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Evaluation of Environmental Management Performance In Riau Province Using DPSIR Method

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ABSTRACT

This study evaluates the environmental management performance of Riau Province using the Driving Forces–Pressure–State–Impact–Response (DPSIR) framework. The assessment was conducted through data analysis, field assistance, stakeholder interviews, and evaluation of the regional environmental response index (IRLH) for 2024. Results show a significant improvement in the completion rate of IRLH inputs, reaching an average of 100%, although several regions still face data limitations and inconsistencies in local government involvement. The DPSIR analysis indicates that population growth, economic expansion, land-use change, and industrial development act as major driving forces that exert pressure on air quality, water quality, land resources, and peatland ecosystems. Key pressures include increasing motor vehicle emissions, forest and land fires, industrial wastewater, and unsustainable land clearing practices. These pressures lead to declining environmental states, evidenced by moderate water quality, degraded land conditions, frequent hydrometeorological disasters, and damage to peat ecosystems. The impacts include increased respiratory diseases, reduced availability of clean water, loss of biodiversity, and increased vulnerability to climate change. In response, the Riau Provincial Government has implemented various strategic programs such as emission monitoring, peatland rewetting, waste management initiatives, forest fire prevention units, and the



integration of environmental monitoring technologies. Although these responses demonstrate progress, challenges remain in enforcement, data quality, and cross-sectoral coordination. This study highlights the need for strengthened governance, improved environmental database systems, and enhanced community participation to support sustainable environmental management in Riau Province.

1. Introduction

The Environmental Quality Index (IKLH) has been used as an indicator of national environmental management performance since 2009 [1], in assessing general environmental conditions. Based on Minister of Environment and Forestry Regulation number 27 of 2022 concerning the Environmental Quality Index, the Environmental Quality Index (IKLH) is calculated based on the Water Quality Index (IKA), Air Quality Index (IKU), Land Quality Index (IKL), and Sea Water Quality Index (IKAL) [2]. The results of this calculation will produce a National IKLH value, an IKLH for each Riau Province, and an IKLH for each Regency/City.

Currently, the Environmental Impact Assessment (IKLH) has been used as one of the Government's Key Performance Indicators, both in the National Medium-Term Development Plan (RPJMN) and the National Medium-Term Development Plan (RPJMD) [3]. One of its priorities is to provide information data to the public regarding environmental quality. In addition, the IKLH also serves as a basis or reference to support the decision-making process in the field of environmental protection and management [4].

An imbalance occurs between the IKLH value that describes the condition of the environment and the efforts of local governments to control environmental pollution and damage, so that supporting instruments are needed to evaluate local government efforts [5]. In January 2022, the Regional Environmental Quality Response Index (IRKLHD) was developed, consisting of five programs, including the BlueSky Program, Clean River Program, Sustainable Beach Program, Sustainable Peat Program, and Green Indonesia Program [6]. The IRKLHD assessment includes seven criteria, including Policies and Regulations, Competency Structure and Development, Activity Planning, Activity Implementation, Stakeholder Involvement, Publication, and Innovation [7][8].

Based on the evaluation results of the Environmental Impact Assessment (IKLH) application in 2022, there are still difficulties in completing the required data. Furthermore, studies and analyses are still needed to determine the relationship between local government efforts to improve IKLH values, as well as recommendations for action plans that local governments can implement to improve IKLH values. Therefore, it is necessary to prepare a preliminary report on the study,

evaluation, and capacity building in the environmental management performance improvement program, which aims to provide information that can be used as a reference in future environmental management [9][10].

2. Research Significance

The purpose of this activity is to conduct studies, evaluations, and capacity building in environmental management performance improvement programs. The objective of this activity is to provide documents on the results of studies, evaluations, and capacity building in environmental management performance improvement programs.

3. Methods

The methods used include assistance in filling out the environmental response index application directly (face-to-face) and online, evaluation of the "DPSIR Analysis" at the Green Leadership award directly (face-to-face) and online, and evaluation of the success of the 2023 Riau Province action plan through interviews and data collection to related OPDs [11][12].

4. Results and Discussion

In 2024, the UNRI PSLH team, acting as a mentor for the Sumatra region, conducted two mentoring activities for filling out the Environmental Response Index (IRLH). These activities were carried out on October 21, 2024 (online) and October 24, 2024 (offline and online). A visible change was that the average achievement of filling out the response index had reached 100% [13]. Although in some places it was not optimal due to data availability, or also the bias of the local government in filling out this response index.

The DPSIR analysis process assumes that social, economic, and environmental conditions are interconnected. This relationship is demonstrated by driving forces, which theoretically cause environmental change by creating pressure on the environment, which ultimately affects environmental conditions. Then, there are impacts that arise in the form of impacts on ecosystems, the economy, and society. These impacts will be responded to by related parties in various ways (responses), including the development of spatial planning policies and environmental protection. The resulting policies will then influence the driving forces, pressure, state, and impact.

Based on Law Number 23 of 2014 concerning Regional Government and Government Regulation No. 38 of 2007, the authority for environmental protection and management (PPLH) which includes prevention, mitigation, recovery and/or environmental supervision has been delegated to provincial and district/city governments. In conducting environmental protection and management analysis and policy evaluation, regional governments need to use the DPSIR (Driver – Pressure – State – Impact – Response) method [14]. DPSIR is a framework for organizing information and data about environmental conditions [15].

The Riau Provincial Government, together with environmental institutions and the community, has initiated several strategic steps to improve environmental conditions, including:

1. Peat Ecosystem Restoration:

Through the Peat Restoration Agency (BRG), peatland rehabilitation is carried out to reduce the risk of fire and improve ecosystem function.

2. Technology-Based Forest and Land Fire Monitoring:

The use of technology such as satellite imagery to detect fire hotspots and enforce the law against perpetrators of illegal burning.

3. Waste and Garbage Management:

Integrated waste management program in urban areas to reduce water and soil pollution.

4. Forest Conservation and Biodiversity:

Empowering local communities through ecotourism and enhancing conservation areas.

Table 1 Completion of the Riau Province IKU DPSIR in 2024

Air Quality Index			
Driver	Pressure	State	Impact
D.1 The population of Riau Province increased to 6,642.87 thousand people, with a population growth rate of 1.40% from 2020 to 2023.	P.1 The increase in the number of motorized vehicles is around 4.5% annually, in 2023 the increase will reach 4,526,046 units, dominated by motorcycles reaching 3,858,981.	S.1 KPI Value (90.89) S.2 IKU Category (VERY GOOD) S.3 Value Per Parameter Average NO2 Concentration Industry: 9.38 Residential: 6.90 Office: 7.92 Transportation: 12.05 Average So2 Concentration Industry: 6.33 Residential: 5.00 Office: 7.15 Transportation: 9.22	I.1 Health: Increasing cases of acute respiratory infections (ARI) and pneumonia in toddlers. I.2 In Riau Province, cases of ISPA Pneumonia reached 1,873 cases with 61 cases classified as severe Pneumonia and 130,279 cases of non-Pneumonia cough.
D.2 Riau Province's economic growth in 2023 will reach 4.21%	P.2 The increase in the area of forest and land fires reached 7,269.58 hectares in 2023 from around 4,930 hectares in 2022 (data from the Riau Province BPBD). P.3 Industrial emissions: Palm Oil Processing Mills (PKS) and coal-fired power plants in Riau Province contribute to air pollution, especially sulfur dioxide (SO ₂), nitrogen dioxide (NO _x), and particulate matter (PM).	S.4 Regency/City Priorities	I.3 The highest pneumonia rate was found in Dumai City at 41.83%, the lowest was in Rokan Hilir Regency at 0.92% and Riau Province at 10.38%, below the national target of 70%. Compared to 2022, the number of pneumonia cases increased by 3.32%.

Driver Response	Pressure Response	State Response	Impact Response
R.1 Expand the air quality monitoring network to determine the extent of air pollution exposure to receptors.	R.1 Monitoring of motor vehicle exhaust emissions through emission testing. Forming an emission testing team. Conducting emission testing in collaboration with relevant stakeholders. R.2 Riau Province and Regency/City Transportation Agency: Improvement and development of public transportation. Increase emission monitoring of commercial motor vehicles/mandatory KIR. R.3 Joint forest and land fire/KARHUTLA patrols (TNI, POLRI, Community Fire Care Groups (MPA), POLHUT). Development of Community Fire Care Groups (MPA). Socialization to communities in areas prone to KARHUTLA. R.4 Establish a Forest and Land Fire (KARHUTLA) Response Brigade of the Riau Province DLHK in efforts to respond to KARHUTLA, including prevention, warning and early detection of KARHUTLA, response & security after KARHUTLA. R.5 Establish a Wetting Operations Team, Forest and Land Fire Control of the Riau Province DLHK in an effort to implement	R.1 Increase the implementation of the BlueSky Program to improve air quality. R.2 Conduct emission tests and level of compliance with private vehicle emission quality standards (EKUP). R.3 Implement a program to reduce the number of vehicles/Car Free Day in priority locations/protocol roads. R.4 Coordination of the implementation of Weather Modification Technology (TMC) during extreme dry seasons during forest and land fire alert conditions as needed. R.5 Promote tree planting activities to absorb air pollution. R.6 Conduct educational campaigns/outreach/guidance to increase public awareness of the impacts of air pollution and encourage public participation in pollution reduction efforts.	R.1 Massive publication through social media regarding air quality conditions in the form of ISPU and actions that must be taken when air concentrations are in the unhealthy, very unhealthy and dangerous categories to reduce the impact on receptors. Publication on the use of masks

Driver Response	Pressure Response	State Response	Impact Response
	forest and land fire control. R.6 Supervision of Compliance with Emission Quality Standards for Industry. R.7 Guidance on the Implementation of Environmental Permits for industries under the authority of Riau Province.		

The analysis of the DPSIR of the KPI indicator shows that the cause of the environmental changes "Driver" that occurred was the increase in population which is directly proportional to the economic growth that occurred in Riau Province. In the "Pressure" indicator in Riau Province there are 3 pressures, namely the increase in the number of motorized vehicles, the increase in forest fires, and the presence of industrial emissions in the form of Palm Oil Processing Factories (PKS) and coal-fired power plants in Riau Province. So that it has an "Impact" on health problems, namely ISPA and Pneumonia experienced by the people in Riau Province. Riau Province, in this case the Riau Province DLHK has responded to overcome environmental problems in Riau Province, some of these responses are in the form of ideas and some are already in the form of activities or programs that have been implemented. The following is the filling of the DPSIR KPI of Riau Province:

In the DPSIR analysis of the IKA indicator, it can be seen that the cause of the environmental changes "Driver" that occurred was the increase in population which is directly proportional to the economic growth that occurred in Riau Province. In the "Pressure" indicator in Riau Province, there are 2 pressures, namely the presence of industry and population growth which causes a decline in water and wastewater quality. So that it has an "Impact" on the decline in the availability of clean water and the occurrence of health problems in the form of diarrhea. Riau Province, in this case the Riau Province DLHK has responded to address environmental problems in Riau Province, some of these responses are in the form of ideas and some are already in the form of activities or programs that have been implemented. The following is the filling of the DPSIR IKA Riau Province:

Table 2. Completion of the 2024 Riau Province IKA DPSIR

Water Quality Index			
Driver	Pressure	State	Impact
D.1 The population of Riau Province has increased year by year, resulting in various consequences, both negative and positive. The population of Riau Province in 2022 was 6,555,746, increasing to 6,642,874 in 2023 (BPS Riau Province). One impact of population growth is the conversion of land for plantations, agriculture, industry, etc. D.2 Riau Province's economic growth in 2023 will reach 4.21%	P.1 The presence of industry is increasing so that the pollution load from industrial wastewater is uncontrolled. P.2 Population growth can lead to a decline in water quality from domestic wastewater that is produced and not managed properly.	S.1 IKA Value (50.84) S.2 IKA Category (MEDIUM) S.3 Number of Water Quality StatusSatisfied: 70 (17.33%) Lightly Polluted: 281 (69.55%) Moderately Polluted: 53 (13.12%) Heavily Polluted: 0 (0%) S.4 Changes in Water Quality Status 2022-2023Improved: 13 (8.23%) Worsened: 44 (27.85%) Stable: 101 (63.92%) S.5 Parameters exceeding the quality standards: pH: 113 (27.97%) BOD: 223 (55.2%) COD: 204 (50.5%) TSS: 63 (15.59%) DO: 0 (0%) NO: 42 (10.4%) T Phosphate: 100 (24.75%) Fecal Coliform: 98 (24.26%)	I.1 Decrease in the availability of clean water (river water) I.2 Declining public health, such as diarrhea. There is an 11% increase in diarrheal disease by 2023.

Driver Response	Pressure Response	State Response	Impact Response
R.1 Inventory of pollution sources	R.1 Provide guidance to districts/cities regarding the improvement of IKA, compliance with wastewater quality for businesses and/or activities under their authority and R.2 Conduct outreach to the community, especially those living on riverbanks, so that they do not throw rubbish into the river. R.3 Conduct supervision of wastewater disposal compliance in businesses and/or activities, especially those located on riverbanks.	R.1 Conduct routine monitoring of river water quality under the authority of Riau Province to determine changes in water quality from year to year (data series). Monitoring was carried out in 3 (three) rivers under the authority of Riau Province (Gangsal River 10 monitoring points, Suir River 4 monitoring points and Kembung River 6 monitoring points). A total of 20 monitoring points representing the upstream, middle and downstream of the river were monitored.	R.1 Conduct outreach to communities that throw rubbish into rivers R.2 Conduct supervision of wastewater disposal compliance in businesses and/or activities R.3 Construction of Breakwaters/Seawalls in River Areas Across Districts/Cities R.4 Carrying out the construction of river embankments in river areas across districts/cities R.5 Carrying out River Normalization/Restoration in River Areas Across Districts/Cities R.6 Conducting outreach to the community about not using the river for toilets and latrines (Health Office activities)

In the DPSIR analysis of the IKL indicator, it can be seen that the cause of the environmental changes "Driver" that occurred was the increase in population which is directly proportional to the need for land that occurred in Riau Province. In the "Pressure" indicator in Riau Province, it is in the form of forest fires and the expansion of the area of forest fires. So that the "Impact" has a reduction in forest area and green land cover, as well as the occurrence of natural disasters such as landslides and floods. Riau Province, in this case the Riau Province DLHK has responded to address environmental problems in Riau Province, some of these responses are in the form of ideas and some are already in the form of activities or programs that have been implemented. The following is the filling of the DPSIR IKL Riau Province:

Table 3. Completion of the Riau Province IKL DPSIR in 2024

Land Quality Index			
Driver	Pressure	State	Impact
D.1 The population of Riau Province increased from 6,394,090 in 2020, increasing to 6,642,870 in 2023, representing a population growth rate of 248,780 over 3 years, or an annual population growth rate of 1.4%. (Source: BPS 2024) D.2 Land requirements to meet the needs of the population in the form of opening new plantation and/or agricultural land with the following conditions: 1. Low public awareness regarding land preparation methods; 2. Land opening at low cost; 3. Land opening that is not in accordance with the Riau RTRWP	P.1 Forest and land fire incidents in 2023 with a total area of 6,991 Ha (Source: SIPONGI with KHG-KLHK overlay analysis). P.2 The increase in the area of forest and land fires reached 7,269.58 hectares in 2023 from around 4,930 hectares in 2022 (data from the Riau Province BPBD).	S.1 IKTL Value (51.69) S.2 IKTL Category (MODERATE) S.3 Priority Locations Percentage of Land Suitability in Protected Areas and Functions (<70%) 1. Rokan Hulu 24.02% 2. Rokan Hilir 28.86% 3. Pekanbaru City 30.92% 4. Pelalawan 47.75% 5. Indragiri Hilir 48.07% 6. Dumai City 57.07% 7. Bengkalis 59.19% 8. Kuantan Singingi 62.27% 1. Rokan Hulu 24.02% 2. Rokan Hilir 28.86% 3. Pekanbaru City 30.92% 4. Pelalawan 47.75% 5. Indragiri Hilir 48.07% 6. Dumai City 57.07% 7. Bengkalis 59.19% 8. Kuantan Singingi 62.27%	I.1 There has been a reduction in the area of forest and green land cover. I.2 Disasters: 1. There were 41 floods in 2022, occurring in almost all regencies/cities except Kuantan Singingi Regency. 2. There were 6 landslides and 4 tidal waves/abrasion in 2022. (Source: DIK [LHD Riau Province 2024]) I.3 The area of critical land has increased. Based on data from the Indragiri Rokan BPDAS in 2023, the area of critical land in Riau Province was 706,167.16 hectares, with a breakdown of very critical land area: 265,861.99 hectares and critical land area: 440,305.17 hectares.

Driver Response	Pressure Response	State Response	Impact Response
	R.1 Forest and Land Fire Management, by: 1. Establishing a Forest and Land Fire Management Brigade within the scope of the Riau Province Environment and Forestry Service (LHK) in accordance with the Decree of the Head of the Riau Province LHK Service No. Kpts.188/DLHK-PIPLD/0100 dated June 12, 2023. 2. Establishing an Operations Team for Discussion, Control of Forest and Land Fires of the Riau Province Environment and Forestry Service in 2024, in accordance with the Decree of the Head of the Riau Province LHK Service No. Kpts.800/DLHK-PIPLD/0217 dated July 5, 2024.		R.1 Making changes to the Riau RTWP 2018-2048

In the analysis of the DPSIR IKEG indicators, it can be seen that the cause of the environmental changes "Driver" that occurred was the increase in population which is directly proportional to the need for land that occurred in Riau Province. In the "Pressure" indicator in Riau Province, it is in the form of forest fires and the expansion of the area of forest fires. So that it has an "Impact" of reducing the area of forest areas and green land cover, as well as the occurrence of natural disasters in the form of landslides and floods. Riau Province, in this case the Riau Province DLHK, has responded to overcome environmental problems in Riau Province, some of these responses are in the form of ideas and some are already in the form of activities or programs that have been implemented. The following is the filling of the DPSIR IKEG Riau Province:

Table 4 Completion of the 2024 Riau Province IKEG DPSIR

Peat Ecosystem Quality Index			
Driver	Pressure	State	Impact
D.1 The population of Riau Province increased from 6,394,090 in 2020, increasing to 6,642,870 in 2023, representing a population growth rate of 248,780 over 3 years, or an annual population growth rate of 1.4%. (Source: BPS 2024)	P.1 Forest and land fires occurred in 2023 covering an area of 4,657 hectares in the KHD and an area of 2,334 hectares outside the KHG with a total area of 6,991 hectares (Source: SIPONGI with KHG overlay analysis)	S.1 IKEG Value (66.19)	I.1 Climate change occurs (GHG emissions increase)
D.2 The need for peatland to meet the needs of the population in the form of opening new plantation and/or agricultural land with the following conditions: 1. Low public awareness regarding sustainable peatland management methods. 2. The need for peatland opening at low cost. 3. Peatland opening that is not in accordance with the Peat Ecosystem Function (Protection Function and Cultivation Function).	P.2 Land clearing by burning still occurs frequently.	S.2 IKEG Category (MODERATE)	I.2 Biodiversity loss
	P.3 Draining peatlands by constructing canals.	S.3 Peat Ecosystem Damage Status Moderate	I.3 Occurrence of land subsidence
	P.4 Utilization of peatland is not yet based on the Peat Ecosystem Function (Protection Function and Cultivation Function).	Damage: 161,023 Ha Severe Damage: 90,781 Ha Very Severe Damage: 470 Ha	I.4 Loss of peatland

Driver Response	Pressure Response	State Response	Impact Response
	R.1 Wetting the peat ecosystem by constructing canal barriers with an affected area of 1,274,590 Ha in 2020, an area of 2,910,232 Ha until 2024 with a percentage change of 128.33%. R.2 Conduct an inventory of peat ecosystem characteristics in all KHGs in Riau Province conducted by the Ministry of Environment and Forestry, with the output being a Peat Ecosystem Function map at a scale of 1:50,000.		R.1 Wetting the peat ecosystem by constructing canal barriers with an affected area of 1,274,590 Ha in 2020, an area of 2,910,232 Ha until 2024 with a percentage change of 128.33%. R.2 Prepare and implement the Riau Province Peat Ecosystem Protection and Management Plan (RPPEG) for 2021-2050 in accordance with the Decree of the Governor of Riau No. Kpts.803/IV/2022.

5. Conclusions

The 2024 Sumatra Regional Environmental Management Performance Evaluation revealed significant achievements in environmental resource management, although several challenges remain that require serious attention. The evaluation results indicate improvements in several key parameters, such as air quality, peat ecosystem restoration, and a reduction in forest and land fires.

This reflects the effective implementation of strategic programs based on sustainability principles. However, a critical analysis of the evaluation data also reveals recurring challenges, including land degradation, water pollution, and anthropogenic pressures resulting from land conversion. Global climate change, which exacerbates the vulnerability of regional ecosystems, further emphasizes the urgency of science-based approaches and adaptive policy innovation.

This study recommends strengthening the environmental governance framework through a holistic approach integrating government, civil society, the business world, and academic institutions. Optimizing monitoring technology, developing a green economy, and enhancing local community capacity in environmental resource management should be priorities in future environmental management agendas.

This evaluation confirms that sustainable environmental management in the Sumatra region requires not only political commitment but also research-based support and empirical data to improve policies. By combining science and best practices, Sumatra has significant potential to become a model region for sustainable environmental management, contributing to the achievement of the Sustainable Development Goals (SDGs) at the national and global levels.

In conclusion, this evaluation serves not only as a reflection on past achievements but also as a strategic foundation for facing future challenges. Sustainable efforts are crucial to ensure a balance between economic growth, ecosystem sustainability, and the social well-being of future generations.

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