International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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Growth performance and community-based rehabilitation of *Rhizophora spp*. in Parangloe Village, Makassar City, Indonesia

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International Journal of Science and Research Archive, 2025, 17(01), 037-040

Publication history: Received on 23 August 2025; revised on 28 September 2025; accepted on 01 October 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.17.1.2729

Abstract

Mangrove ecosystems are essential for coastal protection, carbon sequestration, and biodiversity conservation. This study evaluates the growth performance and early ecological impacts of Rhizophora spp. planted in a 1-hectare restoration site in Parangloe Village, Makassar City, Indonesia. On August 28, 2024, a total of 3,000 propagules were planted using direct planting and nursery transplantation methods. Over six months, environmental parameters, seedling survival, and growth were monitored. The average survival rate was 87.4%, with a mean height increment of 5.8 cm/month. Community participation was pivotal, involving 100 local residents in planting, maintenance, and monitoring. Supported by PT Pertamina Patra Niaga Integrated Terminal Makassar, the community also established a mangrove nursery, successfully propagating 2,000 additional seedlings in 2024. Early ecological benefits included increased mud crab abundance and reduced shoreline erosion. These findings demonstrate the effectiveness of community-driven mangrove rehabilitation in enhancing coastal resilience and providing socio-economic benefits in urban coastal settings.

Keywords: Mangrove restoration; *Rhizophora spp*.; Community participation; Coastal rehabilitation; Makassar

1. Introduction

Mangrove forests play a crucial role in maintaining coastal stability, supporting fisheries, and storing significant amounts of carbon (Alongi, 2012). Indonesia possesses the largest mangrove area in the world, estimated at 3.36 million hectares (Giri et al., 2011). However, anthropogenic pressures such as land reclamation, pollution, and unsustainable harvesting have led to significant degradation (Kusmana, 2014). Parangloe Village in Makassar City has experienced a substantial decline in mangrove cover due to urban expansion and shoreline modification. Rehabilitation programs focusing on Rhizophora spp. are widely adopted in Indonesia because of their high salinity tolerance, structural resilience, and ecological benefits (FAO, 2007). This study aims to assess the initial growth performance of Rhizophora spp. in a 1-hectare degraded site and evaluate the role of community engagement, particularly with the facilitation of PT Pertamina Patra Niaga Integrated Terminal Makassar, in enhancing the sustainability of mangrove restoration efforts.

2. Materials and Methods

2.1. Study Area

The restoration site is located in Kasorokang, Parangloe Village, Tamalanrea District, Makassar City, South Sulawesi, Indonesia (coordinates: -5.108043°S, 119.443061°E). The district covers 31.84 km^2, with Parangloe classified as a

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coastal area bordering Biringkanaya District (north), Panakkukang District (south), Maros Regency (east), and the Makassar Strait (west).

2.2. Planting Material

Propagules of Rhizophora mucronata and Rhizophora apiculata were collected from nearby healthy mangrove stands.

2.3. Planting Methods

On August 28, 2024, 3,000 propagules were planted at 1 m spacing using:

- Direct planting into muddy substrates.
- Nursery transplantation for seedlings pre-grown for 3–4 months.

2.4. Community Participation and Nursery Establishment

The project engaged 100 residents in planting, maintenance, and monitoring. Under the guidance of PT Pertamina Patra Niaga Integrated Terminal Makassar, a community mangrove nursery was established, producing 2,000 additional Rhizophora seedlings in 2024 for future planting and distribution.

2.5. Environmental and Growth Monitoring

Environmental parameters included soil pH (6.8–7.3), water salinity (18–32 ppt), and temperature (28–31°C). Rainfall data were obtained from the Meteorological, Climatological, and Geophysical Agency (BMKG). Growth performance was assessed monthly from a 300-seedling sample (10% of the total), recording height and stem diameter. Survival rate was calculated based on living seedlings at each monitoring period.

3. Results

3.1. Survival and Growth

After six months, the overall survival rate reached 87.4%. Average height increased from 38.5 cm at planting to 73.3 cm, with a mean monthly increment of 5.8 cm. Stem diameter grew from 0.6 cm to 1.4 cm on average. Rhizophora mucronata showed slightly higher survival (88.9%) than Rhizophora apiculata (85.6%).

Table 1 Monthly Growth and Survival Rate of *Rhizophora* spp. in Parangloe Village (August 2024 – February 2025)

Month (2024–2025)	Average Height (cm)	Monthly Height Increment (cm)	Average Stem Diameter (cm)	Survival Rate (%)
Aug 2024 (Planting)	38.5	–	0.60	100.0
Sep 2024	44.6	6.1	0.72	96.8
Oct 2024	50.1	5.5	0.85	94.7
Nov 2024	55.9	5.8	0.97	92.3
Dec 2024	61.3	5.4	1.10	90.5
Jan 2025	67.5	6.2	1.24	88.7
Feb 2025	73.3	5.8	1.40	87.4

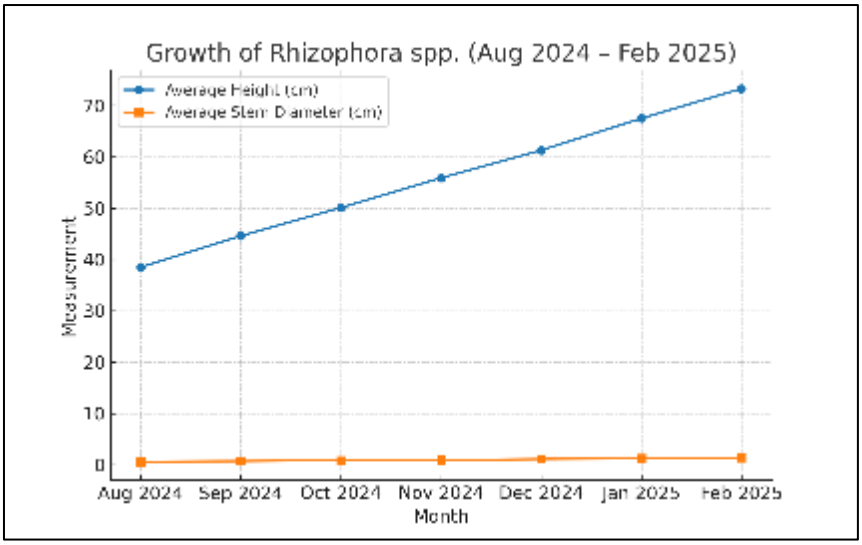

Figure 1 Growth of Rhizophora spp. (Average Height and Stem Diameter, Aug 2024 – Feb 2025)

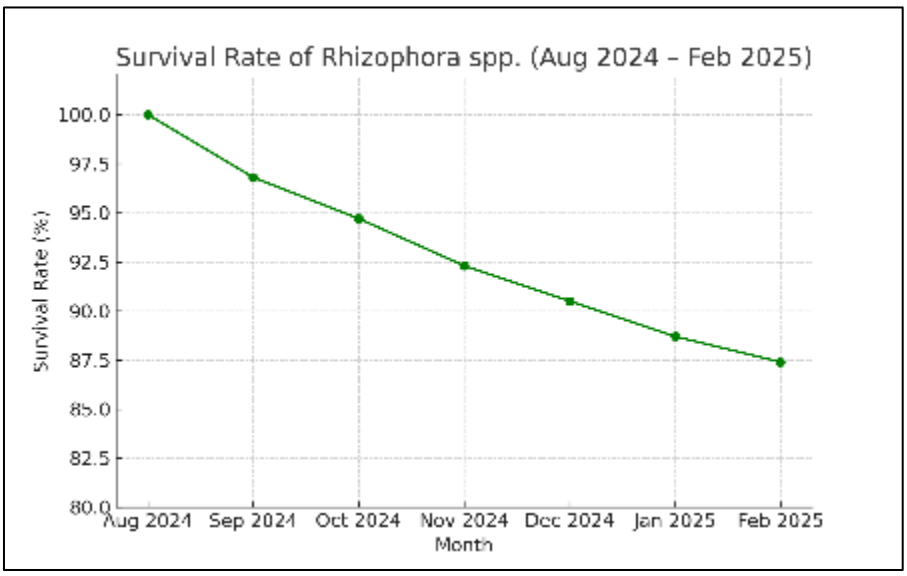

Figure 2 Survival Rate of Rhizophora spp. (Aug 2024 – Feb 2025)

Mangrove planting

Mangrove growth monitoring

Figure 3 Programs Mangrove

3.2. Environmental Conditions

Salinity levels ranged from 18–32 ppt, soil pH from 6.8–7.3, and water temperature from 28–31°C. These values remained within the tolerance range for Rhizophora spp. Sediment stability improved in planted zones, as indicated by reduced erosion markers.

3.3. Ecological and Socio-economic Impacts

- Ecological: Observations recorded an increased presence of mud crabs (Scylla spp.), indicating improved habitat conditions. Shoreline erosion decreased notably in planted areas.
- Socio-economic: Local fishers reported higher crab yields, contributing to supplementary household income. The community mangrove nursery produced 2,000 seedlings in 2024, ensuring a sustainable source for future planting and potential income generation.

4. Discussion

The combination of direct planting and nursery transplantation provided flexibility in adapting to site conditions, contributing to high survival rates. Similar to the findings of Primavera et al. (2012), strong community engagement—supported by institutional facilitation—significantly enhanced project sustainability. The establishment of the mangrove nursery by the local group, with the support of PT Pertamina Patra Niaga Integrated Terminal Makassar, represents a key capacity-building milestone, ensuring the continuity of rehabilitation beyond the initial project. Early ecological improvements, including habitat recovery for commercially valuable species such as mud crabs, highlight the intertwined ecological and economic benefits of mangrove restoration.

5. Conclusion

Mangrove rehabilitation in Parangloe Village successfully established 3,000 Rhizophora spp. seedlings across 1 hectare, achieving an 87.4% survival rate over six months. The integration of community participation, institutional support, and nursery development yielded promising ecological and socio-economic outcomes. Scaling such collaborative models could significantly enhance coastal resilience in urbanized areas of Indonesia.

Compliance with ethical standards

Acknowledgments

The authors express their gratitude to the residents of Parangloe Village, PT Pertamina Patra Niaga Integrated Terminal Makassar, local government agencies, and community organizations for their active participation and support in the mangrove planting and nursery development initiatives.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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