BIODIVERSITAS
Volume 18, Number 3, July 2017
Pages: 978-989

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d180316

Carrying capacity to preserve biodiversity on ecotourism in Mount Rinjani National Park, Indonesia

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Manuscript received: 28 August 2016. Revision accepted: 3 June 2017.

Abstract. *Sadikin PN, Arifin HS, Pramudya B, Mulatsih S. 2017. Carrying capacity to preserve biodiversity on ecotourism in Mount Rinjani National Park, Indonesia. Biodiversitas 18: 978-989.* Mount Rinjani National Park (MRNP) in West Nusa Tenggara, Indonesia has applied ecotourism which becomes more popular at international and national level. Yet, the MRNP ecotourism faces various problems such as ecotourism resources damage, erosion, or garbage left by ecotourism activities, etc. This study aims to analyze (i) the land suitability for ecotourism based on criteria of tourism object range, land use and land cover, zone type, biodiversity range, and slope, and (ii) carrying capacity of the ecotourism area, the total number of visitors who can enjoy ecotourism attraction based on activities type, total area, capacity days, and turnover factor. The results of the land suitability for ecotourism analysis show that the MRNP ecotourism has been applied on the suitable land for ecotourism, except in Pelawangan Senaru and at the Peak of Mount Rinjani due to its sensitive and fragile area. The carrying capacity assessment using Douglass formula (1982) has counted the visitors for up to 42.527 visitors per year for camping activity. Generally, this value is under the average actual visitors at present, i.e. 44.112 visitors per year. It means the MRNP ecotourism is already exceeded its carrying capacity.

Keywords: Carrying capacity, ecotourism, national park

INTRODUCTION

Currently, outdoor tourism activities in Indonesia are increasing and more diverse, which include an outdoor fun walk, hiking, trekking, or mountain biking (Nugroho et al. 2012). The increasing of outdoor tourism activities is also followed by an increasing of tourists in the conservation area due to increasing awareness about nature conservation (Pickering and Hill 2007). Some conservation areas in Indonesia, including national parks, have a positive contribution in ecotourism development at national and international levels (Lucyanti 2013), such as Mount Rinjani National Park (MRNP) on Lombok Island, West Nusa Tenggara, Indonesia.

Ecotourism is purposeful travel to natural areas to understand the culture and natural history of the environment, taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make the conservation of natural resources beneficial to local people (Honey 1999). The Quebec Declaration on Ecotourism (UNEP 2002) defined ecotourism is mainly based on the special object of history, culture, and natural environment. Ecotourism offers a responsible approach, orientated to the conservation of nature and environment and sustainable tourism (Wight 1993). Ecotourism is now defined as responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education (TIES 2015). Unlike the mass tourism, ecotourism has criteria as follow: (i) Activity of tourism is undertaken in natural areas that are less disturbed; (ii) Impact of tourism activity can be minimized; (iii) Natural heritage and cultural can be maintained; (iv) Local people participate actively and get benefit from ecotourism; (v) Benefit from ecotourism can support the sustainable development; (vi) Tourists experience natural education and culture. When principles of ecotourism, including carrying capacity or number of tourists, have not been properly considered, environmental and biodiversity conservation may be disturbed (Arifin 1990; Lagmoj et al. 2013; Lucyanti et al. 2013; Masum et al. 2013; Romadhon et al. 2014).

However, recreation activities can cause impact to resource elements in wilderness ecosystem such as soil, vegetation, wildlife, and water are four primary components affected (Leung and Marion 2000; Lone et al. 2013). Tourism activities can create various negative impacts on the surrounding environment because increased human interference in ecologically areas can cause an irreversible change in existing ecological processes which can be reflected in degraded natural resources, vegetation structure and the size of habitat patch, increased deforestation and decreased upstream water flows (Bunruamkaew and Muruyama 2012). The high number of visitors ignites the occurrence of disturbance on environment ecosystem in ecotourism area and causes its quality decrease, irritated or polluted, then ecotourism environment attraction would degrade, and esthetic value would decrease (Gunn 1994). Habitat modification could

happen in some forms such as coverage changes due to opened tree canopy for trekking trail, occurred barrier for wildlife animal movement, strange and new sound and scent, fire and fume, entered pests and diseases, decreased or lost of feed resources and water, even the disturbance or degraded nesting habitat (Buckley 2004). The movement and presence of visitors bring up sensitivity especially to the bird species, from time to time, and both seasonally and daily (Collins-Kreiner et al. 2013).

Ecotourism activities on trekking trails to the peak of Mount Rinjani and Segara Anak Lake pass into the core zone where there is restriction to carry out any activity (MRNP 2011) since it can cause impacts to the flora and fauna, habitat modification due to tourism facilities development, fume and fire from cooking activity, disturbance for the animals such as sound and odor, and also human presence (Bonita 2010), logging the tree for cooking, garbage and erosion in trekking trail (Rai 2010). Komunitas Sapu Gunung Indonesia revealed that the average waste which is carried from MRNP is as much as 160.24 tons per year (Purnomo 2016) or about 3 kg/visitor.

Ecotourism land suitability assessment provides information to arrange and manage ecotourism area optimally based on its suitability, minimizing the impact of ecotourism activities and creating rehabilitation effectiveness, preservation, protective, and natural resources conservation planning (Bunruamkaew and Muruyama 2012), in addition, to enable the effective planning and development policy to conduct carrying capacity concept (Nugroho et al. 2012). Carrying capacity is a useful concept in wildlife and range management, where it refers to the number of animals of any species that can survive in a given habitat by determining how much recreational use can ultimately be accommodated in a park or protected area (Manning 2002).

This paper aims to analyze (i) the land suitability for ecotourism based on criteria of tourism object range, land use/land cover, zone type, biodiversity range, slope; (ii) carrying capacity to determine how many visitors can enjoy ecotourism attraction, based on activities type, total area, capacity days, and turnover factor.

MATERIALS AND METHODS

Study area

The total area of Mount Rinjani National Park (MRNP), West Nusa Tenggara, Indonesia is 41 330 ha (Figure 1). The research was conducted at two management resorts of MRNP. They were Senaru in Senaru Village, North Lombok, and Sembalun in Sembalun Lawang Village, East Lombok. The tourists and community enter the MRNP generally through the main MRNP gates in these two villages, therefore the villages were considered as a representative location for this research. The trekking trail in MRNP for ecotourism program and activities starts or ends through these two gates. The study was carried out on October 2014-December 2015.

The available ecotourism activities were sightseeing/ relaxing, trekking, camping, bird watching, orchid observation, swimming/bathing, and fishing. Ecotourism potencies were Senaru tropical forest trekking trail, Sembalun savanna trekking trail, the peak of Mount Rinjani for bird watching or orchid observation, Segara Anak Lake, Aiq Keleq, and Kokok Puteq for water scenes or hot spring, and some caves such Goa Susu, Goa Manik, and Goa Payung for cave tourism.

On Sembalun resort ecotourism area, there was flora which was categorized based on two ecosystem types, namely sub-montana (800-1500 m asl.) and montana (>2000 m asl.). On open forest or savanna in Sembalun, the flora found were 68 species of 31 identified family and 7 unidentified species, among others *Ardisia humilis* (bersang), *Antidesma bunius* (burne), *Erythrina variegata* (dadap), *Toddalia asiatica* (jeliti), *Rubus moluccanus* (kalamunting), *Acer niveum* (kalibambang), *Mangifera longipetiolata* (mangga hutan), *Artocarpus integra* (nangka), *Duabanga moluccana* (rajumas) and *Syzygium racemosum* (wah/klokos gunung) in Pemantauan Forest; other species, such as *Ficus benjamina* (beringin), *Dysoxylum hexandrum* (garu), *Leucosyke capitellata* (kelempeak), *Maesa ramentacea* (senak) in Bawaknao Forest, and *Casuarina junghuhniana* (cemara gunung) along the trekking trail to Pelawangan Sembalun. *Engelhardia spicata* (bakbakan) was found almost in every mountain slope and height (MRNP 2014). Meanwhile, the fauna found were nectarivora birds along with other bird species on the trekking trail to Pelawangan Sembalun up to Segara Anak Lake. These birds were around the Wallacea area and were representatives of certain area such as *Nectarinia jugularis* (burung madu Sriganti/kejiwit) of oriental area, *Lichmera lombokia* (burung isap madu Lombok/kecial kebrus) the endemic birds in Nusa Tenggara, and *Lichmera indistincta* (burung madu Australia/kenjalikan) of Australasia area, and other birds species were *Zosterops chloris* (kacamata laut), *Zosterops montanus* (kacamata gunung), *Lonchura punctulata* (Bondol peking), *Elanus caeruleus* (elang tikus), and *Haliastur indus* (elang bondol) (MRNP 2012).

On Senaru resort ecotourism area, several plants were found, such as, *Clerodendrum japonicum* (api-api), *Syzygium littorale* (lungsir), *Ardisia lurida* (kosok), *Ficus* sp. (sukel odong), *Laportea stimulans* (jelateng), *Ziziphus angustifolius* (kunyitan), *Pterospermum javanicum* (bayur), *Aglaia cucullata* (bangsal), *Dracontomelon dao* (dao), and *Rourea mimosoides* (melak daun). The trail from Pelawangan Senaru to Segara Anak Lake was rocky open land and consisted of mostly casuarinas mountain tree which grew sporadically. The fauna on the Senaru trekking trail was with potency of lowland tropical forest, montane tropical forest and wildlife special to the birds, and 22 endemic species were found, with 7 protected species, 2 critically endangered species, 5 vulnerable species, among others *Lichmera lombokia* (isap madu), *Trachypithecus aurattus cristatus* (lutung), *Macaca fascicularis* (monyet abu-abu), *Sus scrofa* (babi hutan), *Rollulus* (puyuh), *Paradoxurus* (musang), *Rattus rattus* (tikus), *Philemon* (koakiau), *Zoothera* (punglor kepala hitam), *Gallus* (ayam hutan), and some other species such as pigeon (merpati hutan), eagle (elang bondol), frog (kodok), lizard (kadal) and snake (ular tanah) (MRNP 2015).

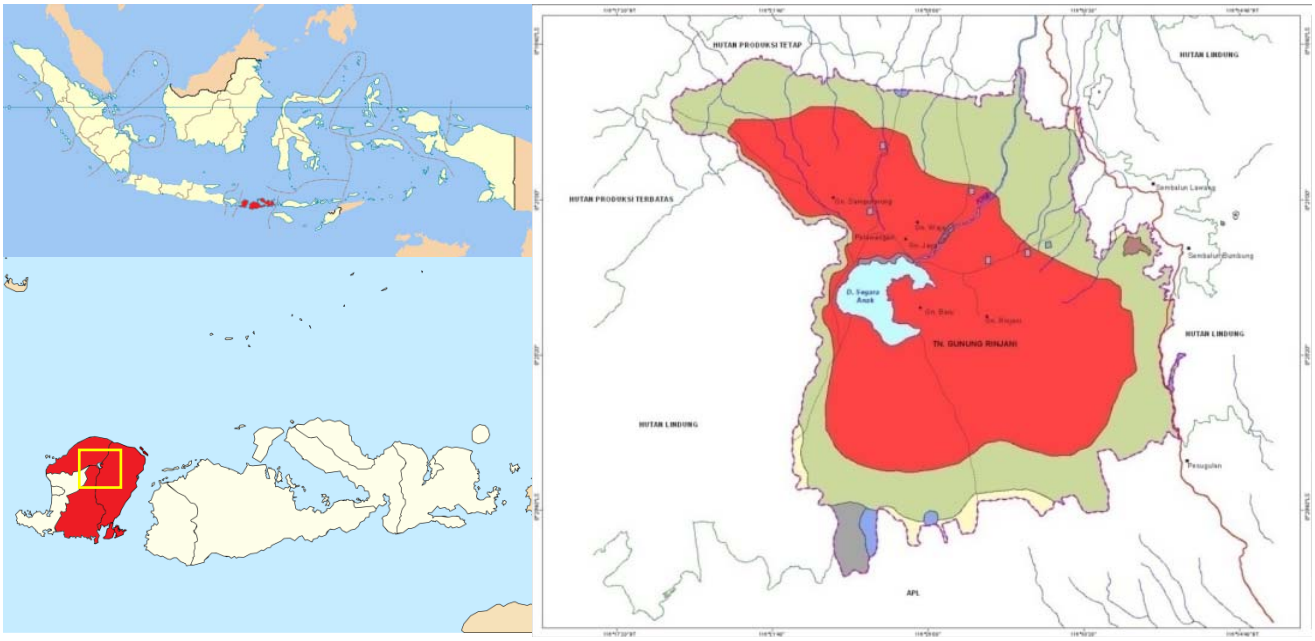

Figure 1. Location of Mount Rinjani National Park, Lombok Island, West Nusa Tenggara, Indonesia. 116º21'30"-116º34'15"E and 8º18'18"-8º32'19"S. (Google Map 2015, Ministry of Forestry 2011)

Data collection

The data are focused on the physical environmental aspect on MRNP. The primary data were collected by survey using a questionnaire to the tourists as respondents and by conducting depth interview with a number of key informants. The tourists who became respondents were 50 non-local tourists and 50 local tourists, and total respondents were 100 respondents who had finished the trekking trail in MRNP and had experienced the MRNP ecotourism. The key informants were from MRNP Official Management Office. The survey questionnaire was aimed to get the information about the tourism activity types in MRNP ecotourism. The other primary data was gathered from observation on the field or ecotourism area. The observation on the location of ecotourism was aimed to get information on the ecotourism area condition, ecotourism object range, and land use or land cover. The area information of each tourism activity points was collected by using a Global Positioning System (GPS) receiver to make sure the area measure which was used for ecotourism and tourists activities. This measure determined the carrying capacity for MRNP ecotourism. The depth interview was carried out to the staffs and responsible persons for ecotourism management in MRNP official management office. The depth interview aimed to assure the actual biophysics dimension condition.

The secondary data were obtained from the literature review of several sources and documents such as previous research, official and unpublished documents, websites. They were general management plan of the national park, zoning map and type, biodiversity range, area ecotourism slope, ecotourism trekking trail map and ecotourism object attraction.

Data analysis

Land suitability for ecotourism

Land suitability for ecotourism of biophysical land ecosystems were analyzed based on their characteristics (Table 1), which consisted of landscapes or naturalness (scenery, land use/land cover), wildlife (preservation/ protection, biodiversity), topography (elevation, slope) (Bunruamkaew and Muruyama 2012; Nugroho et al. 2012). Based on those criteria, for easier representation, these four classes follow the structure of the FAO (1976) suitability classification (Bunruamkaew and Muruyama 2012; Nugroho et al. 2012), the land suitability for ecotourism are classified into 4 rating classes, namely rating 4 ranked as highly suitable, rating 3 ranked as moderately suitable, rating 2 ranked as marginally suitable, rating 1 ranked as not suitable. The highly suitable is the suitable capacity of locations with highly satisfying criteria set up. The moderately suitable is the suitable capacity of locations with mostly satisfying criteria set up, but some criteria are not satisfying. The marginally suitable is the suitable capacity of locations with satisfying criteria set up, but most of them are disappointing. The not suitable assumes that all of the criteria are disappointing. Determining and classifying the type of land use and land cover follow the standards prescribed, but with some modifications, (Table 2) by Bunruamkaew (2012) and Nugroho et al. (2012). The analysis was conducted by categorizing the data of different sites into the factor ratings according to criteria established which was, thus, identified as the best potential area for ecotourism. This land suitability assessment for all dimensions using Liebig minimum law where the limiting factors are the minimum rating and may become an obstacle in other factors development (Odum 1996).

Therefore, the selected ratings to be used as the final rating are the smallest ones.

Tourism attraction factor is considered as the ecotourism objects which are the primary factor to develop ecotourism and to attract visitors to come. The more ecotourism object attractions exist in the area, the more suitable that area to be developed for ecotourism. Furthermore, the closer the area to ecotourism objects, the more suitable that area for ecotourism (Bunruamkaew 2012; Nugroho et al. 2012). Land use/land cover is classified into 10 classes according to biophysical vegetation characteristics of ecotourism potential resource (Bunruamkaew 2012; Nugroho et al. 2012). The reservation/protection factor was classified by the type of protected areas which are suitable for habitat and wildlife abundance with regards to a wildlife reserve, rare species and newly found species (Bunruamkaew 2012; Nugroho et al. 2012). Species diversity factor was evaluated by using the range in the meter to identify the suitability of the land for ecotourism because the tourists of an ecotourism tend to seek out spectacular and remote environments during the journey to the earth's most diversity-rich and often the most fragile (Nugroho et al. 2012). Topography factor was determined by the height of the slope level in the region, the level of suitability for ecotourism is lower (Bunruamkaew 2012; Nugroho et al. 2012).

Carrying capacity analysis

The carrying capacity of a region is a certain physical capacity of an area to receive tourists or travelers at maximum amount that they can have the advantage of an area without causing a decrease environment quality (Soemarwoto 2004). The following equation for the carrying capacity is developed by Douglas (1982):

$$AR = \frac{D \times a}{CD \times TF \times 43{,}560}$$

Where:

AR = area required per activity (sq.ft)
D = demand (total demand per activity)
A = area per person (sq.ft)
CD = capacity day per year
TF = turnover factor
43,560 = constant (Douglass 1982)

Capacity days are counted based on the closed season of MRNP for three months in January until March, and low season on April until Mei and November, which consist of total 26 weeks. One year is 52 weeks, and then 52 weeks minus 26 weeks of the closed season and low season equals 26 weeks. The weekend consists of Saturday and Sunday and there were 26 weeks so that the result will be 52 days of the weekend. Weekend days plus National days off results19 days per year. National days off on closed season are 4 days from January until March and 4 days on April-May-November. So, the total national days off is 11 days (19-8=11). Total days off are 52 days plus 11 national days off equal 63 days. Total open day of TNGR are 26 weeks or 182 days, so, 128 days minus total days off of 63 days equals 119. Capacity Days of TNGR are 119 days.

Turnover Factor refers to the Douglass formula (1982) which is based on activities practiced by ecotourists namely camping TF = 1.0; swimming/bathing TF = 1.5; boating TF = 2.0; and sightseeing, rest or relaxing proxy of picnicking or recreating TF = 1.5, and fishing TF = 1.0. Standard of space needed by every tourist on every activity refers to Douglas (1982) formula, namely camping: 907 feet², swimming/bathing: 544 feet², boating: 302 feet², sightseeing/rest/relaxing: 726 feet², and fishing: 21.53 feet².

RESULTS AND DISCUSSION

Land suitability for ecotourism analysis

Ecotourism of MRNP utilizes Mount Rinjani landscape, its mountains, and hills as its ecotourism appeals. The tourists like to traverse to the summit of Mount Rinjani at 3,726 above sea level. High elevation areas generally attract a lot of tourists to visit, because there are usually attractive and beautiful scenery and landscape. Topography in high elevation area is one of the most important dimensions of attractiveness in the landscape, scenic potential or the topographic attractiveness for tourism (Bunruamkaew 2012). On the other hand, from its geological structure, MRNP has critical land areas and vulnerable to the landscape changes. The land is already sensitive to every single change and will become more open. It will reduce the land ability to absorb, capture and store water, as well as to be easy of having erosion and landslide, and the flora fauna habitat will be degraded, and the species will fade away. However, due to wildlife and biodiversity protection in the national park, the elevation is considered as a fragile and vulnerable area that should be protected. Therefore, using certain zone for ecotourism activities in MRNP which follow the increasing travel demand (Table 5) without any assessment of land suitability for ecotourism and carrying capacity analysis is very risky, because its landscape is highly susceptible to changes. Increasing tourist on the vulnerable ecosystem will cause environment degradation and biodiversity loss, environment contamination due to plastic or canned garbage, and other waste (Masum et al. 2013).

The process of carrying capacity analysis is, first, to analyze the sensitivity of the area (Soemarwoto 2004). The area with fragile ecosystem is not recommended for tourism activities (Soemarwoto 2004). Important variables often used for tourism area are basic physical or land capability characteristics (Muhamad 2013). Thus the assessment of land suitability for ecotourism will provide information to plan, arrange or manage the development of ecotourism area optimally, minimize the impact of ecotourism activities, create rehabilitation effectiveness, preservation, protective, and natural resources conservation planning (Bunruamkaew and Muruyama 2012), in addition, it enables the effective planning and development policy to conduct carrying capacity concept (Nugroho et al. 2012).

Physical environment or land suitability for ecotourism can be seen in Table 6. Reviewing from landscape or

naturalness, ecotourism objects aspects, almost all MRNP ecotourism activity points got rating 4 or highly suitable for ecotourism, except on Senaru and Sembalun gates/Jebag Gawah, on extra Post Senaru and Sembalun, on Demplot and Cemara Lima. The ecotourism area was on the boundary of MRNP core zone without any border to buffer zones. Core zone has natural conditions, both biota and physical pristine where any human activity is prohibited due to the protection and preservation of animal or plant habitat for certain priority or endemic cause or typical species. The MRNP ecotourism activities on ecotourism tourist activities areas which were closed were flora and fauna or biodiversity, landscape, volcanoes, mountains, hills, water body, lake and other ecotourism objects. In addition, Post 1 Pemantauan, Post 2 Tengengean and Post 3 Pada Balong in Sembalun got rating 4 because there were ecotourism attractions, namely savanna, orchids and bird watching. Pelawangan Sembalun got rating 4 because the tourists can have a great sightseeing of MRNP landscape of volcanoes, mountains, hills, lake and others. The tourists prefer extraordinaire nature and exceptional environment which are in a secluded area with the richest biodiversity in the world and often fragile. One of the main appeal and attractive ecotourism is the observation of wildlife in its natural habitat (Bunruamkaew 2012). Activities suggested for these areas include education and research activities related to travel and trekking for a limited number of tourists (Yaakup et al. 2006). The data used were from observation and interview.

Reviewing from landscape or naturalness, land use or land cover aspects, all MRNP ecotourism activity points in Sembalun got rating 3 or moderately suitable for ecotourism, because it was in open forest or savanna. Some parts in Senaru got rating 4 or highly suitable because it was in the dense forest, some other points got rating 3, because it was in open forest or water body. The data which were used in this evaluation were from observation and interview.

Reviewing from wildlife dimensions, preservation/ protection aspects, zoning classification goal is to minimize negative impacts on the environment or national park areas which are vulnerable and fragile. All MRNP ecotourism activity points got rating 4 or highly suitable for ecotourism because all ecotourism points were located in the utilization zone. The data used were from zoning map and interview. Visitor impact threats to compromise wilderness management mandates for preserving and sustaining high-quality natural environments and recreational experiences. The principal goal for managing wilderness visitation is to avoid avoidable impacts and to minimize irreversible negative impact. To achieve this goal, wilderness managers must effectively educate and regulate visitors and manage wilderness resources (Leung and Marion 2000). Increased numbers of tourist can have direct and indirect impacts on ecosystems and cultures of local people that may not be biologically or socially sustainable (Winterbach et al. 2015). Drumm et al. (2004) elaborated that most protected areas provide two or more types of public use zones, they are intensive use zones which are enabled to accept most of the high impacts, where most visitors are concentrated, and extensive use zones which are enable only to accept lower impacts, which usually are designed for trail-oriented visitor use. Meanwhile, other zones usually set aside on parts of the protected area as “untouchable” zones where very little or no public use occurs, either due to remoteness or resource fragility (Drumm et al. 2004). Actually, the zoning scheme can be used to apply the rules and regulation for each zone, including visitor-use level range, to provide a wide spectrum of visitor activities, from intensive use where higher visitor encounters, into lower use where infrequent visitor encounters (Drumm et al. 2004; Nugroho et al. 2012). Management of rules, regulations, and policies should be created and communicated effectively to visitors so that they understand the "ground rules" (Drumm et al. 2004).

Reviewing from wildlife dimensions and species diversity, MRNP ecotourism activity points got rating 4 or highly suitable for ecotourism because all ecotourism points were close to the flora and fauna habitat. Nugroho et al. (2012) evaluated species diversity factor by using the range in the meter to identify land suitability for ecotourism because the tourists of ecotourism tend to seek out spectacular and remote environments during the journey to the earth's most diversity-rich and often the most fragile. The reasons were that the tourists are eager to search the new experience in a remote area which has uniqueness, pristine area and they can observe wildlife in its natural state in protection of biodiversity such as natural habitat, particularly while animals were foraging, inhabiting nesting sites or caring their young (Nugroho et al. 2012). Therefore it should be feasible to become an ecotourism area where it was closer to the area where key species could be found in the region. Thus Yakuup et al. (2006) determined land suitability for ecotourism on habitat area and endangered species factors by using ranges from river or buffer zone (Yakuup et al. 2006). Meanwhile, Bunruamkaew (2012) researched that species diversity factor was classified from the number of recorded species (mammals, birds, reptiles, and amphibians) in order to consider wildlife population abundance in the area in Surat Thani wildlife areas with percentage classification (Bunruamkaew 2012). Due to the abundance of wildlife and the presence of charismatic species, some areas are best suited to wildlife tourism aerial survey data to estimate wildlife biomass and diversity to determine tourism potential (Winterbach et al. 2015). Although, there is a high correlation between a number of birds and their minimal distance from visitors and the number of visitors, not only maximum total visitors at the bird watching tower or post, it should be determined the minimal distance between visitors and birds or animals (Collins-Kreiner et al. 2013). The data which were used in this evaluation were from documents of MRNP and interview.

Reviewing from topography dimensions, Post 3 of Pada Balong, Extra post of Sembalun, Pelawangan 2 Sembalun, Demplot Senaru and Cemara Lima Senaru got Rating 2 or marginally suitable, while the Peak of Mount Rinjani and Pelawangan Senaru got Rating 1 or not suitable. According to Bunruamkaew (2012), the topography is the most important dimension of the attractiveness of the landscape. Potential

Tabel 1. Criteria and benchmark for suitability analysis of physical environmental aspect, classifications and rating factor

Criteria		Annotation/Benchmark	Unit	Factor rating				Data
Sub aspect level 1	Sub aspect level 2			4	3	2	1	
Landscape/Naturalness	Ecotourism objects attraction	The closer to the ecotourism objects in the region, the level of suitability for ecotourism is higher	Range (m)	0-500	500-1000	1000-1500	>1500	Observation, interview
	Land use/cover	The more primary forest land cover in the region, the level of suitability for ecotourism is higher	Class	High	Moderate	Marginal	None	Observation, interview
Wildlife	Preservation/protection	The higher the status of wildlife protection in the region, the level of suitability for ecotourism is lower	Zone type	Utilizing zone	Rehabilitation zone	Forest zone	Core zone	Zoning map, interview
	Species diversity	The closer to an area where key species can be found, the level of suitability for ecotourism is higher	Range (m)	0-500	500-1000	1000-1500	>1500	Survey report, interview
Topography	Slope	The higher the slope level in the region, the level of suitability for ecotourism is lower	Degree	0-5%	5-25%	25-35%	>35%	Biophysical report, interview

Source: After Bunruamkaew (2012) Nugroho et al. (2012) modified

Tabel 2. Land use and land cover

LULC Type	LULC Suitability	Category	Rating
Dense forest	Highly importance for ecotourism can serve as major ecotourist as well as general tourist.	Highly Suitable	4
Open forest	Very important for ecotourism, area needs to be managed and conserved properly to attract eco-tourist as well as general tourist	Moderately Suitable	3
Orchard	Highly importance for agro-tourism can serve as main ecotourism attraction	Moderately Suitable	3
Water body	Active recreation as boating, parks and natural zoological parks	Moderately Suitable	3
Plantation	Should be properly monitored and protected from any encroachment	Marginally Suitable	2
Crop land and farm land	The area under agriculture and farm should not be converted to other schemes. Any infrastructure development should be restricted.	Marginally Suitable	2
Urban and built-up land	Suitable for eco-tourist infrastructure development	Not Suitable	1
Degraded forest	Need to be managed, properly with possibilities of new plantations. Important from medicinal plantations and agroforestry scheme	Not Suitable	1
Miscellaneous land	-do-	Not Suitable	1

Source: Bunruamkaew (2012), Nugroho et al. (2012)

Table 5. Total tourist coming to Senaru and Sembalun Resort of Mount Rinjani National Park, West Nusa Tenggara, Indonesia

Resort	Tourist	Year										
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Senaru	International	1,027	1,351	1,483	1,744	2,652	6,974	3,588	3,777	4,835	6,247	10,103
	Regional	539	391	502	681	600	458	375	637	705	506	1,510
Sembalun	International	1,007	1,465	1,721	2,208	3,390	1,481	4,876	4,223	4,391	8,216	12,282
	Regional	1,328	2,008	1,469	1,427	1,827	1,210	1,952	3,668	4,593	7,974	20,217
Total	International	2,034	2,816	3,386	4,452	6,506	9,172	9,368	8,778	5,540	14,463	22,385
	Regional	3,596	6,724	5,953	5,065	4,885	3,584	4,588	6,252	8,984	8,480	21,727

Source: MRNP (2014, 2015)

Table 6. Rating based on land suitability for ecotourism category in Mount Rinjani National Park, West Nusa Tenggara, Indonesia

Location/Post (m asl)	Tourism Object (m)		Land use/land cover		Preservation & protection (zone type)		Biodiversity (m)		Slope (%)		Final Rating	Category
	Range	Rating	Land cover	Rating	Zone	Rating	Range	Rating	Slope	Rating		
Sembalun												
Gate (A,D) 1 150	500-1000	3	Open forest	3	Utilizing	4	500-1000	3	15	3	3	Moderately Suitable
Post 1 Pemantuan (A,D) 1 432	0-500	4	Open forest	3	Utilizing	4	0-500	4	15	3	3	Moderately Suitable
Post 2 Tengengean (A,D) 1 523	0-500	4	Open forest	3	Utilizing	4	0-500	4	15	3	3	Moderately Suitable
Post 3 Pada Balong (A,D) 1 807	0-500	4	Open forest	3	Utilizing	4	0-500	4	30	2	2	Marginally suitable
Extra Post (A,D) 1 807	500-1000	3	Open forest	3	Utilizing	4	1500-2000	2	30	2	2	Marginally suitable
Pelawangan 2 (A,D) 2 708	0-500	4	Open forest	3	Utilizing	4	0-500	4	35	2	2	Marginally suitable
Peak (A) 3 726	0-500	4	Open forest	3	Utilizing	4	0-500	4	40	1	1	Not suitable
Bird watching Post 2/Post 3 (B) 1 807	0-500	4	Open forest	3	Utilizing	4	0-500	4	20	3	3	Moderately Suitable
Orchid observation Post 2/Post 3 (C) 1 807	0-500	4	Open forest	3	Utilizing	4	0-500	4	20	3	3	Moderately Suitable
Senaru												
Gate: Jebag Gawah (A,D) 600	500-1000	3	Dense forest	4	Utilizing	4	500-1000	3	10	3	3	Moderately Suitable
Post 1 Jebag Gawah (A) 750	0-500	4	Dense forest	4	Utilizing	4	0-500	4	15	3	3	Moderately Suitable
Extra Post of 1 500	500-1000	3	Dense forest	4	Utilizing	4	500-1000	3	15	3	3	Moderately Suitable
Post 2 Montong Satas (A,D) 1 500	0-500	4	Dense forest	4	Utilizing	4	0-500	4	15	3	3	Moderately Suitable
Post 3 Mondokon Lolak (A,D) 2 000	0-500	4	Dense forest	4	Utilizing	4	0-500	4	20	3	3	Moderately Suitable
Demplot (A,D) 2 500	500-1000	3	Open forest	3	Utilizing	4	1000-1500	2	26	2	2	Marginally suitable
Cemara Lima (A,D) 2 500	500-1000	3	Open forest	3	Utilizing	4	500-1000	3	35	2	2	Marginally suitable
Pelawangan 1 (A,D) 2 641	0-500	4	Open forest	3	Utilizing	4	0-500	4	40	1	1	Not suitable
Batu Ceper (A,D) 2 100	0-500	4	Water body	3	Utilizing	4	0-500	4	15	3	3	Moderately Suitable
Quai Danau Segara Anak (A,D, E) 2 100	0-500	4	Water body	3	Utilizing	4	0-500	4	20	3	3	Moderately Suitable
Geyser Aik Keleq (F) 2 100	0-500	4	Water body	3	Utilizing	4	0-500	4	15	3	3	Moderately Suitable

Note: A: Sightseeing, relaxing, B: Bird watching, C: Orchid observation, D: Camping, E: Fishing, F: Swimming, bathing. Source: Observation, MRNP (2000), MRNP (2011)

landscape view or topography appeal for ecotourists. However, due to the protection of wildlife and biodiversity in a national park, this topography factor indicates that this area is vulnerable and fragile and needs to be protected. The more extreme slope of ecotourism area, the suitability for ecotourism is getting smaller. Nonetheless, this slope is the visual appeal that can be observed when crossing the geographic area or a broad landscape. The complexity of the area with certain slope is an important factor in land suitability for ecotourism analysis (Bunruamkaew 2012). An extreme slope is considered as major attraction in ecotourism, especially for travelers who are looking for experience in the wild with adrenaline-fueled activities (Nugroho 2012). In ecotourism industry development, a steep slope is a high risk for ecotourism facilities development. The slope is considered as an indicator of safety in ecotourism activities. The steeper the slope the more dangerous it is. The ecotourism package should consider special interest activities there. Conversely the more sloping, the safer for tourists. Environment and strong ecosystem have a high carrying capacity, such as the location of ramps at low altitude and with good soil (Muhamad 2013). The sloping ground is not easily eroded, and in the case of plant damage, it can be restored. In fact, the physical conditions on highlands or mountain with sloping ground and low temperatures generally have fragile ecosystems and are easily disrupted by the presence of tourists (Muhamad 2013). The data used were from interview and documents.

The final result of land suitability for ecotourism evaluation is by using the Liebig Law (Odum 1996), where the smallest rating will be an obstacle to other factors. It showed that there was no rating 4 or highly suitable for ecotourism in MRNP. Areas with rating 4 are mainly located in the sensitive or vulnerable areas where they can serve as the main attractions including the very rich potential of ecotourism for nature, endemic and endangered flora and fauna species, biological diversity, landscape as well as cultural richness. These areas are characterized by dense forest and need to be conserved due to their locations which were in the protected areas. These areas will be the most sensitive and vulnerable, and facilities or buildings developed for tourism activities there will treat the natural characteristics and can be disastrous. Therefore, it needs controllable and limitation of visitors, necessary management and control of resources to maintain its original condition and to avoid of getting into the areas which are susceptible or impressionable sensitive and difficult to be rehabilitated (Bunruamkaew and Muruyama 2012). The tourists can carry out education and research activities related to travel and trekking for a limited number of tourists (Yaakup et al. 2006; Bunruamkaew and Muruyama 2012) with the use of certain limitations and guidelines (Bunruamkaew and Muruyama 2012). The guideline elaborate in detail to limit the number of tourist and duration of access to the areas is the necessary of conduct. To preserve most of the biodiversity value, ecosystem protection is the first issue for ecotourism development in environmentally sensitive or vulnerable areas (Bunruamkaew and Muruyama 2012). If people are attracted to the most valuable areas too much, this can again harm the quality of the areas (Bunruamkaew and Muruyama 2012).

Jebag Gawah gate in Senaru and Sembalun gate gets rating 3 or moderately suitable for ecotourism. These areas were less sensitive and can be exploited. These areas are mainly characterized as very attractive and have the recreational potential for ecotourism, such as beautiful scenery, spectacular landscape, wildlife abundant and different plant communities (Bunruamkaew and Muruyama 2012). These areas are suitable for tourism development in general, and the organizers can control and promote tourism using natural resources. Usually, it contains great tourism potential with its unique natural resources. Despite being in the protected areas, the development of appropriate ecotourism activities is in the form of active recreations such as boating, parks and natural zoological park, for example, in some places of open forest and water bodies on MRNP ecotourism. The use of ecotourism attraction on those areas may have been considered, especially for passive tourism activities such as camping, sightseeing, soft trekking, bird watching, and activities with very limited development or visiting a specific site for educational purpose (Bunruamkaew and Muruyama 2012). In this type of ecotourism areas, the organizer is allowed to provide ecotourism tourist facilities, and to facilitate the development of proper ecotourism and ecofriendly infrastructure and services under the policy guidelines. The development of ecotourism in this area needs to pay attention to ecotourism infrastructure and facilities or appropriate services, such as green hotels, eco-lodge, restaurants and public convenience facilities which should be developed in harmony with local identity and its nature (Bunruamkaew and Muruyama 2012). However, the construction of some facilities should be done properly for ecotourism in order to minimize the impact on the environment. Limited tourism activities can be held in this zone with a limitation on a number of visitors and facilities that can be build in this area (Drumm et al. 2004; Nugroho et al. 2012), where visitors can be offered with educational and recreational opportunities within a nature environment, with medium concentration of visitors.

Post 3 of Pada Balong, Extra Post of Sembalun and Post Pelawangan 2 Sembalun, Demplot and Cemara Lima get rating 2 or marginally suitable. They have biophysical characteristics which consist of steep slopes and adequate distance to the tourism objects or biodiversity richness, so they can be considered as ecotourism by incorporating appropriate infrastructures and services under the policy guidelines (Bunruamkaew and Muruyama 2012). The main purpose of these areas is to protect most of the national park environments and offer recreational opportunities which were characterized by a minimum of environmental impact and very few groups' encounters. In these areas, roads, improved trails and permanent visitor's infrastructures, exaggerated tourism activities are forbidden (Drumm et al. 2004; Nugroho et al. 2012).

Pelawangan 1 Senaru and the peak of Mount Rinjani get rating 1 or not suitable class, due to its nature and fragileness. These areas are intended specifically for

protection and preservation of the ecosystems (Drumm et al. 2004; Nugroho et al. 2012). Pelawangan 1 Senaru get rating 1 or not suitable for ecotourism due to steep slope to be used as a camping area. To make this area to be more suitable for ecotourism and camping, it needs a workable strategy to create it. It is also necessary to review tourist management and utilize an appropriate technology that can provide ecotourism services. For example, in an area with a steep slope which will be used as the camping area, the terracing technology or the development of remote observation facilities and so forth can be applied. With the development of appropriate infrastructure and ecotourism services, then the marginally or moderately suitable can be developed into highly suitable for ecotourism attraction, and it needs appropriate control as well. The peak of Mount Rinjani also gets Rating 1 or not suitable for ecotourism because of biophysical limitations and that it can aggravate the area or degrade the fragile environment. Meanwhile, at the peak of Rinjani Mount, there was a potency of erosion and slide. This was a high-risk area and may be in poor or damage condition. In fact, ecotourism can be classified as a threat to the environment because it is generally associated with the vulnerable ecology ecotourism attractions (OK 2006). To have benefited from it, it needs appropriate control and intervention with engineering or technology that fits or modifies and adds the suitable tour package for ecotourism as special interest with a very limited visitor. Based on these results, tourist activities should not reach the peak with a high slope because of safety and security reason. It is therefore recommended to create a new track or create attractions which are slightly below the summit so that the vulnerable peak of Mount Rinjani is not disturbed by human activity. Nevertheless, the summit of Mount Rinjani can still be used as points of special interest. An extreme slope profile can become a high attraction in ecotourism, especially for those who seek experience in wild nature and adrenaline activities. On the other hand, in term of ecotourism industry development, high slope means high risk for facilities and building development. In addition, slope as a safety indicator implies the gentler the slope, the higher the safety factor and vice versa (Nugroho et al. 2012). Slope factor should be treated as safety indicator for ecotourism development due to flat landform is the most suitable for ecotourism.

This land suitability assessment needs to deal with carrying capacity to prepare management, visitor management, and ecotourism marketing strategy. Ecotourism management should take the character and potential of existing resources from land suitability for ecotourism analysis in order to arrange appropriate activities and to ensure compatibility between ecotourism and the original activities carried out in the area. This should include the avoidance of any serious conflict, especially in areas that suitable for ecotourism, with other forms of tourism, such as zoning in the form of conservation zone, buffer zone, rehabilitation zone, which should be done not only on protected areas but also on areas which are currently not suitable for ecotourism, the land having severe limitation that preclude the given type of use, can still be improved by specific management (Bunruamkaew and Muruyama 2012).

Carrying capacity analysis

The result of carrying capacity analysis means that for every 1 unit of area, some tourists who perform certain activities can be accommodated. The carrying capacity is calculated based on the activities carried out such as sightseeing or relaxing, bird watching, orchid observation, camping, and fishing, swimming/bathing. Bird watching activities and orchid observation are analogous to sightseeing/relaxing, while swimming or bathing activities are analogous to soaking in geyser lake. Each ecotourism areas can have different carrying capacity for each type of ecotourism activities, such as diving, snorkeling, fishing, mangrove tours and shore excursions (Romadhon et al. 2014). Carrying capacity can be developed and modified on the three components, namely, the ecological, social and economic, by considering the infrastructure and management capacity for the various types of tourism activities, such as cave sightseeing, adventurous touring, the cable car riding, mountain climbing, ecotourism forest exploring (Nghi et al. 2007).

Based on carrying capacity calculation, the MRNP ecotourism capacity can receive travelers as many as 1,452 people per day for all ecotourism activities, or total number is 172,816 visitors per year. Carrying capacity per day for all ecotourism activities in details are sightseeing/rest/relaxation is 747 people/day, bird watching is 22 people/day, orchid observing is 99 people/day, fishing is 54 people/day, and swimming or soaking is 173 people/day, and camping is 358 people/day.

To have all MRNP ecotourism experience, it takes minimal one night. Thus the total carrying capacity for camping activities is 42,525 people per year, and it was smaller than the number of tourists coming into MRNP in 2014 which was 44,112 people for overnight or camping purpose. The total number of tourists consisted of 22,385 of international tourists, and 21,727 of local tourists. If one tent is occupied by three people, then the carrying capacity for the establishment of tents will be 119 tents. Based on interviews, recently, that number had reached about 300 tents. Therefore the number of tents in the MRNP ecotourism camping area currently has exceeded the number of tents that resulted from the analysis of the carrying capacity. It revealed that ecotourism of MRNP had exceeded its carrying capacity to overnight.

The largest proportion activities based on carrying capacity of ecotourism area was sightseeing or relaxing at 51%, followed by camping, and swimming or bathing. Orchid observation and bird watching had smaller proportion due to the limited area provided for both activities. Meanwhile, the smallest proportion was bird watching at 1.55%. Ecotourism activities should be carried out simultaneously with the camping activities in an integrated tourism package in such a vast area of ecotourism activities.

Table 7 Carrying capacity for every ecotourism activity in Mount Rinjani National Park, West Nusa Tenggara, Indonesia

Activities	Area (m^2)	AR (acre)	Standard (sq. ft)	Capacity days (days)	Turnover factor	Carrying capacity (person/year)	Carrying capacity (person/day)	Proportion (%)
Sightseeing/relaxing	33 572.00	8.30	726.00	119.00	1.50	88,848	747	51.41
Bird watching	1 010.00	0.25	726.00	119.00	1.50	2,673	22	1.55
Orchid observation	4 470.00	1.10	726.00	119.00	1.50	11,830	99	6.85
Camping	30 112.00	7.44	907.00	119.00	1.00	42,525	357	24.61
Fishing	645.00	0.16	129.17	119.00	1.00	6,396	54	3.70
Swimming/bathing	300.00	0.07	28.06	119.00	1.50	20,544	173	11.89

According to Douglass (1982), certain tourist areas have certain ability to accommodate tourists. The environmental carrying capacity of the natural attractions is the ability of an area to receive tourists expressed in the number of tourists per unit area per unit time (Soemarwoto 2004). Thus, if the number of visitors, as the tolerant limit and tourist flexible capacity or optimal acceptance to do some tourism activities, could be managed in accordance with the type of activities and characteristics of the land used for ecotourism, then the quality of the biophysical environment for flora and fauna habitat, the quality of tourist's experience, satisfaction and comfort can be continuously maintained as well. Tourism carrying capacity is the highest bearing capacity of a natural, environmental and socio-economic system within which the maximum number of tourists has no influence on the sustainable development of the entire system and tourists' satisfaction is remained during the peak tourism period (Nghi et al. 2007). Carrying capacity approach can be defined as optimal tourist number who are able to carry out certain activities on certain area which related to certain level tourist number on that area, meanwhile economic approach can be defined as the ability of an area to accept certain number of tourist without losing their local activities and benefit by local service ecotourism development (Chougule 2011). Ecology system will degrade when tourist demand number exceeds carrying capacity, therefore tourism demand should be in the balance with its carrying capacity for ecotourism sustainability (Lee 2011). Tourism object which is managed by appropriate carrying capacity approach and with maximum tourist number who can be accepted in the tourism area will reduce negative impact especially to the environment biophysics (Lucyanti et al. 2013). Meanwhile, there is cyclical interaction between visitors and animals, especially birds, as the number of visitors increases when more birds are present, but as the number of visitors increases, the number of birds decrease and their minimum distance from the visitor's increases (Collins-Kreiner et al. 2013).

On the MRNP ecotourism trail trek, especially on Sembalun, there were Wallacea species birds which represented oriental, Australasia and endemic birds due to the woof, land covered by vegetation and altitude (MRNP 2012). The MRNP forest ecosystem can be categorized as unique since it is part of Sunda Kecil eco-region archipelago, between Asia and Australia namely Wallacea sub-mountain, mountain, semi-monsoon and Savanna which is really vulnerable and fragile (MRNP 2014) from time to time, biodiversity, various vegetation with special structure and pattern will differ, especially with human activities. Therefore, ecotourism management for preservation and protection purpose by using carrying capacity and visitor management approach was needed. It was already clear that both core zone and wilderness zone were addressed to be biodiversity preservation and protection area. Even, in the core zone which is actually a nature area without any touch and any changes, the organizer is only allowed to have activities for certain interest such as research and science development, conservation education and cultivation since it is really vulnerable and fragile to disturbance and changes. Meanwhile, wilderness zone was habitat and exploring the area, migrant habitat area, a breeding area which supports core zone and utilization zone, with the allowance on research and science development, conservation education, cultivation and limited tourism purpose.

Visitor management is an important and critical step in an ecotourism management; even open nature tourism is actually a visitor management (Arifin 1990). Visitor management strategy are such as the development of travel packages for special interest, interpretative or educational program, visitors circulation, visitor management infrastructure, carrying capacity for certain ecotourism activities in core, wilderness and utilizing zone, and average total visit time or capacity days in weekday/weekend/vacation, trained and certified guide, etc. (Lindberg and Hawkins 1993, Spenceley et al. 2015). Visitor circulation is needed to provide a connecting path between posts or tourist activities area. This path is a trek trail to Mount Rinjani and is located in core and wilderness zones of MRNP where there is a restriction to held activities. The length of the trekking trail is about 9.6 km from Post 1 Jebag Gawah in Senaru to Segara Anak Lake, and 10.9 km from post 1 Pemantauan in Sembalun to Segara Anak Lake and the peak of Mount Rinjani. The trekking trail needs to be printed on the official map and in the trekking rules and guidance since only trekking can be done there. Thus the visitors, community, guide or porters will not enter the core and wilderness zone. On the trekking

trail, it is forbidden to carry out activities except that it functions as access to pass by only. Based on the trekking trail technical condition and mountain trekking management, the trekking trail width is 3 m maximum (Dirjen KSDAE 2015). The trekking trail is generally so narrow that only one person can pass it at one time.

In summary, the final result of the land suitability for ecotourism analysis showed that the MRNP ecotourism was applied on the moderately or marginally suitable land for ecotourism, except in Pelawangan Senaru and the Peak of Mount Rinjani due to its slope aspect, sensitive and fragile area, and its biophysical limitation which could aggravate the area or degrade the fragile environment. Meanwhile, carrying capacity calculation showed the MRNP ecotourism capacity could accept visitors as many as 1,452 people per day or 172,816 visitors per year for all ecotourism activities. Total carrying capacity for camping was 42,525 people per year which were smaller than the number of tourists coming into MRNP in 2014 which was 44,112 people for overnight or camping purpose. It revealed as well the number of tents in the MRNP ecotourism camping area which was around 300 tents per day which currently has exceeded the possible establishment tents of around 119 tents, each contained of three people. To implement ecotourism management based on this result, there are three recommendations, namely public awareness, information, and education; appropriate and ecofriendly infrastructure; visitor regulation and control.

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