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Community-Driven ESG Governance and Climate-Resilient Livelihoods in Ghana: Evidence from Participatory Action Research

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Abstract

Illegal artisanal and small-scale mining (galamsey) and climate stress jointly degrade ecosystems and livelihoods in Ghana. This paper demonstrates how community-driven governance can realign incentives toward environmental stewardship and inclusive livelihoods. Using an explanatory sequential mixed-methods design—quantitative difference-in-differences followed by qualitative case analysis and Participatory Action Research—we evaluate a structured program combining vocational training, financial literacy, environmental stewardship, and governance alignment. We operationalize Environmental, Social, and Governance (ESG) outcomes via transparent composite indices and triangulate survey, administrative, and focus group evidence. The study identifies conditions under which alternative livelihoods reduce participation in illegal mining, strengthen women's economic agency, and improve adoption of climate-smart practices. Implications include practical guidance for program design (community delivery, matched incentives, oversight), policy (local climate finance and accountability mechanisms), and research (scalable indicators and rigorous impact evaluation in resource-dependent communities).

Keywords: artisanal mining; ESG; galamsey; climate change; SDGs; emerging economies

1. Introduction

Climate change impacts in ecologically sensitive regions of emerging economies are not primarily the result of insufficient environmental awareness or technical knowledge; rather, they reflect persistent governance failures that disconnect climate adaptation, livelihood security, and social protection. In tropical forest regions, environmental degradation caused by illegal resource extraction coexists with poverty, labor precarity, and human rights abuses, revealing that climate vulnerability is as much a governance problem as an ecological one. Yet dominant climate and sustainability frameworks continue to treat governance as a secondary concern, emphasizing environmental indicators over institutional accountability and social outcomes. This governance gap is particularly evident in biodiversity hotspots affected by illegal artisanal mining ("galamsey") and associated social risks such as forced labor and child trafficking. While these activities are often framed as environmental crimes, the existing research shows that they are sustained by weak regulatory enforcement, limited livelihood alternatives, and fragmented community–state

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relations [1]. Climate variability in such contexts exacerbates—but does not originate—these challenges. The core analytical issue is therefore not climate stress per se, but the absence of inclusive governance mechanisms capable of aligning environmental protection with social protection and economic resilience [2].

The Sustainable Development Goals (SDGs) implicitly recognize this interdependence. SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 8 (Decent Work and Economic Growth) are not separate objectives but mutually reinforcing governance challenges. We focus on this triad because climate resilience in biodiversity hotspots hinges on governance that can simultaneously protect terrestrial ecosystems (SDG 15), buffer and adapt to climate risks (SDG 13), and create decent, non-extractive livelihoods (SDG 8). Illegal mining thrives where governance fails to align these objectives; hence, the study centers governance as the binding constraint linking ecological integrity, social protection, and inclusive growth. However, policy and evaluation frameworks frequently operationalize these goals in isolation, privileging environmental outputs while marginalizing governance quality and social safeguards. As a result, climate interventions may succeed in ecological terms yet fail to disrupt exploitative livelihoods or reduce vulnerability to trafficking and informal mining. Environmental, Social, and Governance (ESG) frameworks offer a potentially integrative governance lens, but to date they have been largely confined to corporate sustainability and investor decision-making [3]. This narrow application represents a critical omission. ESG principles—particularly governance accountability and social inclusion—are directly relevant to rural climate adaptation, where community institutions, informal economies, and local power structures shape environmental outcomes. Despite this relevance, there is limited empirical research on how ESG can be recontextualized as a community-level governance framework, nor on how participatory climate interventions operationalize ESG dimensions outside corporate settings. Three gaps therefore motivate this study. First, existing climate adaptation research inadequately theorizes governance as the causal link between environmental degradation and social vulnerability in biodiversity hotspots. Second, ESG scholarship seldom extends beyond firms, leaving its applicability to grassroots climate governance empirically untested. Third, evaluation tools remain environmentally weighted, underrepresenting social protection outcomes such as livelihood diversification, reduced illegal mining participation, and vulnerability to child trafficking. Addressing these gaps requires a framework that simultaneously captures environmental integrity, social resilience, and governance effectiveness. This study responds by examining the following research question: "How does a co-designed ESG–climate justice intervention, implemented through Participatory Action Research (PAR), affect climate resilience and social protection outcomes in ecologically sensitive communities?" Specifically, the study analyzes changes in biodiversity integrity, water quality, soil health, livelihood diversification, illegal mining participation, and child trafficking vulnerability. The study makes three core contributions. First, it conceptually extends ESG from a corporate performance framework to a community-based governance model, demonstrating how governance indicators can structure climate justice interventions in rural contexts. Second, it provides practice-relevant insights by showing how participatory governance mechanisms enable communities to realign livelihoods away from environmentally destructive and socially harmful activities. Third, it advances measurement and policy integration by proposing multi-dimensional indicators that capture Environmental, Social, and Governance outcomes simultaneously, enabling scalability and alignment with national climate adaptation strategies. Empirically, the study draws on a qualitative case study using Participatory Action Research to examine community-led interventions addressing "galamsey", ecological degradation, and social vulnerability. By foregrounding governance rather than urgency, the study reframes climate adaptation as an institutional challenge and offers

evidence that integrated ESG-based approaches can produce durable environmental and social protection outcomes. The remainder of the paper proceeds as follows. Section 2 reviews the literature on alternative livelihoods, ESG governance, and climate justice. This is followed by Section 3 (methodology) detailing the PAR-based case study design. Section 4 (findings) presents empirical evidence from the intervention sites, followed by a discussion of theoretical and policy implications. The paper concludes with limitations and directions for future research.

2. Structured Literature Review Protocol: Design and Search Strategy

A structured narrative review informed by scoping principles was conducted to synthesize evidence on ESG, artisanal and small-scale mining (ASM), and alternative livelihoods in Africa and comparable LMIC contexts. Databases and Search Process: Scopus; Web of Science; Google Scholar; ScienceDirect; SpringerLink; Emerald Insight; and gray literature from UNDP, World Bank, FAO and Ghana Minerals Commission. Searches were conducted January–August 2025. Search strings combined ESG, ASM, and livelihood concepts using Boolean operators, e.g., "Environmental Social Governance" OR "ESG" AND "alternative livelihoods"; "artisanal and small-scale mining" OR "ASM" OR "galamsey" AND "livelihoods"; "illegal mining" AND "youth employment" AND "Ghana"; "livelihood diversification" AND "environmental governance". Backward/forward citation tracking supplemented the database searches. Inclusion/Exclusion Criteria: Included items (2000–2025) from peer-reviewed journals or authoritative institutional reports addressing ESG, sustainability governance, ASM, or alternative livelihoods in Africa/LMICs. Excluded items focused solely on large-scale mining, lacked analytical grounding, or were unavailable in full text. Approximately 85 sources informed the synthesis. We explicitly list database sources, search strings, timeframe (2000–2025), and inclusion/exclusion criteria, and document the use of authoritative gray literature. Backward/forward citation tracking (snowballing) supplemented database searches to reduce coverage bias.

2.1. Literature Review

Environmental, Social, and Governance (ESG) principles have emerged as critical components of corporate strategy, influencing sustainability, risk management, and long-term value creation. This review synthesizes recent scholarly work on ESG integration with alternative livelihoods for ESGS as well as the impacts and drivers to these ESGs.

2.1.1. Alternative Livelihoods for ESGs: An Integrated Literature Review

The ESG principle has been developed for 17 years following its formal proposal in 2004. Ref. [4] refines the characteristics of ESG research, reveals the shortcomings of ESG research, and proposes particular attention to ESG research as a reference for academic research and the practice of ESG. Much has been proclaimed about Environmental, Social, and Governance principles providing solutions for climate change. Yet the evidence shows a consistent pattern of a disconnect between ESG scores and actual outcomes [5]. The illegal artisanal and small-scale mining (ASM)—locally called galamsey—is both a symptom and a driver of rural deprivation in Ghana [6]. Empirical reviews document its ecological devastation (deforestation, soil erosion, turbidity and heavy-metal contamination of rivers) alongside acute occupational hazards (pit collapses, mercury exposure) and social costs (child trafficking, school attrition, health deterioration, price inflation) [7]. These harms are prevalent in communities with limited viable employment options, making alternative livelihood programs (ALPs) central to durable solutions. In Ghana, it has been realized that galamsey is attractive for the youth and for ESGs, especially for youth, enforcement alone cannot succeed [8].

Recent scholarship emphasizes ESG as a critical driver of sustainable business practices [3,9]. ESG frameworks have evolved beyond corporate reporting to influence governance structures that prioritize environmental stewardship, social inclusion, and ethical leadership. According to [Nature Humanities and Social Sciences Communications], ESG integration enhances corporate sustainability by aligning organizational practices with environmental stewardship, social responsibility, and governance transparency. The study emphasizes the need for standardized ESG metrics and highlights gaps in implementation across industries. A systematic review in AMS Review explores the relationship between ESG factors and firm value. The authors find that theories such as Stakeholder Theory and Agency Theory dominate the discourse, with empirical evidence supporting a positive correlation between ESG performance and firm valuation. However, the review calls for greater consistency in ESG measurement standards to improve comparability across studies. The literature collectively underscores ESG's transformative potential in shaping sustainable business practices and enhancing long-term value. However, persistent gaps in measurement, implementation, and contextual research warrant further investigation.

2.1.2. Impacts and Drivers of Alternative Livelihoods

Systematic reviews from 2000 to 2023 attribute ecosystem degradation to widespread, unregulated mining: habitat loss, polluted watercourses, and degraded soils have cascading effects on health and agriculture. Mercury, arsenic, cadmium, and lead concentrations in water and sediments often exceed WHO limits; injuries and fatalities from pit collapses are recurrent. Qualitative and mixed-methods studies show that, despite these harms, galamsey remains attractive because it offers immediate cash income amid unemployment, declining farm yields, and credit constraints; hence, the practice is rational within constrained opportunity sets. Longitudinal livelihood analyses further reveal shifting community trajectories: rising gold prices, land competition, and itinerant mining actors have intensified the pull of ASM, undermining agriculture and social cohesion [10]. Studies in cocoa landscapes demonstrate that mining disrupts labor availability, floods fields through abandoned pits, and reduces yields via disease pressure, yet targeted support (inputs, extension, drainage works, downstream processing, and assured offtake) can restore incomes and reduce migration into galamsey. National programs that pair agricultural production with value-added agro-processing show promise by creating steady cash flows and local jobs beyond raw farming [6,11].

3. Methodology

We employ a mixed-methods case study to assess how Kraban Support Foundation (KSF) integrates microcredit, andragogic life-skills, and agribusiness upgrading to deliver ESG-aligned outcomes and alternative livelihoods in hard-to-reach communities across Yilo Krobo, Lower Manya Krobo, and Shai Osudoku. The approach triangulates panel surveys, program MIS, focus group discussions (FGDs), and key informant interviews (KIIs), guided by national program contexts (SIF). Sampling and Matching: The sampling frame comprises TEACH cohorts and matched comparison communities selected on agro-ecology, market access, and baseline enterprise traits. We use the propensity score and coarsened exact matching to enhance comparability before estimation. Difference-in-Differences: We estimate intent-to-treat effects in a two-way fixed-effects model with cluster-robust standard errors. We probe parallel trends using pre-trend plots and placebo checks when feasible; the estimand captures changes in ESG-aligned outcomes (environmental practices, diversification, women's agency). Appendix A provides survey instruments, an adult-learning fidelity checklist, and ESG indicator definitions used to evaluate KSF's TEACH 2.0 interventions.

3.1. Indicator Framework and ESG Alignment

The indicator framework was Environmental (E): Adoption of climate-smart practices, post-harvest loss reduction, and storage quality in line with agronomic modernization narratives under Ghana's Compact I and SIF's green economy emphasis. Social (S): Women's agency indices, DFS/KYC access, training completion, and health/nutrition behaviors reflecting microfinance impacts and constraints documented in Yilo and Lower Manya Krobo. Governance (G): Transparent loan conditions, cohort accountability, MOUs with SIF/district actors, and legal literacy, consistent with responsible finance and institutional oversight within national program frameworks. Alternative livelihood indicators include diversification scores, value-added processing entry, buyer contracts, and group certification progress.

Qualitative Coding and Reliability: Thematic coding followed a hybrid inductive–deductive approach anchored in andragogy and governance constructs. Inter-coder agreement was established via joint coding sessions and reconciliation memos; triangulation across surveys, MIS, FGDs, and KIIs mitigated common-method bias.

3.2. Units of Analysis and Sampling

The primary unit of analysis is the TEACH cohorts receiving sequenced microcredit linked to adult-learning milestones. The comparison is matched communities not enrolled in TEACH 2.0 (digital financial services, climate-smart upgrading, export enablement), enabling a difference-in-differences (DiD) design. Matching uses agro-ecological, market access, and baseline enterprise characteristics, drawing on local evidence from Krobo-area studies of market women and women-owned microbusinesses.

3.3. Data Sources and Instruments

Data collection involved quantitative data: household/enterprise panel surveys (baseline, 12–18 months, 24–36 months) capturing revenues, margins, savings, repayment, adoption of climate-smart practices (IPM, improved seed, water efficiency), post-harvest loss rates, DFS usage, certification progress, and KSF MIS data on loans and training completion. Qualitative data included the following: FGDs with women cohorts and producer groups, KIIs with district agric officers, SIF officers, and partner banks/fintech agents. National documentation (SIF) informs governance and partnership interview guides.

3.4. Data Analysis

We used a mixed-methods analytical strategy that integrates quantitative and qualitative evidence. Quantitatively, we estimated TEACH 2.0's effects on income, resilience, and environmental practices using descriptive statistics and difference-in-differences (DiD) models. Qualitatively, we conducted thematic content analysis of focus group discussions (FGDs) and key informant interviews (KIIs). The coding frames were constructed to operationalize core andragogic principles—self-direction, experiential learning, and problem-centered relevance—alongside governance features such as transparency, accountability, and partnership oversight.

The analysis also traced KSF's TEACH learning sequence, linking microcredit uptake to adult-learning milestones across enterprise budgeting, health and nutrition, and basic legal literacy. This approach operationalizes Knowles' andragogy by emphasizing relevance, problem-focused tasks, experiential practice, and peer learning, mechanisms known to strengthen adult learners' retention, application of skills, and behavior change in real-world settings.

Our approach to validity and reliability incorporated methodological triangulation across household surveys, MIS administrative data, and qualitative accounts from FGDs

and KIIs. This multi-source integration reduced the risk of common-method bias and strengthened internal validity by comparing patterns across independent data streams. Enumerators were trained in gender-sensitive protocols and local Krobo languages to ensure accurate reporting and culturally grounded engagement, recognizing the documented constraints faced by women entrepreneurs in Krobo settings. Ethical safeguards included informed consent, participant confidentiality, and secure storage of DFS/KYC records, consistent with responsible data-handling norms emphasized in public program governance (e.g., SIF, MiDA). All digital and financial information was handled in accordance with guidelines for secure data management in public-sector development programs.

4. Findings

Our analysis evolved three themes: (1) Andragogy design and adult-learning pathways which drive sustainability by improving skill retention, enterprise management, and responsible loan use; (2) Gender-responsive microfinance which addresses long-standing constraints in Krobo municipalities and enhances economic and social inclusion; (3) Governance and market-upgrading pathways which enable scale, accountability, environmental gains, and integration into higher-value markets. We discuss these three themes below:

4.1. Andragogic Design and Adult-Learning Pathways

The TEACH model integrates microcredit with sequenced learning milestones delivered through peer-based experiential modules in enterprise budgeting, health and nutrition, and basic legal literacy. This design operationalizes core andragogy principles, relevance, problem-centering, experiential practice, and self-direction, which evidence shows enhance adult retention and behavioral transfer in workplace and community settings. This sequencing improves the adoption of enterprise and household practices, strengthens repayment discipline, and reduces misuse of funds relative to training-light microcredit. TEACH's experiential format is consistent with the adult-learning literature emphasizing hands-on approaches and peer collaboration as critical for sustained behavior change. The model also provides the micro-level mechanism for transmitting climate-smart practices, post-harvest improvements, and market-standards literacy—forming the behavioral foundation for environmental and economic upgrading.

4.2. Gender-Responsive Microfinance and Local Constraints

Empirical studies from Yilo Krobo highlight the positive income and welfare impacts of microfinance for market women, while research from Lower Manya Krobo identifies persistent collateral and information asymmetry barriers shaped by patrilineal inheritance systems. These findings justify TEACH 2.0's gender-responsive features: group lending, collateral substitutes, DFS/KYC rails, and basic legal/health literacy to reduce demand-side barriers and expand inclusion. By embedding digital rails and structured learning, TEACH reduces transaction risk, enhances transparency, and supports women's agency—outcomes consistent with SIF's pro-poor access-to-finance mandate. Gender-responsiveness also underpins TEACH's social sustainability by enabling women to adopt climate-smart upgrades, stabilize returns through post-harvest improvements, and participate in value-added processing and certification pathways.

4.3. Governance, Market Upgrading, and Alternative Livelihoods

KSF's operations align with national governance precedents—MiDA/MCC Compact I (infrastructure, land tenure facilitation, modernization of production systems) and SIF's rural microcredit and infrastructure role. Embedding TEACH within these frameworks enables MOUs, shared KPIs, joint training, and co-financing, which strengthen accountability, reduce duplication, and deepen district-level institutional coordination. En-

vironmental sustainability is supported through climate-smart micro-upgrades (improved seed, water-efficient irrigation, IPM) and post-harvest improvements that reduce losses and stabilize quality. Governance is reinforced through transparent loan rules linked to learning milestones, cohort accountability, and formal partnership oversight with public institutions. Market-upgrading and alternative livelihoods—including horticulture, chili pepper, drying/packaging, and group certification—create pathways for inclusive value capture. When phased through TEACH's sequence (DFS rails which are climate-smart practices leading to certification/buyer linkages), these pathways reduce compliance risks and advance national goals for agricultural modernization and market integration. The themes of the findings are represented in an overall outcome of the Theory of Change shown in the Figure 1 below:

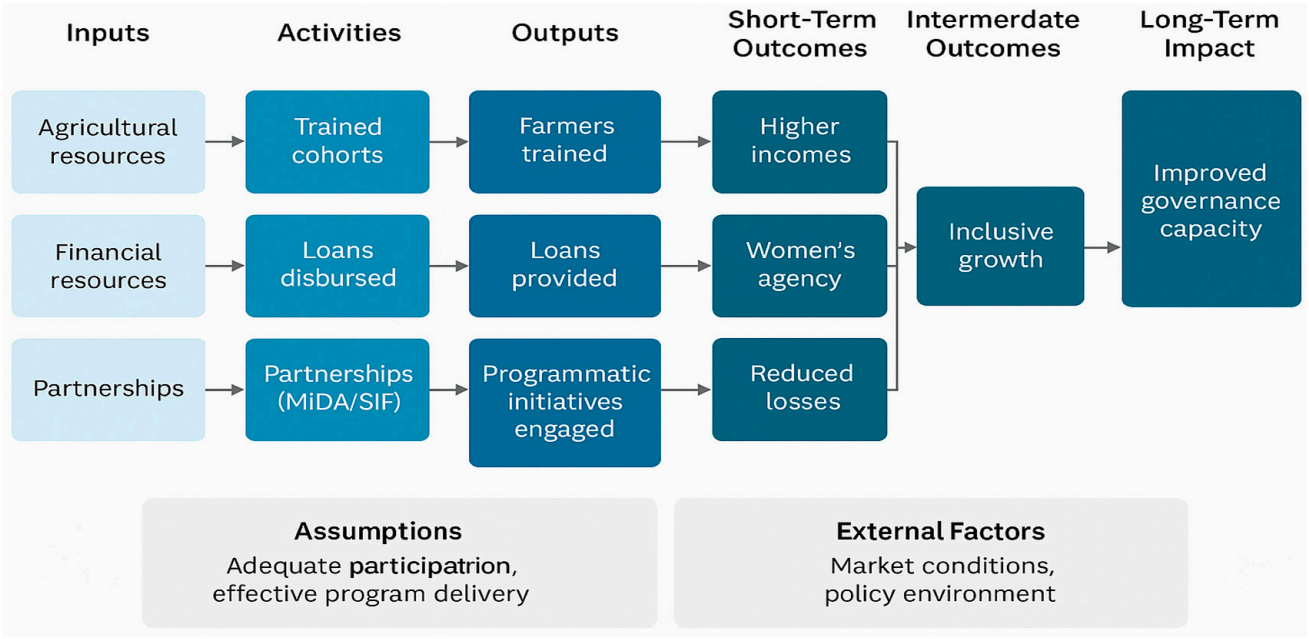


Figure 1. Theory of Change for TEACH.

Figure 1 (Theory of Change) posits that sustainability emerges when inputs (e.g., training, funds, partnerships, climate-smart support) are strategically aligned with activities (e.g., empowerment training, adoption of climate-smart practices, digital onboarding), producing outputs (trained cohorts, loan disbursement, partnership formation, practice adoption) that lead to outcomes (higher incomes, reduced losses, women's agency, climate resilience) and ultimately impacts (inclusive growth, governance capacity, restored ecosystems). Translated to the mining context, the ToC operational pathway includes: chiefs mobilizing youth for replanting trees and restoring rivers; training traditional authorities and local groups in sustainable land use; establishing alternative livelihood enterprises; partnering chiefs with reclamation contractors; forming community monitoring groups; and handing reclaimed lands to new community enterprises. Figure 1 illustrates that when inputs, activities, and outputs are not aligned to environmental and social sustainability, long-term impacts are destructive—even if short-term economic gains materialize. "Figure 1 presents a sustainability-aligned Theory of Change in which inputs, activities, outputs, outcomes, and impacts reinforce empowerment, environmental protection, and climate resilience." When this idealized model is mapped onto the gold mining sector, several structural contradictions emerge. Chief among them are (1) an extraction-centered governance logic within the GoldBod, and (2) the political–economic incentives that lead

some traditional leaders to tacitly or actively support galamsey. When this idealized model is mapped onto the gold mining sector, several structural contradictions emerge.

These contradictions do not merely slow progress; they structurally redirect the system away from sustainability, creating an extraction-first Theory of Change whose impacts fundamentally diverge from those in Figure 1. These findings necessitate a revised conceptual model that accounts for the political economy of resource extraction, customary authority structures, and incentive misalignment. In response, we propose the [Emerging Markets Sustainability Management Model (EM-SMM)], which reconfigures governance incentives to realign community, chief, and state interests toward sustainable outcomes.

5. Discussion

Integration with Results: Observed shifts—increases in climate-smart practice adoption and women's decision-making—trace to capability (training), opportunity (resources/partnerships), and motivation (incentives). Together with extraction-centered governance frictions, these patterns motivate the EM-SMM, which realigns local payoffs toward stewardship. Although Figure 1 outlines a sustainability-aligned Theory of Change, our analysis shows that the gold mining sector operates under a fundamentally different logic. The GoldBod's revenue-maximization incentives, combined with the political–economic pressures shaping traditional leaders' involvement in galamsey, disrupt the alignment of inputs, activities, and outputs necessary for sustainable outcomes. These contradictions not only undermine the Figure 1 model but generate an alternative pathway centered on extraction, short-term gains, and long-term ecological decline. The persistent failure of the existing system to produce sustainable impacts prompted the development of the Emerging Markets Sustainability Management Model (EM-SMM). This model reconfigures local and institutional incentives, positioning chiefs, communities, and regulatory agencies as partners in environmental stewardship and climate resilience.

5.1. Theoretical Implications

The EM-SMM advances several theoretical streams. First is the Principal-Agent and Incentive Design: this reframes resource governance around incentive compatibility for traditional authorities, showing that misaligned payoffs entrench extraction, whereas performance-linked compensation and livelihood bundles catalyze stewardship. Second is the Community-Based Natural Resource Management (CBNRM): this operationalizes social license to protect; legitimacy is earned through visible, local benefits and transparent monitoring, not merely formal regulation. Third is Behavior Change in Environmental Governance: durable change follows capability (training), opportunity (resources/partnerships), and motivation (incentives)—a coherent pathway beyond punitive actions alone. Fourth is the consideration of Socio-Ecological Systems and Path Dependencies: the model interrupts negative feedback loops (pollution, biodiversity loss, mistrust) by aligning economic incentives, governance capacity, and empowerment-oriented activities.

5.2. Managerial and Policy Implications

For implementers, the EM-SMM prescribes performance-based agreements with chiefs, ring-fenced restoration budgets, co-management MOUs with state agencies and NGOs, and transparent community monitoring. For policymakers, it recommends legal mandates that recognize traditional authorities as formal partners, embed mandatory sustainability training and graduated sanctions in licensing, and tie fiscal transfers to verified ecological outcomes. These implications directly support the call for shifting from symbolic enforcement to dismantling the finance and logistics of galamsey while protecting communities that withdraw social cover. Many regions in Ghana for example often lack the adaptive

capacity to respond effectively to climate-induced vulnerabilities, such as biodiversity loss, water scarcity, and soil degradation. In Ghana, the ecosystems surrounding Akwaa and Boti Waterfalls exemplify this fragility. These areas are not only biodiversity hotspots but also socio-economic lifelines for rural communities. However, they face compounded threats from illegal mining (galamsey) and child trafficking—activities that exacerbate environmental degradation and perpetuate cycles of poverty and social inequity. Despite global commitments, localized interventions remain fragmented and often fail to integrate climate resilience with social justice imperatives. This study proposes a holistic framework anchored in Environmental, Social, and Governance (ESG) principles and climate justice, operationalized through Participatory Action Research (PAR).

Integrating Evidence: The observed improvements in women's agency indices, uptake of climate-smart practices, and progress toward formalization are consistent with the EM-SMM mechanisms: capability (training), opportunity (resources/partnerships), and motivation (incentives). Joint displays map quantitative shifts to qualitative narratives on governance, triangulating pathways from program inputs to outcomes.

6. Conclusions

Renaming the Teach One model as the Emerging Markets Sustainability Management Model (EM-SMM) as shown in Figure 2 strengthens theoretical positioning and clarifies the scope. It signals relevance across contexts with similar governance asymmetries (weak enforcement, powerful local authorities, extractive incentives, limited livelihood alternatives), while inviting comparative studies beyond Ghana.

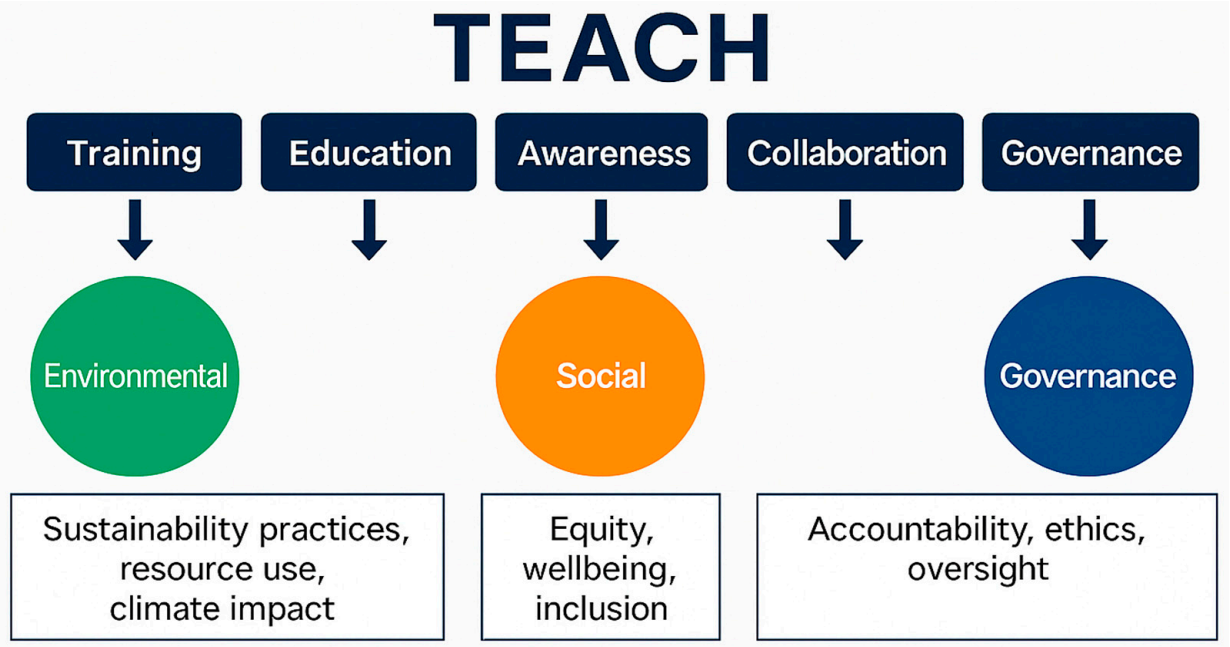


Figure 2. ESG mapping of TEACH components. The TEACH components are represented by dark blue boxes, and arrows point to the ESG pillars Environmental (green circle), Social (orange circle), and Governance (blue circle).

Limitations and Future Research Directions

The case relies on institutional background and national program contexts to frame hypotheses; KSF-specific numeric outcomes must be collected via the outlined panel surveys and MIS extraction. Future work should include land tenure mediation effects (drawing on Compact I land tenure facilitation insights) and longitudinal tracking of certification spillovers on household resilience [12]. As detailed in prior sections, generalizability may

be constrained by country-specific customary systems and political economy dynamics; risks include elite capture and indicator manipulation. Time lags in ecological recovery and data scarcity (especially high-frequency, independent measures) complicate attribution. The term "GoldBod" requires definitional precision for international audiences. These boundary conditions guide the future research agenda articulated in the Conclusions. To support inference, future empirical work should employ quasi-experimental designs (difference-in-differences with staggered rollouts), synthetic control, clustered RCTs where feasible (phased incentive packages across traditional areas), and mixed methods combining ethnography and surveys (trust, legitimacy, norm shifts), alongside remote sensing for land cover and river restoration tracking.

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Appendix A

Methods

This appendix provides survey instruments, an adult-learning fidelity checklist, and ESG indicator definitions used to evaluate KSF's TEACH 2.0 interventions.

Appendix A.1. Survey Instruments (Selected Items)

Household/Enterprise Survey—Baseline/Midline/Endline

Economic Outcomes:

1. Monthly gross revenue from primary enterprise (GHS).
2. Net margin (GHS) = revenue − variable costs.
3. Savings balance (GHS) and frequency of deposits (per month).
4. Loan amount, interest rate, and repayment schedule; current arrears (Y/N).

Social/Gender Outcomes:

5. Decision-making index (e.g., 5-item Likert: decisions on purchasing inputs, spending profits, children's schooling, healthcare, asset sales).
6. Access to DFS/KYC (mobile money account, national ID possession; frequency of use).
7. Training completion (TEACH modules) and self-efficacy scores (enterprise planning, health/nutrition, legal basics).

Environmental Outcomes:

8. Adoption of climate-smart practices (IPM, improved seed, water-saving irrigation)—binary + intensity (plot share).
9. Post-harvest loss rate (% of harvest lost before sale).
10. Storage quality rating (e.g., moisture control, pest prevention checklists).

Innovation/Market Outcomes:

11. Participation in producer groups (Y/N), certification steps completed (Y/N).

12. Buyer contracts signed (Y/N), price realization vs. local benchmark (%).

Appendix A.2. FGD and KII Guides (Core Prompts)

FGDs—Women TEACH participants:

- How did TEACH modules change enterprise decisions and household practices?
- What barriers persist (collateral, market demand, digital access)?
- Which climate-smart practices were feasible and why?
- Perceptions of quality standards and buyer requirements.

KIIs—District Agric/SIF/Bank/Fintech:

- Governance mechanisms (MOUs, KPIs, reporting).
- Co-financing opportunities and infrastructure complementarities (storage, training centers).
- DFS onboarding processes and consumer protection.

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