Social-ecological system status and its implications for coastal and small islands management planning in Tanimbar Islands, Maluku Province, Indonesia

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Abstract. The research was conducted to analyze the status of SES in coastal areas and small islands, and their implications for management planning of coastal areas and small islands. The study used the SES method approach. The dynamics of SES shows the interaction of the four main subsystems (resources, resource units, governance systems, and users), influenced by social, economic, and political settings, and their relevance to ecosystems. Each component of system status varies, and tends to be weak. All components of the system must be important variables in supporting the management planning of coastal areas and small islands in the Tanimbar Islands Regency. The management plan must be carried out through the arrangement of a social, economic and collaborative political system; optimize system management and resource units; developing adaptive governance systems; strengthen user capacity; the negative impact of some interactions of SES components is reduced collectively; and comprehensive measurement of social and ecological performance.

1. Introduction

The entire Tanimbar Islands region is included in the planning area for development of the Islands Cluster-X in Maluku Province. The region has a sea area of 42,892.27 km², land area of 42,892.27 km², and 81 small islands, relatively vulnerable to the pressure of development activities, both social and ecological. Measuring social-ecological resilience and governance framework, is needed to develop policy, planning, and development actions in coastal areas and small islands (CASI) [1,2,3,4].

Development planning in the Tanimbar Islands must consider the potential of the region, get attention in conservation, the existence of local wisdom and knowledge, governmental alignments and local village institutions, as well as adaptive management needs and protection against destructive uses. Various obstacles that have always been faced include low stakeholder compliance, lack of alternative livelihood interventions, low trust on management institutions, and developing local values not accommodated in governance systems [5].

Understanding the SES and its resilience in CASI is a challenge for researchers, decision makers and communities to think about concepts of complexity, nonlinearity, path dependencies, uncertainty and change. Another challenge that cannot be ignored is the influence of external and internal pressures and
shocks such as natural disasters, climate change and resource depletion, so that an adaptive response to human and ecosystem behavior needs to be done [1,6].

SES in coastal areas and small islands is a complex system, but the study of the system cannot be done partially. The interaction of each system component has implications for the achievement of appropriate results in the system. This capability is expected to generate feedback to influence the system and its components, and determine the size or smallness and status of the SES [7]. Therefore, this present study aims to analyze the status of the social-ecological system (SES) in CASI. The results have implications for CASI management planning.

2. Method
The study was conducted in the coastal areas and small islands of the Tanimbar Islands, from July to December 2018. Assessment of SES variable status uses the SES index status ($SES_{is}$) model as follows:

$$SES_{is} = \frac{V_i}{\sum_{i=1}^{n} V_i}$$

Where $V_i$ is the standard value of the $i$-variable, $n$ is the number of variables in all system components. Status differences use flag models. The analysis variables refer to the SES framework [7,8], as follows:

| Resources systems (RS) | Governance system (GS) |
|------------------------|------------------------|
| RS1: sectors          | GS1: government organizations |
| RS2: clarity of system boundaries | GS2: non-government organizations |
| RS3: size of resource system | GS3: network structure |
| RS4: human-constructed facilities | GS4: property-rights system |
| RS5: productivity of system | GS5: operational-choice rules |
| RS6: equilibrium properties | GS6: collective-choice rules |
| RS7: Predictability of system dynamics | GS7: constitutional-choice rules |
| RS8: storage characteristics | GS8: monitoring and rules |
| RS9: location         |                         |

| Resources units (RU) | Actors (A) |
|----------------------|------------|
| RU1: resource unit mobility | A1: number of relevant actors |
| RU2: growth or replacement rate | A2: socioeconomic attributes |
| RU3: interaction among resource units | A3: history of past experiences |
| RU4: economic value | A4: location |
| RU5: number of units | A5: leadership/entrepreneurship |
| RU6: distinctive characteristics | A6: norms |
| RU7: spatial and temporal distribution | A7: knowledge of SES/mental models |
| RU8: distinctive characteristics | A8: importance of resource (dependence) |
| RU9: location         | A9: technologies available |

| Interactions (I) | Outcomes (O) |
|------------------|--------------|
| I1 : harvesting  | O1 : social performance measures |
| I2: information sharing | O2: ecological performance measures |
| I3: deliberation processes | O3: externalities performance measures |
| I4: conflicts between actors |           |
| I5: investment activities |           |
| I6: lobbying activities |           |
| I7: self-organizations activities |           |
| I8: networking activities |           |

| Related ecosystems (EKO) |
|--------------------------|
| climate patterns (ECO1), pollutions patterns (ECO2), flows into and out of focal SES (ECO3) |
3. Results and Discussions

3.1 Social-ecological system status

An assessment of all system components proves the SESis value distribution between 0.41-0.89 (Table 1). Resources systems, actors, governance systems, and social, economic and political settings are weak. The four system components do not contribute well to system dynamics. Status of resources units is moderate. Resource units, economic values, number of units, distinctive characteristics, and spatial and temporal distribution make a significant contribution to system dynamics. On the other hand, related ecosystems do not provide significant pressure on the system, so that the status in the system is strong.

| System components | SESis | Status | Interactions (I) | Outcomes (O) |
|-------------------|-------|--------|-----------------|--------------|
| Resources systems (RS) | 0.41  | Weak   |                 |              |
| Resources units (RU) | 0.57  | Moderate |                |              |
| Actors (A)         | 0.48  | Weak   |                 |              |
| Governance system (GS) | 0.46  | Weak   | 0.46            | 0.42         |
| Social, economics, and political setting (S) | 0.47  | Weak   |                 |              |
| Related ecosystems (ECO) | 0.89  | Strong |                 |              |

Utilization capacity and orientation of system users and resource units differ between actors, and have an impact on the development of economic attributes. At the local village level, the local custom-based management model begins to decline in its role, but is useful for reducing resource use conflicts. Investment activity is very weak, and is not supported by interpersonal relationships between resource users and the market. This condition is also not supported by the capacity of users and local village institutions in regulating an adaptive and sustainable resource management system as well as the weakness of management network across villages and across regions.

SES status assessment proves human integration in nature and artificial depiction of the existence of ecological and social systems, and has an important position in determining conditional situations. Relationships in SES provide feedback and have implications for the resilience and complexity of the system [9,10,11]. All aspects related to the use of resources by users are accommodated in complex systems. Some system components and internal variables are integrated at various levels [11,12].

3.2 Implications for coastal areas and small islands management planning

The status of SES shows the consequences of adaptive management to achieve the sustainability of coastal and small island systems. Redistribution and strengthening the economic capacity of actors through diversification of businesses to reduce disparities, increase added value of fisheries, and develop alternative economic activities that are not extractive. Strengthening the capacity for decision-making in local communities is supported by local institutional systems based on local value systems. Strengthening local government capacity is supported by regional regulations [3,6].

The sustainability of the resource system requires effective policy support and implementation, through the determination of the limits of the resource system with the substance of its connectivity. Control of resource system extraction to maintain productivity through rehabilitation of resource systems. Increased understanding of users and policy actors about the nature of the balance of the resource system. Optimization of local wisdom-based coastal and marine resource management systems with the support of developing an understanding of the migration range of important species [5].

Increased understanding of the growth and turnover rates of resource units is supported by strong information systems about the characteristics of resource units. The management model pays attention to
the spatial-temporal dynamics of important species, and can be accommodated through season and area close systems. Increased coordination with non-government organizations and the optimization of their roles comprehensively. Network development of users of resource units and network management institutions, accompanied by a strong information flow system. Strengthening and structuring ownership rights that develop traditionally in the community, and execution rights that are general in nature supported by customary systems [3,5,6].

The consideration of users' socio-economic attributes is a need for strengthening community capacity. Internalization of location access in mapping resource systems in the region to assist in delineating space allocation. Structuring coastal areas and small islands needs to pay attention to the norms that live in the community. Strengthening users' understanding of the important value of resources (ecological, economic and socio-cultural values) to increase their participation in management. Other implications in planning management of coastal areas and small islands must be supported by the development of regional information centers. Increased exchange rates at the local user level and the development of a psycho-CASI approach model among users are important elements of planning at the actor level.

4. Conclusion
The status of the SES in the coastal areas and small islands in the Tanimbar Islands is still weak. Related ecosystems are reinforced in the system, beside unit resources. Innovative strategies for SES-based management must be implemented through structuring social, economic, and collaborative politics, optimizing the management of systems and resource units, developing adaptive governance systems, strengthening user system capacity, reducing the impact of interactions in negative ones collectively reduced, and determining size comprehensive social and ecological performance.

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