Lovina Beach landscape design in Buleleng Regency Bali based on landscape engineering

M F Ramadhan¹, P Nuryanti²
¹ Department of Landscape Architecture, Faculty of Agriculture, IPB University, Indonesia
² Department of Landscape Architecture, Faculty of Agriculture, IPB University, Indonesia
E-mail: faisal_rmdhn32@apps.ipb.ac.id

Abstract. Lovina Beach is a famous tourist attraction on the northern island of Bali. This beach is somewhat unique because it has an exciting dolphin viewing attraction. However, some lack elements on-site reduce the value of beach tourism, such as an unattractive design, many idle facilities, empty spaces, and puddle. This study aims to analyze and redesign the beach based on landscape engineering to overcome sustainability. The design stage consists of project acceptance, research and analysis, design, and construction drawings combined with the scoring system of the hydro-oceanographic analysis. The analysis aimed to identify the value of coastal vulnerability indexes. The results of this study are site plan concepts, perspective drawings, cut images, planting plans, and detailed engineering designs, which is formed on the results of analysis and synthesis, and preferences score. The design of this coastal waterscape will be used as a recommendation to the beach management.

Keywords: Coastal vulnerability indexes, Dolphin, Scoring, Sustainable, Tourist attraction

1. Introduction
Bali, which is rich in biodiversity, natural ecosystems, and cultural values, provides a potential for developing the world of natural tourism. The character of the economic value of nature tourism objects in one place can be different from natural tourism objects in other places, which is due to differences in the landscape. This tourism is classified into North Bali and South Bali (Sulaiman 2010).

One of the choices that become a destination for local and international tourists for traveling is North Bali. Although its prestige is still inferior to South Bali, North Bali has many attractive tourist destinations. In carrying out the development of a good tourist area, there will be a demand for accommodation for visitors, the provision of equipment for visitor convenience, and the availability of adequate facilities. One of the tourist destinations that provide attractive attractions for visitors is Lovina Beach, Kalibukbuk Village, Singaraja District.

Lovina Beach is located about 10 km west of Singaraja city. Many foreign and local tourists visit to see unspoiled beaches and see dolphins abundant on this beach. One way to optimize the existing potential is by designing a coastal landscape based on engineering and scoring the coastal vulnerability index referring to Ozy et al. (2008) as a reference.

This design focus examines the needs of the coast more deeply based on the questionnaire and the consideration of supporting factors for the coastal density index. Developing and improving this landscape design based on landscape engineering reduces road-noise, protects soil, and creates runoff from structures. This research activity is expected to provide benefits as the right solution for the site, input to parties related to the Lovina Beach area and assist in determining the best use of the site, and become the basis for answers to problems on the site.
2. Method
The method used in this research is the descriptive method with the stages of field surveys and literature study by direct observation, interviews, and questionnaires. There are four stages in data collection: the preparation stage, data collection, data analysis, and design.

3. Preparation Phase
This stage includes coordination and collaboration with the PUPR Office of Buleleng Regency, Bali, the spatial and territorial division for determining research locations, setting objectives, making research proposals, requesting permits to conduct research, and tools and materials for field surveys as references and literature studies.

4. Data Collection Stage
This stage uses data obtained from survey results in the field, interviews with related institutions, traditional leaders and local culture, and literature related to the research topic. The data used in this study were obtained from measurements and direct observations in the field.

5. Data Analysis Stages
The analysis stage is data processing analysis of physical and biophysical aspects and social and cultural factors. The research was carried out by identifying potentials and obstacles, and continue with a solution to the potentials and constraints, and formulating synthesis. Synthesis is developed into coastal concepts and designs.

6. Physical and biophysical aspects
The landscape analysis was implemented to identify potential and constraints related to topography, climate, vegetation, animals, facilities, and utilities. The research results are needed as a landscape design proposal for Lovina coastal waters based on landscape engineering.

7. Cultural and Social Aspect
This aspect analysis is needed to determine the elements that are expected to be on the site, referring to the wants and needs of the site users and the activities therein. The approach to this aspect is in the form of interviews and questionnaires.

The snowball sampling interview method and in-depth interviews, namely the sampling technique with the help of key informants, and from the key informants, the results are explored more deeply. Researchers define criteria as requirements to be sampled (Subagyo 2006). This technique selects traditional leaders or historians who will be critical informants and other informants competent to provide additional data. The in-depth interviews were conducted to prepare a list of questions that had been prepared (Moleong...
2005). This stage will be a reference in the proposed Lovina coastal landscape design based on landscape engineering.

The questionnaire method used is non-probability quota sampling. A total of 30 respondents were randomly selected, including visitors and the surrounding community. The output of this questionnaire will be considered in the final design that is proposed. The form can be seen in the attachment.

8. Hydro-Oceanography Aspects
The vulnerability model that includes all the factors that influence coastal vulnerability consisting of physical, socio-economic, and environmental variables is seen as a complete vulnerability model at this time. The cultural parameters of this assessment model are referred to as integrated vulnerability and become the coastal vulnerability assessment concept that will be applied in this study. There are several references for assessing the vulnerability index used, namely countries that use the Coastal Vulnerability Index (CVI).

9. Design Stage
The design stage is the final stage and produces output in the form of a proposed design. The design process refers to Booth (1983), in which the design process stages consist of; 1. Project acceptance. 2. Research and analysis and engineering aspects with coastal vulnerability index scoring. 3. Design (Design). 4. Construction drawings. 5. Implementation (Implementation). 6. Post-construction evaluation. 7. Maintenance (Maintenance). However, the limitation of this research lasts until stage 4, while stages 5 to 7 will be submitted to Lovina Beach. Then the basic concept and planned design will continue to address the on-site problems until they are identified and produce a block plan. The illustration image is provided in a 3D model of CAD, SketchUp, and Lumion.

10. Results and Discussion

Location and Site Boundary
Lovina Beach is located in Kalibukbuk Village, Buleleng Regency, North Bali, Bali. Geographically it is located at the position 8°03'40" - 8°23'00" LS and 114°25'55" - 115°27'28" East Longitude. This research site has the following site boundaries (Figure 2).
- North boundary: Bali Sea
- Southern boundary: Kayuputih Village
- Eastern boundary: Anturan Village
- West boundary: Kaliasem Village

![Figure 2 Orientation and site boundaries](Source: maps.google.com 2019)

Analysis
Climate
Lovina Beach has an average temperature of 28°C, and average relative humidity of 82%.
The determination of the comfort index based on the THI method connects the weather and comparable humidity conditions in the developed study area (Nieuwolt 1977) in the form of the following equation:

\[ THI = (0.8 \times T) + \{RH \times T / 500\} \]

\( T \) = Average THI temperature = 21-27 (Comfortable) \( RH \) = Humidity \( THI > 27 \) (Uncomfortable)

The result of the THI calculation on Lovina Beach is 26.99. It shows that the THI of the site is in the comfort range. Hence efforts are needed to increase the associated comfort, stabilize the temperature and microclimate in the Lovina Beach area.

Topography and Slope
The district has recorded that it only has a slope of 0-25\% (Table 2).

| District | Slope (0-25\%) | Aslant (25-40\%) | Total |
|----------|----------------|------------------|-------|
| Buleleng | 4.694,00       |                  | 4.694,00 |

(Source: Center for Meteorology, Climatology and Geophysics Region III Denpasar)

Hydrology and Soil
Puddles were found in the parking lot near the entrance. It shows that there are deficiencies in the site design so that the runoff problem still occurs. Then one of the related problems is the absence of adequate parking space. Vehicles that come are irregular, making the placement of drainage channels less possible.

Making drainage channels can be the answer to this problem if it is harmonized with parking arrangements. Additional drainage channels can be made and placed on the sides near the parking line or sidewalk if a parking area is completed.

The sand on Lovina Beach is blackish gray. It makes the beach tends to be hotter than other beaches in Bali. The addition of vegetation shelter for widening the garden is needed to reduce the heat on the beach.

Accessibility and Circulation
Lovina Beach is a pretty strategic tourist destination with its facilities that can be reached with various accesses. Visitors who use the following alternatives:

Accessibility
Access can be reached in two ways, namely air and land routes.
1. Air Line
   The plane to Denpasar and then travel about ±120 Km to the North.

Three alternative path choices, namely through;
a. Gilimanuk or the West line,
b. Bedugul through hills or access perpendicular to the North, and
c. East of the island of Bali via the city of Singaraja.

The time taken is approximately 3-4 hours from I Gusti Ngurah Rai Airport.

2. Land route
   Bus to West Bali Island, Gilimanuk, access from Java Island via the Bali Strait.

Circulation
There were three types of existing circulation include:
a. The Primary circulation for all motorized vehicles and pedestrians along every part of the coast.
b. The secondary circulation. It is inner-shore circulations, which are accessible to pedestrians.
c. The Tertiary circulation. It is the circulation that connects the primary circulation and the secondary circulation.

Facilities and Utilities
Activities on the beach can indeed vary. This is evidenced by the use of the beach, which can be used according to visitors. There is one activity of beach users, namely making the area on the beach’s sand a multi-functional place, as shown in Figure 3.

Figure 3 Sketch of Expression Space Usage Plan

Vegetation and Animals
The vegetation that already exists on the coast is quite diverse from the shade vegetation, directors, to displays that function for aesthetics. Besides the diversity of vegetation that is already on the coast, another aspect that is no less important is the optimization of the functions of the plant’s existence. It takes some vegetation with various strata, for example, the function of shadow cover as a shade as shown below (Figure 4). Then in other aspects, the role of plants or vegetation can be a filter for vehicle noise

Figure 4 Analysis of high, medium, and low vegetation shade cover

Visual
The visual role is quite important for user comfort in order to see the site optimally (Figure 5).

Figure 5 Analysis of noise-breaking vegetation cover and wind barriers
Lovina Beach has pretty good visuals. It was evidenced by the beach, which is in a calm choppy sea. Then the view is centered on the Lovina Beach entrance area, which has signage and a dolphin statue tower. Harris (1998), in the book Standard Time-saver for Landscape Architecture, suggests the optimal degree of view of the human eye, which is 280, so that a certain distance is needed to be able to see the entire scenery around it (Figure 6). This beach still has a lot of land for additional material that can attract visitors and beach users. The view on this beach can also be a good view because visitors can watch the sunset. Lovina Beach also still needs some supporting plants to provide optimal and aesthetic functions on the beach. Overall, this beach can be said to be a good view. However, there are some points which are bad views. Such as guardrails that are less neat and many are destroyed, trash cans that are disturbing near the sea, and rivers that look dirty. It makes the aesthetics of the beach diminish and must be rearranged into a good view.

User activity
User activity uses a database as a result of interviews. The results of questionnaire interviews with respondents related to potentials, constraints, and user expectations of Lovina Beach were obtained, which were considered until the design stage. The number of respondents was 30 people, consisting of 20 men and ten women. The respondents under 15 years old are four people between 15-25 years old, eight people, 25-50 years 12 people, and over 50 years, six people. The activities carried out by users are dominated by users who are walking / sightseeing, then resting, and sunbathing. For tourist attractions that the user needs is natural scenery, while cultural tourism attractions, local traditions, cultural arts, and festivals. The following is the visitor identity data presented in the form of a diagram (Figure 7).

The most visitors found walking/sightseeing is important activities were 17 people. The desired activity to support activities on the beach is walking/sightseeing, equivalent to resting 12 people. The assessment of the beach conditions from the respondents showed that the beach conditions were classified as "Good," with a total of 46.7% of respondents. The most facilities needed by visitors are Gazebo/Shelter, mentioned by 12 people. The desired natural tourist attractions are natural scenic attractions, mentioned by 27 people.
Cultural tourism attractions desired by 23 visitors. For the type of tourism activity desired on Lovina Beach, it is more directed to family tours, mentioned by 24 people. Meanwhile, according to beach visitors, the condition of the beach that must be improved is the rubbish on Lovina Beach which is relatively small because only six people complained.

**Vulnerability Index**

The analysis for each parameter of the vulnerability index can show problem-solving and provide solutions for the coast. However, this is limited by human limitations in landscape engineering. The following is an analysis and synthesis of the variables that determine the value of physical and human parameters; The physical parameters of Lovina Beach get the following values:

1. **Geomorphology (4)**, namely beaches of sand, coral, mud, deltas, mangroves; These geomorphological parameters consist of steep cliffs, medium cliffs, sand dunes, crust rock beaches, and sand beaches or mud beaches. Geomorphological parameters reflect natural coastal landforms and their resistance to erosion.

2. **The rate of change of the coastline (2)** is -1 - 1; This coastline rate can be episodic, seasonal, per decade, or per century. The rate of coastal erosion-rooting can be determined based on comparisons of old maps and aerial photographs.

3. **The slope of the beach (4)** is <0.3; The description and evaluation of potential inundation and possible erosion is implemented in this research. Relatively sloping coastal areas are more rapidly flooded by tidal floods and eroded by erosion than steep beaches.

4. **The rate of increase in sea level (2.5)** is 2.51-3; It is determined based on the rise and fall of the annual mean sea level over a certain period at the tide monitoring station on the coast. Global sea-level height ranges from 5-10 mm per year based on IPCC calculations (2007).

5. **Mount Mount (3,5)** which is 1-2; The high tide mount provides low vulnerability. Conversely, low tide levels are highly susceptible. This view is based on the potential chance of extreme water levels due to storms. In micro-tidal coastal areas, beaches with tides of less than 2m, the chance of inundation are slight because the extreme water level during the storm is lower than the highest water level.

6. **Wave Height(1)** which is under 1.1.

Physical variables are crucial in determining the level of vulnerability of the coast. The crashing of the waves will cause erosion on the beach; the higher the waves, the greater the erosive power. The energy of the waves hitting the shore is directly proportional to the square of the wave height.

IKP F (Physical) (2,56) shows that the vulnerability value of the physical parameters of Lovina beach is moderate.

The Human Influence parameter gets a value, based on Solomon’s 2010 data:

1. **Coastal Protection (2)**, namely 20-30%, is good enough because it was found that there is at least a beach protection building in the form of a jetty. The existing condition is quite good, but it needs to be developed for maximum potential.

2. **Sediment Tappers (1.5)**, namely 20-40%, not very good; it was found that there was a small river outlet but without the surrounding protection.

3. **Coastal Vegetation (1.5)**, namely 30-50%, is dominated by shade plants. However, there are still some areas that are not shaded.

4. **Land Allocation (4)**, namely the tourism industry, is quite good, and the maximum is seen from the many tourists offers on the spot.

5. **Groundwater Consumption (1.5)**, namely 20-30%, Poor drainage, there are puddles in several places.
6. Total population (2.5), namely 2.01 to 2.25,
7. Culture (2), namely 2-3. Explain that there are at least three customary activities found.

IKP PM (Human Influence) (2.01) shows that the vulnerability value to human influence on Lovina Beach is moderate. The recommendation that can be addressed to reduce Lovina Beach's vulnerability in the future lies in the variable part of the human influence of coastal protection. This can be done by modifying the existing coast protection. Lovina Beach has a jetty-type beach protector. The condition of the jetty, which is currently on Lovina beach, is not too good, and its function can still be optimized. Considering the designation of this coastal land as a tourism industry, it will be more if the existing coast guard or jetty does not only function as a coast protector but has few attractions for Lovina beach.

**Concept**

The concept adopted for Lovina Beach is based on the dolphins that are characteristic of Lovina Beach, namely "Dolphin head Anatomy," which is the anatomy or composition of the inner dolphin head. This concept is a philosophy of how the dolphin head has intelligence and translated into the division of space and its functions. Then also means that all types of activities on the beach are ordered, directed, and neatly arranged based on this. Parts of the anatomy are the brain, skull, blowholes, melons, maxilla/mandible, and acoustics. The translation from basic concepts to design concepts used in the division of space (Figure 8).

![Figure 8 Schematic Design Concept](image)

**Development Concept**

The development concept is an advanced stage of the design concept. It discusses space, circulation, vegetation, visuals, facilities, and lighting in more detail. The following is an explanation of the six development concepts.

**Zoning**

The concept of space zoning includes the Brain Room, a place for users to add insight into all things related to Lovina Beach and its history and information on supporting beaches. The skull space is translated into space to strengthen the body, namely sports. Then, the Blowhole Space is a respiration hole that is connected to every part of the dolphin head anatomy and translated as a circulation path. Then the melon is streamed, which is an essential part of the dolphin’s head. It is translated into a place of worship. The maxilla/mandible or the upper and lower jaw of a dolphin means a dining area or restaurant and café. Finally, the acoustics are translated into theater spaces or expression spaces for various activities on Lovina Beach.

The design area is 0.6 ha, with a beach length of 175 m and a beach width of approximately 50 m. The carrying capacity of the facility’s construction is also calculated by referring to the calculation of the area divided by the existing space standard or individual space standards. Nurisjah et al. 2003, argued that carrying capacity is calculated based on the average in m2/person. The goal is to obtain the optimal degree that can be accommodated on-site with various planned activities. The calculation of carrying capacity (DD) for the user is as follows:

\[ DD = \frac{A}{S} \]

Information: \( A \) = Area used (m2), \( S \) = Standard needs per person (m2/person).
Circulation concept
The concept of circulation is designed to optimize the interaction between the user and the beach. The concept is done by utilizing a groove made in such a way as to surround all coastal location points. The seaside location points are connected by connecting each primary, secondary, and tertiary route.

Visual concept
Several locations on Lovina Beach have been identified into several views, namely Good View, Bad View, and Spot View. The locations that have a bad view are view of trash, a bridge over the river estuary, and vacant land in the middle between a food stall and the beach border. Whereas the spot view locations are the Lovina Beach dolphin statue monument, Lovina Beach signage, views towards the sea, and views of the sea from the top of the jetty.

Vegetation concept
The concept of vegetation used is based on the functions of the vegetation itself, include 1. Shade from the sun; 2. Environmental engineering for hydrological systems and animal habitats; 3. The architectural function of vegetation is to divide and direct the site; 4. Aesthetic needs can be seen from the physical vegetation.

Block Plan
The block plan consists of a concept map of space zoning, circulation, visuals, vegetation, facilities and utilities, and lighting (Figure 9).

Design
Site Plan Drawing
This site plan focuses on the overall design that balances functionality and aesthetics (Figure 10). The use of several existing spots becomes a more useful place, seen in a more regular parking lot with dividing lines for each vehicle.

The design is eliminating boundaries between users who have activities when shopping or eating with the beach by adjusting the walkway and seating area. The rearrangement of the existing sports area became multi-functional and added a place to play for children around the area according to the results of the questionnaire interview. It can live up to the beach atmosphere with an expression area for various activities. The overall perspective drawing is a projection of the overall design of the beach made in three dimensions (Figure 11). The sectional view image is a longitudinal and transverse coastline design made with montage (Figure 12), and DED Jetty (Figure 13).
11. Conclusion

Lovina Beach has an area of 0.6 ha with a beach length of 175 meters and a beach width of approximately 50 meters. The condition of the existing beach sand, which is blackish gray, tends to make the beach hotter than other Bali beaches. Additional shelter and widening vegetation are needed to reduce the heat of the beach. Activities usually carried out by users based on observations are sports, walking/looking at the beach, sitting around, and sunbathing. Lovina Beach has quite good tourism potential in terms of natural attractions, as evidenced by field observations which show that the number of tourist visits is quite busy. However, this potential must be balanced because this beach has several obstacles. Based on the Integrated Coastal Vulnerability Index (IKP) results, the score is 1.51, which shows that this beach is classified as having a low level of vulnerability. The concept raised is "Dolphin head anatomy." The concept is implemented to the division of zoning on the coast. There are additional elements on the beach, such as entrance gates, signage, information boards, and the formation of restaurant café and lounge areas. The results of the coastal landscape design based on landscape engineering can be a recommendation for related parties and coastal managers for consideration.

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