime shift (Nayak and Armitage, 2018)

Analyzing the six dimensions provides insight on means of intervention and the potential future trajectories of the system. This thesis will use the six dimensions to form a baseline understanding of change, in addition to highlighting the various points of interactions between the social and ecological subsystems during the ongoing change.

- **Differentiating Drivers:** Current literature has established that there are drivers at various scales that influence change in a SES; however, in most cases, it is assumed that drivers have a top-down influence (Nayak and Armitage, 2017). The lack of recognition of the two-way influence of drivers creates an opportunity for a better understanding of drivers of change. Another gap is present in terms of linking a better understanding of the source, scale, and directionality, to indications of early warning signals for SERS. Geist and Lambin (2002) shed some light on the many underlying drivers a regime shift can have in a SES, that adds to the complexity of the rapid change. The identified drivers of change often depend on the type of regime shift being looked at. The importance of clearly identifying the drivers to implement appropriate management responses in place is evident in the literature (Walker et al., 2012). In many cases, there is a lack of distinction between internal variables and external drivers in a system (Walker et al., 2006), which leads to added uncertainty in understanding the source of change.
- **Levels and scales:** Scale can be broadly defined as the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon, whereas levels can be defined as a unit on a scale (Buizer et al., 2011). In academia, regime shifts are often studied at the scale of the entire system for example ecosystems, or climatic systems (Nayak and Armitage, 2017). Gaps in this area exist in terms of identifying various tools and methods available to analyze scale variations in the occurrence and intensity of regime shifts. Identifying and tracking vulnerable components of social and ecological systems provides useful insights for managing change.

- **Social-Ecological Units or context or Regime Shift:** Most studies undertaken on regime shifts conducted in diverse ecosystems tend to focus on a single resource type. Even though the integration of social-ecological aspects is generally recognized, there is a gap in terms of determining the appropriate social-ecological unit for assessing rapid change instead of the default use of resource systems as a unit (Nayak and Armitage, 2017).
- **Equity and Social Justice concern:** There has been growing interest in understanding the environmental implications of justice. However, some gaps in terms of understanding the cause and effect of equity and justice during ongoing changes, persist (Nayak and Armitage, 2017). There is also a lack of information in academia on how social science can help address these concerns arising from regime shifts (Samonte et al., 2010).
- **Power Dynamics and politics:** The role of power and politics is important for understanding the drivers of regime shifts and implementing effective, sustainable management responses. Gaps for this dimension exist due to the lack of approaches and strategies needed to understand who gains and losses from SERS (Nayak and Armitage, 2017). Managerial approaches such as collective choice arrangements may exist in form, but in practice various bureaucratic actors or local powerful authorities could potentially undermine its validity (Cox et al., 2010).
- **Governance to navigate regime shift:** It is understood that governance can be used to steer away from unexpected and undesirable change. However, there is a gap in terms of understanding the sensitivity to change of the institutions in place (Nayak and Armitage, 2017). Often there is a lag that exists between rapid change and managerial responses leading to a fundamental mismatch between environmental problems and institutional responses (Epstein et al., 2015). To respond to the changes taking place, the governance responses from the various actors could range from preventative, or reactive in the form of influencing transformation. Understanding where actors stand from the local community's perspective could lead to insights on the effectiveness of the said responses.

Dimension	Contribution
Differentiating drivers	<ul style="list-style-type: none"> <li>• Understanding directionality of drivers reveal information regarding current system functions which could lead to a better understanding of critical thresholds of slow variables (Walker et al., 2012)</li> <li>• Distinction between internal and external drivers clarifies the role of local communities in responding to the changes (Geist and Lambin, 2002)</li> </ul>
Levels and Scales	<ul style="list-style-type: none"> <li>• Focus on levels and scales of occurrence of change guides managerial responses to various ecological and social components being impacted first within a system (Crépin et al., 2012)</li> <li>• Insight on local dependence on the ecosystem services provides insights regarding feedback interactions (Kerner and Thomas, 2014)</li> <li>• Identifying vulnerable components of social and ecological subsystems could provide insights on managing thresholds to avoid drastic changes (Biggs et al., 2012)</li> </ul>
Social-ecological units	<ul style="list-style-type: none"> <li>• To move beyond using an ecosystem scale, or a resource system as a social-ecological unit, this dimension focuses on identifying ecological and social units that the local communities depend (Nayak and Armitage, 2017). Hence, moving away from the trend in literature of focusing primarily on the ecological subsystem (Yulianto et al., 2015).</li> </ul>
Equity and social justice concern	<ul style="list-style-type: none"> <li>• Highlighting potential sources for inequity has implications for understanding the interactions between slow and fast variables in feedback interactions (Yulianto et al., 2015).</li> </ul>
Power and Politics	<ul style="list-style-type: none"> <li>• Identifying the most and least powerful individuals or groups could lead to insights on intentionally reorganizing or responding to any ongoing changes, through direct interactions with the fast variables. Fast variables are often dependent on controlling slow variables, however recurring interventions by those in power at the level of fast variables could result in fostering resilience or facilitating transformations. (Setiawan et al., 2017)</li> </ul>
Governance to Navigate regime shift	<ul style="list-style-type: none"> <li>• Assessing governance responses to change provides insights regarding the future direction of managing slow variables and maintaining feedbacks. It provides points for intervention (Nenadovic and Epstein, 2016)</li> </ul>

Table 3.2 contains information regarding how exploring each of the six dimensions of SERS could lead to a better understanding of interactions amongst fast and

slow variables. The six dimensions focuses on the interactions between the social and ecological subsystems. Hence facilitating an understanding of the dynamics of fast and slow variables in both subsystems, rather than following the ongoing trend in literature and focusing primarily on the ecological subsystem.

### **3.3 Identifying Ongoing Changes and Critical Slow Variables Within the SES of Karimunjawa National Park**

This section focuses on identifying social and ecological change, the nature of change, and its implications on crucial slow variables and its ongoing feedback interactions in Karimunjawa. Identifying and managing a limited number of crucial slow variables can foster resilience within a system and prevent drastic and damaging changes (Ferrara et al., 2016; Crépin, 2007; Armitage and Johnson, 2006). Resilience can be defined as “the capacity of a linked social-ecological system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity” (Kerner and Thomas, 2014; Walker et al., 2006; Holling, 1973).

This thesis uses identifying crucial slow variables and their interactions with fast variables as the first step to understanding implications of ongoing change (Ferrara et al., 2016; Crépin, 2007), and is followed by an analysis of changes amongst these variables using an integrated social-ecological systems perspective. To understand the two-way feedback interaction amongst the fast and slow variables within the Karimunjawa SES, ongoing changes are discussed and listed based on local perception in the following sections. Fast and slow variables identified in this chapter by no means form an extensive list of variables within Karimunjawa National Park, but merely highlight the prominent variables as referred to in current literature and as established by the local communities.

#### **3.3.1 Results: Identifying Critical Slow Variables and Ongoing Changes within the Social Subsystem**

Three main slow variables were classified within the social subsystem namely, culture and values, property and use rights, and wealth and infrastructure (Mellado et al., 2014; Coulthard et al., 2011; Wilkinson, 2008) (Table 3.3). Since questions about the nature of change were included in both interviews and survey, the results were combined to present collective data. Some respondents and informants identified more than one



slow variable and others did not indicate any potential feedback interactions, and/or did not participate in the plausibility of future scenarios related to the system functions of Karimunjawa National park. More information about identification of slow variables using the qualitative data analysis tool, Atlas ti, and coding can be found in the methodology chapter of this thesis.

Table 3.3 Slow variables identified within the social subsystem (Interviews n=50; SERS Surveys n=25)

Slow variables	% Of informants and respondents (n=75)
Wealth and infrastructure	49%
Culture, Norms and long standing local institutions	35%
Property and use rights	11%

Wealth and infrastructure was identified as a crucial slow variable by 49% of the informants and respondents. Relevant fast variables discussed include household income, local population, and employment opportunities. Changes and improvements in infrastructure were recognized by 67% of the informants (Table 3.4) in the form of improved conditions of roads, access to electricity, and increased construction of stable brick house structures.

Table 3.4 Changes identified by the local communities (Interviews n=50; SERS Survey n=25)

Change identified	% of informants (n=75)
Increase in local and foreign tourists	87%
Improved economy	73%
Change and improvements in Infrastructure	67%
Change in means of livelihood	64%
Change in land use (including increased number of homestays, resorts and beach developments, facility developments)	57%
Increased social discrepancies causing change in local behavior and attitude	53%
Increased awareness (such as rise in technology)	47%
Increase in number of associations	47%
Increase in pollution	40%

Culture, norms, and long standing institutions were identified by 35% of the respondents as crucial components of their system. Some fast variables interacting with culture as a slow forming variable include local preferences and satisfaction, individual

choices, local demands, and connectivity. Lastly, although identified as a slow variable, property and use rights was not widely seen as a crucial controlling variable. This could potentially be because the impacts of changes in property and use rights and use are not currently widespread. Changes in the form of increase in number of resorts and beach development, as identified by 57% of the informants, are noticeable but the impacts are potentially long term.

Local respondents identified various changes concerning critical slow variables. Table 3.4 contains a list of changes identified by the local respondents and informants in the social subsystem. Individual responses to changes in the social subsystem were not limited to one change.

The rise in the number of tourists was identified as an ongoing change that the local communities were not prepared for. This rise in the number of tourists was assigned to drivers of change such as government strategies, increasing use of technology and social media awareness, combined with the availability of pristine beaches and marine tourist activities. Improvement in the economy was identified as the second most prominent change in the social subsystem. According to the local informants, the improved economy is the byproduct of the rise in tourism and the availability of alternative means of livelihood for the local communities, as they were previously struggling with fishing as their primary source of income. There are prominent changes in livelihoods that are discussed in depth in chapter 4 as a means of adaptation to the ongoing changes.

Change in land use driven by increasing populations, changing infrastructure, and changing demands, is causing further changes in the system such as changing preferences and increased opportunities. Another change identified by 53% of the informants is the increased social discrepancies causing a change in local behavior and attitude. Changes in local attitude and behavior is noted amongst the local families of fishers due to drivers such as increased opportunities, increased westernization, and change in family dynamics. 47% of the informants identified increased awareness as an ongoing change in the form of increased use of social media and technology. The informants believe that improvement in communication is primarily a result of increased globalization. Another change identified within the social subsystem is an increase in the number of

associations. This change in connectivity in the form of the increased number of associations is also discussed in chapter 4 of this thesis. Lastly, 40% of the informants noted an increase in pollution as an ongoing change. Increase in local pollution was primarily attributed to the rise in construction of new buildings and facilities.

Changes in the social subsystems are further discussed through a lens of crucial slow variables and their impacts on fast variables. Each slow variable is defined and discussed in the following sections based on the literature review carried out for this thesis.

### **3.3.1.1 Culture, Norms, and Long Standing Institutions**

Karimunjawa's distinct local culture and values in addition to the long standing local institutions were identified as slow changing components that provide the local communities with grounds to internally communicate and govern their surroundings (Mellado et al., 2014).

Slow changing, controlling variables dictate the state of fast variables that is of immediate and primary concern to the human actors such as fishing effort and level of compliance with local regulations. Culture and norms impact the local communities' ability to take advantage of the improving economy and infrastructure. On the other hand, consistent changes in fast variables such as rising incoming tourists cause disruption and a need for reorganization in the slow variables. This reorganization is seen in the form of a rise in number of associations and changing local culture and norms to accommodate for impacts of westernization.

While discussing plausible future scenarios during on site in-depth interviews and focus groups, one recurring theme that was raised was primarily regarding the future of tourism. Two broad categories were discussed including assessing the future of the younger generations, and the future direction of tourism as compared with other coastal tourist destinations in Indonesia such as Bali. Such comparisons and understandings indicate a need for a focus on the underlying slow variable of culture, value and local institutions (Setiawan et al., 2017).

Predictions and projections regarding the future trajectories in local development are heavily based on local culture and values (Armitage and Johnson, 2006). Some local community members speculate the future to resemble the current state of Bali due to

constant institutional changes made within their society to accommodate for the rise in tourism. The village head of Kemujan Island, the second biggest tourist island in Karimunjawa National Park stated, “*the local institutions have been accommodating changes in tourism in the form of increased associations such as the Association of Tourist Guides*”. In contrast, other local community members speculate that the future would not look like Bali given the local community’s strict, religious code of conduct. A local fisher mentioned that, “*the local culture and religion do not tolerate or accept the consumption or distribution of alcohol, or the normalization of western beachwear*” (Interview 32). Based on the discussion above, and criteria defining slow variables (table 3.1), table 3.5 defines the culture, norms, and local institutions as a slow variable.

Criteria	Description
Nature	<ul style="list-style-type: none"> <li>• The local community’s perception of change and future direction of change is deeply rooted in the local culture, norms, and local institutions.</li> <li>• Fast changing variables impacted by or controlled by culture, norms and long standing institutions include levels of fishing effort, level of compliance with local regulations, awareness, and individual preferences and choices and behavior.</li> </ul>
Scale	<ul style="list-style-type: none"> <li>• Karimunjawa has developed a distinct fishing culture and norms dating back at least five generations of native fishers.</li> </ul>
Feedback interaction	<ul style="list-style-type: none"> <li>• Local communities deeply assimilate themselves as fishers despite the ongoing changes in the form of changing livelihoods and economy</li> <li>• Exogenous drivers including increased globalization, improvement in technology and regional tourism development goals, is impacting local norms and long standing institutions to assimilate to and respond to the changes.</li> </ul>

### 3.3.1.2 Property and Property Use Rights

Drivers of change such as globalization, improvement in technology, detailed regional tourism development plan, and increased outside investment is impacting property and use rights leading to structural changes (Hafsaridevi et al., 2018). The increase in demand for homestays and tourist facilities has necessitated increased attention towards acquiring and obtaining legal property ownership documents. Increasing privatization is also impacting local norms. A local farmer’s wife stated that

*“the cattle were allowed to roam free but now the local community members are getting more and more strict about restraining the cattle in a defined area of land, the children were allowed to roam anywhere on the island and now there are more restrictions and there is increasing privatization of land and decreased public access”* (Interview 8).

A few local beach property owners are taking advantage of their location by building resorts and homestays. However, due to the limited capital and investment available, the local communities have limited opportunities to grow with the changes. An informant mentioned, *“prior to tourism, we used to live farther away from one another, unlike the current landscape of communities living together in close neighborhoods”*. The communities slowly relocated closer to the harbor, hence paving the way to other structural changes such as the development of the “central market”, renovation old harbors, and construction of new harbors etc.



Figure 3.3: Images depicting changes in fast variables as it relates to property and use rights. Picture of the left depicts local households settled in close vicinity to each other. Picture on the right is of a local household renovated to appeal to tourists as a homestay accommodation (Photographs by author)

A persistent change in fast variables such as increasing level of interaction between human actors and social and ecological subsystems (for e.g., in the form of increased outsider investment) led to a change in property and use rights in Karimunjawa (Coulthard et al., 2011). Fast variables that play an important role include people’s preference and satisfaction, as they evolve during ongoing change (Ferrara et al., 2016). Local members of the community started renovating their house to be used as homestays

or guesthouses to accommodate for the growth and development in tourism (Table 3.4) (figure 3.3).

The way in which each community member reacted to change was largely based on perception, skill, and availability of capital at a household level (Ferrara et al., 2016). Change in land use enabled further change as it facilitated growth in tourism. A local fisher and tour guide stated that *“back when tourists started coming here in 2008, the only recreational activity available for the tourists was in the form of a lifejacket, now there are many things for the tourists to do both in the water and on land”* (Interview 49).

The increase in tourism is leading to changes such as more homestays, on-land recreational activities and an increase in pollution. A local resort owner stated, *“there have been a lot of foreign investments in Karimunjawa but not enough development to show for it, the investors are only trying to benefit from the growth and are not interested in strengthening the local economy, so we have a problem with it”* (Interview 29).

The local community interprets rise in foreign investments as a positive change if benefits are shared amongst the local communities. However, with the trend in current investments, investors are solely interested in reselling the land, as Karimunjawa becomes a popular tourist destination on a global scale. A local fisher stated that *“increased privatization for the sake of tourism is good as long as we get some benefits from it...it is not good if it’s only for the sake of individual or selfish gains”* (Interview 3).

Table 3.6 Defining property and use rights as slow variable

Criteria	Description
Nature	<ul style="list-style-type: none"> <li>• Property and use rights in Karimunjawa have a predominant history that involves early settlers of the island using land for cultivation.</li> <li>• Changes in governance systems allow further changes in the form of privatization of land, MPA zoning, and property and use rights. These rights dictate the nature of fast variables such as the local community’s interaction with the ecological subsystem in the form of land use. Other fast variables include foreign investment, access to resources, and local population.</li> </ul>
Scale	<ul style="list-style-type: none"> <li>• Property and use rights maintain stability and tend to remain constant over multiple years</li> </ul>
Feedback interaction	<ul style="list-style-type: none"> <li>• Exogenous drivers include increasing population, globalization, improvement in technology, regional tourism development plan, and increased outside investment</li> <li>• Enabling increased development encourages local growth in economy and changes in livelihood by providing opportunities to the local communities.</li> </ul>

Analyzing property and use rights, as a slow variable is important as it provides insights on the role it plays in the feedback interaction amongst other variables and human responses. It also sheds light on the importance of factoring in individual perception, skill, and availability of capital at a household level to respond to and understand ongoing change. Table 3.6 defines property and use rights as an important slow variable in the social subsystem based on the criteria defined in table 3.1.

### **3.3.1.3 Wealth and Infrastructure**

The third slow variable in the social subsystem discussed in this chapter is wealth and infrastructure. Changes amongst wealth and infrastructure have implications on the unequal distribution of opportunities and rising social discrepancies. A local fisher stated, *“it used to be that each person had their thing, a resort owner only had his resort, a fisher was just a fisher, but now more and more people are doing everything given the growth in wealth. Now, a fisher can also be a homestay owner and a tour guide. This is taking away opportunities from those who are less wealthy”* (Interview 31).

Wealth and infrastructure is an important underlying slow variable within a SES as it dictates local interactions with their natural resources. An informant mentioned that, *“with improvements in infrastructure local lifestyle is becoming more convenient and easier. We used to have to walk everywhere and now we can just use our motorcycle for transportation”* (Interview 17). Changes such as technology and improvement in the local economy are impacting slow variables of wealth and infrastructure. Some locals, depending on their capacity, are using changes such as improvements in technology to their benefits. A fisherman from Karimunjawa mentioned, *“I have been using Whatsapp on my phone to sell fish in the market. I send pictures of my catch, with the prices, to the buyers and they tell me if they want to make the purchase. So far, I believe I am the only one who is using technology like this”* (Interview 47).

Beach aesthetics, as a form of infrastructure, is a fast variable that is being impacted in the form of increased pollution and littering. A local fisher stated that the *“areas of infrastructure that benefit from this wave of the rise in tourism get improvements and funding, other areas such as the matter of proper garbage disposal and increased pollution are not being dealt with”* (Interview 50). Moreover, understanding wealth and infrastructure as a slow variable have implications on

understanding social justice issues and inequity (Samonte et al., 2010). It is primarily the investors and resort owners who are benefiting from the overall changes and not the local communities (further discussion in section 3.5.1.4). Constant changes in fast variables present many possible challenges, but also opportunities for intervention (Ludwig et al., 2001; Taruc, 2011). It is essential to understand the processes that may destabilize these slow variables or the points at which thresholds are reached. Fast and slow variables also exist in the ecological subsystem, and since the separation between the subsystems is arbitrary, changes in one system could impact the other. Table 3.7 defines wealth and infrastructure as a slow variable (based on the criteria defining slow variables in table 3.1).

Criteria	Slow Variable
Nature	<ul style="list-style-type: none"> <li>• Wealth and infrastructure are important building blocks of a social subsystem that provides pathways for future trajectories during ongoing change by providing opportunities for income and development and influencing access to resources.</li> <li>• Fast variables impacted by or often controlled by wealth and infrastructure include income, employment opportunities and local demands.</li> </ul>
Scale	<ul style="list-style-type: none"> <li>• Wealth in a system is accumulated over a period of several years.</li> </ul>
Feedback interaction	<ul style="list-style-type: none"> <li>• Exogenous drivers of change include increased globalization, improvement in technology, regional tourism development plan and increased outside investment.</li> <li>• Growth in wealth and infrastructure provides stable grounds to engage the local communities in alternative means of livelihoods impacting fast variables such as income, employment opportunities, and local demands.</li> </ul>

### 3.3.2 Results: Identifying Critical Slow Variables and Ongoing Changes within the Ecological Subsystem

Slow variables within an ecological subsystem are known to collectively determine the dynamic behavior of a system, and which in turn influence the ecosystem goods and services available to people (Walker et al., 2002; Armitage and Johnson, 2006). Prominent slow variables have been identified using previous research conducted in the coastal social-ecological system of Karimunjawa National Park (Hafsaridevi et al., 2018; Enriquez-Acevedo et al., 2018; Baskara et al., 2017). However, this section focuses on the crucial slow variables, with the potential thresholds of concern, as recognized by research participants, in addition to identifying some prominent fast variables interacting



with ongoing change. These thresholds of concern are based on various ecosystem services that the local community members depend on either directly or indirectly.

Changes identified within the ecological subsystem are stated in table 3.8. These changes are discussed in the following sections as it relates to the prominent slow variables.

Change	% Of informants and respondents
Coral reef destruction	53%
Increased pollution	53%
Reduction in forest area and increased beach development	51%
Decrease in Fish biomass	68%

The main slow variables identified include coral reef structural capacity, beach conditions and functions, and fish biomass and biodiversity (Table 3.9). Functions of these slow variables control fast variables within the social-ecological system of Karimunjawa such as local livelihoods and living conditions (Walker et al., 2002). Changes amongst each slow variable are discussed in the following sections.

Slow variable	% Of informants and respondents
Fish Biomass and Biodiversity	48%
Beach Functions and Conditions	16%
Coral Reef Structural Complexity	12%

Other crucial slow variables that were mentioned and discussed include ecological productivity of the mangrove ecosystems, soil quality, and forest coverage. These slow variables were not included within the scope of this research given the limited amount of mentions by research participants,

### 3.3.2.1 Coral Reef Structural Complexity

Indonesia is one of six countries within the Coral Reef Triangle- the area with the highest species diversity 590 of worlds 793 known reef coral species (Yanovski et al., 2017). Coral reefs are often understood as structurally complex ecosystems that depend

on the heterogeneity of its structural elements and processes for their ability to recover from degraded states (Yanovski et al., 2017). Karimunjawa coral reef habitat and ecological functions support local subsistence fishing and provide ecosystem services such as natural coastal protection, aesthetic and cultural values, and a recently booming tourism sector (Wilkinson, 2008; Setiawan et al., 2017).

Revenue-generating activities such as snorkeling and diving depend on the pristine conditions of coral reef. An informant stated that “*Coral reef has sustained the fishers of this island for decades, and now they continue to sustain us as tourism depends on the beauty of this island*” (Interview 31). Change in fast variables such as increased destruction of coral habitat and long-term persistent use of destructive fishing methods creates patterns of disruption, which leads to structural change in the reef (figure 3.4). Moreover, exogenous drivers such as climate change and rise in greenhouse gas emissions impact the coral reef ecosystem by causing frequent coral bleaching events (Kittinger et al., 2012). Other drivers causing similar impacts include rising occurrences of a severe storm, changing weather patterns and ocean acidification (Hoegh- Guldberg et al., 2007).



Figure 3.4 Images depicting change in fast variables. An example of boats anchored to the underlying coral (not visible) while tourists participate in recreational activities such as snorkeling and diving. The main island of Karimunjawa is visible in the background. (Photographs by author)

Exogenous drivers and persistent changes in fast variables can push thresholds causing an irreversible change in the current state of coral reef. Coral reef ecosystems were identified as the most vulnerable component of the ecological subsystem by 52% of the respondents of the SERS survey. The vulnerability was recognized in the form of the irreversible nature of changes. For example, a local fisher and resort owner stated that *“the coral reef is facing long term damage as one or two types of coral is missing and not regenerating fast enough, there used to be many whales and dolphins visible from the shore as well but not anymore...these changes are impacting the food chain”* (Interview 29). A local high school teacher from Kemujan village stated that *“there is a rise in seaweed growth that is also impacting the state of coral, there is awareness regarding this in our community as the children in senior high schools usually replant coral and learn seaweed cultivation as part of the curriculum”* (Interview 12). There is general awareness regarding the importance of maintaining delicate coral reef ecosystems as it controls ecological functions necessary to produce desirable ecosystem services. Based on the discussion, Table 3.10 defines coral reef structural complexity as a crucial slow variable in Karimunjawa National Park.

Table 3.10 Defining coral reef structural complexity as slow variable

Aspect	Slow Variable
Nature	<ul style="list-style-type: none"> <li>• Coral reef structural complexity, often linked to biodiversity and carrying capacity, can be understood as a slow changing variable that strongly influences the coral ecosystem</li> <li>• Structural complexity controls aspects of coral ecosystem such as food chain interactions and water quality integral to maintaining coral ecosystem and providing ecosystem services to the local resource users</li> </ul>
Scale	<ul style="list-style-type: none"> <li>• Structural complexity on an ecological scale is multifaceted and takes multiple years to take form</li> </ul>
Feedback interaction	<ul style="list-style-type: none"> <li>• Exogenous drivers include global warming that can push thresholds (i.e. by interacting with food chains) and convert stable domains from a coral dominated to coral-depauperate state</li> <li>• Local interactions with the coral reef ecosystem in the form of destructive fishing methods and increasing water pollution prompts positive feedback interactions that disrupts reef ecosystem process</li> </ul>

### 3.3.2.2 Beach Functions and Conditions

Another crucial component of the coastal social-ecological system is beach functions and conditions. Within Karimunjawa, 16% of the total respondents and informants identified beach functions and conditions as a slow variable. The pristine condition of Karimunjawa's white sand beaches is a prominent feature, and a selling point for the thousands of local and international tourists (Enriquez-Acevedo et al., 2018).

The quality and ecological functions of Karimunjawa beaches are being impacted in the form of changing sand quality and clearing of trees and vegetation. An informant mentioned that *“the beach used to be made up of all white sand, and now its slowly turning brown”* (Interview 10). These impacts are primarily due to drivers such as increased beach developments, improvements in infrastructure and rise in pollution (figure 3.5). The community recognizes the need to maintain the “pristine” conditions of the beach to maintain the steady rise in tourism. More adaptive responses are discussed in the next chapter of this thesis.



Figure 3.5 Images depicting drivers of change. On the left is a picture of a beach in Karimunjawa undergoing construction of a resort. Picture on the right is of a beach in Kemujan depicting the beginning stages of building a resort. (Photographs by author)

Combined with changes in other slow variables such as property and use rights, beach functions are made vulnerable to change, as there is an increase in interactions with the beach ecosystem in the form of rise in construction. There are social injustice and inequality implications of identifying beach functions as a slow variable as a local

informant mentioned that, “*outside resort owners hold power to define and control interaction with the beach ecosystem*” (Interview 14). Management of beach functions as a slow variable is limited to locally enforced restrictions, such as constraints on sand extraction for construction, and building houses. One key implication of understanding local beach functions and conditions as a slow variable is the mismatch between the source of vulnerability and impacts, and management approaches in dealing with the change.

Table 3.11 defines beach functions and conditions as a slow variable that plays an important role in defining the parameters of ongoing change in the social-ecological system of Karimunjawa.

Aspect	Slow Variable
Nature	<ul style="list-style-type: none"> <li>• Functions and conditions of sandy beaches of Karimunjawa hold ecological, economic, recreational, aesthetic, and cultural values for the local communities</li> <li>• Beach functions and conditions controls fast variables including water turbidity and coastal erosion</li> </ul>
Scale	<ul style="list-style-type: none"> <li>• Beach conditions including factors such as sand quality takes multiple years to form</li> </ul>
Feedback interaction	<ul style="list-style-type: none"> <li>• Exogenous drivers of change include fluctuating weather patterns, changing wind patterns, increased pressure on coastal development</li> </ul>

### 3.3.2.3 Fish Biomass and Biodiversity

48% of the total respondents and informants identified fish biomass and biodiversity as a slow controlling variable. The most prominent ongoing change within the ecological subsystem is the decrease in fisheries, as identified by 68% of the respondents and informants. Local communities of Karimunjawa have been highly dependent on fisheries for sustenance, and economic or commercial purposes for a long time, long before tourism was introduced in the local economy (Baskara et al., 2017; Setiawan et al., 2017). However, there has been a steady decline in fisheries catch in Karimunjawa as seen in figure 3.6, (Ramadhan et al., 2016; Hafsaridevi et al., 2018).

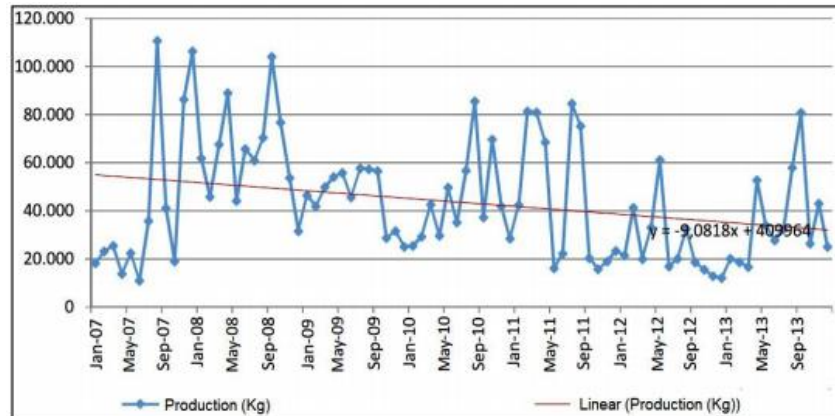


Figure 3.6 Fisheries catch in Karimunjawa National Park from the year 2007- 2013 (Ramadhan et al., 2016; Hafsaridewi et al., 2018)

There are direct drivers of change that include the use of destructive fishing techniques such as trawling, the global phenomenon of climate change leading to habitat destruction, and lack of awareness amongst the fishers that affects fish abundance and biodiversity. Some global drivers such as rise in international demand for fish exports also drive change. Rise in global demands for fish invites commercial fishing vessels that are better equipped to catch and store larger quantities of fish (‘fishing roving bandits’ (Berkes et al., 2006). A local fisher stated that, “*there are big ships that come from places such as Pekalongan, Semarang, and Jepara, who have better technology and equipment, that catch a lot of fish*” (Interview 24). Changes taking place on various levels and scales forms a feedback loop, which when recognized and understood, could lead to sustainable local management strategies (discussed in chapter 5).

In Karimunjawa, the availability of both demersal and pelagic fish attracted many migrant fishers over the years seeking to benefit from the available marine resources. This interaction between the marine resources and the local and migrant fishers plays a big part in defining Karimunjawa National Park into an interactive and complex social-ecological system. The geographical location of Karimunjawa, which is located on the mainland offshore region, makes this area rich in pelagic fish that is of high economic value such as cob, skipjack tuna and mackerel (Ramadhan et al., 2016; Hafsaridevi et al., 2018). Based on the catch results, pelagic fish form majority of the total catch (70%), whereas demersal/coral fish make up 30% of the total catch (Ramadhan et al., 2016). The demersal fish population in Karimunjawa has unique properties such as its wide variety in



which it is available due to the transition between the fish types in the Thousand islands and Bali Sea (Syaifudin et al 2013).

The types of demersal fish with economic value come from the Serranidae (Grouper) and Labridae (Napoleon) family (Hafsaridevi et al., 2018). Prior to Karimunjawa becoming a tourist destination, coral reef fish were not included in the catch target, however with the rise in tourism, the preference for coral reef fish increased leading to an increase in coral reef fish exploitation as seen in figure 3.7 (Hafsaridewi et al., 2018). The results from the interviews also portray this slight shift in focus from pelagic to demersal/ coral fish. A respondent stated that, “*villagers have been eating parrotfish as a regular part of their diet but ever since the tourists started coming here the price of the fish went up so the villagers just tend to sell it to the tourists instead*” (Interview 24).



Figure 3.7 Images depicting changes in fisheries. Picture on the left depicts variety of fish available for purchase especially for the benefit of the tourists at the night market in Karimunjawa (species pictured include: squid, red snapper, shrimp, and parrot fish). Picture on the right depicts a local fisherman preparing anchovies to be dried and prepared as marketable commodity. (Photographs by author)

This impact of tourism is not as evident in other villages where tourism has not developed yet. However, other drivers, such as international demand, are taking effect. An informant from Nyamuk Village, where there is minimal to no development in tourism, stated that, “*the type of fish that we catch now a days is Parrotfish and Kuning, and it’s usually for national and international exports to markets in Jepara, Jakarta and Singapore*” (Interview 39). Additionally, results from the interviews also revealed that

there is increased focus on catching “*Kantri*” or squid and anchovies near the shore due to their increasing demand and high economic value (figure 3.7). In response to questions regarding slow and controlling changes and its impacts, an informant mentioned that, “*due to the changing preferences and demands, the fishers with sophisticated technologies [such as trawlers], puts pressure on the various species that potentially harms the coral and depletes the fish*” (Interview 30). The aforementioned evidence points to three main drivers of change impacting fish biomass and biodiversity, these drivers are the rise in tourism, rise in international demands, and use of sophisticated and modern technologies such as trawlers and large capacity fishing vehicles. There have been efforts to maintain fisheries and biodiversity. However, identifying it as a slow variable allows for a discussion on its feedback interaction, which could lead to a better predictability of change. Table 3.12 defines fish biomass and biodiversity as a slow variable.

Aspect	Slow Variable
Nature	<ul style="list-style-type: none"> <li>• Fish biomass and biodiversity forms a critical slow variable that plays an important role as it is tied to the very fabric of Karimunjawa as a social-ecological system.</li> <li>• Fish biomass and biodiversity governs fast variables such as species availability, fishing effort, local preferences, and choices.</li> </ul>
Scale	<ul style="list-style-type: none"> <li>• Biomass and biodiversity take multiple years to form and establish a stable regime.</li> </ul>
Feedback interaction	<ul style="list-style-type: none"> <li>• Exogenous drivers of change include global warming and fluctuating national and international demands.</li> </ul>

Understanding and identifying fast variables based on the changes taking place within the social-ecological system of Karimunjawa leads to a clearer understanding of drivers of change.

### 3.3.3 Nature of change and social-ecological regime shifts

One of the main attributes of a social-ecological system is its complex nature that makes predicting and managing change a challenging task (Garcia and Charles, 2008; Nayak, 2011; Setiawan et al., 2017). Within this complex system, there are changes



taking place on various scales that leads the system to cross thresholds into new regimes (Armitage and Johnson, 2006). More recently, there has been a shift of focus from viewing humans and the social subsystem as more than just a force or driver of change, but also as an impacted variable necessitating adaptive mechanism and responses (Nayak and Armitage, 2018).

As part of the SERS survey, respondents were asked to select a series of characteristics that defined the social and ecological changes identified by them. The results are presented in tables 3.13 and 3.14. The most notable characteristic used to describe both environmental and social changes is “significant/substantial,” with 52% (social) and 72% (ecological) of survey respondents agreeing that the changes they have been experiencing have widespread positive and negative impacts on the local communities. Other prominent descriptors of change as identified by the local communities include “long-term”, “difficult to predict”, and “difficult to reverse”. While changes within the ecological subsystem were characterized as “dramatic” by 40% of the respondents, the number was lower for the social subsystem (8%).

Table 3.13 Nature of changes taking place in the social subsystem (SERS Survey n=25)

Nature of Changes	% Of respondents
Sudden/Abrupt	12%
Dramatic	8%
Long-term	48%
Significant/substantial	52%
Difficult to predict/anticipate	28%
Came without early warning signals	36%
Difficult to reverse	32%
Problem in understanding/comprehending	28%
Problems in responding to (no just let it be)	28%
Caused substantial reorganization in the structure, functions, and feedbacks of the ecosystem	32%
Change from one ecological state to another	32%
Pose significant challenge to local fisher communities, managers, and others	36%

Nature of changes	% Of respondents
Sudden/Abrupt	0 %
Dramatic	40%
Long-term	60%
Significant/substantial	72%
Difficult to predict/anticipate	64%
Came without early warning signals	44%
Difficult to reverse	68%
Problem in understanding/comprehending	60%
Problems in responding to (no just let it be)	52%
Caused substantial reorganization in the structure, functions and feedbacks of the ecosystem	44%
Change from one ecological state to another	48%
Pose significant challenge to local fisher communities, managers, and others	60%

A social-ecological regime shift is defined using characteristics such as, “long-term”, “significant”, and “difficult to predict”. While more data is needed to conclude specific regime shifts taking place, there is a phenomenon of social-ecological regime shifts taking place in Karimunjawa with implications for ecosystem services (for example dependence of ecological units) and human wellbeing (dependence on social units and injustice and inequity implications). The following section explores the intersection of social and ecological subsystems and the six dimensions of social-ecological regime shifts.

### **3.5 Social-Ecological Regime Shift and its Six Dimensions**

#### **3.5.1 Analyzing Changes Based on the Six Dimensions of SERS**

Identifying nature and drivers of change is based on the type of regime shift being looked at (Nayak and Armitage, 2018). The compilation of various changes within the Karimunjawa National Park has led to a shift from a primarily fisher and farmer community to a tourist destination attracting thousands of local and international visitors each year, with severe implications on both social and ecological systems (Puryono and Suryanti, 2019; Setiawan et al., 2017; BTNKJ, 2017; Yulianto et al., 2010). Identifying social-ecological drivers of change and their linkages uncovers the source of rapid change and leads to uncovering its implication on policy and governance interventions (Nayak and Armitage, 2018). The separation between the social and ecological subsystems is, in

most cases, arbitrary and artificial (Berkes and Folke, 1998). Understanding the link between the proximate causes and underlying forces of change can help minimize uncertainty and complexity within a social-ecological system (Nayak and Armitage, 2018).

Small island rural communities such as the ones residing in Karimunjawa National Park are often highly dependent on marine resources for their livelihoods (Puryono and Suryanti, 2019). Due to the interconnected nature of social-ecological systems, any major disruption in the functions of the ecological system likely causes disruption in the social subsystem and vice versa. Within a social-ecological system, one system might go through drastic, irreversible change before the other system (Nayak and Armitage, 2018). SERS survey was conducted to collect data for each dimension to highlight potential points of intervention during ongoing changes. Following sections present data collected from 25 respondents representing the fishing livelihood category (see section 2.3.5).

### **3.5.1.1 Differentiating Drivers of Regime Shifts**

Differentiating drivers of change provide a means to connect crucial components within a system and understand the flow of change and its impacts, hence making it easier to identify and manage various implications of change. Viewing drivers of change from a lens of positive and negative impacts created could allow for categorization of drivers to understand and respond to ongoing changes. Based on the SERS surveys, the most prominent positive impact of change is a rise in overall income, with 56% of the respondents stating increased income as the main positive impact of changes taking place in Karimunjawa (Table 3.15). The prime drivers of change that led to an overall increase in income are identified to be a rise in demand for tourism-related services such as homestays and tour guides, and goods such as souvenirs and barbequed fresh fish. A fisher from Karimunjawa Village mentioned that overall family incomes were rising because with the increase in tourists, *“the mothers can now sell cooked fish to the tourists in the market”* (SERS survey 2).

Other positive impacts include increased awareness and improved lifestyle of the people of Karimunjawa. As one fisher stated, *“Villagers have increased awareness to improve education and their skill sets. There are a lot of tourists coming here and the*

communities want to maximize their profits from tourists, so they are willing to improve their education level. The younger generations do not want to become fishers, they want to get involved in tourism industry” (SERS Survey 3).

Table 3.15 Positive impacts of change, as identified by respondents (SERS Survey n=25)

Drivers of Change	Positive Impact	% of Respondents
<ul style="list-style-type: none"> <li>• Emergence of Karimunjawa as a tourist destination</li> <li>• Improved economy</li> <li>• Rise in tourism-related income-generating opportunities</li> </ul>	Rise in income	56%
<ul style="list-style-type: none"> <li>• Improvement in technology</li> <li>• Awareness campaigns</li> <li>• Rise in social media use</li> </ul>	Increased awareness (regarding mangroves, importance of coral, education)	44%
<ul style="list-style-type: none"> <li>• Improvements in infrastructure</li> <li>• Rise in income</li> </ul>	Improved lifestyle (access to electricity, use of technology)	44%
Not applicable	No positive	12%

Decreasing fish biomass and the increasing damage inflicted on the coral are the top two negative impacts of change, stated by 60% and 56% of the respondents respectively (table 3.16), followed by a change in culture, which was noted by 48% of the respondents. The change in culture mainly referred to an increase in westernization leading to changes in clothing and behavior amongst the younger generations. Negative impacts in the form of the increasing population were noted by 40% of the respondents. The increasing population encompasses impacts such as overcrowding, increased construction, and increases in the garbage. A respondent stated that “*the streets used to be clean, but now there is too much garbage*” (SERS survey 14).

Changes in behavioral patterns were identified as a negative impact by 32% of the respondents. The responses for this negative impact were primarily targeted towards local fisher’s behavior. A fisher stated that “*with increasing competition and decreasing fish, the income is unpredictable, and the fishers must go farther away to catch fish*” (SERS Survey 15). Another stated that “*in unpredictable circumstances such as there, when a*

*fisherman catches a lot of fish he will be treated like the king and if someone who doesn't get enough fish will be ranked lower"* (SERS Survey 5). 32% of the respondent stated no negative impacts, however, some mentioned that it is possible that the negative impacts will be more prevalent and demand effective management strategies in the near future (discussed in section 3.5.1.2).

Table 3.16 Negative impacts of change, as identified by respondents (SERS Survey n=25)

Drivers of Change	Negative Impact	% Of respondents
<ul style="list-style-type: none"> <li>• Reduction in fisheries catch</li> <li>• Climate change</li> </ul>	Loss of income and disruption in fisher's livelihoods	60%
<ul style="list-style-type: none"> <li>• Destructive fishing methods</li> <li>• Improper interaction with coral</li> <li>• High winds</li> </ul>	Damage inflicted on the coral	56%
<ul style="list-style-type: none"> <li>• Increased westernization</li> <li>• Increased use of social media</li> </ul>	Change in culture	48%
<ul style="list-style-type: none"> <li>• Availability of opportunities</li> <li>• Growing tourism industry</li> <li>• Increasing infrastructure development</li> </ul>	Increasing population	40%
<ul style="list-style-type: none"> <li>• Changing livelihoods</li> <li>• Changes in family structure</li> <li>• Generational gap widened due to widespread use of technology</li> </ul>	Changing behavior	32%
Not applicable	No negative impact	32%
Not applicable	Not answered	12%

The rise in tourism is driving changes such as changes in preference for the fish catch. Prior to Karimunjawa becoming a tourist destination, coral reef fish were not included in the catch target. However, with the rise in tourism, the preference for coral reef fish increased, leading to an increase in coral reef fish exploitation (Hafsaridewi et al., 2018). The results from the interviews also portray this shift in focus from pelagic to demersal/ coral fish. One informant stated that *"fishers are increasingly focusing on catching fish such as Kantri (squid) and anchovy because in order to match the demands created from tourism"* (SERS survey 20).

There is an increased focus on catching squid due to its increasing demand and high economic value. Since the fishers are encouraged to catch the fish with the most economic value, the squid population may face some impacts over the next few seasons. The source, scale and directionality of drivers of change is best described in the following quote from a fisherman who is describing the nature of change as witnessed in Karimunjawa: “*Over the years there has been an increase in tourism, which has led to an increase in the number of homestays and hotels. People are changing their jobs and livelihoods to take advantage of the opportunities in tourism*” (SERS survey 19). As discussed in the previous sections, there are several drivers that cause a rapid increase in tourism, which lead to other changes such as a change in livelihoods, income, and culture in Karimunjawa.

### **3.5.1.2 Levels and Scales of occurrence and interventions**

In a social-ecological system, persistent changes on a local scale can have long-term impacts on ecological processes (Buizer et al., 2011). Responding to change involves identifying and understanding cross-scale dynamics that add to the complexity of managing and governing social-ecological systems. Identifying components of social and ecological subsystems that were impacted first, followed by identifying vulnerable components in each subsystem potentially provides system managers with a flow of most prominent change and impacts. If intervention and management responses do not match the scales and levels at which components are being impacted, it leaves system components vulnerable to further changes in a form of positive feedback interactions (Crépin, 2007; Walker et al., 2012; Buizer et al., 2011). For example, due to the sudden influx of national and international visitors in Karimunjawa, the regional institutions and policies were not well equipped to face a high influx of tourists, which led to a high level of improvisation on a local level (Setiawan et al., 2017). While discussing the initiation of the tourist guide association, the head of the association stated that, “*we were initially a group of five people who wished to be good hosts to the incoming tourists who were visiting us and needed our help navigating around the island*” (Interview 3). The association was formed out of necessity on a local level to respond to the rise in tourism. There were also changes taking place in the ecological subsystem that allow the local communities to respond to the changes in the social subsystem.

The respondents identified a change in fisheries to be an important component of the ecological system that was impacted first (Table 3.17). Local fishers noticed a change in biomass; this change was measured in the form of travelling farther distances for the same amount of catch. They also mentioned damage to the coral reef ecosystem due to the unsustainable fishing practices carried out by non-local fishers with modern and sophisticated technologies such as trawls. 40% of the respondents stated that the quality of soil deteriorated, as they were unsuccessful in yielding crops such as bananas and jackfruit that were previously grown and harvested regularly. 56% of the respondents stated that there were changes taking place in the form of increased pollution that needed to be addressed. Additionally, there is no appropriate waste management solution in Karimunjawa that tackles the issue of rising waste production and rising quantities of sea garbage on a local level (Setiawan et al., 2017; Taruc, 2011).

Table 3.17 Important components of the ecological system impacted first, as identified by the respondents (SERS Survey n=25)

Ecological Components	% Of respondents
Fish abundance (red snapper “ <i>kakap merah</i> ”, groupers “ <i>Kerapu</i> ”)	72%
Coral	60%
Beaches and shoreline (Pollution in the form of increasing sea garbage and increased garbage production)	56%
Soil Quality	40%
No answer	28%

Identifying vulnerable components reveals the ecological reality as perceived by the local communities in Karimunjawa. Hence, providing baseline information needed for targeted intervention and management efforts. The most vulnerable ecological component identified by the respondents is the coral reef ecosystem (Table 3.18), followed by increasing pressure on fish resources. The rise in tourism is leading to a rise in fish demands, causing increasing pressures on fish species such as squid and sea cucumber. The local fishers often rely on sea cucumbers when they are unable to travel farther distances due to factors such as old age and limited availability of petrol for the boat. It is notable that although there are other vulnerable ecological components such as the state of mangrove ecosystem, noted in previous studies carried out in Karimunjawa; the respondents did not raise concerns regarding its state (BTNKJ, 2017; Yulianto et al.,

2010). Using local perception allows for an understanding of awareness regarding the interaction between social and ecological subsystems, hence providing common grounds and point of departure for cooperation for executing managerial responses to change.

Table 3.18 Vulnerable ecological components, as identified by the respondents (SERS Survey n=25)

Vulnerable Ecological Component	% Of Respondents
Coral Reefs	52%
Fish biomass (especially squid, anchovies, sea cucumbers)	22%
Forest	15%
No vulnerability	11%
Water Quality	11%
No answer	18%

In the social subsystem, most (60%) respondents stated income as an important component that was impacted first. Due to the changes in the ecological subsystem and decline in biomass, the fishing communities suffered in the form of loss of livelihoods. Karimunjawa presents a unique situation where impacted fisheries led to an overall decrease in local incomes, however, a sudden increase in local tourism, provided new income-generating opportunities within the local community. Given this unique transitional situation of Karimunjawa, 48% of the people identified a rise in inequality and social conflict to be an important component impacted first (Table 3.19). An example of such conflict and inequality includes high discrepancies in opportunities available for different groups due to reasons such as close ties with governance actors providing opportunities and high social status.

Table 3.19 Important components of the social subsystem impacted first, as identified by the respondents (SERS Survey n=25)

Social Components	% Of respondents
Income	60%
Incoming visitor traffic (increasing number of fishers, rise in number of local and international tourists, researchers)	56%
Rise in inequality and cases of social injustices	48%
No answer	20%



Local communities often rely on their “feel of change” based on their memory built from past experiences, cultural, and governance processes (Herrfahrtdt-Pähle and Pahl-Wostl, 2012). An insight on perceived vulnerable social components reveals scale sensitive information regarding critical thresholds that might initiate processes for reorganization and restructuring within the social-ecological system of Karimunjawa (Selkoe et al., 2015; Crépin, 2007). 44% of the respondents mentioned that their lifestyle and culture are vulnerable to change (table 3.20).

Table 3.20 Vulnerable social component, as identified by the respondents (SERS Survey n=25)

Vulnerable Social Component	% Of Respondents
Lifestyle and culture/next generation	44%
Available space and openness	32%
Less resources for the local community (less food, Local people will find it hard to find land Reduced docking space beach privatized)	32%
Livelihoods	28%
No vulnerability	12%
No answer	12%

One fisher stated that “*with the continuous ongoing changes such as rise in technology, the influence of westernization and diverse opportunities for livelihoods the younger generation is vulnerable to change and to face the impacts of change*” (SERS Survey 23). 32% of the respondents stated that they consider the availability of resources to be vulnerable in the face of constant change. Such information highlights the need for multilevel coordination with respect to managerial responses and interventions.

The vulnerable component can be analyzed based on their interactions with fast or slow variables. The most vulnerable components identified by the respondents were previously identified as slow and controlling variables in previous sections. Analyzing changes to these slow variables, and vulnerable components could lead to new information regarding thresholds of change with a SES.

### 3.5.1.3 Social-Ecological Units

To navigate beyond using resource systems as a social-ecological unit, respondents were asked questions regarding their dependence on natural resources and social organizations. 76% of the respondents stated fish resources, especially economic

species such as red snapper, grouper, squid and lobster, to be an important resource that they depend on and interact with for their livelihoods (Table 3.21). 72% of the respondents stated they depend on the ocean and all its resources. Other natural resources that the local communities depend on include the coral reef ecosystem and coconuts. The most prominent natural resources identified were the ones providing provisioning services to the local communities (Kittinger et al., 2012).

Natural Resource dependence	% Of Respondents
Fish catch	76%
Ocean	72%
Coral	60%
Coconut	40%
No answer	20%

76% of the respondents identified their communities, and weekly gatherings to be the most prominent social organization used daily (Table 3.22). Local communities maintain a common foundation in culture, religion, and livelihoods (Suliyati et al., 2017). This common foundation makes the community itself to be an important social organization based on collective common goals, accessibility, and ease of use. This further allows for the manifestation of collective adaptive actions leading to desirable scenarios.

Another prominent social unit identified was small-scale fisheries association, followed by The Tour Guides' Association, and Association of Boats. Associations make up an important segment of social units as it provides a middle ground between the local community and decision-makers (Bush & Marschke, 2014). Local communities of Karimunjawa are assimilated to the importance of associations as they often turn to weekly/ or monthly meetings to bring up comments, issues, and concerns relating to their day-to-day lives. The topics of discussion range from an increase in pollution, clarifications on change in regulations, upcoming community events, and assistance required on an individual/family level etc.

Social Organizations Used	% Of Respondents
Community gatherings	76%
Small-scale fishers associations	76%
Tour Guide's Association (HPE)	60%
Association of Boats (Persona Bahari)	32%
Other associations (farmers association, association of buyers etc.)	28%
No answer	12%

### 3.5.1.4 Equity and Social Justice concerns

The equity and social justice concerns encompass issues regarding the distribution of benefits and costs associated with rapid changes within a system. Understanding the distinction between the groups of people receiving positive impacts vs. groups of people receiving negative impacts is necessary as it highlights the discrepancies within the system (Gurney et al., 2015).

When asked about the groups receiving positive impacts of change such as rise in income and improved lifestyle, 80% of the respondents stated that everyone in the community benefitted from the changes (Table 3.23). Changes such as improvement in infrastructure and rise in the use of technology benefit everyone living in Karimunjawa National Park as it raises the standard of living for the community (Gurney et al., 2015). 48% of the community members stated that it's specifically the hotel owners and resort owners, potentially including outside investors, who are benefiting the most as they are already coming from a place of wealth.

Responsible groups/ individuals	% Of Respondents
Everyone	80%
Hotel/resort owners and Investors	48%
Tourist guides/ hotel workers	48%
Boat owners	44%
Local Business owners	40%
Don't know	16%

The local community members also benefit from tourism but often in the form of job opportunities. 48% of the respondents stated that members of the society who are

quick at learning how to speak English, become tourist guides or work in hotels and hence are benefitting more than others. 44% of the respondents stated that fishers who own their own boats are benefiting from change because they can also use the boat to transport the tourists from one island to another. Boat owners often take advantage of the opportunity to earn additional income in tourism when factors such as high winds, or when low availability of petrol inhibits them to go far distances for catching fish. Local business owners are another group that is receiving positive impacts of change as stated by 40% of the respondents. Most of their benefits are derived from the rising need for middlemen, booming local tourism, and improved standards of living.

Table 3.24 Groups and individuals receiving negative impacts of the change, as identified by respondents (SERS Survey n=25)

Responsible groups/ individuals	% Of Respondents
Local Small-scale fishers	72%
Local community members	60%
No negative impact	48%
Younger generations	40%
Don't know	16%

It should be noted that groups receiving negative impacts of change are not mutually exclusive from groups receiving positive impacts of change. 72% of the respondents stated that local small-scale fishers receive negative impacts of change as decreasing biomass directly affects their income (Table 3.24). 60% of the respondents stated that local community members got impacted equally in the form of having to face negative impacts of change as stated in section 3.5.1.1., such as a change in culture and behaviors, and rise in the local population. The issue of equity and social justice is further expanded on in chapter 4 as a component to discussing adaptive responses amongst the local community.

### **3.5.1.5 Power and Politics**

Identifying power and political structure in a community makes it easier to assess actions, and to assign responsibilities in face of sudden change. It also helps in drawing conclusions regarding who is more prone to receiving benefits from the ongoing change (Westley et al., 2002). Agent-centered view of power dictates that power is the capacity of an individual to influence the conduct of others based on something that some

individuals have, and others do not (Lukes, 2005; Raik et al., 2008). Structural view on power understands power as a force external to the individual, structural forces instead of the individual (Raik et al., 2008). 72% of the respondents stated that power is derived or defined by an individual's or group's social status or wealth (Table 3.25). A fisher from Parang Island, stated that “*all people who have made any change in the community are rich*” (SERS Survey 7).

Power related to wealth and social status is also related to power to influence and to initiate change (Westley et al., 2002). Another important defining aspect of power was identified to be age by 72% of the respondents. Age plays an important role in how the community not only adapts to change but also responds to it. 60% of the respondents stated that political ties also determine the connectivity of an individual or a group, and hence the power they hold in the society. Another aspect like political ties was stated to be an affiliation with local associations by 44% of the respondents. Many individuals believe that they hold more power when they are affiliated with an association. Individual fishers are also more likely to have their voices heard through their affiliated associations rather than through voicing their opinions as individual members of the society.

Aspects	% of Respondents
Social Status/wealth	72%
Age	72%
Political Ties	60%
Affiliation with local associations and/or social groups	44%
Don't know	12%

Inferring from the data regarding definitions of power in Karimunjawa, it is no surprise that 80% of the respondents identified the sub-district head to hold the most formal (or structural) power within Karimunjawa (Table 3.26). Other identified individual and groups with power include the village head, resort owners, other government employees and landowners in Karimunjawa.

Table 3.26 Most powerful individual or groups, as identified by respondents  
(SERS Survey n=25)

Groups	% Of Respondents
Sub-district head	80%
Village head	76%
Resort owners and investors	60%
Government employees	44%
Land owners	20%
Don't know	12%

On the other hand, the groups identified with the least amount of power were mainly community members and fishers. Most respondents in Karimunjawa stated that no one in the community was least powerful (Table 3.27). This was due to the reasoning that everyone in the community is accepting of where they stand in terms of opportunities and wealth; hence no one is “least powerful”. Next, 28% of the respondents stated that community members, primarily the ones unable to take advantage of opportunities, are the least powerful. 20% of the respondents stated fishers are the least powerful individuals, especially those with low incomes and those who do not own boats. The results were consistent with the definition of power as indicated by the local community. Community members with the least amount of wealth were identified as the least powerful individuals.

Table 3.27 Least powerful individual or groups, as identified by respondents (SERS Survey n=25)

Groups	% Of Respondents
No one	56%
Community members (primarily the ones unable to take advantage of opportunities in tourism due to lack of awareness, old age, or lack of funds)	28%
Fishers (Primarily low income fishers, and fishers without boats)	20%
Don't know	12%

### **3.5.1.6 Governance to Navigate Regime Shift**

Governance structures and institutions can influence change and its impacts in the form of means of intervention, prevention, or transformation in face of change using tools

such as regulations and policies (Kinzig et al., 2006). Examples of such regulations include area-based management (zoning changes to expand the designated recreational area) and increasing needs for permits for building homestays. Key actors hold the power to help community members adapt to change or transform the system into a desirable state. Survey results reveal important information regarding key actors in Karimunjawa that are responsible for the actions in response to change. 80% of the respondents stated that the sub-district head is an important actor in managing their island. Other key institutions and actors managing Karimunjawa are listed in Table 3.28, as identified by the local community members.

Table 3.28 Key institutions and other actors active in managing the place (SERS Survey n=25)

Key institutions/ Actors	% Of Respondents
Sub-district head	80%
Village head	76%
Karimunjawa National Park Authority	52%
Central government	40%
Small area head	40%
Community members	24%
Tourist guide association	24%
Tourist department of Provincial Government	20%
Local Businesses	16%
Don't Know	20%

Given the remote geographic location of Karimunjawa, local government plays an important role in managing the local communities. 80% of the respondents stated that the village head, along with their team, plays a key role in managing Karimunjawa as they act as a mediator in cases involving local conflicts (Table 3.29). The village government also acts as a bridge between the local associations, and the provincial and central government.

Table 3.29 Individuals of groups available for mediation when needs (SERS Survey n=25)

Mediator	% Of Respondents
Village head	80%
Area Head	48%
No mediator	40%
Don't know	12%

### 3.5.2 Using an Understanding of Feedback Interactions to Respond to Regime Shifts

Identifying and highlighting the role of critical slow variables provide comprehensive parameters within which the complex concept of rapid change can be understood, and appropriate management tactics can be formed. Persistent changes in fast variables indicate patterns of change, which provides insight on points of intervention. This section discusses contributions of the six dimensions of rapid change concerning identifying and managing critical slow variables and feedback interactions (as stated in table 3.2)

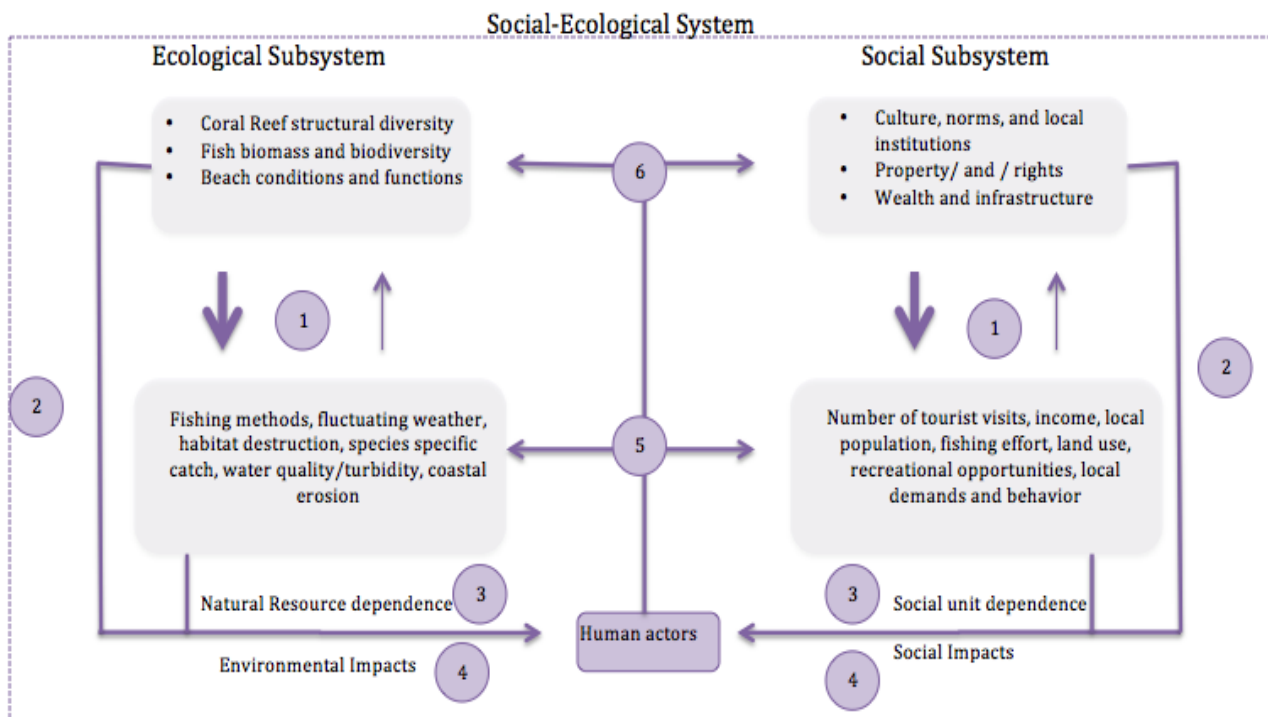


Figure 3.8 Feedback Interaction between fast and slow variables within the social-ecological system of Karimunjawa.

Figure 3.8 Depicts the relationship between fast and slow variables within the social-ecological system of Karimunjawa. It also identifies the practical application of using the 6 dimensions of regime shift and how they influence change in the form of feedback interactions amongst variables. 1) Differentiating drivers of change play an important role as acknowledging dual directionality of drivers of change can allow for



targeted management of impacts of change. 2) Identifying vulnerable components within a SES and examining its scale/level can allow management to prioritize its responses. 3) Dependence and focus on both social and ecological units encourage equal levels of management in both subsystems. 4) Issues of inequity and injustice in the form of environmental and social impacts, form an important dimension wherein managerial responses could initial negative feedback interaction with other variables. 5) Defining political and power dynamics highlights strategic pathways directly influencing and overwhelming fast variables into patterns of disruption. 6) Patterns of disruption can potentially be responded to through governance mechanism aimed at managing underlying slow variables and creating patterns of reorganization according to community and managerial goals, hence preventing any drastic, irreversible change.

The ecological subsystem includes parameters associated with ecological processes and functions that provide necessary ecosystem services, while the social subsystem includes parameters such as predominant history, culture, economy, and/or governance system (Briassoulis, 2015; Kittinger et al., 2012). Together, changes in slow variables initiate feedback interactions amongst variables operating at a smaller temporal and spatial scale (Crépin, 2007). However persistent changes in fast variables can create patterns of disruption and cause a change in slow variables. Identifying slow variables, even on a speculative basis, can provide information on anticipating change for avoiding social-ecological regime shifts with negative implication on local wellbeing (Crépin, 2007; Walker et al., 2012). Figure 3.8 portrays the relationship between fast and slow variables identified in the sections above, integrated with a depiction of the six dimensions of SERS. Although the theoretical understanding of the six dimensions suggests its integration with all aspects of ongoing changes in a social-ecological system, this section discusses findings from each dimension as it relates to specific parts of feedback interactions between fast and slow variables.

The directionality of drivers of change allows resource managers and local communities to determine whether the changes taking place are causing patterns of disruption and restructuring. The emergence of Karimunjawa National Park as a tourist destination and an overall decrease in the fish catch were identified as drivers of change triggering patterns of disruptions in Karimunjawa National Park. Frequent and consistent

changes in fast variables such as the number of tourists, local income, local population, and fishing effort etc., caused patterns of disruption, causing changes in slow forming slow variables such as local wealth, fish biomass and biodiversity, and coral reef structural complexity. Insight on local perception such as willingness to change livelihoods during drastic change allows for an understanding of feedback responses between fast and slow variables impacting future trajectories of change (discussed in chapter 4). Ongoing changes and drivers of change were found to have both positive and negative impacts. Negative impacts of change within a SES encompasses both social and ecological realms, such as increased damage inflicted on the coral, and also change in culture and behavior brought on partly due to the rise in tourism (McGinnis & Ostrom, 2014; Kinzig et al., 2006). Whereas positive impacts of change were primarily identified within the social subsystems, for example, increase in income and an improved lifestyle attributed to improvement in technology. These impacts both positive and negative driver change that causes patterns of disruption and restructuring within the system (this phenomenon is discussed further in section 3.6 of this chapter).

Identifying scale and level of occurrence of change and intervention play an important role in assisting local management to prioritize their response to ongoing changes and to maintain system functions. Patterns can be formed based on local perception as they identified components impacted first followed by vulnerable components within the social and ecological subsystems. Changes in abundance of fish species such as red snapper and groupers were identified as the initial impact of ongoing change due to drivers of change such as the use of destructive fishing methods (e.g. Trawling) by outside fishers. In contrast, fish species such as squid, anchovies, and sea cucumber were identified as vulnerable components attributed to the fluctuating demands, fish availability, and changing fishers' preferences.

Within the social subsystem, local income and rise in the number of tourists were identified as components impacted first, and vulnerable components included local lifestyle and availability of resources. Changes within the ecological subsystems can be assigned to the changes within the social subsystem and vice versa. Identifying dependence on various ecological and social units provides information needed to identify established behavior, processes and structures within Karimunjawa. Information

regarding the degree of dependence on units such as social organizations and ecological resources provides pathways for maintaining slow variables. For example, the degree to which the local communities depend on social and ecological units defines the degree to which the local community will adhere to maintain its functions.

Issues of inequity and injustices that often go unnoticed may catalyze positive feedback interactions and create drastic changes in system dynamics (Gurney et al., 2015). Understanding social justice and equity as one of the six dimensions take a step in the direction of adequately conceptualizing the complexities present in identifying variables that define a social-ecological system. Using fast and slow variables allow for an understanding of the underlying slow changing mechanisms that dictate a system's functions. For example, groups receiving positive impacts of change the most include local hotel/resort owners, investors, and tour guides. This coincides with the perceived defining factor of power, which included social status/wealth, and age. Hence groups with the most power, who benefit the most from ongoing change, can overwhelm fast variables (such as fishing effort, promotion of tourism, local development etc.), to create patterns of disruption. Additionally, if patterns of disruption on a scale of fast variables are combined with lack of effective actions or inactions from local governance to manage critical slow variables, interact in feedback to create drastic irreversible changes within a system.

Two main contributions of tentatively identifying critical slow variables based on local perception and studying each dimension of rapid change can be acknowledged. First, identifying slow variables and fast variables provide pathways for future trajectories hence contributing to anticipating change and its impacts. Moreover, it provides an opportunity for strategic reorganization according to community and managerial goals, before drastic, irreversible change. Second, the six dimensions reveal important information regarding the intersection of social and ecological subsystems, and fast and slow variables, hence providing tools needed to manage feedback interactions within crucial components of a social-ecological system. These concepts also fill gaps in addressing competing value systems that define a social subsystem, hence allowing local management to tackle variables such as local norms, behaviors, and individual choices (Welsh, 2014; Stojanovic et al., 2016).

### **3.6 Analyzing Implications of Using Fast and Slow Variables for Understanding Drivers and Impacts of Change**

An analysis of changes amongst fast and slow variables allows for an understanding of a feedback between drivers and impacts of change. Underlying drivers in both social and ecological subsystems synergize with the proximate changes to push boundaries and facilitate further change, and in some cases, irreversible change in the social-ecological system of Karimunjawa (Geist and Lambin, 2002). Consistent decrease in fish biomass with a rapid increase in tourism creates patterns of change and destruction in the status quo of the slow variables such as, the local fisheries culture (Setiawan et al., 2017; Armitage and Johnson, 2006). The disruption took place in the form of changes in livelihoods, development of infrastructure, unequal distribution of opportunities, dissolution of local institutions, formation of tourism-related associations, increase in frequency of meetings and local involvement.

The restructuring of slow variables in the social subsystem such as culture, values and local institutions, due to persistent changes in the fast variables such as local income, leads to crossing of boundaries into a new system (Armitage and Johnson, 2006). Proximate drivers for the rise in tourism includes the availability of pristine beaches and marine recreational activities, in addition to government agenda promoting tourism and an increased awareness of Karimunjawa as a tourist destination on social media. However, the underlying cause that allowed this change to take place is the decline in fisheries that created a need for an alternative livelihood within the local community. Table 3.30 presents a list of fast and slow variables in the SES, changes taking place, and it is corresponding social-ecological drivers and impacts.

Table 3.30 Drivers and impacts of change taking place amongst the fast and slow variables

Slow Variables	Fast Variables	Social-ecological drivers	Changes	Social-ecological impacts
Culture, Values and Local Institutions	<ul style="list-style-type: none"> <li>•Number of tourist visits</li> <li>•Local individual's preference and satisfaction</li> <li>•Individual's wellbeing</li> <li>•Connectivity</li> <li>•Local demands</li> </ul>	<ul style="list-style-type: none"> <li>•Promotion of Karimunjawa as a tourist destination</li> <li>•Available pristine coral reef for activities such as snorkeling</li> <li>•Rise in social media awareness</li> <li>•Available pristine beaches</li> </ul>	<ul style="list-style-type: none"> <li>•Increase in local and foreign tourists</li> <li>•Improved economy</li> <li>•Increased social discrepancies causing change in local behavior and attitude</li> <li>•Increase in number of associations</li> </ul>	<ul style="list-style-type: none"> <li>• Damaged coral</li> <li>• Increased westernization</li> <li>• Increased demand for human resources</li> <li>• Change in youth culture</li> <li>• Increased interaction with marine ecosystems such as coral reef</li> <li>• Increased competition</li> <li>• Change in culture and behavior</li> <li>• Rising isolation and disconnect on an individual level</li> <li>• Increased legal Requirements such as registrations for boats</li> </ul>
Wealth and Infrastructure	<ul style="list-style-type: none"> <li>•Income</li> <li>•Employment opportunities</li> <li>•Local demands</li> <li>•Government intervention</li> </ul>	<ul style="list-style-type: none"> <li>•Increased demand for homestays</li> <li>•Tourism presented as an alternative means for livelihood to alleviate pressure off fisheries</li> <li>•Improved infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>•Change in means of livelihood</li> <li>•Change and improvements in Infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Increased job opportunities</li> <li>• Increased pollution</li> <li>• Rise in the number of homestays</li> <li>• Rise in tourism</li> <li>• Increased demands and wants</li> <li>• Increased local competition</li> </ul>
Property and use rights	<ul style="list-style-type: none"> <li>•Land Use</li> <li>•Foreign investment</li> <li>•Access to resources</li> <li>•Fluctuating Local population</li> </ul>	<ul style="list-style-type: none"> <li>•Increased demand for human resources</li> <li>•Rise in tourism</li> <li>•Increased awareness</li> <li>•Need for improved infrastructure</li> <li>•Limited and declining income in fisheries</li> <li>•Available opportunities and</li> </ul>	<ul style="list-style-type: none"> <li>•Change in land use (including increased number of homestays, resorts, and beach developments)</li> <li>•Reduction in forest area and</li> </ul>	<ul style="list-style-type: none"> <li>• Increased consumerism</li> <li>• Increase in use of technology such as appliances, cellphone, and motorcycles</li> <li>• Increased number of stores and local businesses</li> <li>• Improved</li> </ul>

		higher income in the tourism industry	increased beach development	accessibility
		<ul style="list-style-type: none"> <li>•Increased monetization of skills</li> </ul>	<ul style="list-style-type: none"> <li>•Increased awareness (such as rise in technology)</li> </ul>	<ul style="list-style-type: none"> <li>• Change in land use</li> <li>• Change in culture</li> <li>• Change in family structure</li> <li>• Improved lifestyle</li> <li>• Change in culture and behavior</li> <li>• Degradation of ecosystems</li> </ul>
Fish Biomass and Biodiversity	<ul style="list-style-type: none"> <li>•Fishing effort</li> <li>•Fluctuating weather</li> <li>•Changing wind patterns</li> <li>•Habitat destruction</li> <li>•Species availability</li> </ul>	<ul style="list-style-type: none"> <li>•Use of non-eco-friendly fishing techniques such as trawling and using potassium</li> <li>•Climate change</li> <li>•Rise in the number of “outside fishers”</li> <li>•Lack of awareness regarding impacts</li> <li>•Increasing global fish demands</li> </ul>	<ul style="list-style-type: none"> <li>•Decrease in fish biomass especially for commercial species such as red snapper and grouper</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of livelihoods</li> <li>• Loss of income</li> <li>• Alternative fish catch including sea cucumbers, anchovies, and squid</li> <li>• Increased need for alternative livelihoods</li> </ul>
Coral reef coverage	<ul style="list-style-type: none"> <li>•Anchor damage</li> <li>•Fishing methods</li> </ul>	<ul style="list-style-type: none"> <li>•Increased interaction with marine ecosystems such as coral reefs</li> <li>•Destructive reef fishing practices</li> <li>•Terrestrial development</li> <li>•Climate change</li> </ul>	<ul style="list-style-type: none"> <li>•Coral reef destruction</li> </ul>	<ul style="list-style-type: none"> <li>• Destruction of fish habitat and coral reefs</li> <li>• Decrease in fish biomass</li> </ul>
Beach conditions and functions	<ul style="list-style-type: none"> <li>•Water quality/turbidity</li> <li>•Mountain development</li> <li>•Marine Protected Area Zoning changes</li> <li>•Coastal erosion</li> <li>•Sand quality</li> </ul>	<ul style="list-style-type: none"> <li>•Overexploitation</li> <li>•Global warming</li> <li>•Increasing beach developments</li> <li>•Increased pollution</li> </ul>	<ul style="list-style-type: none"> <li>•Increased pollution</li> </ul>	<ul style="list-style-type: none"> <li>• Diminishing water quality</li> <li>• Increased “sea garbage”</li> <li>• Previously white beaches turning brown</li> </ul>

Tourism has become one of the biggest industries in the world, especially as a means of promoting socio-economic development in marginalized communities such as the coastal communities of Karimunjawa (Neto, 2003). Given the pristine conditions and natural beauty of Karimunjawa, the tourism department of the Jepara district actively promotes Karimunjawa National Park as a tourist destination on a local and global scale (Laksono and Mussadun, 2014). Despite this active promotion of tourism, the sudden increase in the number of local and international tourists in 2011 was unexpected and sudden for both the local government and the community members (Setiawan et al., 2017). This allows for the assumption that the most probable cause of the growth of tourist visits is the awareness and presence of the island as a tourist destination on social media and the Internet (Setiawan et al., 2017). The rise in tourism is creating impacts such as an increase in pollution and a rise in terrestrial developments that is degrading the quality of beaches. The impacts on the pristine conditions of Karimunjawa may affect the traffic of incoming tourists in the near future. Despite the local government's efforts to inform the tourists and tourist guides regarding proper protocol for interacting with sensitive ecosystems, there exists a lag between institutional responses that monitor and enforce these interactions (Hafsaridevi et al., 2018; Yulianto et al., 2010).

There has been continues improvements in infrastructure in Karimunjawa, mainly in the form of roads and renovated ports to facilitate better traveling experience for the tourists. This change further enables the local communities to prepare for and invite tourism and aspects of western culture within their community.

The rise in the use of technology is identified as a positive impact of change in the SERS survey (table 3.15), however, using the integration of fast and slow variables with drivers, changes and impacts (Table 3.30), links can be formed between the rise in technology as a driver of change and weakened cultural ties. The village head stated that *“the languages are disappearing, for example, Mandar language that comes from Bugis people is spoken less and less, I don't even hear that language here anymore”*. Another informant mentioned, *“There is some change in the culture because of the increase in western influence here. The culture is changing slowly. The kids don't study in the evening anymore, but they go out to watch the tourists instead. Before tourism,*

*Karimunjawa used to be quieter and the day-to-day life used to be better for practicing our religion, but the economy is better now as overall income is rising”.*

Since the beginning of the rise in tourism in Karimunjawa, there have been institutional changes such as an increase in the number of associations formed, and local rules and policies regarding interactions with the tourists. According to the interviews, this change in policy was driven by the need to accommodate to the changes in both ecological and social systems. The local community’s local norms and behaviors changed (section 3.5.1.1). An example of this is the monetization of the local community’s time and labor leading to a lack of free/volunteer labor. Prior to tourism, it was standard for the community members to volunteer their time and labor in exchange for a couple of meals to help their neighbors build their brick houses or build boats. There has also been an increased focus on certifications, and appropriate paperwork to legitimize the boat ownership, homestay establishments etc. Using fast and slow variables as indicators highlights the cascading effects of drivers of change, and the feedback between drivers and impacts. Identifying the relevance of studying change at different levels and scales could lead to new information regarding important thresholds in social and ecological systems. Hence, it could assist human actors in responding to change to maintain important system functions.

### **3.7 Conclusion and Chapter Summary**

This chapter uses a social-ecological systems perspective to analyze ongoing changes taking place across multiple scales (temporal and spatial), and transverse social and ecological boundaries within Karimunjawa National Park. Changes in social and ecological subsystems such as a rise in tourism and a decrease in fish biomass has directly impacted local livelihoods. Local communities identified the nature of such change as significant, long-term, difficult to predict, and difficult to reverse, which suggests an occurrence of a social-ecological regime shift.

Three main conclusions can be drawn from the results and discussions presented in this chapter. First, using an understanding of fast and slow variables encourages a comprehensive understanding of rapid changes within the social-ecological system of Karimunjawa. Second, the six dimensions of regime shifts provide points of intervention



based on interactions between social and ecological subsystems. Third, there are implications of using fast and slow variables for understanding drivers and impacts of change, specifically in regard to the feedback interaction between system variables and ongoing change. Responding to underlying drivers and negative cascading effects requires an understanding of feedback interactions.

Local communities identified prominent slow variables based on experience, knowledge, and interaction with the social and ecological subsystems. These variables include culture, wealth, property and use rights, biodiversity, coral reef ecosystem, and beach functions. Changes amongst each slow variable were discussed in addition to highlighting interactions with fast variables. Fast variables often provide grounds for experimentation and hence act as points of intervention to manage critical slow variables. Example of fast variables within Karimunjawa National Park includes the number of tourists, individual preference, local demands, fishing effort, species-specific catch, level, and intensity of interaction with the coral reef ecosystem, forest conversions, and beach development.

The six dimensions of SERS respond to the interconnected nature of a SES and contribute to managing critical slow variables and feedback interactions. Highlighting the sequence of interactions, whether direct or indirect, allows for an understanding of system thresholds, feedback interactions, and points of intervention. Specific dimensions of rapid change such as scales and levels of intervention, and social injustice and inequity highlight the need for managing critical slow variables such as culture, norms, and long standing institutions, and wealth and infrastructure. Furthermore, integrating the six dimensions of SERS with the conceptual understanding of fast and slow variables highlights the role of human actors in managing and responding to change.

Identifying social-ecological drivers and impacts of rapid change amongst crucial slow variables reveal that responses to change in one slow variable could initiate change in other slow variables. For example, promoting the use of technology for managing wealth and infrastructure, could lead to weakened cultural ties and change in institutions. It also demonstrated that individual capacity to respond to and interact with fast variables depends on the availability of resources, individual skillset, and exposure to learning.

## Chapter 4

### Local Adaptive Responses to Rapid Change

#### 4.0 Introduction

Rural coastal communities, especially in South East Asia, depend highly on natural resources such as fisheries for their sustenance and livelihoods. Due to this dependence, these communities are most vulnerable and marginalized during ongoing changes in their social and ecological subsystems (Bennett et al., 2016). Vulnerability research in the context of social-ecological systems has a long history in a social science discipline such as human geography (Cinner et al., 2012; Adger, 2003; Cutter, 1996; Adger, 2000). However, there is limited research in examining social vulnerability during sudden changes in natural ecosystems such as disruption in coral reefs ecosystem. Human actors within vulnerable communities turn to adaptive responses to maintain system functions such as the provision of ecosystem services. The complex and interconnected nature of a social-ecological system enables feedback interactions, which leads to human actors either catalyzing or decelerating ongoing changes. In other words, local communities adapt to change through collective action, which leads to other changes in the social-ecological system. In Karimunjawa, the need for adaptation was initiated with the decrease in fisheries catch due to factors such as increased fishing pressure and global warming in the early 1990s. During this period, Karimunjawa began to be marketed as a tourist destination (Setiawan et al., 2017). This combination of factors directly impacted local livelihoods.

Adaptive capacity can be defined as the capacity of individuals, groups, and organizations for building resilience through collective action in a social-ecological system during ongoing change (Walker et al., 2004; Folke, 2006). Adaptive capacity depends on many factors such as perceived understanding of change, available resources, and response memory of previous adaptive responses. This chapter presents local responses to social-ecological change and analyzes the adaptive capacity of local communities of Karimunjawa. First, adaptive responses and vulnerabilities are identified and discussed. Second, five attributes of adaptive capacity namely, response diversity, collaborative capacity, connectivity, abundance/reserves, and learning capacity, as

described by Kerner and Thomas (2014) are analyzed to form a deeper understanding of the adaptive capacity of the social subsystem of Karimunjawa. Third, patterns are formed in adaptive responses to understand its implications on the feedback cycle. In doing so this chapter aims to provide recommendations in the form of potential sources for fostering resilience and/or driving transformation.

## **4.2 Literature Review**

### **4.2.1 Vulnerability in Social-Ecological Systems**

IPCC defines vulnerability as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (2020). Vulnerability to environmental disturbances varies across spatial and temporal scales making some individuals and groups more vulnerable (Cinner et al., 2012; Bene, 2009). It is important to analyze the combination of economic, environmental, and social conditions to understand society’s capacity to respond to change and manage vulnerabilities (Setiawan et al., 2017; Cinner et al., 2012). It is also worth applying an understanding of vulnerability to the underlying, slow changing variables that determine system functions.

Three main measures of vulnerability include exposure, sensitivity, and adaptive capacity (Wibowo et al., 2012; Cinner et al., 2012). Exposure, in social-ecological vulnerability context, refers to the degree to which a system is stressed by magnitude, frequency, and duration of a disruptive event such as overfishing (Cinner et al., 2012). In the context of environmental change, sensitivity is, “the state of susceptibility to harm from perturbations or long-term trends” (Adger, 2006). The adaptive capacity of a social system in the face of environmental change refers to the socio-economic conditions that enable adaptive responses (Nelson et al., 2007).

Coastal communities are often more vulnerable and exposed to changes, given their high dependence on natural resources for their daily livelihoods. Studies have taken place that analyzes the exposure of Karimunjawa National Park to changes such as overfishing, leading to depletion in fish stocks (Bennett et al., 2016; Baker et al., 2012). Since Karimunjawa is an island of fishers and farmers, their community is highly sensitive to change. Various managerial efforts have been made to manage and reduce the

sensitivity of the place in the form of introducing alternative, and less natural resource-dependent livelihoods such as aquaculture, and later, livelihoods in tourism (Yulianto et al., 2015). Overall sensitivity to changes decreased over the last decade as more and more of the community members started getting involved in the tourism industry (Setiawan et al., 2017). Furthermore, Setiawan et al. (2017) use the adaptive cycle (Holling, 1973) to analyze the transition of local communities from depending on agriculture and fisheries to the tourism and service sector. It was concluded that there is a high need for local policies that focus on fulfilling social needs and promoting social learning to better adapt to the change. This chapter uses an understanding of vulnerability to highlight vulnerable components on a local level followed by assessing its adaptive capacity.

#### **4.2.2 Understanding Aspects of Adaptive Capacity**

Adaptive capacity is one of the three measures of vulnerability, and it is also considered an important attribute of resilience. In resilience literature, adaptability is referred to as the capacity of the actors involved in building resilience through collective action in a social-ecological system (Walker et al., 2004; Folke, 2006). One way of analysing and forming trends in the local adaptive responses is by using various attributes of adaptive capacity. These attributes control the extent to which a community might be able to exercise resilience and adapt or transform in response to changes. These aspects of adaptive capacity are *response diversity*, *collaborative capacity*, *connectivity*, *abundance/reserves* and *learning Capacity* (Kerner and Thomas, 2014; Tompkins and Adger, 2004).

- **Response diversity**

Response diversity refers to the number of options with which a function or a task within a social-ecological system can be accomplished in different ways, with different resources available, either in face of change or while withstanding a stressor in order to allow continuity of various functions within a system (Kerner and Thomas, 2014; Walker et al., 2006; Holling, 1973). There are equity and social justice implications of response diversity associated with unequal distribution of costs and benefits, in addition to the varying prerequisites needed to benefit from the change (Leslie and McCabe, 2013).

- **Collaborative Capacity**

Collaborative capacity refers to the potential of system stakeholders such as local community members, community leaders, the village head and local government to work cooperatively to ensure system function (Kerner and Thomas, 2014). It is the capacity to act in a coordinated manner (Stokols et al., 2013; Thomas, 2011; Berkes, 2007; Walker et al., 2006). This involves engaging linkages within the community such as relationships, authorities or permissions and roles in a timely manner that ensures the functionality of a system (Carpenter et al., 2012). Engaging these links requires a shared understanding of the objectives of the collaboration amongst the actors involved.

- **Connectivity**

Connectivity within a social system is measured by determining how readily resources and information can be exchanged to ensure continued functionality (Kerner and Thomas, 2014; Carpenter et al., 2012). Connectivity can range from strong to weak depending on the human actors and their horizontal and vertical involvement and interactions within a system (Thrush et al., 2009). Either inadequate or excessive connectivity could potentially reduce the adaptive capacity of the system, hence diminishing system resilience (Walker et al., 2004).

- **Abundance/reserves**

Reserves refer to the ready to use a surplus of capital available in a system in the form of natural capital, economic capital and social capital etc., upon which community members rely on when faced with change or stressful situations (Kerner and Thomas, 2014; Ferrara et al., 2016). Awareness surrounding these reserves within a system is just as important as the reserves itself (Carpenter et al., 2012). These reserves play an important role in managing vulnerability by supporting variety, redundancy, and preparedness in a system (Resilience Alliance, 2019).

- **Learning Capacity**

Learning capacity in terms of adaptability of a system refers to “the ability to acquire, through training, experience, or observation, the knowledge, skills, and capabilities needed to ensure system functionality” (Kerner and Thomas, 2014). Learning capacity can be studied at an individual or household level to highlight any inequity issues (Ostrom, 2005; Berkes, 2007).

### **4.2.3 Exploring Resilience, Transition, and Transformation Literature**

Current adaptability literature is heavily focused on climate change or environmental change on a global scale (Bennett et al., 2016). Undoubtedly, a global understanding of change is necessary as drivers of change on various scales do not converge but interact in a dynamic state of constantly changing variables (Nayak and Armitage, 2018; Kittinger et al., 2012). However, a local level understanding of interaction could lead to practical insights regarding managing change (Whitney et al., 2017; Bennett et al., 2016; Lane et al., 2010). There are extensive theoretical and increasingly empirical studies that suggest the need to explore multiple sources that a community is exposed to that lead to a situation where adaptation is needed (Kerner and Thomas, 2014; Walker et al., 2006).

Concepts such as resilience and transformation provide insights to better understand and respond to issues such as lack of compliance. Adaptation within a SES can be oriented towards three goals namely, to build resilience, to transition, or to transform (Pelling, 2011). Karimunjawa is transitioning from primarily a fishing community to a tourist destination. The transitioning period is marked in the form of incremental social changes such as the rise in local homestays, the number of tour guides and tourist facilities. Transformation refers to the creation of a fundamentally new system with different qualitative characteristics in response to the drastically declining ecological, political, social or economic conditions (Walker et al., 2004; Folke, 2006; Andrachuk and Armitage, 2015). Transformative reorganization of systems characteristics can either be intentional or unintentional as a result of the change (Olsson et al., 2004, Biggs et al., 2010, Chapin et al., 2012). Resilience, in the context of social-ecological systems, can be defined as “the capacity of a linked SES to experience shocks

while retaining essentially the same function, structure, feedbacks, and therefore identity” (Kerner and Thomas, 2014; Walker et al., 2006; Holling, 1973).

Moving towards system transformation vs. building system resilience has implications on the need to incorporate an understanding of critical slow variables that controls system functions, is an integral part of feedbacks and is responsible for maintaining system identity (Chapin et al., 2006; Armitage and Johnson, 2006). Moreover, applying these concepts to the critical slow variables within a system could provide useful and realistic guidelines to manage change. Bennett et al. (2016) state that a key challenge for those living and working in coastal systems is that the various drivers of change do not converge but interact with one another through cascading cross-scale and adaptive feedbacks. Another important emphasis in this literature area is on the lack of convergence of the available scientific knowledge of coastal SESs and various adaptation policies (Lane et al., 2010). Forming trends within the local community’s adaptive responses could potentially lead to information regarding the future direction of the social-ecological system and the objectives of the community in the face of change.

This chapter used vulnerability, adaptation, and resilience literature, in order to review the adaptive capacity of human actors in face of disturbances or change within the social-ecological system of Karimunjawa. Understanding the source of vulnerability for which human actors engage in adaptive responses could lead to insight on social-injustices and inequity. Levels and scales of change and intervention plays an important role as some components of the system are more vulnerable to change than others. The conceptual framework for this chapter guides system managers into navigating change and disturbances within the system. The framework depicts the need to highlight vulnerable components of the system as an initial step for driving transformation or fostering resilience. The adaptive responses are guided by a set of attributes that makes up the adaptive capacity of a place. Based on the adaptive capacity, the system can then be guided towards fostering resilience in face of change or transforming the system into a new stable state (figure 4.1).

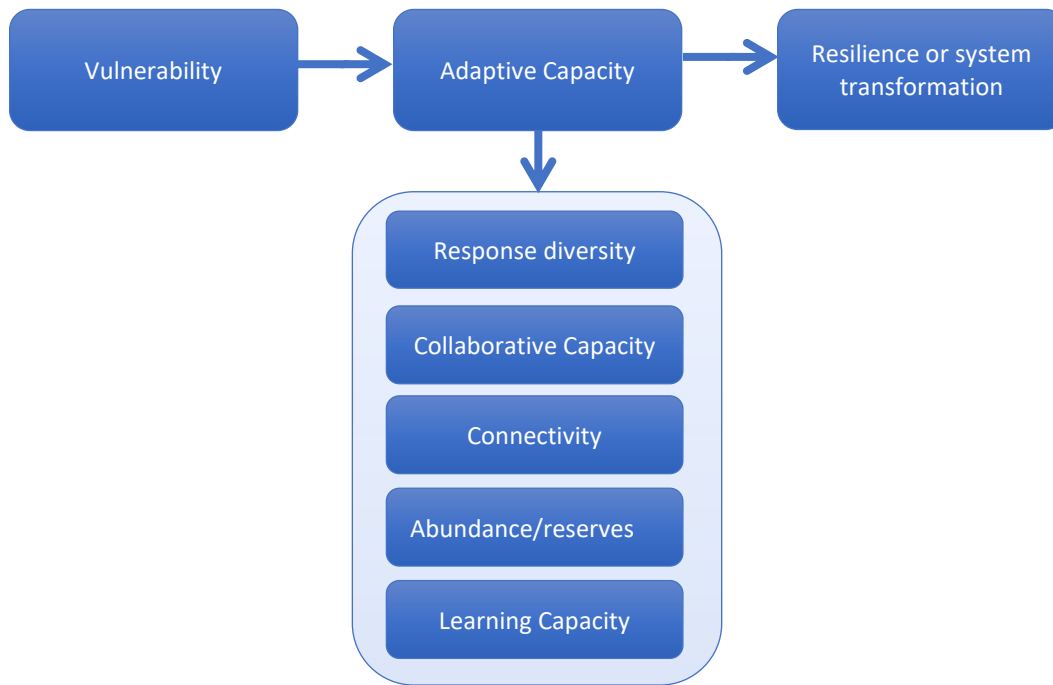


Figure 4.1 Conceptual framework used in this chapter combining concepts of vulnerability, adaptive capacity, and need for fostering resilience or supporting transformation.

## 4.3 Results and Discussion

### 4.3.1 Identifying Vulnerabilities and Adaptive Responses

The following sections present data collected on hypothetical responses to change, involvement in the tourism industry as an adaptive response, and vulnerable components to suggest and discuss examples of vulnerabilities. Data presented were collected using semi-structured interviews and SERS survey.

#### 4.3.1.1 Hypothetical Adaptive Responses to Change

Informants were provided hypothetical responses to adverse impacts of ongoing change and were asked to state potential scenarios that would cause them to opt those responses (Table 4.1). The hypothetical responses (changes in livelihood, migration, and resistance) were shortlisted based on past behaviors of individuals living in coastal communities facing similar adverse impacts of change (Leslie and McCabe, 2013; Cinner et al., 2012; Adger, 2006). The responses were analyzed to determine perceived exposure and sensitivity to change.



Table 4.1 Responses to questions related to hypothetical adaptive responses (Semi-structured interviews n= 50)

Hypothetical response	Response category	% of respondents
Change Livelihoods	Additional income/ job opportunity (primarily in the tourism industry)	60%
	Increased security	26%
	Social Pressure	12%
	Will not change livelihood	12%
Migrate	Will not migrate	44%
	Will relocate within Karimunjawa for better opportunities	32%
	Better opportunity	12%
Resist change	Will not actively resist change (“let it be”)	76%
	To preserve the local culture	16%
	Maintain access to resource	8%

60% of the informants stated that they would opt to change livelihoods for additional income (Table 4.1). Low-income individuals and households are considered more exposed, hence vulnerable to the adversities of ongoing changes (Leslie and McCabe, 2013). 26% of the respondents stated that they would change livelihoods if the alternative option provided security and a steady income for their family. Given the ongoing fluctuations in income in fisheries, and a steady decline in fisheries catch over the last ten years, it is justifiable that lack of security is perceived as vulnerability (Berkes, 2007). 44% of the respondents stated that they would not migrate to another location outside of Karimunjawa, citing an improving economy and increasing job opportunities as a primary reason. An informant mentioned that *“prior to tourism, everyone’s children wanted to leave Karimunjawa for other opportunities. But after tourism, there are hotels here that could provide jobs, and more and more recreational opportunities so they want to stay here”* (Interview 29).

Informants reported “barely getting by”, and “surviving on rice and cassava” prior to an increase in income-generating opportunities. Most respondents also stated that under no circumstance could they imagine actively resisting ongoing change. However, 16% of the respondents stated that they would revolt and actively resist change if it meant preserving the local culture and values. As also discussed, the chapter 3, change in culture was identified as a negative impact of drivers of change such as increased westernization

and increased use of social media. 8% of the informants stated that they would resist ongoing change to maintain access to resources such as petrol for their boats. Increasing dependence on resources such as petrol for motorcycles and boats is increasing sensitivity to change, as limited access to resources directly impacts local livelihoods (Adger, 2006).

#### 4.3.1.2 Local Livelihoods Transitioning from Fishing to Hospitality and Service Sector

This subsection presents data on local involvement in the tourism industry as a means of adaptation (Table 4.2). Additional data on preferred livelihood alternatives (in addition to opportunities in tourism) to determine response diversity is presented and discussed in subsection 4.3.2.1.

Table 4.2 Local involvement in hospitality and service sector. Number 2 (n=24) is a structured question based on the response from no. 1 (n=50)

No.	Inquiry	% of respondents	
1	Are you involved in the tourism industry?	Yes	48%
		No	52%
2	How are you involved in the tourism industry?	Fulltime/part time Tour guide	54%
		Renting boats for marine tourist activities	42%
		Selling Souvenirs/ store	42%
		Homestay establishment	21%
		Part time/ full time Jobs in the tourism industry	21%

It was found that 48% of the total informants were involved in the tourism industry. Out of which 54% stated that they were already working as tour guides to take advantage of the rise in income-generating opportunities. Other participated in tourism-related activities by renting their boats for tourism-related activities such as “island hopping” and snorkeling, selling souvenirs, setting up homestay establishments etc. Adaptive responses in the form of changing livelihoods depend on factors such as stability, convenience, and additional income for each individual and family (Levine et al., 2015). An informant stated that “*due to the ongoing changes in fisheries, the income of fishers fluctuates a lot every week, however in tourism, there is some predictability and stability*” (Interview 16). A fisher could earn 200,000 IDR/day per tourist (an average small-scale fishers boat holds the capacity for 10-12 tourists) if the boat were to be used

for tourist activities such as snorkeling and island hopping. Income earned from fisheries ranged from 20,000 IDR/day to 200,000 IDR/day depending on the fishing season.

Factors such as limited access to petrol increase sensitivity to change, as local communities are rendered vulnerable and in need of alternative responses. Given the lack of availability of petrol, they are unable to travel further distances for fishing, hence resorting to activities that require limited petrol, such as tourism-related trips to local islands. A local respondent mentioned that, *“the limit for each fisher used to be more than 200L per boat per transaction each day. Right now the limit has been reduced to 50L per boat per transaction”* (Interview 50). There was some overlap between the informants taking on more than one role in the tourism industry, as some informants both rented their boats and took on the role of a tour guide. *“There are some in the fisher community who choose to rent their boats for tourism rather than go out to catch fish. Without tourism, this community would have suffered”* (Interview 24).

Adaptive responses such as additional means of livelihoods reduce overall sensitivity to change by reducing dependence on fisheries. 21% of the respondents reported ownership of homestay establishments ready for tourist accommodations and stay (Table 4.2). It was also noted that previously non-income contributing members of the local families including women and children, were now employed and contributing to the household, leading to changes in family structure. There are social-injustice implications of change in livelihoods as a form of adaptation. The discrepancy is due to the varying level of sensitivity and exposure present amongst various groups in Karimunjawa including unequal distribution of opportunities. The next section identifies vulnerable components and adaptive responses within Karimunjawa.

#### **4.3.1.3 Identifying Vulnerable Components within the Social and Ecological Subsystems**

Moving beyond identifying livelihoods as an adaptive response, figure 4.2 contains SERS survey data on vulnerable components in the ecological and social subsystems.

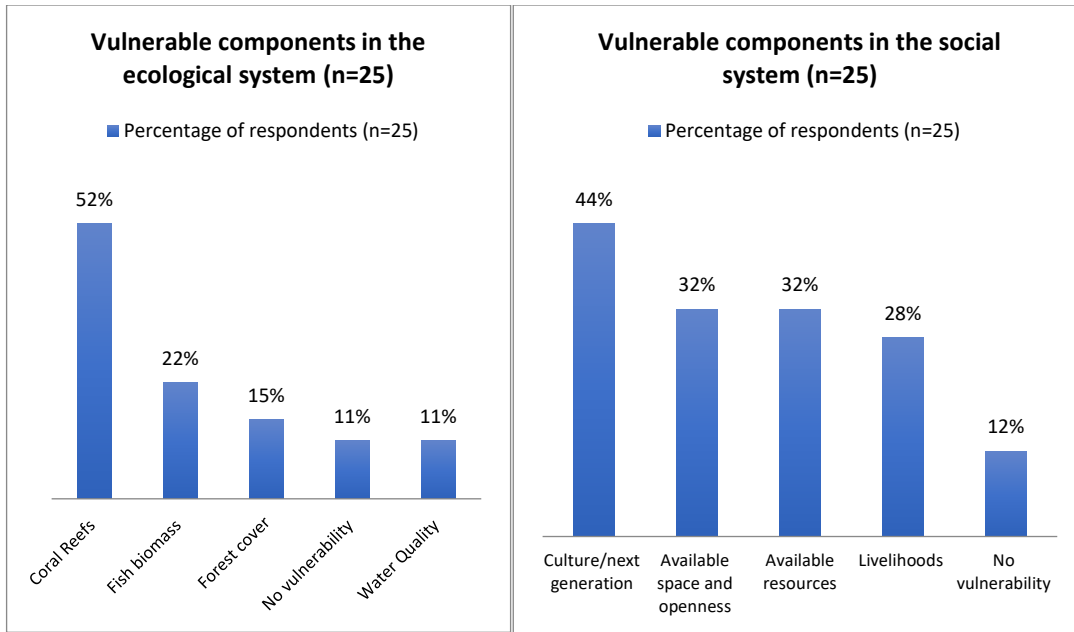


Figure 4.2 Bar graphs depicting vulnerable components in the ecological (left) and social (right) subsystems as identified by the respondents of the SERS survey (n=25)

Coral reefs and local culture were identified as the top two vulnerable components by 52% and 44% of the respondents, respectively within the social and ecological subsystems. Changes and feedback interactions related to coral reef structural complexity is discussed in chapter 3 (section 3.3.2.1). Potential sources of vulnerabilities, although not exclusively highlighted, were discussed such as exposure in the form of persistent use of destructive fishing methods and improper interactions with the reef ecosystem (Cinner et al., 2012). Exogenous factors interacting with a social-ecological system can potentially intensify sensitivity and exposure of various social and ecological components. Fish biomass and biodiversity is also discussed in chapter 3 as a prominent slow variable controlling important system functions in Karimunjawa. Sensitivity to change for fish biomass as a vulnerable component can be attributed to the overlapping boundaries and interactions with “outside” fishers. As rise in global demands for fish invites foreign commercial fishing vessels that are better equipped to catch and store larger quantities of fish (‘fishing roving bandits’) (Berkes et al., 2006).

Available space and “openness” were identified as a vulnerable component within the social subsystem as the local communities predicted the future based on current trends and an increasing number of visitors. A SERS survey respondent stated, “*this island will*

*become more crowded and there will be less and less open space, but the society here is happy about that*” (SERS Survey 13).

Overall system vulnerability is not necessarily perceived as an adverse impact of change amongst the local community. For example, available physical space and “openness” is identified as a vulnerable component, however, community members anticipate and often emphasize the need for improved infrastructure and access to electricity to support the increase in tourism.

Based on local perception no consensus was found regarding sources of vulnerability within social and ecological subsystems. Although there was unanimity in identifying vulnerable components in both subsystems, various levels of sensitivity and exposure were identified. Coral reef habitat was identified as an ecologically vulnerable component. However, perceived sensitivity and exposure varied amongst the respondents. This was especially true amongst fishers grouped based on their fishing technique (using hand spear, spear gun, hand line, reef net, traps). Fisher members of the hookah group (divers using free-flow compressed air via tubes from a boat for spearfishing in deeper waters) attributed the vulnerable state of the coral to the fish traps set by other local traditional fishers, whereas other local fishers attributed coral reef’s high level of exposure to the inappropriate interaction between the diver fishers and the coral reef ecosystem.

There are governance implications for identifying vulnerable components within the social and ecological subsystem. Identifying vulnerable components could potentially assist governance actors to either work towards mitigation or remedial action in case of rapid change. Remedial responses minimize the sensitivity to change, whereas working towards mitigation manage the exposure to change (Santos-Lacueva et al., 2017). For example, respondents who identified forest cover as a vulnerable component attributed its level of exposure to outside investment, change in property and use rights, increasing development etc. In this case, mitigation may seek to regulate property and use rights to maintain essential ecological functions.

#### 4.3.1.4 Identifying Sources of Vulnerabilities

Based on local perception and the results discussed in the sections above, examples of sources of vulnerabilities and adaptations at a local level are compiled in table 4.3.

Examples of sources of vulnerabilities	Potential sources of Adaptation
<ul style="list-style-type: none"> <li>• Degrading coral reef ecosystem</li> <li>• Affected fish biomass</li> <li>• Instability and fluctuations in family income</li> <li>• Low levels of education/ skills</li> <li>• Lack of confidence among residents due to poverty</li> <li>• Limited resources to respond to change in social and ecological subsystems</li> <li>• Conflicting objectives, increased chances for social injustices and inequity issues</li> <li>• Limited access to resources such as petrol</li> <li>• Loss of culture and increased westernization</li> </ul>	<ul style="list-style-type: none"> <li>• Changes in livelihoods (traditional fishers getting involved in the tourism industry)</li> <li>• Changes in family structure (wives and children, previously unemployed, now work for hotels or as tour guides)</li> <li>• Increased participation in associations, and local community meetings</li> <li>• Increased participation in community workshops</li> <li>• Compliance with MPA zoning to accommodate a rise in tourist zones</li> <li>• Compliance with increased legalization (increased requirements for boat license, and house ownership documents)</li> <li>• Increased displays of local culture to promote tourism</li> </ul>

Adaptive responses for ongoing changes in Karimunjawa occur on various levels within the social subsystem including on an individual/household level, municipal/community level, and on the provincial level. One example of adaptive responses on a community level is the initiative of local organizations to promote awareness and foster resilience. The Pitulihur Pulau Foundation organized the “Memeden Sawah” festival in 2018, in order to raise awareness regarding the importance of maintaining acres of land available in Karimunjawa for agricultural purposes to empower local communities rather than the forestland being directed towards hotel conversions. Other activities included in the festival were tree planting, a workshop on making fertilizers, and converting plastic waste into goods that have potential market value. Persistent response to change impacts fast variables such as local participation, efforts,

and behaviors which inadvertently manages crucial slow variables such as culture, norms, and local institutions, and wealth and infrastructure.

Both fishers and farmers face vulnerabilities in the form of environmental degradation and implications with the increase in tourism. Top-down adaptive responses have emerged in the form of changes in legal requirements for local house developments, boat ownership, and issuance of electronic National ID cards (E-KTP) for facilitating loans from the local bank. There is a rise in the local display of traditions and culture in the form of the annual Karimunjawa Festival organized by the Provincial government of Jepara in cooperation with the local communities. Another display of local culture involves a local boat decoration competition. To adapt to and accommodate the rise in tourism and demand for beach properties, there were changes made in MPA zoning to include more tourist zones (BTNKJ, 2017). Increased tourist zones facilitate changes in fast variables such as interactions with coral reef ecosystem and fishing efforts. Persistent changes in fast variables have implications on slow variables as it may trigger changes in fish biomass and biodiversity, and coral reef structural complexity. Areas that were previously protected as nursery, feeding, and spawning grounds, are now potentially exposed to damage given the increased exposure to improper human interactions (Yuliana et al., 2016). Further assessing the adaptive capacity of a social-ecological system allows system managers to determine the need for transformation vs. adaptation given the ongoing changes.

### **4.3.2 Assessing Adaptive Capacity**

Adaptive capacity in ecological subsystems is “related to genetic diversity, biological diversity, and the heterogeneity of landscape mosaics,” whereas, in social systems, it is “the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem-solving and balance power among interest groups” (Resilience Alliance, 2019). This section explores the five attributes of the adaptive capacity of the social subsystem of Karimunjawa. Each attribute reveals information that supports closing the gaps between objectives and actions of human actors partaking in system functions of Karimunjawa.

### 4.3.2.1 Response Diversity

Responses to change within a social-ecological system can involve aspects from both the social and ecological subsystems. Components such as human-built and organic infrastructure, manpower and skill sets, multilevel institutional actors and, formal and casual actors all play an important role in responding to change. Livelihood and income diversity is a common indicator used to determine response diversity in a social subsystem, in addition to indicators such as economic opportunities, level of dependence on natural resources, migration patterns, and willingness to change (Whitney et al., 2017; McLeman and Hunter, 2010). Identifying livelihood diversity in a system allows for an understanding of possible social disparities and unequal distribution of opportunities in the face of change (Leslie and McCabe, 2013). Responses from both semi-structured interviews and the SERS survey were combined to present the collective data on preferred livelihood alternatives (Table 4.4).

Table 4.4 Preferred livelihood alternatives for the local community members  
(interviews n=50, SERS Survey n=25)

Preferred Alternative	% of respondents
Tourism	67%
Salaried employment	33%
Informal, small business	27%
Fishing	27%
Crop/ land based farming	25%
Aquaculture	20%

In a study conducted in 2011 in Karimunjawa, the results revealed that most of the respondents' preferred aquaculture as an alternative means of livelihood (Taruc, 2011). In the same study, jobs in tourism were the second least favored alternative livelihood stated. However, data collected for this thesis reveal that 67% of the informants and respondents prefer an alternative means of livelihood within the tourism sector (Table 4.4). Examples of means of livelihood in the tourism sector include ventures such as becoming a tour guide, investing in homestays, and renting boats for activities such as snorkeling, fishing, and "island hopping". 33% of the local community members interviewed stated salaried employment as a potential alternative means of livelihood. Aquaculture, previously one of the top preferred alternative livelihoods, is now the least



preferred alternative livelihood for the local communities, with only 20% of the informants identifying aquaculture as a preferred livelihood alternative.

The rise in tourism has provided the local communities with possible alternative means of livelihood with better predictability and income security. In recent years, the information and knowledge required to join the tourism industry have become more accessible for the local communities. However, there are issues regarding the unequal distribution of opportunities regarding employing alternative means of livelihoods. It is important to note that there is heterogeneity in the human actor's choices and actions and that not all actors respond the same during stressful situations (Leslie and McCabe, 2013). The availability of alternatives is highly dependent on an individual's awareness, wealth, education, and social connections (Setiawan et al., 2017; Leslie and McCabe, 2013).

Informants involved in the tourism industry attributed connectivity as an important factor in accessing opportunities. A local fisher stated, "*The association tends to give opportunities to the same tour guides over and over again which makes it harder for the new tour guides to earn a living in tourism*" (Interview 50). Another local fisher stated, "*I have a certificate for diving for fishing using a compressor. I am upset with the tour guides, as they are selective with hiring divers for tourism activities. I am usually the last resort, but I don't want to be the last resort anymore. I would like to be more active in the tourism industry if given the opportunity*" (Interview 19). According to the informants, there is a disparity in the distribution of government support in other alternative livelihoods such as aquaculture. A local fisher stated, "*When aquaculture started here, not everyone received help in the form of small boats and cages*" (Interview 34).

An important aspect of assessing response diversity of a system is to determine the cost incurred for employing alternative responses. When asked about the cost incurred to the system for employing alternative livelihoods, the responses mostly included intangible costs such as environmental degradation and loss of culture (Table 4.5). These responses that are overlapping, provide a benchmark for forming trends amongst the community's objectives.

Table 4.5 Cost of employing alternative livelihoods in tourism in Karimunjawa National Park (interviews n=50, SERS Survey n=25)

Cost incurred	n
Environmental degradation	50%
Increased pollution	46%
Westernization	40%
Loss of culture	32%
Increased Individuality	25%

One possible solution for the discrepancy and negative impacts of alternative livelihood is local empowerment. A local resort owner and fisher stated, *“In 2012 I built and opened this resort. The reason for the resort was to challenge the government to prove that the local people can partake in the tourism industry too and we don’t need to sell the land to outside investors. I want other local people to use me as an example and be more active in tourism and open resorts”* (Interview 29). To empower local communities, attention must be paid to the goals of the local communities during ongoing change. It is important to distinguish between the objectives of the local communities and the objectives of the management and find ways to align those objectives to appropriately adapt to the given changes at the same level.

#### 4.3.2.2 Connectivity

With the rise in tourism and tourism-related activities as a major change within Karimunjawa, one of the ways that the community adapted is in the form of increased connectivity. This was identified in the form of an increasing number of local level associations, increased awareness, increased frequency of community meetings and an increase in the use of social media. Community members often leverage connectivity during ongoing change or while facing a stressful situation.

Table 4.6 Response to questions related to local connectivity. Number 2 (n=38) is a structured question based on the responses from number 1 (n=50)

No.	Questions	% of informants	
1	Involved in local organizations/ communal groups	Yes	76%
		No	24%
2	Number of organizations	1 to 3	74%
		3+	26%

76% of the informants indicated their active involvement in local organizations (Table 4.6). The top three organizations and social groups identified as popular means for fostering connectivity include community meetings, fisher’s association, and tourist guides association. Informants involved in weekly/monthly community and association meetings identified frequently discussed topics. Topics of discussion in local association meetings and social gatherings depict the focus of adaptive response within the local community. The three circles presented in figure 4.3 present the discussion topics amongst the top three social gatherings that exist in Karimunjawa. There is an overlapping focus amongst the three prominent social groups on the matters of increasing sea garbage and pollution, in addition to concerns regarding the prevention of environmental degradation and preservation of marine ecological systems such as the coral ecosystem.

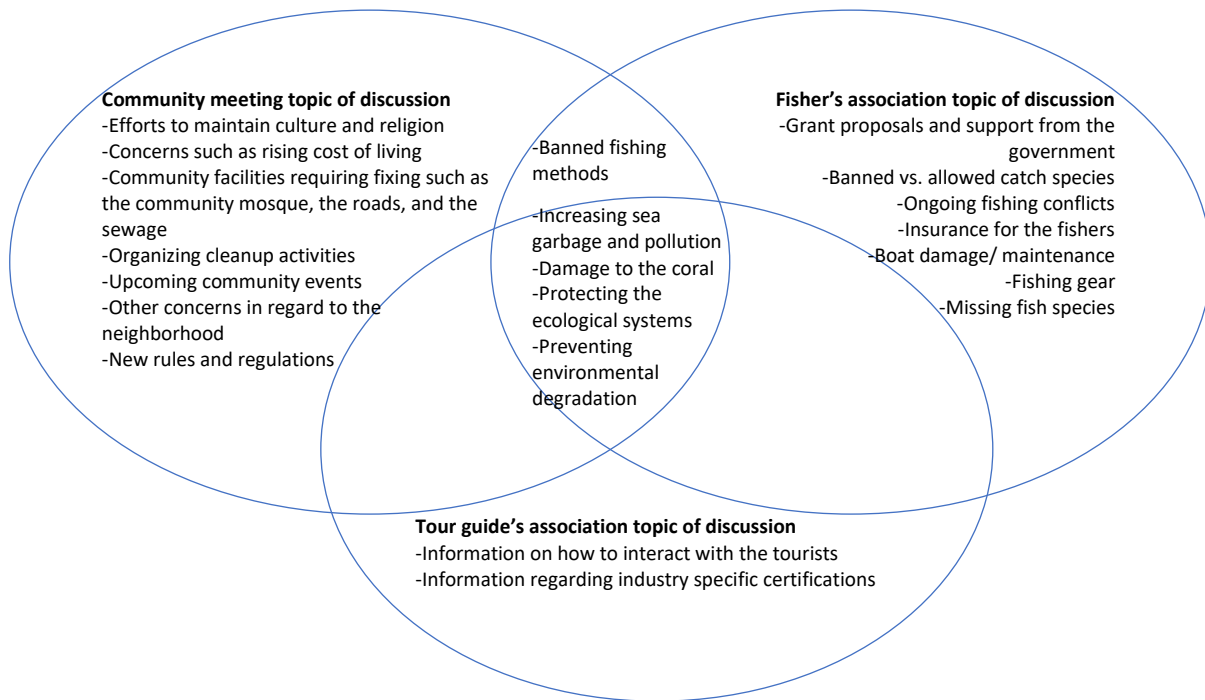


Figure 4.3 Represents common grounds and differences amongst the prominent social groups that exist as social capital for the local communities. Source: Semi-structured interviews and SERS Survey

### 4.3.2.3 Collaborative Capacity

Collaboration within a community often depends on the human actors involved and their level of engagement within a social-ecological system (Leslie and McCabe, 2013).

Table 4.7 Response to questions related to local connectivity. Number 2 (n=38) is a structured question based on the responses from number 1 (n=50)

No.	Query	% of informants
1	Involvement in decision making in the community	
	Yes	36%
	No	64%
2	Involvement in decision making related to natural resource management	
	Yes	12%
	No	88%

Interview results revealed that while most of the informants were involved in local organizations, only 36% perceived that they were involved in the decision making in the community (Table 4.7). Only 12% of the informants believed that they were involved in the decision making related to natural resource management.

Low perceived involvement in decision-making could potentially be attributed to changes witnessed in local linkages. There was a shift from primarily leveraging local relationships, to leveraging authorities and permissions, as the needs and wants of the community members evolved. For example, prior to tourism, the local community depended on linkages amongst community members in order to work together for the general development and growth of their community. Post tourism, collaboration in Karimunjawa involves engaging the links between the local government and the community members primarily for promoting tourism or managing the impacts of tourism. An informant, a local farmer stated, *“if someone was building a brick house, others would help for free. After tourism people want to be paid for their labour”* (Interview 15). Some of these voluntary acts of collaboration became paid services as the local economy improved with the rise in tourism, and the number of opportunities for each individual increased. Moving beyond using decision making as a measure of collaboration, ongoing undertakings requiring collaboration on a local level include

promoting development, promoting tourism, improving literacy rates, managing pollution, and maintaining the culture (table 4.8).

Table 4.8 Collaborative undertakings of the local communities as identified by the informants	
Actions	Sample quotes from informants stating key objectives in face of change
Promoting development	<p><i>“I hope Genting Island is not left behind in terms of development in infrastructure and growth in tourism. I hope there is growth there too. There has been a little growth, but the harbor and roads are not in a good state.”</i></p> <p><i>“The community institutions support development but don’t want this place to become like Bali</i></p>
Promoting tourism	<p><i>“Karimunjawa now is like a dream. Before tourism came here is used to be a forest with no roads or development. Now suddenly it’s like a city and there are cars, ships and motorcycles here.”</i></p> <p><i>“Its fine if this place becomes like Bali because it would be better for the economy here and for the people here”</i></p>
Maintaining culture	<p><i>“I don’t want my children to leave, I want them to stay here and make Karimunjawa better. I believe religion will play a big role in that, as it will keep them grounded and close to their culture. This is one way we can avoid westernization taking over.”</i></p> <p><i>“We will face the price if this place is to become like Bali. However, I do not want the tourists to have full freedom to do whatever they want. I want the culture here to be respected”</i></p>
Managing garbage and pollution	<p><i>“We live in a collaborative society, but I want a growing collaboration and a better system of garbage. There is no end site for garbage in the village. For right now we put it in our backyards”</i></p>
Increasing awareness	<p><i>“It is easy to get information through social media. Before the technology regime, it used to be harder to communicate.”</i></p> <p><i>“Villages have increased awareness to improve education and their skills set. There are a lot of tourists coming here and the communities want to maximize their profits from tourists, so they are willing to improve their education level. The younger generations do not want to become fishermen; they want to get involved in tourism industry.”</i></p>
Developing skills and improving learning capacity	<p><i>“People who used to be fishermen are learning culinary skills and becoming travel guides.”</i></p> <p><i>“The society here learns easily to adapt to changes such as rise in tourism. They put in effort to learn more and more English and to accept the tourists.”</i></p>

The tourism sector in the provincial government uses social media and the Internet to promote Karimunjawa as a tourist destination on a worldwide scale. The local village government is engaged in efforts to maintain local networks and culture in the form of opening dedicated cultural centers for the practice of traditional singing and dance performances. The local communities also collaborate with the local leaders to organize activities such as weekly community clean up, beach cleanup, fixing and repainting the community mosque, installing sewage in the roads for better drainage etc. A local fisher mentioned that they “*must take care of the island and keep it in a pristine condition in order to promote more tourism*”. It is important to build and maintain collaborative competencies to strengthen Karimunjawa’s adaptive capacity. Focusing proactively on improving communication between the local community members and the decision makers is one way to ensure combined objectives. To do so, connectivity amongst the local communities also plays an important role.

#### **4.3.2.4 Reserves**

The local communities of Karimunjawa rely on both human made and natural reserves in their daily lives to adapt to changes. As discussed in the previous chapter (in section 3.5.1.3), prominent ecological reserves consist of resources such as fish catch, coral ecosystem, and availability and harvesting of coconut. Social reserves consist of community gatherings and local level associations (Section 3.5.1.3). A local fisher stated, “*Before tourism, the younger generation all wanted to leave for other opportunities. But after tourism, there are hotels here that could provide job opportunities, so they want to stay here*” (Interview, 29).

Given their high dependence on natural reserves, local communities were struggling prior to tourism, as depletion of natural capital took place in the form of a decrease in fish populations and infertility of the land (Kerner and Thomas, 2014; Hafsaridewi et al., 2018). With assistance from available reserves, the local community is moving away from their resource dependent means of livelihood such as fishing and farming, and more towards the tourism industry. However, it is important to note that alternative livelihood such as tourism also depends on ecological reserves for its success.

Questions were asked regarding the standard of living and asset ownership to determine local progression towards the improved economy and alternative livelihoods

(Table 4.9). In the past, lack of physical assets for production, such as limited electricity, have been linked with slow growth and minimalized capacity to adapt to changes (Sievanen et al., 2005; Taruc, 2011). 96% of the informants reported available access to electricity, indicating the availability of reserves needed for growth. Informants from the main tourist village of Karimunjawa and Kemujan reported 24/7 availability of electricity while informants from other villages reported limited access and frequent incidents of power shortages.

Category	% of informants
Average monthly household income	
< 1.5 M IDR	32%
1.5 M to 5 M IDR	58%
5 M to 10M IDR	4%
> 15 M IDR	6%
Asset ownership	
Property/land in Karimunjawa	92%
Boat	66%
Motorcycle	32%
Possession of household appliances	
Gas stove	88%
Television	84%
Electric fan	40%
Refrigerator	44%
Audio player	60%
Access to utilities	
Water tank	40%
Water pump	36%
Electricity	96%
Roof Material	
Metal	14%
Tile	86%
Wall Material	
Cement/Brick	76%
Wood/ Plywood	24%
Floor Material	
Cement	48%
Tile	34%
Soil	8%
Wood	10%

For Karimunjawa and Kemujan village, electricity is produced from state owned diesel-powered generator. The third most populated village of Karimunjawa National Park, Parang, is undergoing a switch from the diesel-powered generator to solar-powered plant, and the electricity is not as widely available. In 2014, maximum electricity usage per household in Parang village was calculated to be about 1.5 Kilowatts per household. However, the village surpassed the estimated usage of electricity as the demands for electric gadgets and appliances increased with access to electricity. During the interview period, it was found that local community members reach the 1.5 kilowatts mark by 2 pm during the day. Electricity is an important man-made reserve and asset for production that highly influences the capacity to adapt to changes.

In regard to local housing, the majority of the respondent's houses were cement/brick houses, with cement or tile flooring, and tile roofs. 92% of the informants were homeowners or owned land in the sub-district of Karimunjawa. Individual preference, needs, and knowledge play an important role in defining adaptive capacity on a household level (Martinez et al., 2011). Need for immediate benefits, such as impending debt, could cause individuals to sell their land for immediate benefits. Contrarily, depending on the on-hand capital or depending on the availability of a loan, individuals are considering building resorts or homestays for long term profits. Price of land in Karimunjawa at the time of interviews fluctuated from 300,000 IDR to 1 million IDR per square meter depending on its location (i.e. close to water, central market etc.).

Diversifying assets to be used as reserves could play an important role in local growth. The transition of the social-ecological system from a fishing community to a tourism-based industry provides an opportunity to assess and outline the system's vulnerabilities as the social, natural and economic capital is expended (Lade et al., 2017; Higham and Miller, 2018). One way to actively build adaptive capacity is in the form of cross-spatial collaboration to maintain and actively discuss deploying reserves (Vatn and Vedeld, 2012). In order to optimally use the reserves, it is important to understand the learning capacity of the local community that brings attention to aspects such as levels of education, access to resources and cultural memory etc.



#### 4.3.2.5 Learning Capacity

Karimunjawa National Park’s learning capacity is based on the local community’s norms, culture, and collective memory of past experiences (Martinez et al., 2011). Consisting primarily of fishers and farmers, the local communities depended on their ability to learn and adapt when faced with changes such as fluctuating number of fish species and fish availability, and unpredictability in weather and wave patterns. With support from government authorities, the local fishers learned to use technology such as GPS and fish finders to adapt to the changes.

Table 4.10 Preference in communication and learning efforts (semi-structured interviews n=50)

Category	% of informants
Preferred communication method	
In person communication/ informal “chit chat”	66%
Social media/ Whatsapp	24 %
Seminars/workshops	4%
Don’t know	6%
Preferred location for communication	
Local neighborhood	46%
Mosque	38%
Central market	12%
Don’t know	6%

Often in coastal communities, perceptual learning processes are valued more than scientific understandings in collective responses to ecological changes (Berkes et al., 2000). This embedded understanding of the local community was tested when the Karimunjawa National Park Authority held informative workshops and sessions to educate the local communities regarding the importance of maintaining ecological functions in 2010. The community’s cooperation and understanding were vital in establishing Karimunjawa as a National Park. To determine the learning capacity of the local communities, the informants were asked questions regarding their preferred means for communication (Table 4.10).

66% of the local informants stated that they preferred informal communication as a means to get new information (Table 4.10). Communication with the neighbors within the community in the form of daily “chit chat” is an important part of the local norm. Social media is another important form of communication as local association use the

app, Whatsapp, to form groups and message details regarding upcoming meetings or other important information. An informant stated “*I usually get my information about the changes through the tourist guide association WhatsApp group. All members of the association are also members of the WhatsApp group. We can ask questions in the group and clarify anything if need be*” (Interview 45).

One local fisher recently started using WhatsApp to sell fresh catch to the local buyers, by sending pictures and prices over cellphone rather than conducting an in person meeting. Informants identified their local neighborhood and mosque to be the top two preferred locations to receive new information. This further reinforces the idea that collective interaction can potentially influence individual decision and activities that can either have favorable or detrimental impacts on ecological subsystems (Adger et al., 2002).

The local community of Karimunjawa National Park fosters a culture of learning as a form of survival. Changes and disturbances within the social-ecological system, such as a decrease in fish biomass, rise in tourism, and an increase in local populations often warrant a response from the local community based on individual preferences. A local fisher stated that “*the people here just accept the change and let it be*” (Interview 28). Over time the community deemed it important to support tourism to promote local growth and development, which paved the way to increased local involvement. A local fisher stated, “*The society here learns easily, it is necessary to adapt to tourism. They put in an effort to learn more and more English vocabulary and to accept the tourists as part of the community*” (Interview 49). Further learning is taking place as a means to respond to the rise in tourism as local government and institutions support local learning capacity by providing socialization, information sessions, and programs to teach skills needed to succeed in the tourism industry. A local fisher stated that “*The government helps with the learning; they invite the non-working mothers, to train them in the English language and to educate them in the field of hospitality. Training like this happens every other month arranged by the provincial government. I believe society is getting better at learning more and more every day*” (Interview 14). There are training sessions targeted towards the younger generations, as well as certification workshops where a local community member can work towards becoming a certified tour guide.

### 4.3.3 Integration of Slow Variables, Vulnerable Components, Adaptive Capacity and Source of Resilience or Transformation

Due to the ongoing changes, the future trajectory of responses could include maintaining a status quo in the form of fostering resilience, or a pathway that promotes radical change by introducing new rights claims and changes within the social structure of Karimunjawa. Understanding adaptive capacity is important for either mitigating negative impacts of change by fostering a higher resilience, or in transforming the system into a new state. The relationship between the vulnerable components, adaptive capacity, and potential sources of resilience or transformation is summarized in table 4.11. Previously identified slow variables are used as indicators that are critical to the functioning of the social-ecological system of Karimunjawa.

Table 4.11 Identifying Local community’s adaptive capacity and sources of resilience in face of change within the slow controlling variables

Slow Variables	Vulnerable components	Adaptive Capacity	Potential source of resilience / transformation
Culture, Values and Local Institutions	<ul style="list-style-type: none"> <li>•Culture/next generation</li> </ul>	<ul style="list-style-type: none"> <li>•Expanding opportunities in tourism</li> <li>•Social media awareness</li> <li>•Expanding access to information (using means such as technology, and local connectivity)</li> <li>•Attention towards maintaining local and historical ties</li> <li>•Higher education</li> <li>•Increased demand for human resources</li> </ul>	<ul style="list-style-type: none"> <li>•Increased connectivity in existing associations/ dissolving old associations or forming new associations</li> <li>•Encouraging cultural continuity/ development of cultural centers</li> <li>•Emphasis on awareness and education amongst younger generations/increased freedom</li> <li>•Emphasis on cultural exchange / accommodating westernization</li> </ul>
Wealth and Infrastructure	<ul style="list-style-type: none"> <li>•Livelihoods</li> <li>•Available resources</li> </ul>	<ul style="list-style-type: none"> <li>•Local empowerment (in the form of local hiring, investment by local community)</li> <li>•Growth of assets with new properties (Homestays)</li> <li>•Monetization of local skills (construction labor,</li> </ul>	<ul style="list-style-type: none"> <li>•Stability of job opportunities and steady income</li> <li>•Improved access to roads, communication, and markets</li> </ul>

		transportation, etc.) •Need for improved infrastructure	
Property and use rights	<ul style="list-style-type: none"> <li>•Forest cover (land use)</li> <li>•Available space/openness</li> </ul>	<ul style="list-style-type: none"> <li>•Outside investment</li> <li>•Increased legal requirements</li> </ul>	<ul style="list-style-type: none"> <li>•Increased privatization</li> <li>•Increased awareness in regard to the MPA zoning</li> </ul>
Fish Biomass and Biodiversity	<ul style="list-style-type: none"> <li>• Fish biomass</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental awareness</li> </ul>	<ul style="list-style-type: none"> <li>•Abatement of intense fishing efforts</li> <li>•Increased socialization and dissemination of knowledge regarding maintaining biodiversity</li> <li>•Shift in focus from Pelagic to demersal / coral species (increased focus on species such as squid)</li> </ul>
Coral reef structural capacity	<ul style="list-style-type: none"> <li>• Coral reefs</li> <li>•Fish biomass</li> </ul>	<ul style="list-style-type: none"> <li>•Regulations around improper interactions with coral (anchor damage, destructive fishing methods)</li> <li>•Promote aspects of Ecotourism (such as coral planting)</li> </ul>	<ul style="list-style-type: none"> <li>•Increased regulations to minimize improper interactions with coral reef ecosystem</li> <li>•Increased training requirements local tour guides</li> <li>•Diversity of natural tourism</li> <li>•Regulations surrounding use of fishing gear</li> </ul>
Beach conditions and functions	<ul style="list-style-type: none"> <li>•Water quality/turbidity</li> <li>•Forest cover (mangroves)</li> </ul>	<ul style="list-style-type: none"> <li>•Marine Protected Area Zoning changes</li> <li>•Increased attention towards waste management (aspects needing attention include proper disposal, recycling, and waste end-site)</li> <li>•Proactive, and preventative planning such as flood barriers</li> </ul>	<ul style="list-style-type: none"> <li>•Potential natural tourism</li> <li>•Increased socialization and awareness (especially regarding the importance of maintaining natural ecosystems)</li> </ul>

Building adaptive capacity to respond to changes in one slow variable could lead to increased disturbances in other critical variables, hence requiring consequent adaptive responses. For example, adaptive responses to manage change in wealth and infrastructure in the form of improved access to resources and alternative livelihoods could potentially cause a need for an adaptive response in other slow variables within the system such as local culture, values and local institutions. This interconnected feedback response within the adaptive capacity of Karimunjawa's social system suggests the need for a continuous process of review and response.

Understanding the relationship between system vulnerability, adaptive capacity and adaptive responses allows bridging the gap between and bringing harmony between the objectives of the local community and decision makers. It is possible that for some critical variables the adaptive intention and institutional responses are aimed towards radical transformation, however, some critical variables require proactive adaptation to stay resilient when facing stress. Continuous discussion on community objectives and institutional objectives is vital to collectively respond to change with minimal conflicts.

## 4.4 Conclusion and Chapter Summary

The purpose of this chapter was to identify system vulnerabilities and adaptive responses to the changes identified in chapter three. This chapter also determined the adaptive capacity of the local communities. Three main conclusions can be drawn; first, identifying vulnerable components is vital in managing scales and levels of intervention. Second, improving the adaptive capacity of the local community requires an equal focus on sustaining local livelihoods and natural resources. Third, integrating slow variables, vulnerable components, and adaptive capacity provides sources of resilience or transformation, and reveals the interconnected nature of adaptive responses.

It was concluded that vulnerable components (such as coral reef, fish biomass, and culture) coincide with slow variable (such as coral reef structural complexity, fish biomass, local norms, culture, and long standing institutions, and property and use rights) that are crucial for maintaining system functions. Since slow variables provide comprehensive parameters within which the complex concept of rapid change is understood, identifying vulnerabilities improves predictability leading to appropriate management tactics. Fish biomass related to species such as sea cucumbers and squid were identified as vulnerable components and were exposed to change due to drivers such as increasing demand and changing preferences. Paying specific attention to the levels of exposure and sensitivity of the components could lead to insight on targeted and appropriate governance response.

Adaptive responses to change were predominantly limited to changes in livelihood. Alternative livelihoods such as the ones available in the tourism sector, although not strictly extractive, are still confined to a strong reliance on natural resources. Hence, it was concluded that improving the adaptive capacity would involve management objects aligned equally with sustaining local livelihoods and natural resources. The local community was found highly connected, with 76% of the informants involved in at least one local organization or group. Despite the high connectivity, the perceived involvement of the local communities in local decision-making was relatively low. Less than 50% of the informants believed that they were involved in the decision-making.

Lastly, integrating slow variables, vulnerable components, adaptive capacity and sources of resilience or transformation revealed the interconnected nature of adaptive

responses. Adaptive response to the change in one variable could potentially contribute to vulnerabilities in others. Feedback interactions taking place within a system could cause further change or create patterns of disruption requiring community and government intervention. Results indicate the need for continuous discussion on community objectives and distribution of opportunities to manage and minimize social conflict. Local communities tend to use man-made reserves such as access to electricity as an asset for production for further development despite identifying the availability of open space as a vulnerable component. Learning capacity confirmed the importance of using cultural memory and history for understanding patterns in learning preferences and supporting the overall adaptive capacity.

## Chapter 5

# Governing Crucial Slow Variables and Feedbacks for Anticipating and Responding to Social-Ecological Change

### 5.1 Introduction

Karimunjawa National Park is transitioning from a remote landscape primarily composed of a fisher community, into a trendy tourist destination populated with tour guides, and tourist facilities (Purwanti, 2001). There are changes taking place in both social and ecological subsystems at various scales, necessitating adaptive responses from local communities such as a change in livelihoods (As discussed in chapters 3 and 4). Patterns of disruption that initiate a transition from one stable state to another often also provide opportunities for intervention (Crépin, 2007; Armitage and Johnson, 2006). Managing crucial slow variables and feedback interactions is an important aspect of responding to change within a social-ecological system (Crépin, 2007).

This chapter addresses the third and final objective of this thesis, which is to examine governance implications in Karimunjawa with reference to the ongoing changes, documented in chapters two and three. First, this chapter identifies a guideline for managing slow variables and feedbacks in order to maintain a desirable state and system functions. This guideline includes *strengthening feedbacks that maintain desirable regimes, avoiding actions that obscure feedbacks, monitoring important slow variables and establish governance structures that can respond to monitoring information* (Stockholm Resilience Centre, 2019; Miller et al., 2012; Ferrara et al., 2016; Crépin, 2007). Second, gaps between governance responses are identified using modes of governance in the policy dimension based on its binding nature vs. flexibility of implementation (Treib et al., 2007). Use of legal instruments such as modes of coercion, voluntarism, targeting, and framework regulation are explored using data collected from interviews and surveys.

### 5.2 Literature Review

The literature review in this section aims to present the importance of understanding the spatial and temporal scale in governance, especially in the context of



adaptive governance. Ongoing responses to change are identified and linkages are formed in the governance structure of Karimunjawa National Park. Guideline for managing on going changes at various scales and its feedback interactions is described. Furthermore, connections are formed between ongoing changes and using the guideline that consists of *strengthening feedbacks that maintain desirable regimes, avoiding actions that obscure feedbacks, monitoring important slow variables and establish governance structures that can respond to monitoring information*. Lastly, the role of policy is explored using four categories of legal tools as identified in current literature, in order to assess context specific governance structure that is ideal for managing feedback interactions and critical slow variables in Karimunjawa National Park.

### **5.2.1 Adaptive Governance and Significance of Managing Slow Variables**

Problems such as climate change and rising anthropogenic pressure on coastal social-ecological systems, threatening biodiversity and system functions require multilevel and multi-scale solutions in the realm of governance (Young 2002, Biermann 2007, Folke et al., 2007). Governance can be defined as all modes of governing that purposefully guides or steers society and promotes coordination amongst interdependent actors based on institutionalized rule systems (Termeer et al., 2010; Treib et al., 2007; Benz, 2004; Kjaer, 2004). Various political and cultural forces within a social-ecological system influence institutions and management of coastal marine resources (Young et al., 2008). Consequentially, local livelihoods and perception play an important role in the outcome and success of the local institutions (Levine et al., 2015).

Adaptive management is an integrated, multidisciplinary approach for dealing with the complex and uncertain nature of issues surrounding coastal social-ecological systems. This type of management focuses on spatial, temporal, institutional, knowledge and additional scales, with attention on various levels in each scale (Termeer, 2010; Folke et al., 2007). Inclusion of adaptive management responses to change in Karimunjawa National Park is evident in the form of changes implemented to the zoning, introduction of awareness campaigns, and socialization efforts (Setiawan et al., 2017). However, the degree of integration and success of such responses is debatable and requires further inquiry and research.

In a regime of adaptive management, systems are connected both horizontally and vertically, hence being connected in a form of nested enterprise (Plummer et al., 2012; Folke et al., 2007). National Park Authority under the Ministry of Environment and Forestry is an institution that holds the authority to manage Karimunjawa National Park. However, vertical linkages exist in the form of various jurisdictional levels of management. There are four hierarchies of governance claiming the authority of marine resources: national, provincial, district, and village. Local and provincial governments are responsible for managing coastal resources and enforcing regulations, admin affairs, participation in security and sovereignty (within their own jurisdiction). The province itself holds authority over cross-jurisdictional districts and cities (Wever et al., 2012). In the management of Karimunjawa National Park, there are stakeholders who play important roles. Other stakeholders are the Ministry of Marine Affairs and Fisheries, Marine Affairs and Fisheries Office, Indonesian Marine Corps, Indonesian Maritime Police Force, Tourism and Culture Office, regional and provincial governments, and non-governmental organizations (e.g. Wildlife Conservation Society/WCS).

There are also horizontal linkages present within this system in the form of connected communities and villages (Cox et al., 2010). Management of marine resources and coastal communities is a politically and culturally driven process shaped by local livelihoods, perceptions and norms (Levine et al., 2015; Treib et al., 2007). Community engagement and knowledge plays an important role in highlighting and resolving local issues (Levine et al., 2015). However, potential issues exist in adaptive management in the form of scale mismatches and interdependencies between various levels.

Walker et al. (2012) identified three sources of confusion and issues regarding the multi-scale behavior of complex adaptive systems, one of which is confusion around understanding and managing “fast” and “slow” variables within a system. Governing complex coastal social-ecological systems involves sustaining the feedbacks and crucial slow variables that maintain system functions that produce essential ecosystem services. Feedback interactions can enhance resilience by dampening actions that are causing changes in system functions (Biggs et al., 2012). On the other hand, it can also weaken a system by creating further changes. Managing slow variables and feedback is one of the seven principles for building resilience in social-ecological systems (Stockholm

Resilience Centre, 2019). It is important to actively manage the slow variables and feedbacks that produce desirable ecosystem services in order to maintain desirable system functions. Building resiliency helps the local communities and the local government to work together and collaborate towards adaption and/or transformation. The guideline for managing slow variables and feedback involves of *strengthening feedbacks that maintain desirable regimes, avoiding actions that obscure feedbacks, monitoring important slow variables, and establishing governance structures that can respond to monitoring information* (Stockholm Resilience Centre, 2019; Biggs et al., 2012; Kok and Veldkamp, 2011).

#### **5.2.1.1 Strengthening Feedbacks**

Strengthening feedbacks require identifying and working with the objectives of the local community members and ecosystem managers (Kok and Veldkamp, 2011). In Karimunjawa, coral reef ecosystem, biodiversity, and beach functions are important slow variables that provide ecosystem services such as fisheries and marine tourism. Within the social subsystem, slow variables include, but are not limited to, local culture, values and institutions, wealth and infrastructure, and property and use rights. Drivers of change such as increased pressure on fisheries and destructive fishing practices, improper interactions with the coral ecosystem, and rising beach development are causing changes in the provisioning of ecosystem services. Recognizing and strengthening critical feedbacks within a social-ecological system could prevent passive setbacks that cause irreversible changes to critical slow variables that define the system functions and structure (Kok and Veldkamp, 2011).

#### **5.2.1.2 Avoiding Actions that Obscure Feedbacks**

Instruments such as local institutions, sanctions, and policies are often used to enable feedbacks that maintain a desirable regime. As a supporting mechanism, it is important to recognize and prevent actions that mask or hinder viable feedback interactions (Stockholm Resilience Center, 2019). One example is that of the roving bandits (see Berkes et al., 2006). Fishers from outside Karimunjawa, with sophisticated technology and large capacity fishing vessels, often encroach Karimunjawa's fishing grounds. Since these fishers are not locals from Karimunjawa, they have no incentive to

ensure the sustainability of fisheries, hence undermining local institutions. Powerful individuals and groups can often control the direction and nature of change within a social-ecological system based on their incentives for certain actions (Nightingale, 2017). Hence, power dynamics play an important role in avoiding actions that obscure feedbacks.

### **5.2.1.3 Monitoring Important Slow Variables**

Programs in favor of monitoring slow variables, for the collective goals of livelihood-based management and sustaining ecological functions in a social-ecological system can be cost-effective in the long run. Monitoring slow variables in ecological subsystem reveals information regarding critical trophic structures, biodiversity resistance and resilience that form important considerations in understanding thresholds of change (Chaffin et al., 2016; Bellwood et al., 2004).

In the social subsystem, monitoring reveals information, such as the appropriateness of current data in use, and any subtle shift in power dynamics that could improve decision-making in an adaptive management context (Lynam and Smith, 2004). Given the underlying and complex nature of slow variables, management tends to focus more on the visible fast variables such as population and changes in income within the social subsystem (Armitage and Johnson, 2006). However, determining changes within the slow variables could shed light on qualitative variables that could provide guidelines and reference points for long-term management (Crépin, 2007). Local knowledge and traditional knowledge provide insights into local perception and understanding, hence plays an important role in monitoring slow variables (Mellado et al., 2014; Berkes et al., 2000).

### **5.2.1.4 Establishing Governance Structures that can Respond to Monitoring Information**

Lastly, establishing mechanisms that can respond to monitoring information requires creativity and context-specific understanding of ongoing changes. Local governance actors often eliminate local communities as a key component of the governing structure causing miscommunication and lack of transparency (Weber et al., 2012). Leveraging linkages within the governing bodies and creating structures wherein

local communities are involved in monitoring as well as responding to the change could prove essential in the governing scheme of Karimunjawa National park. Efficient and effective dissemination of new knowledge and changes minimizes miscommunication and supports collective learning capacity of the local community (Trimble and Berkes, 2015; Chapin et al., 2006).

Currently, the governing bodies of Karimunjawa reside at various levels with potential for discrepancies and obstacles in communication. Focusing on the slow variables and the guideline for managing feedback interactions could minimize or eliminate issues arising from governance structure distributed across various scales.

### 5.2.2 Identifying Sources of Conflicts within Modes of Governance in the Policy Dimension

To direct attention on practical suggestions in dealing with and responding to change, governance is studied and understood in the realm of policy. Although Chapter 3 and 4 discuss other realms of governance such as politics (power relation between private actors), and polity (forms of governance identified in community, associations, and networks), this section primary discusses the policy dimension. Treib et al. (2007) discuss modes of governance in the policy dimension, which consists of coercion, voluntarism, targeting and framework regulation (figure 5.1). Further investigation of each mode could potentially lead to a higher-level understanding, allowing local scale targeted intervention where necessary. Policies act as steering instruments to guide the society towards a particular, predefined goal or outcome. The four modes of governance can further be dissected to determine the type of instruments applied (legally binding legislation or soft law) and the approach to implementation (rigid or flexible).

		<i>Legal instrument</i>	
		<i>Binding</i>	<i>Non-binding</i>
<i>Implementation</i>	<i>Rigid</i>	Coercion	Targeting
	<i>Flexible</i>	Framework regulation	Voluntarism

Figure 5.1 Modes of governance in the policy dimension based on its biding nature vs. flexibility of implementation (Treib et al., 2007)

Binding legal instruments refer to legal acts such as regulations, directives and decisions, whereas nonbinding instruments refer to recommendations, opinions, and ‘conclusions’ (Treib et al., 2007). Community engagement and knowledge plays an important role in highlighting and resolving local issues. Rigid vs. flexible implementation of the policies is mainly related to the availability or lack of availability of possible options.

Karimunjawa National Park Authority manages Karimunjawa National Park, primarily through coercive area-based management in order to carry out conservation efforts to preserve life support system activities. Coercion is a form of a legal instrument that leaves little flexibility in implementation as it is meant to be fully binding and highly prescriptive. Governing a complex social-ecological system involves many aspects such as local participation and cooperation, rules, sanctions, and monitoring. Management of marine resources and coastal communities is a politically and culturally driven process shaped by local livelihoods, perceptions, and norms (Levine et al., 2015). From 2003-2005 there was a high level of community engagement in Karimunjawa National Park in regard to rezoning and altering the regulations, and from 2005-2009 enforcement was extremely limited (Nurhidayah et al., 2017). From 2005-2009, there was a maximum of eight patrols per year that was mainly focused on the more populated communities. There were no prosecutions or fines imposed for violations of restrictions by the members of local communities, on the other hand, three “outsider” fishers were prosecuted for trawling over coral reef habitats (Nurhidayah et al., 2017). The reported offences committed by local and outsider fishers include destructive fishing practices such as potassium and bomb fishing, illegal fishing gear/trawl operation (Ministry of Forestry, 2011).

Where there is value laden non-renewable resource, there is bound to be some conflict regarding the use and management of that resource. Conflict resolution is essential in maintaining collective action and cooperation for local management. Karimunjawa National Park follows a decentralized governance model of management. The main conflicts that occur within Karimunjawa are between small-scale fishers and government agencies, and small-scale fishers and large-scale fishers (Trimble & Berkes, 2015). In most cases, the common factor amongst conflict resolution mechanisms for

resource crisis involves a participatory co-management approach (Jentoft et al., 1998; Campbell et al., 2012; Trimble & Berkes, 2015). The involvement of local communities in natural based management is becoming an alternate management option in more and more coastal management scenarios (Dirhamsyah, 2005). In Indonesia, there is an increasing focus on stakeholder involvement as it is an essential element of all integrated coastal and marine resources management (Dirhamsyah, 2005). As a management regime, co-management can be viewed as an institutional design that allows for the sharing of costs and benefits in a system (Trimble & Berkes, 2015).

Framework regulation is within the realm of binding law however, it follows a direction of broad goals. In Karimunjawa, non-binding legal instruments are often used on a local scale to reflect the local community's collective goals. Voluntarism exists as a non-binding instrument that defines broad goals set by the societal norms. This form of the mode of governance plays an important role in maintaining the fabrics of the society in Karimunjawa, especially in the realms of maintaining slow variables in the social subsystems such as local culture. Voluntarism as a mode of governance demands involvement from both public and private actors and has dispersed sense of authority (IGI Global, 2015). This dispersed authority could lead to discrepancies in the distribution of opportunities as powerful individuals and group claim autonomy over decision-making. Targeting also uses non-binding recommendations, however, it is more detailed than voluntarism (Treib et al., 2007). The in-depth nature of recommendations leaves little room for maneuver at the implementation stage. The following section presents a conceptual framework followed in this chapter based on the literature review.

### **5.2.3 Conceptual Framework**

Establishing steps to manage important slow variables and feedbacks matched by a context specific mode of governance could minimize conflict and encourage adaptation (Termeer, 2010). The conceptual framework (figure 5.2) encourages management of crucial slow variables that can lead to appropriate managerial responses in the face of change that would yield maximum compliance and success rate of the chosen mode of governance.

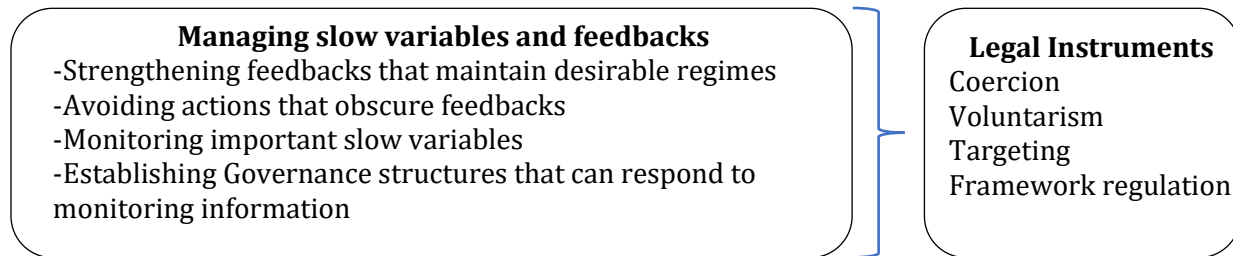


Figure 5.2 Conceptual framework followed by this chapter to establish policy implications of managing slow variables and feedbacks, followed by highlighting appropriate modes of governance within the social-ecological system of Karimunjawa

## 5.3 Results

### 5.3.1 Managing Slow Variables and Feedbacks

Fast variables in a social-ecological system such as income, number of visitors, fishing effort, and individual choice fluctuate often and are not constant, as discussed in chapter 3 (Chapin et al., 2006). Fast variables often fluctuate around a long-term attractor that maintains the system in a stable state. The magnitude of these fluctuations often increases as slow variables approaches a threshold level (Carpenter et al., 2001). For example, as Karimunjawa’s biodiversity and fish biomass are impacted (by external factors such climate change and increasing demands) fast variables such as local income fluctuate drastically (Giardino et al., 2018). Although steps can be taken to manage specific fast variables, this chapter primarily focuses on managing crucial slow variables and feedbacks within Karimunjawa. The following sections explore the guideline for managing slow variables and feedbacks (Stockholm Resilience Centre, 2019). Data collected for this research objective includes data on local preferences, understanding the nature of change, nature of governance responses, and factors hindering governance responses to change.

#### 5.3.1.1 Strengthening Feedbacks that Maintain a Desirable Regime

This subsection presents data in the form of primary objectives of local communities during on-going change (Table 5.1). In order determine the extent to which the agency of individual is practiced in Karimunjawa National Park during on-going change, and to determine their ability to assess situations and make choices, the informants were asked questions in regards to their objectives (Ohlsson, 2000). In case of



disturbances in social-ecological systems, local responses and strategies are often found revolving around social-political and environmental strategies (Prado et al., 2015). Informants were asked to rank the following three objectives: maintaining livelihoods, protecting the environment, and complying with the local policies, based on their perceived adaptive capacity. The results are as stated in table 5.1.

Order of Importance	% of informants
Maintaining Livelihoods > Protecting the Environment > Complying with local policies	60%
Maintaining Livelihoods > Complying with local policies > Protecting the Environment	20%
Complying with local policies > Protecting the Environment > Maintaining Livelihoods	8%
Protecting the Environment > Maintaining Livelihoods > Complying with local policies	6%
Protecting the Environment > Complying with local policies > Maintaining Livelihoods	4%
Complying with local policies > Maintaining Livelihoods > Protecting the Environment	2%

Most of the informants stated that their main objective during ongoing changes such as environmental degradation and rise in tourism is to first and foremost maintain or secure their livelihoods (Table 1). Respondents who placed the most importance on complying with the local policies (10%) were involved in local governance and held positions such as village head, area head, or sub-area head. Underlying incentives and intentions of the local communities often guide local actions, which in combination with management responses assist in strengthening feedbacks.

### 5.3.1.2 Avoiding Actions that Obscure Feedbacks

This subsection presents results regarding the distribution of power within Karimunjawa (Table 5.2). Local respondents identified the following individuals and groups to hold the most power: sub-district head, the village head, resort owners, and investors. Fishers and other residents of Karimunjawa were not identified as powerful, and hence not capable of inflicting any “real” change within the system.

Table 5.2 Most powerful individual or groups, as identified by respondents (SERS Survey n=25)

Groups	% of respondents
Sub-district head	80%
Village head	76%
Resort owners and investors	60%
Government employees	44%
Other Privileged locals (Landowners, younger individuals, wealthy etc.)	28%
Don't know	12%

Foreign investors that have goals primarily aligned with monetary profits obscure feedback interactions in the form of inaction towards development in Karimunjawa on a local, community level. One informant specifically mentioned the rise in “outside investments” and its corresponding lack of development and growth in Karimunjawa could lead to a hindrance in actual economic growth. The main concern raised from this context was regarding the lack of consultation with the local communities regarding strategic planning at a managerial level. Due to ongoing change in land use and property rights the responsibility for development and growth is not primarily localized but controlled by the powerful actors within Karimunjawa. Responses from human actors often feed into the interactions between the social and ecological subsystems by preventing or intensifying any ongoing change. As part of managing such feedback interaction, it is important to discuss factors hindering/ influencing governance responses to ongoing change.

### 5.3.1.3 Monitoring Important Slow Variables

This subsection presents data regarding the local perception of types of change taking place within the ecological and social subsystems (Figure 5.3). Although these results were also presented in a table format in chapter 3 in order to identify the nature of ongoing changes, this subsection specifically focuses on the difference in perception of types of change within social and ecological subsystems.

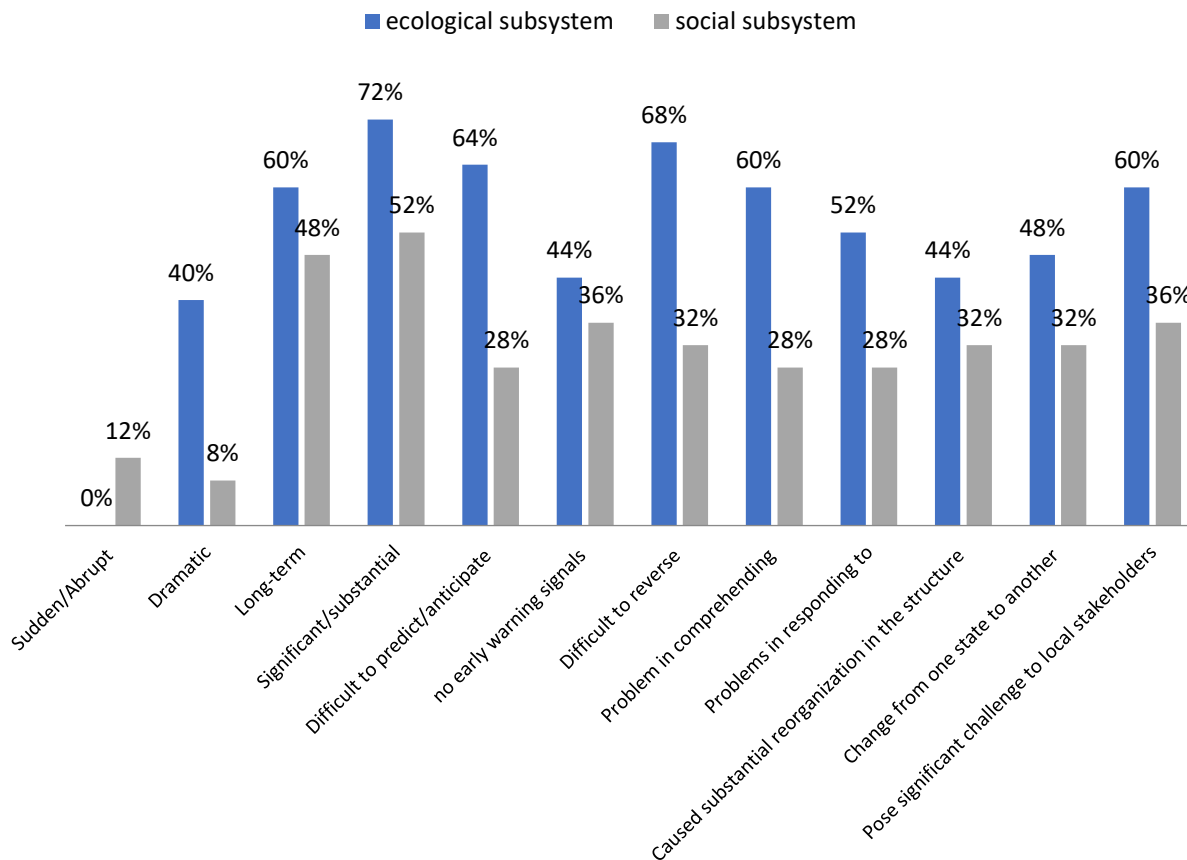


Figure 5.3 The nature of changes taking place in ecological and social subsystem as identified by the local respondents (SERS Survey n=25)

Despite efforts to manage ecological changes, 72% of the respondents described ongoing changes in the ecological subsystem as significant/ substantial (figure 3). 60% of the respondents stated long-term impacts of change indicating a shift in crucial thresholds within the ecological subsystem. None of the local respondents identified ongoing changes in the ecological subsystem as “sudden”, but more so expected. Since Karimunjawa’s ecological subsystem does not operate in isolation from the social subsystem, there are many social and economic factors to be considered such as livelihood management and human wellbeing. Variables monitored and measured in the social subsystems are often quantifiable, such as local population and income. Whereas variables such as local culture and long-term institutions, property rights and use rights, and wealth and infrastructure are often seen as “control variables” used to create

intentional change within a social subsystem (Walker et al., 2012). 52% of the respondents stated that nature of changes taking place in the social subsystem was significant as it impacts the behaviors and demands of the future generations, hence dictating the future state of Karimunjawa (Figure 5.3).

Monitoring important slow variables in both social and ecological subsystems provides insights on the effectiveness of local policies and use of local knowledge in managing feedback interaction and any ongoing change. For example, 64% of the respondents stated that it was difficult to predict the changes in the ecological subsystems, whereas only 28% stated that for the changes taking place in the social subsystem, even though more than 50% of the respondents identified the nature of the change to be “significant” in both subsystems. This could either indicate that the local community members are able to better respond to changes in their social subsystems as compared to the ecological subsystem. Or on the other hand, the data could indicate that the social subsystem is yet to undergo unexpected changes in the near future (Walker et al., 2006). Unforeseen changes can create patterns of disruption in the functions of a social-ecological system requiring governance structures to be able to cope, adapt to, or navigate impacts of change (Crépin, 2007; Walker et al., 2012). Monitoring crucial slow variables in both subsystems could indicate the nature of change taking place, and possibly improve predictability and indicate any early warning signals. Furthermore, monitoring crucial slow variables encourages engagement and involvement of the local communities, leading to overall compliance of rules and regulations.

#### **5.3.1.4 Establishing Governance Structures that can Respond to Monitoring Information**

This subsection contains data regarding the nature of governance responses as identified by the local respondents (Table 5.3) and data on the perceived ability of local governance mechanisms to respond to adverse impacts to change (table 5.4). Respondents were asked to identify the nature of responses by the governance actors to gain insights on governance and management in the context of social-ecological regime shifts (methodology discussed in chapter 2).

Responses	Description	% of Respondents
Anticipating change	Anticipating or preparing for change is an important phase of system transformation (Olsson et al., 2004). Supporting improvement in infrastructure to accommodate a rise in number of tourists is an example of anticipating change	48%
Coping with change	Supporting systems' ability to absorb or withstand perturbations or other stressors in order to maintain the current regime and system functions as a step towards fostering resilience (Walker et al., 2004)	40%
Adapting to change	The degree to which a system is able to adapt to change is an important descriptor of system resilience (Walker et al., 2004)	40%
Navigating change	Navigating the transition is the second phase of system transformation (Olsson et al., 2004)	28%
Mitigating change	Mitigating change involves of supporting the adaptive capacity of a system to alleviate adverse impacts of change based on past conditions (Chapin et al., 2006)	24%
Transforming change	Transformation involves fundamental change, which in the context of sustainability, requires radical, systemic shifts in values and beliefs, patterns of social behavior, and multilevel governance and management regimes (Olsson et al., 2004)	20%
Preventing change	Systems that allow too much change will encounter loss of memory, while systems characterized by a high degree of continuity will almost certainly experience surprise and generate crisis (Berkes et al., 2003)	12%

Responses of governance actors indicate the goals of governance regarding fostering resilience of facilitating transformation during ongoing change. 48% of the respondents stated that governance actors are anticipating change, primarily in the social subsystem in the form of rising population and increasing tourism activities. This potentially indicates the goals surrounding system transformation with implication on the ecological subsystems.

It also indicates that governance actors are more inclined to surrender to changes in the social subsystem and even encourage it, as it is in case of change in the form of rise in tourism, rather than prevent or mitigate it. On the other hand, the respondents who identified the responses by the governance actors to be navigating, preventing or mitigating change, referred to the changes in ecological subsystem such as decreasing fish biomass and other adverse impacts of change.

Table 5.4 Capacity to address adverse impacts of ongoing change (SERS Survey n=25)		
Are the existing governance arrangements able to address adverse impacts of the drivers and respond to the issues of injustice, inequity, power dynamics and negative politics?		
Category	Response	% of respondents
Injustice	Agree	40%
	Disagree	40%
	Don't know/ unsure	20%
Inequity	Agree	28%
	Disagree	24%
	Don't know/ unsure	48%
Power dynamics	Agree	20%
	Disagree	60%
	Don't know/ unsure	20%
Negative politics	Agree	20%
	Disagree	36%
	Don't know/ unsure	44%

Impacts of drivers of change within a social-ecological system include issues of injustice, inequity, power dynamics and negative politics. These impacts often create patterns of positive feedbacks, inadvertently pushing thresholds and creating instability in the usually stable slow variables (Weber et al., 2012; Crépin, 2007). According to the SERS survey results, only 20-40% of the respondents agreed with the claim that existing governance arrangements can address adverse impacts of change such as injustice, inequity, and power dynamics (Table 5.4). Lack of response and attention towards these adverse impacts of drivers of change was attributed to the significant and difficult to predict nature of change within Karimunjawa. A relatively high percent of respondents was unsure in regard to governance responses to issues of inequity and negative politics. This may reveal a lack of understanding, or a lack of contemplation concerning adverse impacts of change such as negative politics within Karimunjawa.

Establishing governance structures that respond to the monitoring information within a social-ecological system could lead to effective and context appropriate

responses to adverse impacts of change. Establishing trust and transparency within governance responses provides a strong foundation for responding to monitoring efforts and managing slow variables (Dirhamsyah, 2005). A respondent stated that, “*even if the fishermen notice any change or impacts in the natural system, it is really difficult to warn other fishermen in the same friend circle. But if the warning is coming from an official and if it can be monitored or acted on, chances are that the community will listen*” (SERS Survey 5). Establishing governance structures that responds to monitoring information enables context specific governance responses to ongoing change and an overall improved level of decision-making.

Moving beyond the guideline for managing feedback interactions and critical slow variables for fostering resilience, understanding the role of politics, policy, and local compliance provides insights on tools and legal instruments to respond to change.

### **5.3.2 Politics, Policy, and Local Compliance**

Legal instruments used in governing the social-ecological system of Karimunjawa can be binding or non-binding and can be implemented in a rigid or flexible nature (Treib et al., 2007). This section presents results and discussions regarding the use of various legal instruments in Karimunjawa to respond to change and to, intentionally or otherwise, manage critical slow variables and feedbacks.

#### **5.3.2.1 MPA zoning compliance**

To determine local compliance to coercive area based management, informants were asked questions regarding their knowledge and compliance to the core zone established as part of creating boundaries for Karimunjawa National Park. Establishment of a core zone is crucial as its primary function is to protect marine resources, and it is also one of the primary means of managing reef fisheries (Yuliano, 2016). 52% of the informants reported compliance with the core zone, 40% reported non-compliance, while 8% were unsure or did not know (Table 5.5). Lack of compliance with the zoning in Karimunjawa was also noticed several years after zoning enacted in 2005 by a Wildlife Conservation Society report (Campbell et al., 2013).

Investing in communication and resources for surveillance are essential for improving compliance within Karimunjawa (Cox et al., 2010), as 35% of the respondents

stated that the reason for their lack of compliance was due to their unawareness. 30% of the respondents stated that it was due to the lack of monitoring, and hence lack of consequences, that they did not strictly comply with the zoning. This was especially true in the non-tourist villages of Parang and Nyamuk, where the local respondents commented on the presence of physical offices of patrolling officers that were built five years ago, but no regular monitoring efforts were witnessed. It would be ideal to use coercive mode of governance where monitoring resources can be made readily available (Dirhamsyah, 2005). On the other hand, 52% of the respondents regularly comply with the zoning. They attributed their compliance to their awareness of the zoning given their political ties and status in the community, socialization, and education efforts by Karimunjawa National Park Authority.

Table 5.5 Response to questions related to perception of coercive area based management in the form of zoning regulations. Number 1 and 2 is based on responses from 50 participants. Number 3 is a structured question based on answers given for 2 (n=20)

No.	Information	% of informants	
1	Knowledge of any areas where fishing restrictions are applied	Yes, I know	56%
		No, I don't Know	44%
2	Compliance to core zone ("no take")	Agree	52%
		Do not agree	40%
		Not sure/do not know	8%
3	Reasons for Lack of Compliance	Unawareness	35%
		Lack of monitoring	30%
		Contradicting objectives	30%
		Don't know/ unsure reason	5%

One of the main reasons for why coercive area-based management in the form of zoning in Karimunjawa is considered only partially successful is due to lack of monitoring and reinforcement (Campbell et al., 2013). Components operating at various temporal and spatial scales cause unpredictability of species abundances such as sea cucumbers, clams, and squids; and also the unpredictability of level of natural resource dependence given the rise and fall in alternative livelihoods, and local preferences and demands (Ariyani and Kismartini, 2018). This unpredictability leads to a need for constant assessment of variables used to define the social and ecological subsystems.



The third reason for the lack of compliance is the complexity of the social dynamics of Karimunjawa and contradicting objectives surrounding zonings, which was identified by 30% of the respondents (Table 5.5). Due to social and ecological drivers such as decreasing fish population (sea cucumber, red snapper, and grouper), rise in tourism, and rising populations, there have been changes in local livelihoods and land use, leading to a rise in local conflicts regarding zoning (BTNKJ, 2017). These conflicts are often a result of competing objectives surrounding development in tourism and maintenance of fisheries resources (Lienert and Burger, 2015). There is an unequal distribution of opportunities in the social subsystem fueling the competing objectives amongst the local individuals. While increased conflicts add to the complexity of using coercion as a legal instrument, it also provides an opportunity for intervention. Further discussion on managerial responses to social and ecological changes is discussed in section 5.3.2.3.

#### **5.3.2.2 Role of Power in Using Voluntarism as a Legal Instrument**

Voluntarism is a form of a non-binding legal instrument that is flexible in implementation (Treib et al., 2007). Prior to becoming a National Park, communities of Karimunjawa were primarily dependent voluntarism to self-govern, and respond to any local necessities requiring a collective response. Since 1998 Karimunjawa National Park Office has been initiating community empowerment activities through improving economy, strengthening institutions, and creating alternative livelihoods (Wibowo et al., 2012). Despite the intervention, there has been an ongoing reliance on voluntarism as a legal instrument.

Given the ambiguous nature and dispersed sense of authority for voluntary initiatives, the most powerful individuals and groups within a social-ecological system tend to drive change and strongly influence feedback interactions (Nightingale, 2017). As part of the SERS survey, respondents were asked questions regarding the role of power and politics (Table 5.6).

Table 5.6 Response to query related to the role of power and politics. Number 1 is based on responses from 25 respondents from SERS Survey. Number 2 is a structured question based on answers given for 1 (n=15)

No.	Information	Distribution	Examples from the interviews
1	Those who benefit the most, or hold the most power facilitate or intensify the change processes in Karimunjawa.  Agree Disagree Maybe/ don't know	60% 12% 28%	n/a n/a n/a
2	What are some ways with which powerful individuals or groups try to influence change?  Organize festivals  Promote local development  Local cleanup initiatives  Unsure/ don't know	40%  27%  13%  20%	<i>"The owner of the hotel promotes the island through the means of charitable donations to promotional events both in and out of the island. They sponsor events such as the Annual Karimunjawa Festival."</i>  <i>"Yes they intensify the process. Before tourism, each person here had his or her roles to play. For example if someone had a hotel, they only had a hotel, if someone had a homestay they only had a homestay, a person who owned a boat only owned a boat but now more and more people have all of that. There used to be an arrangement with the village head and the sub-district head so each person had one thing but this all changed In 2008."</i>  <i>"Hotel owners support the communities if there are any events taking place, or if the community needs resources for local restorations"</i>  n/a

Since voluntarism does not have a strong legal base it may prove inadequate given the lack of financial means in times of financial crisis (Treib et al., 2007). Consequently, favoring and yielding more power to individuals and groups with

accumulated wealth. 60% of the respondents of the SERS survey agreed with the claim that those benefitting from the ongoing changes are responding in ways that intensify change (Table 5.6). Hence, reinforcing positive feedback interactions. Means through which powerful individuals and groups influence change in Karimunjawa as identified by local informants are listed in table 5.7. This change refers to both social and ecological changes such as beach developments and growth in the local economy. Given the impacts of change such as income disparity, and change in livelihood, it is important to determine the relevance and effectiveness of voluntarism as a legal instrument in Karimunjawa. Results indicate the possibility that reliance on voluntarism leads to an increased lag between managerial responses and impacts of ongoing changes, as it encourages local responses (from powerful actors) to ongoing issues.

### **5.3.2.3 Discussing the Role of Non-binding Recommendations in a Transitioning System**

Targeting as a legal instrument can be described as a set of non-binding recommendations that are specific, leaving little room for alterations or changes (Treib et al., 2007). This form of policy is established in Karimunjawa as an institutional response to the ongoing changes (Puryono and Suryanti, 2019). For instance, there are specific associations, awareness campaigns, and training programs in place to meet the rising demands of workers in the tourism industry (Setiawan et al., 2017). These training programs, although rigid in implementation, are not binding (Treib et al., 2007). In-depth interviews with community leaders within Karimunjawa revealed the use of targeting to manage slow variables such as local culture and behavior, and Property and use rights.

*“The local government here manages culture by providing resources and space for the local people to practice their culture. For example, there is a place to dance for the Bugis community. There is also space for community members to practice martial arts, carpentry, woodcarving, culinary arts, etc. Going forward, I want to introduce other means of livelihoods here for the people to branch out, such as potential fields such as human resources, dancing and hospitality etc.”* (Kemujan village head, Interview 28)

*“We are planning for another school to be built in Kemujan specifically for training in social skills and human resources”*. (Kemujan village head, Interview 28)

*“Homestay owners are required to obtain certification regarding training in mannerism and hospitality. Homestay owners prior to the introduction of this certification are allowed to continue but new people must be certified.”*  
(Provincial government employee, interview 18)

The problem with this type of legal instrument, however, is the lack of standardization that could result in positive feedback interactions creating patterns of intense change (Fath et al., 2015). Lack of standardization facilitates social injustice issues as powerful individuals and groups often trump the collective actions of the community. More data is required to determine how navigating and responding to social injustice issues could impact feedback interactions.

#### **5.3.2.4 Decentralization as a Framework Regulation Guiding Responses to Change**

Framework regulation takes on a flexible approach in implementation, however it is binding as a legal instrument (Treib et al., 2007). Following the decentralization regime in Indonesia, the legal framework relevant to Karimunjawa has been heavily focused on biological goals (Campbell et al., 2013). However, there have been attempts to control social behavior to conserve natural ecosystems (Taruc, 2011). Attempts such as the introduction of alternative means of livelihood have been considered and implemented to alleviate pressure from fisheries as a primary source of income. The main issue with this form of legal instrument in Karimunjawa is the unequal focus on social and ecological goals.

Table 5.7 Response to questions related to governance in face of change (SERS Survey, number 2 is a structured question based on answers given for 1)

No.	Information	Distribution
1	Both social and ecological aspects of ongoing changes are equally targeted by the governance and management within Karimunjawa (n=25)	<p style="text-align: right;">Agree 24%</p> <p style="text-align: right;">Disagree 64%</p> <p style="text-align: right;">Unsure 12%</p>
2	Which aspect is targeted more by the governance and management Karimunjawa (n=16)	<p style="text-align: right;">Social Aspects 37%</p> <p style="text-align: right;">Ecological Aspects 44%</p> <p style="text-align: right;">Unsure 19%</p>

64% of the respondents disagreed with that claim that there is an equal focus on responses towards social and ecological subsystems within Karimunjawa. Out of which, most of the respondents believed that there was a higher focus on managing and responding to changes within the ecological subsystem (Table 5.7).

Some of the changes and appropriately managing social-ecological system, as whole neglected social issues that were brought up include increasing poverty, social conflicts, rising garbage, and pollution in Karimunjawa. These issues can also potentially be a result of positive feedback interactions between social and ecological subsystems. Responses to change in one slow variable, for example in this case, ecological variables such as fish biomass and biodiversity, can lead to changes in other slow variables such as wealth and infrastructure in the social subsystem. Understanding the potential mismatch in responding to social and ecological requires acknowledgement and understanding of the feedback interactions and critical slow variables.

#### **5.4 Use of Legal Instruments for Managing Slow Variables**

This section discusses prominent legal instruments and their implications on managing slow variables in Karimunjawa to highlight potential issues or opportunities for managing slow variables. Strategic use of legal instruments is central to adaptive management and governance because it provides means to facilitate targeted intervention and supports the adaptive capacity of the local communities. This is especially important in cases where there are significant ongoing changes giving opportunities for increased conflicts and sources of discrepancies. Exploring policy implications in both binding and non-binding arenas leads to a pragmatic understanding of social and managerial objectives in Karimunjawa.

Table 5.8 Prominent legal instruments and its implications on managing slow variables in Karimunjawa			
Legal Instrument	Targeted management of slow variables	Potential issues/ Opportunities	Examples from interviews
Coercion	<ul style="list-style-type: none"> <li>• Fish biomass and biodiversity (MPA zoning laws)</li> <li>• Coral reef in the form of (resource use etc.)</li> <li>• Land use and restrictions (License /permit requirements)</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of awareness</li> <li>• Unequal distribution of opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• <i>“I don’t know about the new zones because I am usually never at home. I am usually at the sea fishing. I find out about these things through friends and through word of mouth.”</i> (Interview 34)</li> <li>• <i>“I don’t know a lot about the local rules and regulations. I’m usually caught using illegal fishing gear and catching sea turtle even though they are banned.”</i> (Interview 19)</li> <li>• <i>“We usually accidentally break the rule and the local policies, and then learn about it if we get in trouble for it. People built their houses near the shore and after they found out that it was illegal, they couldn’t do anything about it but accept the punishment”</i> (Interview 17)</li> </ul>
Voluntarism	<ul style="list-style-type: none"> <li>• Community initiatives in order to manage beach functions</li> <li>• Local Norms and institutions (increasing popularity of sustainable business practices)</li> <li>• Local norms and behaviors (organized festivals and boat decoration competitions)</li> </ul>	<ul style="list-style-type: none"> <li>• Lag between ongoing negative impacts of rapid change and managerial responses</li> <li>• Social injustice issues</li> </ul>	<ul style="list-style-type: none"> <li>• <i>“In community meetings we don’t discuss tourism. Topics of discussion mainly involve cleaning the roads, fixing the roads, building and fixing the mosque and cleaning/fixing the sewage. If there is a small problem, we usually deal with it on our own or else we’ll get in touch with our area head”</i> (Interview 47)</li> <li>• <i>“We must stay collaborative to maintain the niceness and the humbleness in the society.”</i> (SERS Survey 8)</li> </ul>
Targeting (non-binding recommendations)	<ul style="list-style-type: none"> <li>• Wealth and Infrastructure (Human resource training and experience)</li> <li>• Local norms and institutions (Local training workshops)</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of standardization</li> </ul>	<ul style="list-style-type: none"> <li>• <i>“In a boat there are usually 2 tour guides and the third is a new tour guide who is there to learn from the more experienced guides. Anyone can ask to be trained. 90% of young generation is a tour guide”</i> (Interview 21)</li> </ul>
Framework Regulation	<ul style="list-style-type: none"> <li>• Fisheries and coral reef</li> <li>• Wealth and Infrastructure (promotion of tourism framework and tourism agenda)</li> </ul>	<ul style="list-style-type: none"> <li>• Decentralization focused on biological goals, where social issues such as poverty are overlooked</li> </ul>	<ul style="list-style-type: none"> <li>• <i>“When aquaculture started here, not everyone received help in the form of small boats and cages. This help started coming in about 7 years ago and not everyone received that help.”</i> (Interview 34)</li> </ul>

Understanding the current uses of legal instruments from a local perspective bridges the gap between state intervention and societal autonomy (Glaser et al., 2010). The gap that exists refers to the conflicting objectives of resource managers and local community members living in Karimunjawa. Previous studies and interviews conducted with the informants in Karimunjawa revealed potential issues, such as social injustice issues and lack of awareness etc., which can be understood as opportunities for managing crucial slow variables (Setiawan et al., 2017; Taruc, 2011). Table 5.8 contains information regarding how means of coercion, voluntarism, targeting, and framework regulation can be correlated to the management of slow variables as identified in chapter 3, with insight on potential issues and opportunities for managing slow variables.

Currently, socio-economic factors such as political ties and social status determine the level of awareness regarding coercive legal instrument in Karimunjawa. Hence, coercive area based management highlight opportunity for managing slow variables by responding to the lack of awareness, and unequal distribution of opportunities. Voluntarism as a legal mechanism is part of the fabric of local communities of Karimunjawa.

Power distribution plays an important role in the execution of voluntary based legal responses leading to social injustice issues and lags between ongoing negative impacts of rapid change and managerial responses. During on-going change, there are patterns of disruptions such as increasing pressures on local communities and ecological systems, changing economy, and monetization of time. Voluntarism provides an opportunity for managing slow variables and feedback interactions by breaking patterns of disruption by leveraging local connections. Clear distribution of power and the distinction between roles during ongoing change could minimize negative impacts and guide the system towards a stable state. Targeting or non-binding recommendations lead to a lack of standardization, which could lead to patterns of reinforcing change or intensifying change. This form of the legal instrument provides opportunities for managing feedbacks in the form of increased standardization with the help of local communities.

Lastly, framework regulation focused on developing tourism and reducing pressure on ecological subsystems, such as fisheries and coral reef ecosystem also pose

potential issues such as an unequal focus on biological and social goals. Social issues such as poverty and income discrepancies that create patterns of disruption and positive feedback interactions could amplify change within both subsystems. For example, poverty in fishing communities sometimes leads to responses such as intensifying fishing efforts and the exploitation of natural resources. There is an opportunity for balancing governance efforts to manage social and ecological subsystems by increasing collaboration with local community members. Overall, the use of various legal instruments provides opportunities for managing slow variables and critical feedbacks in order to prevent further drastic change.

## **5.4 Conclusion and Chapter Summary**

This chapter examined the guideline for managing feedbacks and slow variables that consisted of *strengthening feedbacks that maintain desirable regimes, avoiding actions that obscure feedbacks, monitoring important slow variables and establish governance structures that can respond to monitoring information* (Stockholm Resilience Centre, 2019; Miller et al., 2012; Ferrara et al., 2016; Crépin, 2007). Data collected to examine the role of strengthening feedback interactions focused on identifying local objectives during ongoing change. It was determined that underlying incentives and intentions of the local communities often guide local actions, which in combination with management responses assist in strengthening feedbacks. Next, in order to highlight and prevent actions that obscure feedbacks, the role of power was discussed as identified by the local community. It was determined that power plays an important role as responses from human actors often feed into the interactions between the social and ecological subsystems by potentially preventing or intensifying ongoing change.

Data on types of change as perceived by the local respondents were presented to consider the importance of monitoring slow variables and to support the maintenance of system functions. Monitoring crucial slow variables could possibly improve predictability and indicate any early warning signals of rapid change. Moreover, monitoring slow variables encourages engagement and involvement of the local communities, which could lead to overall compliance of rules and regulations. In order to examine the fourth guideline for managing slow variables and feedbacks, nature of governance responses,



and the capacity of governance actors to address adverse impacts of ongoing change was presented as identified by the local community. Identifying the nature of change and nature of governance responses highlights the need for targeted context specific responses and a need for establishing trust and transparency on a local level.

Identifying crucial slow variables and managing feedback interaction using the guideline highlights potential issues regarding social injustice and inequality issues. Moreover, a need for clearly differentiating community objectives versus the objectives of the resource managers was also indicated. Further conclusions can be drawn regarding the use of local policy and legal instruments including means of coercion, voluntarism, targeting, and framework regulation for managing slow variables and feedback interactions. Community perception and responses revealed that each legal instrument poses potential issues or opportunity for intervention that could be responded to manage slow variables. Potential issues include socio-economic status dictating local awareness levels, the unclear distinction between local managerial roles during ongoing change, lack of standardization, and unequal focus on managing social and ecological changes. The next chapter (chapter 6) provides specific recommendations based on the data presented and discussed in chapters 3, 4 and 5.

# Chapter 6

## Conclusion

### 6.1 Thesis Summary

This thesis examined rapid changes occurring in coastal communities, primarily inhabited by small-scale fishers in the Karimunjawa National Park, in Indonesia. A conceptual understanding of feedback interactions between slow and fast variables in a social-ecological system was adopted to identify and respond to ongoing changes. In greater detail, the study was guided by the following objectives: 1) Establishing an understanding of fast and slow changing variables within the social and ecological subsystem of Karimunjawa National Park in order to understand the phenomenon of rapid change; 2) Identifying local responses to social-ecological change in order to assess local adaptive capacity; and 3) Determining governance implications associated with the interactions and outcomes of fast and critical slow variables in Karimunjawa National Park.

The introduction chapter provided a background on the importance and relevance of analyzing critical slow variables to study change. It also contained a synthesis of the literature review conducted for each objective. Chapter 2 included the methods adopted to conduct this study that includes participant observation and scoping, semi-structured interviews, focus groups, and surveys.

Karimunjawa National Park, in Indonesia, is an example of a complex social-ecological system undergoing rapid changes in its social and ecological subsystems. It was concluded that using an understanding of fast and slow variables within social-ecological systems encourages a comprehensive understanding of rapid changes. Part of the understanding is identifying and considering the differences in behavior, processes, and structures between the social and ecological subsystems. Identifying limited critical slow variables within social and ecological subsystem allows for navigating beyond applying naturalistic concepts derived from the ecological subsystems into the social subsystems. This chapter includes thesis conclusions, recommendations regarding managing feedback interactions, and directions for future research.

## 6.2 Conclusions

### 6.2.1 Identifying Changes: Fast and Slow Variables

Analyzing changes using a lens of critical slow variables within the social and ecological subsystems provide insights on feedback interactions essential for maintaining desirable system functions. Slow variables identified and discussed in this thesis include culture, norms and long standing institutions, property and use rights, wealth and infrastructure, fish biomass and biodiversity, beach functions and conditions, and coral reef structural complexity. Insights on feedback interactions refer to the identification of dual directionality of drivers of change, the role of human actors in responding to change, identifying points of interaction within the social and ecological subsystems, and identifying possible **future trajectories and assisting local system managers in anticipating change and its impacts.**

There are both positive and negative impacts of drivers of change. Identifying specific impacts such as rise in income, improved lifestyle, change in culture revealed information regarding local behaviors and preferences. Rise of tourism was identified as an important driver of change impacting the ecological subsystem in the form of change in catch preference, improper interactions with the natural system, and impacting the social subsystem in the form of changing lifestyle and increase in job opportunities. Hence, **applying an understanding of feedback interactions within a system provides an opportunity for strategic system reorganization according to community and managerial goals, prior to drastic, potentially irreversible change.**

**Based on the data collected it was concluded that the six dimensions of SERS provide an appropriate framework for assessing the intersection between the social and ecological subsystems,** and for responding to ongoing rapid changes. For example, highlighting issues of inequity and injustices in combination with understanding power and politics addresses the competing value systems that define a social subsystem. Hence allowing local management to tackle variables such as local norms, behaviors, and individual choices (Welsh, 2014; Stojanovic et al., 2016).

## 6.2.2 Assessing Adaptive Capacity of the Local Communities

**Identifying vulnerabilities and sources of vulnerabilities within a social-ecological system prepares system managers for appropriate governance response to ongoing changes.** Chapter 4 focused on identifying vulnerable components and sources of vulnerabilities as perceived by the local community. Moreover, the adaptive capacity of the local community was assessed to provide practical recommendations for system managers. Examples of sources of vulnerabilities identified include increased exposure of natural resources, instability in family income, individual limitations (such as level of education, skills, level of confidence), conflicting objectives amongst local stakeholders, limited access to resources, and a rise in westernization leading to a possible loss of culture.

Change in livelihoods was witnessed as a prominent adaptive response to the ongoing changes. However, it was noted that adaptive responses such as changes in livelihoods could possibly contribute to increased vulnerability of other components, such as increased exposure of local culture to westernization. **Given the interactive nature of a social-ecological system, a need for a continuous process of reviewing and responding to system vulnerabilities was identified.**

Five attributes of local adaptive capacity were explored, namely, response diversity, connectivity, collaborative capacity, reserves, and learning capacity. Each attribute revealed critical information to support local adaptive capacity. **An increased need for local empowerment, monitoring of critical slow variables, and continuous assessment was identified to foster resilience and promote the selective transformation of system components.**

## 6.2.3 Governance Implications

Chapter 5 explored the use of local policy and legal instruments including means of coercion, voluntarism, targeting, and framework regulation for responding to ongoing changes. **Local responses revealed that each legal instrument poses potential issues or opportunity for intervention that could be responded to as an effort to manage slow variables.** Such issues include social injustice, unequal distribution of opportunities,

mismatch of managerial and community objectives, and unequal focus on managing social and ecological changes within Karimunjawa.

**A need for increased awareness amongst the local community was highlighted, as it is the underlying objectives and intentions that guide local actions and interacts in feedbacks.** Moreover, a need for increased trust and transparency was established based on a discussion on the nature of governance responses, and their capacity to address adverse impacts of ongoing change. This further promotes the strategic use of legal instruments for targeted and context specific intervention to support adaptive governance.

**Since it was concluded that power plays an important role in driving change, clear distribution of power and distinction between management roles during ongoing change could minimize confusion and lags between responses to change.** Governance responses were found to be navigating, preventing, and mitigating in nature pertaining to the ongoing changes in the ecological subsystem. Whereas governance responses were identified as anticipating, and adaptive in nature especially concerning the changes in social subsystem such as rise in tourism.

The following section contains recommendations to respond to and manage implications of rapid change. The recommendations aim to respond to issues and opportunities for intervention identified in chapters 3-5, also summarized in section 6.2. Moreover, steps can be taken by local stakeholders to strengthen the adaptive capacity, also discussed in the section below.

### **6.3 Contribution and Recommendations**

This study contributes to the literature identifying rapid changes in coastal communities using a social-ecological systems perspective (Walker et al., 2006, Virapongse et al., 2016). Currently, there are only a limited number of studies that focus on studying rapid changes in Karimunjawa National Park and its adaptive capacity essential for responding to changes. The significance of this research lies in acknowledging critical variables, drivers and impacts of rapid change at various scales and levels in a social-ecological system. Using a guideline for managing feedbacks provides direction for fostering resilience within the social-ecological system of

Karimunjawa National Park. This section uses the data discussed in chapters 3-5 to provide recommendations for local management.

**Table 6.1 Governance recommendations for applying guidelines for managing slow variables and feedbacks**

<b>Guideline</b>	<b>WHAT (Importance)</b>	<b>HOW (Recommendations)</b>
Strengthening feedbacks that maintain desirable regimes	<ul style="list-style-type: none"> <li>• Harmony in managerial and local objectives in face of change</li> <li>• Ability to foresee avoidable setbacks based on set objectives and goals</li> </ul>	<ul style="list-style-type: none"> <li>• Improve overall adaptive capacity (including increasing connectivity, fostering learning capacity, response diversity in the form of providing alternative means of livelihoods, and supporting social reserves by providing increased access to appropriate training and resources)</li> </ul>
Avoiding actions that obscure feedbacks	<ul style="list-style-type: none"> <li>• Minimize ambiguity</li> <li>• Direct change towards a desirable outcome</li> </ul>	<ul style="list-style-type: none"> <li>• Arrange regular consultations with local community members</li> </ul>
Monitoring important slow variables	<ul style="list-style-type: none"> <li>• Reveal crucial information related to identified slow variables</li> <li>• Sustain equal focus on social and ecological subsystems, especially during ongoing changes</li> </ul>	<ul style="list-style-type: none"> <li>• Actively engage and involve local communities in monitoring efforts</li> <li>• Include non-quantifiable variables especially within the social subsystem such as local culture, norms, and behaviors in ongoing monitoring activities</li> <li>• Establish accountability through regularly conducted external monitoring, audits, and reviews of management</li> </ul>
Establish governance structures that can respond to monitoring information	<ul style="list-style-type: none"> <li>• Recognize effective and context specific governance responses to ongoing change</li> <li>• Improve decision making</li> </ul>	<ul style="list-style-type: none"> <li>• Establish trust and transparency within governance responses</li> <li>• Minimize misunderstanding related to community and management objectives during any ongoing change</li> <li>• Ensure appropriate nature of governance responses according to the defined nature of change</li> </ul>

Recommendations discussed pertain to the management of the slow variables and feedback interactions given the significant changes in both social and ecological subsystems. Practically applying the guideline, as discussed in this section, is highly dependent on the resources available, and based on the objectives of local management (i.e. fostering resilience or supporting transformation).

One main contribution of strengthening feedbacks in a social-ecological system is the collective harmony amongst objectives and goals of the various stakeholders involved. Conflicting objectives result in overwhelmed fast variables such as an increase in improper interactions with the ecological subsystem, causing patterns of disruption. To maintain functions within ecological subsystems and continue a steady supply of ecosystem services, strengthening feedbacks could potentially look like alleviating pressure from fisheries in order to maximize recovery time and to support local livelihoods in the form of alternative livelihoods (Van Oudenhoven et al., 2015). To alleviate rising stresses on the coral reef ecosystem and fisheries in Karimunjawa National Park, the provincial government and Department of Fisheries introduced alternative means of livelihoods such as opportunities in aquaculture (Taruc, 2011). Additionally, efforts to promote ecotourism to sustain local communities and promote economic growth have been ongoing since 2010 (Puryono and Suryanti, 2019). The significant growth in tourism combined with the local communities' primary objective of securing and maintaining livelihoods (Table 5.1), led to diverse opportunities and increase in overall income, which led to an improvement in the overall local economy (Setiawan et al., 2017). Using an understanding of feedback interactions, the crucial slow variable of wealth and infrastructure can be guided into a transformed state, which perhaps supports ecotourism as a means of providing sustainable alternative means of livelihood. A desirable regime for Karimunjawa National Park merits maintaining essential ecosystem services while sustaining local livelihoods (Campbell et al., 2013).

Within a social subsystem, strengthening feedbacks to maintain a desirable regime warrants effort towards bolstering the local community's adaptive capacity. As discussed in chapter 4, adaptive capacity constitutes of a systems response diversity, connectivity, collaborative capacity, availability of reserves, and learning capacity (Setiawan et al., 2017; Vatn and Vedeld, 2012). One of the factors hindering connectivity and learning capacity is the unequal distribution of opportunities (Kok and Veldkamp, 2011). Addressing this issue using a coercive form of governance would be least useful, as 66% of the informants placed the least amount of importance on complying with the local policies during on-going changes.

However, policies that include nonbinding legal instrument such as targeting in the form of increased informational workshops, and training programs (for roles in hospitality) for women and youth could prove beneficial in strengthening feedbacks that support desired system functions (Setiawan et al., 2017). Moreover, change in local livelihoods often results in changes in local family dynamics. Local women and youth are seeking employment opportunities in hotels and resorts, getting involved in selling souvenirs, and culinary arts to provide the tourists with local cuisine. With access to appropriate training and resources, women, and youth present vast untapped potential to improve connectivity and involvement from the local community (Setiawan et al., 2017).

In-depth interviews revealed that to benefit from new information or training program, the best way to engage local community members is to present some form of incentives or immediate rewards in return for their attendance. As one of the informants mentioned, *“the fishers must receive help first, in the form of monetary incentives, guidance etc. and then they will understand what needs to be done for adapting to the changes. It would be helpful if we receive money/ equipment to learn. The community here is not well educated so they must be compensated for their time and to accept new ideas”* (Interview 16).

Current managerial efforts taking place to alleviate the pressure from the ecological subsystem, and to manage social subsystem are unable to keep up with the adverse impacts of ongoing changes (table 5.4), seen in the form of disruption in local livelihoods, and damage inflicted on the coral (table 3.16). Recognizing factors that are obscuring feedback interactions as part of managing slow variables assists in minimizing ambiguity and promotes targeted response to change. It was found that the best way to identify factors obscuring feedback interactions was through regular consultations with local community members.

While discussing the role of powerful individuals in obscuring feedback, 60% of the respondents stated that resort owners and investors are the most powerful groups as they form the wealthy sector of the local population (Table 5.2). These investors and resort owners are not only often perceived as “protected” or unaffected by the changing requirements within the tourism industry, but also as those who influence the direction of change as stated in table 5.7. For example, actions pertaining to local development such



as road repairs and beach cleanup often lead to administrative lags given the distribution of accountability based on power (Giardino et al., 2018). 28% of the respondents identified privileged locals, including the local youth as the most powerful group. In events of ongoing rapid change, managerial and governance responses that are generic, and that disregards the generational gap, obscure feedbacks between the social and ecological subsystems.

There is a wide generational gap which was amplified due to increase in the use of social media, need for a high learning capacity, and willingness to learn, which is generally stated to be higher amongst the younger generations (Setiawan et al., 2017). As discussed in chapter 3, age was identified to be an important defining factor of power by 72% of the respondents of the SERS survey. Younger generations often hold the capacity to fast track change and cause a pattern of disruption within a social-ecological system in the face of rapid change. An 18 year old informant stated that they “*would like to be the king of tourism if given the chance*” (Interview 45), while another informant, 24 years old, stated that he was, “*currently saving up to invest in a big boat to maybe look into organizing and planning for a cruise ship*” (Interview 6). The older generations seemed more inclined towards accepting change and taking advantage of an opportunity when and if it presents itself. An informant, a 50 year old boat owner and fisher stated, “*I am involved in tourism, I usually just drive the boat to take the tourists to their destinations and am a tour guide only sometimes. I did not get any formal training yet, that is mainly just for the younger generation. I don't want to get any training because I am already so old*” (Interview 17). Identifying sources of discrepancies could lead to a clearer understanding of feedback interactions and points for intervention.

There have been some efforts to monitor quantifiable slow variables in the ecological subsystem such as fish biomass and biodiversity (Yuliana et al., 2016; Campbell et al., 2012). As a result of past monitoring programs, Karimunjawa National Park has seen some ecological improvements and reductions in destructive fishing over a period of five years following its establishment as a Marine National Park (Campbell et al., 2013). The similar focus in the social subsystem, especially on non-quantifiable variables such as local culture, norms, and behaviors could reveal important information, hence supporting better decision making and foresight. Monitoring efforts combined with

actively engaging and involving local communities could be beneficial, as also supported in previous studies. A contribution of using an understanding of feedback interactions is that it sets a precedent for equal focus on social and ecological subsystems, hence allowing for appropriate and effective governance responses.

Monitoring efforts followed by establishing governance schemes that respond to monitoring information allows for a preemptive approach to managing adverse impacts of change. 24%-60% of the respondents stated that the current governance schemes were unable to respond to the issues of social injustice, inequity, power dynamics and negative politics. Establishing trust and transparency on a local level plays an important role in fostering resilience and minimizing misunderstanding related to community and managerial objectives.

## **6.2 Directions for Future Research**

This thesis used a conceptual understanding of critical slow variables and feedback interactions to foster resilience during ongoing significant changes. This section states some limitation that can be addressed in future research.

Firstly, slow variables identified in chapter 3 do not form an extensive list of critical, controlling variables within the social-ecological system of Karimunjawa National Park. An example of a plausible slow variable not discussed in this thesis is the ecological productivity of mangroves. Assessing the ecological productivity of mangroves as a slow forming critical variable based on the criteria highlighted in this research could provide useful implications for effective adaptive governance.

Secondly, it could be valuable to investigate exogenous drivers of change such as climate change, and changing trends in global demands, and how it interacts with crucial slow variables, potentially inciting changes in system functions.

Thirdly, future research could entail creating guidelines for managing fast variables, such as fishing effort and local income, since this thesis primarily focuses on responding to and managing identified changes amongst slow variables. The focus of such research could potentially include assessments of socioeconomic responses to change, with a specific focus on economic risks. Furthermore, as supplementary research, identifying certain “control variables” that can be manipulated to reach a predetermined

outcome could assist with intentionally directing feedback interactions towards a desired stable state (Walker et al., 2012). Establishing criteria for “control variable” and “fast variable” within a social-ecological system requires studying tools and mechanism available to manage system functions. Further inquiry regarding governance reserves available could assist with the appropriate deployment of said reserves.

This research studied the adaptive capacity of the local communities of Karimunjawa National Park during ongoing change. Conclusions were drawn regarding strong connectivity. However, given the rise in economic activity, future research could implore the likelihood of weakening of social cohesion, attributed to increased economic rationality (Prado et al., 2015).

While there are barriers in identifying and working with critical slow variables and feedbacks there are also numerous opportunities that are presented in this area of literature. The areas identified above for further research are important opportunities to advance knowledge surrounding social-ecological systems and rapid change. This research is especially important in the current environment of rapid change and development as it provides pathways for fostering resilience and positive transformations.

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# APPENDIX A: Semi-structured Interview Guide

\*Community Member Version

## DEMOGRAPHICS

1. Demographics
  - a. What is your name?
  - b. What is your age?
  - c. What is your occupation? For how long? Do you have another means of income?
  - d. How long have you been living in Karimun Jawa?
  - e. Do you have any kids? If so, how many?
  - f. Education

## OBJECTIVE 1

TO IDENTIFY NATURE OF CHANGE AND TO UNDERSTAND LOCAL PERCEPTION OF FAST AND SLOW VARIABLES

2. Have you noticed any changes in ecological subsystem? Social subsystem?
  - a. When did you first notice this change? What is the duration of the change?
  - b. Would you consider the nature of change fast or slow? Specific changes in the environment, culture/neighbourhood, infrastructure/access to resources, institutions/policies, lifestyle. Is this slow change or fast?
  - c. Would you say the change has been slow and gradual? Did you actively think about the on-going changes in Karimunjawa prior to discussing it now?
  - d. Do you rely on the ecological subsystem for your livelihood? (Ecosystem services: provisioning, cultural, regulatory, and supporting)? Have the on going changes impacted your livelihoods?
  - e. What is causing this change? According to you what main change or controlling change led to other changes?
3. What do you anticipate the future of Karimunjawa might look like?

## OBJECTIVE 2

4. What would be the determining factor that would cause you to seek one of the following options:
  - a. Change the way of your livelihood
  - b. Migrate
  - c. Actively resist change
5. Response diversity
  - a. Are you currently involved in the tourism industry? How?
  - b. What would you choose as your alternative livelihood?
  - c. At what cost to the system—immediately or over time—are substitute livelihood employed? Are there any burdens placed on you to maintain alternative livelihoods?
6. Collaborative capacity

- a. How do you make decisions as a community? How do you decide if an act's benefits outweigh the costs? To what extent are you involved in the decision-making?
- b. Does your community work towards collective objectives?
- c. Involvement in decision making related to natural resource management
- d. Do you believe that you are part of a system in which you know others and with whom you can collaborate? <sup>[L]</sup><sub>[SEP]</sub>
  - i. If yes, can these connections and linkages be established and utilized in a timely manner? <sup>[L]</sup><sub>[SEP]</sub>
- e. Do you know who, in terms of government officials, to reach out to in order to collaborate or respond? <sup>[L]</sup><sub>[SEP]</sub>

7. Connectivity

- f. Are you involved in any local organizations or associations? If yes, how many? Which ones?
  - i. What are the typical topics of discussions in the meeting?
- a. Where, when, and how are information and/or resources exchanged?
- b. Are the pathways and links for that exchange known?
- c. Can these pathways be accessed and employed by <sup>[L]</sup><sub>[SEP]</sub>anybody when necessary? <sup>[L]</sup><sub>[SEP]</sub>Are there pathways personality dependent?

8. Abundance/reserves

- a. What resources does the system maintain for immediate engagement when stressed? <sup>[L]</sup><sub>[SEP]</sub>Are there conditions under which the system's resources are rendered unavailable? <sup>[L]</sup><sub>[SEP]</sub>
- b. What materialistic reserves do you have that you rely on in your daily lives?
  - i. Do you own a vehicle?
  - ii. Do you have access to utilities such as electricity and water?
  - iii. What sort of appliances/ electric gadgets do you own?
  - iv. What is your house (Roof, walls, and floor) made of?

9. Learning capacity

- a. Is there an individual and organizational culture of learning? <sup>[L]</sup><sub>[SEP]</sub>How and where do you prefer to received new information?
- b. Are there active adaptive management and lessons-learned programs in place? <sup>[L]</sup><sub>[SEP]</sub>

OBJECTIVE 3

- 10. What is more important to you, maintaining livelihood, protecting the environment or complying with the local policies (choose the order and explain)?
- 11. How would you describe your relationship with the local governance and institutions in place?
- 12. Are there any factors hindering or influencing governance responses to social and ecological changes? Explain.
- 13. Are you aware of the various zoning within the area?

- a. Are you in any way involved in the monitoring process for the compliance of Karimunjawa zoning laws?
  - b. Would you say you are able to comply with the zone restrictions? If no, why not?
14. Suggestions. Is there anything else you would like to tell me?

**\*Government worker version**

**DEMOGRAPHICS**

- 1. Demographics
  - a. What is your name?
  - b. What is your occupation?

**OBJECTIVE 1**

**TO IDENTIFY NATURE OF CHANGE AND TO UNDERSTAND LOCAL PERCEPTION OF FAST AND SLOW VARIABLES**

- 2. Have you noticed any changes in ecological subsystem? Social subsystem?
  - a. When did you first notice this change? What is the duration of the change?
  - b. Would you consider the nature of change fast or slow? Specific changes in the environment, culture/neighbourhood, infrastructure/access to resources, institutions/policies, lifestyle. Is this slow change or fast?
  - c. What is causing this change? According to you what main change or controlling change led to other changes?
- 3. What do you anticipate the future of Karimunjawa might look like?

**OBJECTIVE 2**

- 4. Response diversity
  - a. What are some alternative livelihoods available for the local communities of Karimunjawa?
  - b. At what cost to the system—immediately or over time—are substitute livelihood employed? Are there any burdens placed on you to maintain alternative livelihoods?
- 5. Collaborative capacity
  - a. How are local decisions concerning the wellbeing of the local communities made? Are the decisions made as a community? How is it decided if an act's benefits outweigh the costs? To what extent are you involved in the decision-making?
  - b. Do you believe the local communities know whom, in terms of government officials, to reach out to in order to collaborate or respond? <sup>[L]</sup><sub>[SEP]</sub>
  - c. Do you believe the community members are motivated, and do they have the time, resources, and skills needed <sup>[L]</sup><sub>[SEP]</sub>to collaborate? <sup>[L]</sup><sub>[SEP]</sub>
- 6. Connectivity
  - d. Where, when, and how are information and/or resources exchanged?
  - d. Are the pathways and links for that exchange known?

- e. Can these pathways be accessed and employed by anybody when necessary? Are there pathways personality dependent?
7. Abundance/reserves
- c. What resources does the system maintain for immediate engagement when stressed? Are there conditions under which the system's resources are rendered unavailable?
8. Learning capacity
- c. Is there an individual and organizational culture of learning within Karimunjawa? How and where is information exchanged?
  - d. Are there active adaptive management and lessons-learned programs in place?

### OBJECTIVE 3

- 9. What do you believe is more important to the local community members, maintaining livelihood, protecting the environment or complying with the local policies (choose the order and explain)?
- 10. Are there any factors hindering or influencing governance responses to social and ecological changes? Explain.
- 11. Suggestions. Is there anything else you would like to tell me?

## **APPENDIX B- Focus Group Activities Guide**

### **Focus group guide**

#### **MIND MAPS**

Define change as a group

- What are the big factors that influence access to your current means of livelihood?
- How are those factors changing?
- How do you respond to the change?
- How are these variables managed?
- Distinguish the variables that are formed and developed over a long time vs. the ones that are relatively quick to change.

#### **TRIANGULATION**

- Are these findings consistent with what you see?
- Is there anything missing?

\*Question composition will vary depending on focus group participants (i.e. only government officials, only community members, etc.)



# APPENDIX C-Survey Guide

## Key Informant Survey Questionnaire Understanding Social-Ecological Regime Shifts in coastal systems

*Name of the enumerator:*

### 1. General Demographic Information

1.1 What is your name?

1.2 What community / village do you belong to?

1.3 What is your educational qualification?

1.4 How many members are there in your family?

*1.4.1 Male adults and their educational qualification:*

*1.4.2 Female adults and their educational qualification:*

*1.4.3 Male children and if they are going to school:*

*1.4.4 Female children and if they are going to school:*

### 2. Determining the nature of changes in the social-ecological system

2.1 For how many years have you / your family been fishing in *place*? (Mention number of years or event)

2.2 Have you observed any changes in the ecological character / subsystem of the *place*?

YES

NO

*2.2.1 If yes, what are some of the important changes? (List all changes mentioned by the respondent)*

*2.2.2 How would you define the changes you have explained above? (Circle all that apply)*

1. Sudden / abrupt
2. Dramatic
3. Long-term
4. Significant / substantial
5. Difficult to predict / anticipate
6. Came without early warning signals

7. Difficult to reverse
8. Problem in understanding, comprehending, interpret
9. Problem in responding to (not easy to respond)
10. Caused substantial reorganization in the structure, functions and feedbacks of the ecosystem
11. Change from one ecological state to another. If yes, explain what to what.
12. Pose significant challenge to local fisher communities, managers, others

2.3 Have you observed any changes in the social character / subsystem of the *place*?  
 YES NO

2.3.1 *If yes, what are some of the important changes? (List all changes mentioned by the respondent)*

2.3.2 *How would you define the changes you have explained above? (Circle all that apply)*

1. Sudden / abrupt
2. Dramatic
3. Long-term
4. Significant / substantial
5. Difficult to predict / anticipate
6. Came without early warning signals
7. Difficult to reverse
8. Problem in understanding, comprehending, interpret
9. Problem in responding to (not easy to respond)
10. Caused substantial reorganization in the structure, functions and feedbacks of the social system
11. Change from one social state to another. If yes, explain what to what.
12. Pose significant challenge to local fisher communities, managers, others

### **3. Differentiating drivers of regime shift**

3.1 What are the main natural / ecological factors influencing these changes?

3.1.1 *Internally induced / proximate causes (i.e., activities or immediate actions and conditions at local level):*

3.1.2 *Externally induced / underlying forces (i.e., fundamental or systemic processes mainly impacting from national and global levels):*

3.2 What are the main social / human factors influencing these changes?

3.2.1 *Internally induced / proximate causes (i.e., activities or immediate actions and conditions at local level):*

*3.2.2 Externally induced / underlying forces (i.e., fundamental or systemic processes mainly impacting from national and global levels):*

3.3 Are there positive outcomes or impacts resulting from these drivers? If yes, list what are they?

3.4 Are there negative outcomes or impacts resulting from these drivers? If yes, list what are they?

3.5 Are there specific natural or ecological factors that have directly impacted the social system?

3.6 Are there specific social or human factors that have directly impacted the ecological system?

3.7 Have some of these factors acted together to create an impact?

#### **4. Levels and scales of occurrence and intervention**

4.1 Can you identify some of the important parts (components) of the social system that were impacted or changed first? What are they and time period of when they changed or impacted.

4.2 Can you identify some of the important parts (components) of the ecological system that were impacted or changed first? What are they and time period of when they changed or impacted.

4.3 What parts (components) of the ecological system do you think are currently vulnerable and likely suffer adverse impacts or go through significant changes in the near future?

4.4 What parts (components) of the social system do you think are currently vulnerable and likely suffer adverse impacts or go through significant changes in the near future?

4.5. Are you aware of any interventions made by external agencies (i.e., government, non-government organisations, private) to address adverse changes / impacts listed above? Yes / No

*4.5.1 If yes, please list them. Mention the type of interventions made, type of changes / impacts and social-ecological system components addressed.*

#### **5. Social-ecological units or the context of regime shifts**

5.1 What are all the different types of natural resources (or ecosystems) in this area you depend on, or you think you have a relationship with, for your economic and social needs?

5.1.1 Do you see any linkages and feedbacks between these different types of natural resources (or ecosystems)?

5.2 What are all the different types of social organisations and institutions in this area and beyond you depend on (linked to, have relationship or a member of) for your social, economic and cultural needs?

5.2.1 How often you depend or come in relation with these organisations and institutions?

5.3 In terms of physical boundaries, how would you define the key features of the *place*? (e.g., what are the

5.4 In terms of normative boundaries, what are some of the norms / cultures / rituals / customs / traditions / customary laws / traditional institutions / forms of social interactions you think you are part of or follow in your engagement with the *place*?

5.5 Is the management *place*-specific or it includes a more comprehensive management approach that include linked resources (i.e., ecosystems)?

## **6. Equity and justice concerns in social-ecological regime shifts**

6.1 In terms of social, economic and political groups, who do you think is responsible for the adverse social-ecological changes in the *place*?

6.2 What are the main adverse impacts of social-ecological changes in *place*? Does everyone in your community receive these impacts somewhat equally?

6.3 Are there specific positive impacts or benefits resulting from the social-ecological changes in *place*? Does everyone in your community have an equal share in these benefits?

6.4 Who are most affected by these changes (social groups who become losers in terms of livelihoods, culture, identity, etc.)? List who are they and what are they losing?

6.4.1 How often do you feel you have been affected by the changes?

6.5 Are there people or social groups (e.g., social elites, economically higher class, etc.) that are benefitting from these changes? List who are they and what are their benefits?

6.5.1 How often do you feel you have benefitted from the changes?

6.6 Are there social groups or people who are completely excluded from any involvement in the *place*?

## **7. Power dynamics and politics of change**

7.1 How would you define power in relation to the place?

7.1.2 *Who do you think (i.e., social groups or individuals) has most power in relation to the place?*

7.1.2 *Who do you think (i.e., social groups or individuals) has the least power in relation to the place?*

7.1.3 *Can you arrange the social groups and/or individuals from the most powerful to the least powerful?*

7.2 Are those who benefit most want the changes to continue and do they in any way facilitate or intensify the change processes in *place*?

7.2.1 *What strategies do they use to facilitate or intensify change?*

7.3 Are those who are heavily impacted contest or oppose the changes?

7.3.1 *??What strategies do they use to oppose the changes and/or advocate for reversing change processes?*

7.4 Are there major differences in the views of social groups / people on:

7.4.1 *How the place should be maintained / managed?*

7.4.2 *What kind of benefits should be derived?*

7.4.3 *Who should be in decision-making role?*

7.4.4 *What are the key features of the place?*

## **8. Governance and management in the context of social-ecological regime shifts**

8.1 What are some of the key institutions and other (governance) actors active in managing the *place*?

8.2 What has been the response of different governance actors to the social-ecological changes in the *place*?

- Responses by your community institution
- Responses by government agencies
- Responses by non-government / private agencies
- Responses by individual fishers like yourself
- Responses by others

8.3 What is the nature of the responses by the governance actors to the social-ecological changes in the *place*?

- Anticipating change
- Navigating change
- Coping with change
- Preventing change
- Mitigating change
- Adapting to change
- Transforming

8.4 Do the responses target both the social and ecological aspects of the changes, or only one of them? Please explain?

8.5 Who makes rules for the *place*?

- Local Institutions – Village/community, regional, Networks, others
- Government – Local, district, provincial, Federal, others
- Others

8.5.1 Do these actors / rule making institutions interact and collaborate with each other? If yes, mention examples.

8.5.2 What is the level of trust between these rule-making actors?

Very high                      High                      Moderate                      Low                      No trust


8.6 Are there institutions that can mediate at times of need?

8.7 Are existing governance arrangements able to address adverse impacts of the drivers, and respond to issues of injustice, inequity, power dynamics and negative politics? Explain, if necessary.

**9. Would you like to ask any questions to me?**

## APPENDIX D- Ethics Clearance

**Ethics Clearance (ORE # 23165)**

 ORE Ethics Application System <OHRAC@uwaterloo.ca>  
Fri 2018-07-27 4:49 PM  
pnayak@uwaterloo.ca; s38kaur@uwaterloo.ca ✕

Dear Researcher:

The recommended revisions/additional information requested in the ethics review of your application for the study:

Title: Understanding Fast and Slow Variables of Karimunjawa Marine Protected Area as a means to Effectively Manage Implications of Rapid Change  
ORE #: 23165  
Faculty Supervisor: Prateep Nayak (pnayak@uwaterloo.ca)  
Student Investigator: Simar Kaur (s38kaur@uwaterloo.ca)

have been reviewed and are considered acceptable. A University of Waterloo Research Ethics Committee is pleased to inform you this study has been given ethics clearance.

A signed copy of the notification of ethics clearance will be sent to the Principal Investigator (or Faculty Supervisor in the case of student research). Ethics approval to start this research is effective as of the date of this email. The above named study is to be conducted in accordance with the submitted application (Form 101/101A) and the most recent approved versions of all supporting materials.

University of Waterloo Research Ethics Committees operate in compliance with the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), Internalization Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), and the applicable laws and regulations of the province of Ontario. Both Committees are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (Human Research Ethics Committee) and IRB00007409 (Clinical Research Ethics Committee).

\*\*\*\*\*

Renewal: Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified by the Research Ethics Committee on the signed notification of ethics clearance. Studies will only be renewed if the renewal report is received and approved before the expiry date (Form 105 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/renewals>). Failure to submit renewal reports by the expiry date will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Ethics Clearance (ORE # 23165)

Modification: Amendments to this study are to be submitted through a modification request (Form 104 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/modifications>) and may only be implemented once the proposed changes have received ethics clearance.

Adverse event: Events that adversely affect a study participant must be reported as soon as possible, but no later than 24 hours following the event, by contacting the Chief Ethics Officer. Submission of an adverse event form (Form 106 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems>) is to follow the next business day.

Deviation: Unanticipated deviations from the approved study protocol or approved documentation or procedures are to be reported within 7 days of the occurrence using a protocol deviation form (Form 107 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems>).

Incidental finding: Anticipated or unanticipated incidental findings are to be reported as soon as possible by contacting the Chief Ethics Officer. Submission of the incidental findings form (Form 108 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems>) is to follow within 3 days of learning of the finding. Participants may not be contacted regarding incidental findings until after approval has been received from a Research Ethics Committee to contact participants to disclose these findings.

Study closure: Report the end of this study using a study closure report (Form 105 - <https://uwaterloo.ca/research/office-research-ethics/research-human-participants/renewals>).

You are responsible for obtaining any additional institutional approvals that might be required to complete this study.

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Best wishes for success with this study.

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A new research ethics system will be available on August 13. Visit the following link for more information <https://uwaterloo.ca/research/faculty-0/your-gateway-research/research-ethics-system>.

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