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by andre scabra

Submission date: 01-Feb-2023 12:57AM (UTC-0600)

Submission ID: 1936713580

File name: Carrying_Capacity_of_Utilization_in_Gitanada_Protected_Area.pdf (1.34M)

Word count: 4772

Character count: 25886

Proceedings

**International Conference on Science
and Technology (ICST)**

Vol. 1, Juni 2020



**Organized by Institute for Research and Community Services
University of Mataram, Indonesia**



Proceeding of International Conference Science and Technology (ICST)

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Vol 1 (2020)

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Suitability and Carrying Capacity of Utilization in Gitanada Protected Area

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Abstract. Various economic and resource activities in Gitanada protected area cause serious mangrove, coral reef and seagrass ecosystems degradation. The aims of this research were study land suitability, determine carrying capacity, and optimize of utilization of marine protected area. The methods employed in this research as: field survey for assessing the biophysics characteristics of the Gitanada protected area; Geographical Information System (GIS) for suitability analysis; Carrying capacity analysis using feasibility. The results of this research showed that condition of mangroves vegetation, live coral and seagrass were categorized from poor to good. 132 ha and 132.99 ha were suitable for molusc and seaweed culture with total production 1,056 tons per year and 1,063 tons per year respectively. 258.11 ha and 1212.35 ha were suitable for scuba diving and snorkeling and coastal tourism with the capacity of tourism were 16,183 person/year and 484,800 person/year respectively. While the suitable for mangrove tourism was 1010.65 ha with 404,261 person/year tourism capacity.

Keywords: suitability, carrying capacity, utilization, protected area

1. Introduction

The Gitanada Conservation Area are three small islands in West Lombok Regency. The condition of clear waters and high level of brightness and biodiversity with high endemism, beautiful landscapes, and strategic geographical location make the Gitanada region very potential for the development of capture fisheries and tourism, so that the area is used as a source of livelihood for the community both around and from outside region.

The basic problem in establishing Gitanada is the ineffective management to conflict of interest, where the community uses resources without considering resource sustainability. so that the available resources experience a threat. Considering that the area is a source of livelihood for the surrounding community, its management needs to be directed to the concept of management that is able to accommodate various interests through a model of area

management based on suitability and carrying capacity. Every activity in the utilization of regional space must be carried out by considering the suitability criteria of conservation-based land.

The most optimal use of conservation area space, it is necessary to analyze the suitability of the utilization and carrying capacity of the area. Every activity that will be developed in each zone is directed at conservation-based management by considering the ecological, economic and socio-cultural links, so that ecologically the quality of resources can be sustained, while contributing to profitable income and can guarantee an increase in social welfare.

The research is an attempt to developed a model of utilization in conservation areas, to answer the fundamental problem whether the determination of each zone is carried out by considering the suitability criteria and how the suitability of the region and its carrying capacity for the development of various activities in its use. The study was conducted to evaluate the zone's fit criteria; analyzing land suitability and calculating the carrying capacity of utilization in each zone of the Gitanada Conservation Area. The results of the study are expected to be beneficial for the government in formulating policies on the management of conservation areas.

2. Methods

Time and Location

The study was conducted from May to September 2018 in the Conservation Areas of Gitanada, West Lombok.

Data Collection Method

Biophysical data collection is done by visual survey and direct measurement. Secondary data were collected from various relevant sources, selected in a structured manner from various related agencies. Mangrove physical data retrieval is done using the Transect square method based on differences in vegetation structure (Bengen, 2001). Seagrass data collection using Systematic Random Sampling method, while coral reef data collection using Line Transect Method to see the closure of coral lifeform.

Socio-economic data were collected by survey method through interview techniques assisted by a structured questionnaire. The sampling method is done by using a stratified random method / stratification, which is sampling from a population that has been divided into several groups, each group is done by a simple random method (Bengen, 2009).

3. Data analysis

Analysis of Zoning, Land Suitability and Carrying Capacity

Zoning criteria analysis uses parameters that have been modified based on conformity criteria according to IUCN, 1984. While the analysis of the suitability of use using the Geographic Information System (GIS). Carrying capacity, using the formulation:

$$DDL = LLS \times KL$$

Where:

DDL = Land Carrying Capacity,

LLS = Land Area Appropriate,

KL = Land Capacity

4. Results and Discussion

The analysis of the identification and existing conditions of coral reefs is quite good with a percent coverage of coral between 31-60%, the characteristics of the waters with a fairly long average reef (> 50 - 100 meters). The seagrass ecosystems are considered unhealthy because the seagrass cover²³ is in the range of 30-60%.

According to regulation of the minister of marine and fisheries of the Republic of Indonesia number 17 of 2008 concerning zones in water conservation areas which refers to a number of suitability criteria that are assessed based on the level of importance (weight) most needed for each zone. The results of the analysis and mapping of the results show that zones based on consideration of conformity criteria can be shown in the following figure:

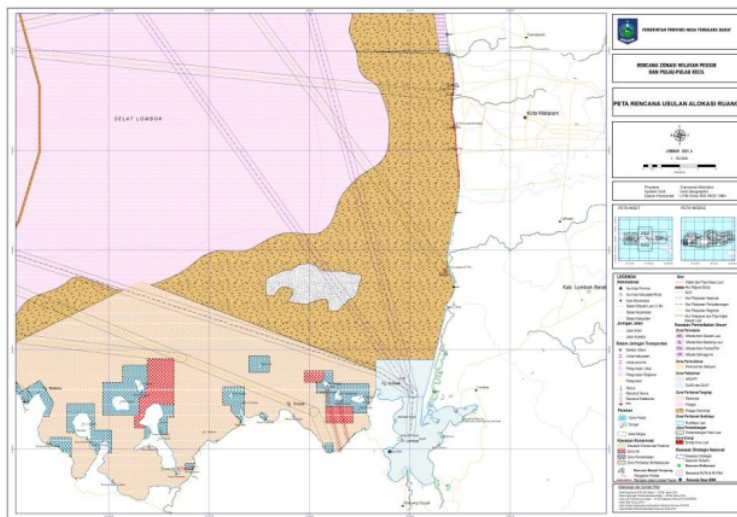


Figure 1. Zonation Map of Gitanada Conservation Area

Suitability for No Take Zones

The core zone for the protection of fish habitats and populations, as well as the migration paths of marine biota, protection of unique and / or vulnerable coastal ecosystems, protection of traditional cultural / traditional sites, research and / or education. The results of spatial analysis and mapping analysis, showed that the appropriate area for the core zone was 158.83 hectares, with a total score reached 18.7 or an average of 1.87 (the appropriate category).

Suitability of Establishment of Limited Use Zones

The limited use zone for the protection of ecosystem and population resources and the environment for a marine culture and tourism, research and development and education. The analysis show that appropriate are for this zone is 241,91 hectares with total score reached 17,4 an average of 1,74 (the appropriate category)

Other Zone Conformity Criteria.

It is a zone outside the core zone and a limited use zone because its functions and conditions are determined as certain zones, including rehabilitation zones, sustainable fishing

zones, and so on. Based on the results of the analysis it was found that the appropriate area for other zones was 2,119.92 hectares, with a total score reached 15.6 on average 1.56 (appropriate category).

Regions for Various Uses in Gitanada Conservation Areas.

Fishing

Based on the results of the analysis of the suitability of the area for coral fisheries obtained an area of 99.58 ha. This suitability condition is possible because the feasibility parameters at the location are very supportive for its development, such as water depth, water bottom topography, brightness, weather changes, coral reef conditions, pollution and abundance of target fish with a total score weighted 19.4 or 1.94 (very high category accordingly) in the range of scores 1-2.

Marine Culture

Marine culture that can be developed in accordance with the suitability of the region is shellfish and seaweed. Based on the analysis results obtained an area for shellfish cultivation covering 132.00 hectares with a production capacity of 1,056 tons per year and seaweed covering an area of 132.99 hectares with a production capacity of 1,063 tons per year. Parameters for shellfish culture such as protection, wave height, flow velocity, water bottom, water depth and salinity with a total weighted score of 24.5 or a mean of 2.45 (very appropriate) in the range of scores 1-3. While parameters for grass cultivation sea, such as protection, wave height, current velocity, water bottom, water depth and salinity with a total weighted score of 25.5 or average 2.55 (very appropriate) in the range of scores 1 - 3. The land suitability conditions are supported by the physical and chemical parameters of the waters in regions as shown in the following tables 1 and 2:

Table 1. Conformity Criteria for Mollusc Cultivation in the Gitanada Conservation Area

Water Quality Parameters	Station								average
	1	2	3	4	5	6	7	8	
Protection	protected	protected	protected	poorly protected	protected	protected	protected	poorly protected	protected
Wave Height (m)	0.40	0.30	0.40	0.50	0.30	0.30	0.40	0.50	0.39
Water depth (m)	14.5	15.8	14.5	15.5	14.5	16	14.6	16	15.18
Stream Speed (m / sec)	0.13	0.10	0.09	0.12	0.15	0.18	0.09	0.12	0.12
Basic Water Material	Sand reefs	muddy	Complex	Complex	muddy	Sand reefs	Complex	Complex	Sand reefs
Salinity (o/oo)	28,80	29,20	29,50	29,70	28,90	27,80	26,70	27,90	28,53

Source: insitu and exsitu results, 2018

Table 2. Criteria for Suitability of Seaweeds in Gitanada Conservation Area

Water Quality Parameters	Station								average
	1	2	3	4	5	6	7	8	
Protection	protected	protected	protected	poorly protected	protected	protected	protected	poorly protected	protected
Depth of water (m)	14,5	15.8	14.5	15.5	14.5	16	14.6	16	15.18
Basic Water Material	Sand reefs	muddy	comple x	comple x	muddy	Sand reefs	comple x	comple x	Sand reefs
Flow Speed (cm / sec)	0.13	0.10	0.09	0.12	0.15	0.18	0.09	0.12	0.12
Brightness (meters)	14,4	17	7	4	5	10	14	5	9,55
Salinity (o / oo)	28,80	29,2	29,50	29,70	28,90	27,80	26,70	27,90	28,53
Temperature (°C)	30,0	30,2	30,4	29,9	30,1	29,7	29,6	30,3	30,03
DO (ppm)	7.23	7.19	7.22	6.71	6.96	6.82	7.19	7.55	7.11

Source: Insitu and exsitu results, 2018

Tourism

According to the Directorate of Directorate General of Marine Management of the Ministry of Marine and Fisheries of the Republic of Indonesia (2003) in the Space Planning Details Plan of Gitanada, the zones that can be used for recreational activities are limited utilization zones and other zones. Day trips are activities that harness the potential of natural resources and the surrounding waters for swimming, sunbathing, diving and snorkeling. The suitability of the waters for day trips is done by considering the suitability parameters (Bengen, 2002) such as water brightness, coral reef type (number of species), coral species (number of species), current velocity, depth of water and basic substrate of water. The analysis showed that the ideal depth for the submarine category is 158.83 hectares, the conditional category is 99.58 hectares. The results indicate that not all areas of Gitanada area are eligible to serve as a tourism destination especially for snorkling and or diving activities, this is due to limiting factors.

Beach Tourism

Beach tourism includes beachside activities such as enjoying the beauty of the beach, beach sports, sunbathing, picnicking, camping, and beach swimming. The various attractions of tourism that can be used as a valuable selling point in this area are the beauty of the sea and the mangrove forest resources and the variety of wildlife within it and the white sand of the limited area. The potential for beach tourism development has not been well managed, but the beach tourism potential is more focused on swimming, sunbathing and water sports activities. Based on the parameters of the suitability of the coastal area (Bengen 2002), the depth of water, the material of water, the speed of stream, the brightness of water, the distance from the beach, the closure of the beach (beach vegetation), and the distance from the pollutant source. The analysis results show that the ideal area for beach tourism is 1,212 hectares.

The travel and whiskey visits increased, however visitors who come to visit are relatively short-lived, with an average of one to three days to enjoy coral reefs and meadows. The tourist arrivals due to lack of promotions, transport facilities, hotel infrastructure and home stay are key variables in the tourism industry. From the institutional point of view, a working group was formed that specifically assisted the management of Gitanada by the name of Wach. The survey results show that in each of the months of July - September, the number of foreign visits reached 1218 people and outside of that month with an average visit of 79 people. Expenses for a stay at Rp. 600,000 per day

allocated to home stay owner Rp. 550.000, -, cash Central Village Rp. 25,000 and Rp. 25,000 for Gitanada conservation group.

Gitanada Area Support

Ecological support in this study is the maximum amount of activity that a conservation area can tolerate for a certain period of time without causing the degradation of natural resources. Given that Gitanada is a conservation area, so any activities undertaken are non-mass activity, and limited utilization space, so determining regional sustainability should consider aspects of environmental sustainable.

The Carrying Capacity of Fisheries

Appropriate of standard for coral production according to Yulianda et al. 2009 reaches about 10-30 tonnes / km² or World Bank predictions (1996) within 1 km² of healthy coral reefs can produce 12-50 tonnes of coral reefs per year (Ochieng et al, 1997). the maximum production capacity of coral reefs in the Gitanada Conservation Area with an average coral cover of 55% and adaptability for coral fisheries at 99.58 ha is 99.58 - 298.74 tonnes per annum.

The Carrying Capacity of Seaweed

Based on the analysis of suitability of area area suitable for 265.98 ha of seaweed cultivation with 50% land area, 531 units of land area for 40 cultivation with 40 x 60 m long field method with area of 132,99 ha was obtained. Aggadireja et al. (2004), states that with a good preservation system for seaweed cultivation it can achieve production of 1000 - 1500 kg dry weight / ha / harvest or about 6-9 ton / ha / year. Thus, grass production in the Gitanada area can reach 797,88 - 1,063.92 tonnes / year

The Carrying Capacity of Shellfish

The calculation of sustainability for the cultivation of clams with long line patterns is used with approaches such as seaweed cultivation calculations. Based on the map overlay results, obtained an area of 264,00 hectares, clams cultivation area with 50 percent, land acquisition support for 528 units of clams with a 40 x 60 m long line method with an area of 132 ha. Buntadir et al. (2007), states that with a good maintenance system a production of 3 – 4 tonnes/ha/ harvest or about 6 - 8 tonnes / ha / year can be achieved. Thus, the production of shellfish reaches a production of 792 - 1,056 tonnes / year.

Tourist Attraction Support

The results of the analysis and map overlays show that the ideal depth for the submarine is 258.41 hectares. Yulianda (2007) suggested that for diving travelers should consider the condition of the reef community, as the percent of coral cover reflects the condition and support of the reef. If the condition of the coral community is good, with a cover of 55 percent then the area of submerged coral reef area is 55 percent of the coral overlay area. Thus it has the capacity to accommodate 16,183 people / year.

Beach Tourism Support

Beach tourism includes all activities at the beach such as enjoying the beauty of the beach, beach sports, sun bathing, picnic, camping and beach swimming. Based on the parameters of the suitability of the coastal area (Bengen 2002) in Maanema 2003 namely, depth of water, groundwater material, current velocity, water brightness, distance from the

beach, closure of beach (beach vegetation), and distance from pollutant sources. The analysis shows that the area suitable for beach tourism is 1,212 hectares with the capacity to accommodate 484,800 people / year, including recreational categories such as water sports, and fishing and for mangrove tourism activities in Gili Tangkong. 41,630 hectares, Gili Sudak covers 69.023 hectares, making it possible to accommodate 404,261 people / year for tourists.

The support beach area of Gitanada is 905,244 per year. Based on current utilization activities, it is known that ecotourism activities are still under ecological support and can still be increased in quantity. The support of the marine tourism is much smaller than the other three tourist activities, due to the limitations of appropriate coral reefs. Judging from the current utilization and the increasing number of visits each year, it is likely that the utilization of both day and beach tourism will be supported especially during peak season if supported by adequate infrastructure.

5. Conclusion

1. Appropriate marine cultivation activities developed in the limited utilization zone of the Gitanada conservation area are 132 hectares of mollusc with production capacity of 1,056 tonnes per annum and seaweed cultivation of 132,99 hectares with production capacity of 1,063 tonnes per years.
2. An appropriate coral fishery to be developed in the 9,558 ha with a production capacity of 99.58 - 298.74 tonnes per annum. 401.74 ha coral reef resource based activities, for dive and snorkeling tours of 258.41 hectares and the rest for beach excursions.
3. The coastal tourism activities developed in the 1212.35 hectare
4. Considering conservation of natural resources and environment and local community involvement in marine cultivation activities will be able to provide value for each of the beneficiaries of interest in Gitanada conservation area.
5. The management Conservation Area is intended to support ecological, economic and social sustainability.
6. This study can be used as a revised material for the Management Plan Document. Therefore to follow up of this research that the local government, has been one of the catalysts in formulating conservation area policy program from the socialization stage of every benefit element so that future management becomes more effective.

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