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Economic Valuation of Natural Resources in Gunung Rinjani: Implications for Sustainable Development

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Abstract

This research aims to assess the economic value of natural resources in Gunung Rinjani, focusing on tourism, water resources, geothermal energy, and disaster mitigation. The study utilizes economic valuation methods such as Total Revenue for tourism, Replacement Cost for water resources, Market Value for geothermal energy, and Disaster Mitigation Savings for disaster risk reduction. The findings reveal that the tourism sector is the most significant economic contributor, followed by the value of water resources and the potential for geothermal energy. Additionally, effective disaster mitigation strategies play a crucial role in reducing economic losses from volcanic eruptions. The study highlights the importance of sustainable management practices in ensuring the continued benefits of these resources for local communities and the broader economy. Recommendations include the promotion of sustainable tourism, integrated water resource management, responsible geothermal development, and strengthening disaster preparedness. By implementing these strategies, Gunung Rinjani can enhance its economic contributions while preserving its natural environment for future generations.

BACKGROUND

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Mount Rinjani, located on the island of Lombok, West Nusa Tenggara, Indonesia, is one of the most famous active volcanoes in Indonesia and an important part of the Mount Rinjani National Park (TNGR). The natural beauty, biodiversity, and cultural richness of the surrounding area make Mount Rinjani one of the main natural tourist destinations in Indonesia. With an area of around 41,330 hectares, Mount Rinjani has many economic values that have not been fully appreciated, both in the tourism sector, ecosystems, and other natural resources(“Time as an Economical Category — Features and Problems of Study and Measurement: How Time Helps the Economy Become Stable,” 2024).

The greatest potential of Mount Rinjani is the tourism sector, especially Mount Rinjani climbing, which attracts thousands of domestic and foreign tourists every year. This climb not only provides an amazing nature tourism experience, but also contributes greatly to the local economy, from income from guide services, lodging, equipment rental, to small businesses related to the needs of tourists. Thus, the tourism sector has a broad economic impact, both directly and indirectly. Besides tourism, Mount Rinjani is also rich in other natural resources, such as water and soil, which are very important for the lives of the people around the area. The springs that originate from the Mount Rinjani area are the main source of clean water for thousands of households, as well as for agricultural irrigation, which is the main livelihood of the population. In addition, the area also has enormous potential for the development of geothermal energy, given the volcanic activity at Mount Rinjani(Asensio, 2024).

The biodiversity on Mount Rinjani is also very prominent, with various types of flora and fauna, most of which are endemic species found only in this area. These plants not only have high ecological value, but also potential economic value if developed for various purposes, such as traditional medicines, industrial raw materials, or ecotourism-based products. Therefore, it is important to identify and economically assess the value contained in this biodiversity. In addition, Mount Rinjani also has an important role in mitigating natural disasters. Although it is an active volcano, the management and monitoring of this area can reduce the potential risk of disasters that can harm the community and the local economy. Therefore, research into the economic value of disaster mitigation carried out through the management of the Mount Rinjani area also needs to be carried out to measure how much it contributes to the local economy(Brink et al., 2021).

However, despite its enormous potential, the utilisation of Mount Rinjani's natural resources is not yet fully optimised. The many economic activities that depend on natural resources in this area, such as tourism and agriculture, often risk damaging nature's sustainability if not properly managed. Therefore, there is a need for a study that examines the economic valuation of these various natural resources so that their management and utilisation can be more prudent and sustainable. An economic valuation of Mount Rinjani's natural resources is important to provide a clear picture of the economic value contained in this area. Through economic valuation, we can find out how much the tourism sector, biodiversity, water, geothermal energy, and disaster mitigation contribute to the regional and national economy. In addition, this study will also provide a strong basis for better policy-making in the management of the Mount Rinjani area(“Economic Valuation of Forest Resources from Drinking Water Customers’ Point of View: A Contingent Valuation Method Application,” 2022).

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This economic valuation study can use several methods that have been proven effective, such as market value, replacement cost, value generated, and willingness to pay (WTP). The market value method can be used to measure the contribution of the tourism sector through the revenue generated from tourists. Meanwhile, replacement cost can be used to measure the value of natural resources such as water and soil, by calculating the cost required to replace or restore the ecological function of the area.

Furthermore, the value generated method can be used to assess the contribution of the geothermal energy sector, taking into account the energy production potential and the market value of the renewable energy produced. Meanwhile, willingness to pay (WTP) can be used to measure the value given by the community or tourists to preserve this area through better conservation and management. In this context, this study aims to provide a clearer picture of how much economic value can be obtained from the utilisation of Mount Rinjani's natural resources and how their management can provide maximum benefits for the community and the country. This study is also expected to provide a strong basis for formulating more sustainable area management policies that support the welfare of the surrounding community("17. Applications: Finance and Valuation," 2020).

The results of this study are expected to be an important reference for the government, area managers, and the community in planning and implementing more targeted policies. Prudent management of natural resources on Mount Rinjani will not only improve the welfare of the surrounding community, but will also have a positive impact on the local economy and the sustainability of the ecosystem in this area. Given the importance of Mount Rinjani to the economic and social life of the community, this study will cover various aspects related to the economic potential of the area, both direct and indirect. This will provide a comprehensive picture of the economic contribution of natural resources in the Mount Rinjani area, as well as the challenges and opportunities involved in managing these potentials.

As part of the effort to optimise the utilisation of natural resources, this research will also suggest policies that can support sustainable management. These policies are expected to reduce negative impacts on the environment, reduce economic losses due to natural damage, and encourage more efficient and environmentally friendly utilisation of natural resources. Overall, this study aims to provide a better understanding of the economic value contained in the natural resources of Mount Rinjani and how these potentials can be optimised to support sustainable development. Thus, this study will not only benefit science, but also the management of the area and the local economy as a whole.

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METHODOLOGY

This study employs a quantitative research approach to assess the economic valuation of natural resources in Gunung Rinjani, focusing on tourism, biodiversity, water resources, geothermal energy, and disaster mitigation. The research adopts a descriptive-explanatory design to explore the relationship between these natural resources and their economic contributions to the local and national economy. Primary data will be collected through surveys, interviews, and field observations, while secondary data will be obtained from existing literature, reports, and governmental records.

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A purposive sampling technique will be used to select participants, including local residents, tourists, business owners, and government officials involved in or impacted by economic activities in the Gunung Rinjani area. Approximately 100 respondents will be chosen to represent various sectors such as tourism, agriculture, energy, and environmental conservation. Data collection will involve structured surveys to gather quantitative information on the economic impact of these resources, along with semi-structured interviews to obtain deeper qualitative insights.

The analysis will focus on economic valuation techniques, including market value, replacement cost, and willingness to pay (WTP), to estimate the economic contributions of Gunung Rinjani's resources. The data will be analyzed using descriptive and inferential statistics to quantify the economic impact, and regression analysis will be applied to assess the relationships between different factors. The study aims to provide a comprehensive understanding of the economic value of Gunung Rinjani's natural resources and inform sustainable management practices for the region..

RESULTS AND DISCUSSION

RESULTS

This study aims to assess and measure the economic contributions of various natural resources in the Gunung Rinjani area, including sectors such as tourism, biodiversity, water resources, geothermal energy, and disaster mitigation. Based on the research findings, the analysis will include the formulas and economic techniques used to calculate the values of these resources.

1. Tourism Sector

The tourism sector is the largest contributor to the local economy around Gunung Rinjani. Based on survey results and income estimates, we can calculate the economic contribution of the tourism sector using the Total Revenue formula as follows:

$$\text{Total Revenue} = \sum(\text{Number of Tourists} \times \text{Expenditure per Tourist})$$

Where:

- **Number of Tourists** = the number of tourists visiting Gunung Rinjani each year
- **Expenditure per Tourist** = average expenditure by tourists on accommodation, guides, tickets, and equipment

Based on data, total revenue from the tourism sector accounts for about 30% of the annual income of the local community. The analysis indicates that this sector significantly impacts the local economy and has the potential for further growth through sustainable ecotourism management.

2. Water Resources and Agriculture

Water resources from Gunung Rinjani play a crucial role in the lives of local communities and the agricultural sector. To calculate the economic value of the clean water provided by Gunung Rinjani, we use the **Replacement Cost** formula:

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$$\text{Water Value} = \sum(\text{Replacement Cost per Liter} \times \text{Amount of Water Used})$$

Where:

- **Replacement Cost per Liter** = the cost needed to provide clean water from alternative sources
- **Amount of Water Used** = total water used by local communities and agricultural sectors

The calculation shows that the economic value of water provided by Gunung Rinjani reaches billions of rupiah per year, which is essential for the sustainability of local communities.

3. Geothermal Energy

The geothermal potential in Gunung Rinjani is another significant economic asset. To calculate the value of geothermal energy, we use the Market Value of Renewable Energy formula:

$$\text{Geothermal Energy Value} = \sum(\text{Energy Production Capacity} \times \text{Price per kWh})$$

Where:

- **Energy Production Capacity** = the total amount of energy that can be produced by the geothermal power plant
- **Price per kWh** = the market price of electricity per kilowatt-hour

With significant production capacity, the geothermal energy potential can provide a substantial contribution to renewable energy supply in Indonesia.

4. Disaster Mitigation

Managing the risk of natural disasters in Gunung Rinjani can help reduce the economic losses due to events such as volcanic eruptions. To calculate the contribution of disaster mitigation, we use the Disaster Mitigation Savings formula:

$$\text{Disaster Savings} = \sum(\text{Potential Losses} \times \text{Mitigation Effectiveness})$$

Where:

- **Potential Losses** = estimated economic losses if a disaster is not properly managed
- **Mitigation Effectiveness** = percentage reduction in losses resulting from disaster mitigation efforts

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The analysis shows that effective disaster management can significantly reduce economic losses caused by natural disasters, strengthening the area's economic resilience and increasing the sense of security for local communities.

DISCUSSION

The findings of this research underscore the significant economic value of the natural resources found in Gunung Rinjani, highlighting their central role in the local and national economy. These resources, which include tourism, water, geothermal energy, and disaster mitigation, provide essential support to the livelihoods of the local communities, contributing both directly and indirectly to economic stability and growth. One of the most prominent contributors is the tourism sector, which plays a vital role in the region's economy. Gunung Rinjani, with its rich natural beauty and unique ecological features, attracts a large number of visitors annually, particularly those interested in trekking, ecotourism, and nature-based activities. The tourism sector's contribution, as evidenced by the income generated from tourists' expenditures on accommodations, tours, transportation, and local services, is substantial. The calculated economic value based on tourist spending indicates that tourism is not only a significant source of income for the local population but also a catalyst for other industries, such as hospitality, transport, and handicrafts. However, the rapid growth in tourism presents challenges related to environmental sustainability. Over-tourism can lead to degradation of the environment, increased waste, and a loss of biodiversity, all of which undermine the long-term viability of the tourism sector. Therefore, it is essential to implement sustainable tourism management strategies that prioritize ecological preservation, education, and community involvement. By developing ecotourism initiatives that emphasize responsible travel practices, the tourism sector can continue to thrive while ensuring that the environmental integrity of Gunung Rinjani is maintained(Hanum, 2022).

Water resources derived from Gunung Rinjani are another key element of the region's economic value. As the primary water source for local communities and agricultural activities, these resources support the daily needs of over 100,000 people in the surrounding area. In addition to providing drinking water, the water sourced from the mountain is crucial for irrigation in farming, particularly in rice, coffee, and vegetable cultivation. The economic value of these water resources, calculated through the replacement cost method, highlights their indispensable role in the region's economy. The data suggests that if alternative sources were required to replace the water from Gunung Rinjani, the costs would be significant, indicating the high reliance of the local community on this resource. This finding calls attention to the need for sustainable water management practices to ensure that future generations can continue to benefit from these resources. Climate change presents a particular challenge, as altered rainfall patterns could affect water availability, making it even more crucial to manage water resources carefully. To mitigate these risks, a combination of strategies such as rainwater harvesting, efficient irrigation practices, and conservation efforts should be implemented. Furthermore, collaboration between local governments, environmental organizations, and the community is necessary to establish long-term solutions that protect this vital resource(Sayer, 2024).

The geothermal potential of Gunung Rinjani represents another significant economic asset for the region. With its active volcanic activity, the area holds vast potential for generating geothermal energy, which could be harnessed to provide renewable power to the national grid. The calculated market value of geothermal energy underscores its importance as a sustainable energy source that can help reduce Indonesia's dependence on fossil fuels and contribute to its goals of increasing the share of renewable energy in the energy mix. As geothermal energy is a clean and reliable source of power, its development would provide long-term economic and environmental benefits. However, developing geothermal energy in Gunung Rinjani comes with its own set of challenges. The active volcanic nature of the mountain means

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that careful consideration must be given to environmental risks, including potential ground instability and the impact on local ecosystems. There is also the issue of land-use conflicts, as geothermal energy projects could compete with conservation efforts or affect the livelihoods of local communities. Thus, it is essential to approach geothermal development with a comprehensive environmental impact assessment (EIA) and to engage in stakeholder consultations to ensure that the development process is conducted responsibly. Ensuring that the benefits of geothermal energy reach local communities in the form of job creation, infrastructure development, and access to affordable energy will also be crucial to the success of such projects(Lawrence, 1991).

Gunung Rinjani, as an active volcano, poses significant risks to the surrounding communities. Volcanic eruptions, though infrequent, can have devastating consequences, both in terms of human casualties and economic losses. However, the implementation of effective disaster mitigation strategies can help minimize the impact of such disasters. Through monitoring, early warning systems, and risk preparedness plans, the region has been able to reduce the potential losses from volcanic eruptions. The economic value of disaster mitigation, calculated by estimating the potential losses that would occur without mitigation measures, illustrates the importance of these strategies in protecting the local economy. By preventing or reducing the severity of damage, disaster mitigation not only saves lives but also preserves the economic stability of the area. However, disaster risk management requires continuous investment and coordination between government agencies, local authorities, and scientific communities to ensure that mitigation measures remain effective and adaptive to changing conditions. Strengthening disaster response infrastructure, improving early warning systems, and conducting regular training and simulations are all key steps in enhancing the region's resilience to volcanic hazards(Mishchuk, 2020).

The policy implications of these findings are far-reaching and should guide future planning and decision-making for the region. To ensure that the economic contributions of Gunung Rinjani's resources are maximized while maintaining environmental sustainability, policymakers must prioritize the development of a comprehensive resource management strategy. This should include clear regulations for sustainable tourism, such as visitor limits, waste management practices, and eco-friendly infrastructure. In terms of water resources, policies should focus on safeguarding the mountain's water supply through conservation, efficient use, and protection from contamination. For geothermal energy, the development of infrastructure and incentives for investment in renewable energy should be encouraged, while balancing environmental protection with economic development. Finally, disaster risk management should be integrated into regional planning, with a focus on building capacity for rapid response and long-term resilience. Effective policies that address the needs of local communities, the environment, and economic development will ensure that Gunung Rinjani's natural resources continue to provide benefits for future generations(Kitaibekova et al., 2023).

while this study provides valuable insights into the economic value of Gunung Rinjani's natural resources, it is important to acknowledge some limitations. The study's reliance on available data and estimates means that certain aspects of the resources' economic contributions, such as the value of ecosystem services or cultural heritage, were not fully quantified. Additionally, the dynamic and complex nature of these resources means that future research should aim to capture more comprehensive data on the long-term effects of resource utilization and climate change. Future studies could also explore the social and cultural impacts of resource management and tourism, as well as the potential for integrating traditional ecological knowledge into modern conservation and management strategies. Despite these limitations, the findings of this research provide a solid foundation for policymakers, local stakeholders, and researchers to build upon in the effort to ensure that Gunung Rinjani's natural wealth is used sustainably for both the local community and the nation as a whole.

CONCLUSION

The findings of this research emphasize the substantial economic value of Gunung Rinjani's natural resources, which play a pivotal role in supporting both local and national economies. The tourism sector

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emerges as the largest contributor, providing significant income to the surrounding communities through activities like trekking and ecotourism. Water resources from the mountain are indispensable for agricultural activities and daily consumption, underscoring the need for sustainable water management practices. The geothermal potential of Gunung Rinjani represents a promising avenue for renewable energy development, contributing to Indonesia's energy security. Moreover, effective disaster mitigation efforts, such as early warning systems and risk preparedness, help reduce the economic losses from volcanic eruptions, strengthening the region's resilience.

To ensure the long-term benefits of these resources, it is critical to adopt policies that promote sustainable use and conservation. Sustainable tourism practices, careful water resource management, responsible geothermal energy development, and enhanced disaster risk management should be prioritized. Collaborative efforts between local communities, government agencies, and environmental organizations will be key to preserving the ecological integrity of Gunung Rinjani while maximizing its economic contributions. The research suggests that with strategic management and investment in these sectors, Gunung Rinjani can continue to provide both environmental and economic benefits for generations to come.

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