

Mangrove Distribution in North Sumatera, Indonesia

A Review

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Abstract—Mangrove forests provide important ecosystem services but are currently undergoing degradation. North Sumatra's mangrove areas are threatened by land conversion and aquaculture. This article describes the overall distribution of mangroves in North Sumatra, Indonesia. The method used in this study is the protocol search, appraisal, synthesis, analysis, report (PSALSAR), and Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) framework. Based on consolidated literature, North Sumatra Province has 34 mangrove species. There are two endangered mangrove species, *Bruguiera hainesii* as a Critically Endangered "CR" species and *Avicennia lanata* as a Vulnerable "VU" species. Knowing the distribution of the species and their threats we can plan appropriate conservation efforts and further research.

Keywords— Coast, Conservation, Diversity, Mangroves.

I. INTRODUCTION

Mangroves are coastal forests that stretch between land and sea in tropical and subtropical regions worldwide [1]. Mangrove forests are home to local plants and animals, which provide essential goods such as seafood and agriculture, firewood, construction materials, medicinal plants, and traditional medicines [2]–[10]. Furthermore, mangrove forests protect coastal environments, minimize the serious effects of natural disasters, including flooding, storms, and tsunamis, prevent salinity change, sequester atmospheric carbon, reduce erosion, and promote biodiversity [11]–[16].

Despite their value, mangroves are under severe ecological strain, with the worldwide mangrove population having been destroyed in the previous fifty years [17]. This loss is mostly the result of land removal and conversion for agriculture or aquaculture, household and industrial waste dumping, oil spills, and dredging for coastal expansion that is not well managed. Climate change consequences, such as soil erosion, storms, and floods, have a part in mangrove destruction in addition to anthropogenic activity [18]–[25]. The mangrove area in North Sumatra Province decreased by 22,513.2 hectares between 1990 and 2015 [26].

The purpose of this paper is to describe the overall distribution of mangroves in North Sumatra, Indonesia. Understanding mangrove distribution is critical for effective conservation efforts [27], [28]. Conservation groups may prioritize areas for preservation, restoration, and sustainable management by determining the sites of mangrove ecosystems. This knowledge also enables for the evaluation of mangrove hazards and dangers, such as deforestation, pollution, and climate change, which aids in the development of conservation plans and interventions [1], [29]–[33]

II. RESEARCH METHODS

The method used in this study is the protocol search, appraisal, synthesis, analysis, report (PSALSAR), and Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) framework. Literature was searched using Publish or Perish 8 software from Google Scholar and Scopus sources [34]–[37]. The keywords used were "Mangroves of North Sumatra" in English and Indonesian to identify literature that fit the research objectives. The results of the search were sorted into double and grey literature. The selected literature included articles, abstracts, research reports, and papers from accessible universities containing mangrove species. The process of selecting relevant applications based on the PSALSAR flow diagram is depicted in Fig. 1.

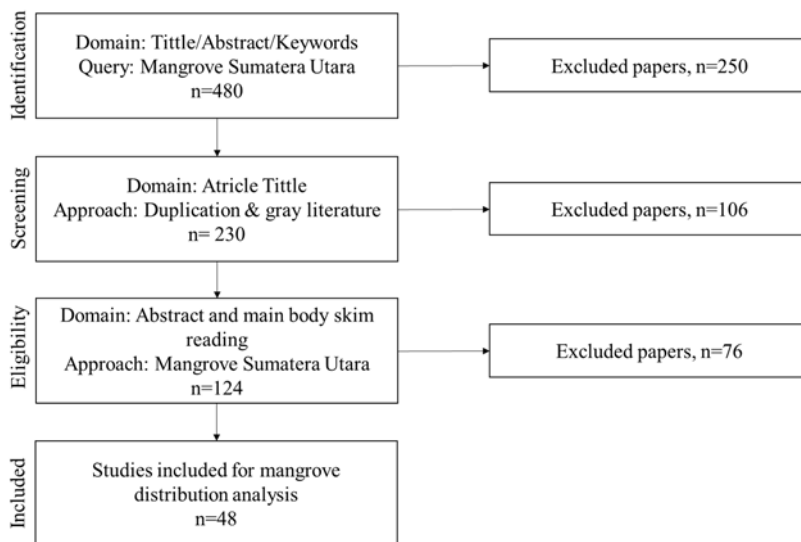


Fig. 1. A modified PSALSAR flow diagram was adapted from [37] to select relevant articles.

Afterward, the results of the consolidated literature were extracted and tabulated to obtain the species of mangroves and their regional distribution. To assess mangrove cover and species status, we combined the literature data with the Global Mangrove Watch (GMW: <https://www.globalmangrovetwatch.org>) database, the Geospatial Information System of the Ministry of Environment and Forestry (SIGAP KLHK: <https://sigap.menlhk.go.id>) and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (www.iucnredlist.org).

III. RESULTS AND DISCUSSION

Overview of the Review

There were 48 literatures out of the 480 that fit the criterion, with 24 being articles and the other 22 being undergraduate and master thesis. There is a disparity in the amount of literature available across North Sumatra province (Fig. 2), with 96% coming from the east coast and certain districts with vast coasts having only one piece of literature mentioning the existence of mangrove species. This disparity may be attributable to more universities in North Sumatra's eastern region

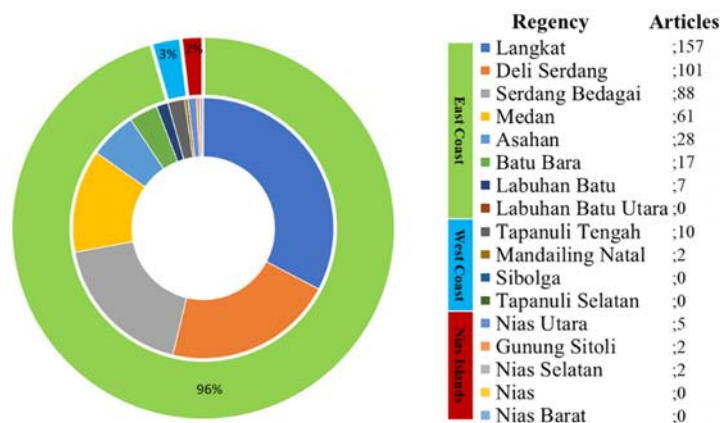


Fig. 2. Number of articles on mangroves in North Sumatera

Mangrove Species Distribution

North Sumatera Province has 17 regencies/cities with coastlines. based on consolidated literature, there are 12 regencies/cities with 14 families and 34 mangrove species: East Coast 33 species with the highest number of species in the district of Langkat (28 species), West Coast 20 species, and Nias Islands 16 species (TABEL I), with the most common species found were *X. granatum*, *R. mucronata*, and *R. apiculata* in 10 districts/city. In contrast, the least common species found in only one region were *P. acidula* (Serdang Bedagai), *K. candel* (Medan), *G. paludosa* (Mandailing Natal), and *A. ebracteatus* (Langkat) (Fig. 3).

TABEL I. North Sumatera Mangrove Species

No	Family	Species	East Coast						West Coast			Nias Islands				
			La	DS	As	SB	Me	BB	LB	TT	MN	NU	NS	GS		
1	Acanthaceae	<i>Acanthus ebracteatus</i>	+													
2	Acanthaceae	<i>Acanthus ilicifolius</i>	+		+	+	+									
3	Arecaceae	<i>Nypa fruticans</i>	+	+	+	+	+		+	+	+					
4	Asclepiadaceae	<i>Gymnanthera paludosa</i>										+				
5	Avicenniaceae	<i>Avicennia alba</i>	+	+	+	+	+	+	+							
6	Avicenniaceae	<i>Avicennia lanata</i>	+	+	+		+	+								
7	Avicenniaceae	<i>Avicennia marina</i>	+	+	+	+	+	+	+							
8	Avicenniaceae	<i>Avicennia officinalis</i>	+	+	+	+		+				+				
9	Combretaceae	<i>Lumnitzera littorea</i>	+	+	+	+				+				+		
10	Combretaceae	<i>Lumnitzera racemosa</i>	+	+	+	+				+						
11	Euphorbiaceae	<i>Excoecaria agallocha</i>	+	+	+	+	+	+		+						
12	Lythraceae	<i>Phemphis acidula</i>				+										
13	Meliaceae	<i>Xylocarpus granatum</i>	+	+	+	+	+	+	+	+			+			+
14	Meliaceae	<i>Xylocarpus moluccensis</i>	+	+		+										
15	Myrsinaceae	<i>Aegiceras corniculatum</i>	+		+			+						+		
16	Myrsinaceae	<i>Aegiceras floridum</i>	+		+											

No	Family	Species	East Coast					West Coast					Nias Islands		
			La	DS	As	SB	Me	BB	LB	TT	MN	NU	NS	GS	
17	Pteridaceae	<i>Acrostichum aureum</i>	+	+	+	+	+				+	+	+		
18	Pteridaceae	<i>Acrostichum speciosum</i>	+	+	+									+	
19	Rhizophoraceae	<i>Bruguiera cylindrica</i>	+	+	+	+			+		+			+	
20	Rhizophoraceae	<i>Bruguiera gymnorrhiza</i>	+	+	+	+	+				+	+		+	
21	Rhizophoraceae	<i>Bruguiera hainessii</i>						+		+					
22	Rhizophoraceae	<i>Bruguiera parviflora</i>		+	+						+		+		
23	Rhizophoraceae	<i>Bruguiera sexangula</i>	+	+	+	+	+	+	+		+			+	
24	Rhizophoraceae	<i>Ceriops decandra</i>	+		+						+				+
25	Rhizophoraceae	<i>Ceriops tagal</i>	+	+	+	+	+	+	+		+			+	
26	Rhizophoraceae	<i>Kandelia candel</i>						+							
27	Rhizophoraceae	<i>Rhizophora apiculata</i>	+	+	+	+	+			+	+			+	+
28	Rhizophoraceae	<i>Rhizophora mucronata</i>	+	+	+	+	+	+	+	+	+	+		+	
29	Rhizophoraceae	<i>Rhizophora stylosa</i>	+	+	+	+	+	+	+		+			+	
30	Rubiaceae	<i>Scyphiphora hydrophyllacea</i>	+	+	+				+	+					
31	Sonneratiaceae	<i>Sonneratia alba</i>	+	+	+	+	+			+	+			+	+
32	Sonneratiaceae	<i>Sonneratia caseolaris</i>	+	+		+	+				+				+
33	Sonneratiaceae	<i>Sonneratia ovata</i>	+	+											
34	Sterculiaceae	<i>Heritiera littoralis</i>		+				+	+						
References			[38]–[74]					[75]–[80]					[81]–[85]		

*La: Langkat; DS: Deli Serdang; As: Asahan; SB: Serdang Bedagai; Me: Medan; BB: Batubara; LB: Labuhanbatu; TT: Tapanuli Tengah; MN: Mandailing Natal; NU: Nias Utara; NS: Nias Selatan; GS: Gunung Sitoli.

Based on the IUCN Red List of Threatened Species, all mangrove species are experiencing declining population trends. There are also two threatened mangrove species, *Bruguiera hainessii* as a Critically Endangered "CR" species and *Avicennia lanata* as a Vulnerable "VU" species [86], [87].



Figure 3. Number of mangrove species in districts/cities in North Sumatera Province, (A) total districts with a specific mangrove species (B) total species in each district.

North Sumatera has two threatened mangrove species: *B. hainesii* "CR" and *A. lanata* "VU". *A. lanata* is indigenous to Southeast Asia, appearing infrequently in Singapore (old records; potentially now locally extinct), western Sarawak, the Philippines (Aurora Province), Vietnam, Papua New Guinea, and Indonesia (Bunaken, North Sulawesi). Tourism and home development are the two most serious threats to this species, which thrives in open groups in moist coastal forests [86], [88]. Also, *B. hainesii* is indigenous to Indonesia, Malaysia, Papua New Guinea, and Singapore. This species is extremely rare, with a limited and patchy distribution. This species lives in the marine intertidal zone. This species is found in transitional estuarine zones with high intertidal zones. It has an extremely low propagation and germination rate. The maturation cycle takes 18 months. It can reach a height of 30 m. Significant coastal development has resulted in at least 27 % of mangrove vegetation within this species' habitat during the last 25 years (under one generation).[87], [88].

Some common species found in most districts are *R. apiculata*, *R. mucronate*, and *X. granatum*. These three species have a wide tolerance to various substrates, so they can spread widely and abundantly. The genus *Rhizophora* has a fast growth rate. Threats to the existence of this species are land conversion, wood harvesting for construction materials and fuel [88]–[91].

Threats And Conservation

Overall, mangrove threats are categorized into three groups: coastal development, aquaculture, and agriculture expansion, and collecting wood for domestic usage are among the most serious risks. Climate change, eutrophication, and hydrological change are regarded as moderate hazards to mangrove ecosystems, while illnesses, Tourism, and pollution (noise, heat, chemicals, and oil) are considered low-level threats [92]–[95].

In Indonesia, mangrove management has complex challenges that include social, ecological, and economic concerns. There are confusing borders between authorities in mangrove areas, as well as overlapping responsibility and enforcement of laws among governmental agencies, as well as complex social and economic factors [92], [96]. The primary drivers of deforestation in

North Sumatran mangroves, particularly in secondary mangrove forests, were sourced from aquaculture land usage. 50% conversion of mangroves into aquaculture ponds and 28.8% oil palm plantation [26].

The mangrove habitat area in North Sumatra was 48,371.88 ha in 2020, representing a linear coverage of 50.65% of the 3,219.19 km of coastline. The mangrove area decreased by 2,978.78 ha between 1996 and 2020 with an average aboveground mangrove biomass density of 109.24 tons/ha in 2020 [97]–[100]. The Map of mangrove distribution in North Sumatra province is in Fig. 4.

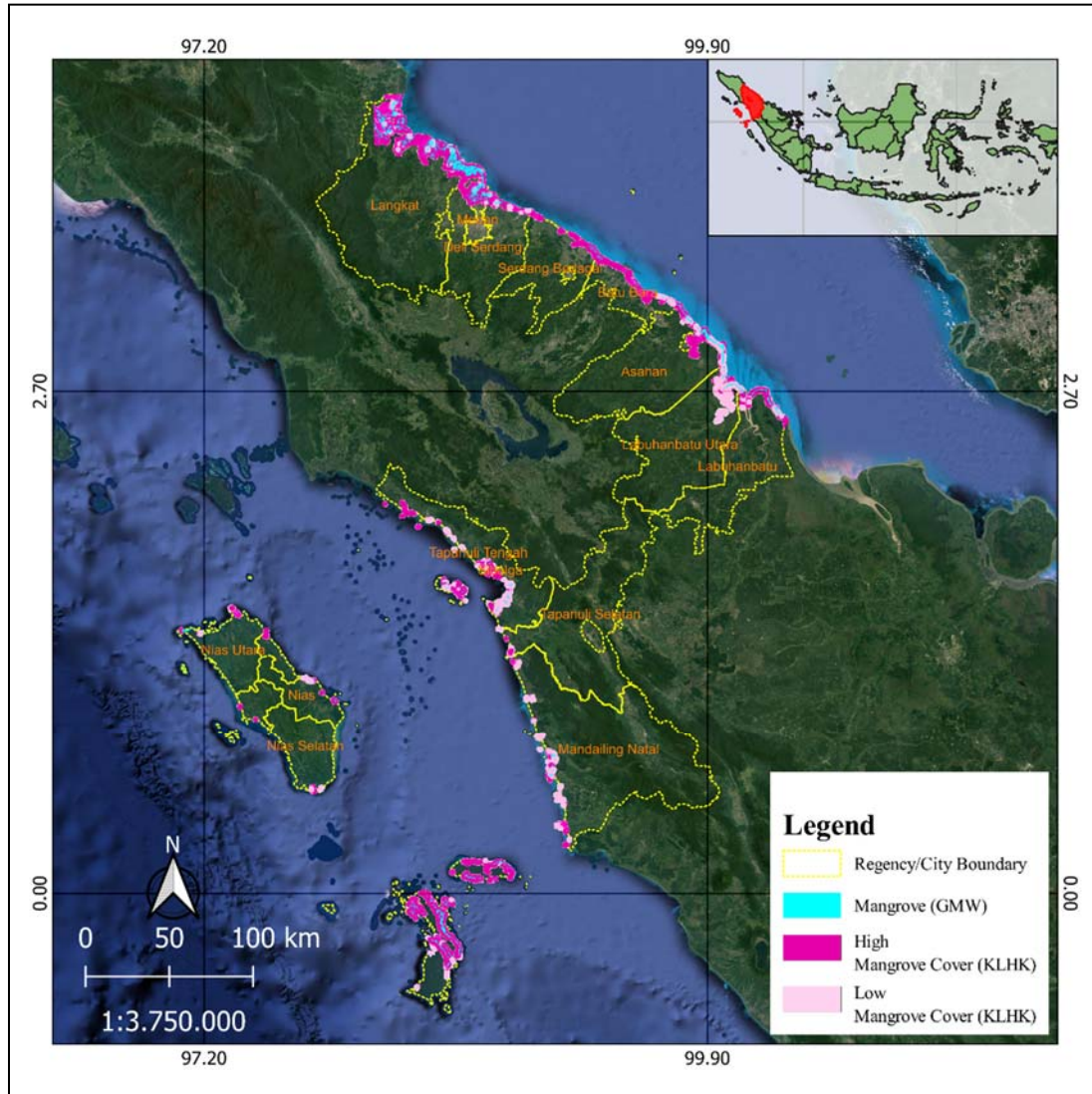


Fig. 4. Map of mangrove distribution in North Sumatra province modified from Global Mangrove Watch (GMW) and Ministry of Environment and Forestry (KLHK)

To manage mangrove forests sustainably in Indonesia, an integrated approach that considers social, economic, and environmental concerns is required. The significance of community involvement in sustainable mangrove management, as well as the need for suitable policies and strategies to address the myriad issues confronting mangrove ecosystem management. The importance of research, science, and technology, as well as information systems, in promoting sustainable mangrove management and satisfying global environmental commitments [19], [96], [101], [102].

IV. CONCLUSION

Based on consolidated literature, North Sumatra Province has 34 mangrove species. There are two endangered mangrove species, *Bruguiera hainesii* as a Critically Endangered "CR" species and *Avicennia lanata* as a Vulnerable "VU" species. The

main factor of deforestation in North Sumatera's mangrove forests comes from aquaculture land use: Conversion of mangrove forests into farms and oil palm plantations. Sustainable mangrove forest management in Indonesia requires an integrated approach considering social, economic, and environmental aspects. Community involvement, suitable policies, and research play key roles in addressing the challenges and meeting global environmental commitments.

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