



Integrating Strategic Environmental Assessment into Regional Development Planning for Sustainable Development in Bireuen Regency

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ABSTRACT

Regional planning in Bireuen has to respond to basic-service needs while also dealing with pressure on watersheds, forested land, and areas exposed to hydro-meteorological hazards. This paper examines how far the 2025-2029 Strategic Environmental Assessment (SEA) is carried into the Regional Medium-Term Development Plan (Indonesian term: *Rencana Pembangunan Jangka Menengah Daerah*/RPJMD), rather than remaining a separate compliance document. A qualitative case-study approach was used. The SEA document was coded against five dimensions of integration and traced to programs, indicators, annual targets, agency responsibilities, and spatial references. Interviews of eight informants were used to interpret gaps in implementation. Among the 266 SDG indicators screened in the SEA, the largest problem was the absence or weakness of data, not poor performance alone. Several recommendations could be followed into RPJMD policy directions and programs, but the chain became less complete when ecological baselines, location-specific safeguards, financing, and monitoring responsibilities were examined. This weakness was most evident for forest cover, catchment rehabilitation, recharge areas, and land-use control. Drawing on these findings, the study proposes a staged SEA-RPJMD traceability model that links environmental diagnosis with planning choices, spatial safeguards, responsible agencies, budget decisions, and annual review. The model offers a practical way to keep the Peusangan and Jambo Aye catchments, forest-cover functions, and green open-space controls visible in regional development decisions.

Keywords: Bireuen Regency, Forest Conservation, Policy Integration, Regional Development Planning, Strategic Environmental Assessment, Watershed Governance

1. Introduction

Regional development is sustainable only when current needs are addressed without transferring unacceptable social and ecological costs to future generations [1]. In practice, this means that economic performance cannot be read separately from environmental limits, access to services, distributional effects, and long-term resilience [2]. The SDGs place these concerns in one framework, but their usefulness at the local level depends on whether they actually influence land-use decisions, infrastructure priorities, public services, and spending choices [3], [4]. Recent work on environmental assessment reaches a similar conclusion: SEA adds value to the SDGs when the goals are used to test alternatives and indicators, not simply cited in planning documents [5], [6].

In Indonesia, these choices are assembled in the Regional Medium-Term Development Plan (Indonesian term: *Rencana Pembangunan Jangka Menengah Daerah*/RPJMD). The RPJMD translates the elected regional head's agenda into objectives, programs, performance indicators, and indicative financing. Its internal logic matters as much as its formal consistency with national and provincial policy: a problem should be connected to a baseline, an intervention, a target, an agency, and eventually a budget [7], [8]. For forest and watershed

management, breaks in that chain can have direct consequences because settlement expansion, plantations, roads, and other infrastructure may alter runoff, soil stability, habitat, and hazard exposure before individual projects are assessed.

Strategic Environmental Assessment (SEA) (Indonesian term: *Kajian Lingkungan Hidup Strategis*/KLHS), is the mechanism intended to bring sustainability considerations into that planning chain [9], [10]. It is undertaken at the policy and plan level so that carrying capacity, ecosystem services, climate risk, biodiversity, resource use, and social vulnerability can influence strategic choices before they are fixed [11], [12]. This function is particularly important where forest estates, recharge areas, and critical catchments overlap with development pressure. If SEA findings are not tied to programs, zoning, and budgets, ecological safeguards may remain descriptive. Evidence from biodiversity assessment likewise shows that ecosystem considerations are more influential when they enter the planning process early enough to affect the available options [13].

The literature on SEA therefore treats integration as more than the presence of a completed assessment report. One strand asks whether environmental, social, and economic concerns alter the substance of objectives and programs [14]. Another focuses on whether SEA is connected to the moments when decisions are actually made [15]. Institutional studies add questions of mandate, coordination, and ownership among planners and implementing agencies [16], [17]. More recent work also points to the practical importance of reliable data, alternatives, spatial information, budgets, and monitoring arrangements [18]-[21]. Taken together, these studies imply that an SEA can meet formal requirements and still have limited influence if its recommendations disappear as planning moves from diagnosis to implementation.

The local setting adds another layer to this problem. SDG indicators cannot simply be copied from a national list and assumed to describe local priorities; they need to be read against the ecological and socioeconomic relationships of the place concerned [22]. Local implementation also depends on who owns the data, how frequently it is updated, and whether local knowledge can be linked with national targets [23], [24]. Spatial information is especially relevant because the same policy can have very different consequences across hazard zones, service areas, catchments, and conservation land [25]. For this reason, the present study examines not only policy content but also institutional links, indicator quality, spatial references, and readiness for implementation.

Bireuen provides a useful case for this analysis because several development pressures meet within one regency planning system. The regency covers about 179,696 ha and consists of 17 districts and 609 villages. Its territory is linked to nine watersheds, three groundwater basins, coastal ecosystems, forest areas, and wildlife corridors [26], [27]. At the same time, the 2025-2029 SEA records uneven access to basic services, poverty and human-development gaps, land-use change, pollution, waste, hydro-meteorological hazards, and environmental-governance concerns [26]. Studies elsewhere in Aceh show how rainfall, infiltration, slope, erosion, and land-cover change can combine to raise flood and runoff risk [28]-[31]. In Bireuen, then, the question of SEA integration is also a question of whether development planning can retain catchment and forest functions while accommodating settlement, infrastructure, and local economic needs.

Much of the SEA literature explains why integration succeeds or fails, but fewer studies follow a local Indonesian SEA recommendation through the full planning sequence: problem definition, program response, indicator, baseline, spatial safeguard, responsible agency, financing, and review. This study follows that sequence in the Bireuen case. It combines the assessment of 266 SDG indicators with a five-dimensional integration framework, document-based spatial traceability, and interviews with eight actors from planning, environmental management, infrastructure, spatial planning, and academia. The analysis asks three questions: which sustainability issues are prioritized, how far they can be traced into the RPJMD, and where the chain becomes incomplete. Its main contribution is a staged SEA-RPJMD traceability model in which data governance and forest-catchment safeguards are treated as part of policy integration itself rather than as supporting background.

2. Method

2.1. Study Area and Research Design

The study was carried out in Bireuen Regency, Aceh Province, Indonesia (4°54'-5°21' N and 96°20'-97°21' E) [40] during 2025-2026. We used a qualitative policy case-study design because the object under review was a specific planning process, bounded by one jurisdiction, one planning period, and a defined set of institutions

and documents [32]. The analysis first describes the issues, indicators, scenarios, programs, spatial references, and institutional roles found in the case, and then evaluates how completely those elements are connected.

2.2. Data Sources and Informants

The main documentary source was the SEA prepared for the Bireuen Regency RPJMD 2025-2029 [26] (Table 1). It contains the screening of 266 SDG indicators, the regional diagnosis, strategic issues, business-as-usual and additional-effort scenarios, program recommendations, annual targets, agency assignments, and indicative implementation needs. To interpret and check this material, we also used regional statistics, relevant planning and environmental regulations, peer-reviewed studies, watershed research, and official environmental-quality records. Documentary analysis was appropriate because the study concerns the way priorities and implementation commitments are recorded in formal policy texts [33].

Eight informants were selected purposively to provide views from the institutions most closely related to the regency planning chain. They included the Head of the Bireuen Public Works and Spatial Planning Agency, the Head of its Human Settlements Division, a senior government planner, the Head of Planning, Control, and Regional Development Evaluation at the regional planning agency, the Secretary of the environmental agency, the Head of Spatial Planning, and two academics. Selection followed direct involvement or relevant expertise, not statistical representativeness. By the final interviews, the same concerns - data, budgets, coordination, and spatial consistency - were recurring across groups, which supported the adequacy of the panel for institutional triangulation [39]. KPH and provincial forestry-service actors were not interviewed because the study boundary was the regency RPJMD process. This is a limitation; forestry and watershed issues were instead examined through SEA/RPJMD documents, DLHK material, spatial-planning evidence, and published studies.

Table 1. Data sources and analytical roles

Data source	Coverage	Information extracted	Analytical role
Bireuen SEA for the 2025-2029 RPJMD	Primary policy document	SDG indicators, strategic issues, scenarios, recommendations, annual targets, agency assignments, and spatial references	Directed content analysis and traceability assessment
Supporting documents and literature	Regulations, regional statistics, hydrological studies, and environmental-quality reports	Legal framework, regional context, forest-catchment risks, indicator definitions, and comparative evidence	Context validation and discussion
Semi-structured interviews	Eight purposively selected informants	Perceptions of integration, coordination, data, budgeting, spatial planning, and implementation barriers	Thematic analysis and triangulation
Research documentation	Interview notes, coding records, and activity documentation	Evidence of data collection and analytical decisions	Audit trail

2.3. Directed Content, Spatial Document, and Thematic Analysis

The document analysis used a directed qualitative approach informed by SEA integration theory and Indonesian planning requirements [34], [35]. We began by identifying the parts of the SEA that dealt with SDG performance, strategic issues, scenarios, recommendations, annual targets, spatial references, and agency roles. A codebook was then prepared for five dimensions of integration: substantive, procedural, institutional, methodological, and implementation. Policy statements, table entries, programs, indicators, baselines, target years, spatial references, budget information, and responsible organizations were coded as recording units. These entries were brought together in a traceability matrix so that a finding in the SEA could be followed into a policy response, an implementation instrument, and a monitoring arrangement. When values differed across document sections or an expected link was missing, the discrepancy was retained as a finding rather than resolved by assumption.

Spatial evidence was examined through document traceability rather than through a new GIS overlay. We checked whether references to watersheds, groundwater basins, forest areas, settlement growth, disaster-prone zones, green open space, and land-use control were carried forward into RPJMD programs, agency responsibilities, location priorities, or monitoring indicators. An ecological issue was coded as a spatial-integration gap when it appeared in the SEA diagnosis but was not matched by a map-based target, a forest-cover baseline, or a catchment-specific intervention. This choice reflects the material available to the study: the document set did not provide geospatial layers suitable for independent land-suitability modelling, while the analytical question was whether existing spatial evidence had influenced the planning instruments.

Interview notes were read several times before coding. Initial codes covered SEA understanding, basic services, sanitation, waste, pollution control, spatial suitability, land-use control, budgeting, data ownership, coordination, and monitoring. Related codes were grouped into candidate themes, checked again against the notes, named, and compared across institutional groups following thematic-analysis procedures [36]. The themes were then compared with the documentary findings rather than interpreted separately. Source and method triangulation, explicit coding rules, and an audit record supported trustworthiness [37], [38]. Table 2 sets out the four-level rubric used to judge how far an SEA issue had moved from recognition to an operational planning chain.

Table 2. Rubric for assessing the depth of SEA integration

Level	Operational definition	Minimum evidence
0 - Not integrated	The SEA issue is absent or has no relevant planning response	No related objective, program, indicator, or target
1 - Normative	The issue appears as a commitment, problem statement, vision, or general direction	Policy narrative exists, but implementation instruments are unclear
2 - Programmatic	The issue is translated into a strategy, program, recommendation, or agency assignment	A program or responsible agency exists, but baseline, indicator, target, financing, or evaluation is incomplete
3 - Operational	The issue has an implementable and monitorable policy chain	Program, outcome indicator, baseline, time-bound target, responsible agency, spatial focus, financing, and evaluation mechanism are available

2.4. Trustworthiness, Ethics, and Study Boundary

Credibility was assessed by comparing the SEA with regional statistics, regulations, hydrological studies, and the interview evidence. We cross-checked indicator values, reference years, definitions, and agency assignments across document sections; where the documents disagreed, the inconsistency was reported as part of the result. The explicit integration rubric supported dependability, while confirmability was addressed by keeping extracted evidence separate from our interpretation and recommendations. Participation in the interviews was voluntary and the material was used for academic purposes. Because the 2025-2029 RPJMD period is still underway, the study evaluates the quality of integration and readiness for implementation, not the final environmental effects of the programs.

3. Results and Discussion

3.1. Strategic Issues and SDG Indicator Status

The Bireuen SEA groups the main sustainability concerns into five broad areas: poverty and unequal access to basic services; human-resource quality; economic growth and employment; environmentally responsive infrastructure; and governance and democracy (Table 3). Reading these categories together is important. Poverty is linked to water, sanitation, housing, nutrition, education, work, and social protection, while infrastructure decisions can change exposure to pollution and hazards as well as pressure on forests and catchments. Governance cuts across all of them because data ownership, budget decisions, and coordination determine whether a stated priority can be acted upon.

Table 3. Strategic sustainable-development issues and planning implications

Strategic issue group	Principal concerns	Dominant dimensions	Planning implication
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Poverty and basic-service inequality	Poverty, social protection, drinking water, sanitation, housing, and access to services	Social, economic, environmental	Integrated household- and area-based intervention across agencies
Human-resource quality	Stunting, nutrition, immunization, education, youth smoking, and skills	Social and governance	Convergence of health, education, sanitation, and family-economy programs
Economic growth and employment	Decent work, micro and small enterprises, agriculture, fisheries, village economy, and tourism	Economic, social, environmental	Local value addition without increasing environmental pressure
Environmentally responsive infrastructure	Water, sanitation, drainage, waste, climate, disasters, spatial planning, forest and catchment protection	Environmental and social	Spatial prioritization, green infrastructure, forest-cover retention, and sustainable financing
Governance and democracy	Data, coordination, participation, public services, spatial control, and evaluation	Governance	Data ownership, lead agencies, coordination forums, and annual evaluation

The SEA screened 266 SDG indicators, and the clearest message from that exercise is the size of the information gap. Eighty-five indicators were recorded as having met their targets and 46 as not having met them, but 135 could not be assessed adequately because data were unavailable or insufficient (Figure 1). This distinction matters for planning: an indicator that performs poorly points to a program problem, whereas an indicator without a defensible baseline prevents the problem from being measured in the first place.

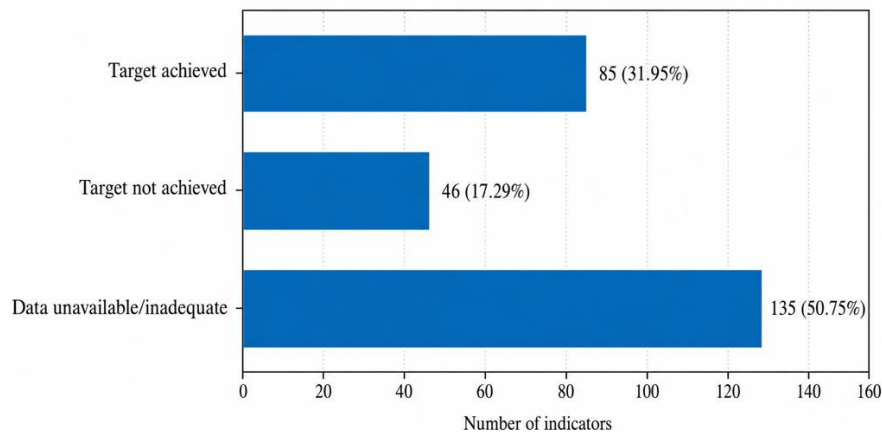


Figure 1. Status of the 266 SDG indicators assessed in the Bireuen SEA

For Bireuen, data availability is therefore not a minor technical issue. Missing data reduce the visibility of service inequality, environmental deterioration, and risk in forest-catchment areas, and they make annual comparison difficult. The finding is consistent with SDG implementation research that treats monitoring capacity and prioritization as conditions for implementation rather than as activities that can be added later [4], [23].

3.2. Depth of SEA Integration and Forest-Watershed Governance

The document trail is strongest for issues that already have established indicators and sectoral responsibilities. Poverty, for example, can be followed from a baseline through projections, annual targets, and implementing agencies. Drinking water, sanitation, health, and nutrition also have relatively clear program links. The chain becomes thinner for waste, climate, environmental quality, and forest-catchment safeguards, where ecological baselines, spatial targets, financing arrangements, and monitoring responsibilities are less complete. In other words, SEA ideas are present in the RPJMD, but the degree to which they are ready to guide implementation varies by issue.

Table 4. Depth of integration for priority SEA issues

Priority issue	Traceable integration evidence	Assessed depth	Main gap	Operational strengthening
Poverty	Baseline, projection, annual targets, agencies, and socioeconomic recommendations	Operational	Targeting data and links to employment and services remain fragmented	Unified poverty data and household graduation packages
Drinking water and sanitation	Indicators, targets, infrastructure recommendations, and agency assignments	Programmatic-operational	Inconsistent sanitation baseline; incomplete wastewater and fecal-sludge service chain	Verified baselines, spatial targets, and service-financing plans
Health and nutrition	Stunting, immunization, breastfeeding, health coverage, youth smoking, and scenarios	Programmatic-operational	Indicator series and cross-sector interventions are not fully connected	Cross-sector health dashboard and vulnerable-area targeting
Employment and local economy	Directions for enterprises, skills, agriculture, fisheries, village economy, and tourism	Programmatic	Limited indicators for job quality, value addition, and environmental effects	Decent-work and green-productivity indicators
Waste, climate, and disasters	Waste targets, 3R recommendations, risk reduction, and environmentally responsive infrastructure	Programmatic	Incomplete emissions, hazardous-waste, environmental-quality, facility-capacity, and financing data	Emission inventory, integrated waste plan, 3R targets, and financing
Forest, land cover, and catchment safeguards	Land-use change, forest areas, watershed risk, coastal and groundwater concerns appear in SEA diagnosis	Programmatic	No verified annual forest-cover, IKL/IKTL, deforestation, recharge-zone, or catchment-rehabilitation target series in the reviewed SEA chain	Forest-cover baseline, catchment-priority map, green open-space safeguards, KPH/provincial forestry coordination, and annual ecological monitoring
Governance	Role assignment, consultation, government performance, and digitalization	Programmatic	Indicator audit, data ownership, and coordination are not institutionalized	SDG data forum, metadata, data owners, and annual review schedule

This difference is particularly visible in forest and watershed governance. The SEA recognizes forest areas, land-use change, catchment relationships, and hydro-meteorological hazards [26], and research from Aceh

shows that rainfall, infiltration, slope, erosion, and changes in land cover affect flood and runoff behaviour [28]-[31]. Yet the planning chain reviewed here does not consistently carry those risks forward into annual forest-cover targets, safeguards for critical recharge areas, catchment-rehabilitation priorities, or green open-space controls. The diagnosis is therefore more developed than the measurable ecological accountability that would be needed during implementation.

That gap has practical consequences. If an SEA recommendation is to influence development, it should help determine where infrastructure is located, where settlement or plantation expansion is constrained, which riparian corridors are protected, and which rehabilitation activities receive funding. Bringing those spatial safeguards into the same chain as programs, indicators, agencies, and budgets adds an operational dimension to earlier integration frameworks [20], [21], [25].

3.3. Indicator Trajectories and Ecological Data Gaps

Several social and basic-service indicators provide a continuous baseline-to-target sequence through 2029 (Table 5). We used poverty, stunting, youth smoking, safe drinking water, adequate sanitation, and municipal waste handling to examine the planned direction of change. Figure 2 plots the three social indicators, while Figure 3 shows the basic-service and waste trajectories. All show improvement, although the 2029 values still leave gaps for some issues. These trajectories are useful not because they predict outcomes with certainty, but because they reveal whether the plan provides a measurable path from the starting condition to the intended result.

Table 5. Planned trajectories for selected priority indicators

Indicator	2023 baseline	2025 target	2027 target	2029 target	Interpretive note
Population below the poverty line (%)	12.12	11.00	9.50	8.80	Declining, but vulnerable to economic and service-access shocks
Stunting prevalence (%)	26.90	24.00	18.00	15.00	Requires convergent health, nutrition, water, sanitation, and poverty interventions
Smoking among population aged ≤18 (%)	26.80	24.00	20.00	16.00	Large residual behavioral and regulatory gap
Access to safe drinking water (%)	89.69	91.00	94.00	97.00	Improves but does not reach universal access
Access to adequate sanitation (%)	84.15*	85.00	87.50	90.00	Baseline must be verified because document sections differ
Municipal waste handled (%)	63.00	65.00	69.00	73.00	Improves but remains below the stated 80% policy aspiration

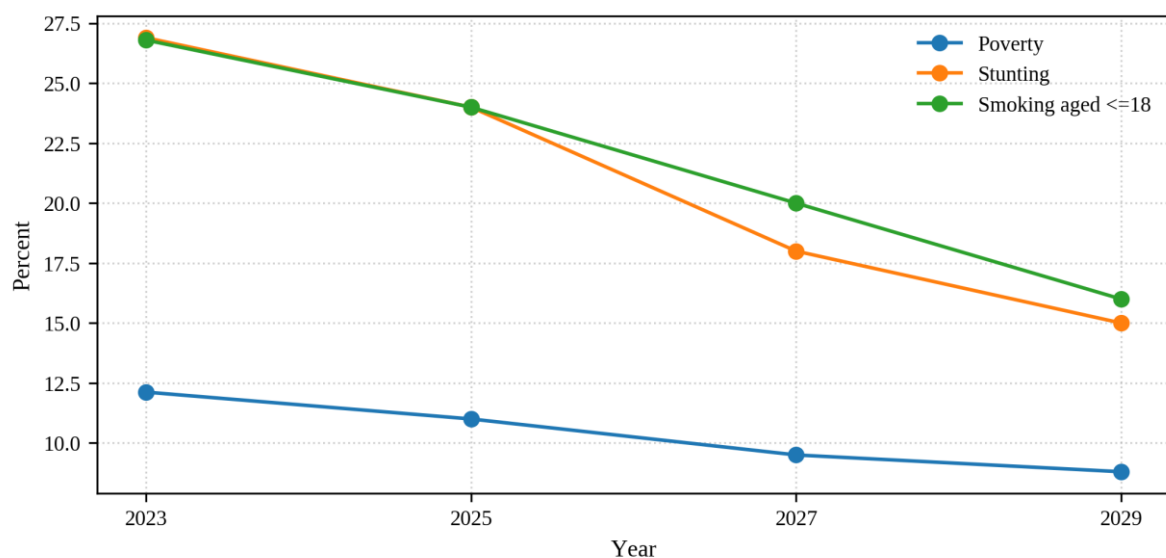


Figure 2. Planned trajectories for selected social indicators, 2023-2029

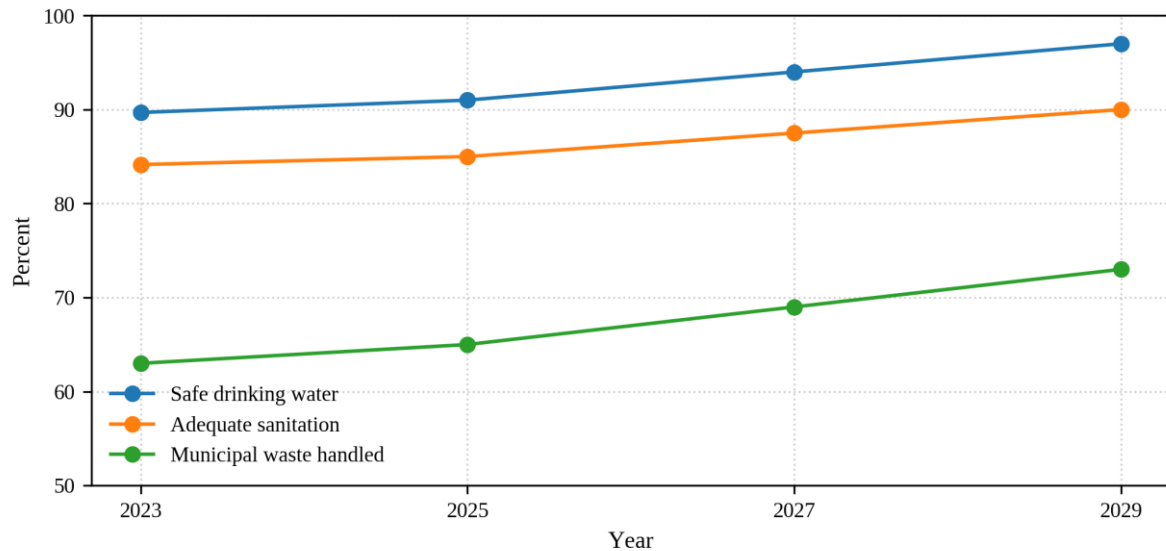


Figure 3. Planned trajectories for basic-service and environmental indicators, 2023-2029

A comparable exercise was attempted for ecological indicators, but the available SEA-RPJMD material did not contain a verified 2025-2029 series for forest cover, deforestation reduction, land-cover quality, rehabilitation of critical catchments, or protection of recharge areas. We did not fill those gaps with assumed values. Instead, their absence was treated as evidence that ecological integration is incomplete. Government work-plan material does provide historical Water Quality Index and Environmental Quality Index values (Figure 4), showing that environmental monitoring is already undertaken, even though it has not yet been converted into a consistent SEA-RPJMD target chain [40].

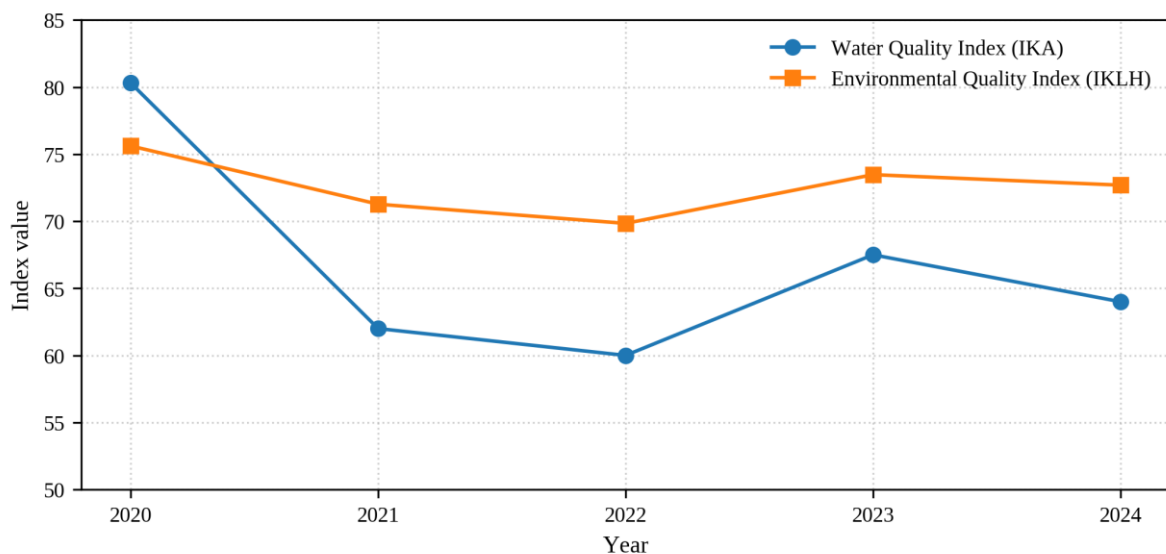


Figure 4. Available historical environmental quality indicators in Bireuen, 2020-2024

Figure 4 is therefore used only as a baseline diagnostic. It shows the kind of continuity that ecological indicators need: one agreed baseline, a clear reference year and method, a named data owner, a spatial unit, annual targets, and a defined review process. Equivalent trajectories for forest and land-cover conditions were not available in the reviewed documents. Without them, the RPJMD cannot readily demonstrate whether development choices are maintaining catchment function, retaining forest cover, or improving land-use control. Similar difficulties have been reported where biodiversity and ecosystem-service evidence is included in SEA but is not linked to measurable, spatially explicit monitoring [13], [25].

3.4. Institutional Themes and Implementation Barriers

Five themes recurred across the interview material: a shared understanding of sustainability, the use of SEA as a planning basis, concern for basic services and spatial conformity, constraints on implementation, and the

need for stronger institutions. Because the available material consisted of interview notes rather than verbatim transcripts, we report coded examples instead of reconstructed quotations. Planning informants repeatedly referred to the need to align SEA, RPJMD, sector plans, indicators, and evaluation. Environmental-management informants focused on waste, pollution control, compliance, and shortages of technical environmental data. Infrastructure informants stressed water, sanitation, drainage, settlement services, and financing. Spatial-planning informants brought attention to RTRW/RDTR conformity, carrying capacity, and hazard-sensitive location decisions. Academic informants placed more emphasis on policy logic, measurable results, transparency, and public participation.

Table 6. Interview themes and implications for SEA integration

Theme	Synthesis of interview evidence	Informant coverage	Implication for SEA integration
Shared sustainability understanding	Sustainability was understood as balance among economic development, social welfare, environmental quality, spatial suitability, and basic services	I-1 to I-8	Provides a common foundation for substantive integration
SEA as a planning basis	SEA should refine policies, indicators, programs, spatial decisions, and environmental-risk management	I-1, I-4, I-5, I-6, I-8	Supports substantive and procedural integration
Priority services and spatial conformity	Drinking water, sanitation, drainage, settlements, health, nutrition, waste, and appropriate land use were repeatedly emphasized	I-1, I-2, I-5, I-6, I-8	Requires area-based targets and multi-agency programs
Forest and catchment safeguards	Forest cover, watershed conservation, and recharge-zone protection were visible in the document analysis but not represented by a dedicated forestry authority informant	Documents, I-6, I-8	Requires KPH/provincial forestry linkage in future SEA-RPJMD evaluation
Implementation constraints	Budget, data, land, coordination, community capacity, disaster damage, and indicator inconsistency constrain implementation	I-1 to I-8	Explains uneven operational integration
Strengthening direction	Unified data, routine coordination, SEA-RPJMD-spatial-plan alignment, participation, financing, and annual evaluation	I-3, I-5, I-6, I-7, I-8	Provides the basis for institutional and policy recommendations

The barriers described by informants are connected rather than independent. Weak baseline data make it harder to justify a budget request; limited budgets delay infrastructure, rehabilitation, and monitoring; unclear institutional leadership fragments cross-sector programs; and weak spatial evidence makes prioritization less defensible. These problems are especially important in forest-catchment management because land-use conversion and inadequate watershed control can quickly increase runoff, erosion, and flood risk [28], [31]. A temporary SEA working group is unlikely to solve this problem if it ends when the document is approved. The coordination function needs to continue into annual planning, budgeting, implementation, and review.

3.5. Staged Traceability Model for Operational Integration

Table 7 presents the study's staged SEA-RPJMD traceability model. Instead of treating integration as a yes-or-no condition, the model follows an issue through recognition, translation, operationalization, and feedback. Three elements that were weak in the Bireuen case are kept within the same chain: data governance, spatial ecological safeguards, and the use of annual evaluation in the next budget cycle. Under this approach, an issue

reaches the operational stage only when the SEA diagnosis can be traced to a measurable action, a responsible institution, a spatial focus where relevant, and a route to financing and review.

Table 7. Staged SEA-RPJMD traceability model proposed by this study

Stage	Core question	Evidence required	Relevance for forest and watershed safeguards
1. Recognition	Is the SEA issue acknowledged in the planning agenda?	Problem statement, strategic issue, or policy direction	Forest, land-use conversion, watersheds, and disaster exposure appear as explicit planning concerns
2. Translation	Is the issue converted into programs and agency roles?	Program, strategy, recommendation, lead and contributing agencies	Forest and catchment safeguards are assigned to DLHK, spatial planning, BPBD, PUPR, and relevant forestry authorities
3. Operationalization	Can the issue be measured, funded, and spatially targeted?	Baseline, indicator, annual target, spatial unit, indicative budget, and monitoring method	Forest-cover retention, IKL/IKTL, water quality, recharge-zone protection, and rehabilitation areas have verified target chains
4. Feedback	Does evaluation influence the next budget and plan?	Annual review, corrective action, and budget adjustment	Ecological deterioration triggers revised zoning control, rehabilitation, enforcement, or investment priority

The findings point to four practical changes. First, each strategic SEA issue should have a traceability record that shows where it enters the RPJMD. Second, SDG and environmental indicators need agreed metadata, data owners, update schedules, quality checks, and correction procedures. Third, coordination should be organized around a small number of shared outcomes - such as poverty reduction, stunting, water and sanitation, waste management, climate and disaster resilience, forest-cover retention, and sustainable livelihoods - rather than around isolated agency activities. Finally, annual evaluation should ask whether conditions changed in priority locations, not only whether activities were completed and budgets spent.

For forest and conservation issues, the same record should identify forest estates, critical catchments, groundwater recharge areas, riparian buffers, and green open spaces that need spatial safeguards. It should also show whether a recommendation was accepted, modified, or rejected, and why. Making that decision trail visible would connect SEA more closely with the decision arena described in strategic-assessment theory [15] and would give environmental recommendations a clearer route into adaptive regional management.

4. Conclusion

The Bireuen case shows that SEA integration is already visible in policy directions, programs, targets, and agency assignments, but operational links remain uneven because baselines and ecological indicators are incomplete, spatial targeting is limited, financing is uncertain, and evaluation is weakly connected to later decisions. The staged SEA-RPJMD traceability model addresses these gaps by linking diagnosis, indicators, spatial safeguards, program design, institutional responsibility, financing, and annual review. For implementation, Bireuen should formalize this traceability matrix, verify SDG and environmental metadata, maintain cross-sector coordination, and connect annual evaluation to budget decisions. Conservation priorities should include reliable land-cover baselines, protection of critical recharge areas, rehabilitation in the Peusangan and Jambo Aye-related systems, riparian and green-open-space controls, and coordination with KPH or provincial forestry authorities. Because this is a single qualitative case without an independent GIS overlay and implementation is still under way, future studies should test the model against final plans, realized budgets, and spatial outcomes with direct involvement of forestry and community-based forest-management actors.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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