

# **Pangandaran Coastal Land Carrying Capacity Analysis for Tourism Activity**

**Bambang Edhi Leksono**, Santi Azarah, Putri Rahmadani, M.Adie Brilian (Indonesia)

Keywords : coastal land, carrying capacity, tourism activity, environment.

## **SUMMARY**

Pangandaran beach has gone through a lot of environmental dynamics due to anthropological interference or natural disasters such as earthquake and tsunami.

Coastal engineering and directed development are needed to prevent Pangandaran Area from undesirable condition such as overshoot carrying capacity or get into the tourism stagnan phase. Study concerning the coastal environment management which is conducted by several parties has been shown to be optimal in restoring environmental degradation without reducing the benefits obtained from tourism activities.

Marine tourism development itself is currently being a hot topic between tourism developers or academic researchers. Uncontrolled marine tourism development will always leads to the imbalance of monetary, social, and ecological aspects and disrupt the sustainability idea. Unfortunately, Pangandaran Beach's land carrying capacity as a largest marine tourism destination in West Java never been analysed; and there is no update of Pangandaran suitability environment to support its marine tourism activity.

To that end, this research aims to analysing the suitability of Pangandaran Beach for tourism area and its land carrying capacity based on its environmental condition to support spatial planning or stakeholder take on policy in order to attain marine tourism sustainability.

The methodology used for calculating Pangandaran Carrying Capacity is referred to Regulation of the Indonesian Minister of Environment and Forestry No. 7 of 2009

Result and Discussion Land carrying capacity status in Pangandaran Sub-districts is overshoot, in as much that the SL value is below the DL value by the year of 2020-2050 from its projection.

## **SUMMARY (Indonesia)**

Pantai Pangandaran banyak mengalami dinamika lingkungan akibat gangguan antropologi atau bencana alam seperti gempa bumi dan tsunami.

Rekayasa pesisir dan pengembangan terarah diperlukan untuk mencegah Kawasan Pangandaran dari kondisi yang tidak diinginkan seperti daya dukung yang terlampaui atau masuk ke fase stagnan pariwisata.

Kajian tentang pengelolaan lingkungan pesisir yang dilakukan oleh beberapa pihak terbukti optimal dalam memulihkan kerusakan lingkungan tanpa mengurangi manfaat yang diperoleh dari kegiatan pariwisata.

Perkembangan wisata bahari sendiri saat ini sedang menjadi perbincangan hangat di kalangan pengembang pariwisata maupun akademisi peneliti.

Perkembangan wisata bahari yang tidak terkendali akan selalu menimbulkan ketidakseimbangan aspek moneter, sosial, dan ekologi serta mengganggu gagasan keberlanjutan.

Sayangnya, daya dukung daratan Pantai Pangandaran sebagai destinasi wisata bahari terbesar di Jawa Barat tidak pernah dianalisis dan belum adanya update kesesuaian lingkungan Pangandaran untuk menunjang kegiatan wisata baharinya.

Untuk itu, penelitian ini bertujuan untuk menganalisis kesesuaian Pantai Pangandaran untuk kawasan wisata dan daya dukung daratannya berdasarkan kondisi lingkungannya untuk mendukung penataan ruang atau pengambilan kebijakan oleh stakeholders dalam rangka mencapai keberlanjutan wisata bahari.

Metodologi yang digunakan untuk menghitung Daya Dukung Pangandaran mengacu pada Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 7 Tahun 2009.

Hasil dan Pembahasan Status daya dukung lahan di Kecamatan Pangandaran terlampaui, karena nilai SL berada di bawah nilai DL pada tahun 2020-2050 dari proyeksi.

# Pangandaran Coastal Land Carrying Capacity Analysis for Tourism Activity

**Bambang Edhi Leksono**, Santi Azarah, Putri Rahmadani, M.Adie Brilian (Indonesia)

## 1. Introduction

Utilization of coastal resources for tourism needs is increasingly prevalent, along with the increasing tendency of tourists to visit the marine tourism industry compared to other types of tourism (Papageorgiou, 2016). Marine tourism is chosen by tourists due to the availability of services interacting with beautiful and unique nature, or in other words, it has a natural atmosphere that is different from the environment the tourist originated (M. Orams, 2002). Pangandaran beach provides marine tourism activity since a long ago. Moreover, the tourism sector contributes the most regional Pangandaran Regency income, up to 36% of total local revenue (BPKD Pangandaran, 2019). Furthermore, the income earned through the tourism industry can instill in the local communities a sense of pride in their environment as well as highlight the connection between tourism and their livelihood (Wu & Tsai, 2016) and potentially accelerate solving localhood poverty (Yoeti, 2008).

The focus of the local government in the tourism sector has led to the increasing economic activity of the people in the Pangandaran region and the growth of building number with several function (Mardiatno et al., 2020). For example, within 5 years, the hotel growth in Pangandaran has reached 208% growth rate (Ahari, 2011). It can be an advantage from the economic perspective, but can leads to the increasement of the potential risk damage (Mardiatno et al., 2020) and environmental degradation in certain territories (Amado dos Santos et al., 2020). On the other hand, the increment of local population can trigger the rise of land use needed for housing or new settlement (Mulder, 2006) or even overshoot its carrying capacity (Mwalyosi, 1991). Need to know that the essence of carrying capacity is the comparison between supply and demand and the extent of the available land has been always limited (Widodo et al., 2015). The concept of carrying capacity especially for tourism activity arises from the perception that tourism cannot grow continuously in a particular region without causing irreversible damage to the local (Coccosis, H., & Mexa, 2017).

Pangandaran beach has gone through a lot of environmental dynamics due to anthropological interference (Yuliadi et al., 2019) or natural disasters such as tsunami (Mardiatno et al., 2020). Coastal engineering and directed development are needed to prevent Pangandaran Area from undesirable condition such as overshoot carrying capacity or get into the tourism stagnan phase (Hidayat, 2016). Study concerning the coastal environment management which is conducted by several parties has been shown to be optimal in restoring environmental degradation without reducing the benefits obtained from tourism activities (Lin et al., 2020; Rao et al., 2014; Scheufele et al., 2018).

Marine tourism development itself is currently being a hot topic between tourism developers or academic researchers (M. B. Orams & Lück, 2014). Uncontrolled marine tourism development

will always leads to the imbalance of monetary, social, and ecological aspects and disrupt the sustainability idea (Long et al., 2014). Unfortunately, Pangandaran Beach's land carrying capacity as a largest marine tourism destination in West Java never been analysed; and there's no update of Pangandaran suitability environment to support its marine tourism activity. To that end, this research aims to analysing the suitability of Pangandaran Beach for tourism area and its land carrying capacity based on its environmental condition to support spatial planning or stakeholder take on policy in order to attain marine tourism sustainability.

## 2. LITERATURE REVIEW

### 2.1 Carrying capacity

Many international organizations and national institutions have launched coastal development strategies and policies in a bid to achieve coastal ecosystem sustainability, and carrying capacity assessment is conducive to promote the coordinated development of the ecological environment and human activities (Liu et al., 2020). Carrying capacity indicates the difficulty of evaluating objectively the interaction between a population and the environment (Seidl & Tisdell, 1999), or the maximum density which a particular range is capable of supporting (Dhondt, 1988). The capacity of land are the minimum living needs that can be provided by land to accommodate life on it. Population pressure on land carrying capacity can be determined based on the ratio value between the population and the percentage of agriculture with a minimum land area for a decent living (Soerमारwoto, 2000).

Referring to the Regulation of the Indonesian Ministry of Environment and Forestry, the formulation used for carrying capacity is represented by this equation:

$$KHLL = \frac{\text{decent living needs of the population}}{\text{local rice productivity}}$$

### 2.2 Resource Suitability for Tourism Activity

Suitability analyses involve the use of a wide variety of methods from different fields of science, and the results are used in every field of sustainable development (Kaptan Ayhan et al., 2020). Suitability techniques enable environmental managers and planners to analyze the interactions among three types of factors: location, development actions, and environmental elements (Collins et al., 2001). The suitability of coastal resources is used for the development of coastal tourism, taking into account ten parameters and four assessment classifications (Yulianda, 2019). The formula used is:

$$IKW = \sum_{i=1}^n (Bi \times Si)$$

n = the number of suitability parameters

Bi = Parameter weight of-i(th)

Si = Parameter score of-i(th)

The tourism suitability analysis uses a suitability matrix arranged based on the importance of each parameter to support activities in the area (Yulianda, 2019), shown by Table 1.

Table 1. Matriks Kesesuaian untuk Wisata Pantai Kategori Rekreasi

No.	Parameter	Weight	Category	Score
1	beach type	0,200	white sand	3
			white sand with coral fragments	2
			black sand, a little steep	1
			mud, rocky, steep	0
2	beach's wide (m)	0,200	>15	3
			10 until 15	2
			3- <10	1
			<3	0
3	sea waters bed material	0,170	sand	3
			sandy coral	2
			muddy sand	1
			mud, sandy mud	0
4	water's depth (m)	0,125	0-3	3
			>3-6	2
			>6-10	1
			>10	0
5	waters brightness (%)	0,125	>80	3
			>50-80	2
			20-50	1
			<20	0
6		0,80	0-17	3

	current velocity (cm/detik)		17-34	2
			34-51	1
			>51	0
7	beach slope (derajat)	0,80	<10	3
			10 - 25	2
			>25-45	1
			>45	0
8	beach land cover	0,010	Coconut trees, open field	3
			Low bush, Savana	2
			High scrub	1
			Mangrove forests, settlements, ports	0
9	dangerous biota	0,005	Null	3
			Sea urchins	2
			Sea urchins, stingray	1
			Sea urchins, stingray, stonefish, shark	0
10	freshwater availability / distance to fresh water source (km)	0,005	<0.5	3
			>0.5-1	2
			>1-2	1
			>2	0

Scoring based on the quality of each suitability parameter during the data collection process in the field. After determining the weights and scores, the tourism suitability index (IKW) value is calculated based on the total multiplication of weights and scores of all parameters for each type of tourism activity. Based on the calculation of the Tourism Suitability Index, the land suitability classes are obtained for coastal recreation tourism (Nugraha et al., 2013).

### 3. THE MATERIAL AND METHOD

This research was conducted in Pangandaran District which is administratively located in Pangandaran Regency, West Java, Indonesia. Geographically, Pangandaran District is located at 07° 42 '06 "South Latitude - 108° 29" 41 "East Longitude (Rahmawan et al., 2020). Pangandaran District has 8 villages with an area of 60.77 km<sup>2</sup> (Badan Pusat Statistik, 2018). Pangandaran District has a beach area of 136 ha (Dinas Pariwisata dan Kebudayaan, 2003). The Pangandaran area is well-known for its tourism potential in the water sector which supports regional income potential (Yuningsih, 2005). Therefore, environmental analysis is needed to support sustainable tourism. Visually, the research location will be shown in the image below.



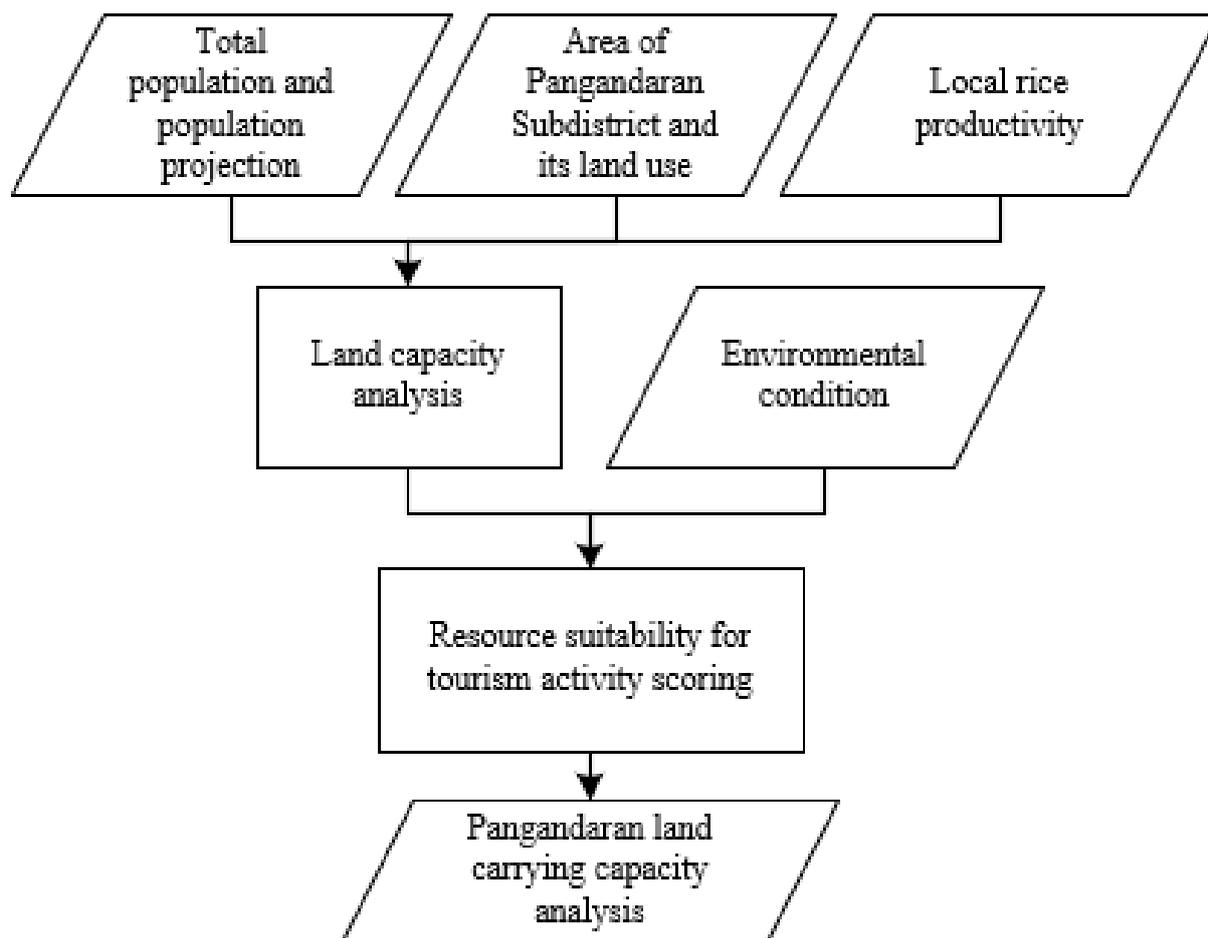


Figure 2. Research Flowchart

The methodology used for calculating Pangandaran Carrying Capacity is referred to Regulation of the Indonesian Minister of Environment and Forestry No. 7 of 2009.

### 3.1 Population Projection

Population projection is counted by exponential methods. This methods is used because its advantages such as the data required easy to fulfill, easy to do, and a model used is close to dynamics that are not linear (Karpen & Fahmi, 2018). Projection result is shown by Table 1.

Table 1. Pangandaran Sub-District Population and Projection

Year	Population (People)	Population Growth Rate (%)
2015	61864	0,558
2016	62210	0,598
2017	62583	0,577
2018	62945	0,529
2019	63279	0,565
Prediction		
2020	63638	
2030	67339	
2040	71256	
2050	75401	

### 3.2 Land Use

Based on data obtained from government agencies such as the Regional Planning and Development Agency of Pangandaran Regency and the Public Works Office of Pangandaran Regency in the form of shapefiles, the authors carried out processing and analysis. The results of data processing can be seen that the land cover in Pangandaran District consists of pond water, canal water, mangrove forests, jungle forests, grasslands, sand or sand dunes, plantations, settlements, rice fields, rainfed rice fields, shrubs, rivers, tourist parks and moor. Furthermore, based on the author's analysis, it can be seen that the land cover in Pangandaran District is dominated by plantations by 88%. More details related to land cover in Pangandaran District will be visualized in the image below.

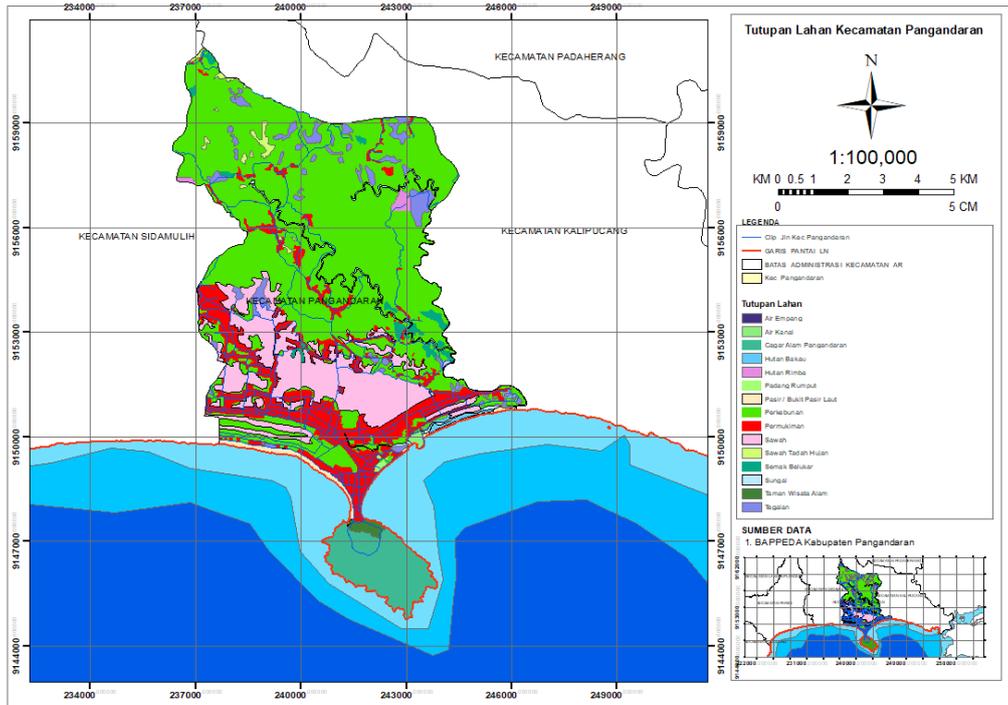


Figure 1. Pangandaran Regency Land Cover

### 3.3 Local Rice Productivity

Environmental productivity to calculate land needs and capacity in terms of rice or local rice productivity in an area. According to the Agriculture Ministerial Regulation No. 07/2012, the criteria for land that can be called productive is when the land can produce 30 quintals of rice per hectare each year. in which there are criteria for each commodity to be called productive. Data related to the results of the 3 commodities above were obtained from the Pangandaran Central Statistics Agency in 2019. More details regarding the data can be seen in the table below.

Table 2. Data produktivitas padi dari tahun 2013-2017 (kw)

Jenis Pertanian	2013 (Kw)	2014 (Kw)	2015 (Kw)	2016 (Kw)	2017 (Kw)	Rata-Rata Keseluruhan (Kw)
Padi	99.53	104.25	104.89	94.27	105.58	101.704

From these data, it can be concluded that according to the Agricultural Ministerial Regulation Number 07 of 2012, Pangandaran District is included in the criteria for productive land.

### 3.3.1 The Area of Land Required for proper living needs per resident

The area of land required for proper living needs per population is the need for decent living per population divided by local rice productivity. According to Pemen LH No. 17 of 2009, for the needs of a decent living per population is assumed to be 1 tonne equivalent to rice / capita / year. According to data from BPS Pangandaran Regency, rice productivity in Pangandaran District is 10170 kg / ha / year. The KHL<sub>L</sub> calculation is made to project land needs in Pangandaran District until 2050 with the population as calculated using the previous exponential method.

The value of the need for a decent life is a constant set by the Ministry of Environment in Permen LHK No. 17 of 2009 in the amount of 1 ton / capita / year. In this calculation, all weight is converted into kilograms for easier calculation. Data on local rice productivity is obtained from the BPS annual report entitled “Pangandaran in Numbers” 2020 edition.  $S_L$  is the value of land availability, and  $D_L$  is the value of land needs; both are expressed in hectares (ha).

Table 3. Land Carrying Capacity Analysis

Year	Population (people)	Decent life necessities (kg/capita/year)	Local rice productivity (kg/ha)	KHL <sub>L</sub>	$S_L$ (ha)	$D_L$ (ha)
2020	63638	1000	10170	0,098328	6.077	6257,402
2030	67339	1000	10170	0,098328	6.077	6621,373
2040	71256	1000	10170	0,098328	6.077	7006,516
2050	75401	1000	10170	0,098328	6.077	7414,061

It can be seen that  $S_L$  has a lower value than  $D_L$  ( $S_L < D_L$ ). This means that the carrying capacity of the land is declared a deficit or overshoot for the projection from 2020 to 2050.

### 3.3.2 Environmental Condition

After observing and data collecting, the environmental condition of Pangandaran Beach can be shown by Table 4. After that, the processed data is then entered into the Tourism Resource Suitability Index equation as stated in the previous section.

Table 4. Pangandaran Beach Environmental Condition

No.	Parameter	Bobot	Skor Eksisting
1	Beach Type	0,200	2
2	Beach Width (m)	0,200	3
3	Basic Water Material	0,170	3
4	Depth of Water (m)	0,125	3
5	Water Brightness (%)	0,125	1
6	Flow Velocity (cm / sec)	0,80	0
8	Coastal Land Closure	0,010	3
9	Dangerous Biota	0,005	3
10	Freshwater Availability / Distance to Fresh Water Source (km)	0,005	2

#### 4. RESULT AND DISCUSSION

Land carrying capacity status in Pangandaran Sub-districts is overshoot, inasmuch that the  $S_L$  value is below the  $D_L$  value by the year of 2020-2050 from its projection. The result shown by Table 5.

Table 5. Land Carrying Capacity Calculation Results

Year	SL	DL (ha)
2020	6077	6257
2030	6077	6621
2040	6077	7007
2050	6077	7414

The population in Pangandaran District is projected to be 75,401 people in 2050. This means that 7,414 ha of land is needed to accommodate these residents if it refers to the decent living standard set by the Ministry of Environment and Forestry. Because the land area cannot be increased, the variable that must be addressed is the population itself. If possible, the Pangandaran Government should immediately make a firm policy regarding pregnancy control (family planning) or direct the planning of vertical housing development in order to meet the needs of residential land for residents in the Pangandaran area. It should be noted that marine tourism activities should not interfere with the lives of local residents (Pham, 2020), in fact, they should provide better livelihoods for local residents themselves (2016). Even so, the environmental conditions of Pangandaran Beach are still included in the category according to

the index of 3,665 for marine tourism activities, even though there have been natural disturbances or anthropological interferences.

## 5. CONCLUSION

From the result of land carrying capacity and resource suitability analysis above, it can be concluded that the urgency of Pangandaran beach is not about its environmental condition and quality. The stakeholders should put some concerns to the local life quality, considering the disparition of its  $D_L$  and  $S_L$  value of land carrying capacity in Pangandaran Sub-districts.

## REFERENCES

## BIOGRAPHICAL NOTES

**Dr. Bambang Edhi LEKSONO**, born in 1957, Graduated in 1982 as Engineer in Surveying and Mapping from Institut Teknologi Bandung (Indonesia), obtaining Master degree in Urban Survey & Human Settlement Analysis (ITC-Holland) in 1990 and Doctorate degree in Geography in 1996 from Universite de Nice Sophia Antipolis (France). Now, Dr. Bambang Edhi Leksono is Lecturer and also member of Surveying and Cadastre Research Group in Institut Teknologi Bandung, Indonesia.

## CONTACTS

**Dr. Bambang Edhi LEKSONO**

**Institut Teknologi Bandung**

Surveying and Cadastre Research Group, ITB

Labtek IX-C Building ,3rd floor, Jl Ganesha 10, Bandung- 40132 ,INDONESIA

Tel. +62.22.2530701 ,Fax. +62.22.2530702

Email: [bleksono2013@gmail.com](mailto:bleksono2013@gmail.com) and [bleksono@gd.itb.ac.id](mailto:bleksono@gd.itb.ac.id)

Mobile : +62 811208137