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Strategies for Mangrove Resource Management: Development of Natural Science Booklet Based on Mangrove Diversity in Gili Sulat, East Lombok

Ainun Diniyatushoaliha[1*], Huraiza Mahmudah[1]

[1] Master of Science Education (Postgraduate), University of Mataram, Mataram, Indonesia.

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Corresponding Author:
Ainun Diniyatushoaliha
ainundini20@gmail.com

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Abstract: The educational approach is one of the strategies in managing mangrove resources, especially mangroves in Gili Sulat. This study aims to develop a science booklet based on mangrove diversity in Gili Sulat, East Lombok. The method of collecting mangrove diversity data is a line transect. The type of research used is Research and Development with a 4-D model, namely defining, designing, developing, and disseminating. The results of the study are in the form of a science booklet design on mangrove diversity in Gili Sulat which has distinctive characteristics, describes the potential and benefits of mangrove forests, displays factual information on mangrove diversity in Gili Sulat, East Lombok, uses short, clear language, is easy to understand and comprehend, and uses an attractive visual display of images.

Keywords: Development; Diversity; Gili Sulat; Mangroves; Science booklet

Introduction

Current environmental issues are closely related to biodiversity so that it must be an important topic that needs to be prioritized in international relations. Attention by international experts and practitioners to biodiversity is a topic that has apparently continued for three decades, where the initial attention to biodiversity was stated in the 1992 Rio de Janeiro Earth Conference. Through this conference, biodiversity and climate change were the main agreements.

Biodiversity is an important priority to protect so that it can be ecologically and economically beneficial. However, the current status shows that genetic, species and ecosystem diversity are very poor and for decades, biodiversity has continued to be lost. The current extinction rate shows that species are naturally lost up to 100 times (Cornehl et al., 2023) and 28% of all species are threatened with extinction (IUCN, 2023). The loss of species is inseparable from the influence of human activities.

The most crucial impact of human actions is deforestation and forest degradation because it contributes greatly to the extinction of biodiversity, especially in mangrove forests. It is known through research conducted by Arifanti et al. (2022) that 261,141 ha of mangrove forests experienced deforestation and degradation during a 10-year period (2009-2019), 182,091 ha were deforested (70%) and 79,050 ha were degraded (30%). Mangrove forests are globally severely degraded and are among the most threatened ecosystems in the world because around 50% have been lost in the last century and 35% were lost by the end of the twentieth century and around 16% of mangrove species are currently threatened with extinction (Alongi, 2002; Giri et al., 2011; Makowski et al., 2018; Polidoro et al., 2010; Valiela et al., 2001). The loss of mangrove ecosystems and the threat to mangrove species will have an impact on various areas of life because of the large

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contribution of mangroves to ecological services for all living things.

Mangroves have a very potential contribution to ecological services, namely as a provider of habitat for young fish and shrimp, a food source for phytoplankton, a place of shelter and fertilization of marine biota, and mitigation of climate change because of its ability to absorb carbon from the atmosphere and store it in biomass and sediment so that it is dubbed as a "powerhouse of carbon sequestration" then the role of mangrove ecological services is very important especially in addressing the issue of climate change (Diniyatushoaliha et al., 2023; A. A. Idrus, 2014; Indrayani et al., 2021; Makowski et al., 2018). Thus, the fact of mangrove biodiversity plays a major role in helping to support environmental stability, providing ecological services, and having an impact on the long-term survival of many living things in the world, especially in Indonesia, precisely in West Nusa Tenggara.

The location of natural mangrove forests in West Nusa Tenggara, one of which is in Gili Sulat, East Lombok with an area of 643 hectares and designated as a Regional Marine Conservation Area (KKPD) of NTB province based on the Decree of the Regent of East Lombok Number 188.45/332/KP/2014 and the Decree of the Minister of Marine Affairs and Fisheries No. 92 of 2018 (Damayanti et al., 2022; Hadiprayitno et al., 2014). This area has the potential for natural resources, both abundant flora and fauna (Hadiprayitno et al., 2014; A. Al Idrus et al., 2018; Mertha et al., 2015; Rahmani et al., 2023; Rizal, 2019) and has the potential for ecological services for mitigating climate change (absorbing and storing carbon) where research was conducted by Diniyatushoaliha et al. (2023).

Behind the great potential of mangrove ecological services in Gili Sulat, there is a major problem, namely the activities of the surrounding community that have been going on for generations depend on their livelihoods on natural resources in Gili Sulat (Hilyana et al., 2021). The potential for biodiversity and the wealth of germplasm in Gili Sulat will be disrupted if there are problems related to illegal logging of mangrove species. If environmental problems in Gili Sulat are not solved, the sustainability of human life in the surrounding area will be worrying.

Education is one approach that can be used in mangrove resource management strategies as well as a solution to the loss of mangrove ecosystems and the threat of extinction of mangrove species. Educational and persuasive efforts can be conveyed to the wider community through formal and non-formal education. Nature-based learning methods, environmental conservation subjects, the use of environmental-based learning media, the use of mangrove ecosystems as natural laboratories (Japa et al., 2022) are efforts to prevent further damage to mangroves, especially in the Gili Sulat mangrove forest.

A strategy that can help overcome existing problems is to develop a booklet. The term booklet comes from the words book and leaflet, meaning a media that is a combination of the two with a leaflet-like format so that it has at least five pages but no more than forty-eight pages excluding the cover (Dewi et al., 2020; Sukmawati et al., 2018). Booklets as learning media must contain complete, clear, factual information with a visual display in the form of images that can attract students' attention to learn. Diversity-based booklets that have been developed include booklets on the diversity of bivalves and echinoderms in seagrass ecosystems (Hidayati et al., 2022; Patech et al., 2022), crustaceae in the mangrove area of Sangiang Island (Wahyuni et al., 2022); types of shrubs and trees in the mangrove areas of Pegatan Besar Village and Beringin Kencana Village (Amintarti et al., 2022; Salsabila et al., 2023); butterflies in Grape Forest and Kerinci Regency (Dewi et al., 2020; Khodijah et al., 2022); macroscopic fungi species (Fitriani et al., 2019); mangroves in Aluh-aluh Besar Village and Bandar Bakau Dumai Nature Tourism Area (Qonita et al., 2021; Rahmah et al., 2022).

The need for local potential-based learning through learning media is still limited, so it is necessary to package learning media with adequate information and attractive and complete visuals (Hidayati et al., 2022; Setyaningsih et al., 2019). The development of a mangrove diversity booklet containing Gili Sulat mangrove content needs to be done to utilize local potential. Thus, the reason for choosing mangrove content in the booklet is because (1) studying mangroves is urgent to support environmental balance and sustainability, (2) increasing students' understanding of the concept and importance of mangroves, (3) environmental issues related to the mangrove ecosystem motivate students to protect the mangrove ecosystem, (4) supporting students' affective aspects, namely caring for the environment, (5) supporting meaningful biodiversity learning for students, (6) instilling the values of conservation and environmental preservation (Ratminingsih et al., 2021; Syukur et al., 2022; Yandri et al., 2023). Through the explanation above, the aim of this research is to develop a science booklet based on the diversity of Gili Sulat mangroves, East Lombok.

Method

This type of research is Research and Development with a 4-D model, namely define, design, development, and disseminate (Sugiyono, 2018). The define stage aims to establish and define learning requirements that begin with an analysis of objectives and needs. The design

stage aims to design the learning format.bookletwhich will be developed. The development stage aims to produce booklet. The dissemination stage aims to distribute the product (booklet), but this stage is not carried out.This research was conducted by developing the results of the mangrove community structure research carried out by researchers in March 2023 in Gili Sulat into a science booklet based on mangrove diversity in Gili Sulat, East Lombok.

Results and Discussion

Results the result of this research is a designbookletIPA based on mangrove diversity Gili Sulat East Lombok. Here is the description.

Define

The results of the study of mangrove diversity in Gili Sulat using the line transect method. In this study, a total of 206 individuals belonging to 10 species and 6 families were identified and recorded. Of these, 4 species (families Rhizophoraceae and Lythraceae) were found at station I (west), 3 species (families Rhizophoraceae and Combretaceae) were found at station II (north) and 5 species (families Rhizoporaceae, Lythraceae, Euphorbiaceae, Meliaceae, and Malvaceae) were found at station III (south). Therefore, all families found at the research location were Rhizoporaceae, Combretaceae, Lythraceae, Euphorbiaceae, Meliaceae, and Malvaceae. The details are presented in the following table 1.

Table 1. Composition and Abundance of Mangrove Species of Gili Sulat, East Lombok, Indonesia

Family (Species)	Number of Individuals at Each Station			Total Individuals
	I	II	III	
Rhizophoraceae				
Rhizopora mucronata	23	0	0	23
Rhizopora apiculata	48	26	0	74
Rhizopora stylosa	0	0	49	49
Bruguiera gymnorrhiza	0	9	0	9
Ceriops tagal	2	0	0	2
Combretaceae				
Lumnitzera racemosa	0	4	0	4
Lythraceae				
Pemphis acidula	23	0	11	34
Euphorbiaceae				
Exoecaria agallocha	0	0	9	9
Meliaceae				
Xylocarpus rumphii	0	0	1	1
Malvaceae				
Hibiscus tiliaceus	0	0	1	1
				206

The number of mangrove individuals on 9 transects at the three stations was grouped based on stem diameter, which was classified into the level of mangrove growth categories, namely: seedlings, saplings, and trees. Where from 206 individuals it was found that the level of mangrove growth category, namely saplings, had the greatest potential, namely 90 individuals; trees 64 individuals; and seedlings 52 individuals. In addition, the H 'value (diversity index) of mangrove species at the seedling, sapling and tree levels were sequentially 1.31; 1.49; 1.86 (all in the criteria of moderate diversity level, moderate ecological pressure).

Booklet IPA based on the diversity of Gili Sulat mangroves has never been developed before, so this research was conducted as content material in a booklet that was developed to be contextual and factual.

Design

The design of the science booklet based on Gili Sulat Mangrove Diversity uses the Canva application with 11 inch x 8.5 inch paper. Then converted using flippdf free. This booklet contains an introduction, contents and conclusion.

Develop

The IPA booklet product based on Gili Sulat Mangrove Diversity was produced at this stage. This booklet consists of 16 pages, including: (1) front page (cover), (2) about the booklet, (3) table of contents, (4) mangroves and the importance of mangroves, (5) Gili Sulat mangrove forest, (6) benefits of mangroves and their potential as a carbon market, (7) location of research stations, (8) population and research samples, (9) research results, (10) bibliography. The following is a picture of the booklet product that has been developed.

Validation was carried out on the Gili Sulat Mangrove Diversity-based science booklet which had been developed by material experts and media experts using a questionnaire.

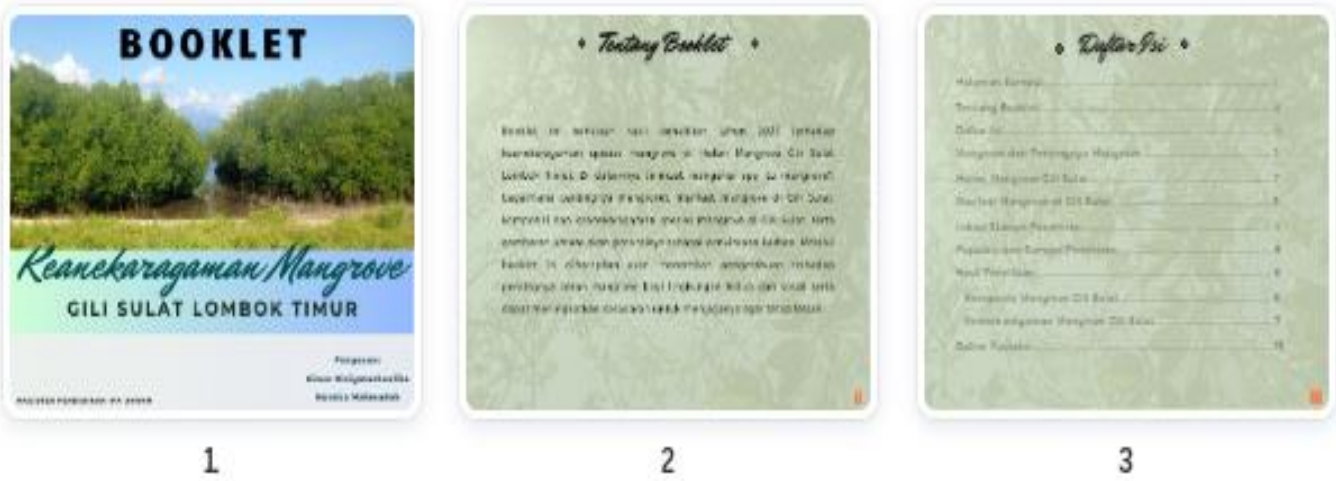

Figure 1. Introduction

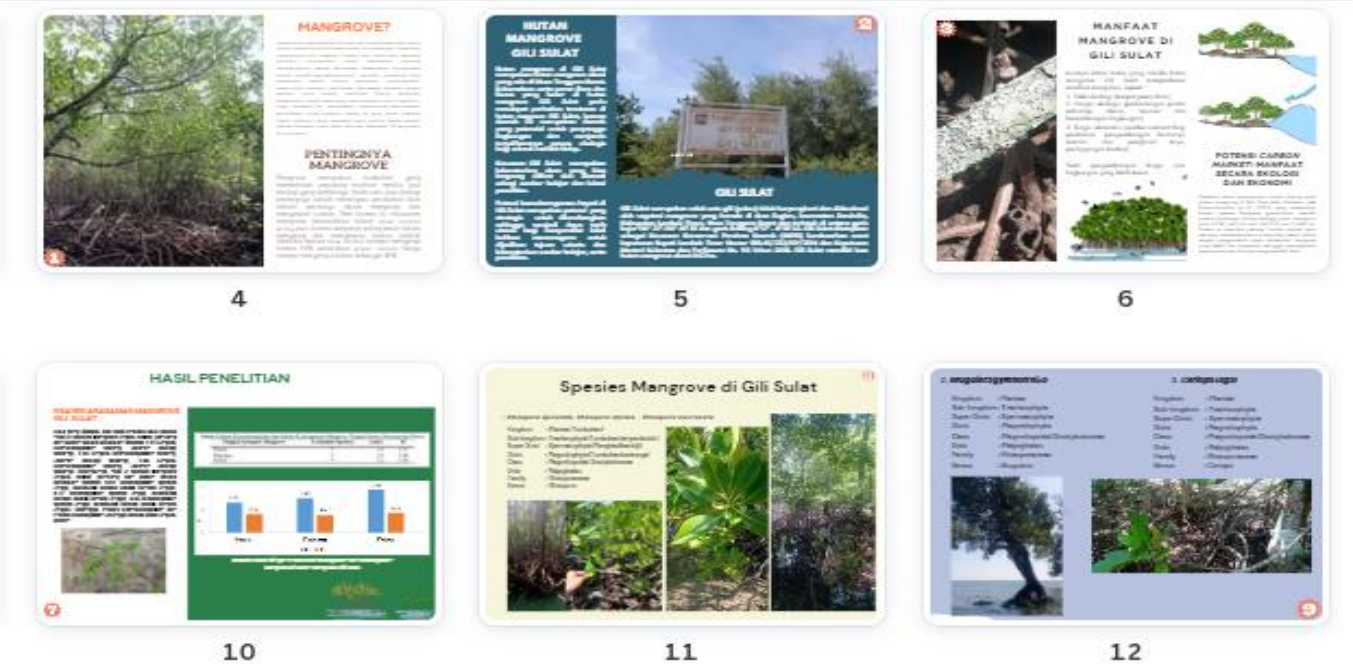

Figure 2. Contents section

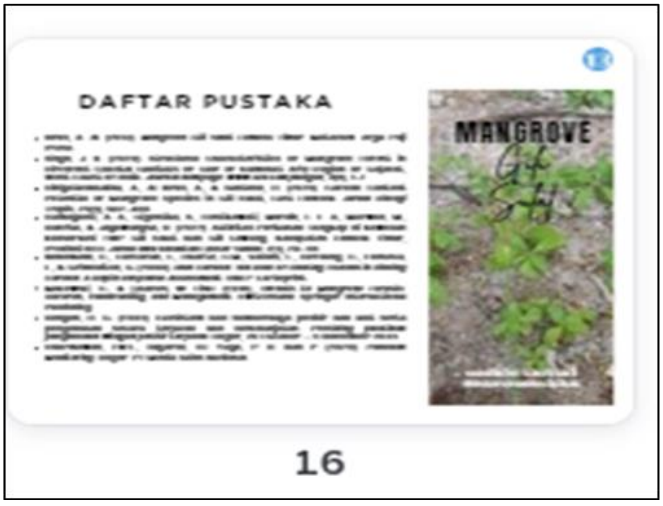

Figure 3. Cover section

Table 2. Expert Validation Results

Validators	Assessment Results (%)	Criteria
Subject Matter Expert	83	Very valid
Media Expert	81	Very valid

Booklet this Gili Sulat Mangrove Diversity-based Science has very valid criteria so that it is suitable for use in learning. Similar research related to the diversity-based booklet mangrove also falls into the eligible category (Qonita et al., 2021; Rahmah et al., 2022). Therefore, the development of booklets has been proven to be a learning medium that can attract interest in learning and is suitable for use as a learning resource for students (Alencia et al., 2021; Purnomo et al., 2020; Puspita et al., 2017; Syamsurizal et al., 2021). It is hoped that after students study this booklet they will have

knowledge of the importance of mangroves, especially mangroves in Gili Sulat, which are able to support environmental sustainability, motivate them to maintain the mangrove ecosystem, form an attitude of caring for the environment, and have conservation and environmental preservation values so that they can help manage mangrove resources in their environment and outside their environment.

Conclusion

Booklet IPA based on Gili Sulat mangrove diversityEast Lombokhas unique and different characteristics when compared to other types booklet others becausedescribing the potential and benefits of mangrove forests, displaying information on biodiversityGili Sulat mangrovesEast Lombok is factual, uses short, clear, easy to understand and comprehend language, and uses attractive visual image displays.This booklet is suitable for use in learning activities.

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