Transformasi: Jurnal Pengabdian Masyarakat, 21 (2), 2025: 407-419
p-ISSN 1858-3571 | e-ISSN 2580-9628

MANGROVE PLANTING IN THE COASTAL AREA OF THE PELAUW VILLAGE, HARUKU ISLAND, MALUKU AS AN EFFORT TO PREVENT SEAWATER INTRUSION

Zulfiah[1]*, Samsul Bahri[1], Delpina Nggolaon[1], Stevi Silahooy[1], Gede Wiratma Jaya[1], Aditya Ramadhan[1], Ervina Rumpakwakra[1]
[1]Universitas Pattimura, Ambon, Indonesia
*zulfiah@lecturer.unpatti.ac.id

Abstrak: Keberadaan aktivitas masyarakat pesisir dan perubahan iklim global dapat menimbulkan permasalahan jangka panjang di wilayah pesisir, seperti abrasi dan intrusi air laut. Permasalahan ini dijumpai di Negeri Pelauw, Pulau Haruku, Maluku yang menunjukan adanya indikasi intrusi air laut di beberapa lokasi sumur. Beberapa studi terdahulu menunjukan bahwa pengaruh intrusi air laut semakin kecil ketika eksosistem mangrove semakin lebar. Atas dasar itu kegiatan pengabdian ini mencoba melakukan penanaman mangrove dalam upaya mengurangi dampak intrusi air laut dan abrasi. Kegiatan ini dilandaskan pada metode community based participatory research (CBPR) yang melibatkan partisipasi aktif kelompok nelayan dan pemerintah setempat. Sebanyak 500 bibit diperoleh dari Balai Pengelolaan Daerah Aliran Sungai (BPDAS) Waihapu Batu Merah, Ambon dan ditanam di dua lokasi yaitu, di Teluk Namaea (100 buah) dan Tanjung Pesona (400 buah). Dua lokasi penanaman tersebut ditentukan berdasarkan hasil diskusi bersama dengan mitra dan pemerintah desa, analisis citra satelit, dan karakteristik sedimen. Kegiatan penanaman mangrove dilaksanakan selama dua hari pada Juli 2025 dengan mempertimbangkan kondisi pasang surut sekitar pantai. Penanaman hari pertama di Teluk Namaea pada pagi hari dan dianjutkan pada sore hari di Tanjung Pesona dengan keterlibatan mitra dan pemerintah desa. Hari kedua penanaman dilanjutkan di Tanjung Pesona yang dibantu juga oleh aparat TNI. Setelah penanaman, monitoring pertumbuhan mangrove dilakukan melalui komunikasi dengan perwakilan masyarakat Pelauw. Hasil evaluasi pertumbuhan mangrove pada bulan pertama, menunjukkan pertumbuhan yang baik, hanya ditemukan beberapa pohon yang mati. Kegiatan ini berharap mangrove bisa tumbuh dan berkembang serta mampu menurunkan dampak intrusi air laut, meskipun dalam jangka waktu yang panjang.

Kata Kunci: air tanah, intrusi air laut, mangrove, sedimen substrat, Pulau Haruku

Abstract: Coastal community activities and global climate change may lead to enduring issues in coastal regions, including erosion and seawater intrusion. We identified this issue at Negeri Pelauw, Haruku Island, Maluku, where we observed seawater intrusion in some dug wells. Prior studies have demonstrated that the impact of seawater intrusion diminishes as the mangrove ecosystem expands. This community service initiative aimed to plant mangroves to mitigate the effects of seawater intrusion and erosion. This project utilized the Community-Based Participatory Research (CBPR) methodology, engaging fisherman groups, coastal communities, and governmental entities. A total of 500 seedlings were acquired from "Balai Pengelolaan Daerah Aliran Sungai (BPDAS)," Waihapu, Batu Merah, Ambon, and planted at two sites: Namaea Bay (100 seedlings) and Tanjung Pesona (400 seedlings). The two planting locations were determined based on discussions with community members and the village government, satellite imagery analysis, and sediment characteristics. The mangrove planting activities were carried out over two days in July 2025, taking into account tidal conditions around the coast. The first day's planting took place in the morning at Namaea Bay, followed by the afternoon at Tanjung Pesona, with partners and the local government involved. The second day's planting continued in Tanjung Pesona, also assisted by Indonesian National Armed Forces (TNI) personnel. The first month's monitoring on mangrove growth showed that it was growing well, with only a few dead trees. Perhaps the mangrove ecosystem will continue to expand and develop, potentially mitigating the impact of seawater intrusion.

Keywords: groundwater, seawater intrusion, mangroves, substrate sediment, Haruku Island

Introduction

A major environmental problem is that seawater intrusion has contaminated multiple shallow groundwater sources in Pelauw Village, Haruku Island, Maluku. Seawater intrusion is common in small islands and coastal regions, making it challenging to supply clean water to local populations (Setyabudi et al., 2020). The primary source of clean water for people's daily consumption needs in the Pelauw region is shallow groundwater. Previous research on geoelectrical measurements (Figure 1) expresses that seawater intrusion has been identified significantly at three geoelectric measurement locations (V7, V8, V12) as indicated by low resistivity values (<7 Ωm), which is a strong indicator of the presence of seawater in the groundwater (Bahri et al., 2024). This result is also supported by the calculation of Dar-Zarrouk parameters used by Bahri et al. (2024), which shows that the saline water category, if Conductance (S)>1, consists of V3, V7, V8, and V12 (Figure 1a), but V3 has a high resistivity value, so it is not categorized as a saltwater aquifer. Water-quality testing of dug wells at several locations also supports this result, which showed high salinity ranging from 1.3 to 2.9% (Rumpakwakra et al., 2024).

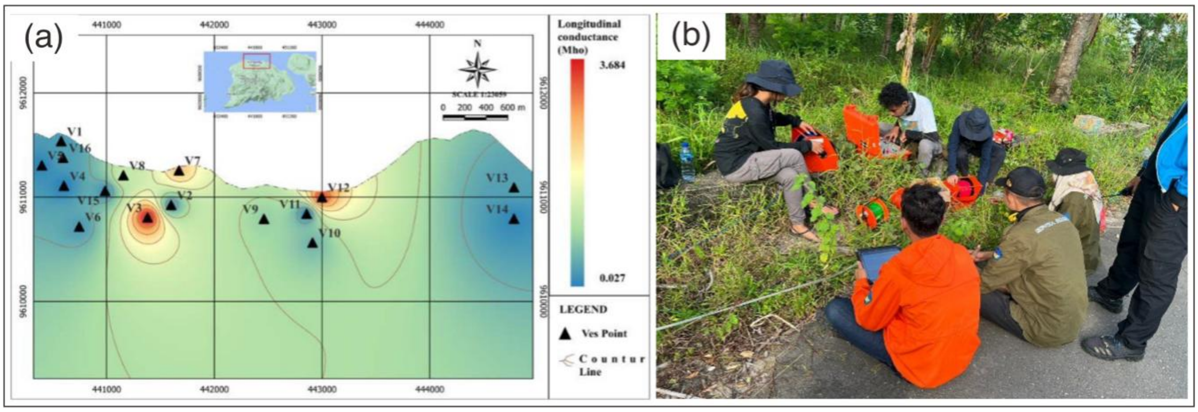

Figure 1. Map of longitudinal conductance in Pelau Village, and (b) Geoelectric resistivity measurement activities for mapping seawater intrusion in the Pelauw area (Bahri et al., 2024)

In addition to harming the ecosystem, seawater intrusion also compromises the health of nearby communities. Groundwater becomes brackish due to seawater intrusion, increasing the risk of hypertension from excess sodium intake (Purnomo et al., 2023), impaired kidney function from increased filtration load, and pre-eclampsia in pregnant women (Shammi et al., 2019). In addition, soil exposed to high salinity will experience a decline in physical and chemical quality (Masganti et al., 2023), including reduced water absorption and nutrient storage, thereby triggering agricultural land degradation in coastal areas, reducing crop productivity, and threatening food security. The society in the Pelauw area has clearly felt some impacts, including reduced coastal agricultural productivity, hypertension from brackish water consumption, and vulnerability to abrasion (Hilmi et al., 2017).

Groundwater is the primary source of drinking water and daily needs for the Pelauw community. Continuous groundwater exploitation will increase the potential for seawater intrusion, making groundwater increasingly saline and undoubtedly affecting long-term health.

To address this, it is necessary to conduct public outreach regarding seawater intrusion, as evidenced by the geoelectrical research of Bahri et al. (2024), and provide solutions. The approach taken involves outreach regarding the dangers and impacts of seawater intrusion. The solution offered is an ecosystem approach.

An ecosystem-based approach is needed to strategically mitigate the negative impacts of seawater intrusion on coastal communities in Pelauw. One efficient solution is to implement mangrove ecosystems (Fauziyah et al., 2024). Mangrove ecosystems play a crucial role as natural filters (natural barriers) that inhibit seawater intrusion through their root systems, stabilize sedimentation, and reduce groundwater salinity (Aurilia & Saputra, 2020; Hilmi et al., 2017). The loss of mangroves due to land conversion exacerbates this condition. Therefore, mangrove rehabilitation is not only an ecological solution but also part of sustainable development that integrates environmental, public health, and local economic aspects—especially for fishermen who depend on coastal ecosystems.

Although planting mangroves is not new in Pelauw, several attempts have failed. The mangroves that were planted perished. The failure was attributed to improper planting places and a lack of awareness of environmental cleanliness, according to preliminary surveys and conversations with the local authorities. Thus, the goal of this action is further to raise public awareness and understanding of environmental protection.

This mangrove planting program is designed to restore hydrological function while empowering communities to become active conservation actors. The mangrove planting program is a national, nature-based solution to mitigate the clean water crisis and restore the environment in the long term. Through a participatory approach, the program aims to increase community capacity in managing mangroves sustainably while also educating them about the relationship between coastal vegetation and groundwater quality. Collaboration with local fishermen ensures the sustainability of this initiative, as they are the frontline workers who depend on the health of coastal ecosystems.

Thus, this community service activity not only addresses local challenges but also contributes to global and national targets. Mangrove rehabilitation in Pelauw serves as an integrative model that combines geophysical science (as demonstrated by VES findings in previous research), local wisdom, and evidence-based policies to create long-term environmental resilience.

The purpose of implementing community service activities in the Pelauw area aligns with SDGs 6 (Access to Clean Water and Sanitation) and 14 (Sustainable Marine Ecosystems), as groundwater pollution threatens food security and public health (Shammi et al., 2019). In addition, mangrove degradation contributes to the violation of SDG 13 (Addressing Climate Change), considering that mangroves are effective carbon sinks. Interventions that promote ecosystem-based community empowerment align with the UN 2030 Agenda's principle of no one left behind, especially for remote coastal communities such as Pelauw. In the national context, this program supports President Prabowo Subianto's Asta Cita, specifically the points "Sustainable Green Development" and "Water and Energy Security." Mangrove rehabilitation prevents seawater intrusion and creates green jobs for the Pelauw Village fishing group—

program partners—as a concrete form of the blue economy. The program aligns with the government's vision to integrate infrastructure development with environmental conservation, as reflected in the 2025–2029 National Medium-Term Development Plan (RPJMN).

Method

The method used in this community service activity is community-based participatory research (CBPR), also known as community-based research (CBR). This method is a community-based approach to social change that prioritizes active participation by community members or service partners (Collins et al., 2018; Duke, 2020; Rusli et al., 2024). Participants in this community service program included 25 people from the Pelauw fisherman group, the Pelauw Village government, and the TNI personnel in Pelauw. The activity took place over two days in July 2025, specifically on July 12-13, 2025. We planted mangroves on the coast of Namaea Bay and Pelauw Beach (Tanjung Pesona), Haruku Island, Central Maluku Regency. Chart 1 and Figure 2 illustrate the various stages of this service activity.

1) Identification of problems based on literature studies from previous research related to the potential for seawater intrusion in the Pelauw Village of Haruku Island.
2) Collaborating with fishing organizations and the local government as partners. This procedure is used to communicate the activity's goals and objectives and to emphasize the value of planting mangroves, which includes reducing the effects of seawater intrusion.
3) Conducting site surveys with partners to determine mangrove planting locations and observing sediment as the mangrove substrate. The fishermen's group was consulted to decide on a suitable planting site. A partner indicated a spot; however, it was close to massive waves and faced the open sea. To ensure future planting sustainability, it was decided to plant next to an established mangrove environment after considering several factors.
4) For two days, fishermen's organizations, the local administration, and TNI staff participated in the mangrove planting event.
5) Collecting sediment samples using the coring method to obtain detailed sediment characteristics.
6) Processing sediment sample data through laboratory analysis in the form of granulometric and component analysis.
7) Direct inspections during the first week and month following planting help to maintain the results of mangrove planting. To immediately examine the planting results, this activity is conducted with partners.
8) Evaluation by measuring mangrove growth results, collecting data on sediment substrate characteristics, and providing recommendations and appropriate follow-up for future mangrove development.

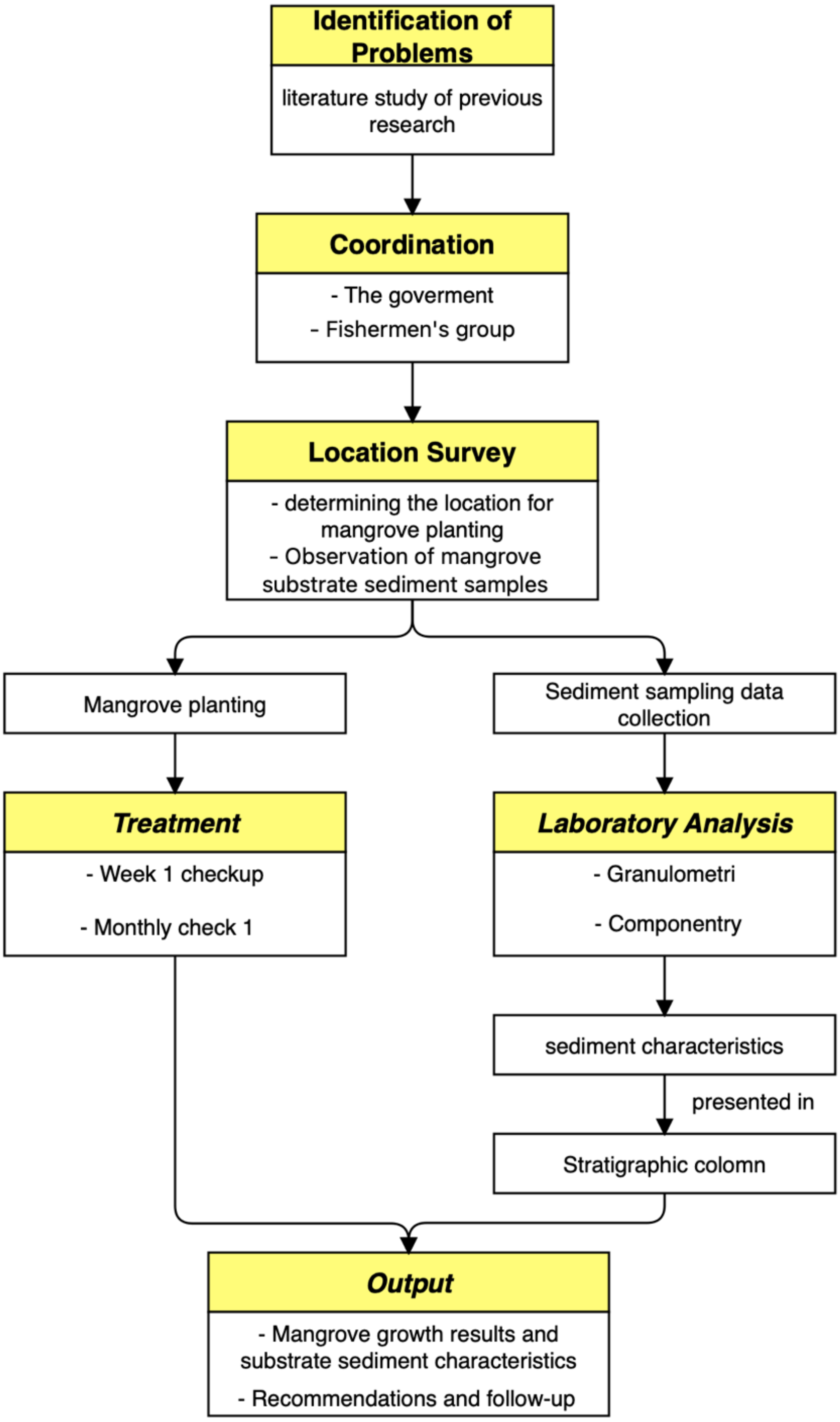

Chart 1. The Framework of the Community Service Program in the Pelauw Village of Haruku Island

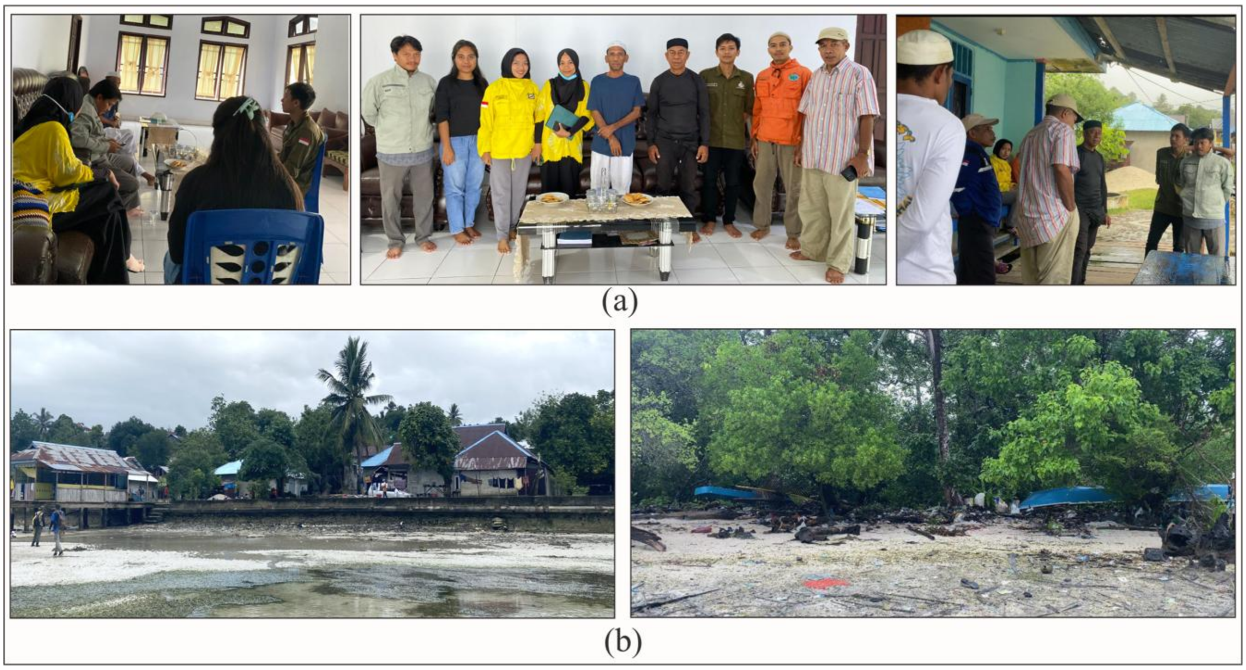

Figure 2. (a) Coordination process with local government and fishing group partners; (b) Survey of mangrove planting locations with partners.

Results and Discussion

This community service activity is based on the findings of Bahri et al. (2024), which showed the potential for seawater intrusion contamination in Pelauw Village, as indicated by geoelectrical subsurface resistivity measurements (Figure 3). In response to this issue, the community service team sought to develop a solution. Planting mangroves is one possible solution. Mangroves can reduce the impact of seawater intrusion by mitigating salinity, pH, pyrite, and anaerobic conditions (Hilmi et al., 2017). Mangrove planting activities were executed at two locations on the coast of Pelauw Village, Haruku Island, Central Maluku Regency (Figure 3). A total of 500 mangrove seedlings were planted, with details of 100 in Namaea Bay and 400 seedlings planted in Pelauw Village.

Prior to the community service activity, the first activity was collecting mangrove seedlings (Figure 4). These seedlings were obtained from the Ministry of Forestry at the Watershed Management Center Waihapu Batu Merah (BPDAS), Ambon. Therefore, this community service activity was carried out with the support and collaboration of the BPDAS Ambon. The mangrove seedlings were collected from the BPDAS nursery located at BTN Waiheru, Ambon City. In addition to mangrove seedlings, the Ambon BPDAS also provides other plant seedlings, such as clove, nutmeg, and others. To obtain these seedlings, must submit a written request to the BPDAS Ambon. Pelauw Village will have the opportunity to obtain seedlings for sustainable mangrove planting through this partnership with the BPDAS Ambon. To facilitate future seedling acquisition, the team has also spoken with partners and the village authority.

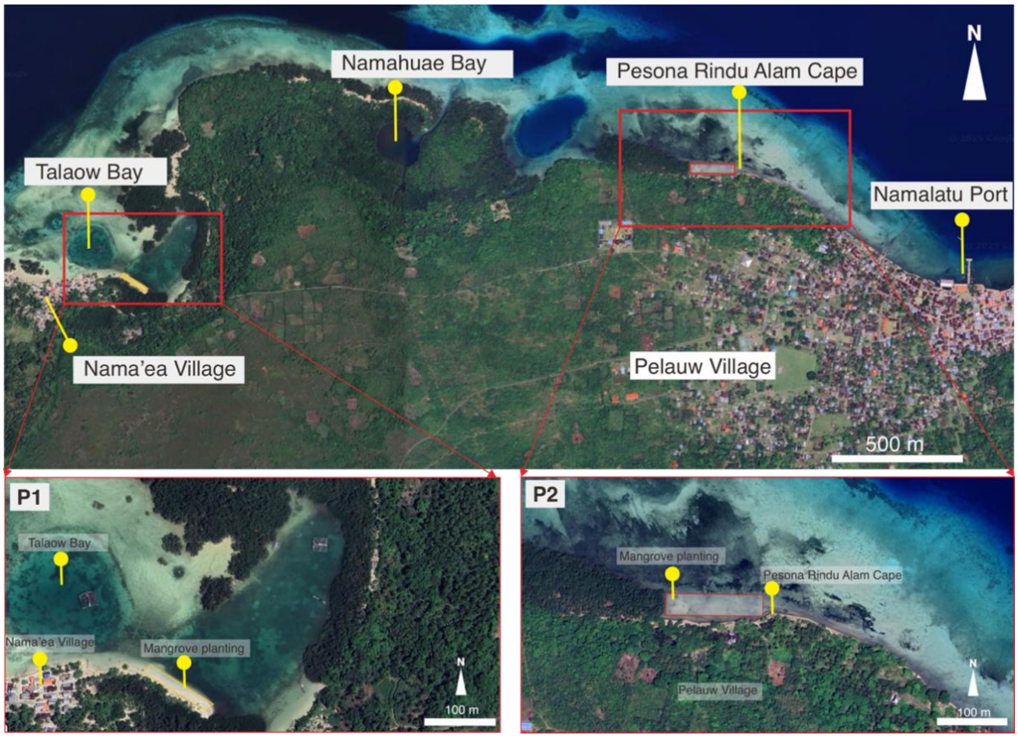

Figure 3. Mangrove planting locations in Nama'ea Village (P1) and in Pelauw Village (P2)

Figure 4. The mangrove seed collection in Waiheru Ambon was carried out in collaboration with BPDAS Ambon.

The mangrove planting activity lasted for two days due to adjustments to the tidal times in Pelauw Village. The pasanglaut.com website provides access to the maximum tidal times for a coastal area. The first mangrove planting activity took place in Namaea Bay on July 12, 2025, in the morning. The mangrove planting process in Pelauw Village took place on July 12, 2025, in the afternoon and continued on July 13, 2025, in the morning. During the planting activity, the fishermen's group, as partners, and the local government assisted. In addition, on the second day of planting, TNI personnel from Pelauw Village also volunteered to help make this mangrove planting activity a success (Figure 5). This activity teaches couples how to plant mangroves, including how to choose a spot, which mangrove variety to plant, how far apart to plant seedlings, how deep to dig holes, and how important support stakes are. Partners are able to plant and maintain the mangroves independently in the future.

Figure 5. Mangrove planting process in Nama'ea and Pelauw Village

In addition to mangrove planting, sediment sampling was also conducted around the planting site. This procedure aimed to identify the sediment's characteristics as a substrate for mangrove planting. Sediment samples were collected using a simple coring method using a one-meter-high pipe. Samples were identified and collected at each layer (Figure 6). Sediment samples collected around the P3 mangrove planting site showed sandy sediment with grain sizes varying from very coarse to very fine sand. The observed sediment depth reached 73 cm and consisted of four layers. Each layer showed a fragment composition consisting of mollusk fragments and coral fragments. The detailed results of the sediment data analysis are shown in the stratigraphy column in Figure 7 below.

Figure 6. Sediment sampling process around the mangrove planting location

The samples were then dried in an oven. This processing was done for further granulometric analysis and identification of the sedimentary fragments. Layer 1 was brownish with coarse sand grains, measuring 25 cm thick. The constituent material was dominated by sand (47.3%), fragments (46.4%), and a clay matrix (6.2%). The identified fragments consisted of mollusk shells and coral fragments. Layer 2 was brownish gray, with coarse sand grains measuring 17 cm thick. The constituent material consisted of sand (49.6%), fragments (49.2%), and a clay matrix (1.2%). Layer 3 was grayish in color, with medium sand grains measuring 21 cm thick. The constituent material was dominated by sand (65.1%), fragments (18.6%), and a clay matrix (16.3%). Layer 4, the top layer, was dark gray, with fine sand grains measuring 10 cm thick. The constituent materials are dominated by sand (87%), a few fragments (3.4%), and a clay matrix (9.6%).

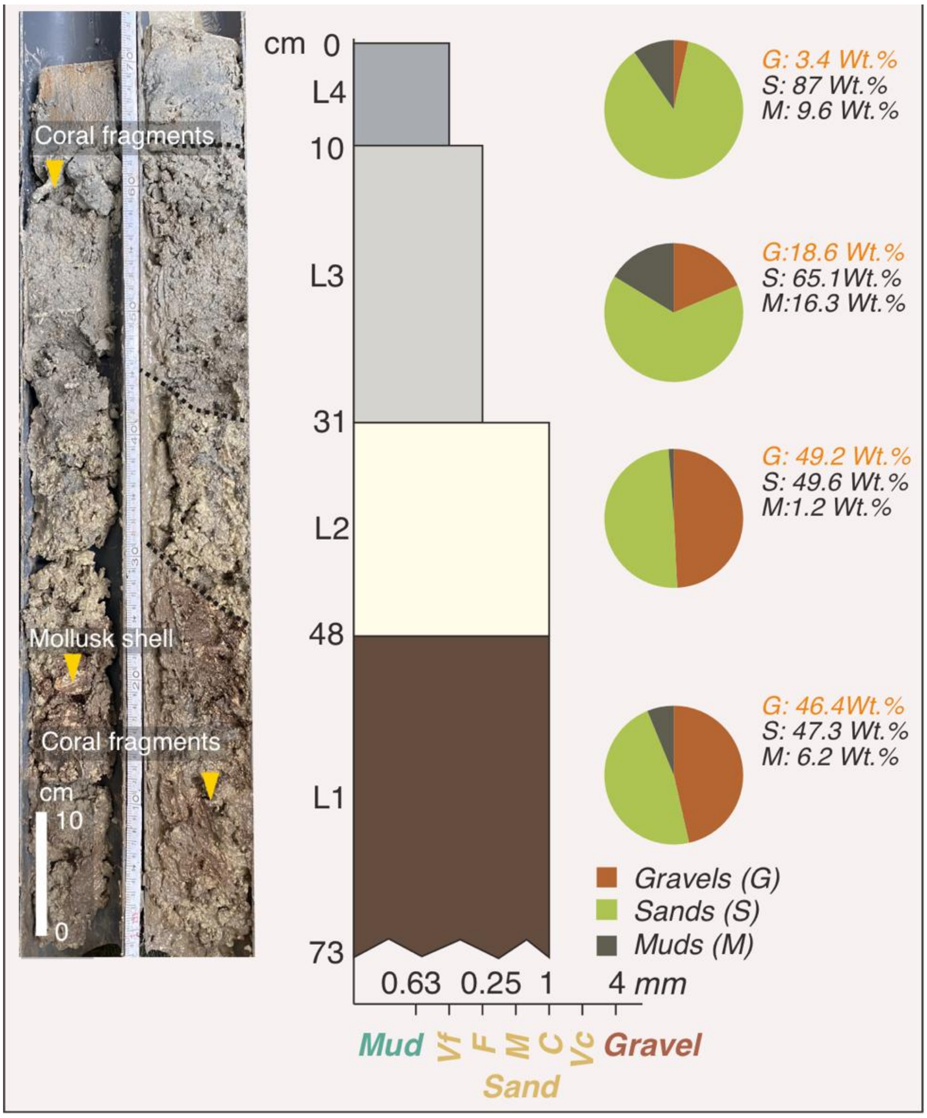

Figure 7. Stratigraphic column of the sediment substrate of the mangrove

The granulometric analysis results indicate that the substrate is dominated by sand. Fortunately, the top layer, approximately 30 cm thick, has a relatively high mud composition, ranging from 9.6 to 16.3 wt% (Figure 7). This substrate is still considered suitable for mangrove planting. This supports the findings of Putri et al. (2025), who claimed that mangroves can thrive on substrates made of fine sand, mud, and coral sediment.

It is suggested that mangrove planting began in areas near established mangrove ecosystems, based on sediment characteristics derived from granulometric analysis of core samples. This suggestion is consistent with the original choice of the planting site. This is because near-established mangrove habitats (Namaea and Tanjung Pesona) have fine-grained sediment. Mangroves are expected to grow and flourish to their full potential. Better mangrove development is indicated by finer sediment substrates with higher organic matter concentrations

(Windusari et al., 2014). Furthermore, water and nutrients required for mangrove growth can be stored in fine sediment (Ayu et al., 2023).

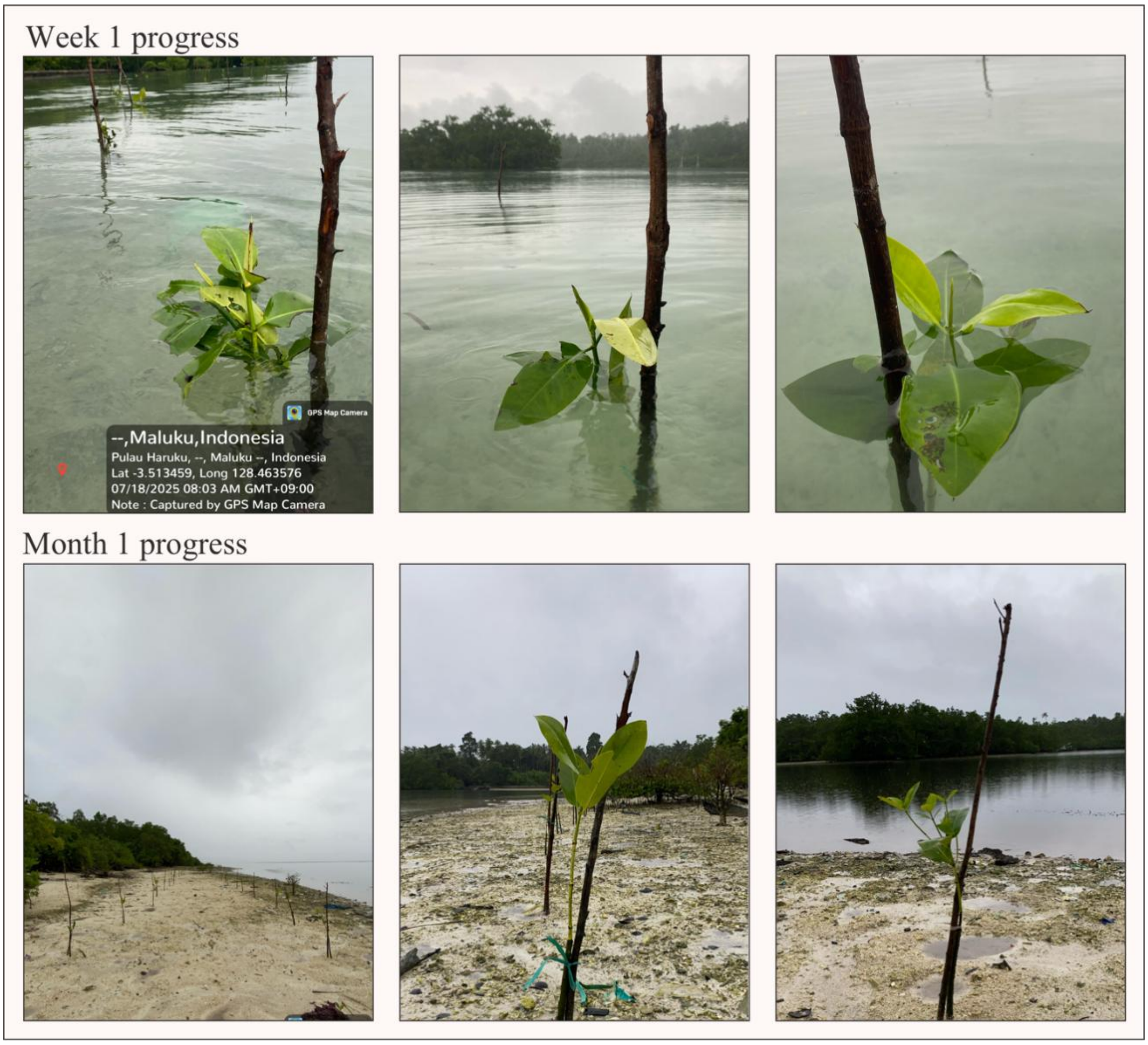

Figure 8. Growth and development of the planted mangrove in Pelauw Village

The evaluation of this mangrove planting activity is based on the development of mangrove growth after one week and one month of planting (Figure 8). However, the mangrove growth will continue to be monitored for the following year. This action aims to ensure the growth rate of the planted mangroves. In the first week of planting, the mangrove seedlings appeared fresh, and some showed new leaf growth. All planted seedlings appeared to be still alive. The first month showed excellent mangrove growth, with only a few dying. Several trees showed new branch development. Recommendations and follow-up going forward require special attention from the local government and community to maintain environmental cleanliness, keep beaches clean, and prevent littering, especially throwing garbage into the sea. The success of mangrove growth depends not only on the substrate type but also on environmental cleanliness.

Conclusion

A community service activity conducted in Pelauw Village, Haruku Island, in collaboration with a fishing group and the local government, successfully planted 500 mangrove trees across two coastal locations. The identification of the sediment characteristics of the mangrove substrate showed grain sizes ranging from coarse sand to very fine sand. The dominant composition was sand with coral fragments and mollusk shells. Evaluation results showed a fairly satisfactory level of mangrove growth, with only a few trees dying after one month of planting. Furthermore, this service activity has raised awareness among our partners about environmental protection and monitored the development of the planted mangroves. Cooperation with mangrove suppliers and Balai Pengelolaan Daerah Aliran Sungai (BPDAS) Waihapu Batu Merah Ambon will continue to ensure the implementation of the follow-up plan for mangrove planting on Haruku Island.

Acknowledgment

We thank Pattimura University for the financial support in 2025 through Rector's Decree No. 1007/UN13/SK/2025, without which this activity would not have been possible. In addition, thanks to the Balai Pengelolaan Daerah Aliran Sungai (BPDAS) Waihapu Batu Merah, Ambon, for helping provide mangrove seedlings. We extend our gratitude to Wildan Nur Hamzah for his assistance during the preparation and data collection process. Our deepest appreciation goes to the Fishermen's Group and the local government of Pelauw Village for their participation and assistance, ensuring this community service activity ran smoothly as planned.

References

Aurilia, M. F., & Saputra, D. R. (2020). Analisis fungsi ekologis mangrove sebagai pencegahan pencemaran air tanah dangkal akibat intrusi air laut. Jurnal Pengelolaan Lingkungan Berkelanjutan (Journal of Environmental Sustainability Management), 424–437. https://doi.org/10.36813/jplb.4.1.424-437

Ayu, S. M., Najib, N. N., Yumna, Witno, Maria, Liana, Sada, N. H., & Pitra (2023). Soil physial characteristics of the mangrove ecosystem in Bone Bay, Palopo City. Planta Tropika, 11(2), 70-79. https://doi.org/10.18196/pt.v11i2.16646

Bahri, S., Tualepe, D., Batlolona, Y. T., Ramadhan, A., & Parnadi, W. W. (2024). Vertical electrical sounding method and Dar Zarrouk analysis to identify the distribution of seawater intrusion in Pelauw Village, Maluku. Journal of Degraded and Mining Lands Management, 11(4), 6089–6097. https://doi.org/10.15243/jdmlm.2024.114.6089

Collins SE, Clifasefi SL, Stanton J, The Leap Advisory Board, Straits KJE, Gil-Kashiwabara E, Rodriguez Espinosa P, Nicasio AV, Andrasik MP, Hawes SM, Miller KA, Nelson LA, Orfaly VE, Duran BM, Wallerstein N. (2018). Community-based participatory research (CBPR): Towards equitable involvement of community in psychology research. Am Psychol, 73(7), 884-898. https://doi.org/10.1037/amp0000167

Duke, M. (2020). Community-Based Participatory Research. Oxford Research Encyclopedia of Anthropology. Retrieved 20 Jan. 2026, from https://oxfordre.com/anthropology/display/10.1093/acrefore/9780190854584.001.0001/acrefore-9780190854584-e-225

Fauziyah, N. L., Wahyu Setyaningsih, Dewi Liesnoor Setyowati, & Wahid Akhsin Budi Nur Sidiq. (2024). Distribusi Spasial dan Ketebalan Hutan Mangrove terhadap Intrusi Air Laut di Kecamatan

Cilacap Tengah. Indonesian Journal of Conservation, 13(1), 8–17. https://doi.org/10.15294/ijc.v13i1.5127
Hilmi, E., Kusmana, C., Suhendang, E., & Iskandar. (2017). Correlation Analysis Between Seawater Intrusion and Mangrove Greenbelt. Indonesian Journal of Forestry Research, 4(2), 151–168. https://doi.org/10.20886/IJFR.2017.4.2.151-168
Masganti, M., Abduh, A. M., Rina D., Y., Alwi, M., Noor, M., & Agustina, R. (2023). Pengelolaan Lahan dan Tanaman Padi di Lahan Salin. Jurnal Sumberdaya Lahan, 16(2), 83. https://doi.org/10.21082/jsdl.v16n2.2022.83-95
Purnomo, M. andy D., Nadhiroh, S. R., & Rachmah, Q. (2023). Hubungan Usia, Lama Melaut, Asupan Natrium, dan Kalium dengan Kejadian Hipertensi pada Nelayan di Desa Blimbing, Paciran Lamongan. Media Gizi Kesmas, 12(2), 827–832. https://doi.org/10.20473/mgk.v12i2.2023.827-832
Putri, L. D. M., Isman, M., Lapong, M. I., Fathuddin, Nobu, S., & Furkan, A. (2025). Hubungan tekstur sedimen terhadap vegetasi mangrove di Sungai Marana Desa Marannu Kecamatan Lau Kabupaten Maros. Jurnal Akuatiklestari, 9(1), 8-14. https://doi.org/10.31629/akuatiklestari.v9i1.7444
Rumpakwakra, E., Jaya, G. W., Bahri, S., Ramahdan, A., Zulfiah, Z., Thohirah, A., & Taipabu, M. I. (2024). Identification of seawater intrusion based on geochemical data in Pelauw-Kariu Region, Maluku. Journal of Degraded and Mining Lands Management, 11(3), 5575–5583. https://doi.org/10.15243/jdmlm.2024.113.5575
Rusli, T. S., Boari, Y., Amelia, D., Rahayu, D., Setiaji, B., Suhadarliyah, Syarfina, Ansar, Syahruddin, Amiruddin, & Yuniwati, I. (2024). Pengantar Metodologi Pengabdian Masyarakat. https://www.researchgate.net/publication/378870237
Setyabudi, H. E. P., Purwoto, S., & Husaini, H. T. (2020). Removal Natrium (Na+), Klorida (Cl-), dan Kesadahan Air Payau dengan Resin Penukar Ion. WAKTU: Jurnal Teknik UNIPA, 18(1), 7–14. https://doi.org/10.36456/waktu.v18i1.2305
Shammi, M., Rahman, Md. M., Bondad, S. E., & Bodrud-Doza, Md. (2019). Impacts of Salinity Intrusion in Community Health: A Review of Experiences on Drinking Water Sodium from Coastal Areas of Bangladesh. Healthcare, 7(1), 50. https://doi.org/10.3390/healthcare7010050
Windusari, Y., Sarno, Saleh, E., & Hanum, L. (2014). Substrate characteristics and its impact on distribution of mangrove species: a case study in Sungai Barong Kecil in the Sembalun National Park at Banyuasin, South Sumatra. Journal of Biological Researches, 19, 82-86. https://berkalahayati.org/files/journals/1/articles/799/submission/799-2350-1-SM.pdf