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Adaptation of Mangrove Ecotourism Management to Coastal Environment Changes in the Special Region of Yogyakarta

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Abstract:

Ecotourism is a practice of utilizing natural ecosystems to support education and conservation efforts. In the Special Region of Yogyakarta (SRY), Indonesia, two mangrove ecosystems have been designated as protected areas and ecotourism sites. However, it is undeniable that the need for space for infrastructure development has been detrimental to these areas. This research set out to identify changes occurring nearby mangrove ecosystems and the impacts they would potentially have in the future. It used a triangulation method that combined secondary data analysis, observation, and primary data collection through in-depth interviews. The observed coastal environments experienced, among others, extensive conversion of agricultural land for the Yogyakarta International Airport (YIA) construction, increased tourism growth and pressures, and varying artificial modifications in parts of mangrove ecosystems utilized for mass tourism; all of which could disrupt sustainability and reduce the ecological functions of mangroves. Intensive aquaculture and iron sand mining in the vicinity could also negatively affect the mangrove ecosystem and ecotourism. Within a certain period, these anthropogenic activities are most likely to pose significant threats to the preservation of mangrove ecotourism. Regional spatial plans are an example of instruments required to regulate sustainable spatial planning and protect mangrove ecosystems.

Keywords: Baros and Jangkaran mangrove ecotourism; in-depth interview; observation; environmental change; infrastructure development.

JEL Classification: Q57; R11.

Introduction

The Special Region of Yogyakarta (SRY), a province on Java Island, Indonesia, has a stretch of coastal area in the south with great potential for tourism (Giri *et al.* 2011). It offers natural beauty, and as such, nature tourism contributes substantially to the regional income (Salem and Mercer 2012). Apart from beautiful strands, the coastal area also comprises special interest tourist attractions, mangrove ecosystems (Hakim, Soemarno and Hong 2012. Most mangrove populations are found on the northern side of the island because its physiography allows the formation of muddy environments—*i.e*., preconditions for proper mangrove growth (Hakim, Siswanto and Nakagoshi 2017), while the few mangrove forests in the south grow separately in several locations. SRY has two attractions that make use of mangrove ecosystems and have incorporated not only ecotourism but also conservation principles in their management: Jangkaran Mangrove Ecotourism (Kulonprogo Regency) and Baros Mangrove Ecotourism (Bantul Regency). However, locally, mangrove ecotourism is less highly popular than beach tourism, considered to result from the seemingly inevitable appeals of coral reef and sand. Besides, the less desirability of mangrove tourism may be caused by the muddy environment, root structure, and dense tree canopy that, instead of attracting visitors, present obstacles for easy access (Hakim, Siswanto and Nakagoshi 2017).

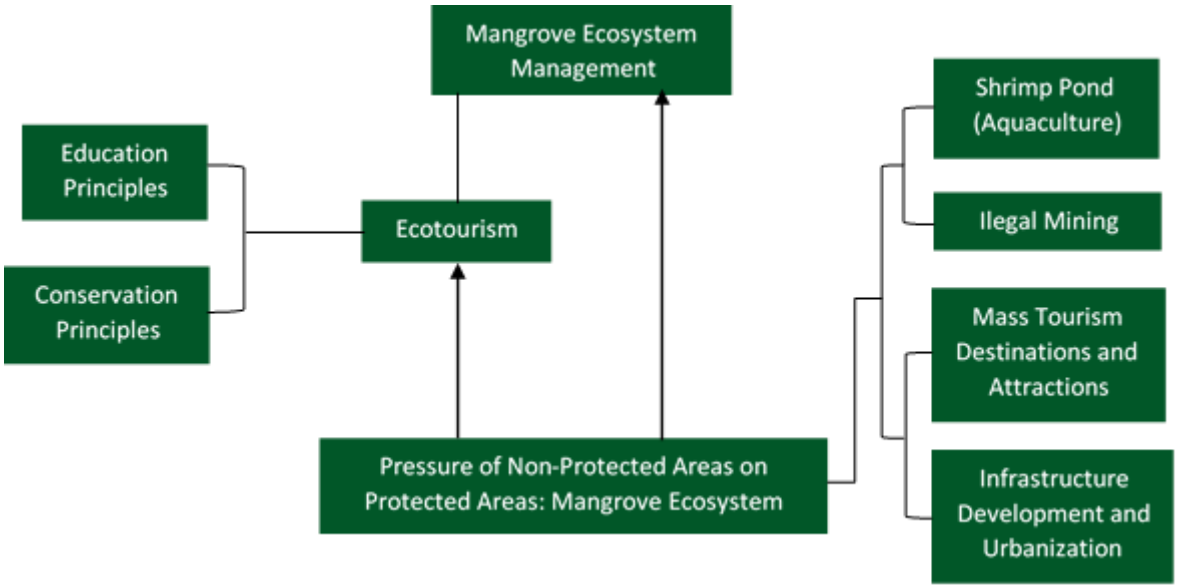
The mangrove ecosystem brings considerable benefits to coastal areas in SRY (Khakhim *et al.* 2019b). Waves at the Indian Ocean can be severely destructive unless there are natural breakwaters along coastal areas dissipating their energy (Mardiatno 2013). As evidence, a mangrove ecosystem acted as a barrier withstanding the forces of waves and abrasion during a storm event induced by Tropical Cyclone Cempaka in 2018, averting economic harms to coastal communities. Moreover, it provides habitats for various fauna, such as birds, reptiles, fish, and crustaceans (Garcia, Malabrigo and Gevana 2014). Apart from environmental benefits, mangrove ecosystems have also been used for research, niche tourism, and ecotourism (as a major part of conservation efforts). In principle, ecotourism aims to preserve the environment and provide education to tourists, which will eventually raise public awareness of environmental preservation among visitors, attraction managers, and local communities. Ecotourism differs from nature tourism in that its practices involve a transfer of knowledge to tourists; this may include education on environmental awareness, conservation, and eco-friendliness. Nevertheless, achieving this purpose is not without hurdles. Some ecotourism attractions still lack supporting facilities and information (*e.g.,* tourist information centers, biodiversity database, educational tourism programs), the capacity to assess mangrove resources, local people involvement, and local government's support and attention (Hakim, Siswanto and Nakagoshi 2017).

SRY is among the Indonesian regions in dire need of infrastructure development (Rijanta, Baiquni, dan Rachmawati 2018). Increasing airport capacity and building toll roads and other supporting infrastructure are current development priorities. The construction of Yogyakarta International Airport (YIA) on the coast of Kulonprogo was just completed. Also, the South Outer Ring Road is an ongoing construction supporting the central government's agenda to create a balance between the northern and southern coastal areas of Java Island. These will undoubtedly benefit the local communities and create opportunities that should be utilized optimally (Drumm and Moore 2002; Raipar, M.N., and Zakaria 2014). However, anthropogenic activities like infrastructure development are frequently faced with limited space availability and, as an alternative, often involve converting protected areas. Residential and agricultural land acquisition has various environmental, social, economic, and livelihood impacts on the local community.

This development process is a known threat to the mangrove ecosystem and its derivative activities, such as ecotourism. In an attempt to identify suitable strategies and priorities, it is necessary to study the impact of such infrastructure development on mangrove sites, whether it creates an obstacle or an opportunity. Accordingly, this research focuses on environmental changes around mangrove ecosystems, caused by the development of infrastructure, mass tourism, aquaculture, and iron-sand mining, and discusses their long-term effects on the sustainability of mangrove conservation and ecotourism in the SRY's coastal areas. Aerocity is a development plan for when the YIA is fully operational. The concept of urban development with an airport as the axis is predicted to provide a large number of new job opportunities (Januarita, Siska and Aqimuddin 2019). Service and trade, which are initially primary sectors, will become the base sector. Also, land-use conversions will continue to occur as neighboring regions develop, and the airport's supporting facilities will rapidly grow and change their physical conditions of these regions (Sahoo, Dash and Nataraj 2010). The increasing pressure of mass tourism and various artificial modifications applied to these protected areas is a step backward for the conservation efforts (Pope *et al*. 2019). Shrimp farming generates waste that changes material flows and transformation and deteriorates water quality in coastal areas and estuaries (Queirosz, Rossi, Meireles and Coelho 2013; Nóbrega *et*

al. 2013; Costa, Soares, Torres and Lacerda 2013; Molnar *et al.* 2013; Koehnken and Rintoul 2018). Illegal sand mining on beaches and rivers are worldwide challenge which has been reported in 70 countries (Koehnken and Rintoul 2018). It is expected to provide a list of recommendations applicable to mangrove ecotourism quality improvement and development. Figure 1 depicts the conceptualization of ideas in this research.

Figure 1. Research Framework



1. Methods

This research was conducted using a qualitative exploratory method. In-depth interviews with various stakeholders were conducted to explore various information about environmental changes and their impacts on the mangrove ecosystem. Informants who are the samples in this study are mangrove ecotourism managers and the government in charge of the tourism sector and mangrove conservation. Field observations aimed to determine the extent and direction of land-use change and potential impacts on mangrove ecotourism sustainability. Field observations are carried out through direct observation and using drones. Comparison between the results of in-depth interviews and observations was used to check the consistency of data collected. Secondary data were obtained from previous studies were used to support the analysis in this study.

In-depth interviews were conducted to two mangrove ecotourism managers and representatives from two departments that had duties in conservation and mangrove management. Mangrove ecotourism managers interviewed were managers who had pioneered ecotourism-based mangrove management in Special Region of Yogyakarta. The two departments had long and worked a lot in the conservation sector and mangrove forest areas for tourism. Informants from the government were determined based on their field and work ability in this research theme (Table 1). Data collection was carried out in line with applicable research ethics. The interviews were conducted openly to obtain the following information: a) how long had the management of mangrove areas in Yogyakarta been carried out?; b) What efforts had been made in mangrove forest management?; c) How was the sustainability of the mangrove area?; d. How did environmental changes occurred in the mangrove area?; e. Where have the changes occurred?; f. When did the changes occurred?; and g. What management has been carried out by managers and the government in the conservation of mangrove areas. Recording and documentation was carried out in the interview process. Various informants' information were paraphrased in this paper in explaining the various findings obtained.

Table 1. Research's Informant

Informant	
Ecostourism managers	
A1	Jangkaran Mangrove Ecotourism
A2	Baros Mangrove Ecotourism
Governments	
B1	Department of Marine Affairs and Fisheries, Yogyakarta Province
B2	Department of Tourism, Kulonprogo Regency

2. Study Area

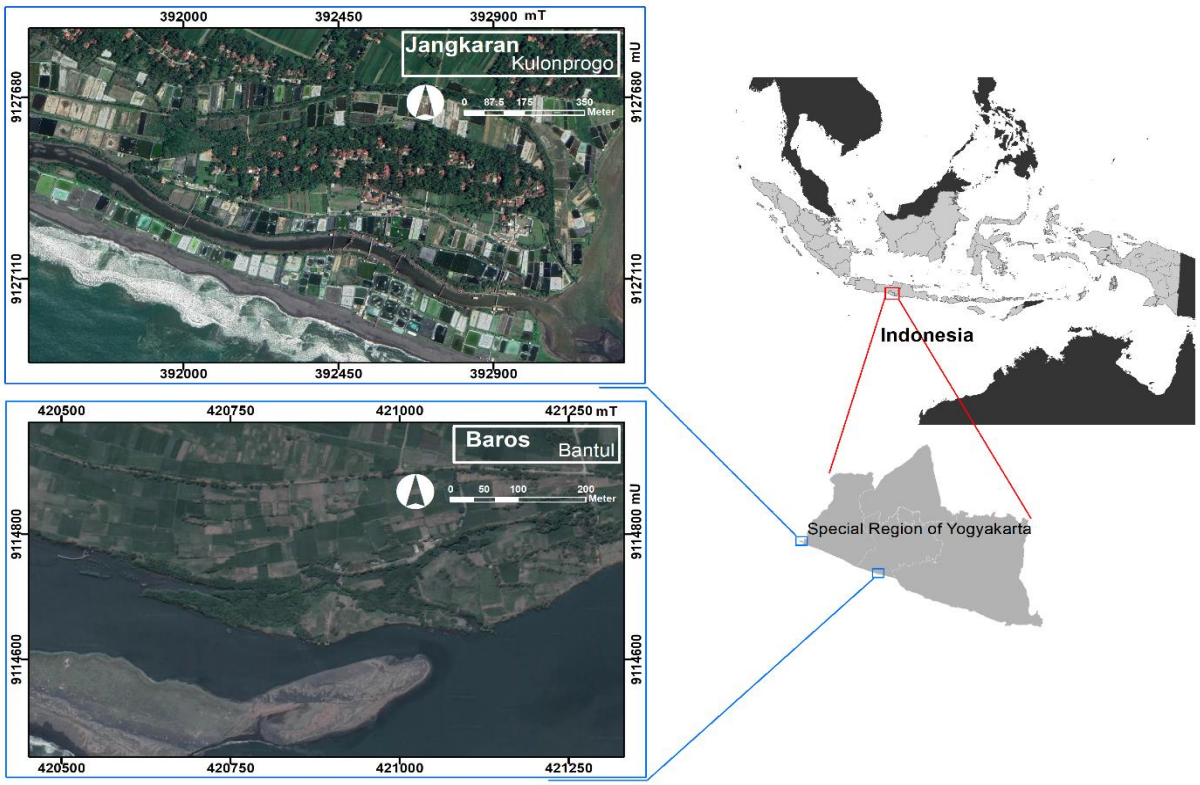
2.1 Baros Mangrove Ecosystem

There are two dominant species in the Baros Mangrove Ecosystem in Kretek, Bantul Regency (Figure 2): *Avicennia sp*. around the mouth of Opak River and *Rhizophora sp*. growing further inland (Khakhim *et al.* 2019a). Both are distributed homogenously because this ecosystem is the result of human activities and replantation. It is now a tourist attraction for ecotourism, especially for educational purposes.

2.2 Jangkaran Mangrove Ecosystem

The mangrove ecosystem in Jangkaran Village (Figure 2) is Riverine Mangrove because it grows in a coastal environment that is mainly influenced by fluvial activities and low tidal levels (Day *et al.* 2013). It has at least three mangrove species: *Avicennia pandanus, Casuarina equisetifolia*, and *Rhizophora sp*. Some species belonging to the genera *Sonneratia, Acanthus*, and *Acrossticum* grow and develop naturally. Other species of *Nypa* and *Sonneratia* are also found, although not evenly distributed. Some objects and aspects make this ecosystem a major tourist attraction, but only one management office develops it for education purposes by adopting ecotourism principles. Fistiningrum and Harini (2021) examined the impact of mangrove ecotourism management on the socio-economic conditions of the community in Kulonprogo Regency and the results showed that mangrove ecotourism in Kulonprogo had a social impact on the opening of new jobs, increased social interaction through community service, increased caring attitudes towards the environment, and increasing social conflict between ecotourism managers and the community. The economic impact of mangrove ecotourism is an increase in community income, especially those involved in ecotourism activities after the existence of mangrove ecotourism due to the opening of job opportunities.

Figure 2. Jangkaran and Baros Mangrove Ecosystems Observed in this Research and Their Locations in the Special Region of Yogyakarta, Indonesia



3. Result and Discussion

Comparison of the results of in-depth interviews and field observations yields information about various environmental changes that have an impact on the mangrove ecosystem. The Jangkaran Mangrove Ecosystem and The Baros Mangrove Ecosystem have different environmental changes and impacts. The Baros Mangrove Ecosystem is affected by the construction of the South Outer Ring Road (SORR) infrastructure, aquaculture and sand mining. The Jangkaran Mangrove Ecosystem is affected by the development of airport and road

infrastructure, the development of mass tourism objects and aquaculture. The construction of the Southern Outer Ring Road (SORR) along the southern coast of Yogyakarta and aquaculture have resulted in environmental changes that have an impact on the sustainability of two mangrove ecosystem areas in Special Region of Yogyakarta (Table 2).

Table 1. Impact of Environmental Changes

Environmental Changes	Baros Mangrove Ecosystem	Jangkaran Mangrove Ecosystem
Infrastructure Development	South Outer Ring Road (SORR)	South Outer Ring Road (SORR) Yogyakarta International Airport (YIA)
Tourism Activities	-	Mass Tourism Destinations and Attractions
Aquaculture	Ponds	Ponds
Other Activities	Sand Mining	-

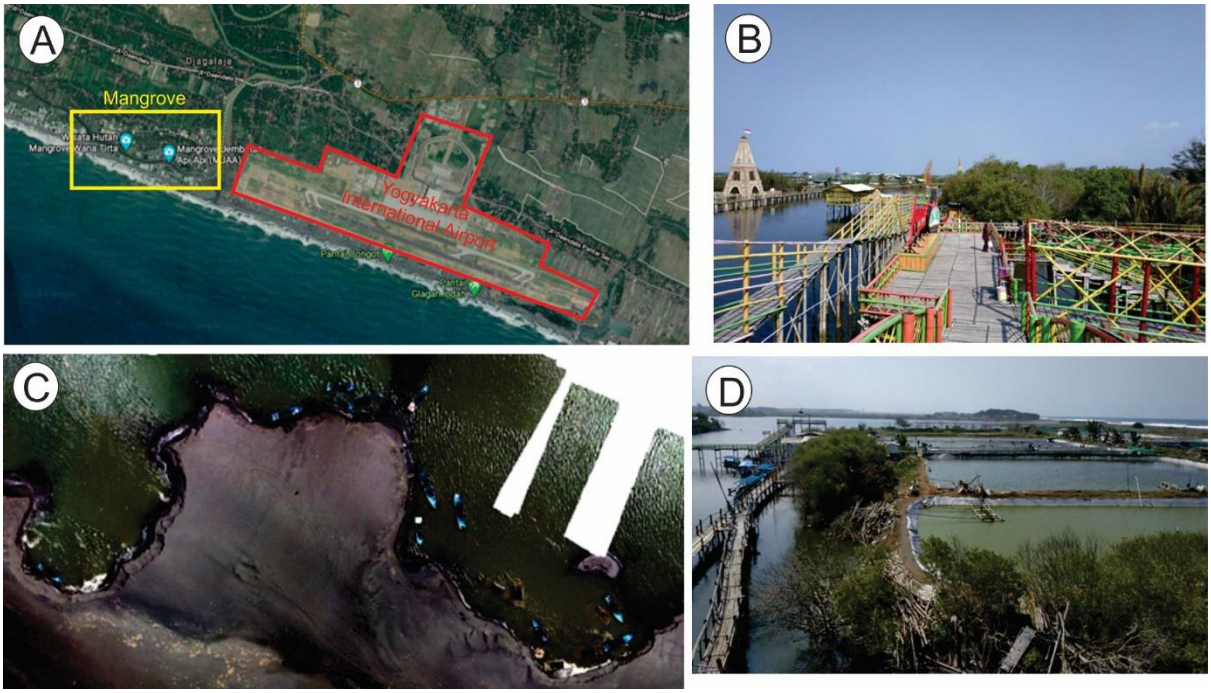
Source: Indept interview and field observation

4. Impact of Environmental Changes

4.1 Infrastructure Development: Yogyakarta International Airport (YIA) and South Outer Ring Road (SORR)

Infrastructure as a point of growth and connecting access will form a spatial structure that is most likely to affect nearby regions (Al-Hader and Rodzi 2009; Seto *et al.* 2014). Infrastructure development in SRY's coastal area is intended to form a new axis of regional growth. YIA is predicted to lead to urbanization in its surroundings, which are currently dominated by rural areas with agricultural activities. Similarly, SORR is a major infrastructure construction project crossing the coastal area and YIA (Figure 3a). The initial phase of the YIA construction involved agricultural land acquisition and relocated the populations of several villages, changing their farm-based livelihoods. With the Aerocity development plan, urbanization will inevitably sprawl into and affect various protected areas in the vicinity (Berawi, Miraj, Adhityo and Sakti 2017; Setiawan *et al.* 2018). Left unmitigated, it will exert increasing pressure on Jangkaran Mangrove Ecosystem, which is located the closest to the airport. Although this process may not affect Baros Mangrove Ecosystem, SORR is predicted to cause more extensive land-use change that will also threaten this ecosystem in the future.

Figure 3 – The Yogyakarta International Airport (YIA) Adjacent to Jangkaran Mangrove Ecosystem, a Tourist Attraction (A); Mass Tourism Development in Jangkaran Mangrove Ecosystem (B); Iron-sand Mining on the Mouth of Opak River Adjacent to Baros Mangrove Ecosystem, an Eco-tourist attraction, as Captured Using UAV (C); Shrimp Ponds Adjacent to Jangkaran Mangrove Ecosystem (D)



Various changes in the surrounding environment have been tapering Jangkaran and Baros Mangrove Ecosystems. The pressure of non-protected areas can negatively affect their sustainability, though it also widely

opens economic opportunities (Ghosh, Bakshi, Bhattacharyya, Nath and Chaudhuri 2015). For instance, air (airport) and land (road) transportation infrastructure will increase access to the SRY's coastal area, including mangrove ecosystems. Designated as tourist attractions, some of these ecosystems will be easier to reach with such infrastructure. Then, coastal regions that meet mangrove growth requirements need to be conserved and developed as protected areas (Suprakto, Soemarno, Marsoedi, Arfiati 2014; Hakim, Siswanto and Nakagoshi 2017).

4.2 Mass Tourism Destinations and Attractions

The mangrove ecosystems have four attractions that make them major tourist destinations at SRY. Two of them are mass tourism (Figure 3b) that, in principle, does not prioritize conservation education as its management goals. It can substantially affect, mainly, the economic sector because its main target is to continuously multiply the number of visitors (Ferreira and Harmse 2014), meaning that income from entrance tickets or the money spent by tourists on-site can help develop the attractions. This practice, however, tends to harm mangrove ecosystems (Marzouki, Froger and Ballet 2012) and the other two attractions that have been designated as education-based ecotourism in SRY. Supporting infrastructure planning and development should be designed or modeled to accommodate environmental sustainability so that ecotourism activities do not harm the local flora and fauna (Glaser, Krause, Oliveira and Fontalvo-Herazo 2010). Therefore, mangrove ecosystems and their various benefits for the ecological sustainability of coastal areas are used as a means of education-based ecotourism instead of mass tourism, though with less profitability. Misapplication of the tourism management concept can reduce the significance of mangrove ecosystems as a means of education, tourist attractions, and natural breakwaters and habitats of diverse species in a coastal environment.

Because mass tourism dominates the development of mangrove ecosystems in SRY, mangrove ecosystems tend to be less developed. Globally, tourism that utilizes coastal resources, especially mangroves, is used as a means to increase and support rehabilitation and conservation activities (Brander, Wagtendonk and Hussain 2012). Globally and locally acknowledged national parks give priority to the integration of sustainability into mangrove education-based ecotourism. This proven concept and its application are believed to be highly relevant to the prevailing Indonesian government's policy on the development of significantly increasing tourism activities. It implies that the government is inclined to apply this concept to many suitable mangrove ecosystems in the country (Hakim, Siswanto and Nakagoshi 2017).

4.3 Ponds (Aquaculture)

In SRY, coastal strands are used for rice farming and aquaculture (ponds), with shrimp as one of the most cultivated commodities. Ponds are often associated with mangrove ecosystems (Figure 3d) because mangrove trees can protect ponds from the destructive impacts of sea waves and, thus, maintain shrimp production stability. Also, in other cases, these trees provide habitats for small fish and many other species and even reduce diseases (Ha, Dijk, Han van. and Bush 2012a). Shrimp ponds somehow proliferate in coastal areas, leading to massive changes in the land-use pattern. For instance, a protected area grown with mangrove trees now decreases in extent as shrimp ponds increasingly take its place. If left unchecked, such massive land modification will continue, thus threatening the sustainability of mangrove ecosystems and their ecological function. Coastal area management needs to consider the livelihoods of mangrove farmers to create a balance between coastal environment sustainability and management. For this reason, clear regulations concerning the spatial use of coastal areas are necessary. Coupled with high market demand for shrimp, regulations that are not strictly enforced can lead decision-makers to prioritize one over another instead of formulating strategy and management designs that integrate the two and promote mutual benefit (Armitage and Johnson 2006; Ha, *et al.* 2012 b). Ecotourism managers as actors of conservation should also be able to provide education to not only tourists but also shrimp farmers, preventing economic activities from disturbing conservation efforts.

4.4 Sand Mining

Along the SRY's coast, sand is mostly ejected from Merapi Volcano and is widely used for building construction needs. Sand accumulating into beach ridges, as shown in Figure 3c, is often extracted, and this process can result in the deepening of river beds and estuaries and the widening of river mouths and coastal bays (Podila Sankara Pitchaiah 2017). Ecologically, it leads to environmental quality deterioration, loss of habitat on beaches, deltas, and coastal areas, loss or change in vegetation structure in riparian zones, and increased or reduced downstream sedimentation—thus, affecting habitat quality (Koehnken and Rintoul 2018). In the long term, there will be a severe shortage of sand in the lower reach of catchments because, with unsustainable sand mining, the

supply of sand from the upper reach cannot cover or compensate for the quantity of sand being dredged over time (Kastl *et al*. 2012). Continuous sand transfer to the delta system is crucial for maintaining delta stability and coastline position and providing front-line protection against storms and other extreme weather events (Anthony, *et al.* 2015). Because of the large demand for sand by construction plans within and outside the area, illegal sand mining is rampant on beaches and rivers. It triggers extensive erosion on the coast and mangrove ecosystem and affects the naturally formed substrates required for mangrove development, thus threatening the sustainability.
Apart from changes that occur in the surroundings, changes in ecotourism can also result in impacts, which are grouped into impacts due to the construction of tourism support facilities and the impact of tourist visits (May. 1991). The size of a sustainable tourism according to Swangjang and Kornpiphat (2021) is assessed by (i) contribution to natural resource conservation, (ii) contribution to environmental improvement and mitigation of negative impacts, (iii) contribution to social welfare, fair distribution of benefits and costs, and respected cultural traditions, (iv) assurance of the quality of tourism and activities managed, and (v) assurance of quality and housing services.

5. Ecotourism Adaptation to Environmental Changes

Varying human activities around protected mangrove areas have put tremendous pressure on the preservation efforts. Local- to large-scale activities change an ecosystem to different extends, and thus mangrove preservation needs to incorporate proper adaptation strategies to any structural modifications in the environment and shifts in land utilization. Ecotourism is an example of mangrove ecosystem preservations that emphasize its management for educational purposes.

In SRY, current mangrove ecotourism continues to run as it should even though many mass tourism activities have been emerging on its surroundings and, at the same time, making use of this ecosystem. The number of tourists will be divided by the varying choices of tourist attractions. Mass tourism sites receive many interests, considering that the combination of artificial and natural structures attracts more tourists in general, as compared with ecotourism (niche tourism) in which only a relatively small proportion of visitors ('special interest or niche tourism group') has the interest. Ecotourism prioritizes the principles of education and environmental preservation so that, in the tourism industry, it is not much in demand. However, its visitors can spend a longer time and gain more intense experience than those of mass tourism sites. Mangrove ecotourism can be developed by sightseeing, aquaculture visits, fishing, canoeing, bird watching, mangrove trails, mangrove river tours, and photography, and providing opportunities for visitors and local communities to volunteer in conservation programs. Also, as part of tourist attractions, ecotourism management needs to include local wisdom to increase the locality and uniqueness of culture and traditions (Hakim, Siswanto and Nakagoshi 2017).

Conservation measures are severely underfunded in many Southeast Asian regions, especially for isolated ecosystems like mangrove forests (Friess 2017). Newly constructed infrastructure will substantially affect regional spatial structure and, in the long term, spatial planning. Ecotourism should be able to adapt to all possibilities and continue to pursue ecological sustainability while governments as regulators formulate zoning policies that side with preserving protected areas.

Most importantly, because the local communities understand the most how mangroves function, they should partake in coastal management so as to maintain the livelihood of shrimp farmers and mangrove ecosystem preservation simultaneously. Besides, most of them are shrimp farmers or farm laborers who rely on ponds as a source of livelihood. In other words, it is necessary to create a balance between pond areas and protected zones in a coastal spatial plan, avoiding overlapping utilization and rights of use.

The paucity of coordination and program synchronization between sectors and agencies causes overlapping authorities and different policies, known as policy failure (Islam 2017). In Indonesia, about 22 regulations and at least 18 different bodies or agencies govern mangrove ecosystems and their management (Wever, Glaser, Gorris and Ferrol-Shulte 2012; Sukardjo 2012). Therefore, a combination of policy and institutional analysis is needed to ensure that the policies adopted have minimal transaction costs and maximum benefits for society. For example, the legally acknowledged Tanjung Panjang Nature Reserve in Gorontalo Province is experiencing severe deforestation due to its remoteness and lack of national oversight, transmigration policy, and local government incentives for aquaculture. Since poor outcomes often lead to general public distrust of governments, many decision-makers have decided to move away from state-managed conservation toward a neoliberal approach that financially encourages conservation and private-public partnerships (Friess, *et al.* 2016). Regulators are partly responsible for creating a balance in spatial uses. The government, a stakeholder behind the development, should be able to give rights to all sectors only as long as sustainability is considered in the implementation and enforcement of spatial plans.

In the context of environmental changes, this research recommends several adaptation measures for mangrove ecotourism management, which have been formulated from two previous studies. Hendrastuti (2018) designed a sustainable management strategy for the Baros Mangrove Ecosystem using the Drives, Pressures, State, Impact, Response (DPSIR) analysis and suggested that ecotourism and other activities in the forestry, agriculture, livestock production, and fishery sectors be integrated (termed as 'integrated ecotourism') to improve the welfare of the local community. It is also necessary to determine which activities are allowed and prohibited in the core zone and utilization zone within the coastal mangrove conservation park. Murtini *et al.* (2018) compiled a mangrove ecotourism development strategy using SWOT analysis and indicators like biophysical conditions, accessibility, infrastructure, and other supporting aspects. The outcome is that the strategic priorities need to be directed at increasing government's role in boosting popularity and attractiveness (through advertisements), designing and introducing mangrove and non-mangrove tourism packages, enhancing mangrove identity, improving the spatial arrangement of the location, and increasing quality human resources.

Adaptation strategies to environmental changes in the context of ecotourism development from the dimensions of sustainable development are described as follows. From the social dimension, Harto, Sidiq and Karneli (2021) proposes to increase participation and strengthen local wisdom of the community and formulate rules and policies for mangrove maintenance based on local wisdom. By doing so, it is hoped that environmental awareness from ecotourism managers and local communities can be formed. From the economic dimension, Lelloltery, Rumanta, and Kunda (2021) proposes to develop the potential of sustainable ecotourism objects through an inventory of mangrove species and other flora and fauna and increase supervision (patrol activity). After the inventory is carried out, it can then assess the carrying capacity of tourist sites and measure the limits of natural and human resources associated with tourism activities and it is necessary to ensure that the supply and demand of mangrove ecosystems from ecotourism activities is balanced (Swangjang, K., and Kornpiphat, P. 2021). From the environmental dimension, Abidin, Setiawan, Muhaimin and Shinta (2021) proposes a balance between maintaining natural capabilities and limiting the use of natural resources and the environment.

6. Adaptation to the Covid-19 Pandemic Impact

Public health threats during the Covid-19 pandemic limits the mobility of tourists (Djausal, Larasati and Muflihah 2020), creating a unique problem for today's ecotourism managers. For instance, niche tourism in Baros Mangrove Ecosystem attracts special interest tourists, such as students, university students, and researchers, coming from outside the area for education, research, or observation purposes. Since the widespread lockdowns were issued, eco-tourist attractions have been restricted from accepting visitors and forced to cancel scheduled programs to curb the spread of the virus.

Per the national and local government policies, public health protocol includes social distancing, which disables several sectors and enterprises depending on a physical presence like tourism (Susan, Gibson and Rus'an 2020). In some regions, eco-tourist attractions are open to public only if they meet the standards of health protocols set by local governments—*i.e.*, available hand washing stations, health protocol information boards, uses of marks, and restrictions on the number of tourists in one tour—, but this policy still requires a series of trials and simulations before it can be put into effect. Jangkaran and Baros Mangrove Ecosystems were still closed for visitors in September 2020, although ecotourism is proposed as an alternative for tourism in the phase of adaptation to new habits (new normal) during the pandemic. Even in normal conditions, ecotourism involves fewer but more intense activities. As special interest tourism in open space, it allows individuals to gain experience personally while strictly complying with health protocols during the tour. It differs from mass tourism that entails large groups of tourists visiting the same attraction.

During the Covid-19 pandemic, ecotourism managers can adapt by developing derivative products of conservation (*i.e.*, product diversification) and designing online tourism, which even widens the opportunities to be in the international markets. This strategy requires collaboration with the government and any parties well-versed in online system development and maintenance. Also, corporate CSR, government programs, environmental community association, NGOs, and training programs conducted by schools and universities can help foster this strategy (Hakim, Siswanto and Nakagoshi 2017).

Conclusion

The mangrove ecosystem in the Special Region of Yogyakarta requires concerted efforts of preservation. Environmental changes due to constructions and sectoral developments in its surroundings have significant detrimental impacts on these efforts. Regional-scale infrastructure development aims to meet the needs of a large number of people by improving services and creating an axis of growth. The extensive development of the small-

scale agricultural sector also determines the sustainability of mangrove conservation. Apart from farming practices, nearby tourism and mining activities have also put increasing pressure on protected areas. The regional spatial plan is considered an instrument that can provide protection for these areas, and, to achieve sustainable development, governments as regulators should be able to create a balance between various activities. In addition, mangrove ecotourism can be an alternative tourism activity in the phase of adaptation to new habits (new normal) because it enables each of the visitors to apply health protocols.

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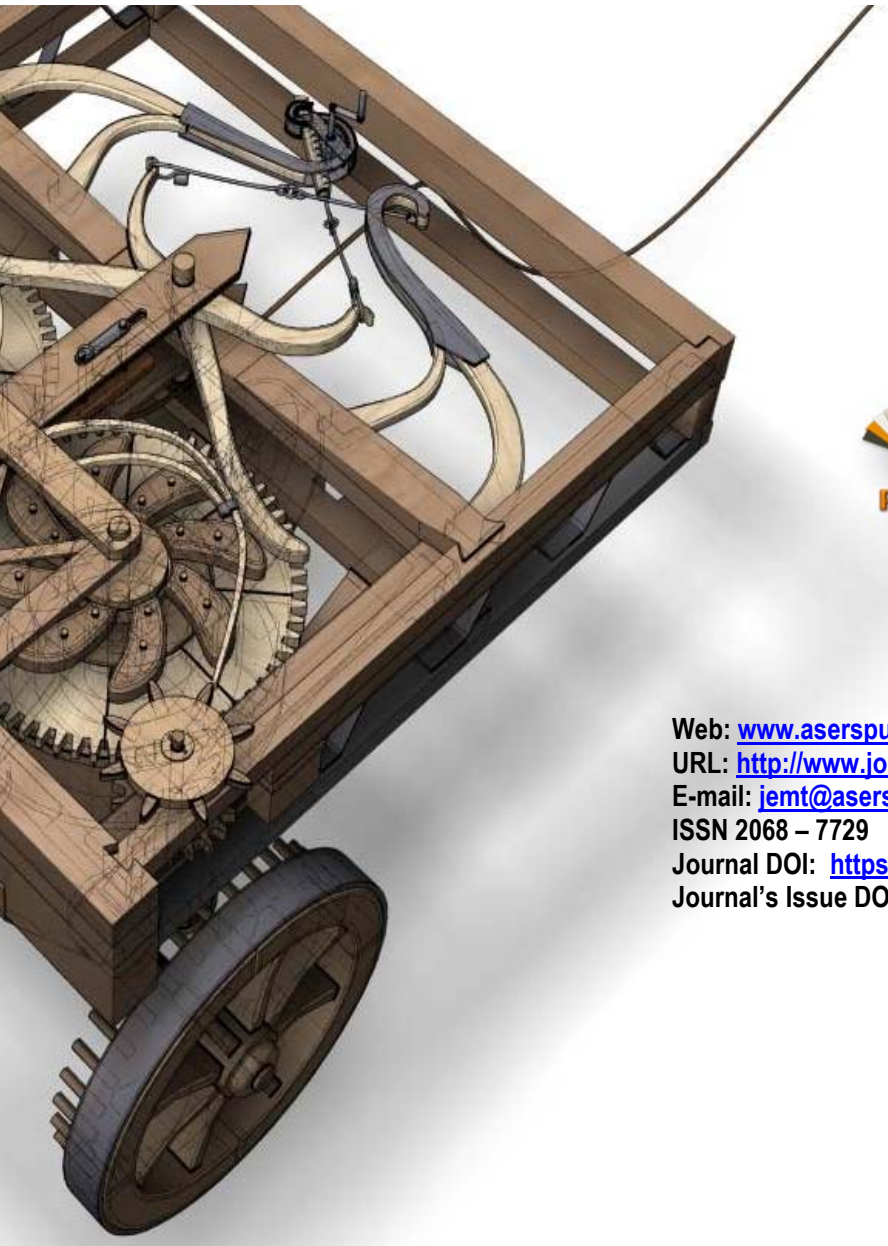

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