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ECOTOURISM DEVELOPMENT MODEL BASED ON DISASTER RISK REDUCTION IN AN ECOTOURISM SITE IN INDONESIA

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Abstract: Ecotourism is one of the sectors that is expected to contribute towards the Sustainable Development Goals. Ecotourism development should consider disaster risk due to its direct impact on human safety and the environment. This study aims to develop an ecotourism development model based on disaster risk reduction in the Gunung Ciremai National Park (GCNP) and its buffer zone. The model was developed based on the supply and demand analysis. Land suitability analysis was used to estimate ecotourism supply using spatial analysis, combined with multiple-criteria decision analysis. Four parameters with 11 sub-parameters were used in the spatial analysis. Demand was examined by measuring tourist preferences. This study found that only 0.18% of GCNP and its buffer zone are classified as unsuitable for ecotourism development and most of the areas falls under the marginally suitable category. Increasing restoration rate and lowering the allowable development area can expand it carrying capacity from 5.62 million to 5.70 million people per year under the moderate scenario and 5.96 million people per year in the optimistic scenario using a 40-year simulation. Disasters risk can also be reduced by embedding mitigation of and adaptation to disasters in ecotourism management planning.

Keywords: Sustainability, supply, demand, modelling, disaster.

Introduction

Tourism is one of the most important economic drivers, ranked as the third-highest export value in 2017 after chemical and fuel, with a total value of US$ 1.568 trillion (The World Tourism Organisation, 2019). Ecotourism has the fastest growth rate compared with other tourism types, where it grew three times faster than other tourism industries (Honey, 2008). Ecotourism is an integral part of sustainable tourism that should ensure tourist needs, maintain tourism sites and protect resources under the sustainability pillars, including the economy, social and environment dimensions. It should also preserve cultural integrity, as well as process essential ecology, biodiversity and life support systems (The World Tourism Organisation, 2016). Ecotourism is considered as an approach to achieve sustainable development due to its economic contribution (Wall, 1997), protection of natural resources and cultures (Khan, 2003; Patterson, 2005; Alikodra, 2012), maintenance of ecology processes (Shimada, 2006) and development of positive social values and relationships in society (Stronza, 2007). Hence, tourism and ecotourism industries have become an important source of growth for developing countries due to their potential of gaining foreign exchange. Indonesia has been promoting tourism as one of the approaches to alleviate poverty, preserve nature, protect the environment, conserve resources, preserve culture and strengthen global partnership (Sutawa, 2012). The country recorded that tourism contributed to 6% of the total GDP and 10.3% of employment opportunities in 2018 (The World Travel and Tourism Council, 2019).

The early introduction of the ecotourism concept into the larger society in Indonesia was marked by a seminar organised by Pact-Indonesia and WALHI in 1995. The following year, ecotourism gains further momentum when the Indonesian Ecotourism Society was established during the Second National

Workshop on Ecotourism held in Bali (Sudarto, 1999). Various ecotourism areas have gained international popularity, including Bali, Labuan Bajo, Wakatobi and Raja Ampat. However, Indonesia is a mega-biodiversity country with endemic species and beautiful landscapes can be found across the country. Most of the biodiversity is preserved in conservation areas, which can be promoted as ecotourism sites. However, Indonesia is also known as a prone-disaster country, with 127 active volcanoes and located in the Pacific Ring of Fire and more than 60% of areas are vulnerable to floods (The World Bank, 2019).

Ecotourism as part of the development process, has been identified to have some negative impacts on the environment and social conditions. In addition, ecotourism development also faces threats of natural disasters such as floods, landslides and fires. Thus, to reduce the negative impacts and potential disasters, an approach to analysing land suitability for ecotourism development is necessary. In addition, land suitability analysis as the principal of regional planning can contribute to achieving Sustainable Development Goals or SDGs (Abbaspour *et al.,* 2011). This analysis can be used to determine the best options for utilising a site (Collins *et al.,* 2001), the availability of land for alternative land uses and the potential impact on the surrounding environment (Baja *et al.,* 2007). Interactions between disaster threats and development planning can be also determined by using this analysis through prevention actions (The Asian Development Bank, 2016). In the economic perspective, the application of land suitability analysis provides the information to assess costs and benefits in developing an area. Land suitability as a parameter of ecotourism development must have clear and measurable variables (Zarkesh *et al.,* 2011).

Disaster events can have a serious impact on the tourism sector economy (Tsai & Chen, 2011). In addition, the impact of disasters has a significant influence on the tourism industry (Wang, 2009). Disaster events can cause tourist destinations to lose their attractiveness and, economic and cultural assets not only temporarily but also permanently (Faulkner & Vikulov, 2001). For tourists, disaster events can cause stress, inconvenience and insecurity, leading to them not visiting tourist objects affected by disasters (Huang & Inoue, 2007; Coombes & Jones, 2010). Jónsdóttir (2011) evaluated the impact of a volcanic explosion in Iceland on the number of tourists and it was found that there was a decrease in tourist arrivals of up to 49% within one year of the disaster. Mazzocchi and Montini (2001) investigated the effect of earthquakes on the number of tourist arrivals in Umbria, Central Italy. Data showed that tourist arrivals decreased drastically in the first month following the earthquake and continued for up to a year after the earthquake.

In this study, we examine the potential ecotourism development model based on the disaster risk in the Gunung Ciremai National Park (GCNP) and its buffer zones. The development of the model will consider the results of the demand and supply analysis, which will decide whether ecotourism development in Kuningan district is reliable. We used the land suitable analysis based on the disaster risk as the supply analysis. This analysis will provide data on the area's tourist carrying capacity. The demand analysis is based on tourist preferences regarding the potential ecotourism development in Kuningan.

The GCNP is relatively new and researchers are still discovering new endemic species at the park. Among the latest finding was the red frog (*Leptophryne javanica*), discovered in 2018 (Hamidy *et al.,* 2018). The national park is located relatively near high population areas, including the capital city of Indonesia. It is three hours away from the capital by land transportation. This indicates a huge potential market for ecotourism development. The average growth of ecotourism between 2008 and 2018 in Kuningan district is 14% (Kuningan District Youth, Sports and Tourism Office, 2018). However, Gunung Ciremai is an active volcanic mountain and forest fire breaks out almost every year at the park. A total of 41 fire events took place in

Kuningan district in 2015, the highest number of incidents the past 10 years. The district is also prone to landslides and land movements, where the highest numbers of incidents were recorded in 2016 and 2017 with 191 and 137 events, respectively (GCNP, 2019; Regional Disaster Management Agency of Kuningan, 2019). In addition, the negative impacts of ecotourism are unavoidable. However, it can be minimised through environmental management, education and visitor management (Blamey, 2001). Disaster impacts can be reduced by developing adaptation programmes through ecotourism development planning by conducting land suitability analysis. This analysis can assist in achieving the SDGs by providing an outlook of the regional planning activities (Abbaspour *et al.,* 2011). In addition, it can also be used to determine the best options for a land-use development (Collins *et al.*, 2001). Alternative land uses and their impacts on the surrounding environments can be also investigated using land suitability analysis (Baja *et al.*, 2007). In this study, we explore the importance of the ecotourism development model by considering the potential disaster risk to ensure human safety and at the same time protect environmental sustainability.

Materials and Methods

Study Site

This research was carried out in the east part of the GCNP and its buffer zone comparising seven sub-districts with a total area of 26.6 thousand ha (Figure 1). The east part of GCNP is located in Kuningan district of West Java province. We conducted the study from October 2018 to August 2019. Gunung Ciremai is the highest mountain in West Java (3,078 m) and is home to endemic and rare species, including lampeni (*Ardisia cymosa*), kandaca (*Platea latifolia*), the leopard (*Phantera pardus*), Indian muntjak (*Muntiacus muntjak*), Western long-beaked echidna (*Zaglossus brujini*), Javan surili (*Presbytis comata*) and Javan hawk-eagle (*Spizaetus bartelsii*) (GCNP, 2019). The national park is also a habitat to the Javan langur, an endangered species that is protected under the Convention on International Trade in Endangered Species. Primary, secondary and pine forests can be found at the park. Most of

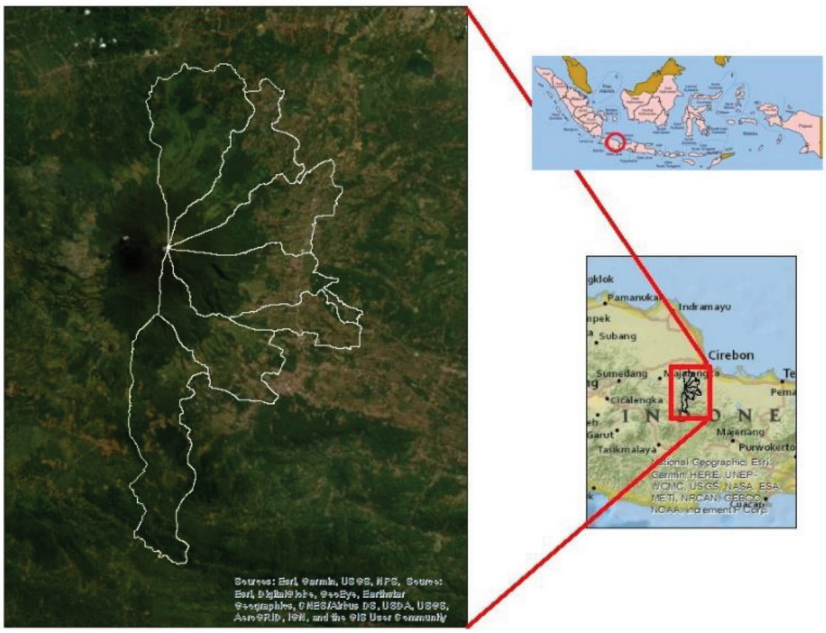

Figure 1: A map of the research location in Kuningan district, West Java, Indonesia

the pine forests are located in the buffer zone (Supartono *et al.,* 2018). The GCNP can be classified as a newly established park since the designation was established only in 2004 (GCNP, 2019).

Model Components

We used multiple approaches to develop the model by analysing both the supply and the demand of for at the national park. The supply analysis was carried out by examining the land suitability for ecotourism development, while the demand was estimated using tourist preference analysis. Figure 2 describes the design of our research.

In this study, we used land suitability analysis to identify potential areas for ecotourism development. The current ecotourism development at the national park is limited to the northern area of the park. We also collected data on potential ecotourism sites in the seven sub-districts bordering the park areas (buffers zone). Land suitability analysis was conducted by analysing four parameters, which are the environment, biodiversity, economy and social dimensions. These parameters were modified from the three sustainability pillars of the SDGs with an additional component of biodiversity sustainability. Each parameter was composed of several sub-parameters. In total, we used 11 sub-parameters, including the slope, height, aspect, disaster risk, flora, fauna, local community income level, facility/infrastructure, status of the area, residential size/population and local community satisfaction level. The sub-parameters for suitability analysis were obtained by conducting a literature review

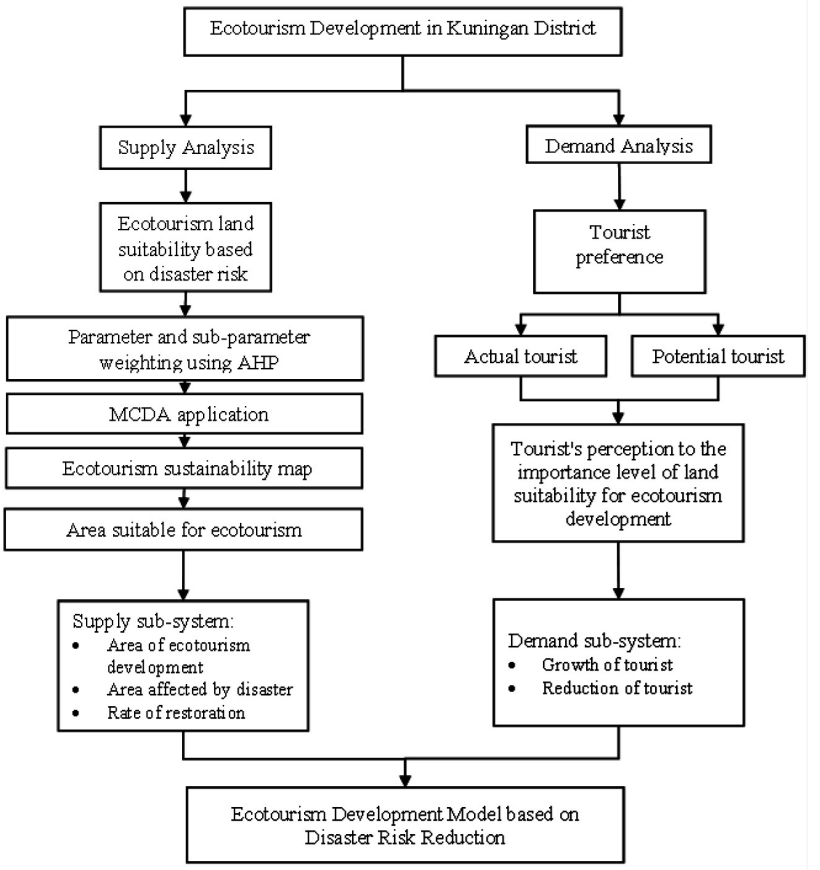

Figure 2: The research design in developing an ecotourism model based on disaster risk reduction

of previous studies. The spatial analysis using the superimpose (overlay) technique, combined with weighting using the multiple-criteria decision analysis (MCDA) method is used to determine the suitability of an area for ecotourism development.

In this study, the MCDA technique was applied to combine expert judgments and preferences using the analytical hierarchy process (AHP) method to obtain the standardisation of parameters and the ratings of ecotourism land suitability parameters. This study used the multiple comparison weighting techniques by comparing the importance of each parameter in pairs. This method emphasises weighting through the normalisation of eigenvectors by associating them with the maximum eigenvalues in a ratio matrix (Malczewski, 1999). Its ability to force decision-makers to assess all parameters makes this method effective in deciding a problem (Zardari *et al.,* 2015). The last step of the AHP is the aggregation of the relative weights obtained at each level of the hierarchy to calculate the parameter suitability rating.

We requested three experts to rank the sub-parameters based on their importance. An assessment using multiple comparisons such as AHP should involve three to six experts as the use of experts outside this amount does not have a significant effect on the results of the assessment (Hora, 2004). The experts were from different backgrounds, including academia, government service and the private sector. The details of the categories used in this study is presented in Table 1.

The environment parameter maps were acquired from the Indonesian Geospasial and Information Agency for the year 2016 while disaster vulnerability maps, including land movement, volcanic eruptions and landslides were obtained from the Kuningan Local Office. The land and forest fire vulnerability maps were collected from the national park office. Several sub-parameters were unavailable in digital format. Thus, we collected related research and reports including conducting fieldwork to develop the maps accordingly. We also used the AHP method, followed by overlapping all conformity maps using the simple additive weight method using Equation (1):

$$S_i = \sum_{i=1}^{n} W_i \text{ x } R_i \quad (1)$$

where n is the number of factors, Wi the multiplication of all related weights in the i-th factor hierarchy and Ri the rank assigned to the class determined from the i-th factor.

The total suitability value of each parameter is combined to form the basis of the land suitability map for ecotourism development. Four suitability classes for ecotourism development, modified from Prakash (2003) were used which are very suitable (S1), suitable (S2), marginally (S3) and not suitable (N). The very suitable (S1) class refers to an area with high sensitivity, there should be no development and is only suitable for research and education activities, site seeing and trekking. The suitable class (S2) refers to an area with high sensitivity but still allows for little development and is only suitable for research, education, site seeing, trekking, camping, bird watching and other limited activities. The marginally suitable class (S3) refers to an area with low sensitivity and allows for development that considers environmental impacts such as green hotels, lodges, restaurants and other public facilities to support ecotourism. The not suitable class (N) refers to an area that is affected by development and environmental degradation that cannot be developed for ecotourism. The classification of suitability was used evenly by taking into consideration the standardised format with values ranging from 0 to 1. Thus, the values obtained for S1 is > 0.75-1.00, S2 0.50-0.75, S3 > 0.25-0.50 and N 0-0.25.

The demand analysis was performed by interviewing tourist for their preferences. We divided tourists into two categories, actual and potential tourists. Actual tourists are visitors who we found at the ecotourism site and was requested to be interviewed onsite. Potential tourists are those who have yet to visit the ecotourism sites in the research site. In total, 308 respondents were involved, comprising 164 actual tourists

Table 1: The criteria of parameters and sub-parameters for the land suitability analysis for ecotourism development

No.	Parameter	Sub-parameter	Unit	Suitability Factor Rating				Sources
				Very Suitable	Suitable	Marginal Suitable	Not Suitable	
1	Environment	Slope	%	0-5	5-25	25-35	> 35	(1)
2		Elevation	Metre	300-400	100-300	> 400	0-100	(1)
3		Aspect	-	Flat, North, Northeast, Northwest	West, East	Southeast, Southwest	South	(2), (3), (4)
4		Disaster risk	Risk	No risk	No risk	No risk	Risk	(3)
5	Biodiversity	Flora	Type of land cover	Forest	Garden/ plantation	Rice fields and shrubs	Water body and developed areas	(1)
6		Fauna	% of recorded key species	>30%	20-30%	5-20 %	< 5%	(1)
7	Economy	Facilities (Attraction, accessibility, accommodation, market, health facilities)	Number of facilities	5 facilities	3-4 facilities	1-2 facilities	No facilities	(1), (2), (4), (5)
8		Local community income	Rp/month	≤ Rp 1.8 mil	> Rp 1.8 mil - 3 mil	Rp > 3 mil - 5 mil	> Rp 5 mil	(6)
9	Social	Status of the areas	Class of the areas	Protected areas	Forested cultivation area and non-forest protected areas	Enclave, fisheries, plantation, settlement and agriculture	Disaster areas and waterbody	(1)
10		Population	Peoples	0	0-1,000	1,001-10,000	>10,000	(1)
11		Local communities' satisfaction to ecotourism development	Satisfaction level	Very satisfied	Satisfied	Less satisfied	Not satisfied	(7)

(1) Bunruamkaew & Murayama, 2011; (2) Bali *et al*., 2015; (3) Cihan *et al.*, 2018; (4) Zarkesh *et al.*, 2011; (5) Boyd & Butler, 1995; (6) Hijriati, 2013; (7) Yusnikusumah & Sulistyawati, 2016

and 144 potential tourists. Data on background, motive and perception were collected from actual tourists. An additional section was added to the questionnaire for potential tourists on their interest to visit ecotourism sites at the park and its buffer zone. In addition to the supply and demand analysis, we also conducted in-depth interviews with six resources person from relevant local institutions to gain further insights into the overall ecotourism dynamic in the Kuningan sub-district.

In this study, we used the dynamic system to simulate the behaviour of a system prepared based on several scenarios, including pessimistic, moderate and optimistic. The dynamic model was performed using Stella 9.0.2. The study constructed a conceptual model on ecotourism development by considering the disaster risk and area capacity as the supply factors and the number of visits when disaster occurs as the demand factor. The model is simulated to obtain a disaster risk-based ecotourism development model that can be applied in Kuningan district. The region's ability to accommodate tourists will be the highest limit for meeting tourist demand. The assumptions used in designing the model are:

1. The average growth and reduction of tourists when a disaster occurs was based on data from 2010 to 2018 data, with the average growth being 14% per year and decreases in tourists due to the disaster 0.17% per year.
2. The number of tourists that can be accommodated in 1 hectare of land is 5 people.
3. The average area of ecotourism location in Kuningan district is 19 ha (Yuniarsih *et al.,* 2014).

Results and Discussion

Analysis of Land Suitability for Ecotourism Development

The weighting of parameters and sub-parameters for ecotourism development based on experts' rankings are presented in Table 2. At the parameter level, this study found that biodiversity is considered to be the most important parameter for ecotourism development. We found that the area status (legality) and disaster risk were two of the most important sub-parameters compared with the nine others. Disaster risk is clearly ranked as the most critical sub-parameter under the environment parameter, with a substantial weight of 0.556. Aspect was considered to be the least important compared with the 10 other sub-parameters. The flora and fauna sub-parameters shared equally important values in the biodiversity parameter.

Based on GIS analysis for each sub-parameter, we mapped a strong satisfaction level among the local community from the current ecotourism activities. More than half of the park and its buffer zone were deemed suitable for ecotourism based on the local community's view under the current ecotourism activities sub-parameters. We found that the majority of the local community's monthly income is below 3 million rupiah (US$ 200). About 90% of the park is 100 m to 300 m above sea level since it is a mountain landscape. The floristic composition of this park is suitable for ecotourism activities. However, in terms of fauna, only half of the area is considered attractive due to the high variety of species in the area. Almost 30% of the area is agricultural land, fisheries and plantation. More than a quarter of the park and its buffer zone are a water catchment area, which classified is as a restricted area. The supporting facility in this area can be classified as suitable in the northern part of the park. More than half of the buffer zone is inhabited by more than 10,000 people per village. Table 3 shows the suitability class for each sub-parameter.

We used the standardised format for land suitability classification in the overlay of all sub-parameters. This study found that almost all of the east part of GCNP and its buffer zones within the Kuningan district are categorised as suitable for ecotourism development (Table 4). Most of the areas were in the S2 class and almost a quarter of the area was marginally suitable. Figure 3 is the final map of the land

Table 2: The weight of parameters and sub-parameters, and their ratings

Parameter	Weight	Sub-parameter	Weight	Total Weight	Rating			
					S1	S2	S3	N
Environment	0.325	Slope	0.201	0.065	1.00	0.59	0.29	0.15
		Elevation	0.170	0.055	1.00	0.93	0.28	0.31
		Aspect	0.073	0.024	1.00	0.67	0.46	0.28
		Disaster risk	0.556	0.181	1.00	-	-	0.24
Biodiversity	0.370	Flora	0.500	0.185	1.00	0.54	0.22	0.13
		Fauna	0.500	0.185	1.00	0.44	0.23	0.12
Economy	0.100	Income level of local community	0.500	0.050	1.00	0.92	0.87	0.59
		Facilities	0.500	0.050	1.00	0.67	0.31	0.14
Social	0.205	Status of the area	0.709	0.145	1.00	0.50	0.24	0.12
		Residential size/ population	0.121	0.025	1.00	0.96	0.46	0.22
		Local community satisfaction level	0.170	0.035	1.00	0.60	0.24	0.13

Table 3: Suitability class for each sub-parameter

No.	Sub-parameter	Very Suitable (%)	Suitable (%)	Marginally Suitable (%)	Not Suitable (%)
1	Slope	9.5	56.9	12.9	20.7
2	Elevation	5.4	4	90.6	0
3	Aspect	32.6	26.7	21.4	19.3
4	Disaster risk		78.6		21.4
5	Flora	17.6	36.3	33.9	12.2
6	Fauna	36.5	6.4	2.0	55.1
7	Income level of local community	0	100	0	0
8	Facility	16.6	48.2	25.9	9.3
9	Status of the area	34.4	8.3	28.9	28.4
10	Residential size/ population	34.1	8.7	57.2	0
11	Local community satisfaction level	80.4	19.6	0	0

(*) The total area of the GCNP and its buffer zone in Kuningan district is 26,572 ha
(**) Disaster risk parameters are only divided into two categories, which are suitable and not suitable

Table 4: Land suitability for ecotourism in Gunung Ciremai National Park and its buffer zone in Kuningan district

Suitable Class	Value	Area	
		Ha	Percentage (%)
Very suitable (S1)	>0.75 – 1.00	62	0.23
Suitable (S2)	>0.50 – 0.75	20,725	77.99
Marginally suitable (S3)	>0.25 – 0.50	5,786	21.77
Not suitable (N)	0.00 – 0.33	0	0
Total		**26,572**	**100.00**

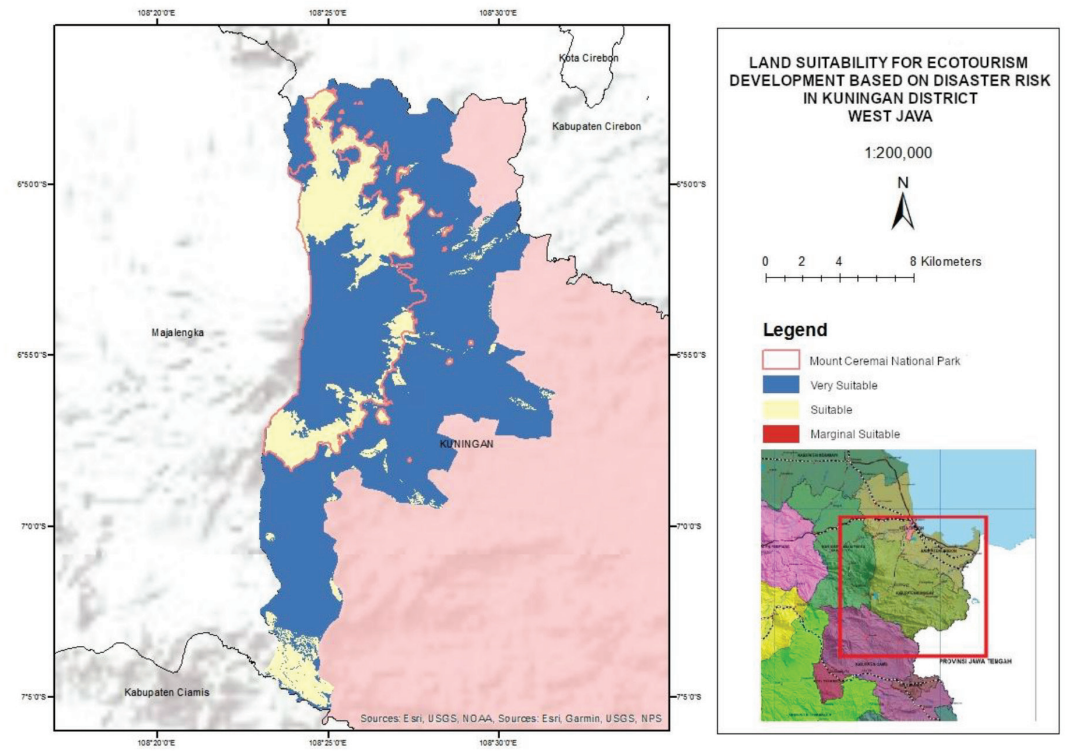

Figure 3: Land suitability for ecotourism development based on disaster risk in Kuningan district, West Java

sustainability for ecotourism development in Kuningan district.

Demand Analysis

Based on the sex of respondents, this study found that the majority of the visitors are male (59%), who are mostly in the 17-35 years old age group (64%), followed by the 36-55 years old group (34%) and the <55 years old group (2%). Most tourists who visited the park and its buffer zone were students (38%), civil servants (28%) and teachers (13%), with the other being less than 10%. Most visitors have obtained their graduate degree (66%), followed by a high school degree (31%) and junior high (3%). However, if it is separated between actual tourists and potential tourists, the results will be slightly different. Among actual tourists, most of them had completed their formal education at the high school level (58%), followed by higher

education (38%) and secondary school (5%). Meanwhile, almost all the potential tourists have received higher education (99%) and only 1% were those with high school education. In terms of monthly income, 35% of the tourists earn 6 million rupiah (≈US$ 400), 44% of tourists earn between 3 million rupiah (≈US$ 200) and 6 million rupiah, and 21% of tourist have an income below 3 million rupiah.

Tourist origin analysis shows that most of the actual tourists came from the region near Kuningan (57%), Cirebon, Majalengka and Indramayu, and the rest are from other regions (43%). The actual tourists from other areas are almost entirely from West Java and Jakarta, only three tourists were from Central Java and one tourist from Riau. Most of the potential tourists are from outside the West Java area (61%). The most common reason for tourists to visit ecotourism destinations in the GCNP was to enjoy the natural beauty (46%). Only 29% of the tourists were drawn to ecotourism areas because of the flora and fauna, with the remaining 26% influenced solely by their admiration of people's culture.

Figure 4 indicates that no clear correlation can be observed between the number of disaster events and the numbers of tourists visiting Kuningan district. It seems that during a disaster event, due to security reasons, the number of tourists that visit Kuningan is slightly decreased. However, the extreme increase in the number of disaster events between 2012 and 2014 had little impact on the number tourist visits. During this period, the number of disaster events increased from 3 to 40.

Our findings (Table 5) indicate that land suitability factors are important for the development of ecotourism. Only biodiversity and distance from other ecotourism sites have slightly lower values at 59% and 58%, respectively. This can be used as an indication that the suitability elements of ecotourism development must be considered by ecotourism stakeholders in Kuningan district to meet tourist demand.

Disaster Risk-based Ecotourism Development Model

Supply and demand are the basis for the ecotourism development model in Kuningan district. The supply sub-system is focused on the capacity of tourists from the region as measured by the area of land suitability for ecotourism development. From the results of land suitability analysis, we found that 26,572 ha of the area are suitable to be developed as ecotourism. The demand sub-system is focused on changing

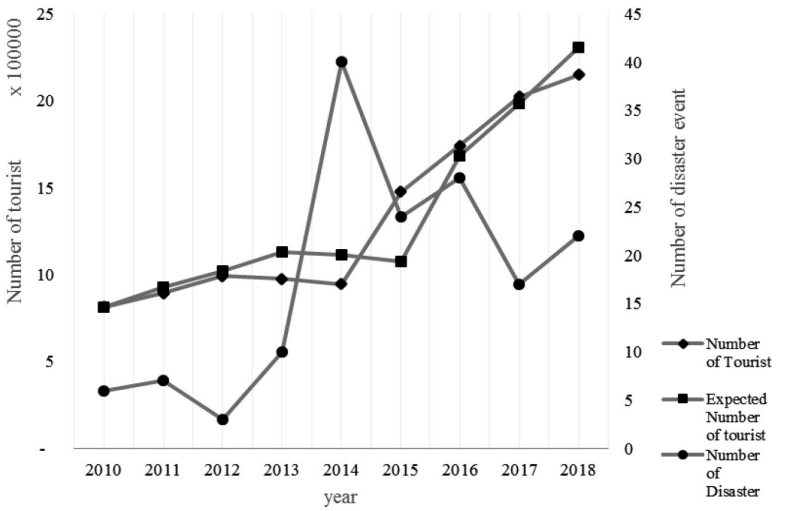

Figure 4: The number of tourists, expected number of tourists and number of disasters

the number of tourists if it is associated with a disaster event.

The main variables used in the supply sub-system are the area of ecotourism development, the area affected by disaster and the rate of restoration. As for the demand sub-system, the main variables are growth and reduction of tourists. The dynamic structure model of ecotourism development based on disaster risk can be seen in Figure 5.

This study carried out three scenarios to simulate the model which are pessimistic, moderate and optimistic. The scenario was applied on only two key variables, including restoration rate and allowable development area. This is due to the fact that immediate policy intervention can be done only on these variables in this sub-system. Table 6 presents the condition of key variables that were simulated to determine the changes that occur in the model.

Figure 6 shows the change in the capacity of tourists based on the three ecotourism development scenarios. Changes in the capacity of tourists will change the number of potential tourists as measured by the difference between the number of tourists and the capacity of the region.

From the simulation results, increasing the rate of restoration and decreasing the percentage of built-up area in the buffer zone can increase

Table 5: Tourists' perception of the importance level of land suitability for ecotourism development

No.	Factor	Important (%)	Not Sure (%)	Not Important (%)
1	Physical environmental conditions	83	12	5
2	Disaster risk	87	9	4
3	Biodiversity	59	25	16
4	Accessibility	90	5	5
5	Distance from other ecotourism	58	19	23
6	Supporting industry and facilities	83	7	10
7	Local community welfare	86	13	1
8	Local cultural	91	8	1

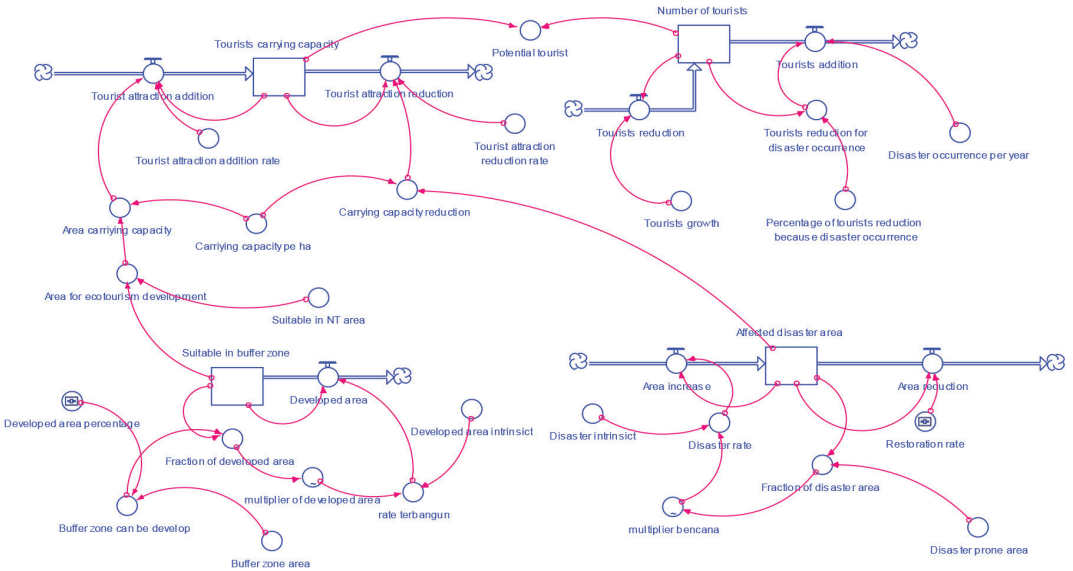

Figure 5: The structure model of ecotourism development based on disaster risk

Table 6: Conditions of key variables in the model scenario

No.	Key Variables	Current Condition	Scenario	
		Pessimistic (1)	Moderate (2)	Optimistic (3)
1	Restoration rate	1.2%	5%	10%
2	Allowable development area	70%	50%	30%

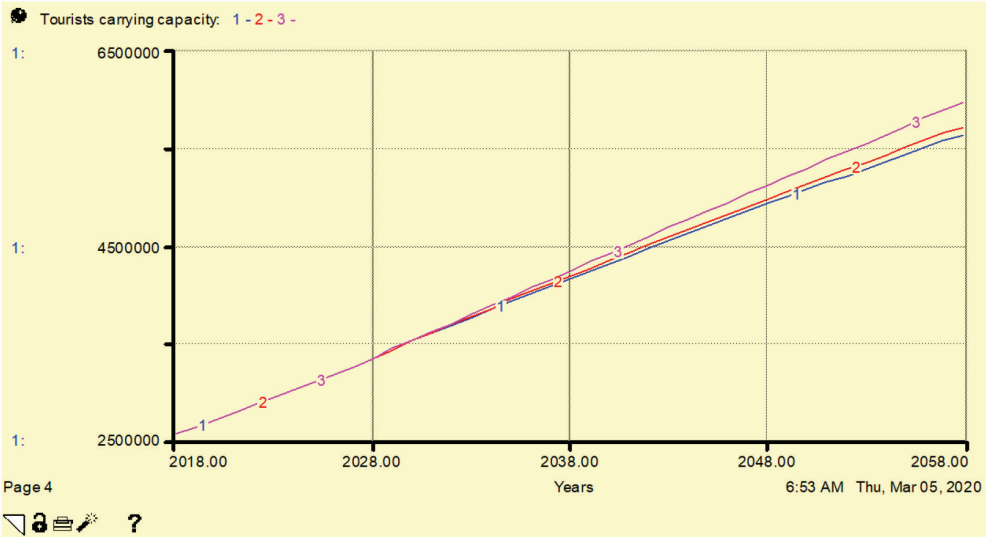

Figure 6: Comparison of current conditions with scenarios pessimistic (1), moderate (2) and optimistic (3)

the tourist carrying capacity. At the end of the simulation time, the results show that if the restoration rate is increased from 1.2% to 5% (moderate) and 10% (optimistic) and the percentage of the area built in the buffer zone decreases from 70% to 50% (moderate) and 30% (optimistic), the capacity increases from 5.62 million people per year in pessimistic scenario to 5.70 million people per year in the moderate scenario and 5.96 million people per year in the optimistic scenario. In general, the model can be used and is very useful for developing scenarios or policies and observing the impact of each scenario. The model is not intended to prove whether an estimate or projection of a scenario will be appropriate but the model is intended to find a way that is reasonable, credible and relevant in shaping an ecotourism development policy.

The development of ecotourism must be considered the ecological aspect in the long run while at the same time being economically feasible, as well as ethically and socially fair to the community. This concept must be in the mind of every ecotourism planner if they want to the ecotourism industry to survive in the long run. The land suitability analysis allows the identification of the most appropriate designation of an area's use, including ecotourism. This analysis will divide the area into suitability classes to determine what activities are possible in the area. The application of land suitability analysis in the development of ecotourism is expected to accelerate the achievement of ecotourism objectives which include the preservation of biological and cultural diversity, poverty reduction, job creation, and increased regional income and foreign exchange.

The east part of GCNP and its buffer zone have high potential as ecotourism locations. The proportional distribution use of the GCNP and its buffer zone must consider the interest of other

sectors. Even though almost all areas in the study location are in the suitable class for ecotourism development (99.8%), the development of ecotourism is a multi-sector effort and requires involvement and support from other sectors. Most of the east part of the GCNP and its buffer zone areas are classified as suitable (S2), hence, the area is more suitable to be used as an area for ecotourism development. Only development that uses environmentally friendly designs and constructions that have minimal impact on the environment can be considered in the area. Thus, we propose that further developments of ecotourism can be carried out in the GCNP buffer zone in Kuningan district despite the fact that almost 30% of the park is a water catchment area. However, development can be done only on a limited basis considering that most of the areas are classified as suitable (S2), which require very limited development without any physical development that changes the environmental conditions.

The land suitability class of ecotourism development is strongly influenced by the weighting value of the parameters, sub-parameters and ratings of the suitability factors of each parameter. This weight value will categorise the suitability class of the ecotourism development location. The weighting method gives cardinal or ordinal values that indicate the relative importance of each parameter in a multiple-criteria decision-making method (Zardari *et al.,* 2015). From the analysis, the disaster risk sub-parameter becomes an important factor in the development of ecotourism, both in terms of supply and demand. This is indicated by the high value of the disaster risk weighting (0.181). This number is only slightly smaller than the flora and fauna diversity weighting value of 0.185. This high value is in line with Đeri *et al.* (2007) who found that tourists will consider unpredictable situation such as a disaster in their decision to travel.

The model shows that an increase in the restoration rate and reduction in the percentage of build area can increase the tourist carrying capacity, which begins in the second 10 years of simulation. This may be because the restoration and the decrease in the development area policy need some time to have an effect after they were implemented. A couple of years is needed for the restoration of degraded so that the area can be covered with trees. The reduction in allowable development percentage needs to be socialised to the community. A certain amount of time is also needed before the effect on the buffer zone quality can be seen.

In general, the model can be used to forecast the tourist carrying capacity of the GCNP to be developed as an ecotourism site based on the disaster risk. Like any other model, the most important thing is not to predict the future but to help the GCNP anticipate events that occur in the future effectively (Fahey & Randall, 1998) and find solutions that are reliable, credible and relevant (Purnomo, 2003). The absence of a disaster risk assessment in site planning has become a problem in ecotourism development. When ecotourism development is carried out in disaster risk areas, it will lead to high development costs due to adjustments of facility and infrastructure construction. Furthermore, a disaster event in a tourist destination will result in losses such as damage to tourist attractions, infrastructure, accessibility or even loss of life (Huang & Inoue, 2007; Coombes & Jones, 2010). Tourists may be hesitant to visit tourist attractions due to this. Tourists are frequently transferred from disaster-affected areas to other countries or regions, posing a significant barrier to the tourism industry's post-disaster recovery (Wu *et al.,* 2020). Ecotourism development will be hampered if disaster risk is not calculated into the equation planning.

Land suitability evaluation based on disaster-risk needs to be used as a basis for ecotourism development planning. The ecotourism development area should be divided into suitability classes based on the disaster risk. Furthermore, the development of ecotourism planning must involve not only stakeholders related to ecotourism but also stakeholders related to disaster management. This combination can create ecotourism development

plans that consider disaster risk management as part of the ecotourism management. The tourism industry should actively participate in disaster risk reduction management (Wu *et al.,* 2020). Disaster risk ecotourism development plans can be used as a starting point for tourism industry players and investors to determine the types and packages of tourism to be developed.

To improve ecotourism development planning, comprehensive measurements of the total area affected by disasters are needed, rather than the number of disasters. Sometimes, one disaster that affects a large area will have more impact on tourists' decision to visit an ecotourism attraction (Filimonau & De Coteau, 2019). The policy of increasing the restoration rate of areas affected by disasters and decreasing the area built up in buffer zones can increase the tourist capacity in the GCNP. The increased capacity will increase the number of tourists without a significant impact on the environment. The use of this variable is important to perfect the model. The disaster risk land suitability class can be an early indicator to determining the type of ecotourism development that is suitable with the disaster conditions. Areas that are categorised as suitable do not require complex structural engineering and technical aspects application in ecotourism development. It will affect existing resources for other activities such as market penetration, product marketing and public education, including those involving tourists. However, when developing ecotourism, vigilance and understanding of disasters risk must still be used.

The disaster risk parameter can become the standard for the development of good ecotourism, considering that disaster events cannot be estimated in terms of scale and time. For this reason, disaster mitigation needs to be well prepared to reduce the impact of disasters. Disasters can have a serious impact on the tourism sector (Ritchie*,* Mair & Walters, 2014). In addition, there is a significant influence between the impacts of disasters and the tourism industry. Catastrophic events can cause tourist destination locations to lose their attraction, their economy and cultural assets, not only temporarily but also permanently. For tourists, catastrophic events can cause stress, discomfort and insecurity, so they choose not to visit tourist objects affected by disasters. Based on these things, the development of ecotourism in the GCNP and its buffer zone must include disaster management in its planning. This can provide a sense of security and comfort for tourists visiting ecotourism destinations in Kuningan district. Rindrasih *et al.* (2018) stated that responses of tourists to disasters must be the focus of disaster management strategies. There is an increasing trend in terms of tourist growth rate per year despite the occurrence of disasters. Most tourists visit Kuningan district to enjoy natural beauty but disaster risk factors that exist at the ecotourism sites remain as a consideration for them. The analysis from the demand side shows that 87% of tourists believe that disaster risk is an important factor for them to decide when they want to visit ecotourism sites. The ability of ecotourism developers to identify potential tourists that are suitable for their ecotourism products can provide a competitive advantage. Tourists are an important factor in disaster risk because they lack awareness and understanding of the actions they need to take when disasters occur (Rindrasih *et al.,* 2018). Based on the characteristics, motivations and perceptions of tourists in Kuningan district, they can be categorised as mainstream ecotourists (Lindberg, 1991). It is important for ecotourism developers in Kuningan district to take into this consideration during the development of business strategies so that they can meet the expectations of these types of tourists.

It is suggested that ecotourism development planning in the GCNP include mitigation and adaptation procedures for disasters. This is an important stage in reducing the impact of disasters, both before and after they occur. Wu *et al.* (2014) suggest that disaster prevention and mitigation measures should be formulated in advance and defence measures must be developed along with an alert system for tourists. Mitigation can begin during the

planning stage and be carried out according to the land suitability class. Areas that are classified as very suitable for ecotourism can be developed immediately. Meanwhile, for suitable and marginally suitable areas, it is necessary to further identify the types of disaster risks that exist in the locations. After determining the type of disaster risk, physical development is kept to a minimum while adhering to the principles of environmentally friendly development. Another mitigation step is to prepare standard evacuation procedures when a disaster occurs such as installing disaster risk signs and directions for evacuation routes at ecotourism locations.

The adaptation process can be carried out by structural adaptation and building ecotourism facilities that are suitable with the disaster risk conditions, in the form of rehabilitation, reforestation, disaster-resistant development and policy adaptation such as making it compulsory for tourism object managers to compile disaster vulnerability maps, determining tourist quotas, and raising awareness of disaster vulnerabilities at tourist sites (Nugraha, 2020). In addition, the awareness among local communities and tourists of the conditions of disaster risk areas needs to be raised so that they can act in compliance with disaster safety standards. The education and information on the disaster risk for local communities and tourists are important to enhance ecotourism development. Tourists have the least understanding of disaster risk in tourist areas and they have not made the disaster risk parameter as an important factor in ecotourism. This makes tourists' awareness of disaster risk an important part of the GCNP ecotourism development planning.

Conclusion

The introduction of an ecotourism development model based on disaster risk can improve ecotourism strategies. As a model sub-system, the use of land suitability evaluation and demand analyses will provide a comprehensive condition of the supply and demand for ecotourism development. Land suitability evaluation using a combination of spatial analysis and MCDA-AHP can provide a robust analysis of the carrying capacity of an ecotourism location. We observed that even though an area is classified under the disaster risk category, it does not necessarily mean that it cannot be developed as an ecotourism site through further analysis of the risks using multiple parameters. In this study, 21.4% of the areas falls under the disaster risk category. However, when it was analysed through other parameters, almost all of the areas can be used for ecotourism development. This was because land suitability is strongly influenced by the weight of each parameter. In this study, the weight of the disaster risk parameter was ranked as second (0.181) after flora and fauna (0.185 each). Each parameter and sub-parameter have a different impact on the land suitability development. Parameter weighting is a crucial method to provide a relative value on how important a parameter is by a decision-maker. This stage is important for the MCDA method since it will determine the outcome of the decision-making process. Moreover, weighting the parameters is a critical step in in MCDA and it must be conducted carefully. Moreover, ecotourism development must consider disaster risk as a key factor in management planning. Disasters can be managed by developing pre-disaster planning and preparedness from the early stage of planning and management. Disaster control through determining the ecotourism land suitability, providing more areas for restoration, and reducing areas that can be built not only reduce disaster risk, but also increase the potential area for ecotourism sites. It is also important to ensure that involve stakeholder collaborations to manage the potential impact of disasters. Given that a disaster event cannot be predicted in terms of scale and time, the disaster risk parameter can become a standard for the development of proper ecotourism. It is suggested that the disaster risk parameter be one of the values of the ecotourism ethics code. The internalisation of these values leads to ecotourism development always considering disaster mitigation and adaptation management.

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