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The System Dynamic of Mangrove Ecotourism of "Kampung Blekok" Situbondo East Java Indonesia: Economic and Ecological Dimension

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Mangroves that grow in coastal areas have ecological and economic values. Research on the behavior of a mangrove ecotourism system is needed as a basis for management to provide sustainable benefits. This study aimed to describe the conceptualization of a mangrove ecotourism system, formulate a mangrove ecotourism model and formulate a scenario for Kampung Blekok mangrove ecotourism in Situbondo Regency. This study used a quantitative analysis with a dynamic system approach to see the behavior of the ecotourism system on the economic and ecological dimensions. The research results on the conceptualization of the ecotourism system with causal loop diagrams showed that the economic subsystem was composed of response variables in the form of ecotourism management income and community business income in ecotourism areas and gross regional domestic product. Meanwhile, the ecological subsystem consisted of response variables in mangroves' death, planting, and rehabilitation. Model formulation with stock-flow diagrams demonstrated the relationship between response variables to explain the system. In the economic subsystem, the variable of community business acceptance had the highest sensitivity that could affect ecotourism income. While in the ecological subsystem, the highest sensitivity was on the variable of mangrove planting, which could affect the density of mangroves. The combination of economic subsystem scenarios optimized tourist visits and streamlined spending. The combination of ecological subsystem scenarios that became the priority was the addition of mangrove seedlings and controlling pests that caused the death of mangrove seedlings. Stakeholders are expected to synergize with each other in managing activities in ecotourism. Apart from exploiting their economic potential, the community and the private sector are also expected to participate in maintaining compliance with regulations to preserve mangroves. The government should monitor and enforce regulations related to ecotourism and support the development of mangrove ecotourism so that its benefits are sustainable.

Keywords: mangrove, ecotourism, system dynamic, economy, ecology.

Introduction

Today's tourism sector has become an essential part as a driver of the community's economy. Foreign exchange from tourism in Indonesia is quite large, amounting to 16.426 billion US dollars, and the contribution of tourism to GDP in 2017 was 4.11% (CBS, 2018). One of the tourism sectors that can be developed is marine tourism. Indonesia's marine tourism potential is reflected in the area of Indonesia's seas, which is 3.257 million km^2, with coastline length of 99,093 km. Marine mega-biodiversity is in the form of corals, various types of fish, seagrass, and mangroves, and 20.87 million hectares of marine, coastal and small island conservation areas (Ministry of Marine Affairs and Fishery, 2018). Mangroves are an exciting resource to examine in coastal areas for supporting marine tourism. Mangrove forest resources are forest formations filled with literary plants influenced by tides, with anaerobic soil conditions. The existence of these forests does not depend on the climate, but generally, mangrove forests grow well in protected coastal areas, such as deltas and estuaries (Pariyono, 2006). Mangrove forest is the main ecosystem that supports life in coastal areas and waters (Saparudin, 2012). Mangrove forests have ecological, economic, and social values that must be preserved to minimize damage (Fattah et al., 2020). Mangrove forest ecosystems provide benefits to humans both directly and indirectly. There are several value benefits from the existence of the mangrove forest, including the direct use value, for example, the catch of fish, shellfish, wood, crabs, birds, tourism, *Wideng* crab (*Sesarma spp*), snakes, birds, vegetables, and medicinal ingredients. Examples of indirect use-value are natural embankments, CO2 absorbers, nursery ground and spawning ground, microclimate stabilizers, and storm shields. The option value, for instance, is biodiversity, bequest value, and existence value (Harahab, 2010). The existence of mangroves is the main support for tourism, especially marine tourism.

Tourism is a series of activities and the provision of services both for the needs of tourist attractions, transportation, accommodation, and other services aimed at meeting the travel needs of a person or a group of people. Sustainable tourism is an effort to meet the needs of tourists and tourist destinations to save and provide opportunities to become more attractive in the future. The basic idea of sustainable development is preserving natural and cultural resources. These resources are the needs of everyone today to live in prosperity but must be maintained and preserved so that they can also be used in the future. So that future generations can enjoy and preserve it (Sugiyama, 2012). Sustainability is a concept that aims to support environmental conservation (ecology), and the community and government can participate in management to provide economic and social benefits (Fauzi, 2018). The mangrove ecosystem's sustainability creates opportunities for responsible tourism or ecotourism (Fattah et al., 2021). Ecotourism is one method of providing income and employment chances to the community (Abdurrahman, et al., 2016). Ecotourism is also a concept of sustainable tourism development that aims to preserve the environment (nature and culture) (Intyas et al., 2021).

Kampung Blekok is a community-based mangrove conservation area with a unique tourist attraction in the form of beautiful mangroves inhabited by thousands of Blekok birds (water birds). The area used to be a slum area but later turned into an attractive ecotourism area initiated by a tourism awareness group from the community in 2017. As soon as ecotourism opened, it got the first best East Java natural tourist attraction category from the East Java Province Tourism Office (dkp.situbondokab.go.id). Currently, the condition of mangroves as the main attraction for ecotourism in this area continues to improve, as reflected by the level of mangrove density which is in the excellent category (Wulandari, 2021). Kampung Blekok in East Java has the potential to become a premier ecotourism destination based on the sustainability principle due to its rapid development. Sofian et al. (2019) delineated the results of a review on mangrove management in Indonesia that ecosystem services are an essential part of mangrove management. The study results by Masiseng et al. (2020) on the Lattebung Makasar mangrove management stated that a dynamic model approach optimized the promotion scenario than the scenario of increasing community empowerment. Hakim et al. (2017) stated that mangroves could be used as nature-based tourist destinations. However, in East Java, mangrove areas that contribute to conservation still lack tourism travel programs. Support from the

community, government, and academics is required for the long-term sustainability of mangrove ecotourism as a tourist destination.

Sustainability is intertemporal, which means that the requirements of the current and future generations can coexist without sacrificing one another. As a result, this principle implicitly demands that consideration of time and the dynamics of sustainability in associated variables be taken into account (Fauzi, 2018).

Thus, it is necessary to research to see the dynamics of the mangrove ecotourism system by considering the utilization of the mangrove forest ecosystem, at least by paying attention to sustainability's ecological and economic aspects for future generations. This study aims to describe the ecotourism system's conceptualization, formulate ecotourism models, and develop scenarios that simulate the Kampung Blekok ecotourism model in Situbondo Regency economically and ecologically.

Methods

This research was conducted in the ecotourism area of Kampung Blekok, located in Klatakan Village, Kendit District, Situbondo Regency, East Java. Purposive sampling was used to recruit participants for this study, with the criterion of the actors involved and understanding of ecotourism in Blekok Village, Situbondo Regency. The number of participants was 24 people consisting of ecotourism managers, traders in ecotourism, local government employees, especially the Forestry and Environment Service of Situbondo Regency, and employees from the Village Office of Kampung Blekok, Situbondo Regency. Data collection techniques utilized interviews, observation, and documentation. Primary data obtained by interviews include data on mangrove planting and mortality, community business income and expenses, and ecotourism management. Primary data were also obtained by observing the mortality of mangroves. Secondary data on the profile of Mangrove Ecotourism in Kampung Blekok were collected from documents issued by the Situbondo Regency Forestry and Environment Service and the Mangrove Ecotourism Manager in Kampung Blekok.

This study is a quantitative research that used a dynamic system approach to see the system's behavior in the Kampung Blekok, Situbondo mangrove ecotourism. Data analysis in this study used a dynamic framework, especially system dynamics. System dynamics is a special elaboration of the dynamic model (Fauzi, 2018). The stages in this research were as follows:

1 Develop system thinking from the ecotourism phenomenon to see the phenomenon as a whole and emphasize the related framework (interconnectedness). In general, system thinking is defined by principles such as considering the "big picture", balancing short-term and long-term perspectives, recognizing dynamic, complex, and interdependent nature systems, accounting for both measurable and non-measurable factors, and remembering that we are all part of the systems in which we function and that we each influence those systems even as they influence us (Anderson et al., 1997). The economic and ecological dimensions of the ecotourism phenomenon must be addressed, as these two factors are interconnected. As a result, it is vital to think systematically about the relationship between the two aspects to utilize it as a foundation for seeing the relationship between the two.
2 Develop a causal loop diagram to describe the causal relationship resulting from system thinking. In the systems thinking paradigm, the structure is built by interdependent elements and forms a closed loop. The relationship of these interdependent elements is a causal relationship of feedback and not a unidirectional relationship. The phenomenon of ecotourism is seen from the economic and ecological dimensions that have been compiled in system thinking and then described in a causal relationship in the main model.
3 Develop stock flow diagrams to formulate the model. In representing activity in a feedback loop, two types of variables are used: level (stock) and rate (flow). Level states the system's condition at a time, or level is the accumulation in the system. Meanwhile, the model's rate (flow) is a variable that can affect the level. Ecotourism phenomena from economic and ecological dimensions have been arranged in systems thinking and visually described in a causal relationship, then formulated in a stock and flow model.
4 The model simulation with sensitivity analysis was performed to determine the effect on the influenced variable if the affecting variable changes. The simulation model on ecotourism with economic and ecologi-

cal dimensions is used to find out how much change in a variable is due to changes in other variables. Based on the results of the previous stage's model simulations, policy scenario analysis is performed to determine the recommended alternatives for the sustainability of the ecotourism system.

The sustainability aspect studied in this research is viewed from the ecological and economic dimensions. System dynamic analysis used *Stella software* tools 9.1.4. Dimensions and variables are presented in *Table 1*.

Table 1. *Dimensions, stocks, flows, and attributes*

Ecology Dimensions	
Stock: Mangrove density	
Flows:	Attribute:
1. Adding mangrove seedlings	1. Number of mangrove seedlings planted in the area (stems/year) 2. Number of mangroves planted to replace damaged ones (stems/year)
2. Mangrove mortality	1. Number of mangroves damaged by wind, storm, and waves (trunk/year) 2. Number of mangroves damaged due to old age (stems/year) 3. Number of mangroves damaged by pests (stems/year)
Economic Dimensions	
Stock: Income	
Flows:	Attribute:
1. Revenue from eco-tourism management	Total revenue from ecotourism management (Rp/year)
2. Revenue from businesses in ecotourism areas	Total revenue from businesses in ecotourism areas (Rp/year)
3. Expenditures from ecotourism forest management	Total expenditure from ecotourism forest management (Rp/year)
4. Expenditures from businesses in ecotourism areas	Total expenses from businesses in ecotourism areas (Rp/year)

Results and Discussion

Conceptualization of Ecotourism System in Kampung Blekok Situbondo Regency with Causal Loop Diagram

The mangrove forest of Kampung Blekok had an average density of 1,528.08 trees per hectare in 2019. So, with 115.72 hectares, it is estimated that the number of mangrove stands in Blekok Village is 12,600 trees (https://dlh.situbondokab.go.id). Preservation and sustainable use for the community's welfare is vital for saving the mangrove ecosystem. The fundamental objective of forest management is to obtain the maximum benefit from these natural resources for the community (Zen et al., 2015). Communities around Blekok Village are residents whose livelihoods are generally craftsmen of surfing equipment and souvenirs from shellfish, while only a few people work as small fishermen. With the existence of ecotourism, Kampung Blekok can increase the livelihoods of local residents by becoming grocery traders and opening a food and beverage shop business, as well as making comfortable homestays for tourists.

The uniqueness found in mangrove forests can be an attractive characteristic feature and complement surrounding tourist destinations oriented towards marine tourism (Mukhlisi, 2017). Kampung Blekok is ecotourism-based nature tourism that emphasizes the conservation of mangroves and Blekok birds or water birds. The ecotourism is in the form of a stretch of mangrove with a unique ecosystem diversity, where thousands of species of water birds live. The mangrove expanse of Kampung Blekok has an area of 115.72 ha with a mangrove thickness of less than 1 km mapping on Google Earth. The mangrove area greatly determines the diversity of plant species and animal species, especially waterbirds. An ample space can reduce competition for food, sunlight, and nutrients in the mangrove habitat. *Fig. 1* shows a map of the location of mangrove ecotourism. From the picture, it can be seen that mangrove ecotourism is located on the north coast of East Java, Indonesia.

Causal loop diagram of the economic subsystem

The development of an ecotourism area can provide employment opportunities for local communities to support the improvement of community welfare in terms of income, education, and health (Herman

& Supriadi, 2020). The economic subsystem in the ecotourism management of Kampung Blekok, Situbondo, is conceptually composed of various factors. In general, there are priority factors, namely income and costs incurred for the management of ecotourism areas and income and costs incurred on community business activities around the ecotourism area.

The development of the tourism sector is shown by the contribution to GRDP, the number of foreign tourists, the number of domestic tourists, and the value of tax revenues (Purwaningrum, 2020). These factors have a causal relationship that can affect the development of ecotourism and contribute to Regional Original Income (RoI), which then also contributes to the Gross Regional Domestic Product (GRDP) for Situbondo Regency. *Fig. 2* regarding the causal loop diagram describes the relationship between factors related to ecotourism on the economic dimension in Kampung Blekok Situbondo. Factors contributing to community income from ecotourism activities in

Fig. 1. *Kampung Blekok by administrative area. Source: Google Maps, 2020*

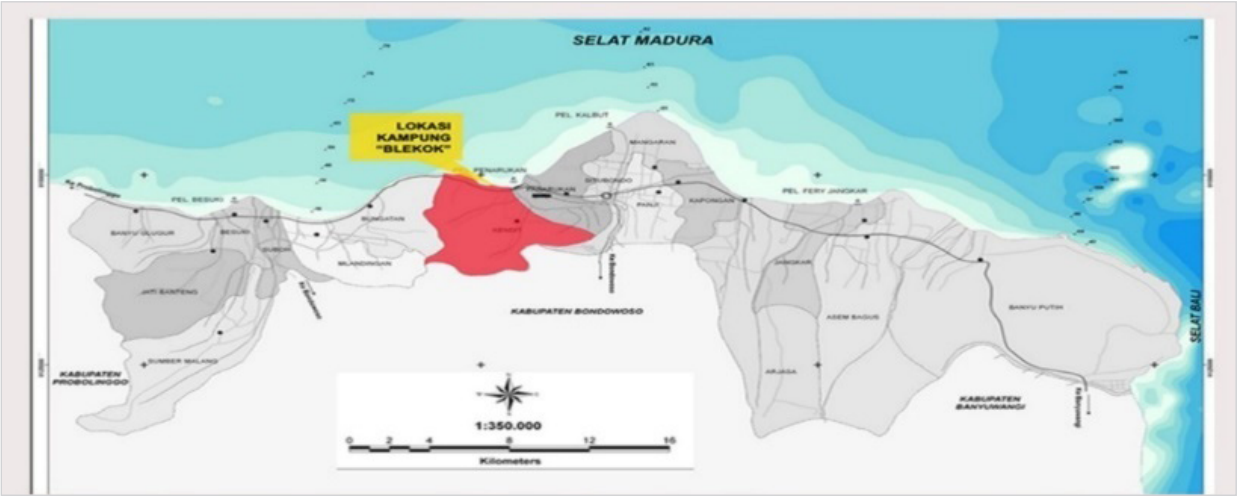
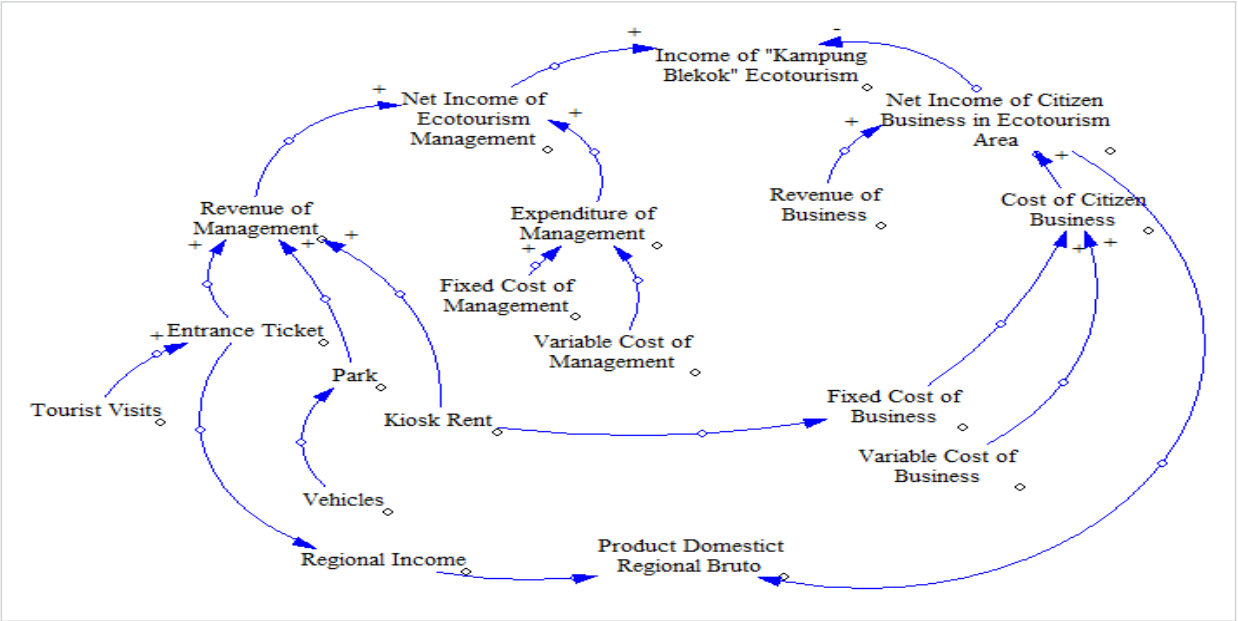


Fig. 2. *Causal loop diagram of ecotourism economic subsystem in Kampung Blekok, Situbondo*



Kampung Blekok include revenues and expenditures from managing ecotourism areas from tourist visits and revenues and costs from community businesses in ecotourism areas.

The income of community groups managing mangroves is obtained with the following assumptions: (i) ecotourism group: number of visits per year x visitor ticket prices, (ii) jogging track management group: number of visits per day x participation fund x 360 days/year, (iii)) parking group: number of vehicles parked per day x parking fee x 360 days/year, (iv) group of street vendors: average amount of income per day x 360 days/year (Nurella & Ichwadi, 2015). Factors that influence the increase in income from

Fig. 3. *Causal loop diagram of ecotourism ecology subsystems in Kampung Blekok, Situbondo*

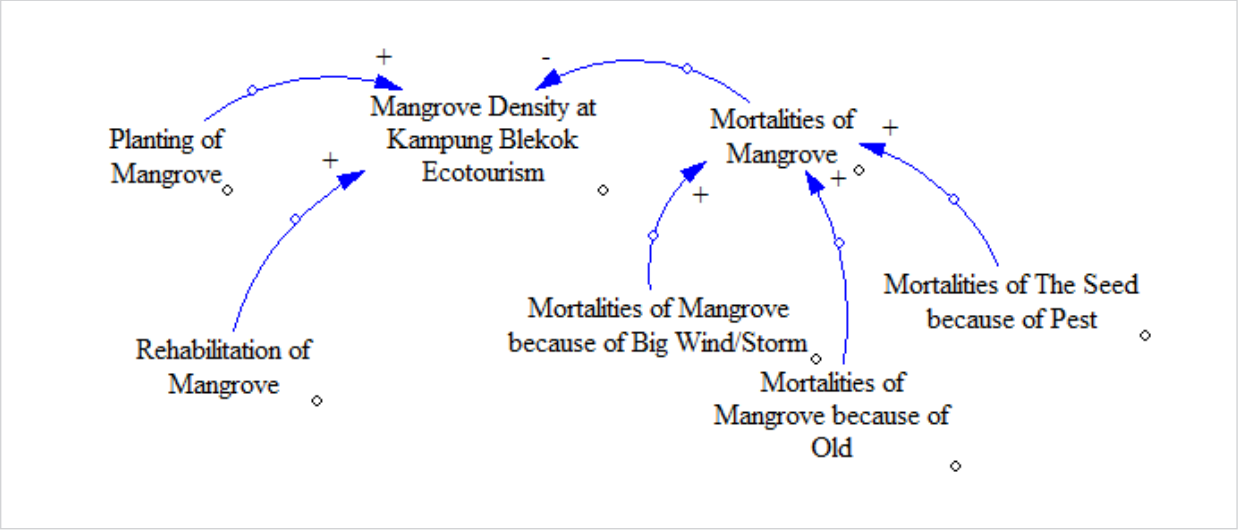
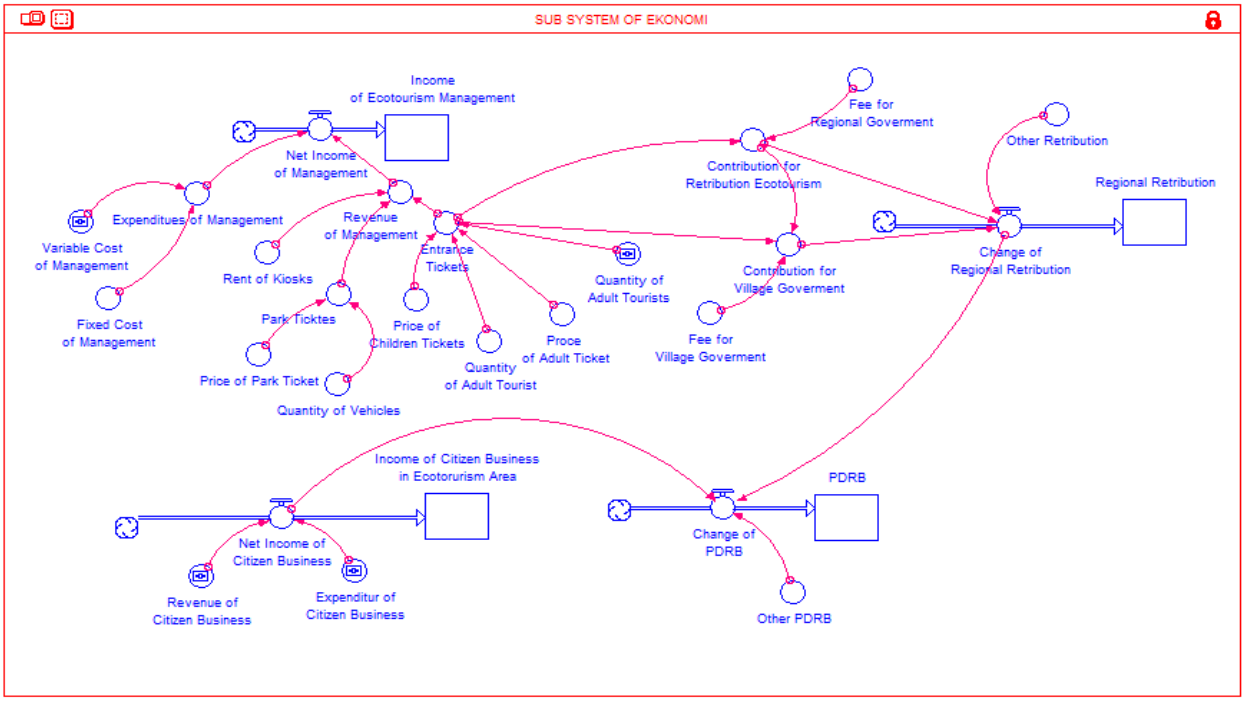


Fig. 4. *Stock flow diagram of ecotourism economic subsystem in Kampung Blekok, Situbondo*



ecotourism management, in this case, the number of visits as a source, are as follows: 1) an increase in the number of tourists has a positive effect on income from user fees; 2) an increase in the number of tourists has a positive effect on income from parking tickets; 3) an increase in the number of tourists has a positive effect on the number of kiosks rented by the community; 4) an increase in the number of tourists has a positive effect on community business income in ecotourism locations; 5) an increase in income from ecotourism management has a positive effect on RoI in Situbondo Regency; 6) an increase in income from RoI has a positive effect on GRDP; 7) increasing income from community businesses in ecotourism locations has a positive influence on GRDP.

Causal loop diagram of an ecological subsystem

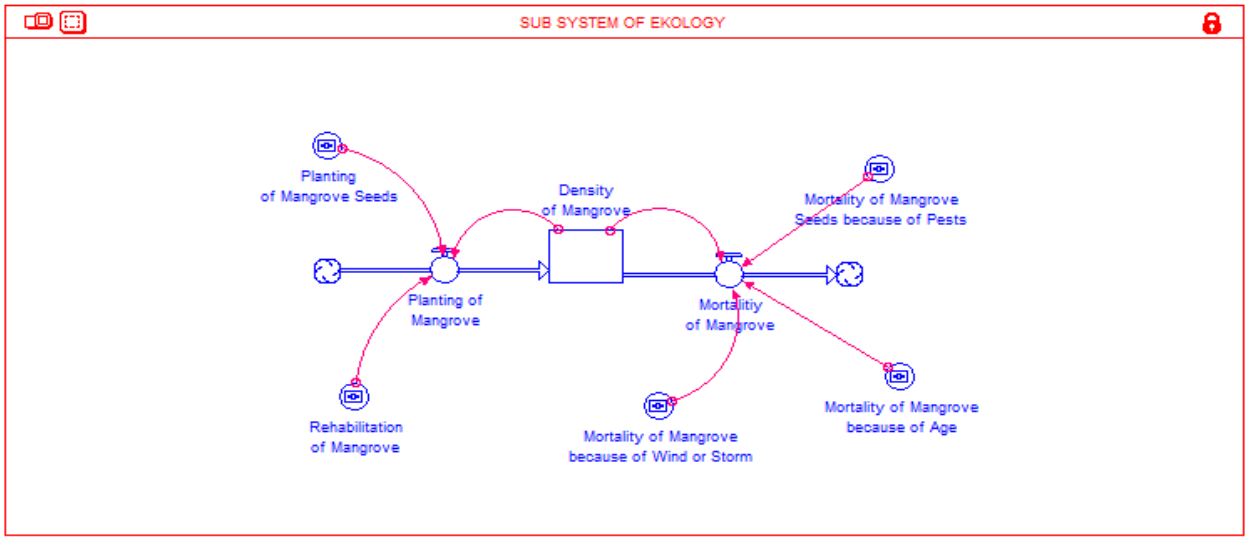
The ecological subsystem in the ecotourism management of Kampung Blekok Situbondo is conceptually composed of various factors. In general, there are priority factors, namely the addition of mangroves and mangrove rehabilitation, which positively affect mangrove density as an indicator of suitability as well as deaths caused by nature such as wind, storms and waves, deaths caused by the aging of mangroves, and death of seedlings caused by pests such as caterpillars, insects, and diseases. The increase in the causes of death had a positive effect on the mangrove's mortality. Vitasari (2015) reported that one of the causes of damage to Indonesia's mangrove forests is waves that cause abrasion. It happens because of the confluence of three forces, namely those originating from land, sea waters, and air; therefore, this ecosystem is known as a dynamic and unique ecosystem. Furthermore, Budiman et al. (2021) delineate that the health of mangrove vegetation is closely related to the level of pest attack and the condition of damage to mangrove vegetation.

Meanwhile, predatory factors such as monkeys, buffaloes, goats, and cows, as well as humans who usually cut down mangroves, are not the cause of damage in the Kampung Blekok ecotourism area. That is because people tend to follow the government's rules prohibiting damaging mangrove ecotourism areas and are aware of how to protect them from harm. These results are in line with the research by Nurrani et al. (2015) who reported that community participation in preserving mangroves includes not cutting down mangrove wood for any reason, planting seeds at every opportunity, and protecting mangroves from other community disturbances. Some of these management methods are expected to inspire stakeholders to develop a mangrove forest management system in different places with similar characteristics.

Ecotourism model formulation in Kampung Blekok, Situbondo Regency with stock flow diagrams

Modeling and making flow diagrams determine behavior patterns and relationships between variables.

Fig. 5. *Stock flow diagram of ecotourism ecology subsystem in Kampung Blekok, Situbondo*



Simulations are performed to determine the model's suitability with behavior in the real world. First, it was by creating a causative diagram, followed by a flow diagram, and it will be a reference to demonstrate the scenario.

Stock flow diagram of the economic subsystem

The economic condition of an area can be seen from the area productivity. GRDP represents productivity at this research location. Situbondo Regency GRDP gets a contribution, one of which is from the management of ecotourism in Kampung Blekok. The contribution of ecotourism activities in Blekok Village is calculated from the income and expenses of the people who run businesses around the tourist attractions. In addition, the contribution is also calculated from the income and expenditure of ecotourism management in the place.

Factors that contribute positively to the maintenance and preservation of mangrove forests are the general condition of mangrove forests, community participation and awareness, implementation of government policies and support for the legislation, and support from Legal Institutions and universities (Mulyadi et al., 2010). Ecotourism management in Situbondo Regency is managed by the community in collaboration with the local government, consisting of the Village Government and Situbondo Regency. This ecotourism area is community-based, so community participation supports the success of achieving the primary goal, namely benefiting from social economy and ecology.

Most of the community businesses around Kampung Blekok ecotourism fall within the category of micro and small businesses, referring to Law No. 20/2008. This business is an opportunity for the community around the area to earn income by meeting the needs of visiting tourists. Forms of community business include food and beverage stalls, souvenir shops, boat rentals, and tour guides.

Stock flow diagram of the ecology subsystem

Mangroves are valuable plants for protecting the environment. The existence of mangroves can be multifunctional, including as a greenbelt or protector of coastal areas from wind and waves from the sea that can erode land or abrasion. Mangroves can function as a habitat for various marine biota, which can be used as food and a source of income for the community. The suitability of mangroves is one of the essential components to manage mangroves sustainably. Density is an indicator of mangrove suitability. In this study, ecological subsistence is represented by one of the indicators of mangrove suitability, namely mangrove density.

Mangrove density is excellent if the cover is more than 75% and the density is more than 1,500 trees per hectare. It is moderate if the cover is between 50%–75% and the density is between 1,000 and 1,500 trees per hectare. The condition is damaged if the cover is less than 50% and the density is less than 1,000 trees per (MEF, 2004). In this study, the variables used in the mangrove density study were the addition of seedlings and mangrove rehabilitation and the death of mangroves due to wind, age, and pests that destroy mangrove seedlings and even cause death.

The next stage in system dynamic simulation is model verification. This stage aims to ensure that the computer program and implementation of the conceptual model do not have an error. The verification process in the Stella program is conducted when the model can be run. Then model validation is carried out to ensure whether the output behavior of the model is fit to the real world. From this model, behavior is obtained appropriately as in the real world.

Scenario model of Kampung Blekok ecotourism Situbondo Regency with economic and ecology dimension

The system scenario in this study was designed to increase the contribution of ecotourism to community and regional income from several influencing factors. It also intended to improve the density of mangroves in ecotourism regions, which are currently underutilized.

Scenario from economic subsystem

The modeling scenario of the ecotourism economic dynamic system of Kampung Blekok Situbondo was performed based on the calculation of revenues and costs incurred by managers and entrepreneurs around the location. The simulation was conducted for ten years to see the estimated income obtained by managers and entrepreneurs who contribute to Situbondo Regency's RoI and GRDP.

Changes in other variables cause changes in one

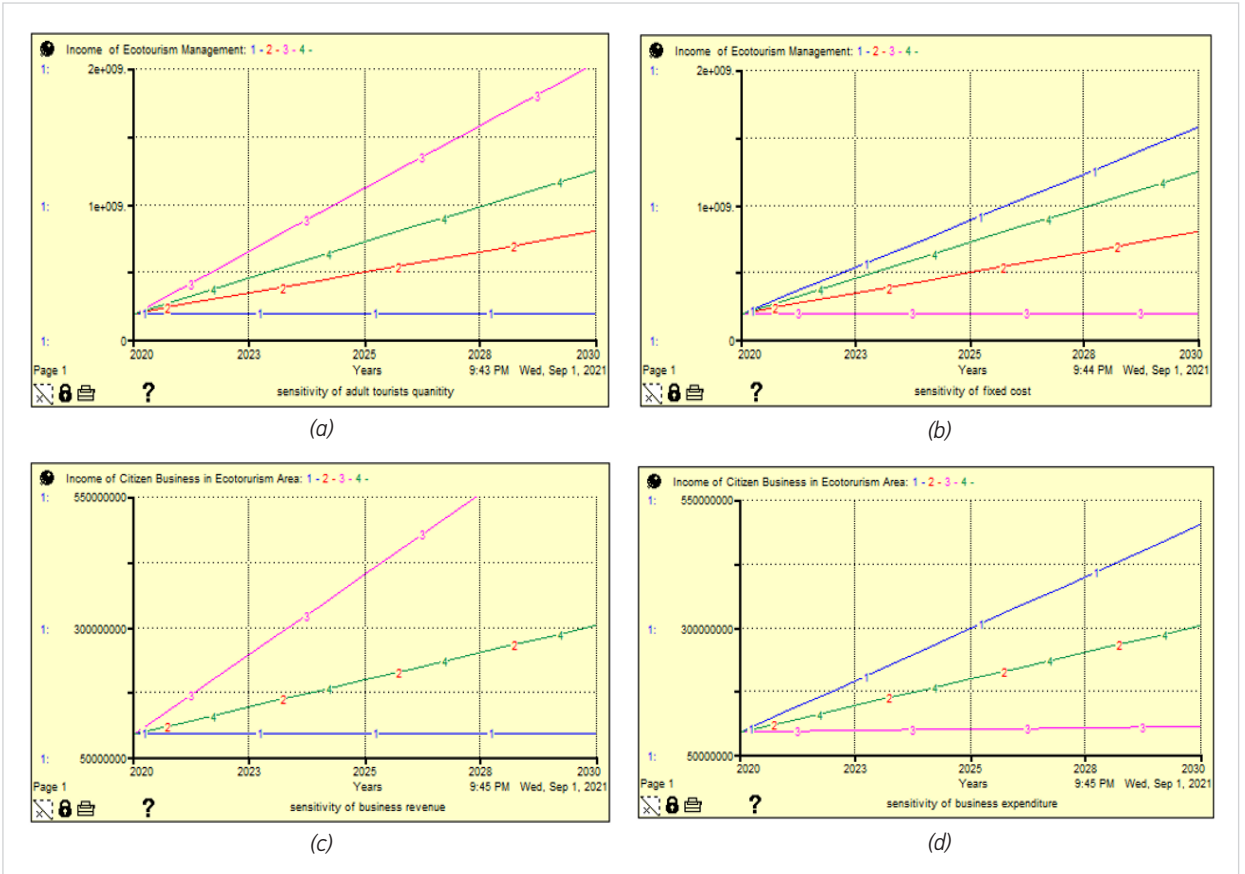
variable. *Fig. 6a* shows that changes in income from ecotourism management are caused by differences in the number of tourists visiting the area. *Fig. 6b* depicts the change in management revenue due to cost changes. Changes in community business revenues in ecotourism are depicted in *Fig. 6c* due to changes in business revenues. *Fig. 6d* depicts the community's ecotourism business income as a result of adjustments in business expenses. Significant income changes were observed in variables with a high sensitivity to income. According to the sensitivity, the community's income surrounding the location was the most sensitive variable to an increase in income. Then the next position follows the number of tourist visits which were sensitive to affect the income of ecotourism management.

Economic subsystem scenario: increase revenue and lower costs

The ecotourism potential must be well-managed to maximize the existing tourist attraction components as tourism support (Putra & Sunarta, 2019). Visits are a crucial component that must be addressed for a tourist destination to thrive. Utari (2017) delineates that tourists' assessment of tourist attractions in the mangrove area requires the development of tourism products, supporting facilities, the availability of food stalls and souvenirs to increase interest in visiting.

Increasing the number of visitors to a mangrove ecotourism site is one way to boost income. According to Ghani (2017), to increase the level of tourist visits is to build and improve tourism infrastructure through innovations that combine cultural elements

Fig. 6. *Eco-tourism economic subsystem sensitivity of Kampung Blekok, Situbondo*



with tourism infrastructure. With an increase in the number of visits, the acceptance of managers and the community who run businesses in ecotourism areas can increase. Increasing the number of visits can be supported by a marketing strategy for ecotourism services. The increase in operating income can be supported by the variety of products sold around the location, affordable prices, and appropriate promotions.

Revenues can also be increased by lowering financing. It can be done by increasing efficiency in managing business financing and ecotourism management. The following scenario in *Fig. 7* depicts a combination to increase revenue. In *Fig. 7a*, a combination of scenarios is illustrated by increasing the number of tourists to 30,000 people, reducing fixed costs to IDR. 8 million, increasing community business revenues to IDR. 50 million, and reducing business expenses to IDR. 10 million/year. *Fig. 7b* shows similar information more clearly displayed in numbers. And *Fig. 7c* shows the slider used to increase and decrease the variable number. *Figure 7a*, *7b* and *7c* show that the priority variables increase tourist visits and reduce costs, both management and business costs, with efficiency measures. There is a significant increase in revenue with this move.

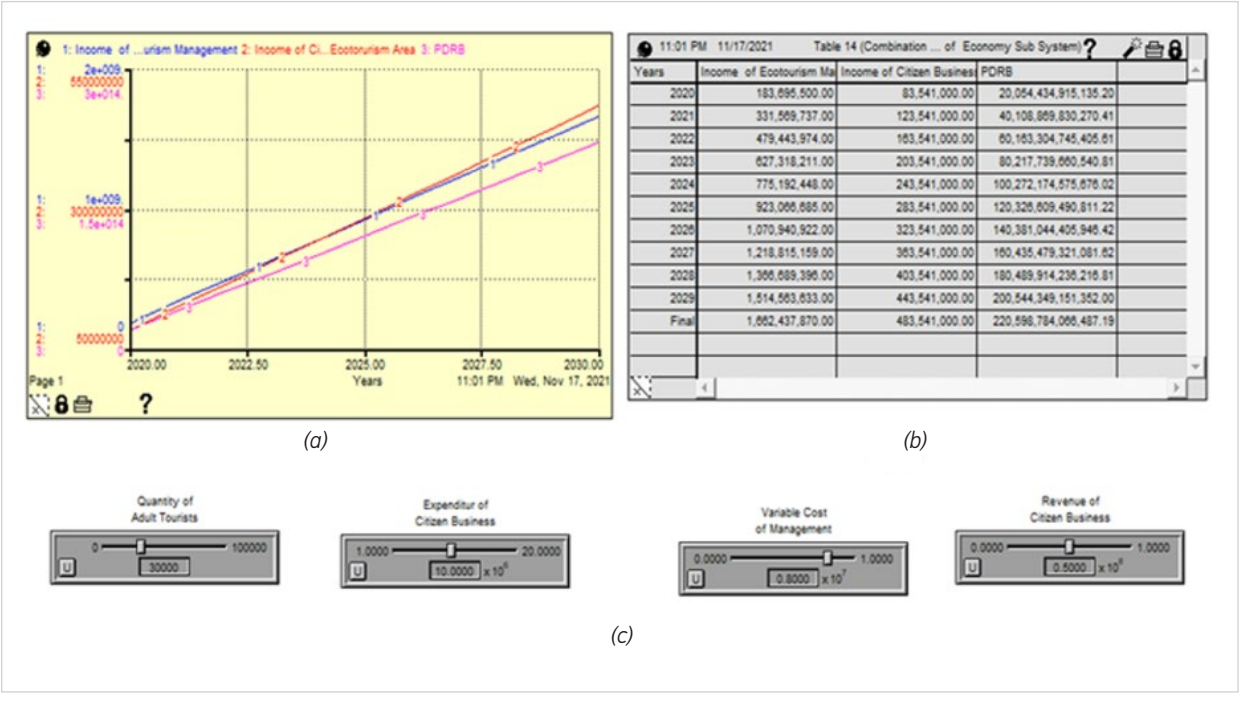
The scenario of ecology subsystem

The modeling scenario of the ecotourism ecological dynamics system in Kampung Blekok Situbondo was conducted to calculate the addition and death of mangroves. The simulation was executed for ten years to see the estimated density of mangroves as an essential component for the suitability of ecotourism areas.

Significant changes in mangrove density could be observed in variables that were sensitive to mangrove density. According to the sensitivity in *Fig. 7*, the planting of mangrove seedlings was the most sensitive variable to an increase in mangrove density. Then the next position followed is the death of mangrove seedlings due to pests.

Significant changes in mangrove density can be seen in variables with high sensitivity to mangrove density. *Fig. 8* illustrates changes in mangrove density due to several changes: *Fig. 8a* – due to changes in mangrove

Fig. 7. *Combined scenario in the ecotourism economic subsystem of Kampung Blekok, Situbondo*



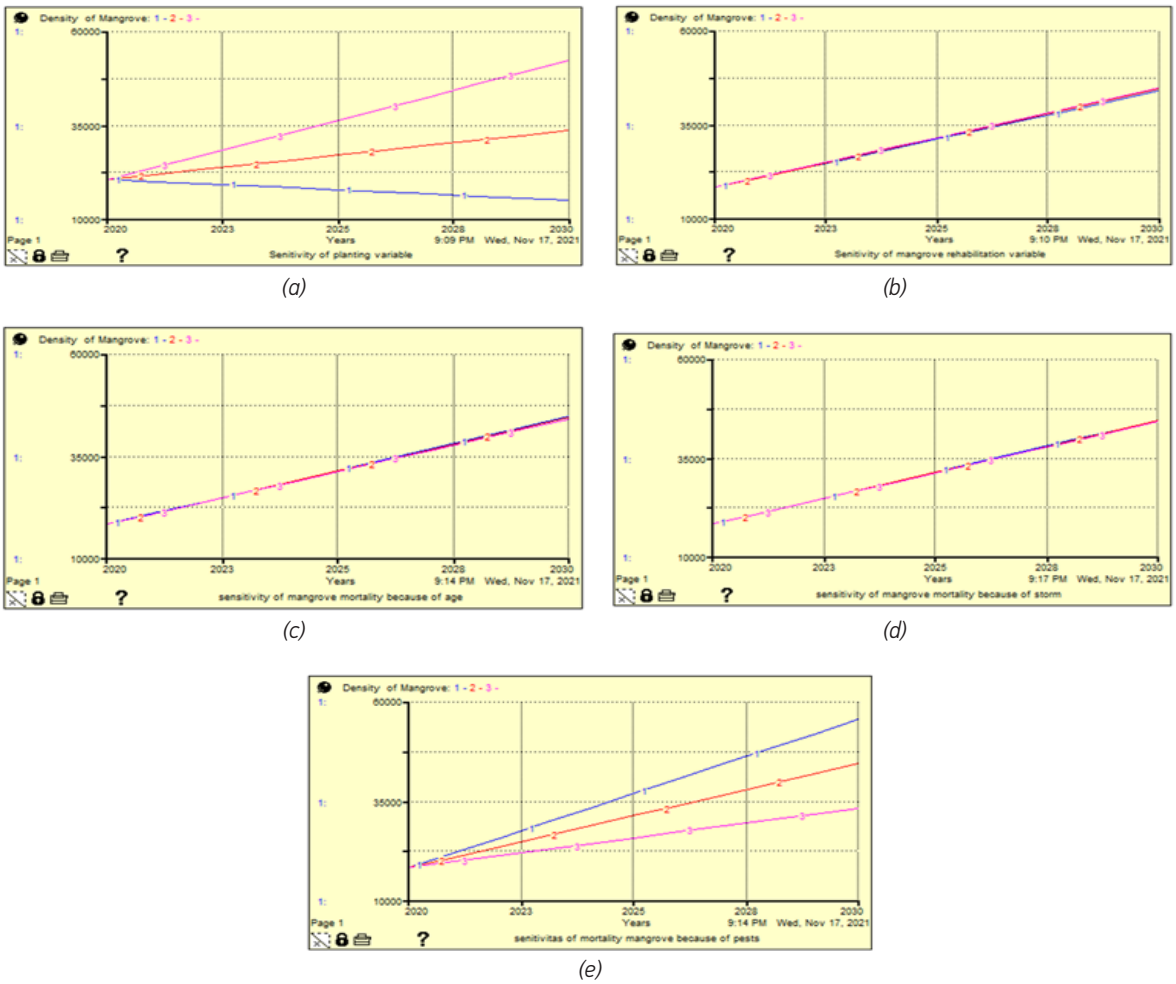
planting; *Fig. 8b* – due to changes in mangrove rehabilitation; *Fig. 8c* – due to the death of old mangroves; *Fig. 8d* – due to wind death of mangroves; and *Fig. 8e* – due to death of seedlings due to pests. From the sensitivity in *Fig. 8*, it is seen that the planting of mangrove seedlings is the most sensitive variable to the increase in mangrove density. Then the next position is the death of mangrove seedlings due to pests.

Scenario 1 of the ecological subsystem: adding mangrove seedlings

The mangrove density can be increased by planting mangroves sustainably and preventing the seedlings from dying due to pests or other factors. Latupapua et al. (2019) recommend that mangroves should be rehabilitated and reforested in ecologically suitable locations as mangrove habitats to maximize the value of suitability by increasing the area of mangrove areas.

In this mangrove ecotourism area, the average density is 2,793 tree trunks per hectare. Mangrove density is in excellent condition if the cover is more than 75% and the density is more than 1,500 trees per hectare. It is moderate if the cover is between 50%–75% and the

Fig. 8. *Sensitivity of ecotourism ecology subsystem in Kampung Blekok, Situbondo*



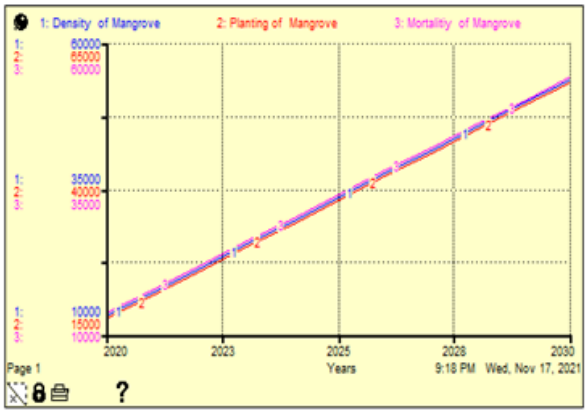
density is between 1,000 and 1,500 trees per hectare. The condition is damaged if the cover is less than 50% and the density is less than 1,000 trees per hectare (MEF, 2004). Thus, it can be said that the condition of the mangroves in the ecotourism of Kampung Blekok is in good condition. Meanwhile, there is still land that has not been fully planted with mangroves in the area, so there are still opportunities to reforest the area with mangroves.

An increase in the number of mangrove plantings is likely to be achieved if it can involve all parties from the government, private sector and community, and academics. The participation of stakeholders will significantly affect the success of maintaining a developing and sustainable mangrove environment. *Fig. 9* below shows the scenario of increasing the number of mangrove seedlings planted by 2,000 stems in the total conservation area. *Fig. 9a* shows a graph, which is clarified by *Fig. 9b* in the form of numbers. The increase in mangrove density is quite significant from year to year until 2030, even though there are still mangrove deaths. Mangrove planting is still very much needed to optimize the function of mangroves as a greenbelt to protect the land between sea and land transitions and other functions so that this scenario is expected to support the achievement of mangrove conservation goals.

Scenario 2 of the ecological subsystem: reducing mangrove seedling mortality

Scenario 2 presented in *Figs. 10a* and *10b* depicts graphs and figures in the ecological subsystem made

Fig. 9. *Scenario 1 in ecological subsystems by increasing the number of mangrove seedlings*



(a)

9:18 PM 11/17/2021 Table 8 (Untitled Table)

Years	Density of Mangr	Planting of Mangr	Mortality of Manc
2020	13,224	17,742	13,692
2021	17,274	21,792	17,742
2022	21,324	25,842	21,792
2023	25,374	29,892	25,842
2024	29,424	33,942	29,892
2025	33,474	37,992	33,942
2026	37,524	42,042	37,992
2027	41,574	46,092	42,042
2028	45,624	50,142	46,092
2029	49,674	54,192	50,142
Final	53,724		

(b)

Fig. 10. *Scenario 2 in ecological subsystems by reducing the number of mangrove seed deaths due to pests*

(a)

9:26 PM 11/17/2021 Table 10 (Untitled Table)

Years	Density of Mangr	Planting of Mangr	Mortality of Manc
2020	13,224	14,742	13,542
2021	14,424	15,942	14,742
2022	15,624	17,142	15,942
2023	16,824	18,342	17,142
2024	18,024	19,542	18,342
2025	19,224	20,742	19,542
2026	20,424	21,942	20,742
2027	21,624	23,142	21,942
2028	22,824	24,342	23,142
2029	24,024	25,542	24,342
Final	25,224		

(b)

by monitoring and eradicating pests that cause death in mangrove seedlings to reduce mangrove mortality. If the mortality of mangrove seedlings due to caterpillars, insects and diseases is reduced to 300 stems, a significant increase in density will be seen.

From the economic subsystem, it is known that community business income in ecotourism areas is the most sensitive variable to increase ecotourism income. Meanwhile, from the ecological subsystem, it is known that the planting of mangrove seedlings is the most sensitive variable to increase the density of mangroves. According to Larasati (2017), the tourism sector can trickle down by creating job opportunities. This condition can occur optimally if the developed sectors are designed according to the economic potential of the region concerned. The trickle-down effect theory, which Albert Otto Hirschman first proposed, explains that the progress achieved by a group of people will automatically trickle down to create jobs and various economic opportunities, which will foster various conditions for the creation of an even distribution of economic growth. The trickle-down effect is one of the indirect strategies of economic development approaches to equalize welfare, emphasizing economic growth. It is indirect because distributing welfare is carried out through increased economic growth in the main sector. Then the main sector will spread the results of economic growth to other sectors. With the dissemination process, it is hoped to improve the community's welfare. The existence of Kampung Blekok ecotourism as the main sector can be seen from increasing community economic growth through income. Furthermore, the stakeholders need to manage coastal area resources and a demographic bonus of productive age population with sinergy, so that the main sector can spread growth results to other industrial sectors such as the creative industry to support community-based ecotourism. These efforts are expected to minimize concerns about the emergence of negative impacts on income inequality with workers in other sectors.

Several parties related to mangrove ecotourism in Blekok Village are tourism awareness groups, government, residents, private companies, and tourists. Actors must synergize in managing ecotourism to balance the benefits and sustainability of mangrove natural resources. According to UNDP (2014), there are three main elements in the governance concept to interact and carry out their respective duties: the government, the private sector, and civil society. The government is assigned to create a conducive political and legal environment. The private sector creates jobs and income. The community plays a role in building social, political, and economic interactions and organizing themselves to participate. Larasati (2017) emphasizes that openness, transparency, and accountability are needed in partnership cooperation, so that stakeholders can share resources and distribute power and influence in a balanced way to minimize the dominance of some parties over others. Thus, the actors can monitor and evaluate each other transparently in ecotourism activities to minimize the adverse impacts of tourism activities in ecotourism areas, such as damage to mangrove resources.

Conclusions

The results showed that the conceptualization of an ecotourism system with a causal loop diagram consisted of the response variables, namely ecotourism management income, community business income in ecotourism areas, gross regional domestic product, mangrove mortality, mangrove planting, and rehabilitation. The data are obtained from the stock-flow diagram about the relationship between the response variables that can explain the system. Possible combinations are made between scenarios to overcome tradeoffs against research parameters. The combination of economic subsystem scenarios increases tourist visits and streamlines spending. The combination of ecological subsystem scenarios that are prioritized is adding mangrove seedlings and controlling pests that cause the death of mangrove seedlings.

Government support is needed to develop mangrove ecotourism management. The community is expected to maintain respectful behavior to preserve mangroves and protect ecotourism areas from obtaining economic and ecological benefits. The limitation of this research is that the study is only conducted on the economic and ecological dimensions with specific attributes. For further research, it is recommended to expand the study on social aspects and add attributes that have not been studied in this current study, namely pollution in ecotourism areas.

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