



Community participation in cleanliness education to maintain the quality of river ecosystems in Indonesia

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ABSTRACT

Background: Indonesian river-management programs increasingly combine environmental education with community participation, but the evidence is fragmented and often conflates awareness, self-reported behavior, governance change, and ecological improvement. This review synthesized how river-focused environmental education relates to behavioral outcomes, the forms and depth of participation reported, and the social, institutional, and ecological outcomes of participatory river management. **Methods:** A PRISMA 2020 systematic literature review searched Google Scholar and ScienceDirect for publications from 2015-2025. Of 305 records identified, 15 studies were included: 12 Indonesian studies and three international empirical comparators. Evidence was synthesized narratively, appraised using the Mixed Methods Appraisal Tool 2018, and interpreted through the Theory of Planned Behavior and Arnstein's participation ladder. **Findings:** Most Indonesian studies described operational participation through clean-ups, campaigns, waste-management activities, planting, or monitoring. Partnership or community control was reported less often and was associated with multi-stakeholder facilitation, organizational access, local leadership, and culturally grounded practices. Knowledge, awareness, participation, and perceived institutional benefits were reported more frequently than sustained behavioral or ecological change. MMAT appraisal yielded three high-, six medium-, and six low-confidence contributions. Only one study directly measured water-quality parameters; therefore, the evidence does not establish that education or participation caused river-ecosystem improvement. **Conclusion:** Practical, place-based education and enabling institutional conditions were repeatedly associated with stronger participation, but ecological benefits remain uncertain. Interpretation is limited by two-database coverage, single-reviewer screening and appraisal, heterogeneous designs, the absence of meta-analysis, and scarce direct ecological measurement. **Novelty/Originality of this article:** The review provides an Indonesia-focused, quality-weighted framework that connects behavioral mechanisms with participation depth while keeping social, institutional, and directly measured ecological outcomes analytically distinct.

KEYWORDS: community participation; environmental education; participatory governance; river ecosystems; systematic literature review.

1. Introduction

River pollution remains a persistent environmental concern in Indonesia, where domestic waste, urban growth, and weak waste-management services place continuing pressure on rivers and downstream ecosystems. Rivers on Java contribute substantial plastic loads to coastal waters, while communities living along river corridors remain exposed to environmental and livelihood risks (Iskandar et al., 2022). These conditions make river management not only a technical issue but also a problem of environmental responsibility, collective norms, and sustained community practice.

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Infrastructure, river rehabilitation, and regulatory measures remain necessary, but they do not by themselves explain whether households reduce waste disposal, participate beyond one-off activities, or influence planning and evaluation. Indonesian studies have reported clean-ups, campaigns, training, waste-management activities, and community monitoring, yet participation often remains concentrated in implementation rather than decision-making (Maharani et al., 2023; Mardianti & Purba, 2023). The relevant question is therefore not simply whether communities are present, but what they are enabled to learn, decide, and sustain.

River-focused environmental education is treated in this review as learning linked to river cleanliness, waste practices, monitoring, and stewardship. Its relevance to environmental character lies in the formation of ecological responsibility, subjective norms, moral commitment, and collective action. Local leadership, gotong royong, social solidarity, and culturally grounded practices such as Reresik Kali may strengthen these processes by connecting environmental messages with community identity and shared obligations (Rahardjanto et al., 2025). These mechanisms, however, should not be assumed to produce ecological improvement unless changes in water quality, biodiversity, waste loads, or comparable indicators are directly measured.

Previous reviews provide important but only partially overlapping evidence. Environmental-education reviews distinguish learning outcomes from conservation outcomes and show that active, context-specific approaches do not automatically produce durable behavior (Ardoin et al., 2020; Monroe et al., 2019; Rau et al., 2022; Zhang et al., 2025). Reviews of participation and water governance likewise show that decision power, institutional support, and context shape outcomes (Hove et al., 2022; Lema, 2025; Newig et al., 2023; Özerol et al., 2018). Citizen-monitoring reviews further distinguish data generation from institutional uptake and community influence (Dominguez-Rendón et al., 2024; Shao & Bishop, 2025). None provides an Indonesia-focused synthesis that simultaneously classifies participation depth, separates behavioral, institutional, and ecological outcomes, and weights interpretation according to methodological quality. The present review addresses that narrower gap rather than claiming that participation, institutional support, or environmental education are themselves new concepts.

The analytical framework combines behavioral, participatory, and socio-ecological perspectives. The Theory of Planned Behavior was used deductively to interpret reported attitudes, subjective norms, and perceived behavioral control; it was not used as a search or eligibility criterion and the review did not test causal Theory of Planned Behavior (TPB) pathways (Ajzen, 1991, 2020). Its water-behavior application was used only as contextual support for interpreting the reported constructs (Gibson et al., 2023). Arnstein's Ladder of Citizen Participation was used as a classificatory lens for distinguishing information or operational involvement, consultation, partnership or co-production, and community control (Arnstein, 1969). Inductive codes captured educational approaches, institutional conditions, local values, and reported outcomes. Together, these lenses trace a plausible pathway from education to participation while retaining a necessary distinction between knowledge or self-reported behavior and directly measured ecological change. Accordingly, the review was guided by the following questions: How is river-focused environmental education associated with reported knowledge, attitudes, intentions, or self-reported behavior? What forms and levels of community participation are reported in river-conservation studies? What social, institutional, and directly measured ecological outcomes are reported, and how does methodological quality affect confidence in those findings?

The review therefore aimed to synthesize education-related behavioral patterns, classify the depth of community participation, and examine reported social, institutional, and ecological outcomes. Its contribution is an evidence-weighted Indonesia-focused synthesis, supported by three international design comparators, rather than a causal test of an education-behavior-ecology pathway.

2. Methods

2.1 Review design, reporting and information sources, search strategy

This systematic literature review synthesized empirical evidence on community participation, environmental education, and river or watershed management. Review design and reporting followed established guidance for systematic literature reviews and PRISMA 2020 (Page et al., 2021a; Page et al., 2021b; Snyder, 2019; Xiao & Watson, 2019). Because the evidence base combined qualitative, quantitative, participatory, and mixed-method studies, the synthesis was narrative rather than meta-analytic.

Google Scholar was searched on 15 March 2026 and ScienceDirect on 18 March 2026. The complete search string was: (“public participation” OR “community participation”) AND (“environmental education” OR “cleanliness education”) AND (“river ecosystem” OR “river management”) AND “Indonesia”. Google Scholar was searched across titles and full text because it does not support reproducible field-specific restrictions; the first 21 result pages were examined (approximately 10 results per page), yielding 210 records. In ScienceDirect, the search was limited to title, abstract, and keywords, yielding 95 records. The different coverage and reproducibility characteristics of Google Scholar were considered when interpreting search completeness (Martín-Martín et al., 2018).

Records were exported in RIS format from Google Scholar through Publish or Perish and directly from ScienceDirect, then managed in Zotero. Zotero was used to identify duplicates, followed by a manual metadata check. Backward and forward citation searching, hand-searching, and snowballing were not conducted; therefore, all included studies originated from the two stated databases.

2.2 Eligibility criteria, study selection and data extraction

Studies were eligible when they were published from 2015 through 2025; were written in Indonesian or English; were full-length, peer-reviewed journal articles or conference proceedings reporting primary empirical data; substantially examined community or public participation, environmental or cleanliness education, and river or watershed management; and reported a sufficiently identifiable research design and findings. Indonesian studies formed the primary evidence base. International empirical studies were retained only as comparative cases and were analyzed separately rather than treated as direct estimates for Indonesia.

Review articles, meta-analyses, editorials, non-empirical papers, short proceedings without primary data, modeling studies without a comparable primary evaluation, studies outside the publication period, insufficiently relevant studies, reports with inadequately described methods, and overlapping datasets were excluded. Retrievable full text was required for appraisal; open-access availability was therefore a retrieval constraint, not a proxy for scientific quality. Database indexing was not used as an inclusion or quality criterion.

One reviewer performed record management, title and abstract screening, full-text assessment, data extraction, thematic coding, and methodological appraisal. Screening was not conducted independently by a second reviewer; consequently, there was no disagreement-adjudication procedure and no inter-reviewer agreement statistic. To reduce decision drift, the reviewer reapplied the eligibility criteria during the final audit and cross-checked each included record against its full-text PDF and the extraction matrix.

The structured extraction matrix recorded author and year, country and location, publication type, study design, sample or data source, educational or participatory approach, Arnstein-informed participation level, social or behavioral outcome, institutional outcome, ecological outcome, directness of ecological measurement, methodological limitations, and safe interpretation. The same reviewer completed extraction and then rechecked author names, years, samples, designs, and outcomes against the source PDFs.

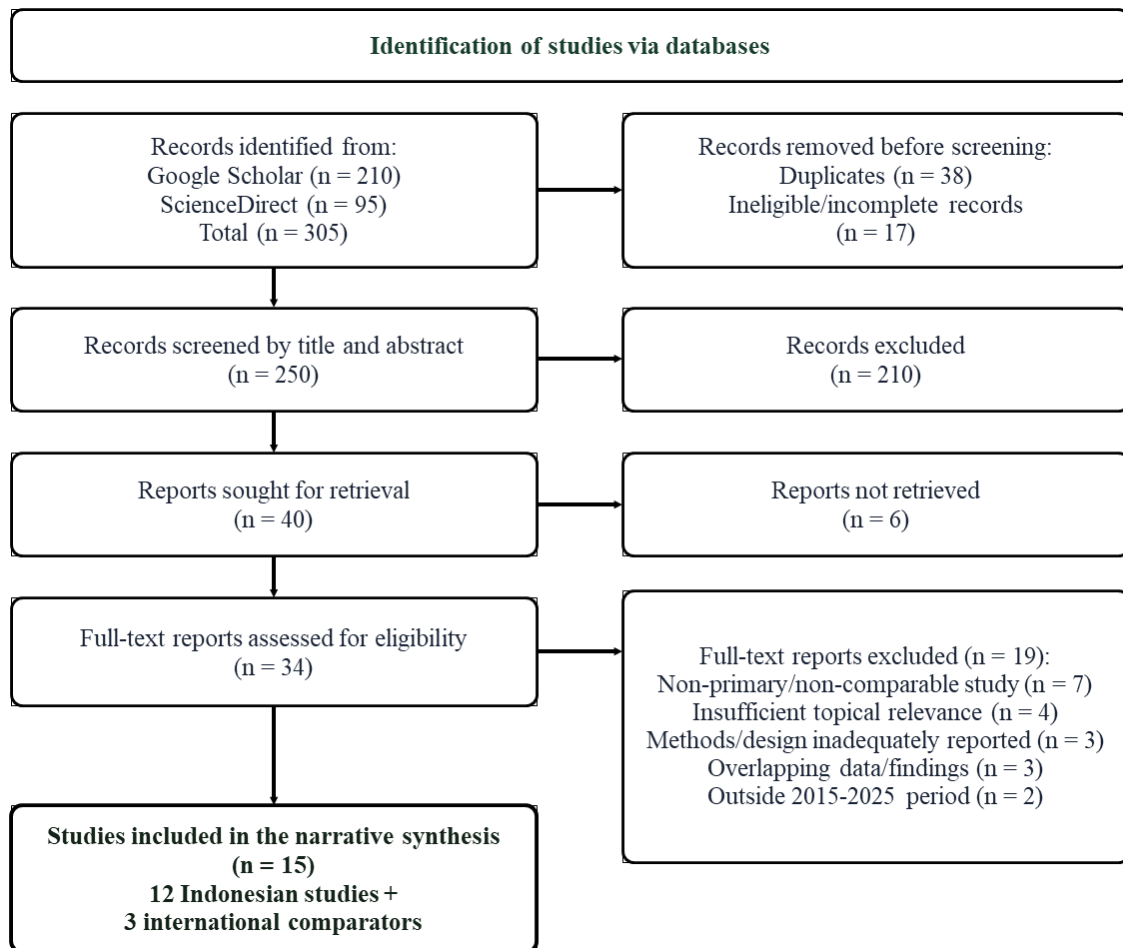


Fig. 1. PRISMA 2020 flow diagram for study selection

2.3 Methodological quality appraisal

Methodological quality was appraised with the Mixed Methods Appraisal Tool (MMAT), version 2018 (Hong et al., 2018). Each study was assigned to the relevant MMAT design category and rated on two screening questions and five design-specific criteria using Yes, No, or Cannot tell. In accordance with MMAT guidance, criterion ratings were not summed into a numerical score.

For narrative weighting, an interpretive confidence label was added: high indicated no critical methodological limitation, medium indicated concerns that constrained inference but did not prevent interpretation, and low indicated critical concerns in sampling, measurement, analysis, or coherence. These labels are synthesis weights, not MMAT scores. Appraisal did not determine eligibility; it determined how strongly each study contributed to the conclusions. The appraisal was performed by the same single reviewer and was not independently duplicated.

2.4 Coding framework and evidence synthesis

Descriptive synthesis summarized publication year, location, design, sample, intervention, and outcome type. Thematic coding combined deductive and inductive procedures, with theme development and trustworthiness checks informed by established thematic-analysis guidance (Braun & Clarke, 2019; Nowell et al., 2017). Deductive codes were derived from the Theory of Planned Behavior (attitudes, subjective norms, and perceived behavioral control) and Arnstein's participation ladder (information or operational participation, consultation, partnership or co-production, and community control) (Ajzen, 2020; Arnstein, 1969). Initial inductive codes included river clean-up,

community training, citizen sampling, consultation, co-production, awareness, self-reported practice, institutional forum, and water-quality parameter. Related codes were grouped into educational approaches, participation depth, behavioral mechanisms, institutional conditions, and ecological evidence.

Outcomes were kept analytically distinct as: knowledge or awareness; self-reported behavior; participation in activities; institutional or governance change; and directly measured ecological change. Themes were then developed around the knowledge-to-behavior gap, the shift from operational to substantive participation, enabling or constraining governance conditions, and the scarcity of direct ecological measurement. The single reviewer coded all studies and rechecked the coded matrix against the full texts; no between-reviewer analytical disagreements occurred because no second coder was used.

2.5 Publication-bias and certainty considerations

Statistical publication-bias tests, funnel plots, and effect-size pooling were not appropriate because the review did not conduct a meta-analysis and the included designs and outcomes were highly heterogeneous. Potential selection and availability bias were considered qualitatively, particularly the restriction to two databases, the limited reproducibility of Google Scholar, the Indonesian- and English-language scope, the requirement for retrievable full text, and the absence of citation searching. These limitations were addressed in interpretation by weighting findings according to methodological confidence and by separating self-reported or perceived outcomes from directly measured ecological outcomes.

3. Results and Discussion

3.1 Study selection and characteristics

The searches identified 305 records: 210 from Google Scholar and 95 from ScienceDirect. Before screening, 38 duplicates and 17 records with ineligible formats or inadequate records were removed, leaving 250 records for title and abstract screening. Of these, 210 were excluded and 40 reports were sought for retrieval. Six full texts could not be obtained, so 34 reports were assessed. Nineteen were excluded: seven were non-primary or non-comparable studies, four had insufficient topical relevance, three inadequately reported their methods or design, three contained overlapping data or findings, and two fell outside 2015-2025. Fifteen studies were included in the narrative synthesis (Figure 1).

The final sample comprised 12 Indonesian studies and three international empirical comparators from Thailand, Canada, and Ecuador. Publication years ranged from 2015 to 2025: four studies were published in 2023, three in 2024, four in 2025, and one each in 2015, 2017, 2021, and 2022. Thirteen were journal articles and two were full-length peer-reviewed proceedings. Designs included six qualitative studies, five mixed-method studies, two quantitative non-randomized studies, and two quantitative descriptive studies. Table 1 distinguishes each study's educational or participatory approach, participation depth, outcome type, and methodological confidence.

3.2 Methodological quality

MMAT appraisal produced three high-confidence, six medium-confidence, and six low-confidence contributions to the narrative synthesis (Table 2). High-confidence evidence comprised Jollymore et al. (2017), Alvarado-Arias et al. (2025), and Rahardjanto et al. (2025). Medium-confidence evidence comprised Apipalakul et al. (2015), Maharani et al. (2023), Mardianti & Purba (2023), Syamsiyah et al. (2023), Hidayaturahmi et al. (2024), and Lubis & Hamidipradja (2025). The remaining studies were weighted as low confidence because of critical limitations such as very small or unclear samples, unvalidated self-report

instruments, insufficient analytical detail, or weak alignment between data and claims. Criterion-level ratings are reported rather than a total MMAT score.

3.3 Participation, behavioral, institutional, and ecological outcomes

Across the Indonesian studies, participation was most often reported through clean-up events, waste-management activities, campaigns, planting, monitoring, or program implementation (Alfala & Nuraini, 2024; Astomo, 2021; Baehaqi & Alicia, 2025; Hutasuhut et al., 2022; Juliandar et al., 2023; Maharani et al., 2023; Mansyur et al., 2024). Evidence of strategic influence was less consistent. Medium-confidence studies documented stronger networking, advocacy, workshops, and co-production in the Ciliwung and Cikapundung initiatives (Hidayaturahmi et al., 2024; Lubis & Hamidipradja, 2025), whereas the high-confidence Reresik Kali study described community-led cultural stewardship and intergenerational learning (Rahardjanto et al., 2025). These findings show variation from operational participation to partnership and community control rather than one uniform national participation level.

Educational and social outcomes were reported more frequently than sustained behavior. Studies described awareness, knowledge, motivation, community identity, or perceived benefits, but most lacked baseline measures, comparison groups, or longitudinal follow-up. The medium-confidence Jakarta survey identified associations between socioeconomic characteristics and self-reported water-management responses, but its cross-sectional design did not establish causality (Mardianti & Purba, 2023). The low-confidence Upper Citarum survey likewise reported a disconnect between ecoliteracy and independent restorative action, suggesting that knowledge alone did not ensure behavior (Juliandar et al., 2023). Institutional access, facilitation, infrastructure, and continuity of coordination repeatedly appeared as enabling or constraining conditions.

Table 1. Characteristics, outcomes, and methodological confidence of the 15 included studies

Author (year)	Location	Design/sample	Education or participation approach	Participation level	Social/institutional outcome	Ecological outcome	MMAT confidence
Apipalakul et al. (2015)	Thailand; Pong Basin	Mixed-method PAR; 170 households + 50 stakeholders	Local-researcher training, FGDs, and tri-sector dialogue	Partnership	Dialogue supported consensus, transparency, and a proposed monitoring committee	Monitoring was proposed; no directly measured ecological outcome	Medium
Jollymore et al. (2017)	Canada; British Columbia	Mixed citizen science; 145 citizen samples + 104 researcher comparisons	Protocol-based citizen sampling and local interpretation	Researcher-led contribution/limited partnership	Learning, place-based ownership, and broader data coverage were reported	DOC, nitrate, TSS, and spectral parameters measured directly; sampling was not representative	High
Astomo (2021)	Indonesia; Mandar watershed	Qualitative socio-legal; 2 village heads + legal documents	Village participation and environmental education duties	Consultation through village government	Limited legal and environmental awareness was described	Pollution was described; no water-quality measurement	Low
Hutasuhut et al. (2022)	Indonesia; Deli watershed	Qualitative; informant number not reported	River clean-ups, campaigns, education, monitoring, and advocacy	Operational/tokenistic in planning	Youth were active in implementation but had limited access to planning and evaluation	Clean-up activities were described; no direct ecological indicator	Low
Maharani et al. (2023)	Indonesia; Citarum Sector 7	Qualitative; 12 informants in Methods (11 in abstract)	Clean-ups, socialization, waste sorting, planting, and discussion	Consultation to limited partnership	Participation varied across villages; joint evaluation and training were needed	Tidier riverbanks were observed; no direct ecological measurement	Medium
Mardianti & Purba (2023)	Indonesia; Jakarta	Cross-sectional non-randomized survey; n = 503	No intervention; survey of actions, pollution tolerance, and willingness to pay	Individual response/ action	Socio-economic factors were associated with self-reported management responses	No water-quality outcome; cross-sectional associations are non-causal	Medium
Juliandar et al. (2023)	Indonesia; Upper Citarum	Cross-sectional survey and SEM; n = 393	Citarum Harum education, waste management, planting, and monitoring	Task-force-mobilized implementation	Knowledge and skills were reported, but independent participation remained limited	Pollution context was described; no primary water-quality measurement	Low

Author (year)	Location	Design/sample	Education or participation approach	Participation level	Social/institutional outcome	Ecological outcome	MMAT confidence
Syamsiyah et al. (2023)	Indonesia; Upper Citarum	Quantitative descriptive MDS/RAPVIL; n = 207	EcoVillage program across ecological, economic, social, and cultural dimensions	Limited community partnership	Social and economic dimensions were rated poorly sustainable; culture was strongest	Ecological index = 48.72 from attributes, not direct water-quality testing	Medium
Alfala & Nuraini (2024)	Indonesia; Karo	Mixed descriptive study; survey n = 100; qualitative sample not specified	Participation in irrigation planning, implementation, evaluation, and education	Implementation exceeded planning/evaluation	35% reported decision involvement, 60% implementation, and 25% evaluation	Water condition was based on observation/perception; no laboratory test	Low
Hidayaturahmi et al. (2024)	Indonesia; Ciliwung	Qualitative case study; representatives of 9/36 communities; informant n not reported	Networking, competency development, advocacy, and community organizing	Multi-stakeholder partnership	Awareness, capacity, networking, and organization were reported	Program products were observed; river quality was not directly measured	Medium
Mansyur et al. (2024)	Indonesia; Jeneberang	Qualitative description; 2 internal informants	FGDs, river tracing/cleaning, planting, and waste-bank socialization	Information/consultation	The program and managers' perceptions were described; participant learning was not evaluated	Physical activities were reported; no measured ecological change	Low
Alvarado-Arias et al. (2025)	Ecuador; four urban rivers	Mixed participatory GIS/citizen science; n = 475 survey/mapping records	Participatory mapping, GIS, interviews, observation, and drone data	Partnership/ co-production	Social values, insecurity, and pollution were mapped; representation was uneven	Spatial conditions were mapped; no chemical/biological water measurement	High
Baehaqi & Alicia (2025)	Indonesia; Cikapundung	Quantitative descriptive case study; n = 46 volunteers	River clean-up as a participatory educational activity	Implementation/ volunteering	Participants reported high awareness, motivation, and satisfaction	Flood-risk reduction was perceived, not directly measured	Low

Author (year)	Location	Design/sample	Education or participation approach	Participation level	Social/institutional outcome	Ecological outcome	MMAT confidence
Lubis & Hamidipradja (2025)	Indonesia; Cikapundung	Mixed methods; 5 interviews, 45 surveys, 5 workshops	Workshops, co-production, clean-ups, and education campaigns	Partnership / co-production	Awareness and support for collaboration were high; waste practices were more neutral	Visual observations only; no before-after water-quality test	Medium
Rahardjanto et al. (2025)	Indonesia; East Java	Hermeneutic phenomenology; 12 informants + 3 follow-up dialogues	Reresik Kali ritual, clean-up, planting, and intergenerational learning	Partnership to community control	Solidarity, identity, moral-ecological awareness, and informal norms were reported	Ecological benefits were perceived/interpreted, not hydrologically measured	High

Note: MMAT confidence is an evidence-synthesis weight derived from critical MMAT limitations; it is not a numerical MMAT score. 'Direct ecological measurement' required an objective water-quality, biodiversity, hydrological, or comparable ecological parameter

Direct ecological evidence was scarce. Only Jollymore et al. (2017) directly measured water-quality parameters, including dissolved organic carbon, nitrate, total suspended solids, and spectral properties, while also documenting limitations in citizen-sampling representativeness. Syamsiyah et al. (2023) reported an ecological sustainability index based on attributes rather than direct water-quality testing. Other studies relied on visual observation, participant perception, descriptions of clean-up activities, or prospective governance benefits. Therefore, the review did not infer that education or participation directly improved river water quality across the included evidence.

Table 2. Criterion-level MMAT 2018 appraisal

Study	MMAT design	S1	S2	C1	C2	C3	C4	C5	Confidence
Apipalakul et al. (2015)	Mixed	Y	Y	Y	Y	Y	CT	CT	Medium
Jollymore et al. (2017)	Mixed	Y	Y	Y	Y	Y	Y	CT	High
Astomo (2021)	Qualitative	Y	CT	Y	N	CT	CT	Y	Low
Hutasuhut et al. (2022)	Qualitative	Y	Y	Y	CT	CT	CT	CT	Low
Maharani et al. (2023)	Qualitative	Y	Y	Y	Y	Y	CT	Y	Medium
Mardianti & Purba (2023)	Quant. non-randomized	Y	Y	CT	CT	Y	Y	CT	Medium
Juliandar et al. (2023)	Quant. non-randomized	Y	Y	CT	CT	CT	N	CT	Low
Syamsiyah et al. (2023)	Quant. descriptive	Y	Y	Y	Y	CT	Y	Y	Medium
Alfala & Nuraini (2024)	Mixed	Y	Y	CT	Y	Y	CT	N	Low
Hidayaturahmi et al. (2024)	Qualitative	Y	Y	Y	Y	Y	CT	Y	Medium
Mansyur et al. (2024)	Qualitative	Y	CT	Y	N	CT	CT	Y	Low

Alvarado-Arias et al. (2025)	Mixed	Y	Y	Y	Y	Y	Y	CT	High
Baehaqi & Alicia (2025)	Quant. descriptive	Y	Y	CT	N	CT	CT	Y	Low
Lubis & Hamidipradja (2025)	Mixed	Y	Y	Y	Y	Y	CT	N	Medium
Rahardjanto et al. (2025)	Qualitative	Y	Y	Y	Y	Y	Y	Y	High

Note: S1-S2 = MMAT screening questions; C1-C5 = design-specific criteria; Y = Yes; N = No; CT = Cannot tell. Criteria are not comparable across design categories and were not summed

3.4 Behavioral mechanisms and the knowledge-to-action gap

The evidence mapped unevenly onto the Theory of Planned Behavior. Awareness, perceived importance, and ecological concern primarily reflected attitudes; collective rituals, local leaders, peer activities, and community identity reflected subjective norms; training, facilities, organizational access, and environmental data reflected perceived behavioral control. However, most studies measured proximal perceptions or participation at one point in time rather than intention, persistent behavior, and ecological consequences in sequence. This knowledge-to-action gap is consistent with broader behavioral research showing that attitudes, intentions, infrastructure, feedback, and actual control should not be treated as interchangeable outcomes (Bamberg & Möser, 2007; Brick et al., 2024; Kollmuss & Agyeman, 2002; Rau et al., 2022). The review therefore supports a plausible mechanism linking practical education with participation, but it does not establish a causal education-behavior-ecology pathway.

3.5 Participation depth and governance

An Arnstein-informed interpretation showed that attendance and physical participation were not equivalent to decision power. This distinction is consistent with participation scholarship emphasizing power, institutional design, and context rather than attendance alone (Arnstein, 1969; Hove et al., 2022; Hurlbert & Gupta, 2024; Reed, 2008). Several Indonesian studies described implementation without sustained influence over planning or evaluation, while partnership was more visible where intermediary organizations created networks, advocacy channels, workshops, or cultural authority (Hidayaturahmi et al., 2024; Lubis & Hamidipradja, 2025; Rahardjanto et al., 2025). The stronger studies indicate that participation becomes more substantive when communities help define problems, generate knowledge, receive feedback, and influence institutional responses. This interpretation also explains why high awareness can coexist with weak independent action when infrastructure, authority, or program continuity remains limited.

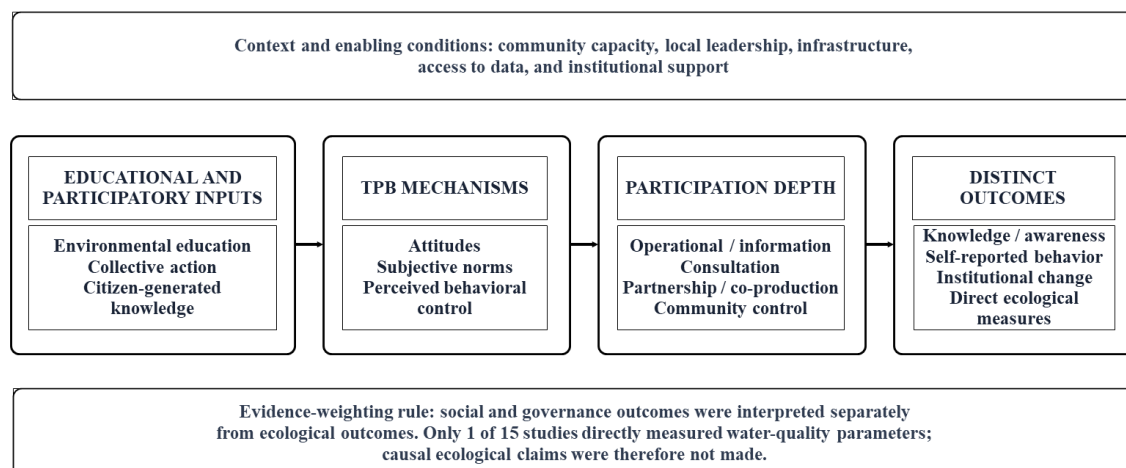


Fig. 2. Author-developed analytical framework used for coding and evidence interpretation

3.6 International comparators and broader review evidence

The three international studies were used as design comparators, not pooled as direct evidence about Indonesia. The Canadian study demonstrated how citizen science can produce objective water-quality data while revealing representativeness problems; the Ecuadorian study demonstrated participatory spatial valuation and co-production; and the Thai study illustrated multi-stakeholder dialogue around water conflict (Alvarado-Arias et al., 2025; Apipalakul et al., 2015; Jollymore et al., 2017). Differences should be attributed cautiously to program design, sampling, data access, institutional arrangements, and

community characteristics rather than to a simple developed-versus-developing-country distinction.

This evidence-weighted interpretation is consistent with international review evidence. Newig et al. (2023) found that stakeholder participation does not automatically improve environmental governance outcomes and that process and context matter, while Ardoin et al. (2020) emphasized the need to distinguish educational outcomes from conservation outcomes. Comparative water-governance reviews similarly stress power, resources, institutional arrangements, and temporal context (Lema, 2025; Özerol et al., 2018), whereas citizen-monitoring reviews distinguish data collection from recognized influence in decision-making (Dominguez-Rendón et al., 2024; Shao & Bishop, 2025). The present review adds an Indonesia-focused observation: evidence for awareness, participation, and institutional mechanisms is much more common than direct evidence of river-ecosystem change.

3.7 Evidence-weighted implications and review limitations

Recommendations were calibrated to evidence strength. High- and medium-confidence studies support practical, place-based education; transparent feedback from monitoring; multi-stakeholder forums; community organizations with advocacy capacity; and culturally grounded stewardship. Low-confidence studies were used only to identify program forms or hypotheses, not to justify causal claims. Programs that intend to claim ecological improvement should add baseline and follow-up measurements of water quality, waste loads, biodiversity, or hydrological conditions, alongside behavioral and institutional indicators. Citizen science is promising, but protocols, sampling coverage, quality assurance, institutional recognition, and data feedback must be explicit (Dominguez-Rendón et al., 2024; Shao & Bishop, 2025).

Contextual literature outside the formal 15-study sample shows comparable dependencies on infrastructure, institutional continuity, sectoral pressures, and community authority across Indonesian and international water-management settings (Asmara & Randhir, 2025; Buchori et al., 2022; Chen, 2024; Daniel et al., 2021; Pamudji et al., 2022; Peker & İlhan, 2023; Yunus et al., 2025). These sources were used only to interpret transferability and implementation conditions; they were not counted as included studies or used to alter the MMAT-weighted findings.

This review has five main limitations. First, a single reviewer conducted screening, extraction, coding, and MMAT appraisal, so independent verification, disagreement resolution, and inter-reviewer agreement were unavailable. Second, the search was restricted to Google Scholar and ScienceDirect; Google Scholar is difficult to reproduce, and no backward or forward citation searching was conducted. Third, restricting the synthesis to Indonesian- and English-language reports with retrievable full text may have introduced language and availability bias. Fourth, heterogeneous designs, participants, interventions, and outcome definitions precluded meta-analysis and statistical publication-bias assessment. Fifth, only one study directly measured water-quality parameters, so conclusions about ecological improvement remain uncertain. These limitations justify the narrative, non-causal, and quality-weighted interpretation used throughout.

4. Conclusions

This review found that river-focused environmental education was most consistently associated with knowledge, awareness, motivation, community identity, and participation in practical activities. Evidence of persistent behavioral change was less consistent because most studies used cross-sectional, qualitative, or self-reported outcomes. The synthesis therefore supports an association between practical education and participation, not a causal education-behavior pathway. Community participation ranged from information and operational implementation to consultation, partnership, co-production, and, in a small number of cases, community control. More substantive participation was reported where

programs provided organizational access, multi-stakeholder facilitation, local leadership, environmental information, and culturally grounded stewardship. Attendance or physical participation alone should therefore not be interpreted as equivalent to decision-making power. The clearest outcomes concerned awareness, participation, networking, and perceived institutional benefits. Direct ecological evidence was scarce: only one of the 15 studies measured water-quality parameters directly. With three high-, six medium-, and six low-confidence contributions, the evidence is insufficient to conclude that environmental education or community participation caused improvements in river-ecosystem quality.

The most defensible policy implication is to combine practical, place-based education with feedback from monitoring, adequate waste-management infrastructure, continuity of facilitation, and forums that allow communities to influence planning and evaluation. Programs intending to claim ecological improvement should measure baseline and follow-up conditions for water quality, waste loads, biodiversity, or hydrology alongside behavioral and institutional indicators. Future studies should use longitudinal or mixed-method designs that examine behavioral persistence and institutional performance together with direct ecological indicators. Comparative international research, including carefully designed ASEAN comparisons, could test whether the observed mechanisms remain consistent across governance and cultural contexts; such transferability is a proposition for future research rather than an established conclusion. Interpretation remains limited by the use of Google Scholar and ScienceDirect only, the restricted reproducibility of Google Scholar, single-reviewer screening, extraction, coding, and MMAT appraisal, Indonesian- and English-language coverage, retrievable-full-text requirements, heterogeneous study designs, the absence of meta-analysis, and limited direct ecological measurement. These limitations require cautious, non-causal interpretation of the synthesis.

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Author Contribution

Conceptualization, M.D.A.; methodology, M.D.A.; software, M.D.A.; validation, M.D.A.; formal analysis, M.D.A.; investigation, M.D.A.; resources, M.D.A.; data curation, M.D.A.; writing - original draft preparation, M.D.A.; writing - review and editing, M.D.A.; visualization, M.D.A.; and project administration, M.D.A. The author has read and agreed to the submitted version of the manuscript.

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Ethical Review Board Statement

This systematic literature review used publicly available publications and did not involve recruitment of human participants, animals, identifiable private information, or collection of new primary data.

Informed Consent Statement

No human participants were recruited and no identifiable participant information was collected.

Data Availability Statement

The review data consist of bibliographic records, eligibility decisions, extracted study characteristics, and MMAT appraisal results. The source publications are cited in the article; the screening log, extraction matrix, and appraisal matrix are available from the corresponding author upon reasonable request. No new primary data were generated.

Conflicts of Interest

The author declares no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author used ChatGPT (OpenAI) to assist with language editing, consistency checking, and document organization. After using this tool, the author reviewed and verified the content against the cited sources and takes full responsibility for the content of the publication.

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