



# A bio-ecoregion development potential based on *Chelonia mydas* conservation in Pangumbahan Sukabumi, Indonesia

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**Abstract.** Conservation areas were designated to protect the biodiversity of the natural ecosystems, in the effort to maintain a balance between exploitation and conservation of the biotic resources in Indonesia. One of the habitats that become a conservation area for *Chelonia mydas* is the Coastal Park of Pangumbahan, Sukabumi, Indonesia. This research aimed to analyze the potential for the development of a bio-ecoregion based on *C. mydas* conservation. The method used in this research was a case study, using primary and secondary data. Descriptive and quantitative analytical methods were used to determine the development level of *C. mydas* conservation areas. The development plan of a bio-ecoregion for *C. mydas* conservation in Pangumbahan can be based on: habitat parameters of a "very suitable" category, including beach slope, sand texture, vegetation, lighting, and "suitable" category, including building, beach width, distance between spawning beaches and feed areas; economic parameters including investment in supporting facilities and infrastructure; social parameters including community responses to sea turtle conservation by the involvement of all stakeholders. The development of *C. mydas* bio-ecoregion conservation based on social aspects, namely: coordination between community groups and conservation managers at the central and regional government level has a 67% importance role, local community knowledge about *C. mydas* conservation ecotourism is 83%.

**Key Words:** ecotourism, sea turtle, biodiversity, development plan.

**Introduction.** West Java is an area that has bio-ecoregion conditions for the southern coastal region. A bio-ecoregion is a landscape in an area that has specific characteristics, compared to other regions (Nurhayati & Purnomo 2018). Coastal areas generally have different bio-ecoregion habitat characteristics. Planning for management of turtle conservation areas for coastal ecotourism activities requires a variety of information. Some of them include the carrying capacity of the region through the socioeconomic and the ecological approach. The southern coastal region of West Java Province has the potential for the development of conservation areas, protected and managed with a zoning system, for fisheries resources preservation, among which the turtle, concerning a conservation area in Pangumbahan village, sub district Ciracap, district Sukabumi, West Java Province. Turtles are reptiles that live in the sea and are able to migrate long distances along the Indian Ocean, Pacific Ocean and Southeast Asia. Their existence has been long threatened, both from nature and human activities that endanger the turtle population directly or indirectly.

The types of turtles in Indonesia are: *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys olivacea*, *Dermochelys coriacea*, *Natator depressus* and *Caretta caretta* (Wicaksono et al 2013). *C. mydas* (the green turtle) populations have declined and are categorized as endangered and protected animals in the International Union for Conservation of Nature Red Data Book which is included in the Convention on International Trade in Endangered Species (Seminoff 2002). In Indonesia, *C. mydas* are protected under Government Regulation No. 7 of 1999 concerning Preservation of Plants and Animals as well as Government Regulation No. 8 of 1999 concerning utilization of

wild plants and animals, which means that all trade in a state of life or death is prohibited.

*C. mydas* conservation is a significant effort to ensure the sustainability of the turtle population. Scarcity that occurs continuously with the tendency of declining population will result in extinction, therefore conservation is required and it must provide benefits to the ecosystem and community environment. Conservation is carried out to maintain the presence of turtles when laying eggs, hatching, growing alive into hatchlings and releasing hatchlings into the waters.

*C. mydas* are subject to direct and indirect threats, which disrupt ecosystems and their life cycle. The main elements of turtle nesting areas consist of macro and micro habitats. Macro habitat depends on the composition of sand, soil and coastal forest formation, while the micro habitat relates to the nutrients (Nuitja 1992). *C. mydas* nesting habitat is also a habitat for other animals, including its predators. Predatory threats are factors that decrease the population of *C. mydas*. Predators that are often found in turtle nesting habitat areas are varanus (monitor lizards), crabs, ants and humans who hunt the eggs of *C. mydas* (Listiani et al 2015).

*C. mydas* conservation area in Pangumbahan Sukabumi has the opportunity to develop ecotourism for environmental education. The development of collaborative management concepts in the management of conservation areas through educational ecotourism is strongly dependent on the perception and participation of stakeholders, which can be improved if the government assumes its role in communities empowering. In the conservation areas management it is essential to identify stakeholder's perceptions of the natural resources that are the object of conservation. The modern conservation paradigm not only emphasizes the function of habitat protection, but must also have economic and social benefits for local people based on the bio-ecoregion conditions. For this reason, the purely ecological *C. mydas* conservation activities have to be followed by with the development of an educational ecotourism area aiming to increase the understanding of sea turtle conservation and to provide economic value opportunities for local communities. This research aims to analyze the potential for the development of a bio-ecoregion based on *C. mydas* conservation in Pangumbahan, Sukabumi West Java Indonesia.

## Material and Method

**Description of the study sites.** This research was conducted in Pangumbahan village, sub district Ciracap, District Sukabumi, West Java Province, Indonesia. The research method used is the case study, an approach which examines a real context intensively and in detail (Nazir 2014), in order to reveal explanatory characteristics related to the principles stated by the main research.

The data used in this research were primary data and secondary data. Primary data in this research consist of two parts: ecological data and socio-economic data. The primary data were obtained through observations and interviews with respondents. The selection of respondents was done by the method of purposive sampling, based on the characteristics of the population and the research objective. The minimum number of respondents was 30, as suggested by Cohen et al (2007). Observations were made deliberately and systematically on the activities of individuals or other objects under research.

Regarding the ecological data, the working procedure of the research was to obtain primary observational data including: beach width, beach slope, tidal type, nest width, nest depth, nest temperature, air temperature, nest acidity (pH), number of nests, egg incubation percentage, beach plant species and natural predators on the beach. The analysis tools for the bio-ecoregion centered on the *C. mydas* conservation in Pangumbahan are based on scaling the habitat parameters, as shown in Table 1.

Table 1

Scoring value for developing bio-ecoregion *Chelonia mydas* conservation in Pangumbahan based on habitat parameters

No	Category	Scoring
1	Very suitable	4
2	Suitable	3
3	Less suitable	2
4	Not suitable	1

Meanwhile, the economic and social parameter data were collected based on the respondents' perception. In this case, community surveys/focused group discussions were used to assess and describe people's perceptions about the development of the *C. mydas* conservation bio-ecoregion. More specifically, the technique for collecting economic and social conservation parameter used a semi-structured interview and was conducted to draw a basic outline of the following community characteristics: 1) existing tourism resources, 2) local infrastructure and natural resources, 3) institutional support, 4) local, regional and national government, and 5) capacity of fisheries. Survey techniques in this particular research activity were intended to illustrate and contextualize the perceptions and involvement of local communities, related to the *C. mydas* conservation bio-ecoregion development. The focus group discussions were also meant to help answering questionnaires given to respondents. The first group of questions was designed to gather the respondent's socio-economic demographics (age, education level, gender, location of residency).

Whenever necessary, secondary data, obtained from documented information, were used to explain all information of primary data. Both primary and secondary data obtained were analyzed descriptively, qualitative and quantitative methods were applied to the facts, properties and relationships between the phenomena under investigation (Fajar et al 2017).

## Results

**Research location.** This research was conducted in Pangumbahan Coast Sea Turtle Park Service Unit (SPTP4) West Java Province Marine and Fisheries Service Branch, geographically located at 7015'08"-7021'50" South latitude and 106023'40"- 106024'10" East longitude, with an area of 584,376 with 2,300 m of beach (Profile of Pangumbahan Beach Turtle Coastal Park 2018), as it can be seen in Figure 1.

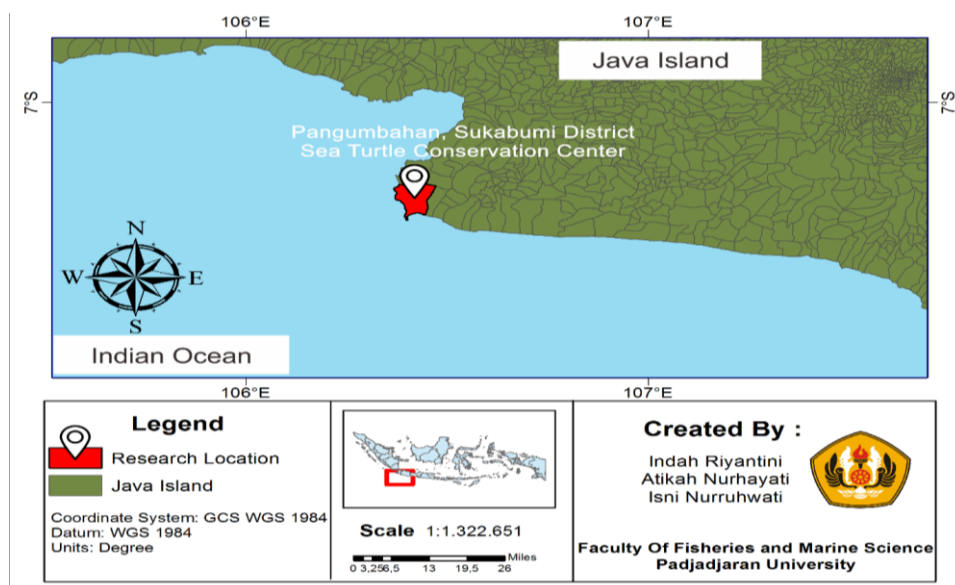


Figure 1. Research location.

Pangumbahan Village is a coastal village with an area of 1,916 hectares. The boundaries in the North are Gunung Batu Village, in the East is Ujung genteng Village, in the South is the Indonesian Ocean and in the West is Cikered Wildlife Reserve Forest. The topography of this region is lowland with an altitude of 0-28 m above sea level, the average daily temperature ranges between 26-32°C with an average rainfall frequency of 3,650 mm annually. The vision of Pangumbahan Beach Sea Turtle Park is the realization of sustainable turtle conservation that can improve the welfare of the community around the area through conservation-based ecotourism activities (sustainable turtles, prosperous communities) while its mission is to increase the turtle population to protect the marine ecosystem, to improve the human resources, including managers, belonging to the community, to raise awareness in the conservation area's surrounding communities and to empower local communities through ecotourism activities improving their well-being (Profile of Pangumbahan Beach Turtle Coastal Park 2018).

Pangumbahan sea turtle conservation is managed by the Pangumbahan Coastal Sea Service Unit of the Maritime Agency and the Fisheries Service, West Java Province. The turtle conservation center conducts beach patrol activities that begin by preparing simple supporting equipment such as headlamps, flashlight and buckets for the turtle eggs when turtle nests are discovered.

**Characteristics of respondents.** Based on interviews with the respondents the following information was obtained: (1) the age: respondents between 30 and 45 amounted 15 (50%); respondents between 46 and 56 amounted 10 (33%) and respondents above the age of 57 amounted 5 (17%). As much as 50% of the respondents are in the productive age, meaning that they have the opportunity to carry out the development of the turtle tourism. Respondents amounted to 30 people, consisting of 5 administrators of the conservation center and 25 community residents.

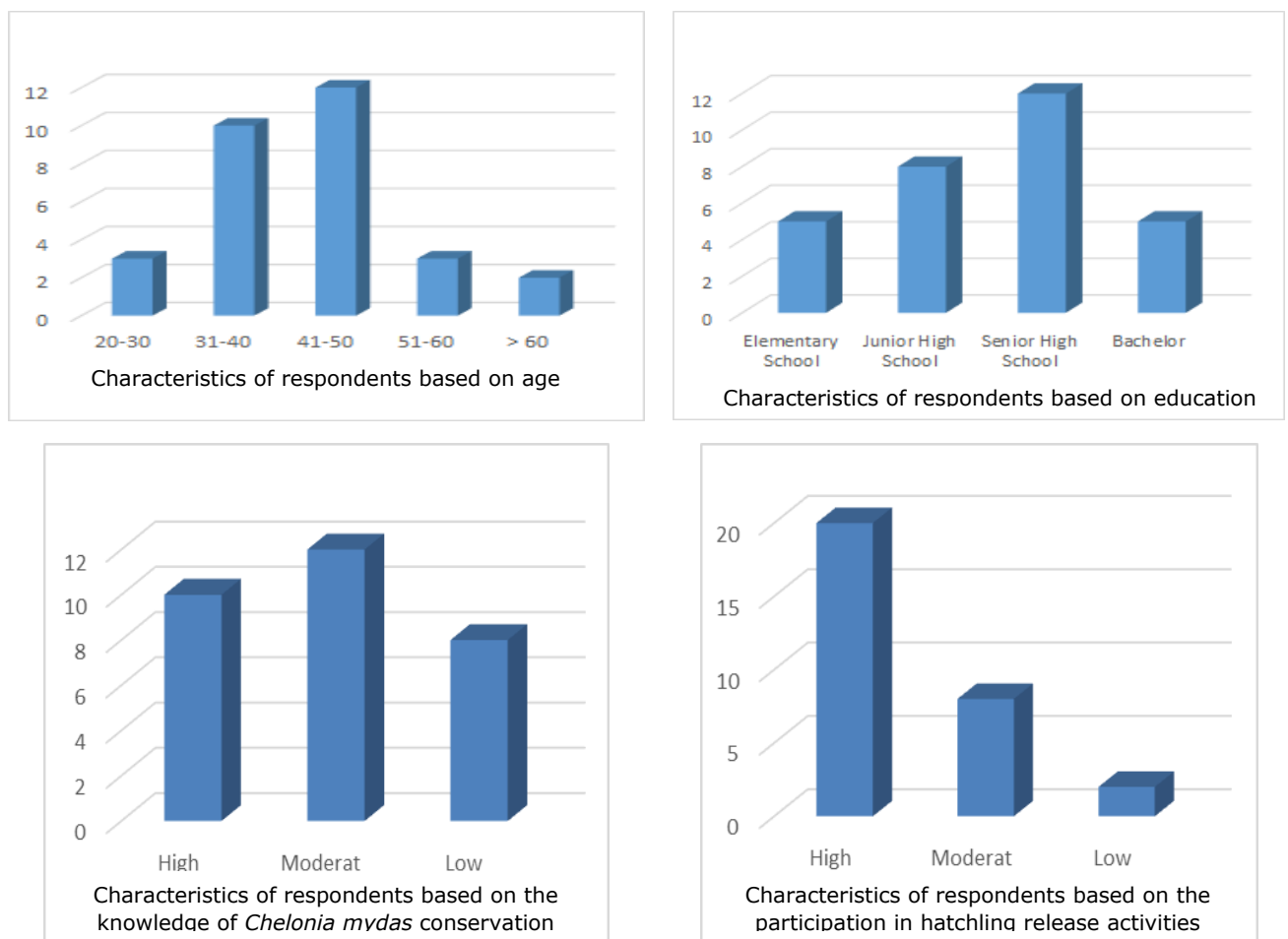


Figure 2. Characteristics of respondents.

In Figure 2 are presented the characteristics of respondents based on their education level: 3% elementary school, 27% junior high school, 53% senior high school and 17% bachelor. The level of education has an influence on the understanding of sea turtle conservation. Based on the results of the research in the field, 33% have a high understanding of the sea turtle conservation and 40% have a moderate understanding. Based on the results of the research in the field, 67% have a high level of participation in the process of releasing hatchlings, 27% moderate and 6% low.

**Taxonomy of green turtles.** The *C. mydas* is a species most commonly found in the tropical sea. Known as the green turtle, *C. mydas* is not colored scales green, but the color of the fat found under the scales is green. The morphology of the turtle, a hard shell on the carapace with rowers feet in front of him, facilitates its swimming agility, but makes its moving on land difficult. Turtles are vertebrates, have scaly skin, breathe through lungs and their body temperature adjusts to the ambient temperature.

Kingdom : Animalia  
 Phylum : Chordata  
 Class : Reptilia  
 Order : Testudines  
 Family : Cheloniidae  
 Genus : Chelonia  
 Species : *Chelonia mydas*



Figure 3. *Chelonia mydas*.

(<https://www.merdeka.com/teknologi/penyu-hijau-kini-memiliki-kesempatan-hidup-yang-lebih-pendek.html>)

The turtle's body is wrapped in a shell or hard carapace that is flat and coated with horn, being a natural protector against predators. Turtles have a hard external digestion tool, to facilitate the destruction, cutting and chewing of food (Lutz et al 2003), and a pair of front legs in the form of rowers, for an increased swimming dexterity. Turtles spend more time in the water than on land, but still must rise to the surface to breathe. Young *C. mydas* eat various types of marine life sea worms, shrimp mussels, seaweed and algae. When the body reaches a size of about 20-30 cm, they turn into herbivores and the main food becomes seaweed.

*C. mydas* live in two different habitats, namely the sea as a major habitat for the whole of his life and terrestrial habitats used during the nesting and eggs hatching. Generally, the place to lay eggs is broad land and ramps located in the upper part of the beach, on slopes averaging 30 degrees and 30-80 meters above the tidal zone, with a type of smooth rocky sand and few iron-fraction concretions that are easily extracted by turtles. Turtles instinctively consider these locations safe to nest eggs at (Noitji 2005).

**Development bio-ecoregion *Chelonia mydas* conservation in Pangumbahan based on habitat parameters.** The development of a bio-ecoregion *C. mydas* conservation in Pangumbahan based on habitat parameters including beach slope, beach width, sand texture, vegetation, lighting, building. Distance between spawning beaches and feed areas can be seen in Table 2.

Table 2

Development bio-ecoregion *Chelonia mydas* conservation in Pangumbahan based on habitat parameters

No	Parameters	Scoring	Category
1	Beach slope	4	Very suitable
2	Beach width	3	Suitable
3	Sand texture	4	Very suitable
4	Vegetation cover	4	Very suitable
5	Lighting	4	Very suitable
6	Building	3	Suitable
7	Distance between spawning beaches and feed areas	3	Suitable

The turtle conservation center in Pangumbahan has 6 observation stations, as described in Table 3, with an average beach width per station of 46.79 meters. Based on secondary data, beach width for *C. mydas* egg nesting is a very suitable category, when its values are still in the range that makes it easy for turtles to reach the nesting area. Farther from the nesting site, the accessibility decreases with the amount of energy spent by the turtle.

Table 3

Habitability index of *Chelonia mydas* turtle spawning in Pangumbahan beach (Ismanea et al 2018; Profile of Pangumbahan Beach Turtle Coastal Park 2018)

Station	Position	Category	Habitability index (%)
1	S 7 <sup>0</sup> 20'5.5"E 106 <sup>0</sup> 23'54.5"	Very suitable	88.41
2	S 7 <sup>0</sup> 19'50.1"E 106 <sup>0</sup> 23'50.0"	Very suitable	92.75
3	S 7 <sup>0</sup> 19'41.89"E 106 <sup>0</sup> 23'43.24"	Very suitable	92.75
4	S 7 <sup>0</sup> 19'32.3"E 106 <sup>0</sup> 23'33.3"	Very suitable	88.41
5	S 7 <sup>0</sup> 19'25.8"E 106 <sup>0</sup> 23'26.7"	Suitable	84.06
6	S 7 <sup>0</sup> 19'11.8"E 106 <sup>0</sup> 23'12.4'	Suitable	84.06

Based on the results of research and secondary data, texture and percentage of sand are very influential on turtle nesting preferences. The percentage of sand from Station 1 to Station 6 has an average value of 97.32%, with a range of 96.90-98.31%, which is very suitable. From the environmental conservation perspective, based on the observations from stations 1 to 6, Pangumbahan Beach falls in the very suitable category.

Depths of 1 to 1.5 m at high tide can make it easy for turtles to feed. The feeding ground location generally starts from the subtidal to the inshore zones, reaching a depth of around 8 meters. Vegetation is neither too open nor too lush. The presence of vegetation is an indicator of protection for sea turtle eggs from runoff and predators, and slows the process of transmitting sunlight to the surface of the sand.

Types of vegetation found on the Pangumbahan beach include *Calophyllum inophyllum*, *Scaevola taccada*, *Hibiscus tiliaceus*, *Crinum asiaticum*, *Ipomea pes-caprae* and *Spinifex littoreus*. Sea turtles have different interests in vegetation. *C. mydas* nesting beaches are generally dominated by pandanus type of vegetation. Vegetation provides protection of turtle nests from predators, being an important variable for the hatchlings survival (Turkozan et al 2011).

The lighting around the spawning habitat influences the instinct of the *C. mydas* in landing and nesting eggs. Based on the results of research and secondary data from stations 1 to 6, the average value of the lighting level is 0.41 lux, with an average range of 0.14-0.81 lux with a very suitable category. Based on the results of the current research observations and on the secondary data based on the distance of spawning beaches and of the feed zone, the category is very suitable. The feeding ground area is indicated by seagrass beds outside the core zone. Figure 4 shows annual fluctuations in *C. mydas* population nesting in Pangumbahan, Sukabumi West Java Province.

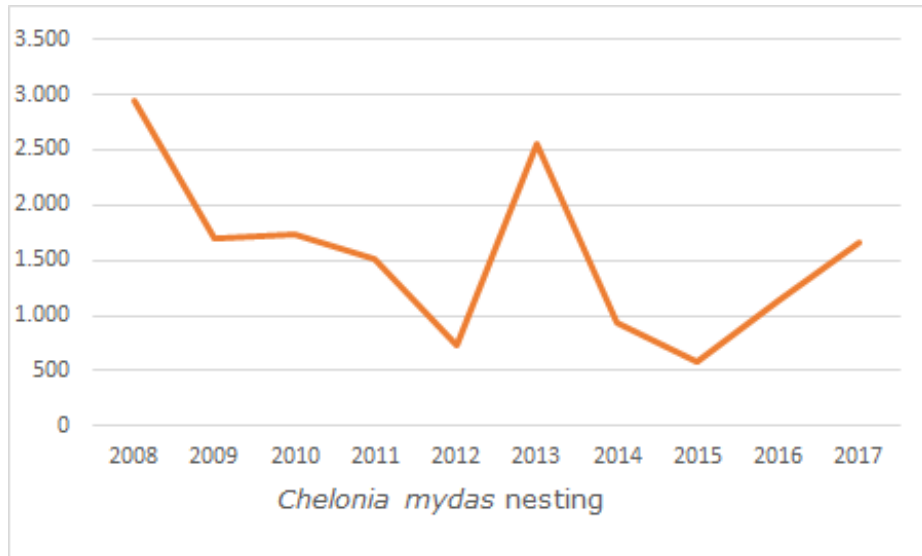


Figure 4. *Chelonia mydas* turtle nesting in Pangumbangan, Sukabumi West Java province.

*C. mydas* nesting season occurs throughout the year with the season peak around May-October. The incubation of *C. mydas* eggs is carried out in sand with a depth of 60 cm or more depending on the number of eggs, maintaining the temperature and increasing the percentage of hatching eggs. The hatching of *C. mydas* eggs can occur after 45-60 even 65 days incubation, depending on the weather. Not all turtle eggs can hatch. This is caused by several factors, including the unfavorable treatment when relocating eggs from natural habitat to semi-natural habitat, where the temperature and humidity of the sand might not be optimal for the turtle eggs, which usually hatch at night. When the turtle's eggs hatch into hatchlings, these will walk to the corners of the hatching room which has been previously lighted.

In Figure 5 can be seen the existing conditions for handling *C. mydas* at Pangumbahan Conservation Center including release of hatchlings, quarantine, egg incubations, relocations of eggs to the hatchery rooms and safeguarding *C. mydas* landing.

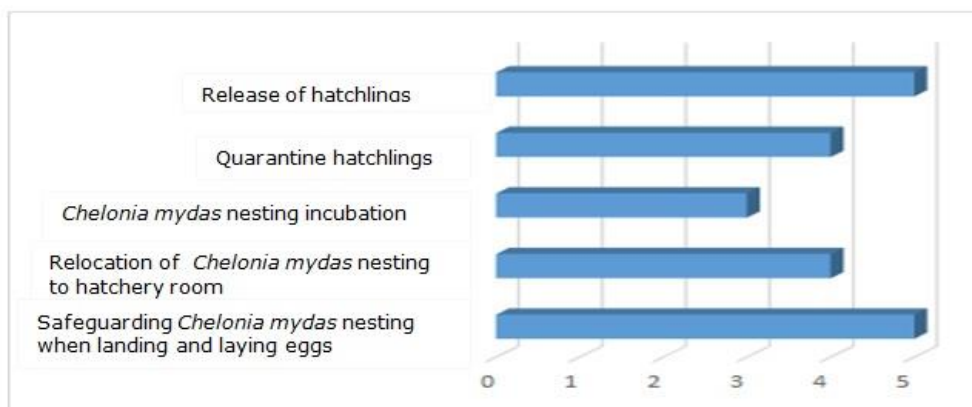


Figure 5. Existing conditions for handling *Chelonia mydas* at Pangumbahan Conservation Center.

***C. mydas* life experiences under natural and artificial threats of extinction.** Disturbances or natural threats that can disrupt at any time the lives of *C. mydas* include: predation of hatchlings by animals, diseases, caused by bacteria, viruses, or due to pollution of the aquatic environment, climate change that causes sea level to rise and

erosion of many spawning beaches, which affects the change in hatchability and balance of the sex ratio of hatchlings.

Disturbances or threats due to human actions which can disrupt the lives of *C. mydas*, include: (1) the capture of sea turtles due to fishery activities, both intentional and unintentional with various fishing gear, such as gill net, longline and trawl, (2) catching adult sea turtles for use of meat, shells and bones, (3) retrieval of turtle eggs which are used as a source of protein, (4) development activities in coastal areas which can damage *C. mydas* habitat for laying eggs such as sand mining, port construction, coastal tourism facilities building.

**Developing a *C. mydas* conservation bio-ecoregion in Pangumbahan based on economic parameters.** The existence of a turtle conservation center in Pangumbahan that is integrated with tourism education has triggered investors to build resorts around the coast in order to support the related activities. In many points of Pangumbahan Village there are villa buildings, inns, restaurants and several entertainment venues built to support the educational activities.

Figure 6 displays the *C. mydas* conservation bio-ecoregion development in Pangumbahan based on economic parameters including (1) investment as hotel and manager are sourced from non-local communities is 83%, (2) investment as a hotel owner and manager sourced from the local community is 17%, (3) increasing the number of hotels for tourism is 83% and (4) retribution for visitor ecotourism turtle conservation for manager is 93%.

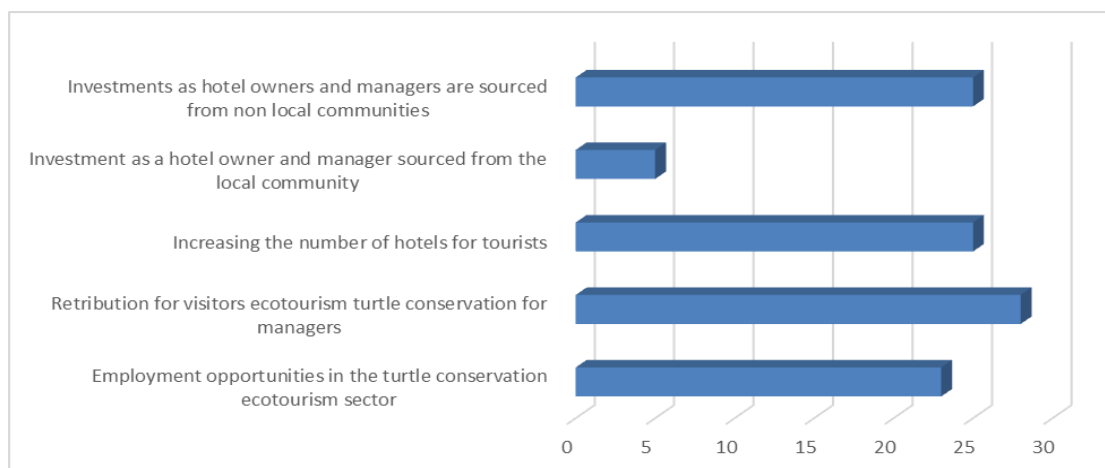


Figure 6. Development bio-ecoregion *Chelonia mydas* conservation in Pangumbahan based on economic parameters.

Based on the results of the field research, the owners of the capital used to build the infrastructures are mostly non-native Pangumbahan villagers, but rather from Jakarta, Bogor and Bandung, some of them being even foreigners. In the tourist education area, visitors can gather an impressive amount of information about sea turtles. This area can also be used for research, education, marine tourism and even for the community's productive and economic development, while still taking into account the environmentally friendly and sustainability principles.

**Development of the *Chelonia mydas* conservation bio-ecoregion in Pangumbahan based on social parameters.** In Figure 7 can be seen the development of a *C. mydas* bio-ecoregion conservation in Pangumbahan based on social parameters including (1) local community in managing *C. mydas* ecotourism is 50%, (2) coordinations between community watch group and turtle conservation center is 67%, (3) knowledge of the local community towards ecotourism *C. mydas* is 83%, social awareness among local communities turtle conservation is 83% and (4) knowledge of local people towards turtle conservation is 67%.



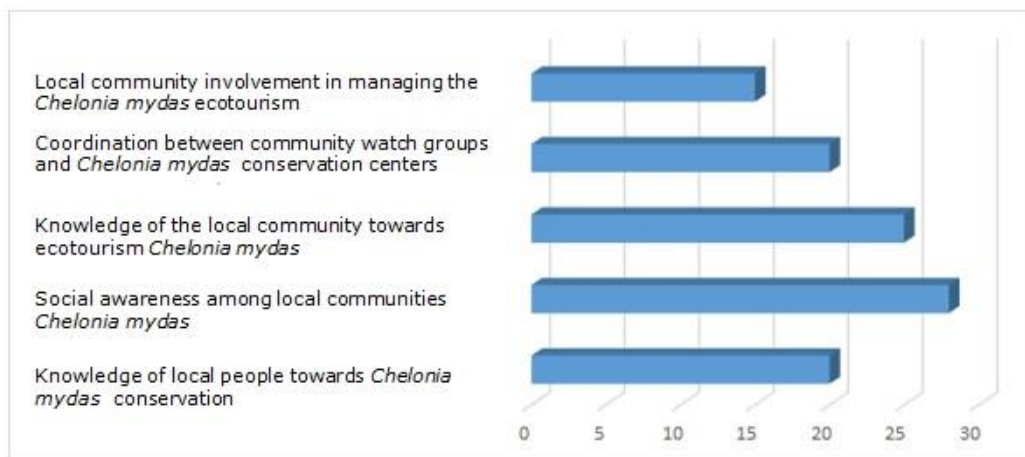


Figure 7. Development bio-ecoregion *Chelonia mydas* conservation in Pangumbahan based on social parameters.

Stakeholders involvement has been used as a method to improve the management of the Pangumbahan Beach Turtle Coastal Park, more specifically the decisions making related to the conservation activities. This has been proven by the establishment of a community watchdog group in collaboration with the government. Government stakeholders who play a role in sea turtle conservation include the central government, regional governments and village governance. The central government institutions that influence the policy on turtle conservation are the Ministry of Forestry and the Ministry of Maritime Affairs and Fisheries. Both ministries have the same basic duties and functions in managing the protected biota through both habitat and biodiversity conservation.

The management objectives of the Pangumbahan Beach Sea Turtle Park are: 1) the conservation of the turtle and of its habitat in Pangumbahan Beach and surrounding waters; 2) the development of the educational tourism based on turtle conservation; 3) the creation of socio-economic and cultural opportunities for the communities around the conservation area. Community involvement in the management of the Pangumbahan Beach Sea Turtle Park has been successful. Recruitment of casual daily laborers, coming from the local community, to deploy the activities in the conservation area is only one of the social benefits of the project.

**Discussion.** The *C. mydas* conservation bio-ecoregion in Pangumbahan, should be based on optimal habitat conditions, as suggested by the current study, with the support of facilities and infrastructure such as core zones, research and education zones, tourism utilization zones, traditional residential zones, traditional land use zones, and traditional water use zones. Bio-ecoregions in the core zone are areas without harvesting, closed to visitors except with permission for research and conservation education. Activities permitted within the core zone are monitoring by regional officers; protection of turtle populations by regional officials in the form of moving turtle eggs from natural nests to artificial nests in the hatchery, research (with special permission). Prohibited activities are taking, digging, disturbing or moving *C. mydas*. The high percentage of sand facilitates the nesting, compared to clay or dirt, and helps stabilizing and reaching more homogenous temperatures. The size of the grains of sand affects important factors determining the incubation success, such as: porosity, moisture and density of the sand (Chen et al 2010).

The depth at Pangumbahan beach is considerably influenced by tidal activity and topographic conditions. Pangumbahan's tides have a semi-diurnal dominant mixed type, with two tides and two receding phases every 24 hours (Hazeri 2016). Topography varies and is steeper to the south side of the beach, which is directly facing the Indian Ocean. This condition provides easy accessibility for the turtle landing in Pangumbahan. Depths of 1 to 1.5 m at high tide facilitate turtles' foraging. The feeding ground location generally starts from the subtidal to the inshore areas, with a depth of around 8 meters (Bennett & Bennett 1999).

The greatest lighting value is on the coastline: the intensity of the light reaches 0.11 lux, due to the high power light sources from villa and residential buildings, fishing and tourist activities (Haryanti 2014). Coasted sea turtles usually secure their surroundings before rising. According to Zarate et al (2013) sea turtles prefer quiet, dark beaches. Changes in The food availability around the habitat will affect the condition of the parent during the egg-laying period, the rate of fertilization, the percentage of hatching eggs and the survival of the embryo, which is also largely determined by the food it consumes (Marquez 1990).

The integration of the conservation activities with the socioeconomic benefits is expected to increase the local communities awareness and understanding of conservation. The development of the *C. mydas* conservation bio-ecoregion in Pangumbahan based on economic parameters including investment as hotel and manager are sourced from non-local communities, investment as s hotel owner and manager sourced from the local community is, increasing the number of hotels for tourism, retribution for visitor ecotourism turtle conservation for manager.

Pangumbahan beach conditions make this area one of the favorite tourist attractions, particularly crowded during holidays. Information about Pangumbahan Beach Sea Turtle Park is often obtained from travel trips. Costs to be incurred in entering the Pangumbahan Coastal Sea Turtle Park have been regulated based on the Regional Regulation No. 6 of 2018 concerning Second Amendment to Regional Regulation of West Java Province Number 14 of 2011 concerning Regional Retribution. The entrance fee for the conservation area for adults is 2 USD/person/day, children 1 USD/person/day, for student groups 2 USD/person/day and for groups of children 1 USD/person/day. Tariff levies see nesting eggs at night for adults 10 USD/person/day, children 5 USD/person/day while for student groups 8 USD/person/day and groups of children 3 USD/person/day. Nightly charges will be imposed at the end of 2018. The aim is to limit the number of visitors at night so that sea turtles can go up to the beach and lay eggs without getting too much interference from tourists.

Community groups have a very important role. Efforts to provide guidance to the community are carried out through relational management and law enforcement. Collaboration between volunteers and law enforcement in the field of fisheries is important in providing effective surveillance capabilities against the theft and smuggling of the turtle eggs and the coastal forests destruction in the park area (Nasuchon & Charles 2010).

Some communities are already aware of the importance of sea turtles conservation efforts, but a lack of coordination appeared, due to the miscommunication of the management with the local community.

The indifferent attitude of the community is influenced by its lack of knowledge on conservation and its basic concepts of protection, preservation and utilization. The community thinks that conservation is only a protective activity. Limited public knowledge shows that the community counseling on the sea turtles conservation is not optimal. Only to the community leaders are in the communication loop and the wider community has not been reached. Development of turtle conservation can be done through several stages, namely:

1. Institutional coordination between stakeholders

The management of *C. mydas* involves various stakeholders, including government, private investors and community and it must be well balanced among the stakeholders, based on sustainability principles.

2. Supervision and control of *C. mydas* resources

Supervision and control of *C. mydas* resources management, such as the eggs adequate capturing and extracting, during the implementation of the provisions of the conservation area project, located in the village of Pangumbahan, Sukabumi Regency, an isolated region lacking of governance and monitoring infrastructure.

3. *C. mydas* conservation area requires funding aspects in its implementation

Limited funding of turtle conservation areas is certainly an obstacle in *C. mydas* conservation activities. At present, there are insufficient or limited funds to support

activities to finance *C. mydas* breeding, such as for conservation staff costs, cleaning costs, food costs for hatchling, and maintenance costs for captive breeding facilities.

#### 4. Condition of *C. mydas* habitat

The habitat conditions have an influence on the growth and decline of the *C. mydas* population, which certainly can hamper the implementation of the turtle conservation policy, via inhibiting factors such as coastal abrasion, climate change, poaching and sale of sea turtle eggs around the conservation area.

Turtle habitat is a natural place to live where food and breeding grounds are available. Sea turtle feed habitat is an environment where turtles can be found in various age groups and species. The nutritional niche is unique for each species determining their habitat; herbivorous *C. mydas* live in shallow waters that are rich in seagrasses and algae.

**Conclusions.** Based on the results of our research, the bio-ecoregion conditions determine the *C. mydas* conservation areas as core zones representing an optimal habitat, considering biological and ecological processes like foraging, breeding, predation, inter-species competition and, in particular, the process of landing and hatching, which is sensitive to both biological factors and spatial characteristics. The suitability of Pangumbahan, Sukabumi, Indonesia as conservation area depends on the beach physical parameters like: slope, width, sand texture, vegetation cover, lighting, buildings and spawning spacing with the feed area. The development of a bio-eco-region based on the conservation of *C. mydas* must be managed through collaborative strategies involving all the stakeholders, for a better integration of the biological and ecological factors with the social-economic functions of the conservation area, for a successful *C. mydas* preservation.

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#### References

- Ismanea M. A., Kusmana C., Gunawan A., Affandi R., 2018 Sustainability management of turtle conservation area in Pangumbahan Beach, Sukabumi, West Java. *Journal of Natural Resources and Environmental Management* 8(1):36-43.
- Bennett P., Bennett U. K., Balazs G., 1999 Photographic evidence for the regression of fibropapillomas afflicting green turtles at Honokowai, Maui, in the Hawaiian Islands. *Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology* 36-38.
- Chen C. L., Wang C. C., Cheng I. J., 2010 Effects of biotic and abiotic factors on the oxygen content of green sea turtle nests during embryogenesis. *Journal of Comparative Physiology* 180:1045-1055.
- Cohen L., Manion L., Morrision K., 2007 *Research methods in education*. Routledge, New York, 657 p.
- Fajar M., Marjan B., Nurhani W., 2017 The economic benefits of the ecotourism of the whale shark (*Rhincodon typus*) in Akudiomi village Yaur district Nabire district. *Journal of IndoPacific Aquatic Resources* 1:105-117.
- Hazeri G., Hartono D., Cahyadinata I., 2016 Feasibility study Laguna Beach, Merpas Village Sub District Nasal District Kaur, as region tourism development and conservation. *Journal Enggano* 1(1):33-41.
- Haryanti R., 2014 Green turtle population status (*Chelonia mydas*, Linnaeus 1758) in a turtle coastal park Pangumbahan, Sukabumi Regency, West Java. *Essay*. Bogor Agricultural University, Indonesia, 21 p.
- Listiani F., Mahardhika H. R., Prayoga N. A., 2015 Effect of sand characteristics and nest location on the hatching of *C. mydas* turtle eggs (*Chelonia mydas*) on Goa Cemara Bantul Beach. *Journal Omni Akuatika* 14:63-68.

- Lutz P. L., Musick J. A., Wyneken J., 2003 The biology of sea turtles Volume II. CRC Press LLC, 472 p.
- Nazir, 2014 Research methods. Ghalia Press, Bogor, Indonesia, 145 p.
- Nasuchon N., Charles A., 2010 Community involvement in fisheries management: experiences in the Gulf of Thailand countries. *Marine Policy* 34(1):163-169.
- Noitji A., 2005 Nusantara Sea. Djambatan Press, Jakarta, 368 p.
- Nuitja I. N. S., 1992 Biology and ecology of sea turtle conservation. IPB Press, Bogor, 160 p.
- Nurhayati A., Purnomo A. H., 2018 Bioecoregion and socio-economic connectivity oriented coastal zone management. *Applied Ecology and Environmental Sciences* 6 (1):31-34.
- Marquez R. M., 1990 Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis, 81 p.
- Seminoff J. A., 2002 Marine turtle specialist global *Chelonia mydas* assessment for the IUCN Red List Program. Report for the Species Survival Commission, Gland, Switzerland, 93 p.
- Turkozan O., Yamamoto K., Yilmaz C., 2011 Nest site preference and hatching success of green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles at Akyatan beach, Turkey. *Chelonian Conservation and Biology* 10:270-275.
- Wicaksono A. M., Elfidasari D., Kurniawan A., 2013 Green turtle conservation activities (*Chelonia mydas*) Marine Turtle Coastal Park, Pangumbahan, Sukabumi District, West Java Province. *Proceedings of the National Seminar on Mathematics, Science and Technology* 4:116-123.
- Zarate P., Bjorndal K. A., Parra M., Dutton P. H., Seminoff J. A., Bolten A. B., 2013 Hatching and emergence success in green turtle *Chelonia mydas* nests in the Galápagos Islands. *Aquatic Biology* 19:217-229.
- \*\*\* Regional Regulation No. 6 of 2018 concerning Second Amendment to Regional Regulation of West Java Province Number 14 of 2011 concerning Regional Retribution.
- \*\*\* Government Regulation No. 7 of 1999 concerning Preservation of plants and animals.
- \*\*\* Government Regulation No. 8 of 1999 concerning Utilization of wild plants and animals.
- \*\*\* Profile of Pangumbahan Beach Turtle Coastal Park, 2018 Directorate of Marine Conservation and Biodiversity Directorate General of Marine Space Management Ministry of Maritime Affairs and Fisheries, Republic of Indonesia. <http://kkji.kp3k.kkp.go.id/index.php/basisdata-kawasan-konservasi/details/1/78>. Accessed on 21 January 2020.

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