

Islamic Ecotheology in an Indonesian Pesantren: A Quantitative Risk-Responsive Pilot Model

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ABSTRACT:

This pilot study develops an Eco-Theology-Risk Alignment Model to examine whether Islamic ecological discourse is connected to institutional action and local environmental risk at Pondok Pesantren Hidayatullah Balikpapan. Guided by Abdullah Saeed's contextual hermeneutics, the study combines computational content analysis of two official Hidayatullah articles (2022 and 2026) with secondary risk indicators from Indonesian public agencies. Five measures are specified: the Islamic Ecotheology Discourse Index (IEDI), Environmental Implementation Score (EIS), Environmental Risk Index (ERI), Institutional Collaboration Score (ICS), and composite Risk Alignment Model score (RAM). The 2026 tree-planting article recorded higher IEDI (1.000), EIS (1.000), and RAM (0.874) than the 2022 conservation article (0.505, 0.550, and 0.455). The result indicates a pilot pattern in which explicit ecological language, concrete action, and collaboration coincide with stronger risk alignment. Because the corpus contains only two observations and ERI is constant, inferential and moderation claims are not warranted. The model is therefore presented as a replicable diagnostic framework requiring validation with a larger corpus, field observation, and multi-coder reliability testing

Keywords: Islamic ecotheology, contextual hermeneutics, pesantren, environmental governance, disaster risk

1. Introduction

Environmental degradation is simultaneously a governance, educational, and moral challenge. Climate-related disasters, biodiversity loss, waste pressure, and land-use change require institutions that can translate scientific knowledge into norms and collective behaviour. Religious educational institutions are relevant because their authority, residential routines, and community links can shape environmental conduct beyond formal classrooms. In Islam, khalifah (stewardship), amanah (trust), mizan (balance), fasad (corruption), islah (repair), rahmah (compassion),

and maslahah (public benefit) provide an ethical vocabulary for ecological responsibility (Nasr, 1996; Izzu Dien, 2000; Foltz et al., 2003).

The empirical problem is that Islamic ecotheology is often discussed normatively, while evidence connecting religious language to institutional practice and local risk remains limited. This gap is important for pesantren, which combine education, worship, residence, discipline, and community outreach. Hidayatullah Balikpapan offers a useful pilot case: its public website includes a 2022 article presenting the Gunung Tembak campus as a conservation space

and a 2026 article reporting tree planting with national and provincial officials (Hidayatullah, 2022, 2026). These texts allow a preliminary test of whether ecological discourse becomes more operational when it includes action and collaboration.

Abdullah Saeed's contextual hermeneutics supplies the interpretive lens. Saeed (2006, 2014) argues that contemporary interpretation should connect linguistic meaning and historical context with a hierarchy of ethico-legal values and present needs. Environmental risk is not a narrow classical legal category, yet it directly implicates justice, responsibility, balance, and prevention of harm. A contextual approach therefore asks whether Islamic values are translated into responses to observable ecological conditions rather than remaining abstract statements.

This study asks: (1) how strongly Hidayatullah's official discourse expresses Islamic ecological values; (2) whether stronger discourse coincides with implementation and collaboration; and (3) whether the resulting pattern aligns with Balikpapan's risk context. Its contribution is a transparent quantitative framework that links discourse, implementation, collaboration, and risk while distinguishing exploratory evidence from statistical confirmation. The model is intended for later replication across a larger corpus and multiple pesantren.

1.1 Islamic Ecotheology and Environmental Education

Islamic environmental ethics begins from the premise that nature is neither morally neutral nor subject to unrestricted human ownership. Creation is understood as a sign of divine order, while human authority is constrained by responsibility. Khalifah denotes accountable stewardship; amanah identifies the natural world as a trust; mizan requires balance; fasad condemns destructive disorder; and islah calls for restoration. Together, these concepts can support conservation, water protection, waste reduction, biodiversity care, and disaster preparedness. Their educational significance lies in connecting environmental conduct to identity and worship rather than presenting sustainability as an external

technical agenda (White, 1967; Nasr, 1996; Izzi Dien, 2000; Khalid, 2002; Foltz et al., 2003; Jenkins, 2013).

Pesantren are especially suitable settings for this translation because they are simultaneously schools, residential communities, moral institutions, and local centres of authority. Santri encounter institutional values through lessons, sermons, rules, routines, peer conduct, and the physical management of the campus. Environmental education can therefore become habitual through cleanliness systems, water and energy discipline, waste separation, tree care, food practices, and community service. Research on pesantren education emphasises that institutional culture and role modelling shape learning beyond the formal curriculum (Lukens-Bull, 2005; Raihani, 2012). Yet this same institutional breadth makes evaluation difficult: ecological identity may be visible in public language without being consistently embedded in operations.

1.2 Contextual Hermeneutics and Risk-Responsive Governance

Saeed's contextual approach offers a structured route from inherited texts to contemporary application. It considers the linguistic and historical setting of revelation, distinguishes enduring higher values from context-specific instructions, and evaluates present circumstances before formulating application (Saeed, 2006, 2014). For environmental governance, the relevant contemporary circumstances include local hazard exposure, waste pressure, land-use change, and institutional capacity. Risk responsiveness therefore becomes evidence that general moral principles have been interpreted in relation to an institution's actual setting.

This reasoning also clarifies why discourse, action, and collaboration should be measured separately. Theological vocabulary indicates moral framing, ecological vocabulary indicates issue salience, implementation terms indicate movement toward practice, and governance terms indicate institutional connection. Collaboration matters because environmental problems normally exceed the authority and

resources of a single school. The proposed model does not claim that higher word frequency proves better performance. Instead, it treats public discourse as one observable layer that must ultimately be triangulated with programmes, records, behaviour, and risk outcomes.

2. Methodology

2.1 Design, Sample, and Data

The study uses a quantitative computational content-analysis and risk-alignment design. The unit of analysis is an official Hidayatullah website article. The pilot sample contains two purposively selected articles that explicitly address environmental activity or conservation: HID001 (2026), concerning collaborative tree planting, and HID002 (2022), concerning campus conservation. Official secondary sources—including BNPB/InaRISK, BPBD Balikpapan,

the local environmental agency, and BPS—provide city-level indicators for multi-hazard, flood, landslide, other hazards, and waste pressure (BNPB, 2024; InaRISK, 2024; BPS Kota Balikpapan, 2025).

Article texts were cleaned, tokenised, and coded using theory-guided dictionaries. Four discourse dimensions were measured: theological terms; ecological terms; implementation terms; and governance/collaboration terms. Manual rubrics separately assessed the action level and institutional collaboration. Automated coding was checked by close reading to reduce the risk of treating keyword frequency as equivalent to meaning, consistent with established cautions in computational text analysis (Grimmer & Stewart, 2013; Roberts et al., 2014; Lucas et al., 2015; Silge & Robinson, 2016; Benoit et al., 2018; Krippendorff, 2018).

Conceptual Framework of the Eco-Theology-Risk Alignment Model

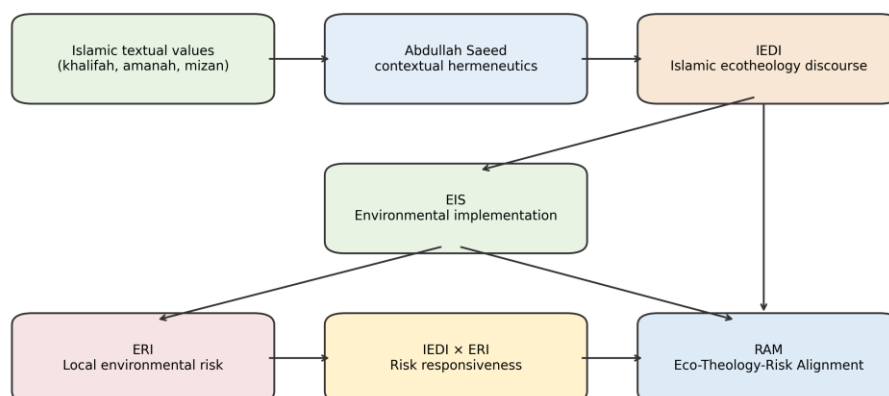


Figure 1. Conceptual framework of the Eco-Theology-Risk Alignment Model

Source: Authors' conceptualisation

Figure 1 presents the model's causal logic without implying that the pilot establishes causality. Islamic textual values are interpreted through contextual hermeneutics and become observable as ecotheological discourse. Discourse is

expected to support environmental implementation, while local environmental risk supplies the context for assessing responsiveness. RAM combines these elements as a diagnostic alignment score.

Table 1. Constructs and operationalisation

Construct	Operational definition	Pilot scoring
IEDI	Normalised intensity of theological, ecological, implementation, and governance vocabulary.	0.25 equal weight per dimension
EIS	Degree to which discourse reports awareness, education, concrete action, or institutionalised action.	Action score / 4
ERI	Composite of official local multi-hazard, flood, landslide, other-hazard, and waste indicators.	Weighted normalised indicators
ICS	Breadth of institutional collaboration, from pesantren-only to multi-stakeholder action.	Collaboration score / 4
RAM	Composite alignment of discourse, implementation, and discourse $\times$ risk responsiveness.	0.40 IEDI + 0.30 EIS + 0.30(IEDI $\times$ ERI)

Source: Authors' calculations

2.2 Measurement and Analysis

For article i and dimension j , the Keyword Frequency Score is:

$$KFS_{ij} = \frac{n_{ij}}{N_i}$$

where n_{ij} is the number of dictionary matches and N_i is the article's token count. Scores are min-max normalised as:

$$X'_{ij} = \frac{X_{ij} - \min_i(X_{ij})}{\max_i(X_{ij}) - \min_i(X_{ij})}$$

The discourse index is :

$$IEDI_i = w_1THEO_i + w_2ECO_i + w_3INT_i + w_4GOV_i$$

Implementation and collaboration are:

$$EIS_i = \frac{C_i}{4}$$

The environmental index is:

$$ERI_t = \alpha_1IRBI_t + \alpha_2FLOOD_t + \alpha_3FIRE_t + \alpha_4WASTE_t + \alpha_5DISASTER_t$$

where ERI_t combines normalised disaster, flood, fire, waste and disaster-occurrence indicators for Balikpapan..Finally,

$$RAM_i = 0.40IEDI_i + 0.30EIS_i + 0.30(IEDI_i \times ERI_t)$$

The planned confirmatory model is:

$$EIS_i = \beta_0 + \beta_1IEDI_i + \beta_2ERI_t + \beta_3(IEDI_i \times ERI_t) + \beta_4ICS_i + \beta_5YEAR_i + \varepsilon_i$$

It is reported as a future specification rather than estimated here because $n = 2$ and ERI does not vary between article observations. The pilot analysis is therefore descriptive: it compares scores, examines whether directionally consistent patterns appear, and documents what additional evidence is required. For a full study, dictionary validation and independent double-coding should be assessed with Cohen's

$$\kappa = \frac{P_o - P_e}{1 - P_e}$$

followed by alternative weights and indicator sets as robustness checks.

2.3 Reliability, Validity, and Ethical Safeguards

Construct validity is addressed by deriving dictionaries and scoring rules from the theoretical framework rather than from the two results. Content validity requires expert review by specialists in Qur'anic studies, pesantren education, and environmental governance. Reliability requires independent double-coding of action and collaboration, transparent reporting of

disagreements, and a pre-specified threshold for Cohen's kappa. Convergent validity should be examined by comparing website scores with curriculum documents, programme records, interviews, surveys, and direct observation. Sensitivity tests should replace equal weights with expert, entropy, or CRITIC weights and assess whether article rankings remain stable.

The study uses only publicly accessible organisational texts and aggregate public-risk indicators; it contains no personal or sensitive participant data. Nevertheless, ethical interpretation remains necessary. A low website score must not be presented as proof that an institution lacks environmental practice, because unreported activity may exist. Conversely, a high

communication score must not be equated with verified performance. The pilot results are therefore reported as evidence about public discourse and model feasibility, with explicit limits on institutional judgement.

3. Results

Balikpapan's baseline composite risk score was 0.58 in the pilot dataset, reflecting meaningful exposure across multi-hazard, flood, landslide, other-hazard, and waste dimensions. Because both articles refer to the same city context, this value is constant and cannot identify a moderating effect. It does, however, supply a contextual benchmark for comparing how explicitly each article connects ecological values with implementation.

Table 2. Environmental-risk components used in the pilot

Risk dimension	Raw indicator	Normalised score	Weight	Contribution
Multi-hazard	IRBI: 159.20	0.796	0.25	0.199
Flood	Risk score: 14.09	0.705	0.15	0.106
Landslide	Risk score: 4.23	0.212	0.10	0.021
Other hazard	Risk score: 4.70	0.235	0.10	0.024
Waste pressure	District indicators	0.772	0.30	0.232
Composite ERI	Weighted sum	0.582	1.00	0.582

Source: Authors' normalisation of BNPB/InaRISK and local public indicators

Table 2 shows that the composite is driven most strongly by multi-hazard exposure and waste pressure. Flood risk also makes a substantial contribution, whereas the normalised landslide and other-hazard components are lower. These

values are not campus-level measurements and should be interpreted as the broader city context within which the pesantren communicates and acts. Their function in the pilot is to make contextual relevance explicit and reproducible.

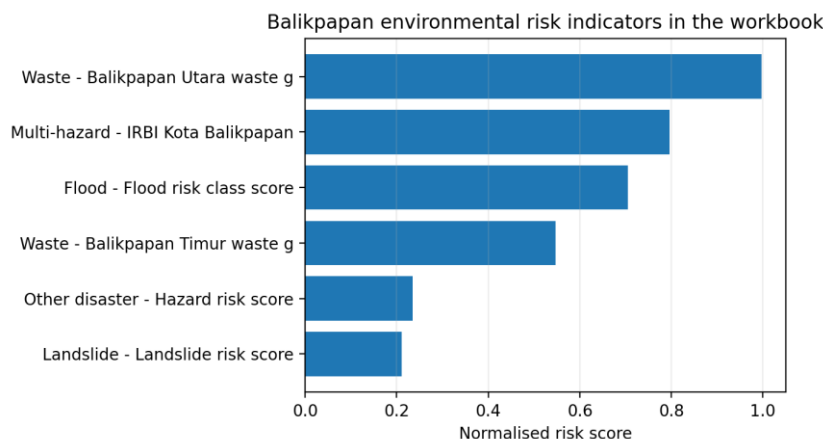


Figure 2. Normalised environmental-risk indicators for Balikpapan

Source: Authors' normalisation of public risk indicators

Figure 2 visually confirms that waste pressure, multi-hazard exposure, and flood risk dominate

the pilot risk profile. Landslide and other-hazard scores are comparatively lower.

Table 3. Pilot article-level results

Article	Year	Action and collaboration	IEDI	EIS	ICS	RAM	Interpretation
HID001	2026	Tree planting; ministry and provincial actors	1.000	1.000	0.250	0.874	Strong pilot alignment
HID002	2022	Campus conservation; no external partner reported	0.505	0.550	0.000	0.455	Weak pilot alignment

Source: Authors' coding of Hidayatullah (2022, 2026).

HID001 obtained the maximum IEDI and EIS values and a RAM score of 0.874. Its discourse combined ecological vocabulary with a concrete activity and named external governmental actors. HID002 recorded IEDI = 0.505, EIS = 0.550, and RAM = 0.455. It communicated a conservation identity but contained less explicit evidence of implemented activity and no reported external collaboration. The RAM difference was 0.419 points, while IEDI and EIS differed by 0.495 and 0.450 points, respectively.

The comparison also reveals that implementation, rather than ecological

vocabulary alone, separates the two observations. HID002 contains a recognisable conservation narrative, yet its lower EIS and zero collaboration score reduce the extent to which that narrative is translated into observable institutional engagement. HID001 combines value language with a specified intervention, identifiable partners, and a contemporary public-risk setting. This layered evidence explains why its stronger RAM score should be interpreted as greater reported alignment, not simply a higher frequency of environmental terms.

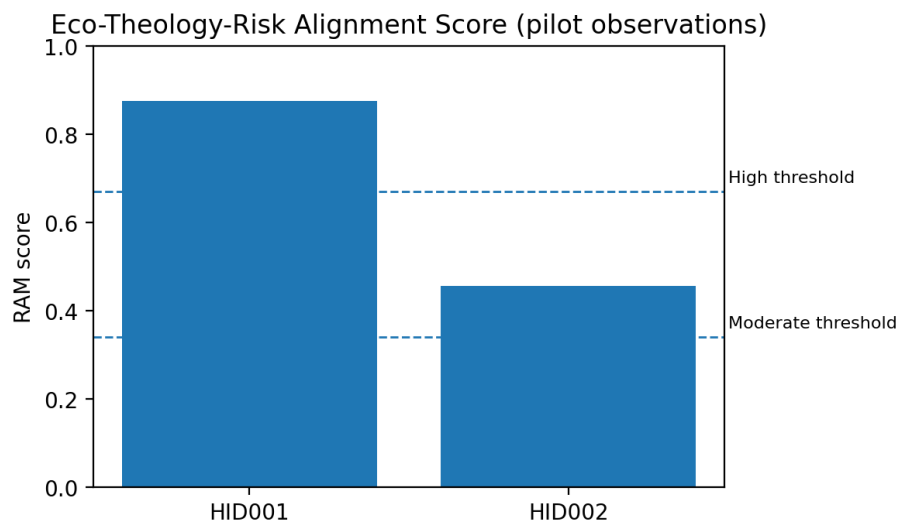


Figure 3. Eco-Theology-Risk Alignment scores for the pilot articles

Source: Authors' calculations

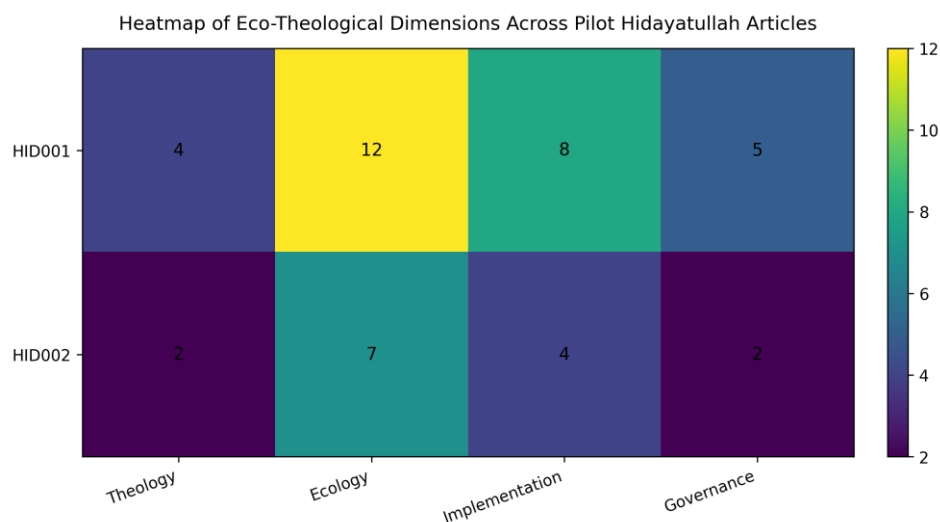


Figure 4. Heatmap of eco-theological dimensions across the pilot articles

Source: Authors' coding and visualisation

Figures 3 and 4 show the same directional pattern: HID001 has the higher RAM score and exceeds HID002 across theology, ecology, implementation, and governance. The

comparison is descriptive; two purposively selected texts cannot support significance, causality, trend, or moderation claims.

Table 4. Decomposition of the RAM score

Article	IEDI component	EIS component	Risk-adjusted component	Total RAM
HID001	0.400	0.300	0.174	0.874
HID002	0.202	0.165	0.088	0.455
Gap	0.198	0.135	0.086	0.419

Source: Authors' calculations using the specified RAM weights

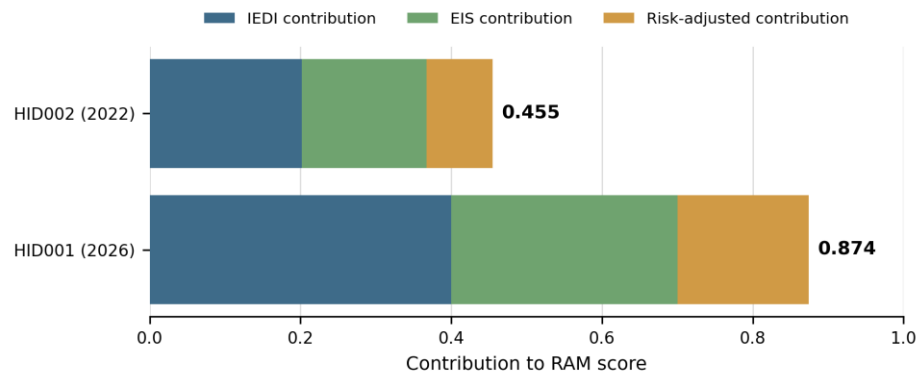


Figure 5. Weighted contribution of each component to the RAM score

Source: Authors' calculations

Table 4 and Figure 5 indicate that the largest share of the gap comes from the discourse component, followed by implementation and

risk-adjusted alignment. The result identifies where the articles differ without treating the composite score as a single opaque value.

Table 5. Status of the model propositions

Proposition	Expected relationship	Pilot evidence	Status
P1	IEDI is positively associated with EIS.	Higher IEDI coincides with higher EIS.	Suggestive only
P2	ICS is positively associated with EIS.	The collaborative article has higher EIS.	Suggestive only
P3	ERI moderates the IEDI–EIS relationship.	ERI is constant across both observations.	Not testable
P4	Action-oriented discourse has higher RAM.	The tree-planting article has higher RAM.	Pilot pattern
P5	Discourse becomes more implementation-oriented over time.	The 2026 score exceeds the 2022 score.	No trend claim

Source: Authors' calculations

Table 5 distinguishes pilot patterns from hypothesis tests. P1, P2, and P4 are directionally consistent; P3 is unidentifiable; and P5 cannot be inferred from two non-consecutive documents.

4. Discussion

The results distinguish symbolic ecological identity from discourse that combines Islamic values, action, collaboration, and local relevance. HID001's stronger pattern is consistent with

Saeed's contextual hermeneutics, in which stewardship, trust, balance, and repair become meaningful through contemporary institutional choices (Saeed, 2006, 2014). The scores nevertheless measure public framing, not verified performance.

For practice, pesantren can connect theology with local inquiry: santri may map flood exposure, audit waste and water, monitor tree survival, and evaluate partnerships. Reporting

should emphasise measurable outcomes such as waste diverted, water saved, participation, survival rates, and preparedness knowledge. Government and environmental agencies could support this work, while the scores should guide improvement rather than ranking.

The two-document purposive sample, keyword misclassification risk, city-level indicators, theory-driven weights, and constant ERI constrain interpretation. A full test requires a larger corpus, field and institutional evidence, independent coders, Cohen's kappa, and weighting sensitivity tests. The propositions remain exploratory.

A further implication concerns institutional learning. Repeated reporting with the same indicators could help pesantren compare planned activities with completed outputs and identify gaps between moral commitments and operational delivery. Used longitudinally, the framework could support internal reflection and

partnership design, provided that communication scores are verified against records and field evidence.

5. Conclusion

This study introduced a transparent risk-responsive model linking Islamic ecotheological discourse, implementation, collaboration, and local risk. The 2026 collaborative tree-planting article scored higher on IEDI, EIS, ICS, and RAM than the 2022 conservation article, a descriptive pattern compatible with contextual application of Islamic values but insufficient for causal or statistical claims. The model can identify where discourse, action, partnership, or risk relevance needs strengthening. Future research should validate it across pesantren and years, triangulate website analysis with field evidence, test inter-coder reliability, and estimate the proposed regression only after sufficient variation is available.

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Author Declaration

The authors confirm that this manuscript is original, has not been published elsewhere, and is not under simultaneous consideration by another journal. The authors declare no conflict of interest. All data used in the pilot are drawn from publicly accessible institutional sources.