Behavioral mapping of human activities in The Pananjung Pangandaran strict nature reserve, Indonesia

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Abstract. The Pananjung Pangandaran Strict Nature Reserve (PPSNR) is one of the sanctuary reserve area in the southern of Java, Indonesia that has unique of plants, animals, and ecosystem. However, the location of the nature reserve area that adjacent to the nature recreation parks has lead to the disturbance of natural resources due to human interferences. This research aims to assess the distribution of human activities in PPSNR and identify factors affecting those activities. The behavioral mapping method was carried out based on interviews with 209 respondents selected by an accidental sampling technique during two weeks field survey. In addition, a direct mapping method using GPS handheld was carried out to collect coordinates data of human activities and their movements. The results showed that human activities in PPSNR could be grouped into tourism activities and non-tourism activities. It was observed that distance from visitors’ house, type of attraction, and time of activity were the main factors affecting human activities in PPSNR. Finally, the authorities must take measures to control human activities in PPSNR, otherwise their impacts on the natural resources will be worsen.

1. Introduction

Protected areas have an important role in protecting biodiversity through activities to protect the life-support systems (e.g. water and oxygen supply) and preserve the diversity of plants, animals and ecosystems. According to the Indonesian Law No. 5/1990, protected areas in Indonesia can be classified into 6 categories such as Strict Nature Reserve, Wildlife Sanctuary, National Park, Nature Recreation Park, and Grand Forest Park [1]. These categories are mentioned starting from the most restricted areas (i.e. Strict Nature Reserve) to the most managed areas (i.e. Grand Forest Park). In the strict nature reserve, a strict protection is to ensure continual development under natural conditions, where access is limited in non-manipulative research and monitoring, while in the nature recreation park and grand forest park, the role is not only to preserve biodiversity but also for research and tourism.

Pananjung Pangandaran Strict Nature Reserve (PPSNR) is one of the nature sanctuary reserve area in the southern of Java, Indonesia that is habitat for variety of plants including endangered Padma flowers (Rafflesia patma). However, the location of PPSNR that is adjacent to the nature recreation parks has made visitors think that PPSNR is part of the nature recreation park so that the area is open for tourist.
The tourism activities inside the PPSNR has lead to the disturbance of natural resources in the surrounding area [2]. The biodiversity in PPSNR has been threaten by human activities such as picking wild flowers, burning wood for bonfire, feeding wild life, taking stones coral, shells and fishes [3]. In addition, a frequent human trail into the area has affected plant compositions in the nature reserve area [4].

It should be understood that PPSNR is categorized as a strict nature reserve where according to the Indonesia Law No. 5/1990 is forbidden for activities besides biodiversity protections [1]. As such, human activities like tourism in PPSNR can be appointed as an illegal activities. This study aims to assess the human activities inside the PPSNR and identify factors affecting those activities. The results of this study will be useful for the authorities to take controlled measures to avoid biodiversity loss in the PPSNR due to human activities.

2. Study Area and Methods

2.1 Study Area

Pananjung Pangandaran Strict Nature Reserve (PPSNR) consists of two reserve areas such as marine reserve area (470 Ha) and nature reserve area (454 Ha). It is administratively located in Pangandaran village, Pangandaran District, Pangandaran Regency, West Java. Geographically, the area is located at 108°39'5"-108°39'43" E dan 7°42'3"-7°42'23" LS. The topographical conditions are ranging from steep slope in the hilly areas to relatively flat closer to the seashore, with an average altitude of 100 masl. PPSNR has B-type climate according to Schmidt-Ferguson climate classification indicating a wet condition throughout the year. The average rainfall is 3.196 mm/year, the average air temperatures ranging between 25°- 35°C, and the air humidity ranges from 80-90%. Soil types in PPSNR are mostly occupied by Podosol red, Latosol brown and Latosol [5].

Figure 1. Location of the Pananjung Pangandaran Strict Nature Reserve (PPSNR) that is adjacent to the Nature Tourism Park

2.2 Methods

2.2.1 Data collection
This research used a behavioral mapping technique that was developed by Ittelson et al. (1970) to record human behavior in a designed setting. In this approach, spatial features and behavior of human activities are linked in both time and space [6]. A Spatial and non-spatial information of human activities in space and time were collected based on primary data and secondary data. Primary data included information about actors (i.e. age, gender, education background, occupation, house distance from location, and intensity of visit), milieu (i.e. type of attraction and space attribute), and time of activity that were obtained from interviews with respondents that were selected based on an accidental sampling method. In this research, the procedure of the accidental sampling where the data collection was carried out for two weeks from morning (07:00 – 10:30 am) to afternoon (15:00 – 17:30 pm). In total 209 of respondents were selected through this procedure [7]. In addition to the interviews, a direct observation of human activities distribution was carried out using GPS handheld to collect coordinates data of human activities and their movements. For the secondary data, we used administrative map of Rupa Bumi Indonesia (RBI) scale 1:25,000 that was made available from Geospatial Information Agency (BIG) and protected area map of west Java scale 1:50,000 from Ministry of Environment and Forestry. Table 1 shows variables collected for behavioral mapping of human activities in PPSNR.

| Variable | Sub-variable | Descriptions |
|----------|--------------|--------------|
| Y        | Human activities (tourism and non tourism) | Age of respondents in the moment of research, is categorized into children (5-12 years old), teenager (13-20 years old), and adult (> 21 years old). |
|          |              | Biologically characteristics that are differentiated into male and female. |
|          |              | The last formal education level completed by the respondents. |
|          |              | The main activity in which one engages to receive income |
|          |              | Distance between study site and places of origin (house); is classified into far (> 8km), intermediate (4-7 km), and close (1-3km) |
|          |              | Frequency of the respondents visiting the study site, is classified into rarely (only once), sometimes (at least once in a week), and often (almost every day). |
| X1       | Age          | |
| X2       | Gender       | |
| X3       | Educational background | |
| X4       | Occupation   | |
| X5       | House distance from location | |
| X6       | Intensity of visit | |
| X7       | Facilities   | Features available to support human activities, such as benches, gazebos, information boards, etc. |
| X8       | Type of attraction | Kind of attraction which becomes the main reason respondents do activity in the study site, such as coasts, forests, caves, camping ground, playground, etc. |
| X9       | Time of activity | Day and time the respondents do activity in the study site, is classified into weekday and weekend, and morning |

Table 1. Variables collected for behavioral mapping of human activities in PPSNR.
The data analysis for the spatial data was carried out using a spatial analysis tool of ArcGIS 10.3 software, while for the non-spatial data (i.e. results of interview) was carried out using statistical analysis namely logistic regression analysis. For the spatial data, the coordinate location of human activities and their movements were mapped and descriptively analyzed. The logistic regression analysis was used to define the factors affecting the human activities in PPSNR. Logistic regression is suitable to conduct when the dependent variable is dichotomous (binary), like in this research [8]. It is a predictive analysis and able to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables. Table 1 shows the dependent variable ($Y$) and the independent variables ($X_n$) used in this research. The logistic regression model is described as follow.

\[
Y(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 \quad \text{Equation 1}
\]

Where $\beta$ is a constant. For this research, we used a significance level of 5%.

3. Results and Discussion

3.1. Distribution of Human Activities in the Pananjung Pangandaran Strict Nature Reserve

Activities in the Pananjung Pangandaran Strict Nature Reserve (PPSNR) can be grouped into two main activities, tourism activities and non-tourism activities. Tourism activity can be classified into recreational tourism, educational tourism, and cultural tourism, which these activities does not include work [9], while non-tourist activities are activities that aim to generate incomes [10]. A total of 209 respondents has been selected by an accidental sampling technique during two weeks field survey. From these respondents, it was identified that 175 respondents (83.7%) carried out tourism activity in the PPSNR and mainly did activity of enjoying coastal scenery, then followed by activities like forest tracking, camping, and caving. The spatial distribution of the tourism activity were mostly found in the northwestern coast of the PPSNR. In this area, more than 30 respondents were clustered in a place and thus categorized as a densely high of human activity tourism area (see Figure 2). Besides enjoying coastal scenery, tourists also enjoyed the forests and caves in the PPSNR, but in a low density where only 1-15 respondents were clustered in a place. Based on the time of the activity, the tourism activities were mostly carried out in the morning, and most tourists visited during weekend or public holidays. According to the tourists, they enjoyed the beautiful natural scenery and the white sand along the coastal area of PPSNR. In addition, the wind are gentle resulting mild waves on the coast so that coral reefs and seagrass ecosystem lived healthy. This has attracted tourists to come for snorkeling.

For the non-tourism activity, 34 respondents (16.3%) who mostly were local people were identified. Renting snorkeling tools for tourists were the dominant non-tourism activities in PPSNR. The other non-tourism activities were fishing, looking for shells and shrimps, and guiding tourists. Similarly to the tourism activity, this non-tourism activity was mostly distributed in the northwestern coast of the PPSNR and done during weekend or public holidays. This area was categorized as an intermediate density of human activity tourism area, where 15-30 respondents were clustered in a place. This was make sense because these non-tourism activities were mainly aimed to serve tourists’ needs. Besides assisting
tourism, the non-tourism activity included security patrols and biodiversity inventory in the forest of PPSNR that were carried out by the staffs of Conservation Resort Area XX of Pangandaran, BKSDA West Java. The spatial distribution of human activities in the Pananjung Pangandaran Strict Nature Reserve is shown in Figure 2.

![Spatial distribution of human activities in the Pananjung Pangandaran Strict Nature Reserve](image)

**Figure 2.** Spatial distribution of human activities of both tourism and non-tourism activities in the Pananjung Pangandaran Strict Nature Reserve

### 3.2. Factors affecting human activities in the Pananjung Pangandaran Strict Nature Reserve

Table 2. shows the results of logistic regression model in a significance level of 5%. From this table, we identified that three variables such as distance from actors’ house, type of attraction and time of activity were the main factors affecting human activities in the PPSNR. Distance from actors’ house gives a significant influence where the tourism activity in PPSNR was tend to carry out by actors from the longer distances from PPSNR, while for the non-tourism activity was tend to carry out by actors from the closer distance from PPSNR. This conditions meant that the tourism activity was mostly performed by outsider, while the non-tourism was mostly performed by the local people. Another important factor was type of attraction. For the tourism activity, the respondents enjoyed the open spaces such as coastal areas compared to the forests and the caves. It was clearly observed that the tourists visited PPSNR mostly to visit the coastal area. On the contrary, the non-tourism activity like security patrols and biodiversity inventory were mostly located in closed areas like forests and caves. The last main factor was time of activity. Human activities for both tourism activity and non-tourism activity in PPSNR were mainly done in the morning (08.00-10.30 WIB). According to the respondents, they enjoyed more the chill atmosphere in the morning than afternoon.
Table 2. Variable in the Equation of Pangandaran Nature Reserve

| Variable                      | Sub-variable | p-value | β     |
|-------------------------------|--------------|---------|-------|
| **Actors**                    |              |         |       |
| Age                           |              | 0.678   | 1.846 |
| Gender                        |              | 0.244   | 0.548 |
| Educational background        |              | 0.498   | 0.438 |
| Occupation                    |              | 0.49    | 1.148 |
| House distance from location  |              | 0.007*  | 0.003 |
| Intensity of visit            |              | 0.12    | 0.19  |
| **Milieu**                    |              |         |       |
| Facilities                    |              | 0.11    | 6.081 |
| Type of attraction            |              | 0.03*   | 0.17  |
| **Time**                      |              |         |       |
| Time of activity              |              | 0.012*  | 2.514 |

Note: * shows statistical significance at a 5% significance level

3.3. Discussion

The protected areas in both marine and inland are facing numerous environmental challenges which mainly are caused by human activities [11]. According to them, tourism activities can adversely affect the environment either directly, indirectly or cumulatively which could determine the sustainability of a protected area.

It is clear that according to Indonesian Law No. 5/1990 a strict nature reserve is forbidden for activities besides biodiversity protections [1]. In addition, it is stated in the Government Regulation of the Republic of Indonesia No. 28/2011 article 33 that activities in the strict nature reserve only limited to research and development of science, education, and improvement of nature conservation and the biodiversity utilization for biomedicine [12]. Therefore, human activities in particular for tourism in PPSNR can be appointed as an illegal activities.

An increased number of tourism activity in PPSNR has evidently increased disturbances to the natural resources. It was observed that human activities inside PPSNR has threaten plants biodiversity because we saw that some tourists carelessly stepped on the understories during forest tracking. In addition, according to the staff of BKSDA West Java who did security patrol in the area, the numbers of *Rafflesia patma* in PPSNR has decreased since tourism become more popular in PPSNR. This tracking activities also resulted in soil compaction inhibiting natural regeneration of plants [13]. Furthermore, tourism activities like making bonfires near the forests and wasting trash during camping were also directly observed as threats to PPSNR environment.

Finally, we urge authorities to take measures to control these illegal activities in PPSNR. Based on table 2. shows three variables that have a significant influence, the government should provide guidance to the general public that PPSNR is not a tourism destination and minimizes information or advertising related to tourism in PPNSR so that people do not activities on weekday or weekend in PPNSR. While
the types of attractions that exist in PPNSR need to be guarded and avoided from community threats with information that PPNSR is illegal for activities. Tourism activities should be controlled to be inside the nature tourism park. Then, security patrol in PPSNR should focus on the biodiversity protections in particular to secure the existence of the endangered *Rafflesia patma*. However, if the authorities have seen a potential resource in the northwestern coast of PPSNR to be developed as a tourism area, it can be considered to include this area as an extended area of the nature tourism park. If this is going to be the case, a throughout study must initially be carried out to assess the environmental impact assessment of tourism in the area. In addition, strategies to address visitor management in this area must be enlisted to ensure that human activities minimize stressors to environment.

4. Conclusion

There were 83.7% visitors carried out tourism activity while the rest carried out non-tourism activity in the Pananjung Pangandaran Strict Nature Reserve (PPSNR). For the tourism activity, enjoying coastal scenery was the most favorable activity. The spatial distribution of the tourism activity was mostly found in the northwestern coast of the PPSNR where we categorized this area as a densely high human activity area. For the non-tourism activity, renting snorkeling tools for tourists was the main activity conducted by the local people. This activity was also distributed in the northwestern coast of the PPSNR. Both tourism and non-tourism activities mostly conducted during weekend or public holidays. Three main factors were found to affect human activities in the PPSNR such as distance from actors’ house, type of attraction, and time of activity. According to Indonesian Law No. 5/1990 and Government Regulation of the Republic of Indonesia No. 28/2011 article 33, these human activities for tourism in PPSNR can be appointed as an illegal activities. We identified that an increased number of tourism activity in PPSNR in the northwestern coast has evidently increased disturbances to the natural resources. Thus, we urge authorities to take measures to control tourism activities to be inside the nature tourism park near PPSNR.

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7
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