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FOREST DEGRADTION DUE TO BUSINESS ACTIVITIES (CASE STUDY IN THE PBPH AREA OF PT WIJAYA SENTOSA, TELUK WONDAMA REGENCY, WEST PAPUA)

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ABSTRACT
Timber companies in West Papua operate within a strict regulatory framework set by the government and efforts to manage forests sustainably. The study aims to determine the environmental impact of logging around the PBPH area of PT Wijaya Sentosa, Teluk Wondama Regency, West Papua. The research method used is mixed using secondary data from AMDAL documents and RKL-RPL implementation report documents for 2019-2023. The study's results in the last five years have shown a decrease in abiotic components (increased noise, decreased surface water quality, and decreased air quality) and decreased biotic components (decreased biodiversity, decreased diversity of aquatic biota species). Changes in positive impacts on social components (job opportunities, opening up business opportunities, increasing community income). Balancing the various interests and stakeholders in forest management is crucial to achieving sustainable results. As well as empowering local communities, improving law enforcement, and coaching.

Keywords: Wood, Biodiversity, Forest Degradation, Logging.

1. INTRODUCTION
The world's forests are essential for human life, home to millions of plant and animal species, providing oxygen, regulating the climate, and storing water reserves (Pambudi, S, A., 2020). Indonesia, which has the third largest tropical forest in the world, is a prime example of the importance of forests (Pambudi, S, A., 2020). Indonesia's forests are renowned for their extraordinary biodiversity, with 10% of the world's flowering plant species, 12% of mammal species, 16% of reptile and amphibian species, and 25% of fish species (Harnowo, D. et al., 2021). (Espinosa et al., 2020) These diverse ecosystems are a treasure trove of natural resources and a vital component of the global climate system.
However, Indonesia's forests continue to face threats, with deforestation rates historically among the highest in the world (Pambudi, S, A., 2020). Driven by factors such as agricultural expansion, illegal logging, and infrastructure development, Indonesia’s forest loss has become a pressing national and global issue (Hidayat, Y. et al., 2021). Recognizing the urgency of this challenge, the Indonesian government has taken steps to curb deforestation, reporting a 75% and 03% decrease in deforestation rates between 2018 and 2019 (Hidayat, Y. et al., 2021). Deforestation and forest degradation remain pressing environmental issues in Indonesia, with the country experiencing one of the highest rates of forest cover loss globally (Sayer, J. et al., 2021).

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Similarly, the private sector has dominated forest management in Indonesia, covering 95.75% of the 42.25 million hectares of forest under private and community control, while local farmers and micro-enterprises only access 4.14% of this area (Pambudi, S, A., 2020). The case of the PBPH (Forest Utilization Business Permit) concession of PT Wijaya Sentosa in Wondama Bay, West Papua, provides an exciting example of the complex dynamics of forest degradation in Indonesia. Indonesia's moratorium on new oil palm, timber, and logging concessions, announced in 2010, aimed to reduce emissions from deforestation (Busch, J. et al., 2015). However, the reality on the ground shows that forest degradation continues, driven by various factors, including the expansion of profitable and legally permissible plantation agriculture, poor logging practices, and small-scale land clearing for agriculture (Sayer, J. et al., 2021).

Balancing the various interests and stakeholders involved in forest management is essential to achieve sustainable results (Hidayat, Y. et al., 2021). Empowering local communities, improving law enforcement, and coaching (Noventy, D, R. and Huseini, M., 2021). International cooperation programs are essential in the struggle to preserve Indonesia's invaluable forest resources. Therefore, a study was conducted on the environmental impacts of logging around the PBPH area of PT Wijaya Sentosa, Teluk Wondama Regency, West Papua. To determine the conditions of abiotic, biotic, and cultural factors around the PBPH area.

2. METODE

Mixed methods research has become an increasingly popular approach in various fields, as it allows researchers to harness the strengths of both quantitative and qualitative methods (Tariq, S. and Woodman, J., 2013). The application of mixed methods in this research has gained traction, providing a more holistic and comprehensive understanding of complex phenomena (Kaur, M., 2016). Analysis of abiotic and biotic samples comparing laboratory analysis results with quality standards—analysis of social samples by conducting interviews. The image of the research location is as follows.

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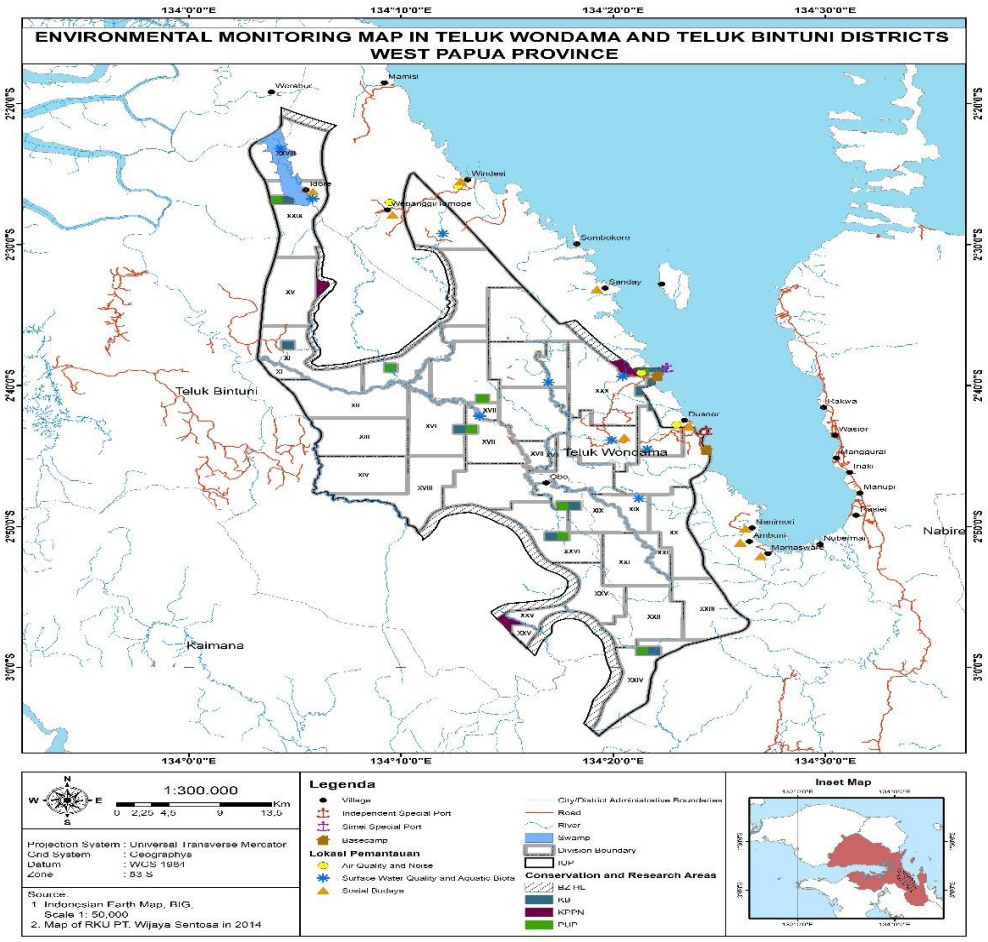

Figure 1 : Research Location Map
Source : Map creation using ArcGIS

3. DISCUSSION

3.1. RESULTS

The impact of the wood industry's existence in Teluk Wondama Regency affects the quality of the Abiotic, biotic, and cultural environment in the PBPH Teluk Wondama area. There is a decrease in air quality, increased noise, decreased surface water quality, and decreased diversity of flora and aquatic biota. In the social component, there is an increase in the number of residents around the PBPH Teluk Wondama area, job opportunities for the community, and increased income.

The existence of massive deforestation and forest degradation has had a severe impact on the damage to infrastructure and forest ecosystems in Indonesia. The issue of forest conservation is currently the most widely discussed issue among the public, academics, practitioners, and the government. This shows the importance of forest conservation. As we know, deforestation has caused severe damage to the environment and ecosystems in the forest. As in West Papua,

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deforestation continues to increase over time. Based on Forest Watch Indonesia (FWI) records from the compilation of data from the Ministry of Environment and Forestry (KLHK), from 2017 to 2020, there has been an increase in the area of production forest utilization in Papua and West Papua, which has reached more than 1 million hectares each year. The forest utilization area in other regions, such as Sumatra, Kalimantan, Nusa Tenggara, Maluku, and Sulawesi, only reaches hundreds of thousands of hectares each year.

Clearing forest areas for logging can lead to increased soil erosion and decreased surface water quality. Implementing best management practices, such as minimizing soil disturbance, maintaining vegetation buffers, and adequately managing logging roads, can help protect water resources (Skog & Stanturf, 2011). In addition to these environmental concerns, impacts on biodiversity, both flora and fauna, are essential considerations in sustainable forest management (Lattimore et al., 2013). Careful planning and selective logging practices can help conserve species diversity and maintain the ecological integrity of forest ecosystems (Sa' et al., 2017).

3.2. Discussion

Timber harvesting and transport activities can have significant environmental impacts, including reduced air quality due to transport of harvested products, microclimate changes due to forest harvesting activities, reduced air quality due to port or wharf activities, increased noise levels around activities and along transport routes, and adverse impacts on surface water quality due to forest clearing (Sahoo et al., 2019). Managing these environmental impacts is critical to sustainable forestry practices. Reducing air pollution, controlling noise levels, and maintaining water quality are vital considerations in managing the environmental impacts of timber harvesting (Lattimore et al., 2013). Careful planning, implementing logging activities, and using reduced-impact logging techniques can help mitigate negative environmental consequences (Putz et al., 2008).

Regarding air quality, emissions from transporting harvested timber can contribute to local and regional air quality degradation (Lattimore et al., 2013). Strategies to address this include optimizing transport routes, using cleaner transport fuels, and implementing emission control technologies (Lattimore et al., 2013). Microclimate changes caused by deforestation, such as temperature, humidity, and wind patterns, can also have broader ecological implications (Lattimore et al., 2013). Careful planning of harvest areas and practices that minimize disturbance to remaining forests can help maintain microclimate conditions and support sustainable ecosystem health (Brecka et al., 2018). Operations at ports and docks, where timber is loaded onto ships, can also generate air and noise pollution. Control measures such as dust suppression, noise barriers, and efficient material handling can help mitigate these impacts (Lattimore et al., 2013).

3.2.1. Abiotic Components

Sustainable forest resource management is a significant concern when facing ongoing environmental challenges. Deforestation and forest degradation can decrease productivity and supply of ecosystem services in the Wondama Bay PBPH area. Sustainable forest management is essential to balance the ecological, social, and economic values forests provide (Boyle et al., 2016). One of the main aspects of sustainable forest management is understanding the impacts of logging and land-clearing activities on the abiotic components of the ecosystem (Shono & Jonsson, 2022). Logging and land clearing in areas with IUPHHK permits can result in significant changes to the

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microclimate, air quality, noise levels, surface water quality, and ocean current and erosion patterns (Babweteera, 2012; Shono & Jonsson, 2022; Boyle et al., 2016).

Microclimate changes can occur due to the loss of forest cover, which causes changes in temperature, humidity, and wind patterns (Shono & Jonsson, 2022; Boyle et al., 2016). Timber transport activities in PBHP areas and port operations can also cause a decrease in air quality through emissions and dust generation. (Jemali et al., 2021) Increased noise levels due to logging and transport activities can negatively impact the local environment (Babweteera, 2012). Land clearing, infrastructure development, and port operations can decrease surface water quality. Changes in ocean current patterns can also occur near port areas, potentially affecting coastal ecosystems. In addition, increased erosion rates can occur due to disturbance of vegetation and soil stability during logging and land clearing (Babweteera, 2012; Balla et al., 2021; Jemali et al., 2021).

These abiotic changes can have cascading impacts on the ecological integrity of the forest ecosystem in the Wondama Bay PBHP area. Maintaining the balance of these abiotic components is very important to support the survival of plant and animal populations and the productivity and sustainability of forest resources in the long term (Jemali et al., 2021).

A. Decrease In Air Quality And Noise

Air quality and noise data collected from 2019 to 2023 from the Teluk Wondama PBHP Area show a consistent pattern of pollution levels within the regulatory limits set by the Indonesian government. In 2019 and 2020, measurements of total suspended particulates, sulfur oxides, nitrogen oxides, and carbon monoxide were relatively stable, with no significant fluctuations between the first and second semesters (Jones, 2004; Kusumaningtyas & Aldrian, 2016). This trend continued in the following three years, 2021 to 2023, indicating that air quality around the PT Wijaya Sentosa concession area remained within acceptable standards during the five years. With coverage of the area around the Logpond Mess, As in the following picture:

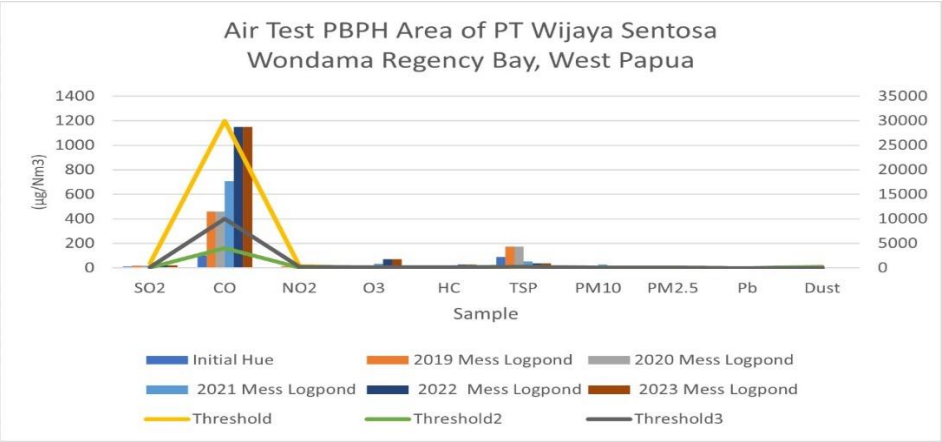

Figure 2 : Ambient air parameters in the PBPH area of PT Wijaya Sentosa Teluk Wondama

The ambient air quality laboratory analysis results were compared with the quality standards based on the Government Regulation of the Republic of Indonesia Number 41 of 1999 concerning Air

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Pollution Control. The average parameter results over five years are TSP parameters 230 mg/L, SO_2 900 mg/L, NO_2 400 mg/L, CO 30,000 mg/L. One potential explanation is the application of appropriate timber harvesting techniques, such as the construction of unique skid trails, which can minimize damage to the remaining stands and reduce the overall environmental impact of logging operations.

Overall, the value of each parameter is greater than the initial hue but still below the allowable threshold. When averaged over five years, the values of SO_2 parameters were 22.5 µg/Nm^3, CO 670.9 µg/Nm^3, NO_2 11.3 µg/Nm^3, O_3 58.1 µg/Nm^3, HC 19.6 µg/Nm^3, TSP 94.3 µg/Nm^3, PM_{10} 18.0 µg/Nm^3, $PM_{2.5}$ 7.8 µg/Nm^3, and Pb 0.1 µg/Nm^3. TSP in 2019 – 2020 reached a value of 174.17 µg/Nm^3, almost close to the threshold value of 230 µg/Nm^3.

In addition, the ASEAN Agreement on Transboundary Haze Pollution, signed in 2002, has facilitated regional cooperation and policy development to address transboundary air pollution issues, which may have contributed to the observed air quality (Jones, 2004; Patimah et al., 2021). There was an increase in noise levels at the activity site and along the logging/transportation route, with laboratory analysis results being compared to applicable quality standards. As in the following figure

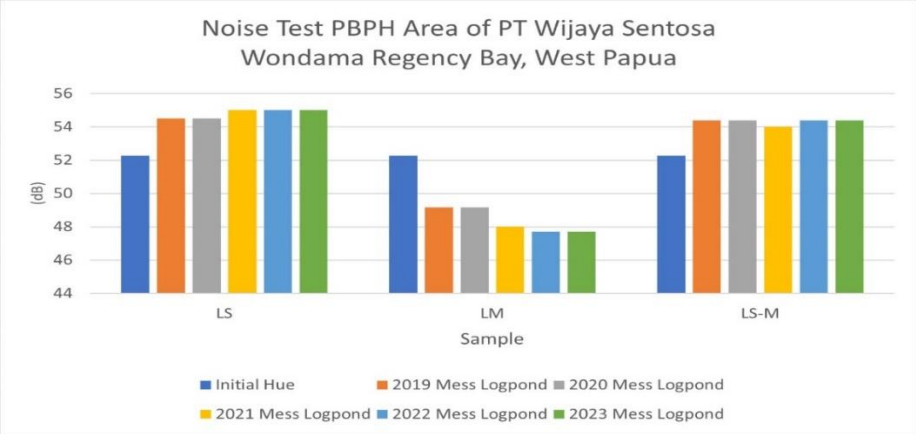

Figure 3: Noise parameters in the PBPH area of PT PT Wijaya Sentosa Teluk Wondama

According to the Decree of the Minister of Environment Number 48 of 1996 (Dewi et al., 2023), the noise quality standard for residential areas is 55 dBA. Noise measurements have been carried out for the past five years at the exact location, including the basecamp area. The noise level is around the Mess Logpond area, averaging 47.7 dB to 54.51 dB. The study results indicate that the noise level in the research area has exceeded the limits permitted by laws and regulations. Research in other areas found that noise levels due to human activities and transportation exceeded noise quality standards. Strategies that can be carried out to overcome noise pollution in the area include regulating the operating hours of recreational areas, regulating the implementation of activities that can cause high noise levels, adding soundproofing devices and planting trees, and carrying out traffic engineering such as regulating vehicle speeds and adding natural noise-reducing materials such as trees (Dewi et al., 2023).

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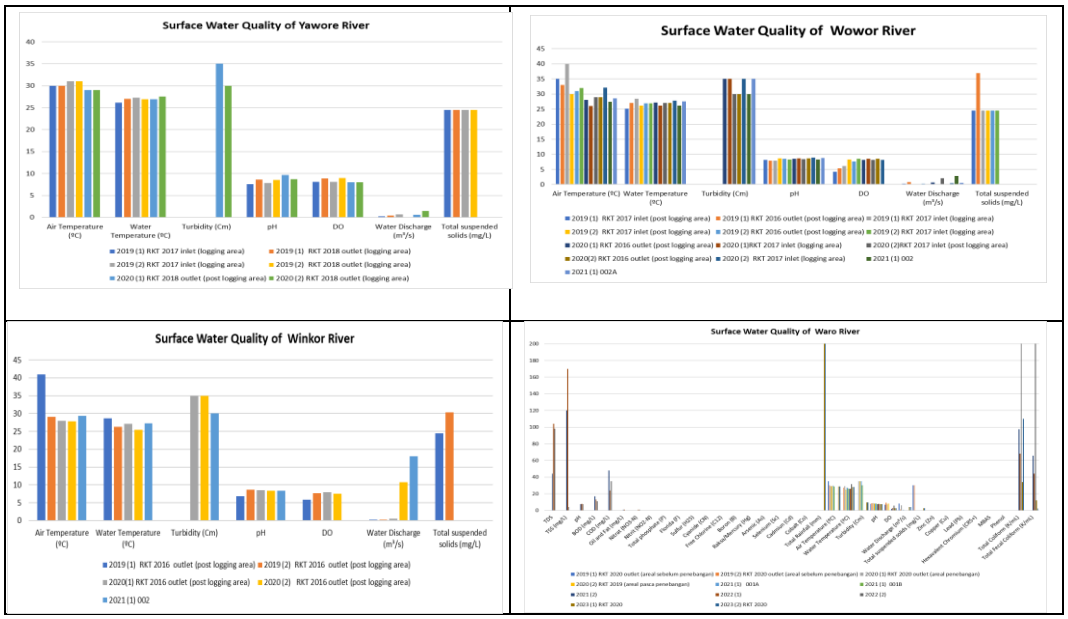
B. Decrease In Surface Water Quality

The decline in surface water quality due to forest clearing and infrastructure maintenance in the PBPH area of PT Wijaya Sentosa in Teluk Wondama Regency, West Papua, has become a significant environmental problem. Analysis of water quality parameters over five years, with sampling at the inlet and outlet of the PBPH area. Rivers in the area include the Yawore River, Wowor River, Winkor River, Waro River and Waro Creek, Urubati River, Naramasa River dan Naramasa Creek, Kasar River, and FSP River. The water quality parameters analyzed from 2019 to 2021 showed that the water was light in color, with an average air temperature range of 26°C to 33°C, a water temperature range of 25.2°C to 29°C, a pH range of 6.8 to 8.84, dissolved oxygen levels of 4.2 to 9.9, and a water discharge range of 0.16 m³/s to 29.84 m³/s. Total dissolved solids averaged 24-45 mg/L to 38.96 mg/L over two years (Rahayu et al., 2020). More comprehensive parameters analyzed from the end of 2021 to 2023 are still within the quality standards. However, a significant increase in the total coliform parameter was observed in 2022, reaching 1700 k/mL, while the highest total fecal coliform was 1500 k/mL.

The fluctuating water quality parameters during the five years are still within the quality standards set by Government Regulation No. 22 of 2021 concerning National Water Quality Standards. The presence of high levels of total coliform and fecal coliform in water samples is a concern because these microbiological indicators indicate potential contamination by pathogenic bacteria, which can pose a risk to human health (Rahayu et al., 2020; Patimah et al., 2023). In addition, the fluctuations in water quality observed during the five years may be caused by ongoing forest clearing and infrastructure maintenance activities in the PBPH area, which can impact the surface water system. Industrial and infrastructure activities often produce waste that can pollute water, either directly or indirectly. If not managed properly, this waste can result in excessive chemical and nutrient pollution, harming aquatic life and the community health that depends on the water source (Pradafitri et al., 2018), as in the following picture.



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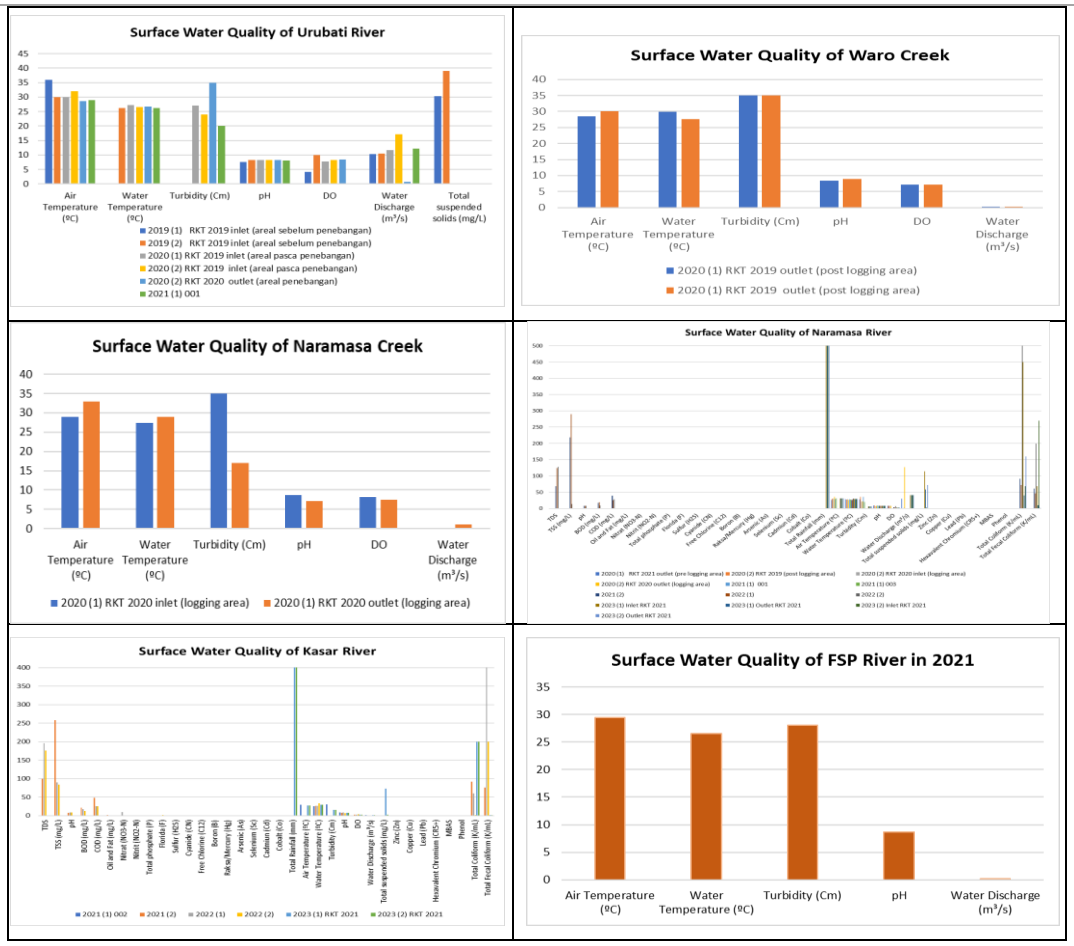

Figure 4: Surface water parameters 2019-2023 in the PBPH area of PT Wijaya Sentosa Wondama Bay

One factor that can affect the quality of surface water in the Wondama Bay PBPH region is rainfall. The region experiences a high annual rainfall of 5076 mm, considered a high rainfall area. Regions with high rainfall can dilute the concentration of particles and dissolved substances in water bodies, especially rivers, leading to lower overall water quality.

Several studies have examined the relationship between rainfall and water quality. One case study on the Yongding Diversion Channel in Beijing found that pollutant concentrations downstream showed more significant changes than those upstream after heavy rainfall, indicating that intense human activities around the channel influenced water quality due to runoff pollution. However, heavy rainfall also had a strong dilution effect (Wang et al., 2014). Similarly, research on the Hadejia River Basin in Nigeria found that while rainfall and temperature were significant drivers of spatial variations in surface water quality, differences in geological formations and land use changes also played a role, widening disparities in water resources across the basin (Umar et al., 2019).

3.2.2. Biological Components

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The forest around the PT Wijaya Sentosa concession in Teluk Wondama Regency, West Papua, has experienced a significant decline in biodiversity in both flora and fauna due to logging activities (Aratrakorn et al., 2006; Singh & Bhagwat, 2013). Tree felling and road construction reduce the number of plants and disrupt the existing ecosystem. The loss of flora directly impacts fauna, as many species depend on the habitat created by these trees (Singh & Bhagwat, 2013).

The resulting environmental instability can lead to soil erosion, water pollution, and local climate change. In addition to ecosystem disruption, the decline in plant diversity also reduces local communities' resources for survival, such as food, medicine, and raw materials. Effective conservation strategies must be implemented to minimize the negative impacts of human activities and promote sustainable management to conserve remaining biodiversity (Aratrakorn et al., 2006). Strict forest clearing monitoring and regulation should be prioritized to conserve threatened flora and fauna (Aratrakorn et al., 2006; Singh & Bhagwat, 2013; Indrawan et al., 2016).

3.2.3. Social Components

PBPH PT Wijaya Sentosa, located in Teluk Wondama Regency, is a business entity operating in the area for several years, providing various products and services to the local community. As a state-owned company, PT Wijaya Sentosa must implement and run Community Development Program activities through a cooperation agreement, just like other state-owned companies such as PT Perkebunan Nusantara III (Safnul et al., 2021). The impact of PBPH in Teluk Wondaman is an increase in the population due to the recruitment of workers around the PBPH area. There are job opportunities with the recruitment of local workers in the area around PBPH. With many local people being accepted as workers, the local community's income will increase.

Through the community development program, PT Wijaya Sentosa aims to empower the surrounding community by encouraging productive activities and expanding business opportunities to achieve mutual progress (Safnul et al., 2021). The company has established partnerships with strategic partners in various fields, including road construction, building construction, and government and private projects (Putra, 2023). One of the main aspects of PT Wijaya Sentosa's community development efforts is the provision of training, counseling, marketing support for its fostered partners, and training costs in the form of grants. This study analysis provides valuable insights into the environmental implications of timber harvesting activities in the PBPH area. Although the results of the study indicate that the transportation of harvested wood from the PT Wijaya Sentosa concession area has not had a significant impact on air quality, vigilance and monitoring of the situation are still essential to ensure the sustainability of the local environment in the long term.

The decline in aquatic biodiversity, flora, and fauna around the PBPH concession area requires serious attention. As a result of various human activities, such as logging, mining, land clearing, and pollution, abiotic and biotic diversity has decreased significantly. The diversity of aquatic biota, flora, fauna, and aquatic vegetation plays a vital role in maintaining the balance of the ecosystem. The decline in these species not only affects the health of the aquatic ecosystem but also threatens the livelihoods of communities that depend on these resources. The findings of this study underline the need for careful monitoring and management of water resources in areas

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undergoing development activities, such as forest clearing and infrastructure maintenance. (Patang et al., 2018)

Therefore, sustainable natural resource management practices and forest rehabilitation must be implemented to maintain surface water quality. Community and stakeholder involvement in the decision-making process is also essential in creating awareness of the importance of maintaining clean water ecosystems and environmental health. In this context, regular research and monitoring of aquatic biota diversity need to be conducted to identify impacts and formulate recovery strategies.

4. CONCLUSION

The analysis of air quality, disturbance levels, and surface air quality in the Wondama Bay PBPH area for the past five years (2019–2023) shows that the environmental conditions are still below the limits set by government regulations. Based on the Decree of the Minister of Environment Number 48 of 1996, the disturbance quality of the organizational area is 55 dBA, and the air quality is by Government Regulation of the Republic of Indonesia Number 41 of 1999 concerning Air Pollution Control. In addition, the surface air quality is still under Government Regulation Number 22 of 2021 concerning Surface Water Quality Standards. Logging activities have decreased abiotic and biotic components, including decreased air quality, increased disturbance levels, and decreased surface air quality. Deforestation and land clearing associated with logging have significant environmental impacts.

Careful planning and selective logging practices can help conserve species diversity and maintain the integrity of forest ecosystems. To address the problem of deforestation and forest degradation, a sustainable development approach that involves local communities as key stakeholders in forest conservation is essential. Involving communities and stakeholders in decision-making is essential to raise awareness of the importance of maintaining clean water ecosystems and a healthy environment. By ensuring the active participation of local communities, the biodiversity and overall well-being of the Wondama Bay area can be protected and enhanced.

REFERENCES

Aratrakorn, S., Thunhikorn, S. and Donald, F, P. (2006) "Changes in bird communities following conversion of lowland forest to oil palm and rubber plantations in southern Thailand," Cambridge University Press, 16(01),p. 71-71.

Busch, J., Ferretti-Gallon, K., Engelmann, J., Wright, M., Austin, K., Stolle, F., Turubanova, S., Potapov, P., Margono, B A., Hansen, M C., & Baccini, A. (2015) "Reductions in emissions from deforestation from Indonesia's moratorium on new oil palm, timber, and logging concessions," National Academy of Sciences, 112(5),p.

Babweteera, F. (2012) Seed Dispersal and Tree Spatial Recruitment Patterns in Secondary Tropical Rain Forests.

Boyle, J. Tapeiner, J. Waring, R. and Smith. (2016) "Sustainable Forestry: Ecology and Silviculture for Resilient Forests," Elsevier BV.

Balla, A., Silini, A., Cherif-Silini, H., Bouket, A. C., Moser, W. K., Nowakowska, J. A., Oszako, T., Benia, F., & Belbahri, L. (2021). The threat of pests and pathogens and the potential for biological control in forest ecosystems. *Forests*, *12*(11), 1–34.

ISSN: 2582-0745
Vol. 7, No. 04; 2024

Dewi, U, S, M, N., Maba, W. and Pandawani, P, N. (2023) "Strategies for Overcoming Environmental Noise in Recreational Area (Case Study in Tibubeneng Village, Kuta Utara District, Badung Regency)," , 06(04).

Espinosa, Griselda, Ikhsan, and Ferawati (2020) The Status of Indigenous Forest in Riau Province.

Hidayat, Y., Alfitri, ., Purnama, D H., & Riswani. (2021) "The Shape of Forest, Social and Economic Conditions of Community Living Around Production Forest with Industrial Plantation Forest Permit (Case Study: Forest Management Unit of KPH Meranti)," IOP Publishing, 810(1),p. 012022-012022.

Harnowo, D. et al. (2021) "Biodiversity conservation through sustainable agriculture, its relevanve to climate change: a review on Indonesia situation," IOP Publishing, 911(1),p. 012066-012066.

Indrawan, M., Caldecott, J. and Ermayanti, E. (2016) "Mitigating Tensions over Land Conversion in Papua, Indonesia," Wiley, 4(1),p. 147-157.

Jemali, N. J. N., Yahya, J., Bam, H. N. R., Majid, S., & Muhammad, M. (2021). High-quality timber species production under multi-storey forest management approach in Malaysia. *IOP Conference Series: Earth and Environmental Science*, *842*(1).

Jones, S, D. (2004) "ASEAN Initiatives to combat Haze pollution: An assessment of regional cooperation in public policy-making," Taylor & Francis, 12(2),p. 59-77.

Kaur, M. (2016) "Application of mixed method approach in public health research," Medknow, 41(2),p. 93-93.

Kusumaningtyas, A, D, S. and Aldrian, E. (2016) "Impact of the June 2013 Riau province Sumatera smoke haze event on regional air pollution," IOP Publishing, 11(7),p. 075007-075007.

Lattimore, B., Smith, C T., Titus, B., Stupak, I., & Egnell, G. (2013) "Woodfuel Harvesting: A Review of Environmental Risks, Criteria and Indicators, and Certification Standards for Environmental Sustainability," Taylor & Francis, 32(1-2),p. 58-88.

Noventy, D, R. and Huseini, M. (2021) "Implementation Efforts of the Nationally Determined Contributions Under the Paris Agreement," Atlantis Press.

Pambudi, S, A. (2020) "The Development of Social Forestry in Indonesia:," , 1(1),p. 57-66.

Putz, F E., Sist, P., Fredericksen, T S., & Dykstra, D P. (2008) "Reduced-impact logging: Challenges and opportunities," Elsevier BV, 256(7),p. 1427-1433.

Putra, A, T. (2023) "Evaluation And Analysis Of Decision-Making on the Business Method of hhe Paseh's Strategic Business Unit (SBU) For The Stones And Non-Metallic Mine At Jasa Sarana (Bumd Of West Java)," , 12(2),p. 989-1006.

Patimah, A. S., Prasetya, A., & Santosa, S. H. M. B. (2023). Environmental assessment of river water quality near oil and gas fields. Global Journal of Environmental Science and Management, 9(2), 1–12.

Pradafitri, S, W., Moersidik, S, S. and Abdini, C. (2018) "East Canal Flood as PDAM water resource DKI Jakarta," EDP Sciences, 74,p. 09001-09001.

Patimah, A. S., Murti, S. H., & Prasetya, A. (2021). Kajian Analisis Kualitas Udara Di Kawasan Migas : Studi Kasus (Tuban Dan Gresik) Jawa Timur. Seri Seminar Nasional Ke-III Universitas Tarumanagara Tahun 2021, 103–110.

Patang, F., Soegianto, A. and Hariyanto, S. (2018) "Benthic Macroinvertebrates Diversity as Bioindicator of Water Quality of Some Rivers in East Kalimantan, Indonesia," Hindawi Publishing Corporation, 2018,p. 1-11.

ISSN: 2582-0745
Vol. 7, No. 04; 2024

Rahayu, D., Anggoro, S. and Soeprobowati, R, T. (2020) "Water quality assessment based on microbiological parameter indicators for drinking water criteria on the Wadaslintang Reservoir," EDP Sciences, 202,p. 05019-05019.

Safnul, D., Kamello, T., Purba, H., & Ikhsan, E. (2021). Implementation of cooperation agreement on partnership and community development program at PT. Perkebunan Nusantara III. *IOP Conference Series: Earth and Environmental Science*, *782*(3).

Singh, M. and Bhagwat, A, S. (2013) Tropical Agricultural Production, Conservation and Carbon Sequesteration Conflicts: Oil Palm Expansion in South East Asia.

Shono, K. and Jonsson, Ö. (2022) "Global progress towards sustainable forest management: bright spots and challenges," Commonwealth Forestry Association, 24(1),p. 85-97.

Sayer, J., Boedhihartono, A K., Langston, J D., Margules, C., Riggs, R A., & Sari, D A. (2021) "Governance challenges to landscape restoration in Indonesia," Elsevier BV, 104,p. 104857-104857.

Sahoo, K., Bergman, R., Alanya-Rosenbaum, S., Gu, H., & Liang, S. (2019). "Life Cycle Assessment of Forest-Based Products: A Review," Multidisciplinary Digital Publishing Institute, 11(17),p. 4722-4722.

Skog, K E., & Stanturf, J A. (2011) "Forest Biomass Sustainability and Availability," American Chemical Society,p. 3-25.

Sa', A., Danjaji, A., & Ariffin, M. (2017) "Green infrastructure policy for sustainable urban development," Inderscience Publishers, 16(2),p. 112-112.

Tariq, S., & Woodman, J. (2013) "Using mixed methods in health research," SAGE Publishing, 4(6),p. 204253331347919-204253331347919.

Umar, D A., Ramli, M F., Aris, A Z., Jamil, N B C E., & Tukur, A I. (2019). Surface water resources management along Hadejia River Basin, northwestern Nigeria. IWA Publishing, 2(1), 184-199.

Wang, X., Li, J., Li, Y., Shen, Z., Wang, X., Yang, Z., & Lou, I. (2014). Is urban development an urban river killer? A case study of Yongding Diversion Channel in Beijing, China. Elsevier BV, 26(6), 1232-1237.