JURNAL PENELITIAN KEHUTANAN WALLACEA
eISSN 2407-7860; pISSN 2302-299X
https://doi.org/10.24259/jpkwallacea.v13i1.28096

Article

Social Ecological Resilience System of Ambon Island Protected Forest, Maluku Province, Indonesia

Evelina Parera[1]*, Ris Hadi Purwanto[2], Dwiko Budi Permadi[2], Sumardi[2]

[1] Forest Department, Pattimura University, Jl.Ir. M. Putuhena, Ambon-Maluku, 97234, Indonesia
[2] Forest Management Department, Gadjah Mada University, Jl. Agro Bulaksumur No.1, Caturtunggal, Yogyakarta, Sleman Regency, Special Region of Yogyakarta, 55281, Indonesia
* Correspondence: evlinparera@gmail.com

Received 03 August 2023;
Accepted 18 April 2024;
Published online 30 April 2024

Citation: Parera, P., Purwanto, R.H., Permadi, D.B. and Sumardi. 2024. Social Ecological Resilience System Protected Forest Ambon Island, Maluku Province. JPK Wallacea, Vol. 13 No. 1 pp. 13-24

Abstract. Humans and nature cannot be separated because both have a close relationship as an ecosystem. The purpose of this study was to determine: 1) the level of social and ecological resilience; 2) Scenarios on ecological and social factors for the sustainability of protected forests. The research method uses survey methods and data analysis uses qualitative-verification analysis based on the results of the calculation of the resilience index and the phase of the socio-ecological system. The results showed that the level of social and economic resilience was partially or simultaneously at the level of resilience with their respective indexes: social: 0.6944); ecology: 0.8148 and socio-ecology 0.7460. The exploitation phase (growth) leads to the conservation phase. The results of the scene show that both of them are at a high level of resilience with a resilience index of 0.8889 (high resilience) and a reorganization phase. If this phase can be maintained with various management interventions according to its function, it will minimize the level of disturbance to the Mount Sirimau Protection Forest Group.

Keywords: Disruption, Change, System

INTRODUCTION

Resilience is defined as an ability of a system to absorb changes in state variables, driving variables and parameters and still survive (Holling, 1973); to adapt to unpleasant circumstances (Wagnild & Young, 1993; Rojas, 2015); to adapt and remain firm in difficult situations (Reivich & Shatté, 2002); to adapt well under special circumstances (Snyder & Lopez, 2002; Iacoviello & Charney, 2014); to bounce back (Smith et al., 2008). Resilience is flexibility, resilience, ability to eliminate negative impacts and change conditions for the better (Desmita, 2017).

The resilience system of a forest area is usually measured by social, ecological or combination of social and ecological factors in a socio-ecological system. Indicators of social-ecological systems developed by Ostrom (2009) and McGinnis & Ostrom (2014) namely social, economic and political, resource systems, government systems, resource units, interactions and ecosystems. Resilience calculation methods vary, depending on the research objectives that affect the analysis of data for resilience measurements. Some use an index with a Likert scale which simply calculates only values and weights (Hafsaridewi et al., 2018; Muliani et al., 2020), for further tests to determine the effect of variables with statistical tests (Saraswati & Dharmawan, 2014), assessing livelihood resilience (Kasmiati et al., 2016; Nurhadi et al., 2022), spatial based on changes in land cover (Soraya et al., 2016) and others.

The Mount Sirimau Protection Forest Group was established in 1996, previously the community lived in the vicinity. Community interaction with the protected forest is high. This is because the community claims it as a customary forest so it has a close relationship religiously, socially, and economically with the forest. Therefore, the community highly respects the forest by obeying the rules handed down by their ancestors. However, in recent decades there have been disturbances of flooding during the rainy season, drought in several places around protected forests and even fires. There was a significant change in land cover from 1999 when four land covers changed to seven land covers in 2019 (Parera et al., 2021). This indicates that there has been a significant disturbance in the protected forest. However, how much the forest is disturbed can be measured by the resilience index of social and ecological factors. Therefore the theme of this article is Social and Ecological System Resilience of the Mount Sirimau Protected Forest Group, Ambon City, Maluku Province; to know: 1) The level of social and ecological resilience; 2) Scenario on ecological and social factors for protection forest sustainability. This research is expected to provide consideration in the management of the Mount Sirimau Protected Forest Group.

MATERIAL AND METHODS

Study Site

The research location is the Mount Sirimau Protected Forest Group, Ambon City, Maluku Province (Figure 1). This location was chosen as the sample because it is strategic in the upstream area of Ambon City so if there is disturbance in the protected forest it will disrupt activities downstream in Ambon City.

The research method used is a survey method. This method is used to obtain data that occurred in the past or present, regarding beliefs, opinions, characteristics, behavior of variable relationships and to test several hypotheses about sociological and psychological variables from the sample (Sugiyono, 2018).

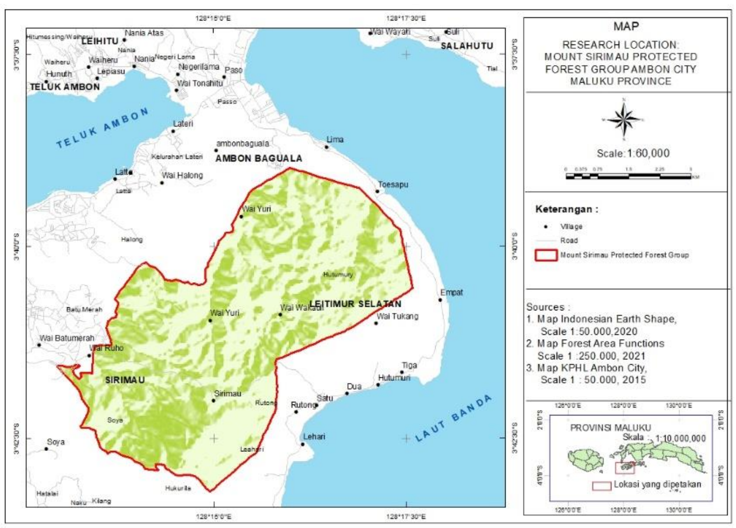

Figure 1. Research Location of Mount Sirimau Protected Forest Group, Ambon City, Maluku Province

Sampling Method

The sampling method for the community is purposive sampling. Intake is made of respondents for social data collection. Respondents taken were 149 people who work as farmers spread over the villages of Hutumuri, Hukurila and Soya. There were 13 key informants, namely related government agencies, community leaders and heads of Soa.

Data collection

Social Data Collection

This research method is a survey method. Data collection was carried out by filling out questionnaires and in-depth interviews. The questionnaire contains the characteristics of the respondents, interactions and community perceptions of protected forests.

Ecological Data Collection

Collection of ecological data in the form of secondary data. The data collection is based on the Biogeophycal Inventory report conducted by the 2015 Maluku Forest Area Consolidation Agency (BPKH, 2015). Ecological data includes flora, fauna, soil types, and rock types. Other documents related to research.

Stakeholders Data Collection

The collection of data on stakeholders involved in the management of protected forests uses the snowball method, starting with the Head of the Protected Forest Management Unit on Ambon Island and Lease Islands. The data collected includes the role and involvement of stakeholders in the management of protected forests.

Data analysis

Data analysis by descriptive analysis. This analysis is used to describe the condition of phenomena in the field without testing hypotheses (Ghozali, 2011). The data collected is tabulated and depicted in graphical form.

Stages in Data Analysis

1. *Identification of social and ecological indicators*

The parameter indicators are based on the results of data analysis on the Socioeconomic and Biogeographical characteristics of the Protected Forest Group. Social Indicators (Folke et al., 2002; Walker and Salt, 2006; Krasny and Tidball, 2009; Purnomo & Suryawati, 2009; Cutter et al., 2010; McGinnis & Ostrom, 2014; Ciptaningrum & Pamungkas, 2017; Arkham et al., 2021; modification, 2022): age, education, livelihood, number of dependents, distance of residence, community income, community perception of protected forests, stakeholder complexity, stakeholder involvement, role of indigenous peoples, management of protected forests by the government, forest management protected by society.

Ecological indicators (Odum, 1996; Wirakusumah, 2003; Modification, 2022): vegetation diversity, vegetation density, fauna diversity, water resources, soil type, rock type, slope, rainfall, land cover change.

2. *Scoring on each indicator element*

Scoring on each indicator element with the following score categories: Score: 1 = low; 2 = enough; 3 = height.

3. *Calculation of Resilience Index*

Calculation of the resilience index uses the formula (Cutter et al., 2010; Hafsaridewi, 2018; Muliani et al., 2020; Modification, 2022).

$$\text{Social Resilience Index} = \frac{\text{Total score of social indicators}}{\text{Total maximum score of social indicators}} \quad (1)$$

$$\text{Ecology Resilience Index} = \frac{\text{Total score of ecology indicators}}{\text{Total maximum score of ecology indicators}} \quad (2)$$

4. *Determine the level of resilience*

$$\text{Social-Ecology Resilience Index} = \frac{\text{Total score of sosial-ecology indicators}}{\text{Total maximum score of sosial-ecology indicators}} \quad (3)$$

Determine the level of resilience based on an index scale where 0 is the lowest and 1 is the highest. (Figure 2).

Figure 2. Classification of resilience (Muliani et al., 2020)

5. *Defining Social Ecology System (SES) Phases*

Social Ecology System (SES) phase determination based on the social-ecological resilience index. The SES resilience phase consists of four phases, namely Growth (Exploitation), which is the growth phase (r), Conservation, which is the conservation phase (K), Release, which is the overhaul phase (Ω), and Reorganization, which is the reorganization phase (α) (Holling et al., 2002) (Figure 3).

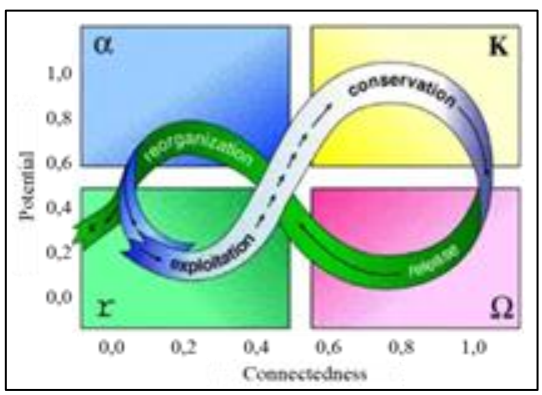

Figure 3. The cycle of ecosystem function phases (R, K, Ω, α) (Holling et al., 2002; Muliani et al., 2020; Modification, 2022)

The exploitation stage (r) is the stage where growth occurs very quickly. The system will grow to a point where connectedness is very high and growth capacity is saturated, a condition where growth slows down and the system enters the conservation (K) stage. Systems in the K stage will be very complex, making them vulnerable to disturbances. A certain amount of disturbance will cause the system to collapse, releasing resources rapidly. This stage is called the discharge stage (Ω). When the system has collapsed, it can re-collect the resources it released to grow into a system with the same identity, or into a completely different new system, creating an unbroken cycle (α).

Data analysis

The data analysis used is a qualitative-verification data analysis strategy (Bungin, 2010). This analysis is used to explain various phenomena that occur and describe them based on theory. Data was collected as much as possible and analyzed inductively from all data obtained throughout the research process.

RESULTS

Level of social, ecological, and socio-ecological resilience

The level of resilience, social, ecological, and socio-ecological of the Mount Sirimau Protected Forest Group can be seen in Table 1.

Table 1. Index of Social and ecological resilience of the Mount Sirimau Protected Forest Group

Indicator	Exsisting		Scenario	
	Score	Maximal Score	Score	Maximal Score
Social				
Age	2	3	3*	3
Education	2	3	3*	3
Livelihood	3	3	3	3
The number of dependents	3	3	2*	3
Distance of residence to protected forest	1	3	1	3
Community income	2	3	3*	3
Community Perceptions of protected forests	3	3	3	3
Stakeholder complexity	3	3	3	3
Stakeholder engagement	1	3	3*	3
The Role of indigenous peoples	2	3	3*	3
Government-protected forest management	1	3	2*	3
Community-protected forest management	2	3	3*	3
Total Score of Sosial	**25**	**36**	**32**	**36**
Existing Social Resilience Index	**0.6944**			
Scenario Social Resilience Index			**0.8889**	
Ecology				
Vegetation diversity	2	3	3*	3
Vegetation density	2	3	3*	3
Fauna diversity	2	3	3*	3
Water resources	2	3	3*	3
Type of soil	3	3	3	3
Rock type	3	3	3	3
Slopes	3	3	3	3
Rainfall	3	3	3	3
Land cover change	2	3	1	3
Total Ecology Score	**24**	**27**	**24**	**27**
Eksisting Social Resilience Index	**0.8148**			
Scenario Social Resilience Index			**0.8889**	
Total Social Ecology Score	**47**	**63**	**56**	**63**
Existing Ecological and Social Resilience Index	**0.7460**			
Scenario Ecological and Social Resilience Index			**0.8889**	

Description : * = Scenario

Table 1 shows the existing social resilience index of 0.6944 in the resilience category. The existing ecological resilience index is 0.8148 including the resilience category. The existing socio-ecological resilience index is 0.7460, belonging to the resilience category. The results of the scenario partially social and ecological aspects and simultaneously show high resilience as indicated by the resilience value of 0.8889.

DISCUSSION

Social resilience

Social resilience parameters that have a high (maximum) value are livelihoods, number of dependents, community perceptions of protected forests, and stakeholder complexity, while other parameters are low – sufficient (Table 1). The livelihoods of the people around the protected forest are dominated by farmers so the intensity of interaction with protected forests is especially high, besides that the claim to be indigenous people also affects the intensity of interaction if there are domestic (village) traditional rituals. The number of family dependents is high because generally, children who are already married live together, especially those who do not have a permanent job, so they are still under the responsibility of their parents. People's perceptions of protected forests are high because they have managed these forests from generation to generation and the rules, advice, advice for protecting forests for the benefit of their children and grandchildren and most importantly related to customs. High stakeholder complexity in protected forest management. Since it was designated as a protected forest, management authority has changed and many related agencies have partially intervened in activities so that management conflicts tend to occur.

Ecological resilience

Parameters with high values are physical parameters, namely soil type, rock type, relative humidity, and rainfall (Table 1). The physical condition of protected forests is very vulnerable to extreme conditions, namely the rainy season and long hot summers. The soil type Dystropepts is included in the soil type Inceptisols, sub-order Tropept and great group Dystropteps, meaning that the soil type does not have sulfidic material at a depth of less than 50 cm from the mineral soil surface, soil temperature regime iconic or hotter, base saturation <50%. Sulfidic materials or acid sulphates are materials which, when oxidized, increase the acidity of the soil so that toxic elements are concentrated (Hardjowigeno, 2002). Haplorthoxs soil type is Oxisol soil type, soil that has an oxic horizon at a depth of > 150 cm, sub-order torrox means that the soil moisture regime is aridic or dry, great group haplorthox means another torrox (Hardjowigeno, 2002). Soil type Hydraquents, order Entisol soil types that have sulfidic material ≤ 50 cm, or always saturated with water, suborder aquents, always wet or wet in certain seasons, great group hydraquents means very soft, low bearing capacity (Hardjowigeno, 2002).

The type of rock in the protected forest is Ambon volcanic rock. Kanikeh Formation Raised Coral Reef and Ultramafic Rocks. These rock types are brittle and prone to landslides with steep slopes because the slopes in protected forests are 15-45%. Rainfall on Ambon Island is relatively high, so the protected forest is prone to landslides and flooding downstream in Ambon City. Conversely, it is also prone to drought if the dry season is long.

Changes in land cover are quite high because there have been changes in land cover reaching seven classes of land cover over the last 20 years (Parera et al., 2021). In addition to the natural disaster, fire, and population pressure, government policies allow residents to be victims of the social conflict in Maluku in 1999.

Socio-ecology Resilience

Socio-ecology simultaneously influences the protected forest. The socio-ecological condition of the Mount Sirimau Protected Forest Group is in the growth (exploitation) phase (Figure 4).

This phase shows that the Mount Sirimau Protected Forest Group is at a stage where growth occurs very quickly. The system will grow to a point where connectedness is very high and growth capacity is saturated, a condition where growth slows down and the system enters the conservation (K) stage. This condition occurs naturally, a lack of intervention in supporting the growth of protected forests. This is also related to the management of protected forests. During this decade, protected forests were still under management and always started from the beginning, the transfer of management authority was due to changes in government policies and the management of protected forests had not been properly filed so the management was not sustainable and partial.

On the other hand, the community only cares for plants that have been passed down from generation to generation using traditional agroforestry systems (dusung) which are old plants. Some plant new trees but not significantly due to limited resources in land rehabilitation such as availability of seeds, assistance from related agencies limited to the project period and others.

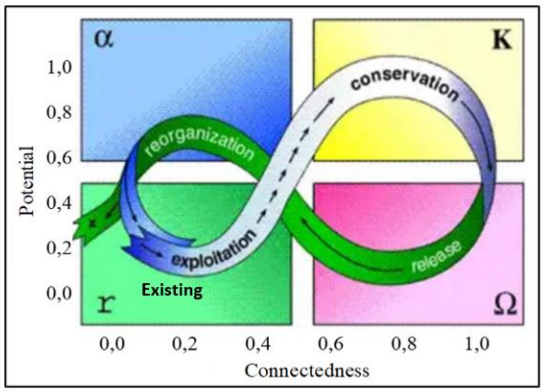

Figure 4. The cycle of ecosystem function phases (R, K, Ω, α) in the current (Existing) Mount Sirimau Protected Forest Group (Holling et al., 2002; Modification, 2022)

Scenario of social and ecological resilience level

Even though it is a protected forest area, it does not mean that it is left alone, but it must be managed properly by applicable regulations so that it will maintain its function as a protected forest. Parameters of social indicators that can be engineered are age, education, number of dependents, community income, stakeholder involvement, role of indigenous peoples, and management of protected forests by the government and the community. It is hoped that the age of the people involved will be more productive so that they can drive the management of protected forests more. It is hoped that the education of the people involved in the management of protected forests will increase to make it easier to understand protected forest management so that it is more developed according to science and technology. The number of community dependents is expected to be lower so as not to have a significant effect on the exploitation of protected forests. This is also related to the community's income from various sources of income related to the management of protected forests that only utilize environmental services and non-timber forest products. Increased income due to diversity of livelihoods and sources of income. The more diverse livelihoods and income sources, the higher the level of resilience (Wilson et al., 2018; Nasdian et al., 2020). Collaborative engagement of stakeholders is expected to optimize protected forest management. The role of indigenous peoples is more optimized in every stage of protected forest management. Management of protected forests by the government and the community is partially improved and simultaneously collaborative.

Ecological indicator parameters that can be engineered are density and diversity of vegetation, diversity of fauna, water resources and changes in land cover. Ecological resilience indices that are expected to increase with changes in social indicators are the diversity and density of vegetation. There is intensive land rehabilitation due to the collaborative involvement of stakeholders which affects the diversity of fauna, increased water resources and changes in land cover. The results of research by Amalia et al., (2015) state that the factors that affect household resilience due to changes in the ecological landscape are gender, number of family members, level of financial capital, household income and level of trust in the network. The scenario results as shown in Table 1 show a high level of resilience for social systems, ecological systems and socio-ecological systems so that they are in the reorganization phase (Figure 5).

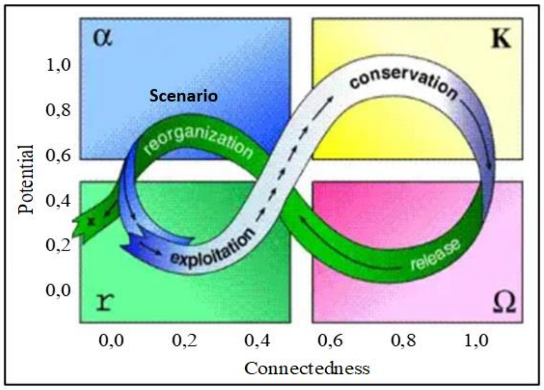

Figure 5. The cycle of ecosystem function phases (R, K, Ω, α) in the future Mount Sirimau Protected Forest Group (Scenario) (Holling et al., 2002; Modification, 2022)

Figure 5 shows the Mount Sirimau Protection Forest Group. In this phase, the Mount Sirimau Protected Forest Group has collapsed in a systemic way, it can collect the resources it has released again to grow into a system with the same identity, or become a new system that is completely different, creating an unbroken cycle. This scenario is expected to take place in the Mount Sirimau Protected Forest Group. Scenario parameter indicators for socio-ecological systems to minimize future conditions for protected forests.

Berke et al. (2012) developed a set of principles to guide the improvement of hazard mitigation such as hazard, vulnerability, capability and risk assessment, mitigation policies, monitoring and coordination with local government. Many factors influence the social ecological system as mentioned by Benson and Garmestani (2011); Allen et al. (2011) although the stated policies are good, their operations are limited due to large-scale ecological and social systems, lack of understanding of complex socio-ecological systems, lack of measurable metrics to measure resilience, incompatibility of resilience thinking with institutional frameworks and management objectives, inadequate legal and regulatory frameworks, and lack of funding (Benson & Garmestani, 2011; Allen et al., 2011). Therefore it is necessary to develop a complex management framework in accordance with inputs and outputs related to the social-ecological system to be produced as proposed by (Harrald, 2012) proposing a logical framework with input, output, activity and outcome measures, to develop a community that can resilience metrics are measured based on socio-economic indicators, social networks, and emergency response capabilities. In addition to making decisions in maintaining protected forests, a comprehensive resource management is also needed which is expected to achieve the goal of socially and ecologically sustainable protected forest management. Management of protected forest social-ecological systems can refer to the framework developed by Williams & Brown, (2012); Brown & Williams, 2015) (Figure 6). The framework describes the context of a systems resilience analysis that includes decision making based on management objectives to maintain the system.

Figure 6 shows framework for resilience management resource systems is affected by management and other external supports, as well as internal resource processes. In combination, these factors affect sustainability and resilience, which in turn can inform future management actions (Brown & Williams, 2015). Figure 6 shows the supporting factors in resilience management, there are disturbance factors that can disrupt the resource system, be it structure, function, process or scale, which will affect management goals and objectives, and resilience and sustainability can occur. Therefore it is necessary to do management (management) by analyzing decisions and adaptive feedback to the resource system. This phenomenon occurs in the Mount Sirimau Protected Forest Group so that the management framework can be carried out schematically and cyclically following the system cycles that occur in nature by the objectives of managing natural resources which are generally in a sustainable phase.

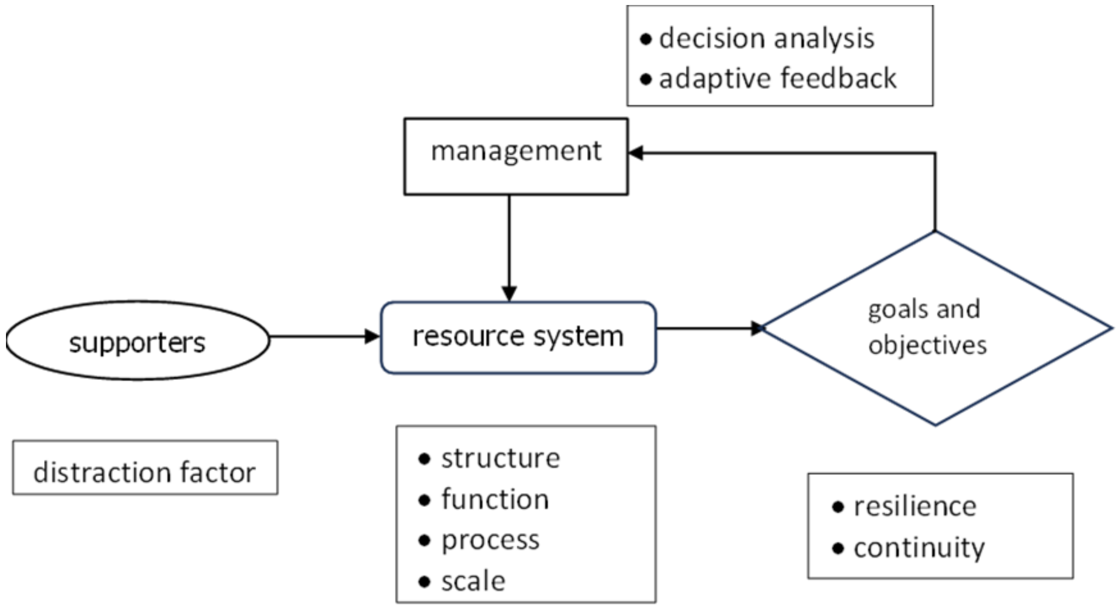

Figure 6. Framework for resilience management resource systems (Brown & Williams, 2015).

CONCLUSION

Humans and forests cannot be separated even though the systems are different, but they can be united in a social-ecological system (SES). The integration of the two systems can be measured by a resilience index to know the phases that occur in the system to carry out engineering (scenarios) for sustainability management to minimize social and ecological trade-offs. The Mount Sirimau Protected Forest Group is currently in the growth (exploitation) phase if the scenario will move into the reorganization phase. To sustain the reorganization phase, a management framework that is collective, comprehensive and simultaneous in the socio-ecological system is needed.

ACKNOWLEDGMENT

Thanks are conveyed to the Director of Higher Education as the donor of Domestic Postgraduate Education Scholarships, the Regional Technical Implementation Unit of the Ambon Island Forest Management Unit (FMU) and Lease Islands, the Maluku Provincial Forestry Service, the Technical Implementation Unit regarding the scope Ministry of Forestry; The government and people of Hutumuri village, Soya village and Hukurila village who have facilitated the data and spent their time in this research.

AUTHOR CONTRIBUTIONS

Evelin Parera: main contributor, processing, data interpretation, script writing. Ris Purwanto: member contributor, script writing, script review. Dwiko Permadi: member contributor, script writing, script review. Sumardi: member contributor script writing, manuscript review.

CONFLICTS OF INTEREST

There is no conflict of interest related to financial financing and authorship orders for this article.

REFERENCES

Allen, C. R., Cumming, G. S., Garmestani, A. J., Taylor, P. D., & Walker, B. H. (2011). Managing for resilience. Wildl Biol 17:337–349. http://dx.doi.org/10.2981/10-084.

Amalia, R., Dharmawan, A. H., & Putri, E. I. K. (2015). Perubahan Lanskap Ekologi Dan Resiliensi Nafkah Rumahtangga Petani Di Sekitar Hutan Di Kalimantan Timur. Sodality: Jurnal Sosiologi Pedesaan, 3(3), 121–127. https://doi.org/10.22500/sodality.v3i3.10643.

Arkham, M. N., Wahyudin, Y., Kelana, P. P., Haris, R. B. K., & Sari, R. P. (2021). Studi Penilaian Resiliensi Nelayan Dalam Pengelolaan Ekosistem Terumbu Karang Di Pulau Biawak, Kabupaten Indramayu. Samakia : Jurnal Ilmu Perikanan, 12(1), 1–17. https://doi.org/10.35316/jsapi.v12i1.855.

Balai Pemantapan Kawasan Hutan (BPKH) Wilayah Maluku. (2015). Laporan Hasil Inventarisasi Biogeofisik Kesatuan Pengelolaan Hutan Lindung (KPHL) Unit XIV. Di Kecamatan Sirimau Kota Ambon Provinsi Maluku. Ambon : Balai Pemantapan Kawasan Hutan Wilayah IX.

Benson, M. H., & Garmestani A. S. (2011). Embracing panarchy, building resilience and integrating adaptive management through a rebirth of the National Environmental Policy Act. Journal of Environmental Management 92:1420-1427. https://dx.doi.org/10.1016/j.jenvman.2010.10.011.

Berke, P., Smith, G., & Lyles, W. (2012). Planning for Resiliency: Evaluation of State Hazard Mitigation Plans under the Disaster Mitigation Act. Natural Hazards Review, 13(2), 139–149. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000063.

Brown, E. D., & Williams, B. K. (2015). Resilience and Resource Management. Journal Environmental Management, 56(6), 1416–1427. https://doi.org/10.1007/s00267-015-0582-1.

Ciptaningrum, M. U., & Pamungkas, A. (2017). Penilaian Resiliensi Dimensi Sosial Berdasarkan Konsep Climate and Disaster Resilience Initiative (CDRI). Jurnal Teknik ITS, 6(2). https://doi.org/10.12962/j23373539.v6i2.25028.

Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster Resilience Indicators for Benchmarking Baseline Conditions. Journal of Homeland Security and Emergency Management, 7(1). https://doi.org/10.2202/1547-7355.1732.

Desmita. (2017). Psikologi Perkembangan Peserta Didik. Remaja Rosdakarya. Bandung.

Folke C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, CS., Walker, B., Bengtsson, J., Berkes, F., Colding, J., Danell, K., Falkenmark, M., Gordon, L., Kasperson, R., Kautsky, N., Kinzig, A., Levin, S., Maler, K. G., Moberg, F ., Ohlsson, L., Olsson, P., Ostrom, E., Reid, W., Rockstrom, J., Savenije, H., & Svedin, U. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in A World of Transformations. Report for the Swedish Environmental Advisory Council 2002:1. Stockholm: Ministry of The Environment. www.mvb.gov.se and also ICSU Series on Science for Sustainable Development No. 3, 2002. Paris : International Council for Science. https://www.researchgate.net/ publication/11086054.

Ghozali, I. (2011). Aplikasi analisis multivariate dengan program SPSS. Semarang : Badan Penerbit Universitas Diponegoro.

Hafsaridewi, R., Khairuddin, B., Ninef, J., Rahadiati, A., & Adimu, E. (2018). Pengelolaan Wilayah Pesisir Secara Terpadu. Buletin Ilmiah"MARINA" Sosial Ekonomi Kelautan Dan Perikanan, 4(2), 61–74. https://www.researchgate.net/publication/337988891.

Harrald, J. (2012). The case for resilience: A comparative analysis. International Journal of Critical Infrastructures, 8 (1), 3–21. https://doi.org/10.1504/IJCIS.2012.046550.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics. 4050:1-23. https://www.jstor.org/stable/2096802.

Holling, CS., Gunderson, LH., Ludwig, D. (2002). In Quest of Theory of Adaptive Change. In: Gunderson LH, Holling CS (editor). Panarchy: understanding transformations in human and natural systems. Washington (DC): Island Press.

Hardjowigeno, S. 2002. Ilmu Tanah. Jakarta : Mediyatama Sarana Perkasa.

Iacoviello, B. M., & Charney, D. S. (2014). Psychosocial facets of resilience: implications for preventing posttrauma psychopathology, treating trauma survivors, and enhancing community resilience. European Journal of Psychotraumatology, 5, 1–3. https://doi.org/10.3402/ejpt.v5.23970.

Krasny, ME., & Tidball, KG. (2009). Social-Ecological System Resilience, Role of Environmental Education. Canada: World Environmental Education Congress Montreal.

Kasmiati, Dharmawan, A. H., & S. Bratakusumah, D. (2016). Ekowisata, Sistem Nafkah dan Decoupling Sustainability di Wakatobi, Sulawesi Tenggara. Sodality: Jurnal Sosiologi Pedesaan, 4(2). https://doi.org/10.22500/sodality.v4i2.13391.

McGinnis, M. D., & Ostrom, E. (2014). Social-ecological system framework : initial changes and continuing. Journal Ecology and Society, 19(2). http://dx.doi.org/10.5751/ES-06387-190230.

Muliani, Adrianto, L., Hariyadi, S., Rahman, & Ali, M. (2020). Resiliensi sistem sosial ekologi kawasan desa pesisir Kabupaten Subang. Jurnal Grouper, 11(2), 33–44. https://doi.org/10.30736/grouper.v11i2.74.

Nasdian, F. T., Katrina Pandjaitan, N., & Ardinal Barlan, Z. (2020). Community Resilience of Mining Area and Food Vulnerability in South Kalimantan. Sodality: Jurnal Sosiologi Pedesaan, 8(1), 47–63. https://doi.org/10.22500/8202028246.

Nurhadi, I., Sumarti, T., Hadi Dharmawan, A., & S Damanhuri, D. (2022). Cultural Commodification and Ethical Transition of Tourism Development: A Case in Osing Community, Indonesia. Sodality: Jurnal Sosiologi Pedesaan, 10 (1), 24–43. https://doi.org/10.22500/10202238564.

Odum, EP. (1996). Dasar-dasar Ekologi (Penerjemah: Samingan, Tj). Edisi Ketiga. Yogyakarta : Gadjah Mada University Press.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. Science 325:419-422. http://dx.doi.org/10.1126/science.1172133.

Parera, E., Hadi Purwanto, R., Budi Permadi, D., & Sumardi. (2021). Changes in Land Cover of the Mount Sirimau Protected Group, Ambon City Maluku Province. International Journal of Advanced Research, 9(01), 877–885. https://doi.org/10.21474/ijar01/12364.

Purnomo, A. H., & Suryawati, S. H. (2009). Siklus Adaptif, Resiliensi dan Isu Keberlanjutan di Segara Anakan. Jurnal Bijak Dan Riset Sosek, 4(2), 157–173. doi:10.15578/jsekp.v4i2.5827.

Reivich, K & Shatté, A. (2002). The Resilience Factor: 7 Essential Skill For Overcoming Life's Inevitable Obstacle. New York: Broadway Books.

Rojas F., L. F. (2015). Factors Affecting Academic Resilience in Middle School Students: A Case Study. GiST Education and Learning Research Journal, 11(11), 63–78. https://doi.org/10.26817/16925777.286.

Saraswati, Y., & Dharmawan, A. H. (2014). Resiliensi Nafkah Rumahtangga Petani Hutan Rakyat di Kecamatan Giriwoyo, Wonogiri. Sosiologi Pedesaan, 02(01), 63–75. https:doi.org/10.22500/sodality.v2i1.9413.

Soraya, E., Wardhana, W., & Sadono, R. (2016). Pemodelan Spasial Resiliensi Ekosistemn Gunung Api Merapi Pasca Erupsi. Jurnal Ilmu Kehutanan, 10(2), 86–97. https://doi.org/10.22146/jik.16509

Sugiyono. (2018). Metode Penelitian Kombinasi (Mixed Methods). Bandung : CV Alfabeta.

Smith, P.H.F., Broadmeadow, M.S.J. & Lynch, J.M. (2008). Forest and climate change: The knowledge-base for action. In Smith, P.H.F, Broadmeadow, M.S.J & Lynch, J.M (Ed), Forestry and climate change (pp. 38-48). UK.Snyder C.R, & Lopez S.J. (2002). Handbook of positive psychology (Vol. 000, p. 2382). https://doi.org/10.1007/s10980-008-9299-3.

Snyder, CR, & Lopez, SJ. (2002). Handbook of positive psychology (Vol. 000, p. 2382). https://awspntest.apa.org/record/2002-02382-000.

Wagnild, G. M., & Young, H. M. (1993). Development and psychometric evaluation of the Resilience Scale. Journal of Nursing Measurement, 1(2), 165–178. https://psycnet.apa.org/record/1996-05738-006.

Walker, B. H., & Salt, D. A. (2006). Resilience Climate, History and Human Action. Thinking: Sustaining Ecosystems and Columbia University Press, New York. People in A Changing World. Washington, D.C., USA: Island Press.

Wilson, J., Gering, S., Pinard, J., Lucas, R., & Briggs, B. R. (2018). Bio-production of gaseous alkenes: Ethylene, isoprene, isobutene. Biotechnology for Biofuels, 11(1). https://doi.org/10.1186/s13068-018-1230-9.

Wirakusumah, S. (2003). Dasar-dasar Ekologi Bagi Populasi dan Komunitas. Jakarta: UI Press.

Williams, BK., & Brown, ED. (2012) Adaptive management: the U.S. Department of the Interior Applications Guide. Washington, DC: Department of the Interior.