



SUSTAINABLE ECOPE SANTREN EDUCATION MANAGEMENT MODEL FOR DISASTER MITIGATION STRATEGIES AND SDGs ACHIEVEMENT

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ABSTRACT

Pesantren (Islamic boarding schools) occupy a strategic position in Indonesia's educational landscape, yet many are located in disaster-prone regions and have not systematically integrated environmental sustainability and disaster risk reduction into institutional management. This study aims to develop a Sustainable Ecpesantren Education Management Model that integrates disaster mitigation strategies with the Sustainable Development Goals (SDGs). Using a Research and Development (R&D) approach combined with a qualitative case study design, data were collected through interviews, focus group discussions, document analysis, and field observation involving pesantren leaders, educators, students, and local disaster management stakeholders. The model was validated through expert judgment and a limited field trial in selected disaster-prone pesantren. Findings indicate that integrating ecological literacy, disaster-preparedness curricula, green infrastructure, and community-based mitigation practices strengthens institutional resilience while advancing SDG 4 (quality education), SDG 11 (sustainable cities and communities), and SDG 13 (climate action). Religious values and local wisdom embedded in pesantren culture provide an effective foundation for disaster risk reduction and environmental stewardship. The study offers a practical and theoretical framework for developing faith-based, disaster-resilient, and sustainability-oriented education management systems with potential for replication in disaster-prone regions.

Keywords: *ecopesantren; education management; disaster mitigation; sustainable development goals; environmental sustainability*

INTRODUCTION

Indonesia is home to one of the largest networks of Islamic boarding schools (pesantren) in the world, with tens of thousands of institutions serving millions of students and functioning as centers of religious education, character formation, and community leadership (Kementerian Agama RI, 2023). Beyond their religious mandate, pesantren are deeply embedded within local communities and frequently occupy geographically vulnerable locations along coastlines, volcanic slopes, riverbanks, and seismically active zones. The national disaster risk index consistently identifies a large proportion of Indonesian regencies, many of which host substantial pesantren populations, as high or very-high risk for flooding, earthquakes, landslides, and volcanic hazards

(Badan Nasional Penanggulangan Bencana [BNPB], 2022). This geographical reality places pesantren communities at the intersection of two urgent agendas: safeguarding educational continuity in the face of recurrent disasters, and cultivating environmental stewardship consistent with Islamic teachings on the human role as *khalifah fil ardh* (steward of the earth).

Despite this strategic exposure, institutional management practices within most pesantren have not systematically incorporated environmental sustainability principles or structured disaster risk reduction (DRR) measures. Prior studies on Islamic educational institutions in Indonesia note that ecological programs, where they exist, tend to be sporadic, project-based, and dependent on individual leadership initiative rather than embedded within governance structures, curricula, and long-term institutional planning (Mangunjaya & McKay, 2012; Gade, 2019). At the same time, international research on disaster education demonstrates that schools and community-based educational institutions can play a decisive role in reducing vulnerability when disaster-preparedness knowledge, infrastructure, and community mitigation practices are deliberately integrated into everyday institutional life (Selby & Kagawa, 2012; Shiwaku et al., 2016; Amri et al., 2017). The convergence of these two bodies of knowledge, Islamic environmental ethics and disaster risk reduction education, remains under-theorized, particularly with respect to the pesantren as a distinct institutional form combining religious authority, communal living, and educational governance.

The Ecopesantren movement initiated by Indonesia's Ministry of Environment and Forestry represents an important policy response, encouraging pesantren to adopt environmentally friendly practices such as waste management, water conservation, and green open space development (Kementerian Lingkungan Hidup dan Kehutanan [KLHK], 2021). However, this initiative has generally emphasized ecological programs in isolation from disaster risk reduction and from the global Sustainable Development Goals (SDGs) framework. The 2030 Agenda explicitly links quality education (SDG 4), sustainable cities and communities (SDG 11), and climate action (SDG 13) as mutually reinforcing targets that require institutional-level implementation (Sachs et al., 2019; Le Blanc, 2015). Educational institutions situated in disaster-prone regions, including pesantren, are therefore uniquely positioned to advance these interconnected goals if their management systems are redesigned to integrate ecological literacy, disaster-preparedness curricula, resilient infrastructure, and community-based mitigation practices.

This study responds to that need by developing a Sustainable Ecopesantren Education Management Model that explicitly connects disaster mitigation strategies with SDG achievement, while grounding the model in the religious values and local wisdom that already shape everyday life within pesantren communities. In doing so, the study seeks to move beyond fragmented, ad hoc greening initiatives toward a structured, replicable management framework suitable for adoption by Islamic educational institutions across disaster-prone regions of Indonesia and, by extension, other Muslim-majority contexts facing similar environmental and disaster risks.

Problem Statement, Research Questions, and Objectives

The central problem addressed in this study is the absence of a systematic, institutionally embedded management model that simultaneously addresses environmental sustainability, disaster risk reduction, and SDG achievement within the pesantren context. Existing management practices in most pesantren remain oriented primarily toward religious curricula and administrative routines, with environmental and disaster-related concerns treated as peripheral rather than core institutional functions (Mangunjaya & McKay, 2012). This gap is particularly consequential given



that pesantren often host large residential student populations (santri) who reside on campus around the clock, magnifying the human cost of inadequate disaster preparedness and environmental mismanagement.

Based on this gap, the study addresses three research questions: (i) what are the existing ecological conditions and disaster risk profiles of pesantren located in disaster-prone regions; (ii) what components constitute an effective Sustainable Ecoresources Education Management Model that integrates ecological literacy, disaster-preparedness curricula, green infrastructure, and community-based mitigation with SDG indicators; and (iii) to what extent is the developed model valid, feasible, and acceptable when evaluated through expert judgment and a limited field trial. Correspondingly, the objectives of this research are to map the ecological and disaster risk conditions of selected pesantren, to design and validate a Sustainable Ecoresources Education Management Model, and to examine the model's contribution to SDG 4, SDG 11, and SDG 13 indicators.

Literature Review

The literature informing this study converges along four interrelated strands: Islamic environmental ethics, disaster risk reduction education, sustainability education linked to the SDGs, and design and development research methodology. Islamic environmental ethics provides the theological foundation for ecological stewardship within pesantren culture. Gade (2019) demonstrates that Indonesian Muslim environmentalism draws upon Qur'anic concepts of *khalifah* (stewardship), *mizan* (balance), and *amanah* (trust) to frame environmental care as a religious obligation rather than a secular add-on. Mangunjaya and McKay (2012) similarly argue that reviving Islamic approaches to conservation, including fatwa on environmental protection issued by Indonesian Islamic scholarly bodies, offers a culturally resonant pathway for mobilizing pesantren communities toward sustainability practices that are more likely to be internalized than externally imposed programs.

Research on disaster risk reduction education underscores the pivotal role that educational institutions play in reducing community vulnerability. Selby and Kagawa (2012) document how integrating disaster risk reduction into school curricula across diverse national contexts strengthens preparedness knowledge and behavioral readiness among students. Shiwaku, Sakurai, and Shaw (2016) extend this argument by showing that the resilience of education systems depends not only on curriculum content but also on physical infrastructure, institutional leadership, and community linkages. In the Indonesian context specifically, Amri et al. (2017) identify persistent challenges in scaling disaster risk reduction education, including inconsistent policy implementation, limited teacher training, and weak integration between formal curricula and community-based disaster management structures administered by local disaster management agencies (BPBD). Djalante et al. (2017) further emphasize those structural and governance gaps that continue to hinder disaster resilience efforts across Indonesian institutions, while Djalante (2019) highlights the urgency of aligning national disaster frameworks, such as the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNISDR, 2015), with climate adaptation imperatives.

A third strand of literature situates institutional sustainability practices within the global SDG framework. Le Blanc (2015) conceptualizes the SDGs as an interconnected network of targets in which progress in one domain, such as education, reinforces progress in others, including

climate action and sustainable urban development. Sachs et al. (2019) argue that achieving the SDGs requires deliberate institutional transformation rather than incremental adjustment, a proposition consistent with UNESCO's (2017) call for embedding sustainability learning objectives across all levels and forms of education. Leal Filho et al. (2019) provide empirical evidence that educational institutions which formally embed SDG-oriented practices into governance and teaching demonstrate measurably stronger sustainability outcomes than those pursuing sustainability informally.

Finally, the design and development research (R&D) tradition offers methodological grounding for translating these theoretical strands into an implementable institutional model. Richey and Klein (2007) characterize design and development research as an iterative process of model construction, expert validation, and field testing intended to produce practical, generalizable solutions to complex educational problems. This methodological orientation is well suited to the present study's aim of producing not merely a conceptual argument but a validated, field-tested management model.

Taken together, this body of literature reveals a critical gap: while Islamic environmental ethics, disaster risk reduction education, and SDG-oriented sustainability practices have each been studied extensively in isolation, few studies integrate all three within a single institutional management model tailored to the pesantren context. This study addresses that gap by developing and validating a model that treats religious values and local wisdom not as an ancillary cultural backdrop, but as the structural foundation upon which ecological literacy, disaster-preparedness curricula, green infrastructure, and community-based mitigation practices are built.

METHOD

This study employs a Research and Development (R&D) approach following the design and development research tradition (Richey & Klein, 2007), combined with a qualitative case study design (Yin, 2018) to capture the contextual richness of pesantren institutional life. The R&D approach was selected because the study's primary output is a validated, implementable management model rather than a purely descriptive or explanatory account. The research was conducted in five phases: (1) a preliminary needs analysis to map existing ecological conditions and disaster risk profiles; (2) conceptual model design based on the literature review and preliminary findings; (3) expert judgment validation; (4) a limited field trial in selected pesantren; and (5) model revision based on trial results and stakeholder feedback.

Research sites were purposively selected using two criteria: location within a BNPB-designated high or very-high disaster risk zone (BNPB, 2022), encompassing flood-, earthquake-, and landslide-prone regions, and demonstrated institutional openness to participate in ecological and disaster-related program development. Participants comprised pesantren leaders (kyai and pengasuh), educators (ustadz and ustadzah), students (santri), and local disaster management stakeholders from BPBD and village-level disaster preparedness units (Kelompok Siaga Bencana). This purposive, multi-stakeholder composition was intended to capture both institutional decision-making perspectives and grassroots implementation realities.

Data were collected through four complementary techniques: in-depth semi-structured interviews with pesantren leaders and disaster management officials; focus group discussions (FGDs) with educators and students to explore curricular and behavioral dimensions of disaster preparedness and environmental practice; document analysis of institutional policies, curricula, and existing environmental or disaster-related programs; and field observation of physical infrastructure, evacuation routes, waste management systems, and green open space. Data



collection continued until thematic saturation was reached across the four techniques, consistent with qualitative case study conventions (Yin, 2018).

Data were analyzed using the thematic analysis procedures outlined by Miles, Huberman, and Saldaña (2014), involving data condensation, data display, and conclusion drawing/verification conducted iteratively across the data corpus. Codes were developed inductively from interview transcripts, FGD notes, and observation records, then organized into broader themes corresponding to the model's core dimensions: ecological literacy and curriculum, green infrastructure, community-based mitigation, institutional leadership, and SDG-related outcomes. Trustworthiness was strengthened through methodological triangulation across data sources, member checking with key informants, and peer debriefing among the research team.

The developed model was validated in two stages. First, expert judgment validation was conducted with specialists in Islamic education management, disaster risk reduction, and environmental education, who rated the relevance, clarity, and feasibility of each model component using a structured validation instrument; results were analyzed for content validity to determine whether components required revision prior to field testing. Second, a limited field trial was implemented in selected pesantren located in disaster-prone areas, during which model components were introduced through workshops, curriculum pilots, and infrastructure demonstration activities. Evaluation of the trial combined qualitative feedback from FGDs with pre- and post-implementation observation of institutional practices, allowing the research team to assess the model's practical feasibility and acceptability before finalizing its structure.

RESULTS AND DISCUSSION

Ecological and Disaster Risk Profile of Pesantren

Preliminary findings indicate that the surveyed pesantren face substantial, largely unmanaged disaster exposure. Interview and observation data reveal that most institutions lack formal evacuation routes, early warning mechanisms, or designated assembly points, despite operating in zones classified as high risk for flooding, earthquakes, or landslides (BNPB, 2022). Waste management practices were generally informal, relying on open burning or unmanaged disposal rather than structured reduction, reuse, and recycling systems. Green open space was similarly limited, with campus development historically prioritizing dormitory and classroom capacity over ecological or disaster-buffering infrastructure such as vegetative cover, water catchment areas, or defensible open ground.

At the same time, informants consistently described strong latent social capital, including established norms of mutual cooperation (*ta'awun*), communal labor traditions (*gotong royong* and *kerja bakti*), and hierarchical trust in *kyai* leadership, that could be readily mobilized for disaster mitigation and environmental programs once appropriately structured. This finding echoes Amri et al. (2017), who note that Indonesian disaster education initiatives often falter not from a lack of community willingness but from insufficient institutional structuring and curricular integration. The pesantren context, characterized by dense residential communities and strong internal authority structures, therefore presents distinct opportunities for rapid mobilization once a clear management model is introduced.

Development of the Sustainable Ecopesantren Education Management Model

Drawing on the preliminary findings and literature review, the study developed a management model comprising five interlocking components: (1) institutional leadership and policy commitment, articulated through formal decrees (*surat keputusan*) integrating ecological and disaster-risk priorities into pesantren governance; (2) ecological literacy and disaster-preparedness curricula, embedded within both *diniyah* (religious) and general subjects as well as extracurricular activities; (3) green infrastructure, encompassing water and waste management, renewable energy where feasible, and green open space; (4) community-based mitigation practices, formalized through partnership agreements with BPBD and village disaster preparedness units; and (5) monitoring and evaluation mechanisms to sustain implementation over time. This structure is consistent with Richey and Klein's (2007) emphasis on iterative, multi-component model design validated through expert review and field testing.

Expert judgment validation confirmed the relevance and feasibility of all five components, with reviewers particularly emphasizing the importance of anchoring the model in religious values to enhance acceptability among pesantren leadership. Minor revisions were made to the curriculum integration component following expert feedback, most notably the recommendation to align disaster-preparedness content explicitly with existing *tahfiz* and *diniyah* scheduling structures rather than introducing a separate, competing curriculum track. This adjustment reflects a broader principle observed throughout the validation process: model components gained stronger endorsement when framed as extensions of existing pesantren practices rather than external impositions.

Ecological Literacy and Disaster-Preparedness Curriculum Integration

Field trial data show that curriculum integration was most successful when disaster-preparedness content was woven into existing subjects rather than delivered as a stand-alone module. Educators reported that framing earthquake and flood response procedures alongside *fiqh* discussions of *amanah* (trust) and *hifz al-nafs* (preservation of life) increased student engagement and helped position disaster preparedness as a religiously grounded obligation rather than a secular civic exercise. This finding is consistent with Selby and Kagawa's (2012) observation that disaster risk reduction curricula achieve greater uptake when localized to the cultural and value systems of the implementing institution rather than adopted as generic, imported content.

Extracurricular activities, including simulated evacuation drills and student-led environmental clubs, further reinforced curricular content through experiential learning. Students who participated in evacuation drills demonstrated markedly improved procedural knowledge during post-trial assessment compared to baseline observation, aligning with Shiwaku et al.'s (2016) argument that disaster-resilient education systems depend on the combination of cognitive content and practiced behavioral routines rather than classroom instruction alone.

Green Infrastructure and Community-Based Mitigation Practices

The field trial introduced low-cost green infrastructure interventions, including rainwater harvesting systems, a student-managed waste bank (*bank sampah*) segregating organic and inorganic waste, and vegetative buffer planting along vulnerable slopes and drainage channels. These interventions were selected for their feasibility within limited pesantren budgets and their capacity to simultaneously serve ecological and disaster-mitigation functions; vegetative buffers, for instance, were valued by informants both for landscaping and for reducing landslide and flood runoff risk.

Community-based mitigation practices were strengthened through formal partnerships with BPBD and village disaster preparedness units, which provided technical training on early



warning systems and evacuation planning. Field observation indicated that pesantren which formalized these partnerships, rather than relying on informal or ad hoc contact with disaster agencies, demonstrated more consistent implementation of evacuation signage, designated assembly points, and periodic drill schedules. This pattern corroborates Djalante et al.'s (2017) argument that Indonesian disaster resilience outcomes depend heavily on the strength and formality of multi-stakeholder governance linkages rather than technical knowledge alone.

Expert Validation and Limited Field Trial Outcomes

Content validity results from the expert judgment stage indicated strong agreement on the relevance of all five model components, with the highest consensus on the curriculum integration and community partnership components and comparatively more caution expressed regarding the pace and cost of green infrastructure implementation in resource-constrained pesantren. This feedback informed a phased implementation guideline within the final model, allowing institutions to sequence infrastructure investment according to available resources while implementing curriculum and partnership components immediately at minimal cost.

Field trial evaluation, conducted through FGDs and comparative pre- and post-implementation observation, indicated broad stakeholder acceptance of the model. Pesantren leaders reported that the model's explicit grounding in Islamic values eased internal socialization, while educators and students described increased confidence in disaster response procedures. Local disaster management stakeholders noted that the formalized partnership structure improved coordination that had previously depended on informal, leader-to-leader contact. These outcomes suggest that the model is both feasible and acceptable for broader implementation, consistent with the iterative validation logic of design and development research (Richey & Klein, 2007).

Contribution to SDG 4, SDG 11, and SDG 13

The model's components map directly onto specific SDG targets and indicators. Curriculum integration of ecological literacy and disaster preparedness advances SDG target 4.7, which calls for education that promotes sustainable development and a culture of peace and resilience (UNESCO, 2017). Green infrastructure and community-based mitigation practices contribute to SDG target 11.5, reducing deaths and losses caused by disasters, and SDG target 11.b, increasing the number of settlements implementing integrated disaster risk reduction policies. Finally, the model's emphasis on institutional adaptation to climate-related hazards supports SDG target 13.1, strengthening resilience and adaptive capacity to climate-related hazards, and SDG target 13.3, improving education and institutional capacity on climate change mitigation and adaptation.

This alignment illustrates Le Blanc's (2015) conceptualization of the SDGs as an interconnected network rather than a set of isolated targets: strengthening pesantren educational management simultaneously advances educational, urban resilience, and climate objectives. The model thus offers a concrete institutional pathway through which faith-based educational institutions can operationalize SDG achievement, addressing Sachs et al.'s (2019) call for deliberate institutional transformation rather than incremental, uncoordinated sustainability initiatives.

Religious Values and Local Wisdom as a Foundation for Disaster Risk Reduction

A recurring finding across interviews, FGDs, and field observation is that religious values function not merely as motivational rhetoric but as an operational foundation that shapes how disaster mitigation and environmental practices are implemented and sustained within pesantren communities. Concepts such as *khalifah fil ardh* (stewardship of the earth), *amanah* (trust), *ta'awun* (mutual cooperation), and *ukhuwah* (brotherhood/solidarity) were repeatedly invoked by pesantren leaders to frame environmental care and disaster preparedness as extensions of religious duty rather than externally imposed technical requirements. This finding is consistent with Gade's (2019) and Mangunjaya and McKay's (2012) arguments that Indonesian Muslim environmentalism draws its legitimacy and mobilizing power from theological grounding rather than secular environmental discourse alone.

Practically, this religious grounding translated into higher rates of voluntary participation in communal labor for infrastructure development, stronger internal enforcement of waste management norms through moral rather than punitive mechanisms, and greater willingness among students to internalize disaster-preparedness routines framed as acts of self-preservation consistent with Islamic teaching. These findings support the study's central argument that effective ecopesantren management models must treat religious values and local wisdom as structural foundations, rather than supplementary framing, for disaster risk reduction and environmental stewardship.

FINDINGS MODEL AND IMPLICATIONS

Synthesizing the results above, the study proposes the Sustainable Ecopesantren Education Management Model illustrated below. Religious values and local wisdom form the foundational layer upon which three operational pillars, ecological literacy and disaster-preparedness curriculum, green infrastructure, and community-based mitigation practices, are constructed. These pillars are coordinated through an institutional management layer encompassing leadership commitment, policy formalization, and monitoring and evaluation, which together strengthen institutional and community resilience and ultimately advance SDG 4, SDG 11, and SDG 13 indicators.

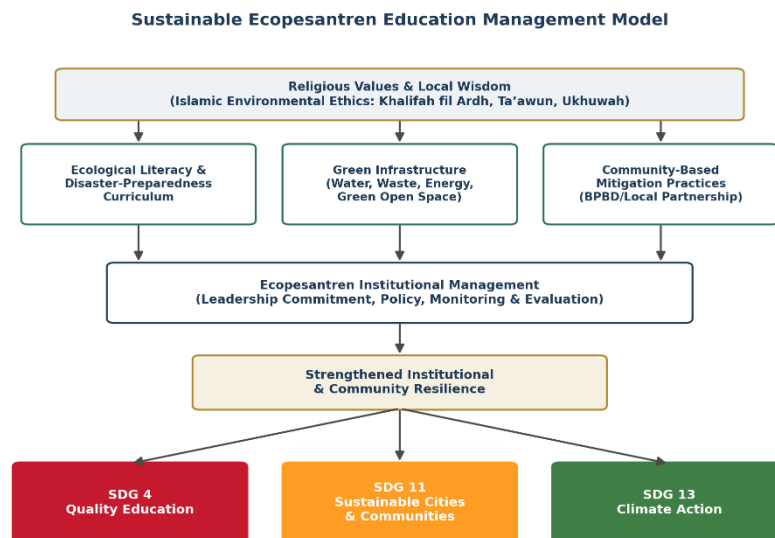


Figure 1. The Sustainable Ecopesantren Education Management Model



This study carries three primary implications. First, theoretically, the model extends the discourse on Islamic environmental ethics by demonstrating how religious values can be operationalized as structural components of institutional disaster risk management, rather than treated as an abstract cultural backdrop to secular sustainability programs. Second, practically, the model offers pesantren administrators a phased, low-cost implementation pathway that prioritizes curriculum integration and community partnership before capital-intensive infrastructure investment, addressing the resource constraints repeatedly emphasized by informants. Third, in terms of policy, the model provides a framework through which government bodies such as the Ministry of Religious Affairs, the Ministry of Environment and Forestry, and BNPB can coordinate support for pesantren-based disaster risk reduction and sustainability programs in a manner consistent with existing pesantren governance structures rather than requiring institutional restructuring.

From a research perspective, the model developed here can be further tested across a larger sample of pesantren representing diverse hazard types, geographic regions, and institutional sizes to examine its generalizability. Future research may also employ quantitative approaches to measure the model's longer-term impact on disaster resilience indicators and SDG-related outcomes, as well as comparative studies examining how similar models might be adapted for other faith-based educational institutions beyond the Indonesian pesantren context.

CONCLUSION

This study developed and validated a Sustainable Ecopesantren Education Management Model that integrates ecological literacy, disaster-preparedness curricula, green infrastructure, and community-based mitigation practices within a management framework explicitly grounded in Islamic religious values and local wisdom. Findings demonstrate that pesantren located in disaster-prone regions possess substantial latent social capital and religious legitimacy that, when structured through deliberate institutional management, can significantly strengthen both disaster resilience and progress toward SDG 4, SDG 11, and SDG 13 indicators.

The study's principal contribution lies in demonstrating that religious values function as an operational foundation, rather than a peripheral framing device, for sustainable and disaster-resilient institutional management. By validating the model through expert judgment and a limited field trial, this research offers a practical and theoretical framework that policymakers and pesantren administrators can adopt and adapt, providing a replicable pathway for Islamic educational institutions to become simultaneously faith-based, disaster-resilient, and sustainability-oriented. Continued refinement and broader testing of the model across diverse pesantren contexts remain important directions for future research and policy development.

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