

Intergenerational Ecological Responsibility and Sustainable Coffee Agroecosystems: Integrating Ecotheology and Indigenous Knowledge in Ermera Municipality, Timor-Leste

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Abstract:

➤ *Introduction*

Environmental degradation in agrarian ecosystems is increasingly recognized not only as an ecological and economic challenge but also as an ethical, cultural, and spiritual crisis. In coffee-producing regions such as Ermera Municipality, Timor-Leste, sustainability is shaped by complex interactions among indigenous ecological knowledge, religious values, community governance, and environmental stewardship. However, existing sustainability studies often emphasize technical and economic dimensions while overlooking moral and intergenerational responsibilities.

➤ *Objective*

This study aims to examine how intergenerational ecological responsibility contributes to the sustainable governance of coffee agroecosystems in Ermera, Timor-Leste, through the integration of ecotheology and Indigenous Ecological Knowledge (IEK).

➤ *Method of Research*

An interpretive qualitative case study approach was employed within an interpretive-constructivist paradigm. Data were collected through in-depth semi-structured interviews, focus group discussions, participant observation, and document analysis involving coffee farmers, customary leaders, Catholic clergy, youth representatives, and environmental actors. Purposive sampling was used to select information-rich participants. Data were analyzed using thematic analysis and hermeneutic interpretation, guided by Hans Jonas' ethics of responsibility, ecotheology, Indigenous Ecological Knowledge, Social-Ecological Systems (SES) theory, and biocultural diversity perspectives.

➤ *Results and Discussion*

Five major themes emerged: (1) ecological degradation and increasing pressure on coffee landscapes; (2) faith-based environmental stewardship rooted in Catholic ecological ethics; (3) Indigenous Ecological Knowledge and customary land ethics as mechanisms of environmental regulation; (4) intergenerational environmental memory and responsibility as vehicles for transmitting ecological values; and (5) the emergence of a contextual sustainability model integrating ecological vulnerability, indigenous knowledge, faith-based ethics, intergenerational accountability, and community governance. Findings indicate that sustainability is maintained through moral, cultural, and social institutions rather than through technical management alone.

The findings demonstrate that ecological sustainability in Ermera is a relational and socially governed process. Ecotheology and indigenous ecological knowledge function as complementary governance mechanisms that reinforce

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stewardship, collective responsibility, and ecological resilience. However, modernization, market expansion, and changing generational aspirations threaten the continuity of traditional ecological knowledge and intergenerational responsibility.

➤ *Conclusion*

Sustainable coffee agroecosystem governance in Ermera depends on integrating ecological stewardship, indigenous knowledge systems, faith-based ethics, and community governance. The study proposes a Contextual Ecotheological Social-Ecological Sustainability Framework that advances sustainability scholarship by linking intergenerational ethics, moral ecology, indigenous knowledge, and adaptive governance to promote long-term ecological resilience.

Keywords: *Intergenerational Ecological Responsibility; Ecotheology; Indigenous Ecological Knowledge; Sustainable Coffee Agroecosystems; Social-Ecological Systems.*

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I. INTRODUCTION

The environmental crisis of the twenty-first century—manifested through climate change, deforestation, biodiversity loss, land degradation, and ecological imbalance—has become a multidimensional challenge that exceeds purely scientific or technical explanations. Increasingly, environmental degradation is framed as an ethical and social crisis, requiring governance approaches that incorporate moral responsibility, cultural meaning, and community participation (Francis, 2015; Francis, 2023).

A central concept in environmental ethics is *intergenerational ecological responsibility*, the moral obligation of the present generation to preserve ecological integrity for future generations. Hans Jonas' "principle of responsibility" argues that modern power over ecological systems expands moral accountability beyond immediate human relations, demanding foresight and ethical consideration for future life (Jonas, 1984). From an environmental justice perspective, intergenerational responsibility extends fairness across time—meaning that sustainability must protect ecosystem integrity and livelihood security so future communities retain environmental and social options for survival (Jonas, 1984; Scott, 2021).

Coffee agroecosystems are prominent *social-ecological systems* in many developing countries, especially in rural mountainous regions where livelihoods depend on environmental stability. While sustainability research on coffee often emphasizes technical adaptation (e.g., agroforestry practices, climate-resilient management, and productivity improvements), the ethical and cultural dimensions of environmental stewardship may be under addressed. This limitation is important because environmental behavior and governance in agrarian settings are often shaped by moral norms, identity, and place-based ecological values rather than by technical interventions alone (Berkes, 2018; Ostrom, 2009; Larsen & Löff, 2025).

Timor-Leste provides an especially relevant context for examining the links among ecological sustainability, indigenous knowledge, faith-based moral responsibility, and

governance. The country remains vulnerable to interconnected environmental and socio-economic pressures, including deforestation, land degradation, and weak governance capacity in rural areas (Asian Development Bank [ADB], 2019; World Bank, 2023). Coffee is also a central export and livelihood commodity in Timor-Leste, making coffee landscapes a critical arena for sustainability and governance transformation (ADB, 2019; World Bank, 2024).

Within Timor-Leste, Ermera Municipality stands as a major coffee-producing region and a socially embedded landscape where customary land relations, rural livelihoods, ecological vulnerability, and Catholic identity intersect. In such contexts, indigenous ecological knowledge (IEK) plays a major role in shaping environmental stewardship. IEK is understood as locally developed ecological understanding, adaptive practices, and environmental ethics formed through long-term human–environment relationships (Berkes, 2018; McGregor, 2021). These knowledge systems often regulate land use, resource protection, seasonal cycles, and biodiversity through moral and symbolic mechanisms—such as sacred restrictions, ancestral obligations, and intergenerational storytelling—which can function as informal governance institutions (Berkes, 2018; Thompson et al., 2020).

At the same time, Timor-Leste's predominantly Catholic identity provides a moral-spiritual framework that shapes ecological consciousness. Catholic ecological thought—particularly *Laudato Si'* and *Laudate Deum*—emphasizes that care for the environment is inseparable from moral responsibility, social justice, and care for future generations (Francis, 2015; Francis, 2023). Thus, ecotheology and integral ecology can be interpreted not only as theological reflection but also as resources for moral governance that influence community-level environmental behavior (Francis, 2015; Francis, 2023).

Despite increasing scholarship on sustainability and indigenous environmental governance, gaps remain. First, sustainability studies of coffee often prioritize technical and economic dimensions while under-emphasizing ethical and intergenerational dimensions. Second, integrative studies

connecting ecotheology and IEK within governance frameworks remain limited, particularly in Timor-Leste's coffee systems. Therefore, this study asks: How does intergenerational ecological responsibility contribute to sustainable governance of the coffee agroecosystem in Ermera through the integration of ecotheology and indigenous ecological knowledge?

To answer this question, the study adopts an interpretive qualitative case study approach to examine how ecological values, stewardship practices, and moral responsibilities are socially constructed, culturally transmitted, and spiritually reinforced in coffee-farming communities. The research ultimately broadens sustainability discourse beyond productivity-centered interventions toward a contextual moral-social-ecological governance framework (Ostrom, 2009; Maffi, 2005; Jonas, 1984).

II. METHOD OF RESEARCH (METHODOLOGY)

➤ *Research Paradigm*

This study is grounded in an interpretive-constructivist research paradigm. Such a paradigm assumes that social and ecological realities are not fixed or purely objective; rather, they are shaped through lived experience, cultural meanings, historical memory, and institutional interactions (Lincoln & Guba, 1985). In environmental governance research, interpretivism is useful for examining how communities interpret ecological responsibility and how stewardship practices emerge from moral and relational systems—not only from measurable biophysical variables (Creswell & Poth, 2024).

Interpretivist orientation also recognizes sustainability as a *negotiated socio-ecological process*. Thus, the study investigates how intergenerational ecological responsibility is interpreted and enacted through religious ethics, indigenous knowledge systems, customary norms, and community governance (Merriam & Tisdell, 2016).

➤ *Research Design*

A qualitative interpretive case study design is used. Qualitative methods are appropriate because the research aims to explore meaning, values, and socially embedded stewardship practices rather than to test statistical causal relationships (Yin, 2018). Ermera Municipality is treated as a bounded case because it represents a specific social-ecological landscape where coffee production, ecological vulnerability, customary land ethics, and Catholic social influence converge (Yin, 2018; Creswell & Poth, 2024).

➤ *Study Site and Justification*

The study was conducted in Ermera Municipality, Timor-Leste. The case is ecologically significant due to its sensitivity to land-use change, erosion, deforestation pressures, and watershed instability. It is also socioeconomically significant because coffee farming is a central source of livelihood. Finally, the Municipality is culturally and religiously significant due to the interaction of

customary ecological norms and Catholic identity (ADB, 2019; World Bank, 2024).

➤ *Participants and Sampling Strategy*

Purposive sampling was employed to select information-rich participants relevant to the study objectives (Nowell et al., 2017). Participants included: coffee farmers, traditional elders/customary leaders, Catholic clergy/pastoral actors, youth/younger generations, and community-based environmental actors/NGOs. Sampling continued until thematic saturation was achieved—when additional data no longer produced substantial new themes (Braun & Clarke, 2021; Nowell et al., 2017).

➤ *Data Collection Methods*

To strengthen methodological rigor through triangulation, multiple qualitative techniques were used:

- In-depth semi-structured interviews with key participants to explore lived experiences, environmental meanings, moral perceptions, and stewardship practices (Creswell & Poth, 2024).
- Focus group discussions (FGDs) to explore shared ecological narratives, tensions across generations, and community governance perspectives.
- Participant observation to contextualize farming routines, land-use practices, symbolic behaviors, and governance interactions (Merriam & Tisdell, 2016).
- Document analysis of relevant materials, including environmental and agricultural policy texts and Church ecological teachings, to triangulate community narratives with institutional documents (Yin, 2018).

➤ *Data Analysis*

Data analysis used thematic analysis combined with hermeneutic interpretation. The process included: data familiarization, open coding, axial coding, thematic synthesis, and interpretive integration using the study's theoretical lenses (Braun & Clarke, 2021; Nowell et al., 2017). Expected analytical themes included ecological degradation pressures, faith-based stewardship, indigenous land ethics, intergenerational environmental memory, and contextual sustainability governance.

Hermeneutic interpretation then positioned findings within:

- Hans Jonas' responsibility ethics (Jonas, 1984)
- Ecotheology/integral ecology (Francis, 2015; Francis, 2023)
- IEK (Berkes, 2018)
- SES governance (Ostrom, 2009)
- Biocultural diversity and cultural–ecological co-impacts (Maffi, 2005; Maffi & Woodley, 2010).

➤ *Trustworthiness and Ethics*

Trustworthiness was ensured through credibility, transferability, dependability, and confirmability strategies, including prolonged engagement, triangulation, member checking, reflexive journaling, and audit transparency (Lincoln & Guba, 1985; Nowell et al., 2017). Ethical procedures included informed consent,

confidentiality/anonymization, cultural respect, and the minimization of potential harm related to sensitive land and ecological knowledge (Merriam & Tisdell, 2016).

III. RESULTS (FINDINGS)

The findings show that ecological sustainability in Ermera's coffee agroecosystems is shaped through interactions among environmental pressures, moral stewardship, indigenous ecological norms, intergenerational transmission of responsibility, and community-based adaptive governance. Five major thematic patterns were identified.

➤ *Ecological Degradation and Coffee Landscape Pressure*

Participants consistently described the increasing vulnerability of coffee agroecosystems. Ecological decline was linked to forest loss and land-conversion pressures, resulting in reduced ecological buffering and increased erosion and soil instability in mountainous landscapes. Farmers also reported soil degradation, loss of fertility and moisture retention, and greater vulnerability to rainfall variability, which collectively threaten both productivity and long-term livelihood security. Climate variability and ecological uncertainty were also perceived as disruptions to farming cycles and ecological predictability. Importantly, participants interpreted ecological decline not only as an agronomic risk but as a moral concern because it threatens future generations' ability to inherit productive land and ecological security. This aligns with intergenerational responsibility as an ethical lens for understanding environmental governance (Jonas, 1984; Scott, 2021).

➤ *Faith-Based Environmental Stewardship*

A second major theme concerned the role of faith-based stewardship in shaping ecological responsibility. In predominantly Catholic communities, ecological care was frequently framed as stewardship of creation rather than as purely economic management of resources. Church actors were described as moral voices that reinforce ecological consciousness, moderation, and community responsibility. Environmental degradation was also interpreted through relational responsibility—meaning care for land was linked to responsibility toward God, community, and future generations. These faith-based values appeared to strengthen collective solidarity and to function as informal governance mechanisms that shape ecological behavior (Francis, 2015; Francis, 2023; Ostrom, 2009).

➤ *Indigenous Ecological Norms and Land Ethics*

The third theme highlighted the continuing importance of Indigenous Ecological Knowledge and customary ecological ethics. Elders and community participants emphasized that land is not merely a commodity; it is tied to ancestry, memory, identity, and communal responsibility. Sacred environmental respect—manifested in ritual caution, restrictions on certain areas, and community norms—helped limit harmful ecological behavior. Collective stewardship ethics were also prominent: responsibility was framed as communal rather than individual, through shared obligations and social accountability. Participants also described

experiential ecological knowledge (seasonal rhythms, soil behavior, water patterns) embedded in ongoing practice. However, modernization and market integration were perceived as weakening certain customary norms and reducing younger generations' engagement with symbolic stewardship. Even so, IEK remained a crucial adaptive and ethical sustainability resource (Berkes, 2018; Thompson et al., 2020).

➤ *Intergenerational Environmental Memory and Responsibility*

A fourth theme addressed intergenerational environmental memory and responsibility. Participants framed ecological care as an inheritance, a continuity, and a future obligation. Land was described as intergenerational trust rather than only private property. Older participants linked the current environmental vulnerability to historical changes, citing forest decline and altered water conditions as evidence of a growing threat and a future duty. Youth perspectives were mixed: some youth expressed strong ecological concern and willingness to preserve practices, while others reported tensions related to migration, modernization, and reduced attachment to traditional ecological systems. Responsibility transmission occurred through family practices, agricultural participation, community memory, religious values, and customary norms, but intergenerational continuity was uneven due to social transformation. These results illustrate intergenerational ecological responsibility as both an ethical and a socially transmitted form of governance (Jonas, 1984; Hebinck, 2025).

➤ *Toward a Contextual Eco Theological Sustainability Model*

The final integrated result described an emergent sustainability model in which sustainability depends on five interacting components: ecological vulnerability, indigenous ecological knowledge, faith-based ecological ethics, intergenerational accountability, and community-based governance. Participants suggested that sustainable coffee agroecosystems cannot be explained by technical environmental management alone; rather, sustainability emerges as a moral-social-ecological governance process integrating ecotheology, indigenous knowledge, intergenerational ethics, and adaptive collective regulation (Ostrom, 2009; Maffi, 2005; Francis, 2015).

IV. DISCUSSION

The study demonstrates that sustainability in Ermera's coffee agroecosystems is not adequately explained by productivity-centered or purely technical frameworks. Instead, ecological responsibility is relational, culturally embedded, morally negotiated, and socially governed. The interaction among ecological vulnerability, faith-based stewardship, customary land ethics, intergenerational transmission, and community governance positions coffee agroecosystems as complex moral-social-ecological systems.

This discussion synthesizes the findings with theoretical debates on intergenerational ethics, ecotheology, indigenous knowledge, SES governance, and biocultural sustainability (Jonas, 1984; Francis, 2015; Ostrom, 2009; Berkes, 2018; Maffi, 2005).

➤ *Intergenerational Ecological Responsibility as Lived Moral Governance*

Participants understood land as an inherited trust and future-oriented ecological continuity. This aligns with Jonas' ethical argument that human action must be judged by its long-term ecological consequences for future life (Jonas, 1984). However, the Ermera case extends Jonas by showing that intergenerational responsibility becomes concrete through agrarian practices: soil fertility management, watershed stewardship, family memory, customary norms, and community expectations. In other words, intergenerational ethics is not only abstract foresight but also a lived social institution reproduced across generations. This strengthens sustainability ethics by suggesting that long-term justice improves when communities embed future responsibility within daily governance practices (Scott, 2021; Jonas, 1984).

➤ *Ecotheology and Integral Ecology as Practical Governance Ethics*

Findings support ecotheological and integral ecology approaches in sustainability analysis. Ecological degradation was interpreted as a crisis of relational ethics—one that weakens responsibility toward God, land, and community. Catholic ecological teachings emphasize interconnectedness and moral accountability, linking environmental protection with social justice and care for future generations (Francis, 2015; Francis, 2023). The Ermera findings further suggest that ecotheology can operate as a practical governance resource: faith-based moral legitimacy helps sustain ecological responsibility and collective solidarity, functioning alongside customary institutions. This indicates ecotheology's relevance as both a theological and governance framework (Francis, 2015; Ostrom, 2009).

➤ *Indigenous Ecological Knowledge as Moral-Symbolic Regulation*

The findings align with Berkes' view that IEK enhances governance through adaptation and resource management (Berkes, 2018). In Ermera, IEK clearly informs practical ecological adaptation (seasonality, soil behavior, water patterns). Yet the study also reveals a moral-symbolic governance dimension: sacred respect, ancestral land relations, and communal ecological identity serve as informal institutions that regulate harmful behavior and restrain ecological exploitation. At the same time, tensions surrounding modernization highlight the fragility of IEK transmission. This supports broader sustainability concerns that development pressures can erode ecological knowledge systems and their intergenerational continuity (Berkes, 2018; Thompson et al., 2020).

➤ *Social-Ecological Systems: Governance Beyond Formal Institutions*

SES theory emphasizes that ecological outcomes depend on interactions among resources, users, institutions, and governance structures (Ostrom, 2009). The Ermera case supports this by showing that sustainability emerges through community-based governance mechanisms—shared land ethics, informal regulation, collective stewardship, and adaptive practices. Importantly, the study extends SES by showing that governance resilience in Ermera also relies on moral legitimacy: faith systems and symbolic stewardship strengthen compliance and collective responsibility, meaning that cultural and ethical structures are not “external” to governance but part of it (Ostrom, 2009; Larsen & Löf, 2025).

➤ *Biocultural Diversity: Cultural Memory as Ecological Security*

The findings strongly reflect the logic of biocultural diversity, in which ecological sustainability is interlinked with cultural continuity (Maffi, 2005; Maffi & Woodley, 2010). Coffee landscapes are not merely production systems; they are socio-cultural ecological spaces. Respect for sacred land, ecological narratives, and customary practices indirectly contributes to ecological protection by preserving biodiversity and ecological functions. At the same time, environmental degradation threatens cultural memory and identity—suggesting that ecological vulnerability also produces biocultural vulnerability. This supports a broader understanding of sustainability as cultural-ecological co-resilience (Maffi, 2005; Maffi & Woodley, 2010).

➤ *Theoretical Synthesis: A Contextual Eco Theological Social-Ecological Framework*

The principal theoretical contribution is the integration of fragmented traditions into a Contextual Ecotheological Social-Ecological Sustainability Framework. The framework connects:

- Jonas → intergenerational ecological responsibility (Jonas, 1984)
- ecotheology/integral ecology → moral and relational stewardship (Francis, 2015; Francis, 2023)
- Berkes → indigenous ecological knowledge (Berkes, 2018)
- Ostrom → community-based SES governance (Ostrom, 2009)
- biocultural diversity → cultural-ecological continuity (Maffi, 2005).

Together, these explain sustainability in Ermera as a moral-social-ecological governance process shaped by ecological vulnerability, ethical systems, indigenous knowledge, cultural continuity, and intergenerational accountability. This framework extends sustainability scholarship beyond productivity-centered adaptation and argues that culturally grounded moral institutions are necessary for durable governance and ecological resilience (Ostrom, 2009; Jonas, 1984; Francis, 2015).

➤ *Implications for Sustainability Governance in Timor-Leste*

The findings suggest that governance interventions in coffee landscapes should: (1) strengthen community-based ecological governance through participatory stewardship models that include customary leaders and farmers; (2) recognize Church institutions as influential moral partners capable of supporting ecological education; (3) prioritize youth-focused intergenerational environmental education to maintain ecological memory; (4) preserve indigenous ecological knowledge and integrate it into planning and adaptation strategies; and (5) implement resilient agroforestry and landscape governance that balances productivity and ecosystem integrity (ADB, 2019; World Bank, 2024; Prasmatiwi, 2024). These implications resonate with SES governance logic, in which governance performance depends on institutional fit with local moral legitimacy and adaptive capacity (Ostrom, 2009).

V. CONCLUSION

This study examined how intergenerational ecological responsibility contributes to sustainable governance of the coffee agroecosystem through ecotheology and indigenous ecological knowledge in Ermera, Timor-Leste. Situated in a social-ecological landscape characterized by ecological vulnerability, livelihood dependence, customary identity, and Catholic ethical influence, the research demonstrates that sustainability in coffee-farming communities cannot be fully understood through technical or productivity-centered approaches alone. Instead, ecological sustainability emerges as a relational, culturally embedded, morally negotiated, and socially governed process.

Five key conclusions follow. First, ecological degradation and pressure on the coffee landscape threaten both agronomic productivity and the continuity of long-term livelihoods, while also raising moral concerns about the future inheritance of viable land. Second, faith-based environmental stewardship frames ecological care as stewardship of creation and relational responsibility toward God, community, and future generations, contributing to informal ecological governance. Third, indigenous ecological norms and customary land ethics sustain adaptive and ethical stewardship through sacred restrictions and collective reserves, which serve as central mechanisms for transmitting ecological responsibility and the continuity of transmission capabilities and experiential ecological understanding, though these systems face weakening pressures from modernization and market expansion. Fourth, intergenerational environmental memory serves as a central mechanism for transmitting ecological responsibility, but the continuity of transmission is uneven due to migration, generational shifts, and changing aspirations. Fifth, sustainability in Ermera is best conceptualized as a moral-social-ecological governance process integrating ecological vulnerability, IEK, faith-based ethics, intergenerational accountability, and community governance (Jonas, 1984; Francis, 2015; Berkes, 2018; Ostrom, 2009; Maffi, 2005).

THEORETICAL AND PRACTICAL SIGNIFICANCE

The study develops a Contextual Eco theological Social-Ecological Sustainability Framework that synthesizes intergenerational ethics, moral stewardship, indigenous knowledge, SES governance, and biocultural continuity. Practically, it implies that coffee sustainability governance in Timor-Leste should invest not only in agronomic adaptation but also in culturally grounded ethical systems that support long-term collective stewardship and ecological resilience (Ostrom, 2009; World Bank, 2024).

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