

**Social-Ecological Regime Shift in the South China Sea:
Examining Governance Approaches in Zhuhai,
Guangdong**

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

The objective of this research is to examine governance approaches implemented in Zhuhai, Guangdong, for dealing with social-ecological regime shifts (SERS). Here, SERS refers to abrupt, long-term, and significant changes in linked systems of people and nature with uncertain implications for ecosystem services and human well-being. Such large-scale changes have allowed substantial disturbances to occur in Zhuhai, and they remain ongoing phenomena despite decades of governance interventions. To address this purpose of this research, I followed three objectives: (1) to identify the nature of ongoing SERS in Coastal Zhuhai, Guangdong, China; (2) to examine and assess key policies and regulations in relation to those SERS; and (3) to examine possible governance interventions that have the potential to better respond to future SERS. This research contributes a better understanding of SERS in the local context, and provides a glimpse of how to more effectively transform scientific findings into practical applications. My research starts by identify impacts on ecosystem services posed by ongoing SERS in the region. Then, I conduct a thorough analysis that identifies drivers of change that contribute to SERS. More importantly, by collecting data in the field, my case study facilitates an examination of governance approaches implemented for addressing changes under the local context. I used a combination of semi-structured interviews, focus group discussions, and participatory observations. The research confirmed that that anthropogenic factors, such as rapid population growth, primarily contributed to the changes in Zhuhai. While there are actions taking place in China to deal with the issues, my analysis indicates that more efforts are necessary on public awareness, governance norms, and equity to support ongoing governance policy regulations in place in China. In conclusion, this thesis provides several recommendations regarding effective governance interventions to enhance the capacity of the system to deal with the ongoing SERS and their impacts and to prevent further disturbances.

Keywords: social-ecological regime shifts, rapid change, ecosystem services, adaptive governance

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Chapter 1. Introduction

1.1. Background

“Information about regime shifts in China’s coastal ecosystems is rare” (K. Zhang, 2016, p. 90). Regime shifts are defined here as large, sudden, and persistent changes in ecological systems capable of altering the structure, function, and identity of the system, and which often result in significant consequences like declining resources or breakdown of social norms (Lade, Tavoni, Levin, & Schlüter, 2013). Such abrupt and persistent changes are occurring in China’s coastal systems, and they have resulted in significant impacts on ecosystem services (e.g., coastal climate, food from the ocean, identity, and culture for coastal communities) and human well-being (subjective, relational and material benefits to sustain life). Zhuhai, a Chinese coastal city located next to the South China Sea, is a demonstrative case study. This research intends to study the nature of regime shifts happening in this region by examining changes in relation to ecological and social aspects of the Zhuhai coast. To this end, this thesis uses a social-ecological regime shifts [SERS] perspective to help understand processes of change in nature, society, and relationships between the two, or in other words, “in linked systems of people and nature (Nayak & Armitage, 2018, p. 84).” Information collected suggest that coastal SERS have already occurred in Zhuhai. And it identified shifts to a eutrophic state, as well as considerable changes in the abundance of marine resources.

More importantly, this thesis includes an analysis of relevant governance arrangements and interventions towards the SERS in China. In the context of the interactions between nature and humans, governance is a crucial social factor to consider for effective responses to the unwanted changes in the system, such as those included in SERS. A combination of primary data collected in the field and relevant secondary sources have been used to deliver a clear understanding of the context and the status of SERS and their governance in Zhuhai.

1.2. Problem analysis

Available information provides explanations for SERS in Zhuhai. First, the occurrence of harmful algal blooms [HABs], an indicator of eutrophication (K. Zhang, 2016), suggests that the local coastal environment is experiencing a shift to the eutrophic state. Corresponding statistics indicate the occurrence of HABs increased dramatically from an average of 50 times per year in the 1980s to 250 times per year in the 2000s in this nation (Fei, 2004). As for Zhuhai, HABs have become emerged annually. Since the 2000s, there have been news articles covering their occurrences in the region. Given the relationship between HABs and eutrophication, reports on intensifying HABs indicate that local waters may be moving towards a eutrophic state.

Anthropogenic factors can have significantly contributed to eutrophication in China's coastal environment. In detail, when scholars considered nutrient inputs as some typical driver for marine eutrophication (J. C. Rocha, Peterson, & Biggs, 2015), nutrient concentrations have significantly increased in China's coastal environment since the late 20th century. For example, monitoring data indicates there has been a significant increase in nutrient levels in the Yellow Sea of China between the 1960s and 1980s (Liu et al., 2013). Further, according to Fei (2004), population growth in fast-expanding coastal cities is a significant source of nutrient deposits in the coastal environment that ultimately leads to eutrophication. This is likely the case for Zhuhai, as well as many other cities along the coastline, which has experienced a fast-growth period after the announcement of China's economy-reform policy after the late 1970s. Similar situations may continue to occur in China's coastal areas if immediate steps are not taken to manage coastal pollution and eutrophication.

Second, some indicate that the South China Sea is experiencing fisheries collapse induced by overfishing and other factors (Sumaila & Cheung, 2015), and this has some implications for the case in Zhuhai. As a coastal city located next to it, Zhuhai can hardly avoid the same fate. Changes regarding fish stock dynamics in the South China Sea can be explained in three ways (Sumaila & Chueng 2015). First, the volume of marine resources available in the region is down to 5 to 30% of the 1950s levels. Second, catch rates have declined by 3 to 4

times for fisheries over the past two decades. Third, an abundance of certain reef fish species declined by almost 80% over eight years (Sumaila & Cheung, 2015). These factors point out rapid changes that are equivalent to a regime shift. What can be the cause[s] of such changes? According to a publication summarizing the status of China’s fishery (Wu, 2014), the primary cause is overexploitation of coastal and marine resources due to increasing consumption, or in the case of the South China Sea, “Heavy fishing pressure for more than 30 years and decades of intensive commercial trawl fishing in coastal areas” (Sumaila & Cheung, 2015, p. 4). Thus, overexploitation is likely the primary contributor to changes occurring in the South China Sea. Of course, there can be other reasons or different perspectives to explain change, which can emerge as new information becomes available. For example, scholar clarifies that major stock collapse of Atlantic cod was due to overfishing (Rose, 2004). Yet climate-induced productivity changes also played a role in such a case, as Rose also identified. A similar situation may also apply to SERS in Zhuhai, which highlights the need to conduct contemporary research.

1.3. Statement and research questions

Given the growing influence of humanity upon nature, it is necessary to examine how the human world interacts with the environment, as well as better ways for both to co-exist. The subject of this research, SERS, offers a new way of interpreting interactions among the human and nature systems. Zhuhai is a real-life case useful for studying it.

The overarching purpose of this research is to analyze SERS in Zhuhai and their governance. The specific objectives of the research are:

- (1) To identify the nature of ongoing SERS in Coastal Zhuhai, Guangdong, China;
- (2) To examine and assess key policies and regulations in relation to those SERS social; and
- (3) To examine possible governance interventions that have the potential to better respond to future SERS.

1.4. Literature review

The literature review chapter of this thesis covers theories—ecosystem services, resilience, and

governance—used to guide empirical research with a theoretical ground for examining SERS in Zhuhai and their governance. When ‘ecosystem services’ provides a tool to examine the SERS in Zhuhai, ‘resilience’ and ‘governance’ sets up the ideal way of addressing changes in systems, for example, through adaptive governance. By the Millennium Ecosystem Assessment (2005), ecosystem services, in general, are how humans perceive their relationships with nature. Besides characterizing the services and benefits humans receive from nature, ecosystem services also refer to the anthropogenic actions that directly affect the delivery of services from nature. The implicit social-ecological systems approach within the concept fits this research perfectly. The sections on resilience and governance concepts provide a theoretical framework for addressing SERS to achieve better outcomes in Zhuhai in the end. Namely, this city should aim for an adaptive governance framework that builds resilience allowing for systems to maintain ideal functions and hence, meet the needs of future generations.

1.5. Study area and methods

The study area and methods chapter cover the background information of Zhuhai and the methods used to collect data there. The first section covers the geography of Zhuhai and some description of its history. In 1980, Zhuhai became one of the special economic zones [SEZs] of China. The city began to expand rapidly by population, economy, and urban area. Though, from the standpoint of this research, the outcomes of rapid expansion are debatable as positive or negative.

Overall, this research takes a mixed-methods approach, which recognizes the usefulness of both quantitative and qualitative data. It leverages different types of secondary data such as the GDP growth of Zhuhai over the past few decades. It also included semi-structured interviews and focus group discussions during the field study period for obtaining in-depth insights from the local people’s perspectives — for example, their thoughts on public participation and awareness regarding SERS in this region.

1.6. Significance

Addressing SERS in Zhuhai will contribute to sustainable development as the impacts from

SERS compromise what needs to be sustained. In general, sustainability is about “ensur[ing] that it[development] meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment, 1987, p. 16).” Generally, SERS can compromise the needs of future generations, as they could alter the structure and function at the present that makes certain ecosystem services unavailable in the future. According to Kates, Parris & Leiserowitz (2005), nature, life support systems, and community with ties to nature are all affected. The significance of this research is that it provides recommendations on how to make coastal ecosystems and communities, and their support systems, more sustainable. By these recommendations, it will help to restore the critical linkages between Zhuhai coastal ecosystem services and human well-being by connecting nature with the culture interpreted by local communities. Also, results from this research are valuable for developing appropriate strategies in other areas of the world for dealing with SERS, considering such changes will occur all over the world with increasing frequency and intensity requiring local responses (J. C. Rocha et al., 2015).

1.7. Limitations

There are three limitations to this research. First, the study is limited to a designated geographical boundary and highly unlikely to cover the whole dynamic nature of SERS happening there. There are factors likely occurring outside of the boundaries, contributing to SERS and their governance. Such factors are outside of the scope of this research. Second, the study focuses on ecosystem changes related to marine eutrophication and fisheries collapse and their societal implications. However, there can be other changes happening in the region, but their potential to affect SERS are outside of the scope of this research, and hence not treated with any significant depth or breadth. Third, based on the preliminary literature review, there is limited literature regarding SERS in China, which may affect the scope and scale of insights used to guide this research.

1.8. Organization of thesis

Here is a list of the following five chapters:

Chapter 2 includes a literature review that focuses on ecosystem services, resilience, and governance. When the ecosystem services concept provides a tool to examine the nature of regime shifts in Zhuhai, the resilience concept associating with governance (/adaptive governance) sets up the ideal way of dealing with changes in the systems. Namely, it should aim for an adaptive governance framework that builds up resilience that allows the systems to maintain ideal functions meeting future needs.

Chapter 3 describes the background of Zhuhai and the methods used to collect data. It includes relevant information about the data collection procedures, as well as geographical knowledge of Zhuhai, for helping readers getting the necessary context information. Further, there is a general description of the data analysis, along with the limitations of this research.

Chapter 4 analyzes the ongoing SERS in Zhuhai. The Chapter discusses the occurrences of SERS, their impacts, and underlying drivers contributing to the issues.

Chapter 5 analyzes governance approaches used to address SERS in Zhuhai. It offers recommendations for future improvement based on the current performance based on the available information.

Chapter 6 summaries the contents of the above chapters. It also offers a conclusion and thinking of future studies.

Chapter 2. Changes in Zhuhai, and Governance: A Literature Review

2.1. Introduction

This chapter reviews the theories and concepts used in this research, including ecosystem services, resilience, and governance. The literature regarding ecosystem services helps to answer the objective of identifying the nature of SERS in Zhuhai. Literature related to resilience and governance explains the essential factors shaping effective management of SERS, which addresses the second and third objectives of this research.

This research adopts a social-ecological systems perspective to examine regime shift issues in Zhuhai, recognized in the use of the concept SERS. When Zhuhai is expanding rapidly from economy and population growth, rapid changes appear in local systems. Different than the standard way of viewing of rapid change from an ecological perspective, this research sees the social sub-system as playing an essential role in causing and addressing SERS. Under such circumstances, 'ecosystem services' is a useful concept to approach issues of change, as the modern interpretation considers ecosystem services as productions of social-ecological systems (Folke et al., 2011). Or in alternative words, it is about outputs of interactions between humanity and nature, which are currently under the influence of SERS in the research area. Resilience and governance offer some specific guidance for advancing a sustainable future in Zhuhai. In particular, the viability of the adaptive governance framework to strengthen the resilience of the systems is assessed for its capacity for addressing SERS.

2.2. Ecosystem services and SERS

This research adopts ecosystem services as a part of the theoretical grounding. Ecosystem services concept has the potential to provide a better way of managing social-ecological systems by providing new integrative understandings of its components (Alonso Roldán, Villasante, & Outeiro, 2015). While this research focuses on analyzing SERS (Nayak & Armitage, 2018), it is fundamentally about learning how societies and nature interact with each one another. To these ends, then, ecosystem services is a helpful concept.

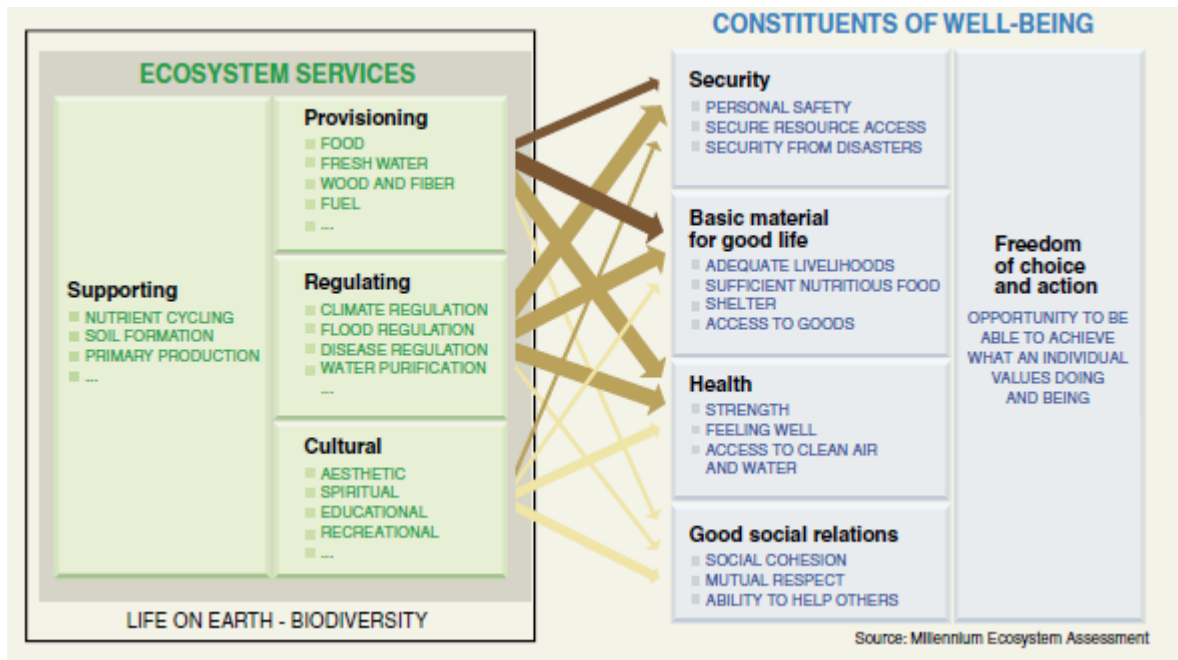
2.2.1. Ecosystem services

The understanding of and the definitions of ecosystem services has grown exponentially in recent years. Recently, the ecosystem services concept is defined as “the benefits provided by ecosystems” (Millennium Ecosystem Assessment, 2005, p. 39). Carpenter and his colleagues (2009) interpret the concept as a to means view and study ecosystems through the lens of the services or benefits provided by nature to society. Various additional clarifications or interpretations have emerged (Ojea, Chiabai, & Martin-Ortega, 2010). One of the definitions relevant to this research defines the ecosystem services as a result of complex webs of interactions from the local to global in social-ecological systems (Folke et al., 2011, p. 738). Furthermore, the common ground shared by different researchers, the emphasis on the human use of ecosystem services, is expanding. Therefore, the concept is complementary to SERS. There is a degradation of the ecosystem services available to the society across the world (Carpenter et al., 2009; Fairhead, Leach, & Scoones, 2012; Folke et al., 2011; Millennium Ecosystem Assessment, 2005). Some scholars considered SERS as a critical outcome of human-natural interactions that of disrupting and degrading those services (Crépin et al., 2012; Folke et al., 2004; J. Rocha et al., 2014; Zhang, 2016). Considerable scientific attention has been on studying the relationships among society, ecosystem, and politics to understand those interactions better.

In the early 2000s, many scientists from different disciplines gathered their expertise together, following the call by the United Nations, to better define human-nature interactions that influence the status of ecosystem services (Norgaard, 2008). They categorized ecosystem services into four categories, including supporting, provisioning, regulating, and cultural groups (Millennium Ecosystem Assessment, 2005; Figure 2.1). A paper published in *Conservation Biology* written by Norgaard (2008), who was also part of the Millennium Ecosystem Assessment, concluded that ecosystem services had a significant meaning as a scientific concept as “it helped [scientists] see the complex interactions of people and the environment in a deeper way (Pg.867).” Moreover, Carpenter et al. (2009), argued that studies invoking the concept after the Millennium Ecosystem Assessment have started to reveal new possibilities for measuring and projecting the relationships among the human well-being,

ecosystem services, and policy choices.

Figure 2.1 Linkages between ecosystem services and human well-being (Millennium Ecosystem Assessment, 2005)



2.2.2. The relationship to social-ecological regime shifts

This research, not different from others, could also be a response to the Millennium Ecosystem Assessment for better defining the relationships between human interactions and ecosystem services. While it is hard to determine whether the development of ecosystem services stimulates exploration regarding regime shifts. Yet, based on the results of case studies in lagoons of Vietnam and India (Nayak & Armitage, 2018), SERS can provide new knowledge of managing ecosystem services in coastal systems. In other scholars' findings, it can help to identify the problems in the governance of some essential ecosystem services that mattered to the stakeholders (Alonso Roldán et al., 2015). By "problems," it means the severe impacts SERS can pose on ecosystem services by altering functions of the system when there is none proper management.

In detail, regime shifts could pose substantial impacts on ecosystem services, and yet, a better understanding of their relationships is needed (J. C. Rocha et al., 2015). There are

numerous definitions of SERS that discuss how they are abrupt and persistent changes that alter the functions of a system (Andersen et al., 2009; Collie, Richardson, & Steele, 2004; Walker & Meyers, 2004). Crépin et al. (2012) provide a more targeted characterization as “large, abrupt, and persistent changes in the provision of ecosystem services (p.15).” According to this definition, the management of regime shifts is roughly the same as ecosystem services conservation. Furthermore, Rocha et al. (2015) argue that science is needed to assess “the diverse ways in which human activities are reshaping marine ecosystems can produce a variety of regime shifts that have substantial impacts on a broad set of ecosystem services (J. C. Rocha et al., 2015, p. 10).” As an example, with relevance to this research, Rocha and his colleagues (2014; Figure 2.2) discuss what kind of ecosystem services fisheries collapse, and marine eutrophication can impact. Interestingly, Rocha and his colleagues also expressed in Figure 2.2 that drivers of change are primarily anthropogenic. It tells a story that, in addition to benefiting from ecosystem services or receiving problems due to the degradation of services available, humanity itself is also fully capable of altering ecosystem functions or services by causing specific changes. In such a case, the knowledge delivered from applying the SERS concept can be helpful in terms of identifying the gaps in how interactions between social and natural systems are understood and addressed in governance. However, SERS requires further theoretical development to better understand such linkages among the social-ecological system components (Crépin et al., 2012; Lade et al., 2013; Nayak, Armitage, & Andrachuk, 2016). This research contributes to this development.

Figure 2.2 Summary of Regime shifts analyzed – fisheries collapse & marine eutrophication (J. Rocha et al., 2014)

regime shift name	key drivers	ecosystem services impacted	key reference
fisheries collapse	access to markets demand ENSO-like events fishing fishing technology global warming nutrient inputs subsidies tragedy of the commons upwellings urbanization	primary production nutrient cycling biodiversity fisheries pest and disease regulation recreation aesthetic values knowledge and educational values	[21]
marine eutrophication	agriculture deforestation demand droughts erosion fertilizers use fishing floods flushing global warming human population impoundments irrigation landscape fragmentation nutrient input rainfall variability sewage urban storm water runoff urbanization	primary production nutrient cycling biodiversity fisheries water purification recreation aesthetic values	[24]

2.2.3. Further considerations

One of the problems commonly discussed regarding the ecosystem services is the challenges associated with transforming scientific findings into so that they are useful for practical applications. Carpenter and his colleagues (2009) pose questions that give insight about these challenges, “How do human choices and actions affect local flows of ecosystem services and spill over to affect other regions? What institutions, incentives, and regulations are effective in sustaining flows of ecosystem services (p. 1309)?” Daily and Matson (2008) argued

that institutions, incentives, and regulations, key aspects of governance, need to be clarified in local contexts. They indicate that the design and implementation of policies for ecosystem service conservation in light of rapid change can vary based on the “biophysical, socioeconomic, political, and general dynamic context (Daily & Matson, 2008, p. 9455).” This means that the implementation of specific policies or regulations for managing or conserving ecosystem services, or in this case, SERS is context sensitive. Given that there is no similar study conducted in Zhuhai, this research contributes to the twin needs of providing practical insights for governance of SERS in Zhuhai and building evidence-based insights about how from theory to practice in governance that can address SERS in the local contexts (Objective 3). However, to effectively leverage the ecosystem services concept (Folke et al., 2011), it is needed to reconceptualize the relationship between humanity and nature in the context of SERS due to the involved complex interactions and feedbacks (Objective 2).

2.3. Resilience and SERS

The concept, ‘resilience’ offers theoretical grounding for governing changes that occur related to SERS. The classic (and original) definition of resilience is the capacity of a system to absorb disturbance and reorganize while undergoing changes and still retain the same function, structure, identity, as well as feedbacks (Walker, Holling, Carpenter, & Kinzig, 2004). However, ‘resilience’ has undergone multiple developments in the decades after the first emergence of the idea of resilience in the 1960s and early 1970s. Now its core meaning relates to maintaining the state of the system when it is in a desirable situation while allowing alterations to occur for moving towards desired states when the current situation is rather undesirable (Walker et al., 2004, p. 7). In other words, rather than maintaining the resilience of a system, sometimes “disturbance has the potential to create an opportunity for doing new things, for innovation and development (Folke, 2006, p. 253).” Such interpretation comes from the current definition of resilience that recognizes the governance of a system to be dynamic and context-dependent, and approaches taken need to reflect local or regional attributes.

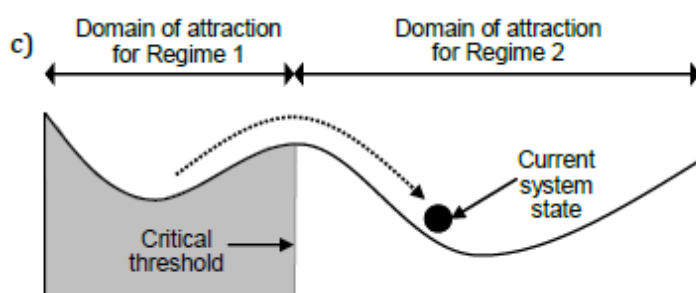
Moreover, the definition of resilience also needs to recognize in governance that humans as agents of ecosystem change rather than external to the system. According to the literature

(Folke, 2006; Walker et al., 2004), this is because human actions are not only dominant actors in a system regarding being relying on ecosystem services and support but as well as being significant forces in changing the ecosystem. This signals the appropriate of the SERS perspective to learn about and address interactions between social and natural sub-systems.

In the literature, there is a direct linkage made between regime shifts and resilience: eroding resilience results in an increased likelihood of SERS in ecosystems. There is evidence revealed by Folke and his colleagues (2004) that regime shifts will be more likely to occur in the ecosystems when humans are actively intensifying pressures through, as for example, removing functional groups of species and associated ecosystem diversity, adding nutrients related to waste and pollutants, and altering magnitude, frequency, and duration of disturbance. Such intensifying pressures make systems “more vulnerable to changes that previously could be absorbed (Folke et al., 2004, p. 575).” Moreover, these pressures push systems over critical thresholds more rapidly. Figure 2.3 illustrates the relationship graphically. In Figure 2.3, the depth of the “cups” (the capacity for resilience) become much shallower and allow the “balls” (the state of the system) to travel cross the critical thresholds into another regime if the system is becoming less resilient.

This is what appears to be happening in China. Zhang (2016, p.95) argues that “increasing regime shifts in key components of China’s coastal ecosystems are symptomatic of the continuous decline of system resilience.” Moreover, according to Zhang (2016), when multiple types of pressures and their combined effects are increasing the possibility of regime shifts by making ecosystems in China more vulnerable, it may lead to ripple effects that trigger other changes in China’s coastal systems. Due to the difficulty of reversing SERS, the state of the systems will likely stay in highly resilient but undesirable alternative regimes. Under such circumstances, building resilience has a considerable and urgent role. It is also essential to define approaches that will actively strengthen or alter the resilience of coastal systems in Zhuhai in desirable ways.

Figure 2.3 Representation of regime shifts (Rocha, Biggs, & Peterson, 2014, Pg.2).



Several capacities and attributes can contribute to building resilience in a system. For example, Folke et al. (2011, p.728) argue that “ecosystem-based management in any place operates in a global context and requires collaboration and collective action is much more complex institutional and actor settings than previously acknowledged ...” For Lebel and his colleagues (2006), such capacities and attributes refer to the capacity of a system for self-organization and the capacity to learn and adapt, where ‘self-organization’ reflects the capacity of a system to maintain and re-create its identity, and the ‘capacity to learn and adapt’ is about the capacity knowing change and using that knowledge to pursue a desirable state while the context changes. There is newer research that argues for similar capacities (e.g., Kerner and Thomas, 2014; Figure 2.4). However, Kerner and Thomas (2014) use different terms: ‘adaptive capacity’ stands for ‘self-organization’, and ‘readiness’ stands for ‘learn and adapt’. Further than that, Kerner and Thomas (2014, p.682) include “stability” as a term, which reflects “the degree to which a system can continue to function if inputs, controls, or conditions are disrupted.” Such definitions of resilience do provide more clarity for the governance of SERS by providing a better understanding of the relationship between resilience and SERS.

Figure 2.4 Categories of Resilience Attributes (Kerner & Thomas, 2014, p. 682)

Single Points of Failure	Response Diversity	Situational Awareness	
Controllable Degradation	Collaborative Capacity	Simplicity/Understandability	
Resistance	Connectivity	Preparedness	
Balance	Abundance/Reserves	False Subsidies	
Dispersion	Learning Capacity	Autonomy	
Leadership and Initiative			
Stability	Adaptive Capacity		Readiness

2.4. Governance and SERS

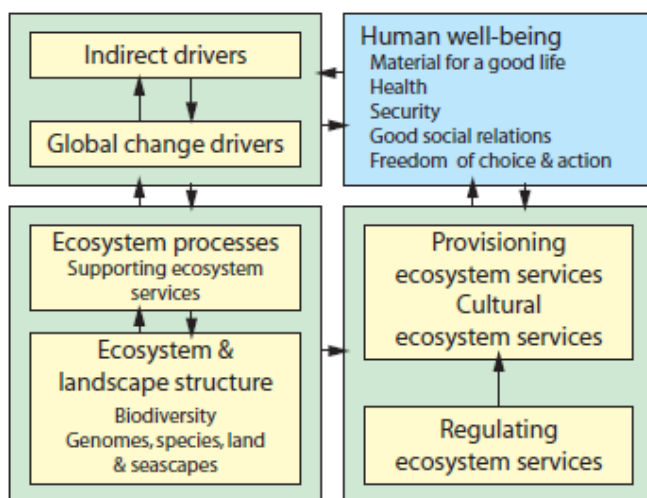
Governance is an essential mechanism of human society to manage problematic actions and deliver desirable outcomes. And when SERS make changes to ecosystem services that define the linkages inside the social-ecological system, governance can play an essential role by building the resilience of systems. In the end, this requires more adaptive approaches, or adaptive governance, than are found in conventional governance arrangements, which can help societies address SERS by strengthening the resilience of systems.

2.4.1. Governance

‘Governance’ is not a new concept, and there are many definitions and interpretations to explain its functions at multiple levels in society (Bevir, 2008). For this research, the most useful definition of governance is “the set of regulatory processes, mechanisms, and organizations through which political actors influence environmental actions and outcomes (Lemos & Agrawal, 2006, p. 298), referred to as “environmental governance.” Lemos and Agrawal view environmental governance as a response to the issues of declining ecosystem services mentioned in the Millennium Ecosystem Assessment (2005). Based on their interpretation, the effective sustainable development of ecosystems services depends heavily on the strategies of environmental governance. Later literature conducted about the findings of the MEA shared the similar thinking (Carpenter et al., 2009), which views governance interlinks with

ecosystems services by building or maintaining it at multiple scales. Relating the case to SERS, scholars consider if doing right (J. C. Rocha et al., 2015), appropriate governance could build resilience into the system to sustain ecosystem services. In detail, it is about building the capacity to adapt when changes happen, as well as reducing the likelihood of its occurrence (Crépin et al., 2012).

Figure 2.5 The overarching feedback loop (Carpenter et al., 2009)



“Changes in institutional and environmental governance frameworks are sometimes required to create the enabling conditions for effective management of ecosystems, while in other cases existing institutions could meet these needs but face significant barriers (Millennium Ecosystem Assessment, 2005, p. 20).”

When issues like SERS occur and lead to undesirable system functions, changes in governance are necessary. The Millennium Ecosystem Assessment (2005) has proposed several governance interventions to guide such changes: (1) integrate of ecosystem management goals; (2) increase coordination among and between institutions; and (3) increase transparency and accountability of government and private-sector. Later studies conducted also propose similar suggestions but with other criteria (Ölund Wingqvist et al., 2012; UNDP, 2010). The United

Nations Development Programme (UNDP) stated that good governance needs to “make governing institutions more responsive and accountable, and respectful of international norms and principles (2010, p. 48).” In detail, compared to the MEA, UNDP added public participation, equitable access to resources, adhering to the rule of law, and gender equality as important governance outcomes. Furthermore, in the context of governing social-ecological systems broadly (Folke, Hahn, Olsson, & Norberg, 2005; Lebel et al., 2006), or SERS, specifically. (Crépin et al., 2012; Folke et al., 2004), an adaptive framework that treats the ecosystems as complex entities filled with environmental uncertainties is needed for dealing with the impacts of SERS on ecosystem services.

2.4.2. Adaptive governance

Adaptive governance is an essential tool to deal with the challenge by helping governance systems supporting long-term sustainable development when SERS are occurring at increasing rates due to the eroding resilience of ecosystems. As an extension of conventional resource governance, adaptive governance is, in general, a process of building resilience by creating adaptability and transformability in a system (Walker et al., 2004). Here, ‘adaptability’ refers to steering systems to co-evolve with change and prevent from crossing into an undesirable system regime, and ‘transformability’ means building capacity for transforming the undesirable aspects in a system (Walker et al., 2004). In other words, the purpose of developing such a framework is to sustain desired ecosystems states and adapt, and transform them into fundamentally new or say more desirable configurations when needed (Folke et al., 2004). Some scholars provide more guidance for achieving these goals. For example, Folke (2006, p.262) argues that there needs to be a “collaboration of a diverse set of stakeholders operating at different social and ecological scales in multi-level institutions and organizations.” In other words, an effective governance framework that includes the interpretation and response to ecosystem feedbacks, the development of flexible institutions at multi-levels, and the building of environmental capacity to deal with uncertainty or other external drivers that emerge as part of system dynamics.

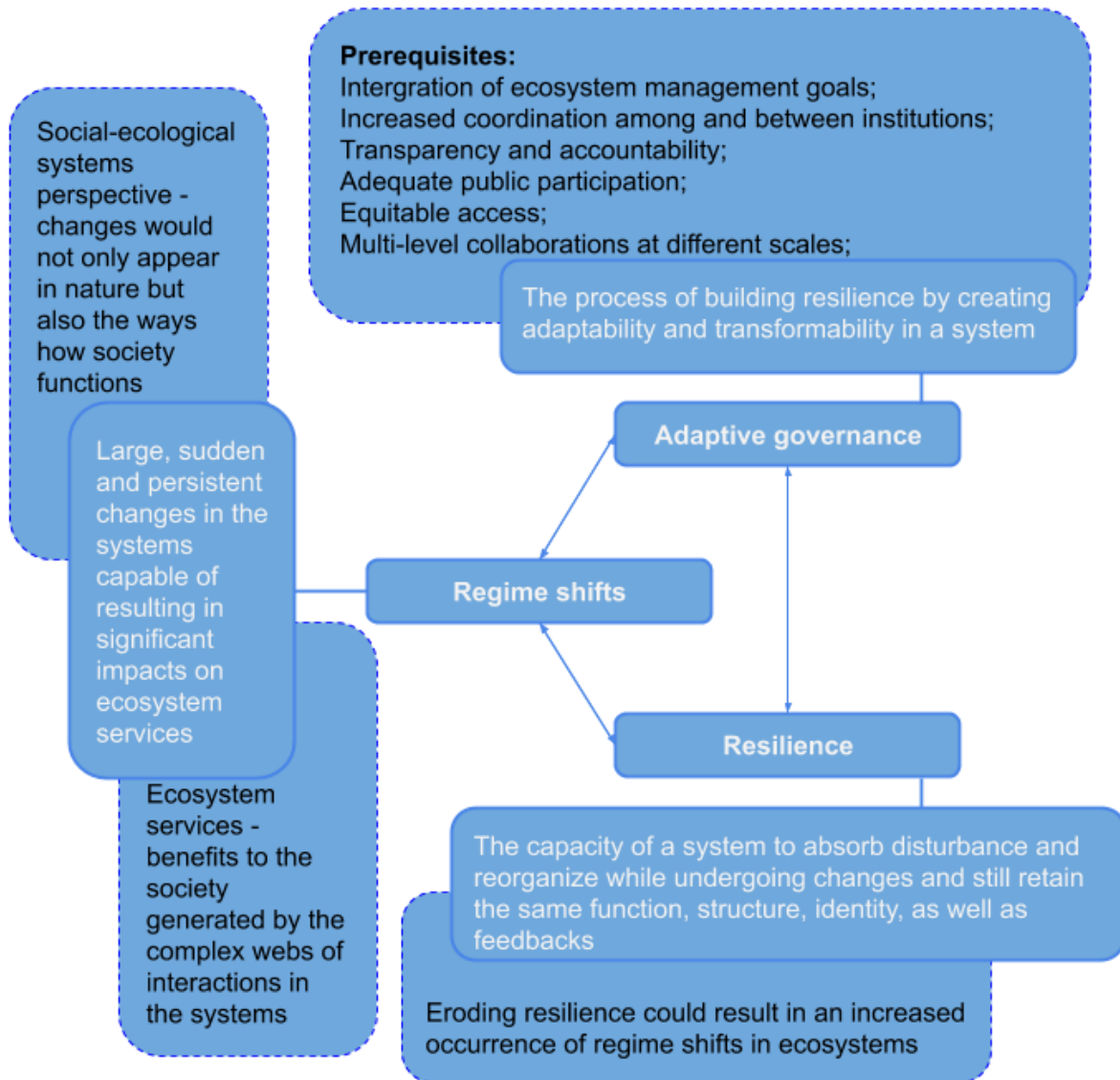
However, adaptive governance is still a theory in development (Chaffin, Gosnell, &

Cosens, 2014). An early critique of this theory is that more knowledge is needed to manifest the governance structures that build resilience in the ecosystems (Walker et al. 2004). This has been a key concern of scholars or policymakers who have made advancements of the theory since its emergence in scholarly literature in the early 2000s. Questions related to the implementation of adaptive governance in the real world remain, however (Chaffin et al., 2014). Specifically, three major issues need to be solved (Chaffin et al., 2014, p. 10): (1) What is the relationship between principles of adaptive governance and principles that generally fall under the heading of “good” governance? (2) What is required to prepare for and take advantage of windows of opportunity to increase the likelihood of successful transformations to adaptive governance? And (3) What are the barriers within existing institutions to adopt and implement adaptive governance? These and other questions remain under-addressed. Yet, to effectively manage social-ecological regime shifts, despite those questions, there is a necessity to push for developing an adaptive governance framework to guide management for three reasons.

First, it is necessary for building resilience in a system as there is a direct link between resilience and SERS. When low resilience increases the likelihood of SERS, as adaptive governance is a theory to build resilience (Walker et al., 2004), it is appropriate to integrate it for governing SERS. Second, SERS and associated resilience of a system are relevant to policy and policy-making, as societies, as well as the globalized economies, rely heavily on ecosystem services threatened by SERS (Folke, 2006; JC Rocha, Biggs, & Peterson, 2014). Third, the literature indicates that adaptive governance frequently functions ineffectively due to the existing governance structures (Walker et al., 2004). This is likely true for China. For example, there is a lack of capacity of China’s current policy systems for effectively coping with uncertainty and change regarding SERS (K. Zhang, 2016). Therefore, there is a practical and urgent need to integrate adaptive governance to steer China’s policy processes to allow more effective responses to changing conditions associated with SERS. Figure 2.6 summarizes my conceptual framework including the theories and relationships among them described above.

2.5. Conceptual framework

Figure 2.6 Conceptual framework



Chapter 3. Study Area and Methods

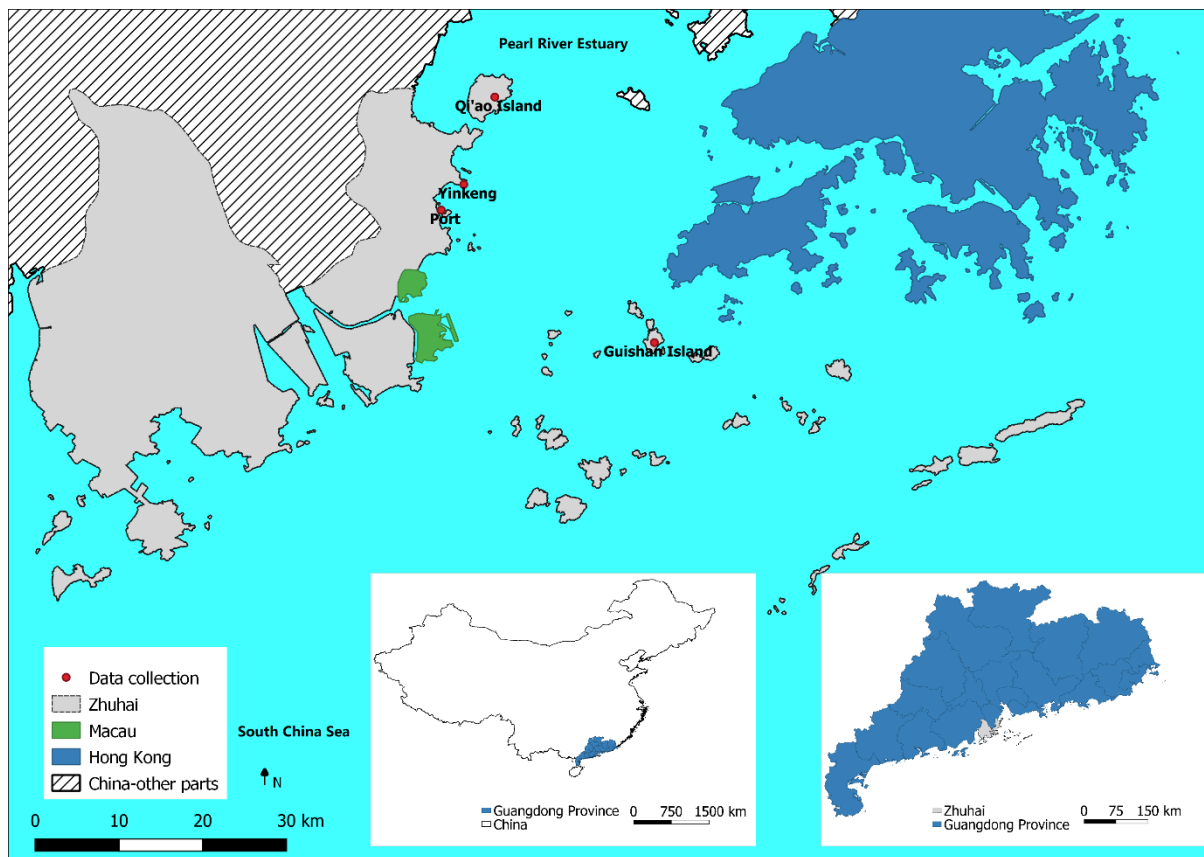
3.1. Introduction

This chapter discusses the study area – Zhuhai, China, and methods adopted to analyze SERS and their governance. The first section covers background information like Zhuhai's geographic features and its general history. The second section includes descriptions of the methods used. As this research aims to define the nature of SERS happening in Zhuhai, as well as related governance approaches, it requires a certain amount of data covering a wide range of perceptions. In this case, this research adopts a mixed-method approach that acknowledges the usefulness of both quantitative and qualitative information. This research combines statistical information, semi-structured interviews and focus group discussions.

3.2. Study area – Zhuhai

This section provides background information about Zhuhai (Figure 3.1). Zhuhai is a coastal city located in the southern part of China. It is located next to Macau and Hong Kong, which are two of the most significant economic entities in the Asia continent. Such a situation provided an ideal context to test the significance of human factors in initiating SERS. From 1980, a year after it became a prefectural-level city (also referred to as “prefecture-level municipality [地级市]” in China), Zhuhai began to share an interlaced fate with China's economic reform governance style by becoming one of China's special economic zones. Then, the economic, environmental, and social statuses of Zhuhai started changing rapidly. This provided a perfect conditions for SERS since intensifying human factors are the most common contributors to ecosystem change. For example, in addition to the fact that Zhuhai is expanding in all aspects. There is an agenda for boosting the economic growth of the Pearl River Delta Metropolitan Region (including cities surrounding Pearl River estuary), which may result in all different kinds of outcomes - environmentally friendly or not. In this way, it makes more sense to study the environmental issues in this region and develop related strategies for the better good of future generations.

Figure 3.1 Zhuhai and its surroundings. Source: drawn by the author



The history of Zhuhai is short yet rich. Unlike many other cities in China with a long history that some even tracing back over three thousand years, ‘Zhuhai,’ as a city name, appeared in 1952 when the authorities established a county there. Before that, the name ‘Zhuhai’ did not appear in the historical documents (Sheng & Tang, 2013, p. 70). Nevertheless, with the establishment of the county and later establishment of SEZ, among other factors, the city tripled in size from 0.4 million in 1979 to 1.5 million people living as of 2009 (Wei & Wei, 2010) (Appendix A). The city’s population pales in comparison with other cities in China which has one of the highest population densities in the world and most precipitous population growth rates since WWII. However, local population growth was still quite extraordinary.

There is also a rapid urban and economic expansion in Zhuhai, accompanying the growing population. Such made it one of the most significant metropolitans in China. However, on the other hand, more human activities usually means more environmental concerns, like SERS this research focuses on. Of course, undeniably, Zhuhai did have an exciting journey

from being ‘nobody’ to ‘big shot.’ And it will likely keep being one of the most prosperous cities in China. Though, the key question is whether it will happen in the way of increasing the likelihood of SERS, or other sorts of environmental problems. This research will help to answer this question.

Data collected to address this question have limitations. Data collection covered only the eastern coast of Zhuhai due to limited resources (e.g., budget, and convenience of transportation) and opportunities to examine SERS in one of the most developed areas in Zhuhai. I collected most data along the Lovers Road (also known as QingLv Road), which is a coastal road built in the early 1990s that covers the entire eastern coastline reaching north to Macau’s border. It is sufficient to collect data here because this side of Zhuhai witnessed the highest amount of social-ecological changes. Data collection happened mostly at a few ‘hotspots’ identified in preliminary research. Most of the interviews were conducted at Qi’ao island, Yinkeng, and the port area, where are ideal for recruiting participants with a strong awareness of coastal issues.

I also visited Guishan Island of Zhuhai. Over the past few decades, fisheries in Zhuhai endured a process of moving towards the outer sea for reasons such as declining fish stocks in coastal waters. And this gave me a reason to visit Guishan island, which is remote from the mainland, as one can see from the map (Figure 3.1). Some early interview participants considered that there is still an abundant fisheries resource.

3.3. Research design

My research design leveraged a considerable amount of data to define the changes happening in Zhuhai, as well as their drivers. The study used both quantitative (i.e., statistical secondary data) and qualitative (i.e., semi-structured interview and focus group data) research methodologies. Combining quantitative and qualitative data often delivers a more convincing and complete examination as diverse data types tend to complement each other (Fairhead et al., 2012). I adopt the epistemological position that this research is not entirely objective or subjective. Instead, I take an intermediate position in social sciences that acknowledges the usefulness of both objective and subjective views of the reality (Ansari, Panhwar, & Mahesar,

2016). Following my epistemological and methodological standpoints, I conducted the research in two phases. First, I used secondary data to learn about the research context. Second, I used semi-structured interviews and focus groups on gathering information about SERS with more depth and breadth.

This research received ethics approval from the University of Waterloo Research Ethics Committees (ORE#23117). During each stage of the research, I took efforts to ensure I met the ethical standards of data collection. This included being sensitive to the experiences of change by participants, and respecting the privacy of participants, and upholding their confidentiality by de-identifying data during data management and coding.

3.3.1. Secondary data

During data collection, I identified available secondary sources to more effectively generate a better understanding of SERS, their drivers, and the local context of governance in Zhuhai, as opposed to just using one data source. In this case, statistics can provide a numeric overview of trends of phenomena related to SERS (e.g., HABs), and the attitudes of a population. Kelly (2003) indicates that if there are statistics available for the problem analysis delivered from a study covering a broader coverage of people or events, then they can allow having a more generalizable conclusion at the end. To gather the data, I visited the local city library during the stay to locate specific publications that cover the local context in addition to the typical approach of using the academic database like Google Scholar. For example, books like 珠海的海洋和农渔业 [Zhuhai's Ocean, Agriculture, and Fishery] (Wei & Wei, 2010) were resourceful to this research as they provided information regarding changes that happened in Zhuhai associated with the ocean. Of course, there were also other publications being resourceful to this research, but I will not list each of them here. Furthermore, due to the general degree of reliability of published findings, the use of these context-sensitive secondary sources advanced the credibility of the results by allowing cross-checking data across primary and secondary data. Through the presentation of results, I did use both primary and secondary data to clarify research points.

3.3.2. Semi-structured interviews

I used semi-structured interviews to generate a better understanding of the SERS-related issues based on the local context that set the stage for developing recommendations for governance interventions. The primary advantage of the interview is that it can deliver more in-depth open-ended answers, rather than close-ended limited information compared to some other methods (Creswell, 2014). In other words, semi-structured interviews can provide more thorough and detailed information on the research subject (Adams & Cox, 2008).

The selection of participants was mostly randomized, but there was some purposive and snowball sampling used. I picked some sites in Zhuhai for recruitment that had direct connections to the ocean. For example, some interviews took place at Qi'ao Island because this island has a long history with the sea and is a tourist 'hot zone'. Interviews conducted there provided a lot of useful information along with other sites chosen, including Zhuhai's east coast road (Lovers Road), as well as Yinkeng and Guishan Island (Table 3.1). I approached people at random (randomized sampling). Then I used some guiding questions (Appendix D) to determine the knowledge base and their viability as potential participants (purposive sampling). Beyond that, I used snowball sampling to help with the data collection. When it was hard to find participants in Zhuhai at the beginning, such a sampling method contributed to identifying potential subjects. The whole process did not happen in a standard way (i.e., early participants nominating others). Instead, I used the insights from those involved early to find different sampling sites.

Table 3.1 The number of interviews conducted.

Locations conducting interviews	Number of participants
Guishan Island	2
Lovers Road	2
Qi'ao Island	7
Yinkeng	5
Other (landlords, university students, etc.)	7
Total	23

I conducted semi-structured interviews face-to-face. This approach is more relaxed for a participant to reveal relevant and valuable insights when she or he feels at ease (Adams & Cox,

2008). In detail, compared to the regular interview setting with a set of fixed questions, I used an interview guide (Appendix D) to direct the conversation roughly. Besides that, this research took a face-to-face approach to conduct interviews during the data collection, because there can be some benefits. In detail, face-to-face interviews are sometimes seen as an ideal model as it may provide much extra information due to the more effective communication (Opdenakker, 2006). For example, researchers can observe participants' attitudes towards certain events from their body language, voice, and other signs. Interviews that take place by telephone or the internet, by comparison, may suffer from the absence of some extra information, including such social cues (Opdenakker, 2006, p. 4). In the end, interviews conducted did provide insightful information for this research, as well as raising some relevant topics worthy of study.

3.3.3. Focus groups

I conducted focus group discussions in addition to semi-structured interviews. First of all, the focus group approach has the potential to provide some better insights regarding the research subject. The primary goal of adopting the focus group approach is to deliver better insight into specific topics of the researcher's interest (Polak, Mishkov, & Williams, 2015). The focus group discussions covered topics including (1) public participation and awareness of SERS and other environmental matters; and (2) fishers' opinions of the current interactions between fishery and tourism development in Zhuhai (Table 3.2). The collaborative nature of focus groups revealed helpful reflections on these topics and did so efficiently (Adams & Cox, 2008).

Table 3.2 Focus groups and covered topics.

	Location	Discussion topics	Number of participants
Group 1	Near the Port of Zhuhai (Jiuzhou Port)	Fishers' opinions towards the current interactions between fishery and tourism development in Zhuhai.	4
Group 2	Bookstore 21H; Tangjiawan District (north of downtown)	Public participation and awareness of SERS and other environmental matters.	12

Initially, the researcher intended to bring diverse stakeholders into a room to discuss issues related to governing SERS. According to previous research (Kahan, 2001), such an approach is efficient for uncovering potential policy problems associated with addressing SERS. However, due to the difficulty of finding and bringing together different stakeholders

related to SERS in Zhuhai. I used focus groups to explore further the depth and breadth of the mentioned topics for delivering more concrete results at the end. For example, I used focus groups to elicit collaborative thinking on specific topics that emerged from some of the interview results. Focus groups increased the quality insights, including related issues about the lack of awareness and knowledge about SERS in this region.

The way I conducted the focus groups is a little bit different than the interviews. As with the interviews, I came up with some questions and statements to guide the discussions. The focus groups were different. For example, during one of the focus group discussions, I made a statement that tourism development is posing negative impacts on the fishery, and later asked participants for their opinions on that. And unlike the interviews, the focus group allowed multiway conversations and facilitated participants' ability to add on or even speak against points made by others. In this case, I was able to gather some insights from different perspectives regarding the same subject, which is helpful for the analysis of my research problem.

3.3.4. Group research survey

As a part of the group research led by Dr. Prateep Kumar Nayak, I conducted a survey questionnaire in Zhuhai involving 21 participants. The title of this research is *Social-Ecological Regime Shifts (SERS) and Governance in Coastal-Marine Systems*. The registered number with the University of Waterloo Research Ethics Committees is ORE #23136. This project simultaneously took place in different locations over the world, including Indonesia, Mexico, India, and China. With the approval of Dr. Nayak, I used some of the survey data in this research. For the detail information about this group research, please contact Dr. Nayak.

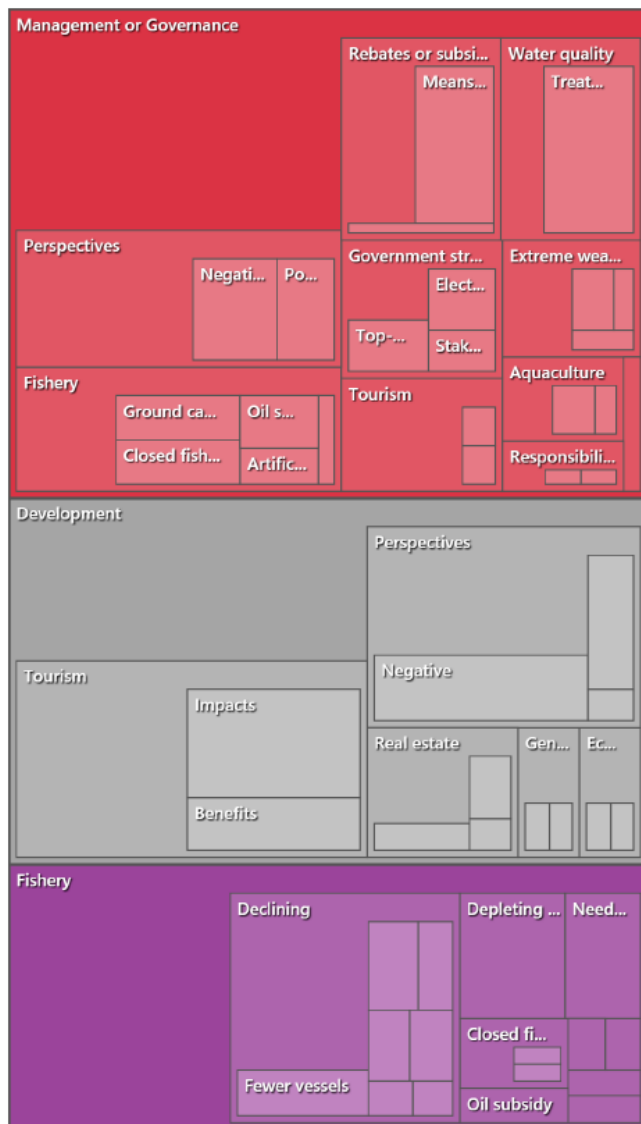
3.4. Data analysis

I took some steps to organize and categorize collected data before moving to analysis. I explored *NVivo 12*. This is a qualitative data analysis computer software that can arrange and combine data from different sources and hence, allows for comparisons where necessary. I arranged data collected into two categories—primary and secondary sources—due to the

distinctive characteristics of each type of data. Then, I coded and analyzed these data separately and then collectively. This made it possible to cross-check data more easily for the delivery of more concrete results.

For coding, I arranged the data into different carefully designed subsections in NVivo 12 guided by the research's objectives related to identifying types of SERS in Zhuhai, their drivers, and associated governance (Figure 3.2). The literature review conducted before the field study assisted the researcher in this categorization by providing some vital information. For example, I was able to identify that fishery collapse and eutrophication were two significant issues bothering Zhuhai at the time. These served as essential subsections in the data categorization. Then I followed emergent themes in interviews, focus groups, and secondary sources, which allowed the classification of the data to cover more details as they are understood from different perspectives. In the end, I would say that NVivo 12 helped to reveal the status of SERS in Zhuhai through easing up the processes of locating similar sources and drawing lines between them.

Figure 3.2 Example: part of the hierarchy chart generated by NVivo based on themes.



3.5. Limitations and boundaries

The study is limited to a designated geographic boundary, which unlikely covers all the interactions associated with the dynamic nature of SERS in Zhuhai. SERS likely do not share the same geographical restrictions as the research. Even though the primary focus of this research is the changes happening in Zhuhai, it is essential to understand that drivers and factors contributing to SERS are not limited to those in the study region. For example, some data suggested upstream pollution from cities, factories, and agriculture fields along China’s rivers are the primary sources of eutrophication (CCICED, 2013). As being at the Pearl River estuary,

Zhuhai receives a massive amount of pollution from the upstream, which is a significant driver of the local issues. However, due to constraints on data collection, I was not able to collect data at neighboring areas for substantially expanding the scope of the study. Further, I mostly restricted data collection to the eastern coastline of Zhuhai. Collecting data from other coastal areas of Zhuhai could make the research more comprehensive. Highly likely, they can provide some different perspectives regarding SERS to this research and make it more conclusive.

There are other limitations related to data collection. It was difficult to control the randomness and purposiveness in sampling. During the limited field study time, for example, there was restricted access to potential participants that likely required early and length trust-building to establish enough connections. The researcher initially intended to collect more primary data from more perspectives, like from some government officials, but it was not feasible. However, the insights obtained from those available sources proved to be quite resourceful without those additional perspectives. The perspectives collected involved ideas from fishers, urban residents, island residents, government views, and a marine scientist. Such diversity was sufficient to support the credibility of findings.

Another limitation was that there were different types of SERS other than fisheries collapse and marine eutrophication in the region that I was not able to investigate. The mixed-approach design of this research can deliver a convincing and complete response but only related to the objectives of this research. It can be better if there will be future studies covering emerging themes in Zhuhai with different perspectives – especially from the viewpoints of other types of SERS.

Chapter 4. Social-ecological regime shifts in Zhuhai, and their nature

4.1. Introduction

This research is a case study that examines SERS in Zhuhai, China. Here, ‘regime shifts’ represent large, sudden, and persistent changes in ecological systems, which are capable of altering the structure, function, and identity of the system (Lade et al., 2013). Such a concept appeared sometime in the late 20th century already, but it has experienced considerable attention in recent years. This research takes a further step toward adopting an enhanced theoretical perspective about regime shifts to recognize that change does not solely take place alone in ecosystems. Rather, there will simultaneously be changes occurring in those associated social subsystems that affect human well-being. In this way, this research adopts Nayak and Armitage's (2018, p.84) definition of SERS as “abrupt, long-term and significant changes in linked systems of people and nature. Such a definition provides a lens to develop a greater understanding of the changes in the systems, and hence, to open new dialogue regarding the environmental matters and associated governance of the area. Technically speaking, the novelty of ‘SERS’ is the primary reason why new studies like this one are emerging; or, from another perspective, why the researcher will first have to try to identify the nature of the SERS that are taking place in Zhuhai (objective 1). Such a concept still begs for practical and contextual applications.

Zhuhai, as well as other China’s coastal cities, are facing severe environmental pressures that include but are not limited to SERS, and the knowledge about the resultant changes is underdocumented. While China has experienced rapid economic growth after the late 1970s, environmental challenges in China have also multiplied, including the emergence of environmental disasters that demand interventions from governmental authorities (Economy, 2007). In this way, SERS, due to its significant impacts on ecosystem services and human well-being, is a matter deserving of being taken seriously. That said, addressing SERS requires the appropriate knowledge to document the processes, and there is a lack of information about SERS in China generally, and Zhuhai specifically (K. Zhang, 2016). Hence governance requires new scientific research to can lead to practical information to guide interventions

related to SERS. Moreover, the knowledge provided from this research will contribute to practical applications at a local level in Zhuhai, contextual information to support effective governance. Furthermore, considering there is an increasing occurrence of SERS across the world, the results of this research will help other regions with similar issues in the end.

In this chapter, I analyze SERS related to fisheries collapse and coastal marine eutrophication in Zhuhai and their drivers. Other studies have covered fisheries collapse and marine eutrophication widely and deeply in other regions. However, there was no previous study conducted on SERS before in Zhuhai. Hence, this situation necessitates research to study the phenomena and allows addressing this gap.

Figure 4.1 Zhuhai, and fishing vessels; photos were taken at Lovers Road.





4.2. Fisheries collapse

Zhuhai is experiencing fisheries collapse, a type of SERS largely induced by over-exploitation among other factors. Scholars consider fisheries collapse as a common type of regime shift in marine environments (Rocha et al., 2014). Some even indicate fisheries collapse are becoming worldwide phenomena (Mollmann, Folke, Edwards, & Conversi, 2014). In China, scholars identified that fishery resources are degrading and urged for sustainable management (CCICED, 2013). Meanwhile, combined data suggests that Zhuhai is in a persistent state of having insufficient fishery resources; this fits with the general characteristics of regime shifts (Rocha et al., 2015; Scheffer, Carpenter, Foley, Folke, & Walker, 2001). Further, in addition to its impacts on the ecological subsystem, due to the effects on human well-being. For example, from the ecosystem services concept perspective, the change in Zhuhai is affecting the provisioning services by limiting people's access to food or food production. This research considers what is happening in Zhuhai as a SERS.

First, how do we know a fisheries collapse is happening? Different kinds of evidence suggest that a fisheries collapse in the study area is occurring because the local system has shifted from a state with a high to considerably lower fish resource abundance, and this fits with the general characteristics of SERS (J. C. Rocha et al., 2015; Scheffer et al., 2001).

Furthermore, while participants of the survey questionnaires used different terminologies like “depleting resources,” “marine resources,” and “fish stock” among others, 19 out of 21 participants all agreed that there was an ongoing adverse ecosystem change related to the fishery resources.

Table 4.1 Summary - data suggesting the occurrence of fisheries collapse

Data suggesting the occurrence of fisheries collapse	
Type of data	Details
Survey	Part of group research; 19 out of 21 participants expressed there are issues regarding fisheries collapse in Zhuhai.
Interview	Participants [082001, 082201, 082601, 082801, 090902] expressed that there is much less fish available to fish in recent years; [082801, 090201, 090602, 090901, 091201] also indicated a trend that fishers need to travel further away from the coast to capture sufficient amount of fish.
Secondary statistics	Xu, Liu, and Li (2017) stated how to classify marine waters based on the depth, as well as the trend of fishing operations shifted to deeper waters after 2000 in Guangdong, etc.

Other sources (Table 4.1) also came to a similar conclusion. The most direct description provided by some of the interviewees was that there was nothing left to fish in recent years [082001, 082201, 082601, 082801, 090902]. This observation came from both the groups of regular residents and local fishers, which suggests it was a common observation shared in the designated study area.

Furthermore, some participants (mostly fishers) commented that they tended to need to travel further away from the coast to capture enough stock compared to the travel distances in the past [082801, 090201, 090602, 090901, 091201]. One local secondary source supported this observation (Xu, Liu, & Li, 2017). It stated that during 1990-2000, 70% of the capture in Guangdong happened in coastal waters (within 40m depth), and the operations moved further away from the coast in recent years, with 50% capture happened in inshore waters (40m-100m depth) after 2000. There was also an increase of capture in offshore waters (100-200m) from 10% to 12% during this period. Combining these data suggests that there has been persistent depletion of fisheries resources in the coastal waters off of Zhuhai. Hence, this provides evidence for fisheries collapse in the local coastal system compromising ecosystem services

(i.e., provisioning services) with impacts to local communities.

4.2.1. What are the impacts?

“Fishers need to travel to Wanshan Island for fishing, which is far away from the urban center of Zhuhai. However, the capture rate is still not that great. Generally speaking, we have to travel further and further for fishing these years.” – participants of case # 091201 (a few fishers found in Yinkeng, Zhuhai)

Fisheries collapse mostly affects access to food production as one of the ecosystem services. As Folke and his colleagues (2011, p. 720) stated in their research, ecosystems and people share an intertwined relationship expressed as ecosystem services generated by social-ecological systems. This statement provides guidance for investigating the impacts of fisheries collapse or other SERS by analyzing associated ecosystem services, as in this case, food production. Interview participants (Table 4.2) that were aware of a crisis in fish resources expressed that, in general, the food production ecosystem service was negatively affected.

According to one of the interviewees [072301], seafood will continue to be the primary food source in this region. However, additional information provided by another interviewee [082601] indicated that there was a possibility that local restaurants will have to depend on imports, and the local people will end up consuming seafood brought from other areas rather than those locally produced. Also, connected to food production, some fisher participants have expressed concerns that the changes to fish resources have impacted their livelihoods in terms of increasing investment risks and income fluctuations related to fishing. These insights demonstrate that fisheries collapse has altered the local people’s access to food/seafood. Hence, it has altered the interactions between humans and nature. Related to well-being, according to the Millennium Ecosystem Assessment (2005), fisheries collapse as a provisioning issue intervenes with the ability to have adequate and secure livelihoods, which is an essential component of well-being. While the report stated that any ecosystem changes could generate

impacts on all the elements of well-being (Millennium Ecosystem Assessment, 2005), fisheries collapse clearly impacts human welfare in other different sorts of ways. An example of this is the social inequality in obtaining livelihoods, identified in research in Tam Giang lagoon of Vietnam or Chilika lagoon of India (Nayak et al., 2016). It is not definitive at this stage this applies to Zhuhai, but it is possible.

Table 4.2 Feedbacks from participants regarding the impacts of fisheries collapse.

Feedback from participants regarding impacts of fisheries collapse		
Generalization / Themes	Participants sharing the similar insights	Quotes / Examples (Q=Interviewer's questions; A=Participants' answers)
A. Finding less fish resource available in the coastal waters than before.	082001	082601
	082201 082601 082801 090902	Q: Do you think resources available in the surround waters is much less than before? A: Fishery collapse: much less resources available; nothing to catch around the island; only scatter fishing activities with limited production nowadays.
		090902 Q: As an angler, do you feel there is an issue of fishery collapse, or say declining marine resources? A: As whom fishes regularly, I felt there was less and less fish available along Zhuhai's coast line due to overfishing and other issues.
B. Fishers now need to travel further away to capturing fish.	082801	082801
	090201 090602 090901 091201	Q: Do you know anything about environmental problems occurred around? A: During his past few years living in Yinkeng, he can feel the fishery collapse up close that there is less and less resources available at the nearby water. Some still are fishing here, but they usually need to travel quite a distance to other places.
		090901 Q: What do you know about fishery on this island? A: The activities are declining locally; Since 2011, fishery activities keep declining, and she thought it was majorly due to less resources available, which made fishermen chose to travel to further offshore waters.

4.2.2. What are the drivers?

In the Anthropocene, human actions are changing planetary processes that sometimes manifest as SERS (J. C. Rocha et al., 2015). This is case Zhuhai. Interview participants considered “urban expansion” and “consumption,” among others (Table 4.3) as the primary social drives of changes in the systems. Most often, human activities are dominant actors in a system by being a significant force in changing the ecosystem dynamics, yet, as well as relying on ecosystem services (Folke, 2006; Walker & Meyers, 2004). As participants’ insights suggest,

there are intensifying human actions that function as dominant contributors to the fisheries collapse in Zhuhai, including coastal marine eutrophication and other potential system changes. Beyond that, there can also be other natural factors contributing to the changes in Zhuhai, like as mentioned, climate change in the case of the Atlantic cod population collapse (Rose, 2004).Zhuhai.

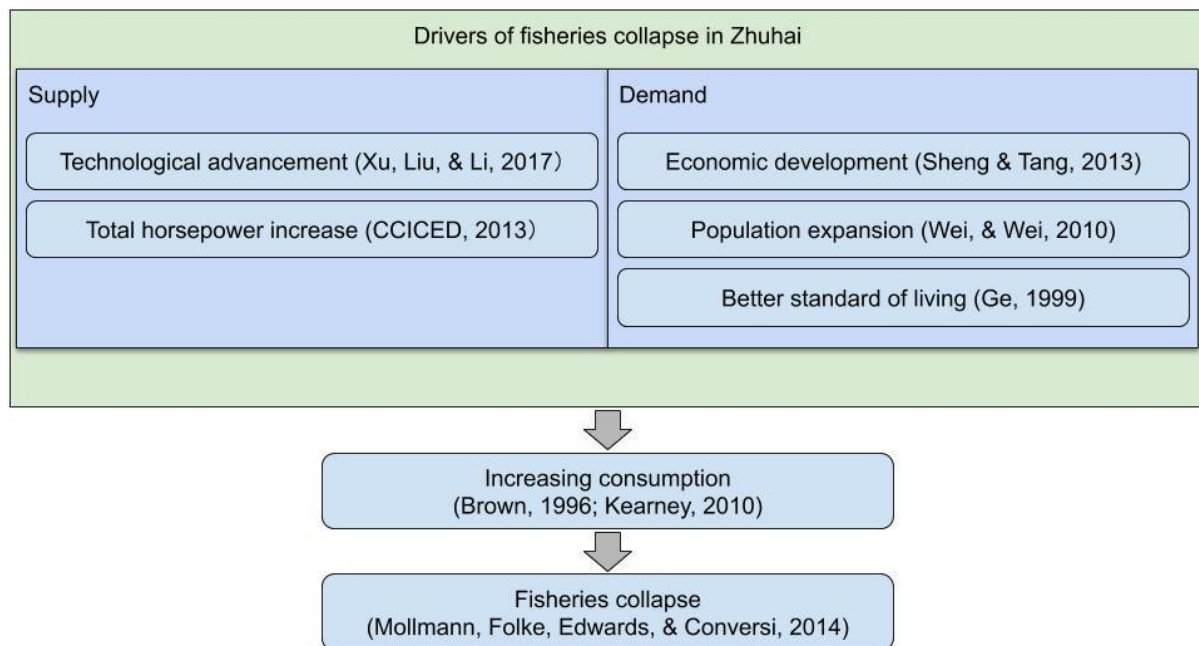
Table 4.3 Interviews coding – drivers that participants considered responsible for the fisheries collapse.

Participants #	Quotes (Q = Question; A = Answer)	Types of drivers mentioned
072301	<p>Q: What you think the key factors leading to the current environmental problems in this region?</p> <p>A: Key factors of the environmental changes: consumption and population growth.</p>	Consumption; population growth
082601	<p>Q: Do you think resources available in the surround waters is much less than before?</p> <p>A: Indeed much less resources available. Nothing to catch around the island; Only scatter fishing activities with limited production nowadays</p> <p>Q: What do you think cause that?</p> <p>A: Agreed that over-consumption is the major driver, at least locally.</p>	Consumption
090902	<p>Q: What do you know about the fishery activities in Zhuhai?</p> <p>A: I know something called “ground cage” often used by fishers: it is a type of net, regularly used by some fishermen in Zhuhai. The mesh on this tool is too small that makes it too efficient that it leaves nearly nothing escape; As angling a lot, I can feel the damage. And you can see such type of fishing tools all over Zhuhai's coast line during the low tide.</p> <p>Q: All things considered, do you think overfishing causes fishery collapse?</p> <p>A: Agreed that the major cause of fishery collapse is overfishing.</p>	Overfishing
081501	<p>Q: What can be the factors leading to the environmental problems mentioned?</p> <p>A: I considered the rapid urban development and population growth as the major driver of the environmental issues.</p>	Consumption; Urban expansion
081201	<p>Q: Do you think there are some factors delaying having an effective management of environmental problems in this region?</p> <p>A: During the conversation, the interviewee commented that “the management level changes so rapidly and I cannot even sure who is the mayor at the moment.” He believed policies, especially those regarding environment, changed too fast to make a difference.</p> <p>Q: What could be other major drivers in this region?</p> <p>A: Urban development/expansion; For example, the bridge connected the Qi'ao island to the mainland that is built in early 2000s.</p>	Short-term governance; Urban expansion
082801	<p>Q: I have heard this village is famous for the fishery, is it true?</p> <p>A: For Yinkeng, fishery is a traditional income; yet, it is fading out recent years. Since last year, I saw the amount of aquaculture activities (oyster cultivation) decreased dramatically along the nearby coast due to the government's management. Not 100% sure, but I considered real estate development (/urban development) along the coast during recent years could be one of the causes.</p>	Urban expansion

A closer look at the fisheries collapse in Zhuhai reveals that numerous factors allowed the occurrence of over-exploitation of marine resources, and this situation fundamentally has

led to the fisheries collapse. There is evidence suggesting overfishing, or over-exploitation, can result in the collapse of the fish community (Mollmann et al., 2014), for example, as mentioned, the collapse of Atlantic Cod (Rose, 2004). In this research, based on secondary data collected in the field (Figure 4.2), several significant events contributed to the fisheries collapse status that allowed the over-exploitation of marine resources in Zhuhai, and it is more than coincidental that these drivers have emerged into the famous supply-demand categorization. Even though environmental economics is not within the theoretical scope of this research, it happens to provide an insightful way to understand the situation. In general, the increasing consumption and the greater fishing capacity allowed the fisheries resources to enter an over-exploitation state resulted in SERS. From the demand side, the famous ‘reform and opening-up’ policy of the late 1970s made Zhuhai one of the first special economic zones in China, which eventually led to increasing local consumption. Several trends facilitated this increase, including population growth (Wei & Wei, 2010), rapid economic development (Sheng & Tang, 2013), and increased standards of living related to income and welfare (Ge, 1999), which, researchers found, share direct connections with increasing consumption (Brown, 1996; Kearney, 2010). As for the supply side, the substantial increase in horsepower of fishing vessels in China since the 1960s (CCICED, 2013), and other technological advancements in terms of fishing methods, tools, and vessel capacity in the 1990s promoted greater fishing capacity (Xu et al., 2017). This laid the foundation of over-exploitation as the supply chain capitalized to meet demand. Ideally, if there is no limit that nature can provide, there would be no issues; hence, no fisheries collapse. Unfortunately, that is hardly the case most of the time.

Figure 4.2 Summarization of drivers of fisheries collapse and associated sources.



4.3. Coastal marine eutrophication

Coastal marine eutrophication is another common type of SERS globally (J. Rocha et al., 2014), and which Zhuhai is also experiencing. Like the fisheries collapse, it is a common environmental issue. And in China, eutrophication started to receive attention in the 1970s due to an increased occurrence of HABs (Liu et al., 2013; K. Zhang, 2016). Previous research identified a positive relationship between HABs and eutrophication (Heisler et al., 2008; K. Zhang, 2016). The recorded persistent occurrence of HABS in Zhuhai over the past decade is indicative of eutrophication as a primary issue. Further, its impacts on original functions of ecosystem services, majorly food production, indicate eutrophication as a SERS that can deliver harmful impacts on social-ecological systems.

The linkages between HABs and eutrophication helped to define the issue in Zhuhai. When scholars considered there were apparent ties between HABs and eutrophication (Heisler et al., 2008; K. Zhang, 2016), HABs became regular events in Zhuhai's coastal waters and surrounding regions. Such a phenomenon fits with the characteristics of SERS (J. C. Rocha et al., 2015; Scheffer et al., 2001).

Eutrophication in Zhuhai reflects a common trend in China's coastal waters for quite

some time. The research conducted by Fei (2004) summarized that HABs in China's coastal waters had increased dramatically from an average of 50 times per year in the 1980s to 250 times per year in recent decades (Fei, 2004). Even though research does not explicitly list Zhuhai, it does state that Guangdong, the province in which Zhuhai locates, is one of the coastal regions in China experiencing eutrophication.

Concerning Zhuhai, other data sources indicated the same trend happening in this region. For example, available news reports suggest that HABs occurred in Zhuhai every year from 2009 until 2016 (Table 4.4). These reports proved HABs as some regular events in Zhuhai, at least. Further, in Zhuhai's 13th five-year official environmental plan (Zhuhai Environmental Protection Bureau, 2016), governmental officials have stated that HABs or "red tides" are an often-occurring natural hazard with no easy solutions to overcome. Similarly, Wei and Wei (2010, p. 8) documented similar trends when describing Zhuhai's local natural hazards. These sources among others confirm that eutrophication had become a familiar and routine problem across China, including Zhuhai, although these sources are not invoking 'SERS' to describe it (CCICED, 2013; Ren, Tang, Liu, & Shen, 2011; Wei & Wei, 2010).

Table 4.4 Some news reports regarding HABs in this region and surrounding

Media	Location(s)	Time period	Extra Information
羊城晚报 (Yangcheng Evening News)	Guangdong's coastal regions (including Zhuhai)	2009-2013	Accounted HABs, by the reporter 2009: 11 2010: 14 2011: 10 2012: 16 2013: 6
中国新闻 (Chinanews)	Zhuhai	August, 2011	Lasted 14 days; About 100 Sq. Km; Estimated costs 3.16 million CNY
羊城晚报 (Yangcheng Evening News)	Zhuhai	November, 2014	Along the Lovers (/Qinglv) Road – Trunk Road connects north and south of the city long the coast
珠海特区报 (Zhuhai Daily)	Zhuhai	2015	Government's bulletin – two HABs in this year; one was luminous red tide event
珠海特区报 (Zhuhai Daily)	Zhuhai	2016	Government's bulletin – two HABs – largest scale, 70 sq. km

4.3.1. What is uncertain?

“As a marine science undergraduate, I know marine eutrophication is an ongoing issue in this region, and I did personally have a look at the luminous algae outbreak [that] happened in 2015. However, I thought people generally have no idea what is happening; or say, have no idea what eutrophication is.” – participant # 083101 (marine science undergraduate student from the local campus of Sun Yat-Sen University)

This research's results illustrate gaps in the personal knowledge of residents about SERS, as

indicated by research participants. These gaps make the analysis more difficult than expected. In detail, the majority of participants in this research found it difficult to indicate what is happening accurately relating to SERS. Most often, participants indicated that there was a water quality issue in the region. However, a few participants involved provided extra details of the ‘water quality issue,’ and discussed marine eutrophication in Zhuhai (Table 4.5). They mentioned that they were aware of eutrophication in Zhuhai and have witnessed algae outbreaks in the coastal waters. However, the limited insights from other residents connecting water quality with eutrophication made it more challenging to determine the nature of the region’s coastal marine eutrophication from their perspective.

A possible explanation for limited environmental knowledge of research participants is that a lack of environmental knowledge is common in China. This prevents moving to a more environmentally friendly status - even though the Chinese are generally aware of the severity of environmental problems but not specific aspects of it (Harris, 2008; He, Hong, Liu, & Tiefenbacher, 2011). During data collection, a focus group [090701] covered this topic, and generally, all 12 participants agreed that there is a lack of public awareness and participation among residents regarding environmental matters. With potentially more environmental education in the future, the public’s understanding of the eutrophication or other issues may soon improve.

Table 4.5 Interviews coding - perceptions regarding the awareness of the eutrophication issue.

Participants #	Categorized based on the types of perceptions	
	A : Aware of the issue	B : Do not aware of the issue
081502_1	"I witnessed algae outbreak some time ago in the region and I considered that marine eutrophication is still an issue at the moment; However, I considered it as a less concerned matter as the marine eutrophication may not necessarily affect my life."	
083101_01	"Marine eutrophication: such issue is occurring in the region; In 2015, I witnessed a algae outbreak at the nearby beach during that time, and it was even a luminous one."	"I believed the general public have no idea what is happening; or say, have no idea what marine eutrophication is. And usually only those with professional knowledge will pay attention to."
091201		"The water quality is not suitable for aquaculture anymore, but we cannot tell what's going on exactly and have no knowledge regarding what is ocean eutrophication; what you ask is just too scientific for us."

4.3.2. What are the impacts?

Like fisheries collapse, coastal marine eutrophication in Zhuhai is a social-ecological problem. that influences local food production. However, some uncertainties remain. As discussed, there is limited knowledge among the locals regarding the prevalence of eutrophication. This situation leads to a limited amount of first-hand feedback available from those who might be affected. As from those having something to share, like the insight from interview participant #090902: aquaculture operations, which is an essential part of food production in the region, are under severe impacts from some water quality issues. And based on some publications (CCICED, 2013; Wei & Wei, 2010; Xu et al., 2017), coastal marine eutrophication holds quite some responsibility in this case, among others. In simple words, eutrophication, along with other sorts of environmental degradation, can impact aquaculture or fisheries operations. For example, when eutrophication allows HABs to happen, the damage can be severe (Tang, Kester, Ni, Qi, & Kawamura, 2003). In this way, from an ecosystem service perspective, coastal marine

eutrophication is an obstacle to ensure food production in local systems. Beyond that, it is possible that marine eutrophication can also affect ecosystem services like water purification and recreational services, but the available data does not necessarily support these connections. The literature includes a potential explanation for this as “information about regime shifts in China’s coastal ecosystems is rare (K. Zhang, 2016, p. 90).”

“I believed one of the major issues happening is the water problem. For example, the alongshore water is no longer suitable for aquaculture. Waters away from the urban area is okay, like here around Guishan Island, but things are getting worse recently.” - participant # 090902 (A fishing enthusiast interviewed at Guishan Island.)

On the other hand, there is an intertwined relationship between eutrophication and aquaculture. Literature indicates that aquaculture could be the key contributor to eutrophication in some areas of this world (Smith, Tilman, & Nekola, 1999; Tovar, Moreno, Manuel-Vez, & García-Vargas, 2000). Some considered the same applied to China’s situation (Cao et al., 2007; Jin, Lu, Hu, Jiang, & Wu, 2008; Tang et al., 2003). In this way, besides being a “victim,” aquaculture operations in Zhuhai can also be the “suspect” that causes marine eutrophication. Such a relationship requires investigation in future studies.

4.3.3. What are the drivers?

Increasing human actions is also a major contributor to marine eutrophication. According to the literature, increasing nutrient inputs is a dominant driver of marine eutrophication (J. C. Rocha et al., 2015), and the rapidly expanding human activities in Zhuhai are continually contributing to the nutrient-rich status of its coastal waters. Four factors are contributing to increasing nutrient inputs (Table 4.6). First, population growth is a critical contributor, adding nutrients to the coastal waters globally (Fei, 2004; Heisler et al., 2008; Smith et al., 1999), and Zhuhai’s population expanded about four times over the past thirty years (Sheng & Tang, 2013). Second, the urban/build-up land in Zhuhai increased about 11 times from 1989 to 1997 (Weng,

2001). This was directly associated with population growth and guaranteed more nutrients inputs from domestic sewage. Third, there was an increase in nutrients inputs from industrial waste with a rapidly increasing number of industrial enterprises in the region. Even though it is hard to estimate the exact number of corporations established after the ‘reform and opening-up’ of China in Zhuhai, Sheng and Tang (2013) estimated over 3,000 enterprises were established by the early 1990s. This is likely just a glimpse of the economic growth that happened, but it at least proved there was some rapid economic or industrial development locally during a specific period. Fourth, expanding agricultural activity locally is likely to lead to more nutrients inputs and coastal marine eutrophication (Appendix B; Wei & Wei, 2010; Xu et al., 2017). This reflects broader trends in the world (Fei, 2004; Smith et al., 1999), and in southern and eastern Asia (Rabalais, Turner, Diaz, & Justic, 2009).

These four factors do not rule out other influences not included in this analysis. For example, the geographical location of Zhuhai may be an essential factor (Figure 3.1). As Zhuhai is located in the Pearl River estuary – a place that is constantly receiving the upstream discharge - there are sources of nutrients input that extend beyond Zhuhai’s borders. According to previous research, this geographical feature makes it more difficult for solving the eutrophication issues in this region (Huang, Huang, & Yue, 2003, p. 31).

Table 4.6 Summary of drivers of marine eutrophication and associated sources

Population growth	With 30 years experimental experience, the total population of Zhuhai has increased from 0.36 million in 1979 to 1.56 million in 2010 (Sheng & Tang, 2013, p. 72).
Agriculture	Total aggregated agriculture output increased from ¥363 million to ¥5,162 million in Zhuhai based on the current value (Wei & Wei, 2010). In Guangdong, mariculture land use increased from 93,790 hectares to 201,834 from 1992 to 2012 (Xu et al., 2017).
Economic/Industrial	There is a fast growing GDP in Zhuhai especially since 1984 and over 3,000 cooperative enterprises established by the early 1990s (Sheng & Tang, 2013).
Urban expansion	Based on the comparison between satellite images taken between 1989 and 1997, the urban/build-up land increased about 1,100% in Zhuhai (Weng, 2001).

4.4. Other considerations

Climate change and other factors likely contributed to SERS in this region. These changes may

become more severe in the future. Research points to climate change as a common factor of SERS (Folke et al., 2004; J. C. Rocha et al., 2015; K. Zhang, 2016). And during data collection, participants expressed their concerns regarding the impacts of climate change on the local systems. However, it is difficult to define what role climate change plays locally based on the information collected for this research.

Furthermore, more issues would likely arrive with the newly-built Hong Kong-Zhuhai-Macao Bridge that connects three large economic entities. As researchers predicted (Sheng & Tang, 2013; Yang, 2006), there will be a boost to economic development in Zhuhai with the openness of a new channel of capital investment. Considering that economic development is a crucial contributor to the system changes in the region, as discussed - under the consideration of this study, projects like this will not necessarily contribute to local sustainability. It could be better if constant and accountable environmental monitoring is available in this region for the prevention of potential issues.

Figure 4.3 Hong Kong-Zhuhai-Macao Bridge; taken directly beneath it in a boat.



In conclusion, it is expected that the increasing amount of human activities will bring more changes to the ecosystem, which sometimes can be undesirable. With the combined data from all sources, this research identified fisheries collapse and coastal marine eutrophication as dominant SERS in Zhuhai. Then, this research documented the dominant impacts of SERS on local systems in relation to their ecosystem services, mostly food production, and the results point to some local drivers of these changes. There seems to be a link between Zhuhai's rapid development and its environmental issues that occurred in the region. Moreover, with the construction of the Hong Kong-Zhuhai-Macao Bridge, there will likely be more development in this region, which may intensify the contribution of economic and industrial development to SERS.

Chapter 5. Governing social-ecological regime shifts in Zhuhai

5.1. Introduction

SERS are occurring at increasing rates and scales in coastal and marine ecosystems worldwide (Mollmann et al., 2014; K. Zhang, 2016). Governance plays an essential role in addressing such issues. Yet, what is governance? Some scholars (Folke et al., 2005; Lebel et al., 2006) see it as the structure and process people sharing power, making decisions, and structuring collective actions. Though, there is a growing consensus that governance plays an essential role in achieving desired environmental actions and outcomes (Ölund Wingqvist et al., 2012). For this research, it is useful to interpret governance as a form of ‘environmental governance, which some define as “the set of regulatory processes, mechanisms, and organizations through which political actors influence environmental actions and outcomes (Lemos & Agrawal, 2006, p. 298).”

Further, as this research more precisely focuses on SERS here, governance majorly means building capacity to adapting to changes and reducing uncertainties (Crépin et al., 2012) when regime shifts can pose severe impacts on ecosystem services and human wellbeing in a diverse way (J. C. Rocha et al., 2015). Zhuhai is experiencing SERS like many other places, and there is limited information in China regarding the matter (K. Zhang, 2016), including how past and present governance in Zhuhai has influenced SERS, and how future can be altered to more effectively address SERS.

Why did the problems occur? What is happening currently? What must be done to create a more sustainable future? These questions help the researcher define “the past, present, and future” in this paper. In detail, it is about analyzing what kind of roles the governance was, is, or should be playing in Zhuhai. In this way, it will allow people to understand what actions are appropriate and what not. Possessing such knowledge can deliver strategies that would enable the local systems to move into a sustainable state more smoothly in the future. Building adaptive governance can, in theory, deal with SERS efficiently by creating a governance framework that will keep building resilience into the future (Folke et al., 2004; Walker, Holling, Carpenter, & Kinzig, 2004). As the world is ever-evolving, so should society have a governance

system that is capable of self-learning and can keep up.

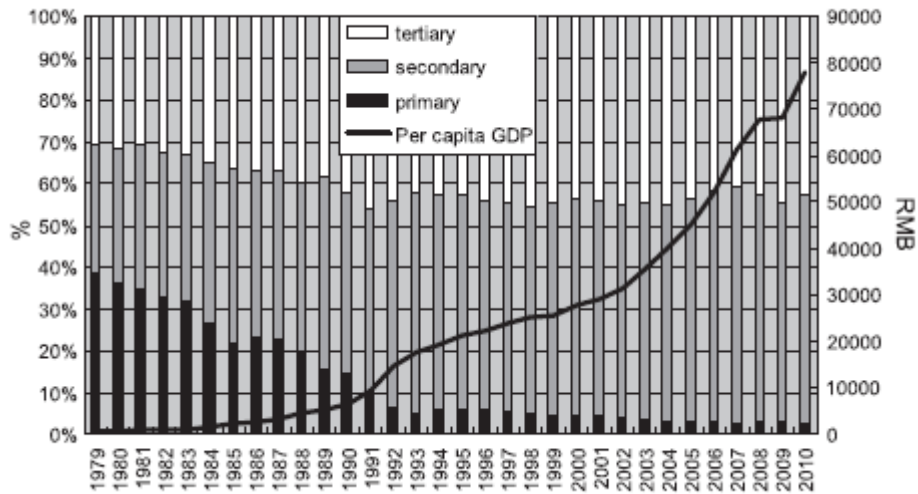
The following sections in this chapter provide a chronological analysis. It started by analyzing events that happened in the past that formed up the current status. Then, it assessed the effectiveness of ongoing governance approaches. And in the end, it provided some future considerations.

5.2. The past

“Study the past if you would define the future.” – Confucius

An analysis of past events can indicate how governance enabled or constrained SERS in Zhuhai to develop lessons for the future. In Zhuhai, China’s ‘reform and opening-up’ policy, starting in the 1970s, played a crucial role in shaping the governance of this place. ‘Reform and opening-up’ or otherwise known as economic-reform governance, was the one laying laid the foundation of the economic growth in Zhuhai but may also have led to issues like fisheries collapse and marine eutrophication. Hence, there are complicated outcomes of this policy and associated governance. Some benefits occurred, like providing people with a better standard of living (Ge, 1999), but these came with adverse environmental changes (Harris, 2008).

Figure 5.1 Composition of GDP and per capita GDP in Zhuhai (1979-2010). Source: (Sheng & Tang, 2013, p. 73)



What does ‘reform and opening-up’ mean to Zhuhai? In general, such a policy is about promoting economic reforms by changing the ways authorities managing the financial practices. One may refer to ‘reform and opening-up’ as one of the essential policies ever published in China; no matter if the outcomes ended up as good or bad, it directly made China into its current economic status. Before the ‘reform and opening-up’ policy, Zhuhai was an ordinary coastal town like many others in China. In 1980, after the central government officially announced Zhuhai as one of the first SEZs (Sheng & Tang, 2013), Zhuhai started to develop a strong interlaced relationship with China’s style of economic-reform governance. Meanwhile, the ‘reform and opening-up’ also contributed to the fiscal decentralization by giving some autonomy to the local government to allocate spending on different projects accordingly by their agendas (T. Zhang & Zou, 1998), which made ‘reform and opening-up’ took various forms in different regions. This further explains the importance of conducting this research in Zhuhai. Just as like Daily and Matson (2008) indicated, the environmental problems and associated solutions are commonly context-specified, the policy design and implementation of ecosystem conservation will vary by the context.

Economic-reform governance boosted the local economy. This governance style

generates many benefits to Zhuhai or other SEZs of China. For example, the GDP of Zhuhai increased about 600 times from RMB 0.2 billion to RMB 120 billion from 1978 to 2010 (Sheng & Tang, 2013). Zhuhai’s population also expanded from 0.36 million to 1.56 million during this time (Sheng & Tang, 2013). Based on the comparison between satellite images taken between 1989 and 1997, the urban/build-up land also increased about 11 times (Weng, 2001). Based on this information, it seems the governance style that prioritizes economic development brought economic success to Zhuhai.

Table 5.1 Social/human factors survey participants that considered causing SERS.

Source: survey

Survey question - 3.2 What are the main social / human factors influencing these changes?		
Terms used	Times mentioned	Relevant to economy (Y/N)
Over-exploitation	13 (62%)	Y
Urban development	9 (43%)	Y
Population growth	8 (38%)	Y
Demand increase	6 (29%)	Y
Industrial development	6 (29%)	Y
Economic transformation	4 (19%)	Y
Education	2 (10%)	N
N=21		

Despite rapid economic growth, the economic-reform governance style of China did not necessarily advance sustainable development. A survey conducted during the fieldwork indicates that participants commonly considered economic-relevant factors to be the primary social/human factors leading to SERS (Table 5.1). Such finding is not new; other sources also share a similar concern. For example, an international advisory council (CCICED, 2013) indicated that one of the causes of China's ineffective environmental governance is the economy-driven norm embedded inside the authorities that prioritize economic development over all other considerations. Related to that, other scholars pointed out that rapid economic growth is a crucial factor contributing to the adverse environmental changes across China (Economy, 2007; Harris, 2008). Hence, the economic-reform governance style, and its major ‘reform and opening-up’ policy reveals a classic challenge in sustainability between advancing

sustainable development and economic benefits in China simultaneously (Economy, 2007). There are some governance interventions leading to positive environmental change, but the question remains as to whether such interventions are sufficient to address SERS.

5.2.1. Tourism development and pollution control in Zhuhai

Economic reform created some level of financial autonomy regarding allocating the local government spending onto different projects; in the case of Zhuhai, there was considerable investment in tourism development since the late 1970s, and this had benefited sustainable development directly or indirectly. There are geographical advantages of investing in the tourism industry since the establishment of the SEZ, and the local governance capitalized on such advantages (Bao & Zhu, 1999; Sheng & Tang, 2013). Under these conditions, however, the government favored development strategies that were more environmentally friendly and generated fewer adverse environmental changes that negatively impacted the tourism industry. However, this was probably more about maintaining the economic benefits of tourism rather than reducing environmental harm for its own sake. In the late 1990s, the tourism industry accounted for about 11% of Zhuhai's total GDP, and this trend has continued in recent years (Bao & Zhu, 1999). According to the Zhuhai Statistics Bureau (2018), Zhuhai hosted about 5 million foreign tourists and 35 million domestic tourists in 2017. It appears that the numbers are anticipated to grow, all pointing to successful tourism development. Between 1984 and 1992, the government prioritized industrial development over sustainable development, as the government feared that being environmentally friendly suppressed economic growth (Sheng & Tang, 2013). Even though Zhuhai has returned to the initial agenda of being environmentally friendly in the development of the tourism industry, it is difficult to tell if this trend will continue in the future. After all, the governance style in China is majorly economy-driven.

Figure 5.2 Zhuhai Opera House



The governance style that prioritized industrial development was canceled in 1992 (Sheng & Tang, 2013). Then, Zhuhai refocused on sustainable development, majorly related to pollution control, specifically by dealing with water pollution related to sewage and wastewater. These forms of pollution are some of the major contributors to eutrophication in ecosystems and potentially other SERS, including fisheries collapse (J. Rocha et al., 2014; Smith et al., 1999). The Zhuhai government adopted several approaches over time, and one of the most significant may be the enhancement of water treatment capacity. In the 1990s, Zhuhai started a large project that included the installation of additional water treatment plants and the construction of sewage systems across the region (Zhuhai Environmental Protection Bureau, 1998). This project is continually delivering better treatment on a bigger scale (Zhuhai Environmental Protection Bureau, 2016). It is anticipated to continue to improve operations until it reached near-total coverage in 2020. Its ongoing status may explain the mixed reflection on the water treatment capacity from the research participants (Table 5.2). Previous studies considered efforts on pollution control to be insufficient in China (Hu & Cheng, 2013), and this can also apply to Zhuhai. Given Zhuhai will continue to grow in the aspects of population, industry, and other social factors (Bao & Zhu, 1999; Sheng & Tang, 2013), there may be more

drivers contributing to SERS related to eutrophication. While better treatment capacity will help deal with eutrophication, the real question is whether this level of effort is sufficient to govern those rapid and abrupt changes in the future.

Table 5.2 Perceptions regarding the government-led water treatment project. Source: semi-structured interviews.

Participants	Quotes	Generalization
081502_1	Agreed that the government-led water treatment projects made a difference to the city’s environmental issues; However, he mentioned that there are still some remaining pipelines directly discharge sewage into the ocean, which the government was not able to deal with yet.	Appreciating current efforts on improving water treatment in Zhuhai; However, it still needs further amelioration.
090902	Even though it can be a little bit delayed, he endorsed the current efforts the government made on improving the water treatment capacity, and the water pollution issues are much better than before. However, some pollution originated from the upstream, which the authorities yet need to deal with.	

5.3. The present

The governance style started to change in China as sustainable development became popular. After 2010s, China began to adopt sustainability as one of its governance goals more rapidly, which benefits the treatment of SERS in Zhuhai. The central government’s Five-Year Plan provides instruction to different levels of authorities in order to ensure alignment of governance goals throughout multiple bureaucratic levels. According to the U.S.-China Economic and Security Review Commission, Five-Year plans are about “key indicators of the direction and changes in development philosophy” of China’s leadership (Casey & Koleski, 2011, p. 1).

Anyhow, the Five-Year plans are clear indicators of the current governance style. And according to China’s 12th and 13th Five-Year plans, governance started advance more environmentally friendly outcomes. For example. during the 12th Five-Year plan (2011 to 2015), it included environmental protection and energy efficiency (Casey & Koleski, 2011; Lewis, 2011). In detail, there were specific agendas for achieving a “resource-conserving environmentally friendly society (Casey & Koleski, 2011, p. 11).” Lewis (2011) referred it as

China's response to it as China's actions taken to meet the declaration made during the Copenhagen climate negotiations in 2009 about having a massive reduction in the total carbon intensity. . Anyway, at that time, China was starting to make big moves towards sustainability. As for Zhuhai, the local government took necessary steps to promote environmental protection during this period by focusing on addressing pollution sources across the region, according to the official report announced (Zhuhai Environmental Protection Bureau, 2012). The newer China's 13th Five-Year Plan (2016 to 2020) advanced environmentally friendly even further.

“Local state environmental bureaus have until recently been understaffed and functioning under the jurisdiction of local governments. They will now be better staffed and strengthened in terms of rank in order to withstand pressure from local officials who focus their attention solely on economic development. Perhaps even more importantly, government officials will in the future be held responsible for pollution beyond their terms of office (Brødsgaard, 2016, p. 99).”

Since the 13th Five-Year Plan, China's political norms toward sustainability are changing. These changes can contribute to sustainable development in Zhuhai, including the treatment of SERS. First, there seems to be greater decentralization in China, which takes the form of allowing the regional governments to develop specific policies based on local needs. Such policies cover different aspects of society, including “public services, transportation, innovation promotion, law enforcement operations, and environmental protection (Koleski, 2017, p. 15).” Regarding environmental protection, the 13th Five-Year Plan makes it clear that the local governments will receive more power, as well as responsibility, to govern (Brødsgaard, 2016). In Chapter 44 of the government report of the 13th Five-Year Plan it officially stated such process as “step up comprehensive environmental governance (Central Committee of the Communist Party of China, 2016).”

Table 5.3 Some environmental targets of the 13th Five-Year Plan in Zhuhai. Source: (Zhuhai Environmental Protection Bureau, 2016)

Targets	Detail
Water treatment capacity improvement	Till 2020, reaching total coverage of sewage system across Zhuhai; Reaching city sewage capacity at 1 million cubic meters/day.
Better air quality	Concentrating factories in industrial areas with better heating and power supply systems that generate less pollution.
Controlling soil pollution sources	Enhanced registry and monitoring of pollution sources; Till 2020, ensuring a 20% decrease of heavy metal pollution in some key areas.
Environmental information system innovation	Collecting and storing environmental information from all related institutions; providing network-based government services.
Green economy	Emissions trading; associating companies' bank credit with their environmental performance.

Zhuhai took new actions to advance sustainability, but some problems remain. For example, Zhuhai initiated an agenda for starting an information system that tracked environmental sustainability (Zhuhai Environmental Protection Bureau, 2016). This system aims to have an improved environmental governance system providing better monitoring and decision-making with advanced information technology, which can allow a better chance of anticipating the impacts of pollution. On the other hand, Zhang (2016) mentioned that it requires improved information sharing and transparency for managing regime shifts effectively. So, when information systems are capable of delivering positive outcomes by affecting beliefs and actions concerning sustainability (Melville, 2010), what is happening in Zhuhai can turn to be beneficial. Meanwhile, Zhuhai's government planned to conduct environmental public education to raise the awareness of its citizens about environmental problems (Zhuhai Environmental Protection Bureau, 2016). Unfortunately, primary data did not indicate active public engagement. For example, one of the interviewees (# 083101) commented that there is a lack of knowledge or understanding of environmental matters among the public. Furthermore, none of the participants mentioned Zhuhai's information system innovation, illustrating a problem of low public participation or awareness of environmental matters and efforts taken to address them. This can make it challenging to deliver the desired outcomes. Such a situation is

not beneficial for further development of the system, as the government cannot improve the system single-handedly; it requires input and assistance from other actors.

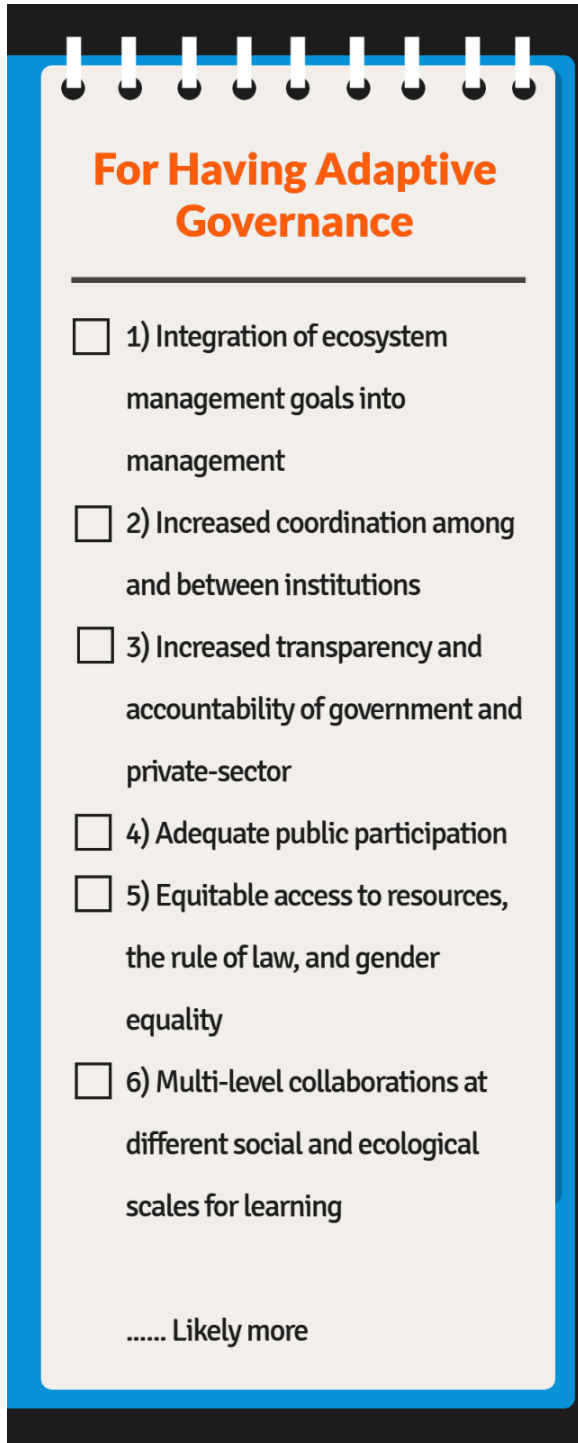
5.4. The future

To support long-term sustainable development, governance requires a framework that fully acknowledges the complexity of the system, as well as the need to building adaptive capacity to counter uncertainty and surprise (Crépin et al., 2012; Folke et al., 2005; Lebel et al., 2006), which the scholars referred to as – adaptive governance and its normative goal of building resilience. Resilience means the capacity of a system to absorb disturbance and reorganize to retain the same functionality while undergoing changes (Walker et al., 2004). Eroding resilience is responsible for an increasing rate of regime shifts in this world (Folke et al., 2004). Under such conditions, adaptive governance can play an essential role in addressing SERS through efforts that build resilience (Walker et al., 2004),.

Adaptive governance is a process of building resilience by creating adaptability and transformability in a system (Walker et al., 2004). In other words, the purpose in the context of SERS and other changes is to sustain desired ecosystems states and transform those degraded into fundamentally new or more desirable configurations (Folke et al., 2004). Such a process involves creating adaptability and transformability in a system. By adaptability, I mean managing resilience from crossing into an undesirable system regime. By transformability, it means building capacity for transforming the undesirable state of a system (Walker et al., 2004). It is the case in China - adaptive governance is needed. One researcher concluded, “increasing regime shifts in key components of China’s coastal ecosystems are symptomatic of the continuous decline of system resilience (K. Zhang, 2016, p. 95).” In this way, it can be necessary for a coastal city such as Zhuhai to have its interventions reflect an adaptive governance approach. There are already signs of some factors contributing to eroding resilience based on the information found (Figure 5.3; Chapter 4). For example, as previous research indicated (CCICED, 2013), the economy-driven norm could be an obstacle to effective environmental governance in China. Correspondingly, in the case of Zhuhai, local governance once favored industrial development due to economic considerations from 1984 to 1992, which

capacity of a system to allow its ability to maintain and recreate and to transform into a desirable state if necessary.

Figure 5.4 Prerequisites for having adaptive governance. Source: created by the author based on literature



5.4.1. The case in Zhuhai

My results suggest that Zhuhai is moving towards adaptive governance but requires greater changes to manifest this form of governance on the broader scale. Based on available information, the governance in Zhuhai meets some of the prerequisites of having adaptive governance. For example, there is an agenda of integrating sustainability into the political system (Sheng & Tang, 2013). And, this goal is becoming a national development agenda in recent years, according to China's newest Five-Year Plan (Brødsgaard, 2016). Given the influence of those plans on local planning agendas, it follows that there will likely be an integration of ecosystem management goals locally.

There is a progress of allocating more power to the regional government in terms of environmental management and others with the continuing fiscal decentralization of China from the 1970s (Koleski, 2017; T. Zhang & Zou, 1998). Even though decentralization does not equal to adaptive governance, such progress can contribute to multi-level/multi-party collaborations by improving capacity to have regionally specific decision-making. Furthermore, when there is an environmental information system innovation happening there (Zhuhai Environmental Protection Bureau, 2016), collaborations among different parties can technically become more accessible as information technology can ease the process (Dao, Langella, & Carbo, 2011). Such innovations can likely contribute to improving transparency and accountability of the authorities and the private sectors involved. Furthermore, it allows the public to access information such as public records of corporations' violations of environmental regulation (Figure 5.5). However, public participation in this system is less than adequate in Zhuhai, and this can degrade the performance of the information system innovation and, therefore, its contributions to adaptive governance.

“There are limited supports from the government to help us figuring out the next we need to take.” – A couple of fishers [091201]

Moreover, the political environment is still economy-driven in most of China. While Zhuhai is more environmentally friendly in terms of tourism development than other cities (Sheng & Tang, 2013). It is unclear whether Zhuhai will continue to dedicate a large portion of

its efforts to sustainability without considering other factors like the economy. This uncertainty makes it more challenging to ensure equitable access for all parties involved in all kinds of sustainability matters. For example, research participants who identified as fishers believed that the current governance neglected the fishery industry in favor of tourism development. This indicates an inadequate or inequitable consideration of the benefits or losses of advancing sustainability.

Figure 5.5 Quarterly government reports of the list of companies that refuse to enforce environmental administrative penalties [In Chinese]. Source

URL: <http://www.zhepb.gov.cn/xxgkml/ywgz/hjjc/wrqymd/>

The screenshot shows the website of the Zhuhai Municipal Environmental Protection Administration (珠海市生态环境局). The page is titled "创建全国生态文明示范市" (Creating a National Demonstration City for Ecological Civilization). The main content area displays a list of companies that refused to enforce environmental administrative penalties, categorized by quarter and year. The list includes the following entries:

Quarter/Year	Company Name	Date
2019年第一季	拒不执行已生效的环境行政处罚决定的企业	2019-04-18
2018年第四季	拒不执行已生效的环境行政处罚决定的企业	2019-01-18
2018年第三季	拒不执行已生效的环境行政处罚决定的企业	2018-10-15
珠海市环境保护局行政处罚应缴未收款明细表(2012-2017年)		2018-10-29
2018年第二季	拒不执行已生效的环境行政处罚决定的企业	2018-07-20
2018年第一季	拒不执行已生效的环境行政处罚决定的企业	2018-04-26
2017年第四季	拒不执行已生效的环境行政处罚决定的企业	2018-01-24
2017年第三季	拒不执行已生效的环境行政处罚决定的企业	2017-10-11
2017年第二季	拒不执行已生效的环境行政处罚决定的企业	2017-07-14
2017年第一季	拒不执行已生效的环境行政处罚决定的企业	2017-04-07
2016年第四季	拒不执行已生效的环境行政处罚决定的企业	2017-01-11
2016年第三季	拒不执行已生效的环境行政处罚决定的企业	2016-10-14
2016年第二季	拒不执行已生效的环境行政处罚决定的企业	2016-07-08
2016年第一季	拒不执行已生效的环境行政处罚决定的企业	2016-04-08
2015年第四季	拒不执行已生效的环境行政处罚决定的企业	2016-01-15

The page also features a sidebar with navigation options such as "信息公开目录" (Information Disclosure Directory), "环保重点领域信息公开" (Information Disclosure in Key Environmental Fields), and "污染源环境监管信息公开" (Information Disclosure on Environmental Supervision of Pollution Sources). The footer contains contact information for the Zhuhai Municipal Environmental Protection Administration, including the address, phone number (0756-2538371), and fax number (0756-2218740).

To improve this situation, more efforts or innovative approaches are needed to promote public participation and awareness regarding environmental matters. In an ideal situation, this will make stakeholders of SERS or other issues more willing to take part in the solution-making. Governmental authorities will need to come up with a better approach to manifest multi-party collaborations. The information system innovation can be an opportunity on which to capitalize since it can be a gateway to new dialogue among different parties. However, the system will require further investment. Such investment can, of course, be economical by addressing the fact that “information about regime shifts in China’s coastal ecosystems is rare (K. Zhang, 2016, p. 90).” Thus, for a theory that is still in development (Chaffin et al., 2014), there is a lot to learn about adaptive governance or others surrounding the environmental governance concept. For example, it can be essential to figure out what it means to the governance of SERS in Zhuhai or other regions in the future when the newly constructed Hong Kong-Zhuhai-Macau bridge brings opportunities, challenges, or uncertainties to the Pearl River Delta.

Further, it is essential to think beyond the current thresholds. New types of issues will likely emerge in the systems in the future with totally different characteristics. Hence, the adaptive governance framework may require constant updates on the knowledge base to function properly. This may also apply to the understandings of adaptive governance itself.

Chapter 6. Conclusion

This chapter summarizes the findings of this research and provides an: (1) overview of the study; (2) summary of results; and (3) recommendations for future studies.

6.1. Overview

Humanity is now fully capable of altering ecosystem functions and services, and scholars commonly see human actions as a significant contributor to rapid changes in the ecosystems – also known as regime shifts. However, changes related to regime shifts may appear both in nature and also in how society functions. Hence, this research analyzes the social-ecological regime shifts or SERS and their governance in Zhuhai. While there is limited knowledge in this field in China (K. Zhang, 2016), to have a SERS view can help develop new knowledge to respond to rapid changes in coastal systems (Nayak & Armitage, 2018).

The overarching purpose of this research was to analyze SERS and their governance in Zhuhai. At the same time, identifying the nature of SERS happening in this region is another thing this research trying to do. This study finds that fisheries collapse and marine eutrophication are the primary SERS in this case. By adopting ecosystem services theory, the results find that SERS in Zhuhai primarily endanger provisioning services or say food production. Moreover, another finding is that the rapid development in Zhuhai plays as the primary contributor to the situation.

Results from this research indicate that China's economic-reform governance over the past few decades is responsible for the mentioned adverse environmental consequences in this study. Of course, such a governance style has resulted in enormous benefits to the region – for example, the population in Zhuhai endured a fourfold expansion. from 1978 to 2010 (Sheng & Tang, 2013). Yet, the primary consideration of this research primarily resides with SERS, as well as related governance approaches. To improve the governance of SERS, this study recommended an adaptive governance framework that enables systems to be more resilient to the regime shifts by doing so (Crépin et al., 2012; Folke et al., 2005; Lebel et al., 2006).

This study adopted a mixed-methods approach. It involves quantitative and qualitative

research methods following two phases. I studied the research context and necessary information based on some secondary data gathered, and the semi-structured interviews and focus group discussions helped to expand the knowledge base and deliver the results in the end. Survey data collected for the group research also contributed to the process.

6.2. Summary of findings

There are three primary research objectives (Chapter 2) in this study, and the research's findings address each objective in turn. By answering the first objective, This research identified the nature of SERS happening in Zhuhai. It identified that fisheries collapse and coastal marine eutrophication are two major SERS in Zhuhai. Along with that, essential drivers allowing SERS to occur have also been identified. In detail, as for fisheries collapse, over-exploitation of marine resources from technological advancement played a significant role (Figure 4.2). As for coastal marine eutrophication, the available data suggested that the rapid expansion of population, agriculture, industries, and urban area are the major drivers of change (Table 4.6).

This study further examines governance approaches associated with SERS by answering the second and third research objective. This research indicated that adverse environmental consequences are associated with China's economy-reform governance. To be more precise, this study answers three essential questions: 1) why did the problems occur? 2) what is happening currently? 3) what does it require for a more sustainable future?

As an answer to the first question, economic reform offers a robust economic expansion with many benefits, such as a better standard of living. However, this governance style is a 'double-edged sword' as such economic development brings adverse environmental consequences by altering original interactions between nature and human society.

As an answer to the second question, there are signs that Zhuhai is moving towards sustainability. From a broader perspective, China is starting to make big moves towards sustainability, and governance is orienting toward more environmentally friendly outcomes. For example, China's 13th Five-Year Plan (2016 to 2020) makes it clear that local environmental departments will receive more power, as well as responsibility, in environmental matters. At the same time, Zhuhai has taken actions, like initiating an information system

information, that suggests it will capitalize on this new power and responsible for greater sustainability.

As an answer to the final question, this study finds out that there need to be more considerable efforts to deal with SERS in Zhuhai, for example, through fully realizing a functional adaptive governance framework. For doing that, the literature provides guidance (Figure 5.4). Based on the information delivered from previous sections, this study proposes the following: raising public participation and awareness, transforming the economy-driven governance norm, and promoting more equitable access to decision-making.

6.3. Recommendations for future studies.

Zhuhai is one of many coastal cities in China, and there are other regions struggling with SERS. Future studies covering similar topics in those regions will be able to contribute to a complete picture of the SERS and their governance in China. Moreover, there can be other empirical gaps to fill in Zhuhai. For example, the geographical boundary of this study limited the discovery of outside factors contributing to the matter. Other research could be conducted with a broader spatial scale. Rapid economic development, a considerable driving factor of SERS in this study, does not solely occur in China; India, Thailand, or others are experiencing similar trends that need a critical examination to full address SERS through governance.

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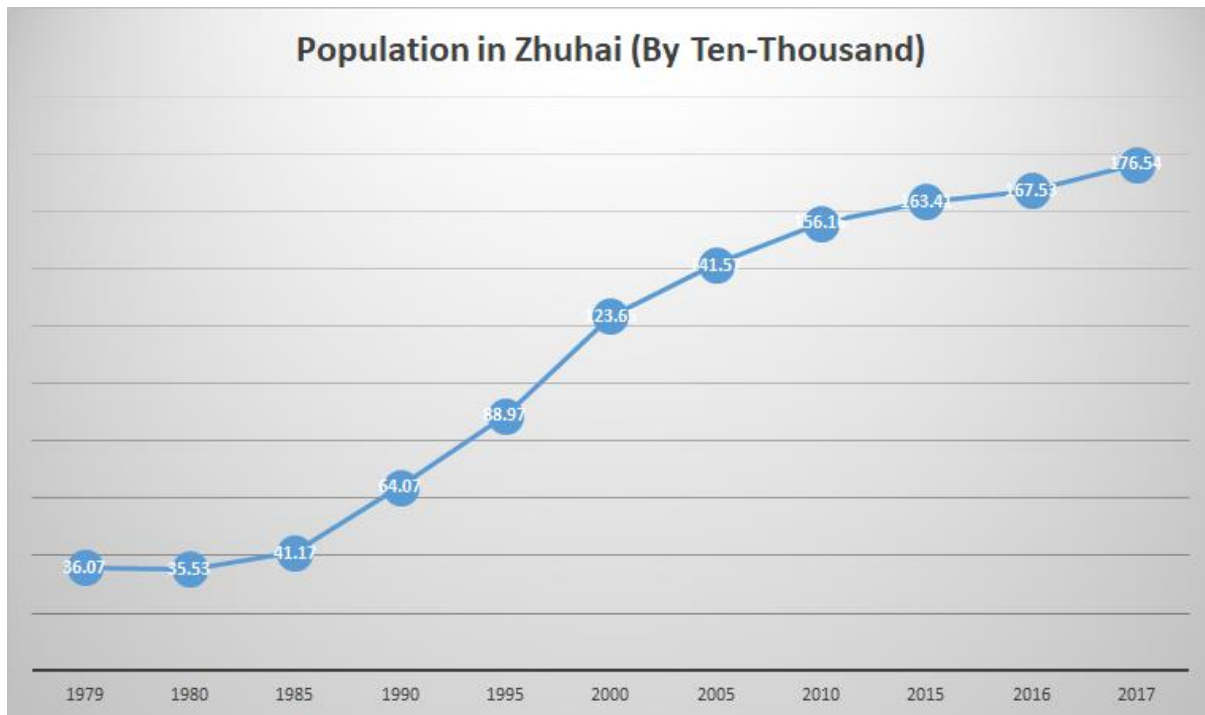
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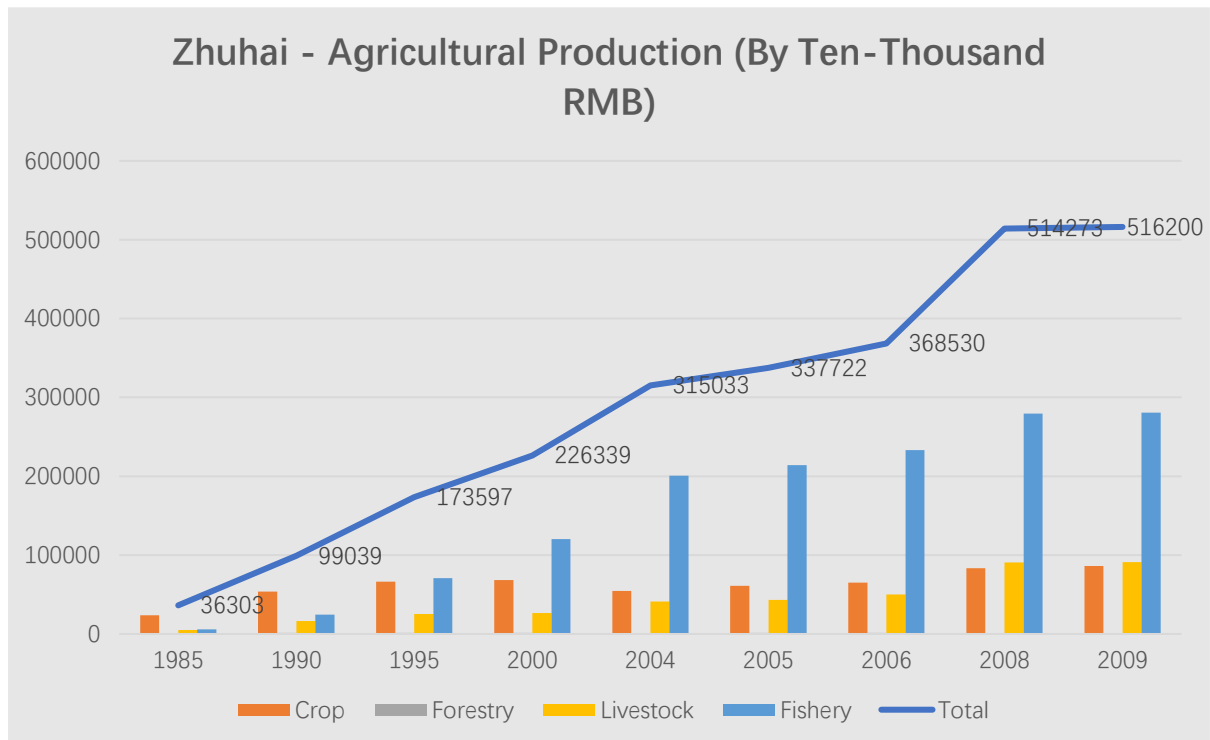
Appendix A – Population in Zhuhai (By Ten-Thousand)

Original data: (Wei & Wei, 2010, p. 33)

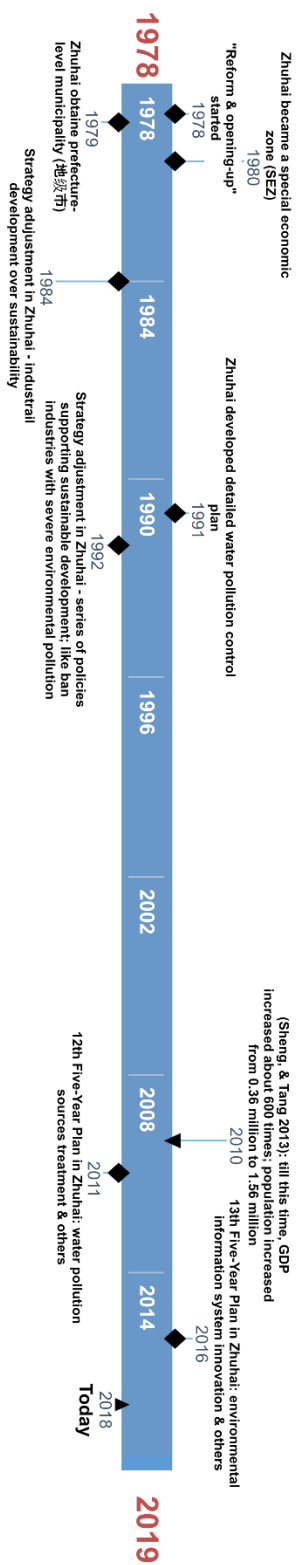


Appendix B – Zhuhai – Agricultural Production (By Ten-Thousand RMB)

Original data: (Wei & Wei, 2010, p. 51)



Appendix C – Timeline of Some Governance Changes



Appendix D – Semi-Structured Interview Guide Questions

Start

- Greetings and introduction
- Signing the consent form

General questions:

- Can you tell me about yourself, and your general feeling of where you live or work regarding the environment?
- What comes to mind when you think about rapid changes happening in the ecosystems (general description of social-ecological regime shifts)?
- Do you think any of them happened or are happening in this region?

Ecosystem services

- How would you describe the current condition of ecosystem services (e.g., fisheries resources) in this region?
- Do you think there are noticeable changes over the years compared to the current condition?
- Can you describe the magnitude of changes you just mentioned? Do you believe they threaten or degrade the environmental quality of this place?

Relationship

- How do you view your relationships to them?
 - Do you think they pose impacts on your work or personal life in any way?
 - Do you think you play a role in it? If yes, in general term, in what way?
- On the other hand, if possible, can you generally describe how they impact local people's activities?

Factors and Drivers

- In your mind, what would you consider as factors or drivers contributing to the situation?
- Do you think they are manageable in certain levels with proper approaches? Why and why not?
- If it keeps what it is, what you think the condition will be in the future?

Perceptions of Governance

- Who is in charge of managing the SERS?
- Are there any policies or regulations that you know, and you consider associated?

Success and Failure

- If there are any associated policies or regulations, would you recognize any of them make things better? If yes, what made it successful?
- Do you think the associated people in charge make competent decisions at the time? Why and Why not?

Expectations

- In the future, what do you think is required regarding governance for more effective management?
 - Do you believe there should be governance interventions aiming at factors or drivers you mentioned?
 - In your mind, which is most important?

Conclusion

- Appreciation
- Reconfirm the consent
- Providing my contact details
- Checking participants' contact information for sending the summary

Appendix E – Focus Group Guide Questions

Start

- Greetings and introductions
- Signing the consent forms
- Providing materials (pen, paper, etc.) to participants

Identification

- What social-ecological regime shifts (rapid changes in ecosystems) you observed?
- Do you agree with others' observations? Why and why not?

Factors/Drivers Worth Noticing

- What are vital factors/drivers for SERS identified?
- How they pose impacts?
- Are they interconnected in certain levels?

Effective Governance

- Based on what found, what is required for effective governance in this region?
- Can you give three or more suggestions you think as the priority?

Reconfirmation

- Do you agree with the findings?
- If not, what is missing?

Conclusion

- Appreciation
- Reconfirm the consent
- Providing my contact details
- Checking participants' contact information for sending the summary of interview