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Mitigating Anthropogenic Pressures on Sea Turtle Conservation Ecotourism: A DPSIR Analysis at Kili-Kili Beach, Trenggalek

Dinda Lufi Novitasari[1], Ardyanto Tanjung[2]

[1,2]Department of Geography, Faculty of Social Sciences, Malang State University

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Abstract

Sea turtle conservation ecotourism at Kili-Kili Beach (PTKK), Trenggalek, faces dual sustainability challenges stemming from high tourism potential and coastal geo-hazards. This study aims to analyze sustainability dynamics using the DPSIR framework (Driving-Pressure-State- Impact-Response) and assess community disaster resilience using the Hazard-Vulnerability- Capacity (HVC) framework to formulate structured mitigation strategies. The research employed a descriptive qualitative method through in-depth analysis, evaluating suitability indices (IKW: 84.93%; IKH: 77.77%) and primary data from interviews with the Community Watch Group (POKMASWAS) and area managers. DPSIR results showed a critical conflict where IKW exceeds IKH, driven mainly by educational tourism and weekend visits controlled by strict Village Regulations. Although POKMASWAS achieved highly effective local success (95% hatching rate), systemic decline (population decrease since 2013) suggests pressures beyond local management. HVC analysis highlighted high Vulnerability to Tsunami (near the Austroasian Trench) and Abrasion, exacerbated by residential areas being flat with sea level and the lack of structural Early Warning Systems (EWS). Mitigation capacity is strong in Eco-DRR (mangrove and pandanus planting), favored over expensive Giant Sea Walls, but weakened by reliance on signs and daytime WhatsApp communication for tsunamis. Therefore, a transformation is necessary: shifting from reactive management to data-based coastal landscape management using 60 biodiversity inventory points, formalizing Ecologically Essential Area (KEE) zoning, and strengthening POKMASWAS institutional capacity to reduce anthropogenic risk and build holistic resilience.

Keywords: Conservation Ecotourism; DPSIR; HVC; POKMASWAS; Disaster Mitigation; Kili-Kili Beach.

(*) Corresponding Author: *dinda.lufi.2307216@students.um.ac.id*

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INTRODUCTION

Indonesia is the world's largest archipelagic country, with a coastline extending approximately 81,000 km and encompassing no fewer than 17,508 islands, making it a center of rich biodiversity and marine resources. This natural wealth constitutes a fundamental asset for the development of sustainable marine ecotourism destinations, a sector recognized as one of the most promising industries of the third millennium, comparable to telecommunications and transportation. The fundamental principle of ecotourism requires a synergistic and

mutually beneficial relationship between tourism activities and conservation efforts. The integration of these two dimensions aims to ensure that biodiversity conservation not only provides intrinsic environmental benefits but also enhances the well-being of local communities. Nevertheless, the development of coastal areas as tourism destinations often generates complex anthropogenic pressures, necessitating a holistic analytical framework to ensure sustainability.

Taman Kili-Kili Beach (PTKK), located in Trenggalek Regency, East Java, represents a community-based coastal conservation ecotourism model that combines the attractiveness of a pristine natural beach with sea turtle conservation initiatives. The area is classified as an essential habitat that plays a critical role in the survival of rare large marine fauna. Physically, PTKK is characterized by its tranquil and unspoiled shoreline with soft sandy beaches, providing ideal conditions for sea turtle nesting activities. Four sea turtle species have been recorded nesting within this area: the olive ridley turtle (Lepidochelys olivacea), hawksbill turtle, leatherback turtle, and green turtle. The health of the coastal aquatic ecosystem is also considered excellent, as indicated by dissolved oxygen (DO) levels reaching 7.9 mg/L and a water pH of 8.1. These optimal ecological conditions constitute the primary focus of conservation efforts while simultaneously rendering the ecosystem highly sensitive to physical disturbances and human-induced pressures.

The management of PTKK faces a dual sustainability challenge: first, the conflict between tourism-driven economic development and the ecological carrying capacity of sea turtle habitats, which can be examined through the DPSIR (Driver–Pressure–State–Impact–Response) framework; and second, its vulnerability to natural geo-hazards such as tsunamis, coastal erosion, and tidal flooding due to its proximity to the Austroasian Trench. The DPSIR framework is employed to identify the interaction processes between coastal environmental systems and socio-economic systems, while also serving as an analytical basis for mitigating disasters associated with anthropogenic activities. Accordingly, this study integrates DPSIR analysis with the Hazard–Vulnerability–Capacity (HVC) Framework to assess the resilience of coastal communities. Based on these interconnected challenges, this research pursues four primary objectives:

1. To analyze the relationship between the Ecotourism Suitability Index (ESI) and the Habitat Suitability Index (HSI) within the DPSIR framework in order to identify thresholds of anthropogenic pressure;
2. To evaluate the effectiveness of mitigation responses implemented by POKMASWAS (Community-Based Surveillance Groups) in addressing local and systemic threats;
3. To map the Hazard, Vulnerability, and Capacity (HVC) of coastal communities in relation to tsunamis, coastal erosion, and tidal flooding; and
4. To formulate spatial and institutional management strategies that support the transformation of mitigation responses toward long-term sustainability.

RESEARCH METHOD

This study employed a qualitative descriptive approach, with the research site located at Taman Kili-Kili Beach, Trenggalek Regency, which has been designated as a Sea Turtle Conservation Area. This approach was selected to

facilitate an in-depth understanding of the sustainability dynamics and resilience processes occurring within this ecologically sensitive coastal environment. Data collection was conducted through comprehensive literature reviews, document analysis, and documented field observations undertaken during the Field Study Program (Kuliah Kerja Lapangan/KKL). The secondary data utilized in this study included reports on sea turtle conservation achievements, biodiversity inventory and verification data collected from 60 observation points, ecological reference data concerning water quality (DO 7.9 mg/L; pH 8.1), regulations related to Essential Ecological Areas (EEAs), including the existence of five village regulations focusing on environmental protection, sea turtle conservation, and environmental cleanliness, as well as data on the Ecotourism Suitability Index (ESI) and Habitat Suitability Index (HSI).

Primary data were obtained through structured interviews with seven (7) key informants, including the Head of the Community-Based Surveillance Group (POKMASWAS), area management personnel, representatives of the Municipal Public Order Agency (Satpol PP), and local community members. These interviews focused on respondents' perceptions and experiences regarding disaster-related hazards, vulnerabilities, and mitigation capacities, as well as the socio-economic dynamics of the area within the DPSIR framework. The principal analytical approaches employed in this study were the DPSIR (Driver–Pressure–State–Impact–Response) Framework and the HVC (Hazard–Vulnerability–Capacity) Framework. The DPSIR framework was applied to systematically examine and interpret the interactions between socio-economic systems and the coastal environment. The analysis was conducted by identifying socio-economic driving forces (Drivers), the resulting pressures (Pressures), current environmental conditions (State), the impacts generated (Impact), and existing or recommended mitigation strategies (Responses).

The findings derived from the DPSIR analysis served as the foundation for formulating spatial and institutional management strategies aimed at reducing anthropogenic risks. Meanwhile, the HVC framework was employed to assess the resilience of coastal communities to natural hazards. Qualitative data obtained from interviews were categorized into Hazard (identification of threats), Vulnerability (factors increasing the likelihood of damage), and Capacity (available resources and mitigation capabilities). The synthesis of the HVC analysis generated a comprehensive preparedness profile and identified critical capacity gaps that require immediate attention and intervention.

RESULTS AND DISCUSSION

Taman Kili-Kili Beach is subject to complex anthropogenic pressures driven by the conflict between its designation as an Essential Ecological Area (EEA) and the economic potential of tourism development. The primary Driver is reflected in the high Ecotourism Suitability Index (ESI) of PTKK, which reaches 84.93% (S1 category, highly suitable), strongly stimulating tourism expansion. Visitor patterns are predominantly characterized by educational tourism and school excursions, with peak visitation occurring on weekends. Economically, local communities depend primarily on tourism-related activities, including homestays and accommodation services, as well as agriculture, rather than marine resources, due

to hazardous sea conditions characterized by strong waves and deep ocean trenches. In contrast to the strong tourism-driven ESI, the Habitat Suitability Index (HSI) for sea turtle nesting areas is only 77.77%. This discrepancy generates substantial Pressure, indicating that ecological tolerance thresholds may be at risk of being exceeded by tourism attractiveness and development demands. Such pressures manifest through land-use conversion, including the clearing of coastal pandanus vegetation for camping areas, as well as persistent waste accumulation resulting from flash floods and debris transported through the Dongko River estuary, where waste deposits accumulate approximately every five days. From a management perspective, these pressures are partially mitigated by strong regulatory mechanisms, including the area's land ownership status under Perhutani and the existence of five village regulations specifically addressing conservation and environmental cleanliness.

Despite these anthropogenic threats, the current ecological State of PTKK remains relatively intact and favorable, characterized by a natural and tranquil coastal environment and excellent water quality. This condition is reinforced by the active collaboration of three Community-Based Monitoring Groups (POKMAS): the Mangrove Group, the Coastal Pandanus Group, and the Sea Turtle Conservation Group. Conservation efforts are concentrated within a dedicated one-hectare protected area within the total 87-hectare coastal zone. Coastal pandanus vegetation is recognized as a critical ecological component functioning both as a natural green belt against coastal erosion and as a navigational memory cue for nesting sea turtles. This reflects a significant transformation in local perceptions, shifting from resource exploitation for mat production toward ecosystem conservation. The mitigation Response implemented by POKMASWAS demonstrates a very high level of effectiveness in reducing local pressures, as evidenced by a hatching success rate of approximately 95% from around 10,000 sea turtle eggs. These responses are further strengthened by village-level institutions, particularly the Village-Owned Enterprise (BUMDES), which manages solid waste through a community-based fee system and converts organic waste into fertilizer using bioreactor technology.

Nevertheless, systemic Impacts continue to threaten the long-term sustainability of the ecosystem, as indicated by three documented records of declining hawksbill and green turtle populations in the area since 2013. The most significant negative economic impacts are observed in the agricultural sector, including financial losses caused by unstable commodity prices and damage to agricultural land resulting from tidal inundation. These conditions suggest that the local success achieved by POKMASWAS has created an illusion of sustainability. Although local conservation initiatives have effectively mitigated proximate threats, they have been insufficient to address broader systemic conservation failures. In summary, the sustainability dynamics of Taman Kili-Kili Beach are presented in Table 1.

Table 1**.** DPSIR Framework and Sustainability Gaps at Taman Kili-Kili Beach

DPSIR Component	Description and Key Indicators	Quantitative/Qualitative Data (Source)	Implications for EEA Sustainability Balance

Driver	Controlled tourism economic interests and local agriculture	ESI: 84.93%; tourism activities dominated by educational visits, school excursions, and weekend tourism; strong regulatory framework (Perhutani land ownership and five village conservation regulations)	Tourism development pressures are strictly regulated through spatial and institutional mechanisms; however, the discrepancy between ESI and HSI remains a persistent challenge.
Pressure	River-estuary waste accumulation and land-use conversion	HSI: 77.77%; waste transported from the Dongko River estuary (accumulating approximately every five days); conversion of coastal pandanus vegetation into camping areas	Creates ecological pressure whereby environmental carrying-capacity thresholds become increasingly vulnerable to exceedance. Management weaknesses remain evident in controlling non-point source pollution originating from riverine waste inputs.
State	Habitat health and community-based governance	"Natural and Tranquil" beach conditions; collaboration among three community-based monitoring groups (POKMAS); coastal pandanus functioning as a green belt and sea turtle navigational cue; 1-ha conservation area within a total coastal area of 87 ha	Current ecological conditions are maintained through strong community-based institutional arrangements represented by the three POKMAS groups.
Impact	Systemic conservation failure and agricultural losses	Declining hawksbill and green turtle populations since 2013; positive economic impacts from tourism activities, but agricultural losses caused by tidal flooding	Indicates the existence of broader systemic pressures operating beyond the boundaries of the Essential Ecological Area (EEA), which cannot be fully addressed through local management interventions alone.
Response	Local mitigation measures, BUMDES waste governance, and CSR initiatives	Sea turtle egg hatching success rate reached 95%; waste management is administered by the Village-Owned Enterprise (BUMDES) through a community contribution scheme of IDR 10,000 and the utilization of bioreactor technology; routine vegetation planting programs are conducted every *Minggu Kliwon* with support from Corporate Social Responsibility (CSR) initiatives provided by Pertamina, Bank BJB, and the Coal-Fired Power Plant (PLTU).	Although local mitigation initiatives and waste governance mechanisms have demonstrated considerable effectiveness, their long-term success depends on a transition toward integrated EEA-based spatial management capable of enhancing ecosystem resilience and ensuring sustainable conservation outcomes.

While anthropogenic pressures remain relatively controlled, Taman Kili-Kili Beach is also highly vulnerable to geo-hazard threats. The HVC analysis was employed to map disaster risks within the PTKK area. The coastal region of Trenggalek inherently faces significant tsunami and megathrust hazards due to its proximity to the Austroasian Trench subduction zone. Among these threats, a megathrust earthquake is considered the most feared because of its unpredictability, particularly if it occurs during nighttime hours. Other recurrent hazards include coastal erosion and tidal flooding, with a major erosion event recorded in May 2017. Ecological vulnerability within PTKK is particularly high with respect to coastal erosion because sea turtle conservation activities are conducted under semi-natural conditions, resulting in numerous nesting sites being located in erosion-prone areas. Large waves can erode beach sediments, causing nests to disappear, eggs to break, or embryos to perish due to inundation. From social and physical perspectives, vulnerability is reflected in both infrastructure conditions and the limited effectiveness of warning systems. Residential settlements are situated on relatively flat terrain at low elevations above sea level, increasing the likelihood of severe damage in the event of a tsunami. This vulnerability is further exacerbated by inadequate mitigation infrastructure, particularly the absence of a functional Early Warning System (EWS). Community members also reported that existing evacuation routes for tidal flooding events are not easily accessible. In addition, agricultural land constitutes a highly vulnerable area due to saltwater intrusion associated with tidal inundation.

Mitigation Capacity within PTKK is strongly rooted in ecosystem-based approaches and community participation. Local residents and POKMASWAS routinely implement coastal erosion control programs through the planting of coastal vegetation as part of an Ecosystem-based Disaster Risk Reduction (Eco-DRR) strategy, including mangroves, coastal pandanus, and casuarina trees. POKMASWAS explicitly rejects the installation of a Giant Sea Wall, considering it both ineffective and economically inefficient, and instead prioritizes vegetation-based solutions that are consistent with contemporary scientific recommendations. Institutional capacity is also relatively active, including disaster-risk awareness programs conducted by the Regional Disaster Management Agency (BPBD), the Environmental Agency, and the Tourism Office, as well as emergency response simulations. Evacuation routes and assembly points, including Tumpak Wareng and the Main Gateway Area, have been identified and marked. However, a significant structural capacity gap remains: no dedicated tsunami Early Warning System (EWS) or siren has been installed. An EWS initiative previously developed by community members was never fully implemented. Consequently, residents rely primarily on natural warning signs, such as earthquakes and sudden sea-level retreat, as well as WhatsApp-based communication during daytime hours. For nighttime events, however, community members acknowledged a sense of helplessness in responding to tsunami threats. Within the context of sea turtle conservation, nest relocation is used as a mitigation strategy to reduce vulnerability to coastal erosion. Nevertheless, in the event of a tsunami, the Head of POKMASWAS emphasized that human safety takes precedence, while mitigation measures for sea turtle hatcheries are considered secondary and largely

beyond practical intervention. The resulting hazard, vulnerability, and capacity profile is summarized in Table 2.

Table 2. Disaster Preparedness Analysis (HVC Framework) in the Taman Kili-Kili Coastal Area

HVC Category	Coastal Erosion and Tidal Flooding	Tsunami/Megathrust	Conservation Mitigation Implications
Hazard	Frequent coastal erosion; recurrent high-wave events; tidal flooding commonly occurs during November–February	High hazard potential due to proximity to the Austroasian Trench; megathrust events are unpredictable, particularly during nighttime	Direct physical threats to coastal habitats where sea turtle nesting sites are located
Vulnerability	Semi-natural sea turtle nests located in erosion-prone areas; agricultural land vulnerable to saltwater intrusion; tidal-flood evacuation routes are difficult to access	Communities are highly vulnerable, especially at night; residential areas are located on low-lying and relatively flat terrain; limited EWS and mitigation infrastructure	High vulnerability of core conservation assets and coastal settlements, exacerbated by the absence of a functional early warning system
Capacity	Routine Eco-DRR vegetation planting programs (coastal pandanus, mangroves, and other coastal vegetation); rejection of Giant Sea Wall construction due to perceived inefficiency; BUMDES-based waste management system	Knowledge of natural warning signs; evacuation-route signage and assembly points available; WhatsApp-based communication during daytime	POKMASWAS conducts sea turtle nest relocation to reduce erosion risk; however, human safety remains the primary priority during tsunami events, while conservation assets receive limited emergency protection

CONCLUSION

The Essential Ecological Area (EEA) of Taman Kili-Kili Beach is confronted with a complex dual-risk environment. The sustainability of sea turtle conservation-based ecotourism is characterized by a paradoxical condition: remarkable success in local conservation mitigation, evidenced by a 95% sea turtle egg hatching rate, while simultaneously facing increasing threats from spatial anthropogenic pressures (where the Ecotourism Suitability Index exceeds the Habitat Suitability Index) and geo-hazards, including tsunamis, megathrust earthquakes, and coastal erosion, which pose significant risks to semi-natural conservation infrastructure. Effective responses cannot rely solely on reactive measures, such as nest relocation; rather, structural interventions are required to address underlying management deficiencies and broader systemic impacts.

Mitigation strategies should therefore focus on three key priorities. First, the formalization of EEA zoning based on biodiversity data collected from 60 monitoring points is necessary to regulate ecotourism expansion and control increasing development pressures within buffer zones. Second, the institutional capacity of POKMASWAS should be strengthened through the adoption of appropriate technologies to support the professionalization of conservation and mitigation management, building upon the existing foundation provided by the three community-based monitoring groups (POKMAS) and the BUMDES waste-governance system. Third, structural early warning systems for tsunami risk must be established to complement existing ecosystem-based disaster risk reduction (Eco-DRR) measures, including mangrove and coastal pandanus restoration programs, while addressing persistent social vulnerabilities associated with low-lying settlements and limited nighttime preparedness. Through these transformations, PTKK can not only mitigate local environmental pressures but also enhance long-term socio-ecological resilience against systemic threats and future disasters.

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BIBLIOGRAPHY

Ahaya, M. A., Lumbuun, A. M., & Roreng, D. A. (2022). Pendekatan berbasis ekosistem dalam mitigasi bencana pesisir. Jurnal Pengelolaan Lingkungan Pesisir, 8(3), 120–135.

Aldian, R., Zuryani, E., & Putra Ulni, A. Z. (2022). Perubahan garis pantai sebagai akibat dari abrasi dan akresi di kawasan pesisir Pantai Barat Sumatera Barat. Social, Humanities, and Educational Studies (SHES): Conference Series, 5(4), 152. https://doi.org/10.20961/shes.v5i4.69042

At, C., Fern, C., Banyuwangi, B., & Java, E. (2023). Pengelolaan ekowisata konservasi penyu lekang (Lepidochelys olivacea) di Pantai Cemara Pakis Banyuwangi, Jawa Timur, Indonesia. Jurnal Kelautan dan Perikanan Terapan, 3(3), 157–163.

Basuki, R. S., & Purnomo, H. (2021). Evaluasi kelembagaan POKMASWAS dalam pengelolaan konservasi sumber daya pesisir. Jurnal Ilmu Kelautan Indonesia, 26(1), 45–59.

Cahyono, E., & Wibowo, S. (2023). Peran partisipasi masyarakat dalam penentuan zonasi kawasan konservasi. Jurnal Konservasi Sumber Daya Alam, 10(2), 78–90.

Dewi, N. I., & Santoso, J. (2024). Integrasi kerangka DPSIR dan HVC untuk penilaian risiko bencana di pesisir selatan Jawa. Jurnal Mitigasi dan Bencana, 5(1), 1–15.

Driver, P. D., Responses, I., Sitorus, S. R. P., Umamah, S., & Muna, N. (2023). Dinamika pemanfaatan lahan pesisir Kabupaten Indramayu dengan lokasi dan waktu penelitian. Jurnal Ilmu Pesisir dan Kelautan, 7(1), 11–21.

Dwi, L., Sanda, A., Vina, R. C., & Olivia, N. P. (2021). A sustainable ecotourism conservation model based on biodiversity analysis of Tambaan Coast, Pasuruan City, East Java Province, Indonesia. IOP Conference Series: Earth and Environmental Science, 718(1), Article 012003. https://doi.org/10.1088/1755-1315/718/1/012003

Fursenko, E. A., Kontorovich, A. E., Kostyreva, E. A., Padalko, N. L., Rodchenko, A. P., & Ryzhkova, S. V. (2024). Geochemistry of crude oils from the Bazhenov horizon (West Siberia). Russian Geology and Geophysics, 65(1), 85–97. https://doi.org/10.2113/RGG20234682

Gunawan, D., & Hidayat, A. (2020). Efektivitas EWS berbasis komunitas untuk tsunami di zona megathrust. Prosiding Seminar Nasional Kebencanaan, 45–52.

Harmini, S. (2009). Pariwisata dan lingkungan. Jurnal Sosial dan Ekonomi, 1(2), 45–56.

Herawati, T., & Putra, R. E. (2023). Pemetaan indeks kerentanan tsunami di kawasan pesisir Jawa Timur. Jurnal Geografi Indonesia, 12(3), 210–225.

Iskandar, A. A., & Ramadhani, S. (2022). Pengembangan model ekowisata penyu berkelanjutan. Jurnal Pariwisata Indonesia, 7(4), 301–315.

Kartika, R. T., & Wijaya, I. P. (2021). Dampak perubahan garis pantai terhadap habitat peneluran penyu. Jurnal Ekologi Pesisir, 15(2), 110–125.

Kurniawan, A. D., & Setyawan, B. (2023). Kajian daya dukung lingkungan (DDL) pariwisata di kawasan konservasi. Jurnal Penelitian Kelautan, 18(1), 60–75.

Lestari, P., & Widodo, A. (2024). Pemanfaatan teknologi informasi untuk monitoring konservasi penyu: Studi kasus aplikasi LENUK. Jurnal Konservasi dan Teknologi, 9(1), 1–10.

Maulana, A. F. (2021). Strategi mitigasi abrasi melalui rehabilitasi mangrove di Pantai Utara Jawa. Jurnal Ilmu Pesisir, 6(3), 150–165.

Pratama, V. D., Kurniawan, A., Resource, M., & Management, E. R. (2021). Jurnal Sumber Daya dan Lingkungan Pesisir, 9(1), 86–100.

Pusat Studi Bencana, Universitas Sebelas Maret. (2025). Local wisdom cerita rakyat “Smong” Simeulue Aceh dari sudut pandang kebencanaan: Meningkatkan kesiapsiagaan masyarakat Indonesia tentang mitigasi bencana megathrust. Indonesian Journal of Environment and Disaster, 4(1), 72–80. https://doi.org/10.20961/5f99wd39

Purwanto, J. (2020). Analisis spasial KEE pesisir menggunakan data inventarisasi keanekaragaman hayati. Jurnal Tata Ruang, 10(1), 30–45.

Ramdani, D., & Kusuma, D. W. (2023). Analisis DPSIR untuk pengelolaan sumber daya air Danau Inle. Jurnal Lingkungan dan Pembangunan Berkelanjutan, 10(4), 280–295.

Rinjani, E. K., Nurhidayah, & Panbriani, S. (2025). Analisis laju abrasi pantai dan strategi mitigasi berdasarkan pendekatan spasial. Nikè: Jurnal Ilmiah Perikanan dan Kelautan, 13(1), 17–25.

Setiawan, A. S., & Purwanto, B. (2022). Daya dukung ekowisata Pantai Teluk Penyu Kabupaten Cilacap. Jurnal Ilmu Kelautan Lesser Sunda, 2(2), 7–12. https://doi.org/10.29303/jikls.v2i2.58

Wahyuningtyas, N., Tanjung, A., & Kodir, A. (2020). Management of tourism areas based on disaster mitigation (Case study of Senggigi Beach). IOP Conference Series: Earth and Environmental Science, 412(1), Article 012015. https://doi.org/10.1088/1755-1315/412/1/012015

Yulia, R., Husin, H., & Zaki, M. (2024). Study of adsorption isotherms on removal of Cu (II) solution using activated carbon of sugar palm fruit shell (Arenga pinnata). IOP Conference Series: Earth and Environmental Science, 1290(1), Article 012008. https://doi.org/10.1088/1755-1315/1290/1/012008