ASERS

# Journal of Environmental Management and Tourism

Quarterly
Volume XIII
Issue 3(59)
Summer 2022
ISSN 2068 – 7729
Journal DOI
https://doi.org/10.14505/jemt

ASERS Publishing

Summer 2022
Volume XIII
Issue 3(59)



ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

# Table of Contents:

Summer 2022
Volume XIII
Issue 3(59)



ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

# Call for Papers
# Fall Issues 2022
# Journal of Environmental Management and Tourism

**Journal of Environmental Management and Tourism** is an interdisciplinary research journal, aimed to publish articles and original research papers that should contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences.

Journal will publish original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modeling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies, etc. This topic may include the fields indicated above, but are not limited to these.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in environmental management.

*Journal of Environmental Management and Tourism* is indexed in SCOPUS, RePEC, CEEOL, ProQuest, EBSCO and Cabell Directory databases.

All the papers will be first considered by the Editors for general relevance, originality and significance. If accepted for review, papers will then be subject to double blind peer review.

| | |
|---|---|
| **Deadline for submission**: | 31th July 2022 |
| **Expected publication date**: | September 2022 |
| **Website:** | https://journals.aserspublishing.eu/jemt |
| **E-mail**: | jemt@aserspublishing.eu |

To prepare your paper for submission, please see full author guidelines in the following file: JEMT_Full_Paper_Template.docx, then send it via email at jemt@aserspublishing.eu.

DOI: https://doi.org/10.14505/jemt.v13.3(59).20

# Characteristics of Mangrove Fisheries in Essential Ecosystem Area Ujungpangkah, Indonesia

Dhira K. SAPUTRA
CORECT-RG, Brawijaya University, East Java, Indonesia
saputra.dhira@ub.ac.id
Bambang SEMEDI
CORECT-RG, Brawijaya University, East Java, Indonesia
bambangsemedi@ub.ac.id
Ade YAMINDAGO
CORECT-RG, Brawijaya University, East Java, Indonesia
adeydago@ub.ac.id
Citra S.U. DEWI
CORECT-RG, Brawijaya University, East Java, Indonesia
satryacitra@ub.ac.id
M.A. ASADI
CORECT-RG, Brawijaya University, East Java, Indonesia
asadi@ub.ac.id
Andik ISDIANTO
CORECT-RG, Brawijaya University, East Java, Indonesia
andik.isdianto@ub.ac.id
Dian ALIVIYANTI
CORECT-RG, Brawijaya University, East Java, Indonesia
alviyantidian@ub.ac.id
R. D. KASITOWATI
CORECT-RG, Brawijaya University, East Java, Indonesia
raraskasitowati@ub.ac.id
Arief DARMAWAN
CORECT-RG, Brawijaya University, East Java, Indonesia
ariefdarma@ub.ac.id
Arief SETYANTO
CORECT-RG, Brawijaya University, East Java, Indonesia
asetyanto@ub.ac.id
O.M. LUTHFI
CORECT-RG, Brawijaya University, East Java, Indonesia
omuzakyl@ub.ac.id
Dwi C. PRATIWI
CORECT-RG, Brawijaya University, East Java, Indonesia
dwicandra@ub.ac.id
Sulastri ARSAD
Brawijaya University, East Java, Indonesia
sulastriarsad@ub.ac.id

**Suggested Citation:**

Saputra, D.K. *et al.* (2022). Characteristics of Mangrove Fisheries in Essential Ecosystem Area Ujungpangkah, Indonesia. *Journal of Environmental Management and Tourism*, (Volume XIII, Summer), 3(59): 812-820. DOI:10.14505/jemt.v13.3(59).20

**Article's History:**

Received 14th of December 2021; Received in revised form 12th of January 2022. Accepted 26th of April 2022; Published 3rd of June 2022. 

**Abstract**

Ujungpangkah represents a deltaic region with one of the largest mangrove areas in East Java. This 1,554 Ha of high productivity mangrove area were designated as Essential Ecosystem Area (EEA) in 2020. However, linkage between mangrove conditions and fisheries activities within region have not been well documented. This study combines satellite remote sensing to analyze the temporal extent and distribution of mangrove vegetations, and field observation to identify local mangrove-fisheries characteristic. Area of study consists of mangrove and local fishing groups in Pangkahkulon and Pangkahwetan coastal villages. Both MVI and NDVI algorithms were performed on Landsat 8 and Sentinel-2 satellite imageries, using machine learning Google Earth Engine, to provide spatio-temporal change in mangrove extent during last decade (2011-2021). Field activities carried out in 8 sampling stations to analyze existing mangrove condition using Mangrove Health Index (MHI) tool, while semi-structured interview was conducted with representatives from 14 groups of fishermen from two coastal villages within EEA Ujungpangkah. Data obtained from this study include fish species, fishing gear, fishing ground locations, fisheries productivity, and fishery activities related to the mangrove in EEA Ujungpangkah. Correlation between mangrove conditions and fishery productivity in Ujungpangkah is expected to provide information about the local-based function of the mangrove ecosystem. This information may support stakeholders, particularly area managers, to implement sustainable management based on mangrove ecosystems in accordance with the SDGs -SDG2, SDG 13, and SDG 14.

**Keywords:** mangrove conservation; sustainable management; coastal resilience; Mangrove Health Index.

**JEL Classification**: Q22; Q57; R11.

## Introduction

Mangrove Ujungpangkah is one of the priority mangrove areas in East Java. It consists of 3 coastal villages: Pangkahwetan, Pangkahkulon, and Banyuurip, with area cover of 31.86 km$^2$ (318,600 Ha), 21.80 km$^2$ (218,000 Ha) and 5.35 km$^2$ (53,500 Ha) respectively (BPS Kabupaten Gresik. Kabupaten Gresik Dalam Angka 2021). This area becomes hotspot for capture fisheries and aquaculture activities in north coast of East Java, particularly for 1,749 local fishermen and 1,471 fish farmers in Pangkahkulon and Pangkahwetan villages. This deltaic region becomes a mixing area of nutrient-rich runoff from the largest river in Java Island (Bengawan Solo), which is connected to Java Sea and Madura Strait. Important role of the Bengawan Solo estuary for coastal fisheries written in documentation of *Atlas Van Tropich Nederland*, dated in 1938, which mentioned: *«Accroissement de l'embouchure artificiellement déplacée du K. Solo (cote sept. de Java)»* (Zakiyah 2014). This 1,554 Ha of coastal wetland ecosystem now designated as Ecosystem Essential Area (EEA) Mangrove Ujungpangkah, (based on Governor Decree of East Java Province, No. 188/309/KPTS/013/2020). However, change in mangrove extent and its relationship with fisheries activities surrounding mangrove EEA area has not been well documented.

This study analyzes mangrove spatio-temporal change within last decade (2011 – 2021) using satellite remote sensing, while ground check activities were carried out to investigate present mangrove condition. Semi-structured interviews to fishermen groups aimed to observe relation between mangrove condition to fisheries activities in the vicinity of EEA Ujungpangkah. Moreover, this information can be taken into consideration for stakeholders to prioritize specific goals for mangrove rehabilitation and community empowerment programs, in accordance with strengthening coastal resilience as well as achievement of SDGs goals (https://sdgs.un.org/goals) in this region.

## 1. Research Background

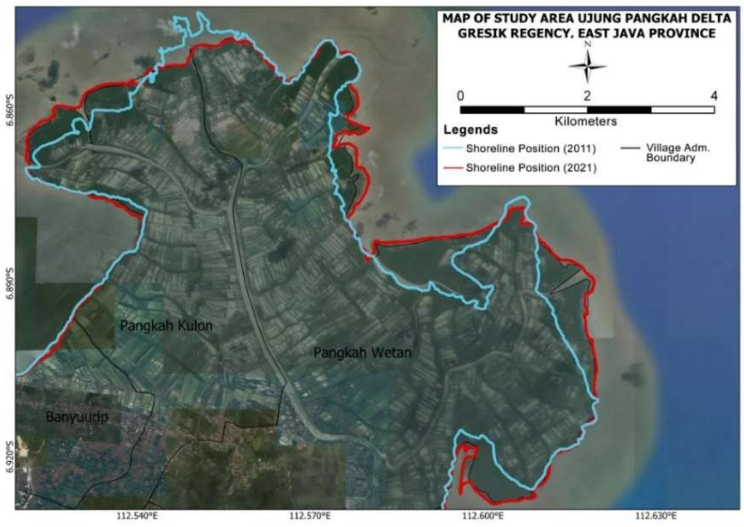
Indonesia has 3.3 million hectares of mangrove (KLHK. Peta Mangrove Nasional untuk Langkah Tepat Pengelolaan Mangrove. 2021) with 637,000 ha or 10–33% of mangrove areas have been degraded and converted over decades. EEA Ujungpangkah is one of the most important mangrove areas in East Java, at the same time, most vulnerable. As largest deltaic region in Java, this region receives exceptional input of riverine sedimentation. Deep muddy substrate supports rapid development of mangroves area seaward. On the other hand, as center of aquaculture in northern coast of Gresik, rear mangrove is constantly converted into fish farms. Land conversion results in permanent loss of mangrove area, while pollution (particularly plastic debris and chemical pollution), inhibit growth and development of mangrove habitats (van Oudenhoven *et al.* 2015; Budi Arifanti *et al.* 2022). Satellite remote sensing provides spatio-temporal mangrove area change detection. Development of MVI algotithm using SWIR1 and green bands on Sentinel-2 imagery is able to produce accurate mangrove classification (Baloloy *et al.* 2020). Recent development of machine learning Google Earth Engine (GEE) application has been used to simplify and speed up processing of satellite images (Chen *et al.* 2017; Saputra *et al.* 2022).

Mangroves are crucial habitats for coastal fisheries, as a primary source of food and shelter for fishery resources (van Oudenhoven *et al.* 2015; Twilley 1988; Nagelkerken *et al.* 2008). Detritus from mangrove vegetations, coupled with the presence of phytoplankton and periphyton algae, resulted in high productivity of mangrove habitat (12–14), which provide direct economic benefit for fishermen in the vicinity (Twilley 1988; Harahab 2009; Hutchison, Spalding, Ermgassen 2021; Hartati 2010; Manson *et al.* 2005; Huxham, Kimani and Augley 2004; Seary *et al.* 2021). Interaction between mangrove habitat and high fishery productivity has been described in various publications (Hutchison, Spalding, Ermgassen 2021; Seary *et al.* 2021; zu Ermgassen *et al.* 2021). Fisheries related to mangrove habitat can be categorized as (a) inshore multispecies (b) inshore crustacea dan mollusca (c) offshore fisheries (<30 miles) and (d) recreational fisheries (Hutchison, Spalding and zu Ermgassen 2014). Fisheries commodities captured from surrounding mangrove areas ranged from 20–1,327 kg/ha/yr. Factors enhanced fisheries productivity includes environmental drivers: high primary productivity of both mangroves and other producers, high level of nutrients input and high runoffs or freshwater inputs (16). Conversely, significant decrease of mangrove extent and habitat quality resulted in lower fishery productivity. Mangrove Health Index (MHI) is a tool developed by Oceanography Research Center, *National Research and Innovation Agency* (PRO-BRIN) as a single metric to determine the quality of mangrove habitat (Dharmawan *et al.* 2020).

## 2. Methodology

*Spatio-temporal mangrove extent and existing mangrove condition*

Figure 1. Map of the mangrove survey area in EEA Mangrove Ujungpangkah, Gresik




Change in mangrove extent within last decade (2011 – 2021) obtained from NDVI analysis of Landsat 8 imageries. This algorithm use NIR (B5) dan Red band (B4) (Baloloy *et al.* 2020). NDVI analysis performed using machine learning GEE, with processing code as follows:

$$var\ nir = image.select('B5');$$
$$var\ red = image.select('B4');$$
$$var\ ndvi = nir.substract(red).divide(nir.add(red)).clip(AOI).rename('NDVI');$$

Mangrove Vegetation Index (MVI) (7) were performed on Sentinel 2 imagery to obtain mangrove extent in 2021. This method calculated SWIR1 band (B11, λ: 1565 – 1655 nm), SWIR band (B8, λ: 785–900 nm) and green band (B3, λ: 543–578 nm) using following formula:

$$Sentinel\ 2\ MVI = \frac{(B8 - B3)}{(B11 - B3)}$$

which is translated into GEE code for MVI analysis as follows:

$$var\ mvi = \left(image.select('B8').substract\left(image.select('B3')\right)\right).divide$$
$$(image.select('B11').substract(image.select('B3'))).clip(AOI).rename('MVI');$$

This research covers 8 sampling stations of mangrove areas within EEA Mangrove Ujungpangkah following standard procedure from PRO-BRIN (Dharmawan *et al.* 2020). MonMang mobile application developed by PRO BRIN is used to record and input data. Field activity aimed to obtain data on existing mangrove conditions (MHI), which derived from canopy cover, sapling density and sapling-tree diameter ( Nurdiansah and Dharmawan 2021).

*Mangrove-fisheries activities*

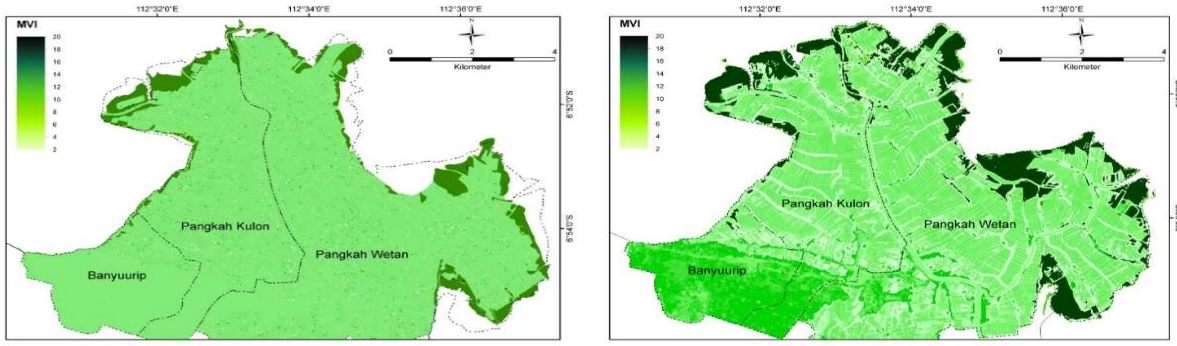
Semi-structured interview was carried out to representatives of 7 fishermen groups from two vilages, Pangkahkulon (PK) and Pangkahwetan (PW). Mangrove associated fisheries characteristics can be described by function/objectives, fishing gear, fisheries species, locations, fishing calendar and fisheries productivity. This activity was carried out through interviews with the members of each fishing group from two villages. Informations obtained from this activity consists of number of groups and members of each fishermen group, types of fishing gear and frequency of fishing activities, number and species of catch, fishing areas, socio-economic conditions and environmental changes which affect fisheries productivity during last two decades.

## 3. Case Studies

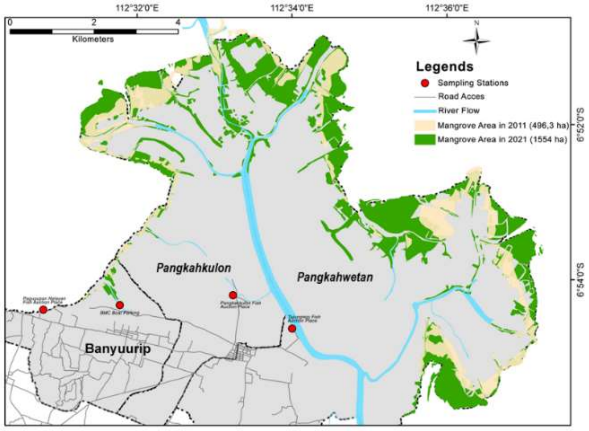
*Mangrove conditions*

Mangroves in Ujungpangkah are classified with MVI values ranging from 11-14 in 2011, and a higher threshold value of 12 in 2021. These values tend to be high considering MVI value of 4.6 is safe minimum threshold for Landsat-based MVI mangrove mapping (Baloloy *et al.* 2020). During last decade (2011 – 2021), Mangrove in Ujungpangkah have developed seaward, because of constant sedimentation (natural regeneration). Mangrove extent increase from 496.3 Ha (2011) to 1,554 Ha (2021), with rate of increase 105.8 Ha/yr. Rapid seaward development of mangroves followed by loss of rear mangrove, which converted into fish farms in PK and PW coastal villages (Figure 2).

Figure 2. MVI value in the mangrove area in Ujungpangkah shows temporal change of mangrove extent during 2011-2021

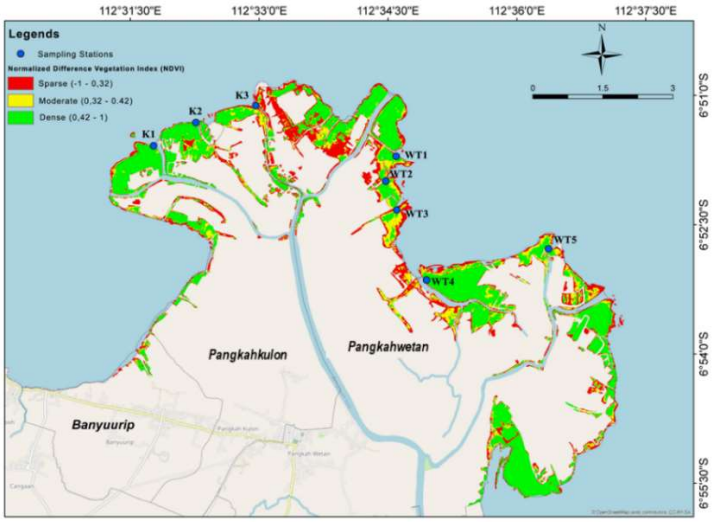



a. 2011: 496.3 Ha b. 2021: 1,554 Ha



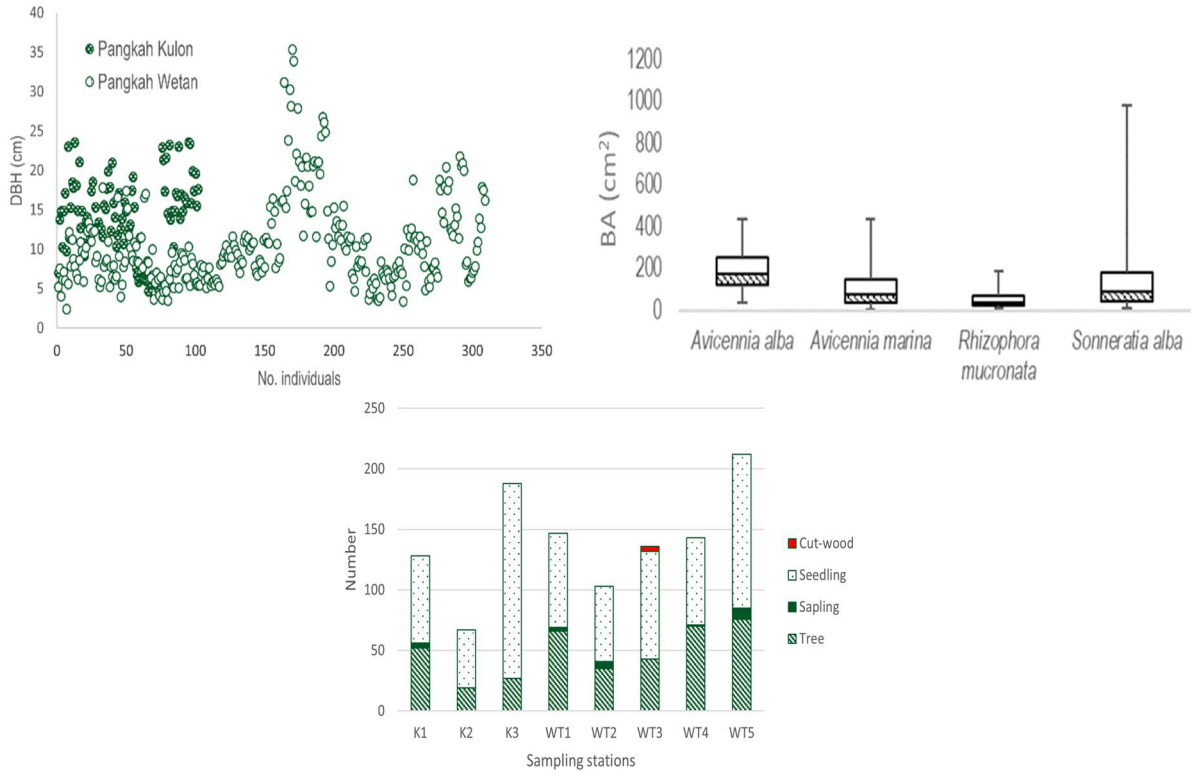

Mangrove sampling stations determined based on NDVI values on Landsat satellite images (Figure 3). Existing mangrove in Ujungpangkah is dominated by dense category (NDVI>0.42) covering an area of 1165.8 Ha (75% of total mangrove extent). In addition, there are 264.6 Ha (17%) of mangroves in sparse category (NDVI<0.32), and 123.6 Ha (8%) of mangroves categorized as moderate (NDVI 0.32–0.42). High NDVI scores and vast mangrove extents distributed over PK and PW indicates these two coastal villages represent most important mangrove areas in EEA Ujungpangkah.

Figure 3. NDVI value and sampling stations in EEA Pangkahkulon and Pangkahwetan villages



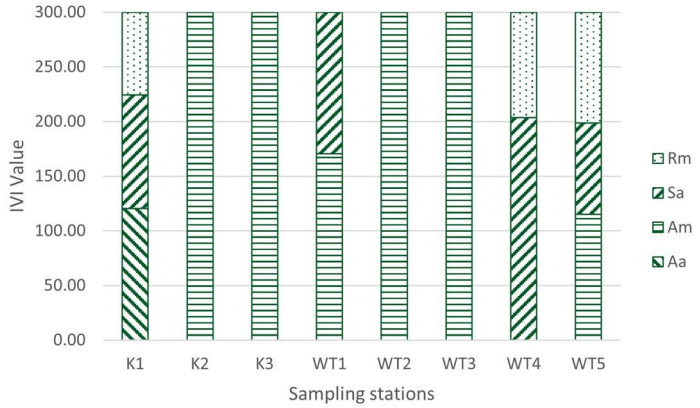

Characteristics of deep muddy delta resulted sampling stations mostly located in front mangrove (Figure 3). Mangrove stands in this area has grown naturally in the last 10 years. In this study, 4 species of true mangroves recorded from 411 individuals within 8 sampling stations in PK and PW, while at least 18 mangroves (25) and 90 species of shorebirds found in the EEA Ujungpangkah (26). Natural stands of genus *Avicennia* dominate this region, while various size of *Sonneratia alba* grow in the back as riverine mangrove. DBH size range from 2.39–35.33 cm (mean: 11.34; st.dev: 5.61) and vegetation height range from 4.12–28.69 m (mean: 8.65; st.dev: 4.36). Most of canopy cover were in dense class (mean: 85%; st.dev: 7.71%) with percent cover range from 60–94%. High proportion of seedlings shows occurrence of natural regeneration. Canopy cover represents dense formation of mangrove with most of remains mangrove stands located in front, while rear mangrove stands mostly converted into aquaculture farms. Land tenure appears to be main issue in rapid development deltas, and according to local community, most of the mangrove area within EEA Ujungpangkah has been claimed for personal ownership over decades.

Figure 4. Species composition and characteristic of mangrove DBH on sampling stations



Important Value Index (IVI) values show genus *Avicennia* dominates sampling stations, due to its ability to tolerate high salt content and frequent tidal inundation. Meanwhile, genus *Sonneratia* is known as a mangrove which has a favorite habitat in river mouths, due to the ability to adapt to vast range of salinity that enters the river mouth periodically during high tide. On the other hand, small portions of *Rhizopora mucronata* mainly result of rehabilitation programs carried out by government and CSRs. Large number of *Rhizopora* spp were planted during these activities but tend to be overgrown within 2-3 years after by Avicenniaceae and Sonneratiaceae as natural vegetation in EEA Ujungpangkah.

Figure 5. IVI value of mangrove species in study area




Mangrove Health Index (MHI) category in EEA Ujungpangkah ranging from "moderate" to "excellent". This is due to the number of mangrove species, dense canopy cover and high suitability environmental conditions to support mangrove development. These values represent suitable environmental factors to enhance fisheries productivity.

Table 2. Mangrove Health Index (MHI) in the study area

| Site code | Plot code | Lattitude | Longitude | MHI (%) category |
|---|---|---|---|---|
| PK | K1 | 6°51'36.36"S | 112°31'46.35"E | 48.95% (MODERATE) |
| PK | K2 | 6°51'20.05"S | 112°32'15.87"E | 50.44% (MODERATE) |
| PK | K3 | 6°51'8.78"S | 112°33'0.20"E | 76.57% (EXCELLENT) |
| PW | WT1 | 6°51'44.69"S | 112°34'39.37"E | 70.26% (EXCELLENT) |
| PW | WT2 | 6°51'58.85"S | 112°34'29.45"E | 62.05% (MODERATE) |
| PW | WT3 | 6°52'19.08"S | 112°34'37.06"E | 69.33% (EXCELLENT) |
| PW | WT4 | 6°53'8.77"S | 112°34'55.42"E | 81.53% (EXCELLENT) |
| PW | WT5 | 6°52'50.56"S | 112°36'22.54"E | 72.62% (EXCELLENT) |

### *Mangrove-fisheries characteristics*

Each village of PK and PW consist of one combined fishermen group (Rukun Nelayan – Fishermen Association) which oversees 7 smaller groups of fishermen based on their fishing gears. Even so, each fisherman has at least two fishing gears, to anticipate variations in catches along with shifting seasons. Fishermen association of "Pangkah Kulon" located in PK village, consists of 7 fishermen groups (total number of boats: 400), while Fishermen Association of "Muara Solo" located in PW village, consists of 7 fishermen groups with 419 number of boats (Table 2). In addition, there are total of 90 recreational fishing boats were operated in those villages. In general, each boat is operated by 2–3 people, which means at least 1818 fishermen involved in mangrove-fisheries activities in both coastal villages.

All of fishermen using <5 GT motorboats. Fishing becomes primary occupation, and almost all fish are caught all year round (except for offshore fishermen). Most of fishing locations were inshore (riverine, estuary and surrounding mangrove areas). Only one fishermen group going offshore (<30 miles) to catch *Pampus argenteus*. Some fishermen also provide boat rentals for recreational fishing. Catch commodities are abundance throughout region, mostly in north and east EEA Ujungpangkah. Fishermen shifted into different fishing locations during certain seasons (*e.g* rainy season). They catch different favorable types of fish (*e.g Portunus*), which can be abundant during high nutrient river runoff mixed with sea water into rivermouth. Also, during rainy season, fishermen with small boats shift closer to rear mangrove areas, to take shelter from storm and waves.

Table 3. Fishermen groups and categories of fishing gear in Ujung Pangkah

| Village | Fishermen group and primary target | FG | MS (“) | IMS | ICM | OFF | REC |
|---|---|---|---|---|---|---|---|
| PK | JKO – Mullet | Gillnet | <2 | v | v | | v |
| PK | JKR – Mangrove crab and blue crab | Gillnet | 2 to 3 | v | v | | v |
| PK | JKA – Barramundi | Gillnet | 4 | v | v | | v |
| PK | JC – Silver pomfret | Gillnet | >6 | | | v | v |
| PK | JKE – Spotted catfish | Gillnet | >6 | v | v | | |
| PK | CAG – multispecies of fish and shrimp | Fish trap | <3 | v | v | | |
| PK | CAD – multispecies of fish and shrimp (river) | Gillnet | <2 | v | v | | |
| PW | JKO – Mullet | Gillnet | <2 | v | v | | v |
| PW | JKR – Mangrove crab and blue crab | Gillnet | 2 to 3 | v | v | | v |
| PW | JS – Mullet and multispecies | Dredge | | v | v | | |
| PW | CAD - Shrimp | Gillnet | <2 | v | v | | |
| PW | PE – Mangrove crab | Fish trap | | v | v | | |
| PW | AN – Shrimp and mangrove crab (river) | Lift net | <2 | v | v | | |
| PW | PES – farm harvest worker | n/a | | | | | |

**PK (Pangkah Kulon); PW (Pangkahwetan); FG (Fishing Gear); MS (Mesh Size); IMS (Inshore Multi Species); ICM (Inshore Crustacea-Mollusca); OFF (Offshore); REC (Recreational fishing)*

Fisheries activity in EEA Ujungpangkah mostly characterized by one day fishing, as do fishermen in the Perancak mangrove area, Bali (Seary *et al.* 2021). Even so, number of catches were relatively high, which is economically significant to fishermen. At least three catch categories include finfish, crustaceans, and shellfish. More than 27 fish species are recorded in EEA Ujungpangkah (Table 3).

Table 4. List of fish species captured in the EEA Ujungpangkah

| No | Category | Local name | Genus/Species |
|---|---|---|---|
| 1 | Fish | Ikan Belanak | *Mugil spp* |
| 2 | | Ikan Bandeng | *Chanos chanos* |
| 3 | | Ikan Mujaer | *Oreochromis mossambicus* |
| 4 | | Ikan Kakap putih | *Lates calcarifer* |
| 5 | | Ikan Kakap | *Lutjanus spp* |
| 6 | | Ikan Glumo | *Gerres oyena* |
| 7 | | Ikan Putihan | *Caranx sexfasciatus* |
| 8 | | Ikan Payus | *Elops hawaiensis* |
| 9 | | Ikan Lausan | *E. tetradactylum* |
| 10 | | Ikan Geting | *Mystus gulio* |
| 11 | | Ikan Lidah | *Cynoglossus lingua* |
| 12 | | Ikan Bawal putih | *Pampus argenteus* |
| 13 | | Ikan Belosoh | *Acentrogobius caninus* |
| 14 | | Ikan Serinding | *Ambassis spp* |
| 15 | | Ikan Keting | *Arius maculatus* |
| 16 | | Ikan peperek | *A. fasciata* |
| 17 | Crustacean | Udang | *Penaeus* |
| 18 | | | *Macrobrachium* |
| 19 | | Kepiting bakau | *Scylla spp* |
| 20 | | Rajungan | *Portunus pelagicus* |
| 21 | Bivalve | Kerang kepah | *Meretrix* |
| 22 | | Kerang Batik | *Paphia* |
| 23 | | Kerang Simping | *Placuna* |
| 24 | | Kerang Darah | *Tegillarca* |
| 25 | | | *Noetia* |
| 26 | | Kerang Hijau | *Perna* |
| 27 | | Kerang Emas | *Limnoperna* |

Inshore fisheries mostly carried out on half day fishing category (6 to 8 hours), with number of catches varies greatly depending on fishing gear and season. In this study, which is carried out during outside fish harvest season, daily income of Ujungpangkah fishermen from direct selling fish range from Rp 40,000.00 – Rp 750,000.00 (average daily wage of informal workers in Gresik Regency is Rp 100,000.00). High fisheries productivity resulted EEA

Ujungpangkah remains favorable fishing destination for fishermen, even outside Gresik Regency. However, respondents describe those current fisheries conditions are much difficult compared two decades ago. Destruction of mangrove forests, water pollution and human development reduce fisheries catches, both in terms of size and number of catches.

## Conclusion

Mangrove in EEA Ujungpangkah plays important role to support fishing activities in north coast of East Java, where all of fishery's activities of within region connected to mangrove habitat. Although mangrove areas develop rapidly due to huge sedimentation rates, threat from land conversion remains a top priority in management. In accordance with Indonesian government's policy on mangrove conservation and rehabilitation, this area is suitable as priority for program implementations. Activities can be focused on existing mangrove protection initiative (local and national regulation), enhance diversification of derivative products (tourism, recreational fishing, processing of mangrove derivative products). Mangrove replanting activities can be carried out on a small scale for the purpose of species enrichment, considering this rapid development of deltaic region provides vast amounts of natural regenation of mangrove stands.

## Acknowledgements

This research is supported by Institute of Research and Community Services Brawijaya University (Grant of CoE/Research Group No.1204.17/UN10.C10/PN/2021)

## References

[1] Baloloy, A.B., Blanco, A.C, Raymund Rhommel, R.R.C., and Nadaoka, K. 2020. Development and application of a new mangrove vegetation index (MVI) for rapid and accurate mangrove mapping. *ISPRS J Photogramm Remote Sens.,*166: 95–117. DOI: 10.1016/j.isprsjprs.2020.06.001

[2] Budi Arifanti V., *et al.* 2022. Challenges and Strategies for Sustainable Mangrove Management in Indonesia. *A Review*, 13(5): 695. DOI: 10.3390/F13050695\

[3] Chen, B, *et al.* 2017. A mangrove forest map of China in 2015: Analysis of time series Landsat 7/8 and Sentinel-1A imagery in Google Earth Engine cloud computing platform. *ISPRS J Photogramm Remote Sens*. 131:104–20. DOI: 10.1016/j.isprsjprs.2017.07.011

[4] Dharmawan IWE, Suyarso, Ulumuddin YI, Pramudji. 2020. Panduan Monitoring Struktur Komunitas Mangrove Di Indonesia. 89 p. (in Indonesian)

[5] Harahab, N. 2009. Pengaruh Ekosistem Hutan Mangrove Terhadap Produksi Perikanan Tangkap (Studi Kasus Di Kabupaten Pasuruan, Jawa Timur). *J Perikan (J Fish Sci)*., XI(I): 100–106. Available at: https://jurnal.ugm.ac.id/jfs/article/view/2989/2697 (in Indonesian)

[6] Hartati, R, Widianingsih, W, and Prasetyo, Y. 2010. Komposisi dan Kelimpahan Krustasea di Kawasan Mangrove Muara Sungai Bengawan Solo, Ujung Pangkah - *Gresik. J Mar Sci.*, 13(1): 49–56. DOI:10.14710/IK.IJMS.13.1.49-56 (in Indonesian)

[7] Hutchison, J, Spalding, M, Zu Ermgassen, P. 2021. The Role of Mangroves in Fisheries Enhancement. Available at: www.nature.org.

[8] Hutchison, J, Spalding, M, zu Ermgassen P. 2014. The Role of Mangroves in Fisheries Enhancement. 54 p.

[9] Huxham, M., Kimani, E., and Augley, J. 2004. Mangrove fish: A comparison of community structure between forested and cleared habitats. *Estuar Coast Shelf Sci*., 60(4): 637–47. DOI: 10.1016/j.ecss.2004.03.003

[10] Manson, F.J., *et al.* 2005. A broad-scale analysis of links between coastal fisheries production and mangrove extent: A case-study for northeastern Australia. *Fish Res*. 1; 74(1–3): 69–85. DOI:10.1016/J.FISHRES.2005.04.001

[11] Martosubroto, P. and Naamin, N. 1977. Relationship Between Tidal Forests (Mangroves) and Commercial Shrimp Production in Indonesia. *Mar Res Indones*., 18: 81–6. Available at: https://mri.lipi.go.id/index.php/MRI/article/view/363/183

[12] Nagelkerken, I. *et al.* 2008. The habitat function of mangroves for terrestrial and marine fauna: A review. *Aquatic Botany*. 89(2): 155–85. DOI: 10.1016/j.aquabot.2007.12.007

[13] Nurdiansah, D., and Dharmawan, IWE. 2021. Struktur Komunitas dan Kondisi Kesehatan Mangrove di Pulau Middlebur. *J Ilmu dan Teknol Kelaut Trop*., 13: 81–96. (in Indonesian)

[14] Odum, WE, Heald, EJ. 1975. Mangrove Forests and Aquatic Productivity. 3: 129–36.

[15] Saputra, D.K., *et al.* 2022. Shoreline Evolution and Mangrove Landscape Transition in Probolinggo, East Java, Indonesia, 28(1). DOI: 10.53550/EEC.2022.v28i01.015

[16] Seary R, *et al.* 2021. Defining mangrove-fisheries: A typology from the Perancak Estuary, Bali, Indonesia. *PLoS One*. 16:e0249173. DOI: 10.1371/journal.pone.0249173

[17] Sukardjo, S. 2004. Fisheries Associated With Mangrove Ecosystem In Indonesia: A View from a Mangrove Ecologist. *Biotropia* (Bogor), 23:13–39.

[18] The 17 GOALS Sustainable Development. Available at: https://sdgs.un.org/goals

[19] Twilley, RR. 1988. Coupling of mangroves to the productivity of. Lect Notes Coast Estuar Stud. 22:155–80.

[20] van Oudenhoven APE, *et al.* 2015. Effects of different management regimes on mangrove ecosystem services in Java, Indonesia. *Ocean Coast Manag*., 116: 353–67. DOI: 10.1016/j.ocecoaman.2015.08.003

[21] Yona D, *et al.* 2018. Teknik Pembibitan Dan Penanaman Mangrove Di Banyuurip Mangrove Center, Desa Banyuurip, Kecamatan Ujungpangkah, Kabupaten Gresik. *J-Dinamika J Pengabdi Masy*, 3(1): 1–4. (in Indonesian)

[22] Zakiyah, DM. 2014. Pengembangan Perikanan Budidaya: Efektivitas Program Minapolitan Dalam Pengelolaan Perikanan Budidaya Berkelanjutan di Kabupaten Gresik. *J Pembang Wil dan Kota*. 10(4):453–65. Available at: https://ejournal.undip.ac.id/index.php/pwk/article/view/8171 (in Indonesian)

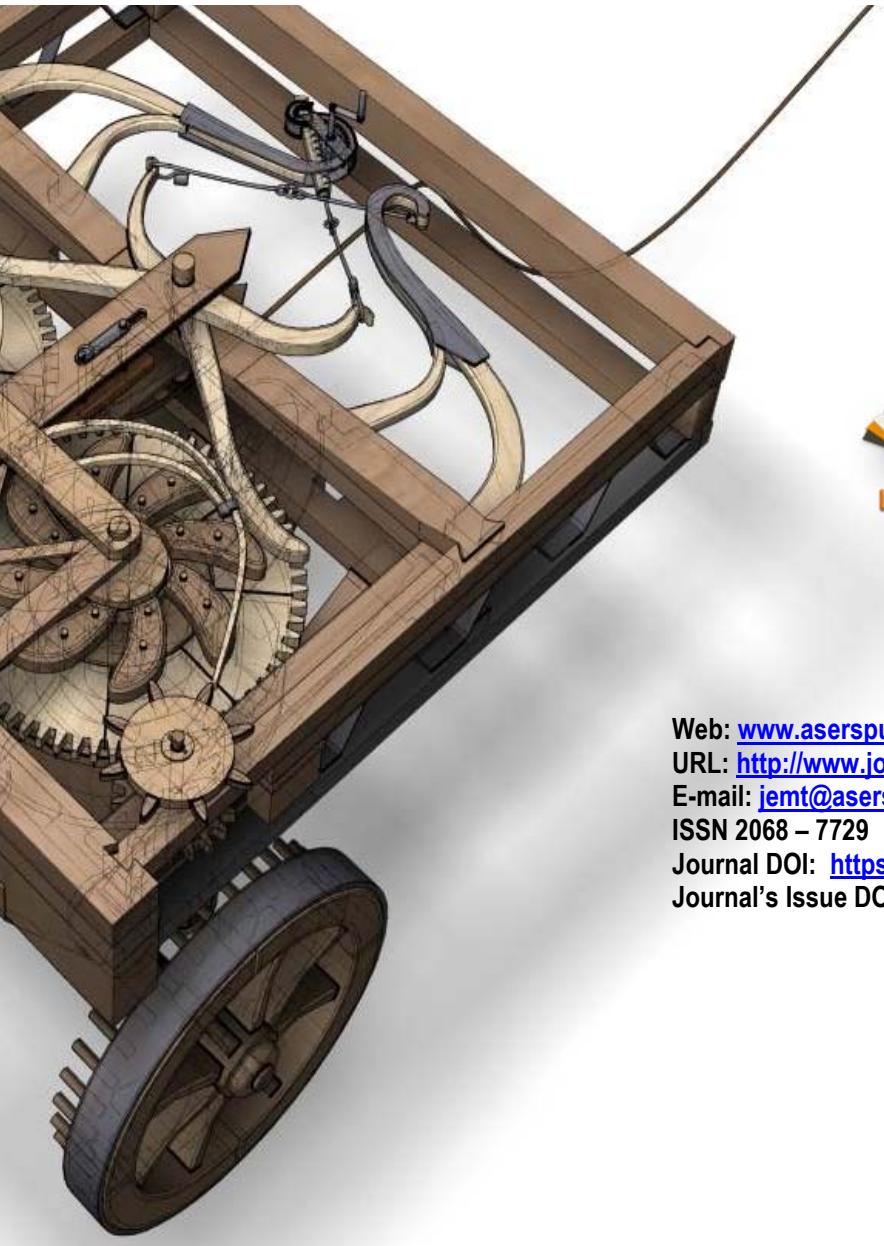
[23] zu Ermgassen PSE, *et al.* 2021. Fishers who rely on mangroves: Modelling and mapping the global intensity of mangrove-associated fisheries. *Estuar Coast Shelf Sci*., 248. Available at: http://creativecommons.org/licenses/by/4.0/

[24] BPS Kabupaten Gresik. 2021. Kabupaten Gresik Dalam Angka 2021. Gresik.

[25] KEE Ujung Pangkah: Antara Mangrove, Burung Migran, dan Ekonomi Masyarakat : Mongabay.co.id. [cited 2021 Jun 13]. Available at: https://www.mongabay.co.id/2021/03/26/kee-ujung-pangkah-antara-mangrove-burung-migran-dan-ekonomi-masyarakat/ (in Indonesian)

[26] KLHK. Peta Mangrove Nasional untuk Langkah Tepat Pengelolaan Mangrove. 2021. KLHK (in Indonesian)

ASERS



Web: www.aserspublishing.eu
URL: http://www.journals.aserspublishing.eu/jemt
E-mail: jemt@aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt
Journal's Issue DOI: https://doi.org/10.14505/jemt.v13.3(59).00