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RESEARCH ARTICLE

Investigating the Roles of Actors in the Management of the Setiu Mangrove Swamp System within a Social-Ecological System (SES) Framework

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ABSTRACT

Lack of stakeholder involvement in the management of mangrove swamp systems has recently become a global issue. Mangrove swamp ecosystems are known as biological communities that interact as biotic and abiotic components. The management of mangrove swamps in Malaysia is a cause for concern as the quality and quantity of the area are deteriorating. The objectives of this study are to examine stakeholder involvement in the management of Setiu mangrove swamp systems, identify key issues faced by stakeholders in managing mangrove swamp systems more sustainably, and recommend to stakeholders the best management practices for managing mangrove swamp systems. In this study, a qualitative study was conducted using a diagnostic approach guided by the Social-Ecological System (SES). Participants will be involved in the management of mangrove systems using Ostrom's (2009) theory based on the Social-Ecological System (SES) framework. This interaction involves actors (A) and management systems (GS) in Setiu mangrove swamp ecosystems based on the Social-Ecological System (SES). Actors (A) focus on the number of involved actors (A1), socio-economic characteristics (A2), leadership (A5), and resource importance (A8). The governance system (GS) includes government organizations (GS1), non-governmental organizations (GS2), collective election rules (GS6), and supervisory sanction rules (GS8). A limitation of

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the study was that obtaining information and reading about the Social-Ecological System (SES) made it difficult for the researcher to gather data. The study showed that many participants were involved in activities in the mangrove swamp area.

Contribution/Originality: The study is expected to benefit the parties involved in the administering the mangrove swamp system using the Ostrom (2009) Theory in Setiu. The purpose of this study is to produce research that will benefit the Knowledge Corps, the Public Community, Local Authorities (PBT) and Policy Makers.

1. Introduction

Lack of stakeholder involvement in the management of mangrove swamp systems has recently become a worldwide issue (Astuti & Titah, 2021). Mangrove swamp ecosystems are very unique, as there are many plant communities on the coast (Safuridar & Andiny, 2019). The growth of mangrove swamp trees can be observed in tidal areas such as coastal environments, estuaries, and tropical climates (Dzulhelmi et al., 2019). Mangrove swamp ecosystems are known as living communities of organisms that interact as biotic and abiotic components (Hugua et al., 2022). The management of mangrove swamps in Malaysia is a cause for concern, as the quality and quantity of the area are deteriorating due to environmental pollution, such as oil spills, deforestation, and toxic waste disposal (Lim & Osman, 2020).

The total area of mangroves in the world is estimated to be 15.2 million hectares, of which 40% (equivalent to 6 million hectares) is located in Asia (Ahmad et al., 2018). In 2015, the area of mangrove swamps in Malaysia reached 525,686 hectares, covering the Peninsula, Sabah and Sarawak. Mangrove swamps provide many social and environmental benefits to coastal areas (Syamsuddin et al., 2019). Stakeholder engagement is an important factor in addressing the deterioration of governance in mangrove swamp systems and has been widely and deeply studied (Heniwati et al., 2023). This study specifically focuses on two main components of mangrove swamp management, namely actors (A) and governance systems (GS).

The purpose of this study is to identify the problems encountered in stakeholder engagement and management of mangrove swamp systems. Failure of good management systems may lead to problems in mangrove swamps. There is a lack of actors and scientific research on mangrove ecosystems to protect and manage them. In addition, the failure of good management systems may lead to problems such as water pollution (Astuti & Titah, 2021). Mangrove swamps are becoming increasingly polluted due to poor management systems and the extinction of plant and animal habitats. Mangrove swamps are being invaded due to a lack of supervision and patrols by authorities in mangrove swamp areas (Fadzli et al., 2023).

1.1. Research Objectives

The main purpose of applying Ostrom's (2009) theory of stakeholder participation in the management of mangrove swamp systems was to study stakeholder participation in the management of the Setiu mangrove swamp system. Next, the important issues faced by stakeholders in managing the mangrove swamp system more effectively were identified.

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In addition, the participants were presented with the best management practices for managing the mangrove swamp system.

2. Literature Review

2.1. Social Ecology

According to Arnaiz-Schmitz et al. (2018), ecology refers to the study of the interdependent relationships between organisms and their environment. Ecology focuses on the relationship between plants, humans, and their environment and is concerned with the system balance that leads to various problems. The most important aspect of social ecology is the interaction between ecological understanding and socio-economic values (Nazar et al., 2021). Budiyanti (2018), believes that the term social ecology emphasizes the concept of ecology, that is, the relationship between humans and nature. Social ecology includes ecology, economics, culture, politics, and socio-ecological interactions (Naibaho et al., 2022). Social-ecological systems maintain the interaction between biophysical structures and socio-economic structures (Setiyaningrum et al., 2020).

2.2. Stakeholder Involvement

Participants are crucial in reflecting the ability of stakeholders-such as individuals, groups, and organizations-to influence the decision-making process (Royandi & Keiya, 2019). These participants include stakeholders from the federal government, state and local governments, companies, non-governmental organizations, communities, and individuals (Hasbullah & Ab Rahman, 2020). Additionally, participants refer to individuals and organizations that are actively and directly involved in project management or have an interest in the successful implementation and completion of the project. Effective stakeholders can significantly impact project performance in terms of time, cost, and quality management (Ahmad et al., 2018).

2.3. Mangrove Swamp Ecosystem

According to Kamus Dewan Edisi Keempat (2017), an ecosystem is defined as the interaction between communities, including animals and plants, and their inanimate environment, such as air, wind, and moisture. Mangrove swamp areas, increasingly utilized for aquaculture, are part of these ecosystems, specifically as shrimp and fish habitats (Rosli et al., 2023). A mangrove swamp ecosystem has distinct advantages and natural resources, including water sources, food sources, and habitats for both terrestrial and aquatic animals (Rustam, 2019).

2.4. Governance System

According to Aziz et al. (2019), the governance system is a decision-making process and a process for exercising power. Good governance includes policies and practices that ensure good resource management according to established rules, namely accountability, transparency, responsiveness, consent, fairness, prevention of corruption, and efficient and effective direction of organizational functions (Aziz et al., 2019). Governance is a major factor in determining the success or failure of an organization. For family organizations, the involvement of family members introduces a unique governance mechanism that aims to ensure that the behavior of organizational stakeholders is consistent with the goals and objectives of the organization (Aziz et al., 2019).

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2.5. Government Organizations and Non-Governmental Organizations

Government organizations have their own administrative bodies to manage organizational governance. An important aspect of national governance is public decision-making, i.e., public decision-making. Formulate and implement government policies to safeguard the interests of the people (Rumondang et al., 2023). The decisions made must be thorough and detailed to meet the needs of the public without negatively affecting government organizations and related parties. Non-governmental organizations (NGOs) are defined as registered organizations, community groups, professional associations, and charities. Non-governmental organizations are an increasingly important entity in the Malaysian government system. Organizations are not authorized to engage in social and humanitarian activities (Pingking & Hussin, 2023). Non-governmental organizations (NGOs) refer to all organizations other than the government. Non-governmental organizations (NGOs) have four characteristics, namely, voluntary, non-partisan, charitable, and non-criminal activities (Tumin & Nurhadi, 2007).

2.6. Causes of destruction of mangrove swamp ecosystems

According to Syamsuddin et al. (2019), the destruction of mangrove swamp ecosystems has led to changes in coastal areas. The disappearance of mangroves has led to a sudden and continuous decline in the quality and quantity of the ecosystem. The three main reasons for the destruction of mangrove swamp ecosystems are: water pollution, development, and deforestation activities (Andika et al., 2019). Population growth leads to urbanization, land use, and climate change. Population growth has serious impacts on natural and human systems, threatening land ecological and social systems (Sagalaa et al., 2021). According to Rasyid et al. (2022), the development of mangrove swamps has caused many environmental problems such as mangrove swamp pollution. The extinction of the ecosystem has a negative impact on the food chain due to the lack of food resources. Therefore, most of the destruction of mangrove swamp ecosystems is caused by water pollution, deforestation, land development, etc.

2.7. Socio-Ecological Functions of Mangrove Swamp Areas to Society

According to Abu Bakar et al. (2020), the ecosystem is divided into several parts that provide services such as food and water. The second is regulatory services such as flood control and drought prevention. In addition, there are cultural services such as recreation and health (Abu Bakar et al., 2020). Mangrove ecosystems provide ecological benefits as suppliers of nutrients and protect beaches from wave erosion. Mangrove swamp ecosystems also benefit from an economic perspective by providing mangrove wood products used as construction piles and mangrove seeds for protection (Syamsuddin et al., 2019).

2.8. Roles and Responsibilities of Actors Related to Mangrove Swamps

According to Hasbullah and Ab Rahman (2020), the role of actors is to provide assistance in maintaining mangroves. The role of the big government in mangrove swamp management. The government should improve the sustainability of mangrove swamp ecosystems to maintain the quality of life and its contribution to society. All parties, especially local communities, must take care of mangroves and improve planting techniques. According to Heniwati et al. (2023), the government provides education on mangrove resource management and demonstrates how to plant mangrove seedlings.

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The government's efforts can make the community aware of the importance of protecting the mangrove swamp ecosystem. The government should guide all parties related to mangrove swamps to plant more mangroves to promote the conservation process of mangrove swamps (Iswahyudi et al., 2019).

2.9. Social-Ecological Systems (SES)

According to Sagala et al. (2022), Social-Ecological Systems (SES) is a field that studies the relationship between humans and the environment. A Social-Ecological System (SES) is an ecosystem that has a relationship with and influences one or more social systems. A system consisting of interdependent organisms is called an ecosystem (Sagala et al., 2021). Sociality means the tendency to cooperate and depend on others. In this way, interdependent, interacting units form a social-ecological system. A better relationship between humans and sustainable nature and the ability to adapt to changes in conditions in the Social-Ecological System (SES) (Partelow et al., 2018a, 2018b). A Social-Ecological System (SES) is considered as a complex adaptive system in which actors with different values and interests interact with their natural environment (Hugua et al., 2022). Social-Ecological Systems (SES) have various functions related to ecosystem services. Ecosystem services are divided into four components: utility services, regulating services, cultural services, and supporting services. The supporting services component is eliminated and replaced by habitat services (Nurokhmah et al., 2019).

3. Research Methods

3.1. Research Design

This study adopts a qualitative research based on the Social-Ecological System (SES) diagnostic approach (Partelow et al., 2018a). The design of this study includes a case study of Setiu, Terengganu. According to Partelow et al. (2018a), Ostrom's (2009) framework was selected as a suitable diagnostic tool to analyze the Social-Ecological System (SES) of stakeholders involved in the governance of mangrove swamp systems. The unit of analysis in this study refers to the Social-Ecological System (SES) of the governance system (GS) and actors (A) in the context of the same mangrove swamp area. This study explores the following questions based on the Social-Ecological System (SES):

i. How can stakeholders participate in the management of the Setiu mangrove swamp system?
ii. What are the key issues that stakeholders need to address to more effectively manage the mangrove swamp system?
iii. How can the best management system be applied to the actors involved in the management of the mangrove swamp system?

The secondary attribute values selected for analysis are measured in the field. These values can be obtained from the literature or from the society through observations, interviews. The Social-Ecological System (SES) conceptual framework was proposed by Ostrom (2009) in 2009 and modified by McGinnis and Ostrom (2014) in 2014 (Partelow et al., 2018a). It consists of eight first-order attributes of resource systems (RS) and resource units (RU). In the natural component, governance and governance are complementary in other aspects. The governance system (GS) and actors (A) constitute the social component. These components interact through key action scenarios to produce interactions (I) and outcomes (O) from the natural or social components. Figure 1 shows the Social-Ecological System (SES) framework. Therefore, this study follows the

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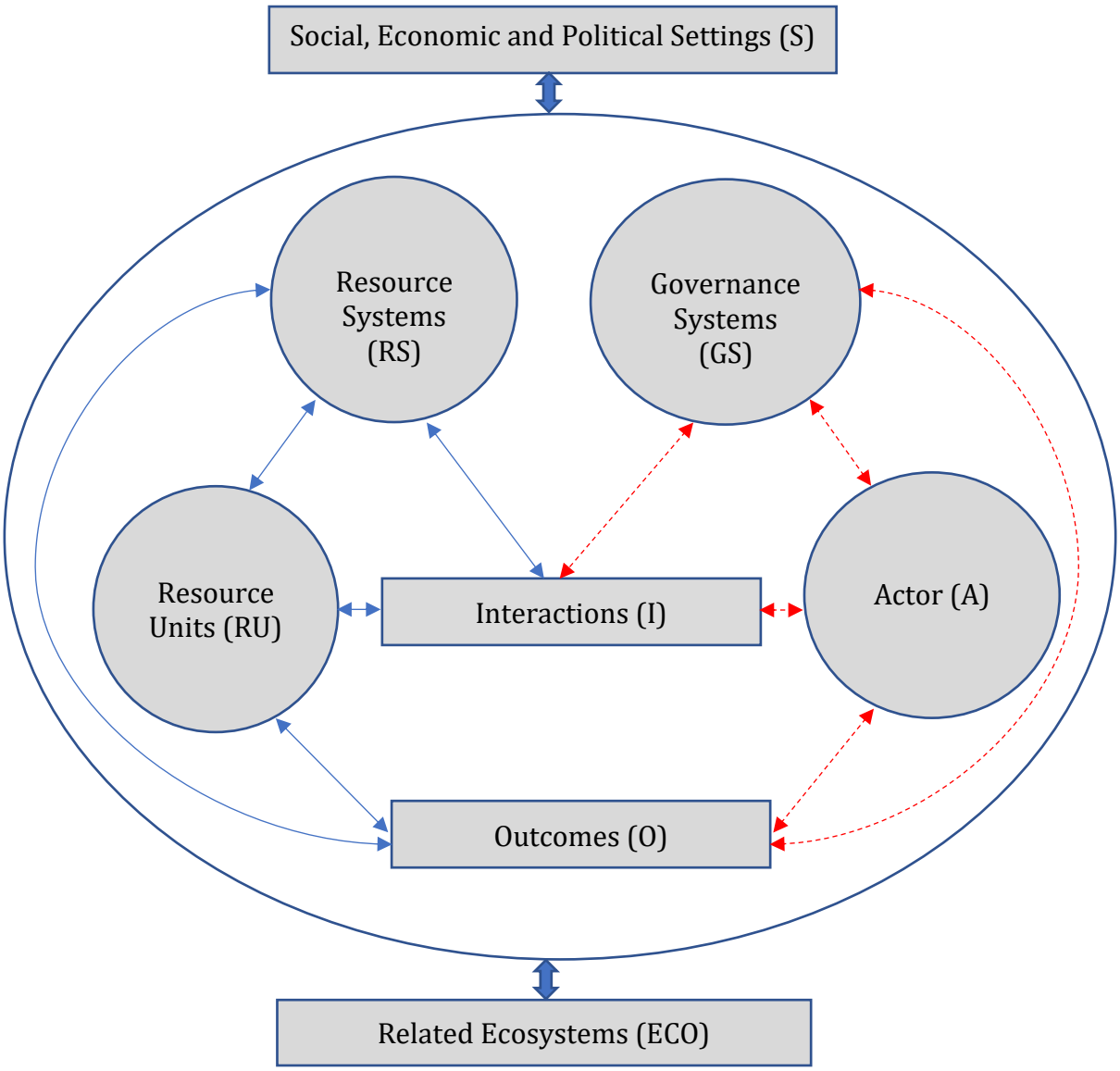
three-step process described by McGinnis and Ostrom (2014) in 2014 in the Social-Ecological System (SES) framework (Partelow et al., 2018a).

Figure 1: Social-Ecological Systems (SES) Framework Note: The boundaries of the study are indicated by arrows with red dots and red circles, respectively.



Source: Modified by the author from McGinnis and Ostrom (2014)

The first step is to focus the analysis on describing how users interact with products and services in specific governance (GS). Each activity has a resource unit (RU), an actor (A), governance (GS), an interaction (I) and an outcome (O). The second step is to select the second-order attributes to be measured in sub-SES. The goal is to reveal the Social-Ecological System (SES) framework of each actor. The third step is also to establish a clear Social-Ecological System (SES) framework to compare the results with other studies. In this case, the second-order attributes are selected based on each of the three sub- Social-Ecological Systems (SES) described previously. The management model based on Ostrom's (2009) mangrove management theory is used to study the adaptation strategies (Partelow et al., 2018a).

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3.2. Study Participants

The selection of participants in this study was based on purposive sampling to determine the organizations, departments, groups, and individuals related to the study conducted. The purpose is to meet the research questions, obtain the necessary information directly, and improve cooperation between actors. This study uses targeted sampling involving a total of 25 main informants, namely actors (A), consisting of the State Government with five informants, the Federal Government with three informants, the Local Government with three informants, Non-Governmental Organizations (NGOs) with three informants, professionals with one informant, and the community and the public with ten informants in Setiu, Terengganu. This sampling method is suitable for this study because the selection of informants is very strong and aims to obtain the information needed. This method was chosen to ensure that the selected informants were truly representative of the population in the study. The selection of these informants has been approved by the Universiti Malaysia Terengganu 2024 ethics approval committee. This study also uses the Social-Ecological Systems (SES) method to obtain information and analyze data. The data collection techniques used by researchers are based on primary and secondary data.

3.3. Data Collection

3.3.1. Interviews

Interviews are qualitative research methods that involve careful face-to-face interviews with a small number of informants to explore their views on a particular concept, initiative, or situation. Interview instruments are classified into two categories: structured interviews and unstructured interviews.

A total of 25 key informants, i.e., actors (A), participated in this study. This method gave the informants an opportunity to discuss issues or opinions by using open-ended questions, making them more flexible. The informants were free to express their opinions and reactions to stakeholders involved in the management of mangrove swamp systems. This attribute is important in generating in-depth and detailed data on the case study in the real world.

3.3.2. Observation

Observation involves careful observation and watching the behavior of the subjects (Syamsuddin et al., 2019). The researcher observes the population, i.e. actors and the participation of people living in the natural conditions of the study area without being informed in advance of the observations.

Figure 2 shows the visits to research sites. These observations were conducted to examine the participation of the participants in the management of the Setiu mangrove swamp. Naturalistic observation data are detailed data of a specific sample or population. The researcher also conducted observations based on the literature review and other sources related to this study. Next, the researcher also used observation tools to observe the interaction between the sample and the participants in the management of the Setiu mangrove swamp system in Terengganu.

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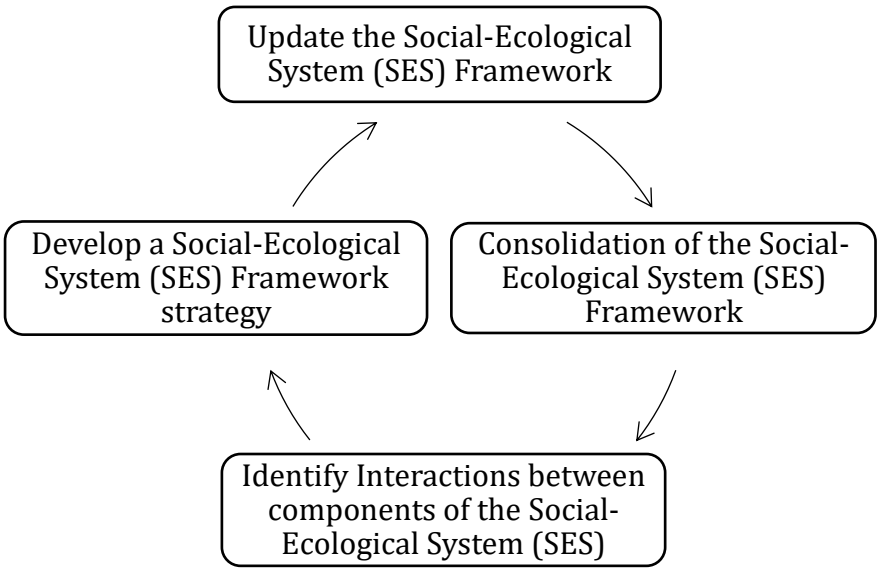
Figure 2: Visits to research sites

3.4. Social-Ecological Systems (SES) Approach

As part of the SES approach, the abbreviations of the results (O) are used to summarize the findings. The interactions within and between the four first-level attributes (I), which are the resource units (RU) that form part of the resource system (RS), are determined by the overall governance system (GS) and the actors of interest (A). The government governs within the context of the social, the broader economic and political (S), and the ecology (ECO). There are four main steps to implement the Social-Ecological Systems (SES) framework to obtain a comprehensive analysis of the management of mangrove swamp systems as depicted. Figure 3 shows the step by step Process Social-Ecological Systems (SES) framework. The first step is to update the Social-Ecological Systems (SES) framework. The second step is the classification of the Social-Ecological Systems (SES) framework. The third step is to identify the interactions of the SES components. The fourth step is to develop a Social-Ecological Systems (SES) framework strategy.

Figure 3: Process Social-Ecological Systems (SES) framework



Source: Modified by the author from McGinnis and Ostrom (2014)

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3.5. Data analysis

3.5.1. Step 1: Update the Social-Ecological System (SES) Framework

The framework is used to gain a comprehensive understanding of the socio-ecological complexity of mangrove swamp management. This can be achieved through direct empirical observations from the research literature examining mangrove swamp systems. Develop an updated Social-Ecological System (SES) framework specifically for the management of mangrove swamp systems. All components of the Social-Ecological System (SES) must be incorporated within the framework of the Social-Ecological System (SES), regardless of their relationship to mangrove swamps. In the early stages of the Social-Ecological System (SES) framework, there were many system-related components, but in this study, the researchers focused on only two system components, namely the Governance System (GS) and Actors (A).

3.5.2. Step 2: Consolidation of the Social-Ecological System (SES) Framework

Classifying mangrove swamp governance system using the Social-Ecological System (SES) framework allows identification of the number of interacting components of mangrove ecosystems in order to analyze the interactions of these components. Attribute data of system components can now be used to classify the Social-Ecological System (SES) using the updated mangrove swamp framework. The Administrative System (GS) includes eight attributes, but this study only focuses on government organizations (GS1), non-governmental organizations (GS2), collective election regulations (GS6), and supervision and sanctions regulations (GS8).

3.5.3. Step 3: Identify interactions between components the Social-Ecological System (SES)

Analyze interactions between as many components as possible and collect data. This is one of the most interesting areas of social science research and involves the analysis of interactions between social and ecological processes. Empirical analysis supports context-based assessments and the ability to adapt effectively. Different components of a SES interact at different rates. There are multiple ways to conduct interaction analysis depending on the system component of interest, and the SES framework can make an important contribution to integrating these components.

3.5.4. Step 4: Develop a Social-Ecological System (SES) Framework strategy

Develop a basic management strategy for the Social-Ecological System (SES). Components that continuously interact with the regulating feedbacks in the mangrove swamp system that occurs in interconnected space and time. Policy management combines the dynamic learning process of adaptation to the environment with the collaborative participation of community actors (A) to develop policies to manage the Social-Ecological System (SES). Implement management strategies and monitor the Social-Ecological System (SES). Implementation of the mangrove swamp management plan requires collaboration between experts, stakeholders, and researchers to develop practical management strategies.

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4. Results

4.1. Actor (A) Interaction in the Mangrove System

Using the socio-ecological system adapted by McGinnis and Ostrom (2014) in 2014 (Partelow et al., 2018a), various actors are involved in the management of mangrove swamp systems. This study focused on the involvement of stakeholders in the management of mangrove swamp systems among the stakeholder groups that are directly or indirectly involved. There are a total of 25 relevant actors (A1) representing 8 categories and 6 organizations, namely federal agencies, state governments, local governments, non-governmental organizations (NGOs), professionals, and the public that are related to mangrove swamps. Table 1 shows the selection of actors interviewed. This actor works with all relevant sectors to strengthen the mangrove swamp management system. The involvement of cross-institutional actors is evident in the organization of projects and activities in mangrove swamp areas. Involving local communities in the recruitment and decision-making process can encourage participation and support for different types of mangrove planting (Pingking & Hussin, 2023).

Table 1: Selection of Actors Interviewed

Actors	Respondents	Source Agency
State Governments	5 people	Terengganu State Parks Board (MPTN)
Federal Governments	3 people	1. Terengganu State Environment Department (JAST) 2. Terengganu State Forestry Department (JPNT) 3. Town and Country Planning Department (PLANMalaysia)
Local Governments	3 people	Setiu District Council (MDS)
Non-Governmental Organizations (NGOs)	3 people	Malaysian Nature Creators Society (MNS)
Professional Websites	1 person	Lecturer
Society and Ordinary People	10 people	village Chiefs and Civilians

Socioeconomic characteristics of residents around the mangrove swamp area in Setiu (A2). From the whole field, the largest group of people is employed in the mangrove swamp area, including menial jobs such as cleaners, street vendors, helpers and manual laborers. This is followed by agriculture, forestry and fisheries, as well as services and sales. The Setiu community also serves as tour guides to convey the importance of mangrove swamps to people. Currently, in addition to government agencies, there are multiple stakeholders such as local residents, non-governmental organizations and the private sector active in the mangrove swamp area, but the overall management of the mangrove swamp system (A5) is the responsibility of all stakeholders. The community, non-governmental organizations and the private sector are committed partners in protecting the mangrove swamp ecosystem. This cooperation includes involving managers with the authority to manage mangrove wetlands to solve any problems, especially encroachment and pollution. Many people rely on natural resources in the mangrove swamps, such as crabs and fish. The difficulty in earning income may be related to the importance of crop resources in the mangrove swamps when the seasons change (A8) (Abu Bakar et al., 2020).

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4.2. Actor Networks and Gavernance in Mangrove Swamp Systems

This governance system (GS) includes actors involved in the governance of the mangrove swamp system, applying Ostrom (2009) Setiu's theory (Partelow et al., 2018a). Table 2 shows the analysis of actors with power over mangrove swamps.

Table 2: Analysis of Actors with Power Over Mangrove Swamps

Actor	Type of organization	Role	Field of authority
State Government	Terangganu State Park Management Council (MPTN)	Directly manage, implement and monitor the mangrove wetlands in Setiawang Wetland State Park.	State
Federal Government	1. Terengganu State Environment Department (JAST)	Environmental protection, sustainable development planning and public education and awareness.	Federal
	2. Terengganu State Forestry Department (JPNT)	Enforcement related to mangrove swamp protection and research and monitoring.	
	3. Town and Country Planning Department (PLANMalaysia)	Preparation of structure and local plans and environmental impact assessments.	
Local Government	Setiu District Council (MDS)	Mangrove wetland management and monitoring, law enforcement and sustainable tourism development.	District
Non-Governmental Organizations (NGOs)	Malaysian Nature Lovers Society (MNS)	Conservation and reforestation projects, education and awareness programmes, and working with local communities.	National
Professional Fields	Lecturer	Conduct research and development to lay the foundation for mangrove conservation and develop innovations and technologies for mangrove monitoring and protection.	International
Society and the Public	Village Chiefs and Civilians	Protect mangrove ecosystems, support government policies and collaborate with mangrove stakeholders.	District

The mangrove swamp governance system is combined with the decision-making power of the mangrove swamp governance organization (GS1) as it has policies and measures that can create a more sustainable governance system. This mangrove swamp area is controlled by various government agencies to improve the efficiency of mangrove swamp management. The effective management of mangrove swamps requires that all parties understand their ecological importance. Actors should conduct regular monitoring to maintain the balance of mangrove swamp ecosystems, promote research, and implement conservation measures such as reforestation and habitat protection. Local governments play an important role in the management of mangrove swamps by issuing policies, regulations, and plans to control development activities in mangrove swamp areas. The non-governmental organization (GS2) aims to support the governance system related to

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the protection and preservation of mangroves and abiotic and biotic ecosystems (Hugua et al., 2022). Many non-governmental organizations (NGOs) work to protect mangrove swamps. They play an important role in putting pressure on the authorities to protect mangrove swamps from destructive development.

Participants engaged in the management of the Setiu mangrove swamp system using Ostrom's (2009) theory. Collective choice rules (GS6) consist of government actors, non-governmental organizations, and mangrove swamp residents. These collective choice rules promote actions aimed at implementing management plans and enforcing rules. Good regulations can strengthen the management system of mangrove swamps by setting clear guidelines for the protection, monitoring, and use of existing resources. Biodiversity can be protected through regulations that ensure that mangrove wetlands are protected, habitats for existing species are maintained, and fresh water is provided to the community. Supervision and sanctions regulations (GS8) for smooth administrative and enforcement processes depend on the presence of clear laws and guidelines. Laws, planning methods, planning policies and planning standards for development management and control in Terengganu State. Regulations governing mangrove swamp ecosystems include the Terengganu State Parks Act 2017 (Setiu Wetlands State Park Only) and the Town and Country Planning Act 1976 (Act 172).

According to Ostrom's (2009) theory, the participation of actors in the management of the Setiu mangrove swamp system is carried out within the framework of the Social-Ecological System (SES). This interaction includes actors (A) and management systems (GS) in the Setiu mangrove swamp ecosystem based on the Social-Ecological System (SES) (SES). Based on the three-agent scheme (A), it focuses on the number of actors involved (A1), socio-economic attributes (A2), leadership (A5), and source benefits (A8). While the administrative system (GS) includes government organizations (GS1), non-governmental organizations (GS2), collective election regulations (GS6), and supervision and restriction regulations (GS8). Table 3 shows the secondary attributes of Social-Ecological System (SES), adapted from McGinnis and Ostrom (2014) in 2014. This study discusses the issue of stakeholder participation in the management of the mangrove swamp system and combines the goal of studying stakeholder participation in the management of the Setiu mangrove swamp system. The next step is to identify the important issues faced by stakeholders in managing the mangrove swamp system more sustainably. In addition, the best management system for managing the mangrove swamp system should be provided to stakeholders.

Table 3: Secondary Attributes of Social-Ecological System (SES)

Actor (A)	**Governance System (GS)**
A1 Number of connected actors	GS1 Governmental organizations
A2 Socioeconomic characteristics	GS2 Non-governmental organizations
A3 History or previous experience	GS3 Network structures
A4 Paper strips	GS4 Proprietary systems
A5 Leadership/entrepreneurship	GS5 Operational selection provisions
A6 Norms (trust and reciprocity)/social capital	GS6 Group selection method
A7 SES/mental model knowledge	GS7 Constitutional optional provisions
A8 Source meaning (dependencies)	GS8 Monitoring and containment provisions
A9 Available technology	

Source: Modified by the author from McGinnis and Ostrom (2014)

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The first purpose of the discussion was to explore the involvement of the participants in the management of the Setiu mangrove swamp system. In fact, many stakeholders are involved in the management of the Setiu mangrove swamp system. The participants collaborate with all relevant authorities to strengthen the mangrove swamp management system (Heniwati et al., 2023). This collaboration takes the form of activities, monitoring and enforcement in the mangrove wetlands. The Malaysian government, through its agencies, is involved and responsible for the management of the mangrove swamp. All stakeholders should do their part in managing the mangrove swamp. Due to the diversity of flora and fauna, this mangrove swamp area can serve as a tourist attraction. The participants have done their part in managing the mangrove swamp. In order to meet the future development needs of Setiu, the participants are required to provide integrated infrastructure and utilities. The community facilities provided include education, health, safety, religious and community facilities. The provision of adequate and quality community facilities is an important prerequisite to support social development (Isa et al., 2021).

The Setiu community also plays the role of fishermen, farmers and guides (Syamsuddin et al., 2019). Most members of the community work in important jobs including cleaners, salespeople, helpers and manual labourers. The sustainability of the mangrove swamp ecosystem can be maintained for the benefit of future generations. In the management of the mangrove swamp system, the participation of all parties is very important and it is not just the government's responsibility. Community members, non-governmental organisations and the private sector must also play an equal role in taking care of the mangrove wetlands. The community, non-governmental organisations and the private sector are committed partners in the conservation of the mangrove swamp ecosystem. This collaboration includes the participation of managers who have the authority to manage the mangrove wetlands to address all issues, especially encroachment and pollution.

Next, key issues faced by stakeholders in managing mangrove swamp systems more sustainably were identified. Management of mangrove swamps is effectively conducted by actors. Effective management of mangrove swamps requires that all parties understand their ecological importance. Actors should conduct regular monitoring to maintain the balance of mangrove swamp ecosystems, promote research, and implement conservation measures such as reforestation and habitat protection. These management owners usually include ecologists, natural resource managers, and local stakeholders. One challenge that leads to poor management of mangrove swamps is coastal development, where opening up areas for industrial development, housing, or tourism can lead to the destruction of mangrove swamp habitats (Syamsuddin et al., 2019). Public awareness of mangrove swamps is low. Management conflicts between government agencies and stakeholders often lead to poor implementation of policies and regulations. Conservation of mangrove ecosystems is important for maintaining the balance of nature and supporting human life. One of the importance of conserving mangrove ecosystems is that it can protect against floods and tsunamis. Mangrove swamps block waves and protect coastal areas. Due to their thickness and density, mangroves can reduce wind speed, thereby buffering strong winds.

Development projects that emphasize the natural environment are important for flora, fauna, and humans. Select appropriate sites that do not have a significant impact on the existing mangrove swamp ecosystem (Sagala et al., 2021). This may include conducting a thorough environmental impact assessment before construction begins. Development

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projects should incorporate environmentally friendly design elements, such as recreational parks, to protect biodiversity. Mangrove swamp ecosystems provide many economic benefits to the surrounding communities in Setiu. Economic activities in Setiu include fishing, collecting snails, sea cucumbers, mussels, and palm crabs. Fisheries are one of the most important agricultural sectors in the state of Terengganu.

In addition, the best governance system is recommended for the actors involved in the management of mangrove swamp systems. The rules used in the management of mangrove swamps can initiate management and enforcement procedures based on clear behaviors and guidelines (Thompson & Friess, 2019). The laws, planning methods, planning policies and planning standards for development management and control in Terengganu. The regulations used to manage mangrove swamp ecosystems include the Terengganu State Parks Act 2017 (Setiu Wetlands State Park Only) and the Town and Country Planning Act 1976 (Act 172). The rules used in the management of mangrove swamp systems are important for the formulation and evaluation of policies and regulations, as well as the level of implementation of proposed initiatives. Terengganu State Structure Plan (RSN) 2020. The development strategy for the Setiu area in the Terengganu State Structure Plan (RSN) 2020 is to develop research facilities and improve accommodation facilities suitable for school groups, youth and researchers.

Actors have different approaches to managing mangrove swamps. Weaknesses in the governance and management of mangrove swamps. One of the weaknesses that need to be overcome in the management of the Setiu mangrove swamp system is the lack of coordination between different departments and technical agencies. A weak enforcement system has led to uncontrolled development in Setiu. Land grabbing, land use conflicts, development activities that threaten the biodiversity of flora and fauna, and pollution caused by uncontrolled agricultural and aquaculture activities. Regulations can strengthen the governance system of mangrove swamps. Good regulations can strengthen the mangrove governance system by setting clear guidelines for the protection, monitoring and use of existing resources (Mondal et al., 2021). It is important to ensure the sustainability of the habitat and ecosystem benefits associated with mangrove swamps. The rules passed can strengthen the mangrove swamp governance system in terms of physical land use in the mangrove swamp area. Monitoring is carried out by the agency that manages the mangrove wetlands, the Terengganu State Parks Board (MPTN), which has the power to control and manage the Setiu Wetland State Park under the Terengganu State Parks Act 2017. Monitoring is carried out by the Setiu District Council (MDS). Under the provisions of the Local Government Act 1976 (Act 171).

4.3. Study Limitations and Recommendations

The limitation of the study lies in the challenges associated with acquiring information and literature on the Social-Ecological System (SES). The available reading material was limited, and there were few studies that applied Ostrom's (2009) theory to the management of mangrove swamp systems. This scarcity made it difficult for the researcher to gather additional information on the relevant topic and hindered the ability to conduct more detailed and in-depth analyses, particularly in using Ostrom's (2009) theory to identify stakeholders involved in the management of mangrove swamp systems.

Recommendations for further research are that the involvement of different actors in the management of mangrove swamp systems varies, as each agency has its own role. Actors should continuously monitor mangrove swamp ecosystems to detect changes and

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emerging issues, such as pollution and encroachment. International cooperation in mangrove swamp conservation should be expanded through the exchange of knowledge, technology and resources, and regional cooperation plans for the protection of mangrove swamp ecosystems should be developed. Through these steps, stakeholders can ensure the sustainability of mangrove swamps as important habitats for marine biodiversity.

Stakeholders are advised to formulate laws and regulations to promote the conservation of mangrove swamps more effectively. Communities living in mangrove swamps should be involved in mangrove reforestation projects and provide accurate information on the importance and maintenance of mangrove ecosystems. Active participation of stakeholders can ensure the sustainability of mangrove swamps and their continued benefits to communities and ecosystems. Therefore, cooperation among all parties can ensure that mangrove swamp ecosystems are fully and effectively conserved.

Effective management of the proposed mangrove swamp system can be achieved in a number of ways. Implementation of initiatives to protect and restore mangrove swamps through replanting and protection of biotic and abiotic habitats and introduction of suitable and environmentally resilient mangrove tree species. Effective management of mangrove swamps. Delineation of protected areas as per legal provisions to prevent development from damaging the mangrove swamp ecosystem.

5. Conclusion

The purpose of this study was to identify stakeholders involved in the management of mangrove swamp systems using Ostrom's (2009) theory. The results revealed that numerous actors are involved in the mangrove swamp area. Therefore, many agencies need to consider these actors' involvement in the management of the Setiu mangrove swamp system. The findings indicated that the most powerful actors in the mangrove wetland area are the Setiu District Office and the Setiu Land Office, while the Terengganu State Parks Board (MPTN) holds power only within the Setiu Wetland State Park area. Overall, the researchers believe that applying Ostrom's (2009) theory to engage stakeholders in the management of mangrove systems is a key strategy for improving management efficiency and maintaining mangrove areas.

Ethics Approval and Consent to Participate

The researchers used the research ethics guidelines prepared by the Research Ethics Committee of Universiti Malaysia Terengganu (UMT). All procedures performed in this study involving human subjects have been carried out in accordance with the ethical standards of the institution's research committee. Permission and consent to participate in the study were also obtained from all study participants.

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Conflict of Interest

The author has no conflict of interest with any party involved in this study and publication.

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