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# A Social Ecological System of Recreational Fishing in the Seagrass Meadow Conservation Area on the East Coast of Bintan Island, Indonesia

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ABSTRACT

The objective of this research was to map the social ecological system (SES) of recreational fishing in the seagrass meadow conservation area on the east coast of Bintan Island, Indonesia. This mapping was conducted to determine the ecosystem services provided by seagrass habitat in the study area; that is Berakit, Malang Rapat and Teluk Bakau villages. The results of this research show the seagrass ecosystem in the study area provides significant value within the socio-economic framework of the coastal communities in surrounding areas, due to the existence of recreational fishing activity within seagrass habitat. The existence of this recreational fishing may provide direct and indirect economic impacts and induce demand, based on how the economic value of the seagrass ecosystem is distributed, so that the purchasing power of the coastal communities in surrounding areas is strengthened. We hope that this SES mapping may support considerations to protect the seagrass ecosystem and local economic development related to the recreational fishing in the seagrass conservation area.

## 1. Introduction

Seagrass is one of the most important components of tropical coastal ecosystems, besides mangroves and coral reefs (de la Torre-Castro, 2006), and has wide global distribution (den Hartog, 1970). Compared with mangroves and coral reefs, the seagrass ecosystem has perhaps received less scholarly attention, yet this ecosystem has much potential benefit and provides crucial services (de la Torre-Castro et al., 2014). While at a local level seagrass has been acknowledged as an important ecosystem *and* social ecological system (SES) (de la Torre-Castro and Ronnback, 2004), it has not yet been recognized more broadly as a global SES (Cullen-Unsworth et al., 2014; de la Torre-Castro et al., 2014).

The seagrass ecosystem as a coastal habitat is capable of supporting a variety of ecosystem services, such as the supply of fish (de la Torre-Castro et al., 2014). Seagrass supports the largest volume of fish catch compared with other coastal ecosystems (corals and mangroves). de la Torre-Castro et al. (2014) state that the seagrass ecosystem in Chwaka village, Zanzibar - Tanzania, as a provisioning service, supports a fish catch of > 46.41 t, compared with corals (12.03 t) and mangroves (11.81 t). Seagrass also supports the largest number of fishers (individuals) in utilizing the coastal ecosystem as their fishing ground; that is, 57.69 fishers $km^{-2}\,day^{-1}$, while coral reefs support 13.53 fishers $km^{-2}\,day^{-1}$ and mangroves 15.26 fishers $km^{-2}\,day^{-1}$ (de la Torre-Castro et al., 2014).

The provision of ecosystem services by seagrasses has been acknowledged by the *Millennium Ecosystem Assessment* – MEA (2003) and *The Economics of Ecosystems and Biodiversity* (UNEP, 2008), and is divided into provisioning services, regulating services, cultural services, and supporting services. All the services provided by the seagrass ecosystem equate to an economic value, which can be measured by using methods related to the economic value of biodiversity (Costanza et al., 2014; Nunes et al., 2002; de Groot et al., 2002; Costanza et al., 1997).

One of the services provides by seagrasses – cultural services – can be measured using data on the recreational fishing that occurs in and around this ecosystem. Thus, our research set out to map the SES of the Bintan Island seagrass ecosystem through the cultural services provided by recreational fishing in the seagrass conservation area on the east coast. The study area is shown in Fig. 1.

## 2. Methods

### 2.1. Research Framework

Our technical research framework was based on the seagrasses

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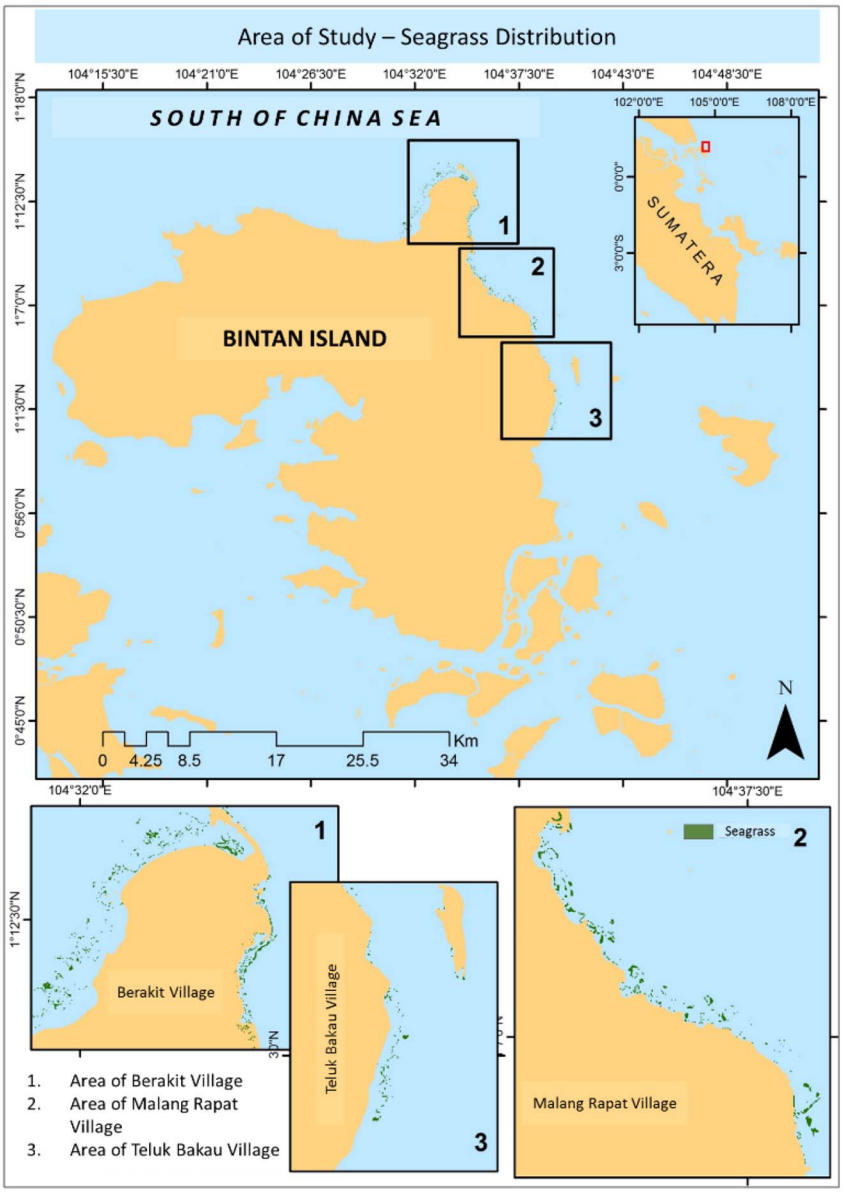


**Fig. 1.** The study area for mapping the social ecological system (SES) of recreational fishing in the seagrass meadow conservation area on the east coast of Bintan Island, Indonesia.

social ecological system (SES) framework developed by Gillbert and Jansenn (1998) and was modified based on the area of interest for this research. It is well-known that seagrasses have their own ecological functions and processes. As mentioned previously, these functions and processes provide four ecosystem services: provisioning services, regulating services, cultural services and supporting services (MEA, 2003).

These ecosystem services are utilized by people through their interactions (socio-economic activities) with seagrass, such as fishing and leisure. As a human system, these activities are undertaken by local people in surrounding areas and provide benefits in terms of supporting their wellbeing. Our framework for mapping the SES of the seagrass ecosystem through the cultural services provided by recreational fishing in the study area is shown in Fig. 2.

### 2.2. Data Collection Method

The basis for our data and information collection was a modified framework based on Janssen and Anderies (2013), shown in Fig. 3. We gathered data and information related to this research by using a semi-structured interview and survey. Individuals and/or households using the seagrass ecosystem as a recreational fishing ground were interviewed.

Fig. 3 shows the four components of SES that were mapped using the data and information gathered from the survey; that is: (i) Recreational fishing, (ii) Users, (iii) Public infrastructure provider; and (iv) Public infrastructure. The figure shows that all the components are interconnected (1–6) and influenced by supporting external factors such as the related ecosystem (seagrass) and the socio-economic and political environment (8 and 7). Data was gathered based on the interactions among the SES components shown in Fig. 3 and the indicators we developed are shown in Table 1.

Respondents were chosen randomly and the number of respondents was defined by using the structured formula developed by Parel et al. (1973).

$$n = \frac{Nz^2 p(1-p)}{Nd^2 + z^2 p(1-p)}$$

when, $n$ is a defined number of respondents, $z$ is a value of Z (1.96) based on the desired confidence level of 95%, $p$ is a proportional sample (respondent) from the total number of tourists in the area of study, $d$ is an accepted error from statistical models and N is the total number of tourists in the area of study.