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The dynamic of urban and protected areas at Balai Raja Wildlife Reserve, Riau, Indonesia: a social ecology approach

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Abstract. The development process has resulted in deforestation. A comprehensive study is needed to obtain an objective solution by integrating the ecological dimension and human dimension. This study was conducted within Balai Raja Wildlife Reserve (BRWR), Bengkalis Regency, Riau Province, Indonesia. We used the social-ecological systems (SES) approach based on local characteristics, categorized into ecological status, social status and actors. Each factoris ranked using Multi-Dimensional Scaling (MDS).BRWR sustainability levels are in moderate condition. The ecological dimension is in a less sustainable state, with leverage: (1) forest conversion; (2) local ecological knowledge; (3) high conservation value. The social dimension is in a less sustainable state, with leverage: (1) community empowerment; (2) social conflict; (3) participation in landscape management. Dimensions actors are on a fairly sustainable status, with leverage: (1) institutional interaction; (2) stakeholder's commitment; (3) law enforcement. We recommend strengthening community empowerment, local ecological knowledge, interaction, and stakeholder commitment
Keywords: protected area, social ecology, sustainability, urban

1. Introduction

Sumatra Island has lost 6.6 million ha of forest or 557,000 ha per year since the early 1970s. The largest area, about 30% was lost from Riau Province, Indonesia [1]. This condition occurs in areas managed by the public as well as by the state, one of which is Balai Raja Wildlife Reserve (BRWR). Forest areas are subsequently converted to commercial activities, such as settlements, plantations, agriculture, mining, and infrastructure.

Deforestation is closely related to the human dimension, on the one hand, humans have made the greatest contribution to today's landscape changes [2], and on the other hand, human beings are the beneficiaries of the negative environmental impacts [3]. Population growth and urbanization [4] became one of the factors driving natural resource degradation [5], [6]. Therefore, in the context of sustainable area management, we need examining the interrelationships between humans and natural resources, complex and involves identifying feedback relationships among people, resources and institutions [7], [8], [9].

Efforts to improve the knowledge of the multi-dimensional and multi-scale complex interactions between human development and the natural environment have led to novel ideas of social-ecological systems (SES) for studying these processes [10]. Fundamentally, a "social-ecological system" is composed of an ecosystem and the people that interact with it. Such systems are complex and adaptive

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society and environment are considered to "co-evolve" [11]. SESs are systems that include social, economic, and ecological elements as well as the interactions between them. The concept of an SES is useful for protected area (PA) management because it explicitly implies that the manager, other stakeholders, and related institutions are part of a cohesive whole, the system. This, in turn, suggests that approaches that incorporate these elements into dynamic models of system interactions, rather than treating them as immutable external influences on ecosystems, may identify opportunities to enhance the resilience of systems that would otherwise be overlooked. Moreover, PAs do not exist in a vacuum and interact with, contain, and/or are nested within other SESs [12].

2. Research Method

This study was conducted within BRWR (0˚24' N-01˚25' S, 101˚50' E-101˚55' E), Bengkalis Regency, Riau Province, Indonesia from November 2016 to February 2017. This research is conducted through the following stages: (a) desk study; (b) determination of key factors; (c) surveys; (d) data analysis. The type of data used in this study consists of primary data and secondary data. Primary data comes from survey results and focus group discussions (FGDs). Secondary data is obtained from relevant agencies at the national and local levels. We use the modification of SES framework [13], [14] to analyze the ecological status, social status, and actors. The framework can comprise multiple, concurrent sets of each subsystem. Analysis of the socio-ecological status is done with the approach Multi-Dimensional Scaling (MDS) using RAPFISH [15]. As for visualization actors, we use GEPHI [16].

3. Results and Discussion

The results of the analysis show that the BRWR sustainability index for the ecological dimension is 47.06 (less sustainable), social dimension is 47.96 (less sustainable), and the dimension's actors are 59.13 (sustainable enough). The results of Monte Carlo analysis show that 95% confidence level for each dimension is not much difference (relatively small difference). This condition shows that this simulation has a high level of trust. The differences or differences between the sustainability indexes of MDS and Monte Carlo are relatively small, with a range of values of 0.30-0.77. This indicates that the simulation is quite good as one of the BRWR sustainability evaluation tools. The sustainability index has a stress value ranging from 0.13-0.14 and the determination value (R2) between 0.94-0.95. Based on the value of stress smaller than 0.25 and the value of determination (R2) close to 1.0 indicates that the results obtained are quite accurate and can be accounted for. In general, BRWR sustainability levels are in moderate condition. However, this condition still has a chance to turn bad if not anticipated by concrete action and joint action.

Table 1. Result of MDS, Monte Carlo, and statistic analysis.

Dimensions	Sustainability Index		Difference	Statistic	
	MDS	Monte Carlo		Stress	R^2
Ecological	47.06	46.76	0.30	0.13	0.95
Social	47.96	47.56	0.40	0.13	0.95
Actors	59.13	5836	0.77	0.14	0.94

We used 10 attributes to analyze the sustainability of ecological dimensions, namely: (1) ecosystem services; (2) pressure on forests; (3) important conservation values; (4) carbon potential; (5) local wisdom; (6) wildlife; (7) biodiversity; (8) land cover; (9) land use suitability; (10) forest conversion. The ecological dimension is in a less sustainable state, with leverage: (1) forest conversion; (2) local ecological knowledge; (3) high conservation value (Figure 2). BRWR has component complexity and interaction, a mix of PA and urban (Duri City). BRWR has an area of 15,343.95 Ha in accordance with the Decree of the Minister of Forestry Number: 3978/Menhut-VII/KUH/2014.

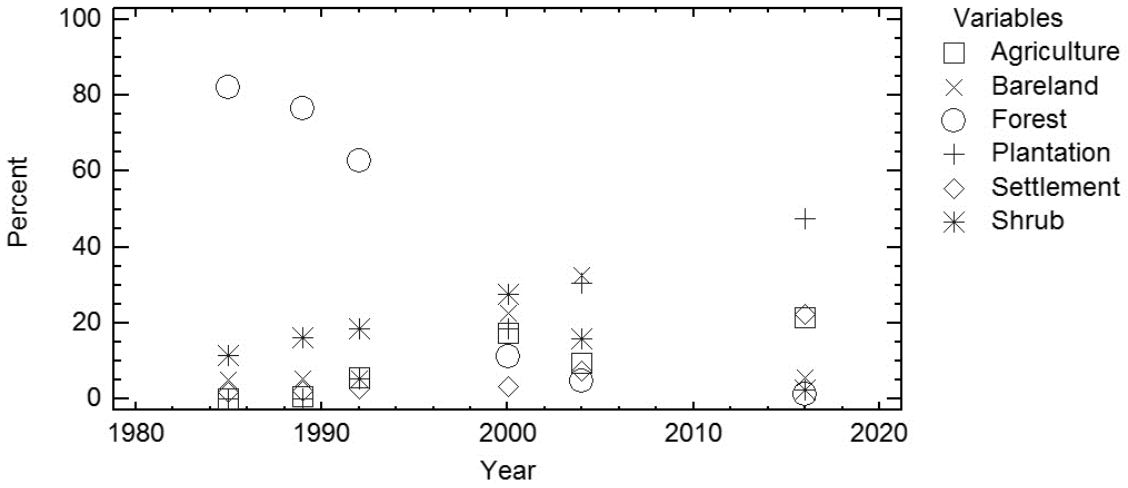


Figure 1. Land cover changes in BRWR (1985-2015).

The result of time series analysis in 1985, 1989, 1992, 2000, 2004 (PPLH IPB & CPI, 2005) and 2015, indicates that there has been a decrease of forest cover area in BRWR as follows 82% (13,705.19 ha), 76.44 % (12,767.78 ha), 62.89% (10,504.84 ha), 11.17% (1,865.88 ha), 4.64% (705.85 ha) and 0.98% (150.66 ha). Thus there is a loss of forests of 4.99% per annum on average. While there was an increase in land use for settlements and bare land from 1985 of 280.51 ha (settlement) and 825.78 ha (bare land) increased in 2004 to 1,103.36 ha (settlement) and 4,947.59 ha (bare land).

The forest conversion occurring at BRWR creates a negative reciprocal relationship. The local wisdom that once was able to maintain harmony between nature and human now loses its existence. In addition, this conversion also poses a threat to high conservation value, such as human-elephant conflict [17] and Tiger [18], [19].

We used 7 attributes to analyse the sustainability of social dimensions, namely: (1) forest area management; (2) community empowerment; (3) public awareness; (4) social conflict; (5) the role of indigenous peoples; (6) participation in landscape management; (7) community education. The social dimension is in a less sustainable state, with leverage: (1) community empowerment; (2) social conflict; (3) participation in landscape management (Figure 2).

Community empowerment is very important in the protection and management of BRWR, as they are the main actors of any policy implementation. Empowerment implemented so far is not optimal, especially in terms of empowerment program, where the role of government is very dominant. So there is a very high dependence on funding from the state, while the state has limited funding. In the end, the implementation of the program cannot be implemented as planned.

Community empowerment is related to social conflict, both as cause and effect. Weak development of partnerships leads to inappropriate relationships. As a result, there is a gap in access to resources that impact on the emergence of social conflict. The issue of social conflict at BRWR shows an increasing intensity, leading to society versus government. On the one hand, communities are prohibited from engaging in conservation areas. On the other hand, the government also issued permits to various activities undertaken by the community. The issue of migrants is very important in this region, as population growth and migrants increase rapidly.

Population growth would have an impact on the increased needs of life. The most significant implication is the conversion of agricultural land into settlements, according to [20], the conversion of agricultural land into settlements in Duri City is 669.68 Ha in the period 1995-2005, and 378.60 Ha in the period of 2005-2015. Not only agricultural land, the dominant change is plantation land of 57.42 Ha in the period 1995-2005 and 64.85 Ha in the period of 2005-2015. Surely this poses a special threat to BRWR's sustainability, due to its adjacent location. In the context of the relationship between urban and protected areas, these conditions can be both opportunities and challenges. The current global

urbanization implies two things of importance. First, that urban environment is getting closer to the large area of global protection [21]. And second, that protection of urban nature is increasingly important for sustainable development of cities as well as safeguarding urban biodiversity as part of global biodiversity [22].

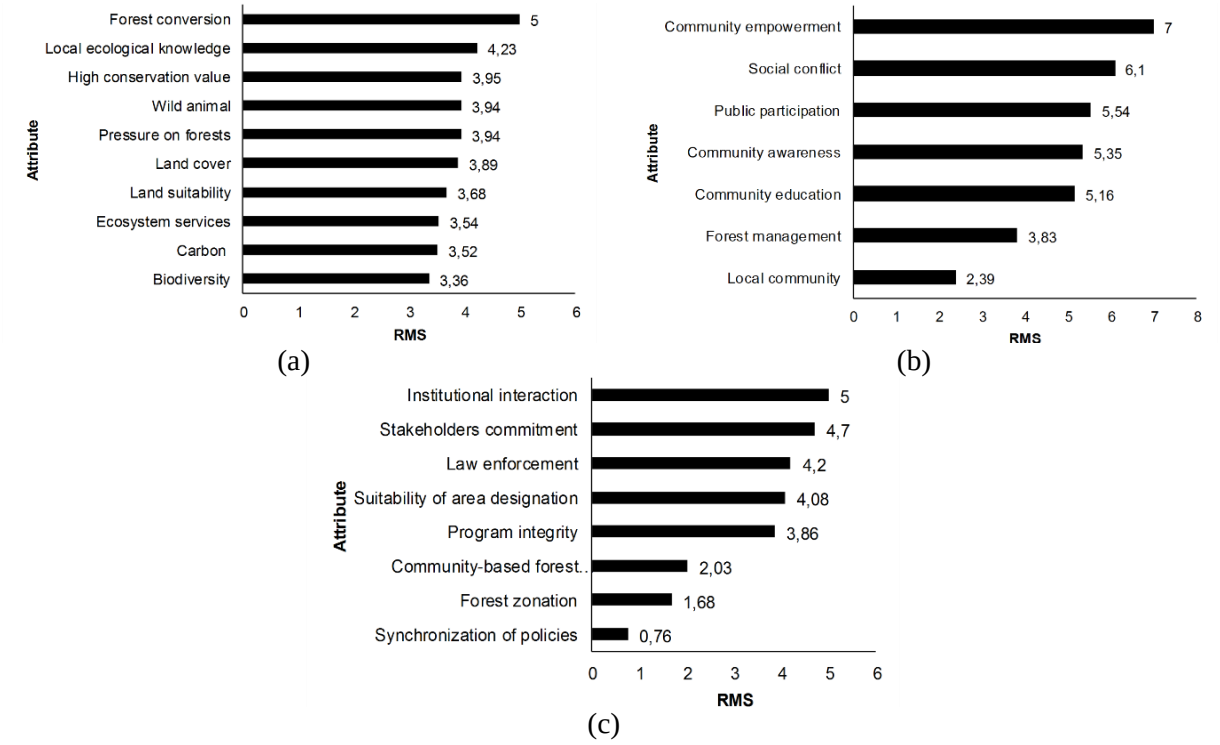


Figure 2. Leverage of attributes on sustainability score: (a) ecological; (b) social; (c) actors.

We used 8 attributes to analyse the sustainability of dimensions' actors, namely: (1) zoning of the region; (2) forest area management; (3) interaction between institutions; (4) the suitability of regional designation; (5) stakeholder's commitment; (6) program integrity; (7) law enforcement; (8) policy synchronization. Dimensions actors are on a fairly sustainable status, with leverage: (1) institutional interaction; (2) stakeholder's commitment; (3) law enforcement.

We analyse stakeholder interactions and identify their contribution to BRWR management. We integrate between nodes and edges, where nodes represent interconnected parties. In Figure 3, the size and colour of the node is proportional to the number of contributions each side: the more they interact, the larger the edge size. The most active parties are Natural Resources Conservation Agency, Environment and Forestry Agency, NGOs, local people, and University. We also consider the intensity of the interaction of stakeholders, represented by the width of each edge, which is proportional to the number of interactions held together. We observed several strong ties between the stakeholders: Natural Resources Conservation Agency-local people, Natural Resources Conservation Agency-law enforcer, NGOs-local people, private company-local people.

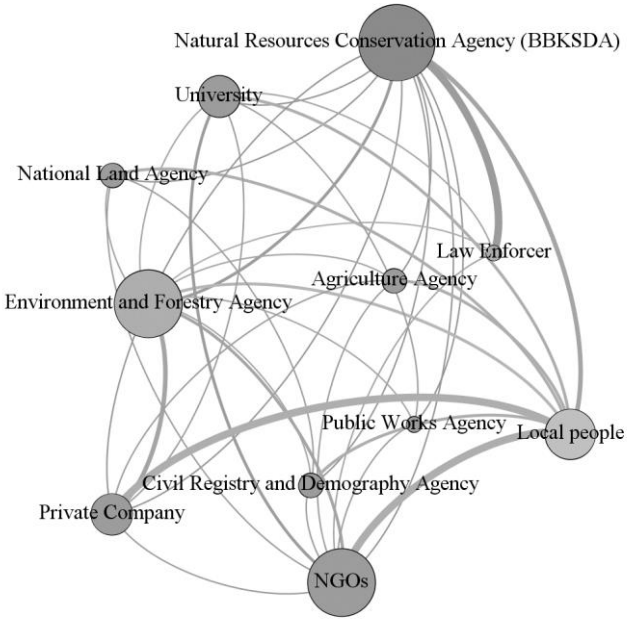


Figure 3. Interaction between actors.

4. Conclusion

BRWR sustainability levels are in moderate condition. The ecological dimension is in a less sustainable state, with leverage: (1) forest conversion; (2) local ecological knowledge; (3) high conservation value. The social dimension is in a less sustainable state, with leverage: (1) community empowerment; (2) social conflict; (3) participation in landscape management. Dimensions actors are on a fairly sustainable status, with leverage: (1) institutional interaction; (2) stakeholders commitment; (3) law enforcement. We recommend strengthening community empowerment, local ecological knowledge, interaction, and stakeholder commitment.

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