The Untapped Social Capital: Top-Down Policies, Grassroots Marginalization, and the Paradox of Conservation in Lake Tana

Melkmariam Genet

***Bahir Dar University-EiTEX*, Bahir Dar, Ethiopia**

Abstract

Lake Tana, Ethiopia's largest freshwater ecosystem, is facing severe ecological degradation. While national environmental policies exist, local implementation is hindered by fragmented, top-down governance. This study explores a critical conservation paradox at Lake Tana: the presence of immense, untapped community social capital juxtaposed against systematic grassroots marginalization. Employing a pragmatist mixed-methods design, we analyzed quantitative data from 391 shoreline households using Item Response Theory (IRT) and the Graded Response Model (GRM), triangulating the results with qualitative stakeholder narratives. The findings reveal a severe attitude-practice gap. While an overwhelming 93% of the community expressed a willingness to support conservation financially—demonstrating exceptionally high pro-environmental attitudes ($\alpha = 0.89$)—actual participation is stifled by structural exclusion and poor policy awareness. Notably, 78% of respondents reported they are never consulted by state institutions before project implementation. IRT difficulty parameters indicate that while residents easily grasp basic conservation needs, systemic exclusion prevents them from engaging in formalized environmental practices. The study concludes that Environmental Policy Integration (EPI) in developing nations cannot rely solely on bureaucratic alignment between ministries; it demands participatory co-management. Reversing Lake Tana's ecological collapse requires a shift toward inclusive governance that resolves institutional fragmentation and formally integrates local communities' social capital into actionable environmental stewardship.

ARTICLE HISTORY

Received 10 April 2026

Accepted 14 June 2026

Keywords:
Social Capital
Environmental Policy Integration
Grassroots Marginalization
Item Response Theory
Participatory Governance
Lake Tana

Citations: Genet, M. (2026). The Untapped Social Capital: Top-Down Policies, Grassroots Marginalization, and the Paradox of Conservation in Lake Tana. *ARSU, 1*(1),2026.109-133.

CONTACT *Melkemariam Genet, Email:melkeagenet@gmail.com, Bahir Dar University, Bahir Dar, Ethiopia*

Introduction

Human societies have a long and complex history of managing the environment, with formal environmental and natural resource policies dating back to ancient civilizations aimed at preventing overexploitation (Bueren, 2019). However, the unprecedented acceleration of population growth, rapid urbanization, and industrialization in recent centuries has triggered profound environmental crises on a global scale (Choudhary & Chauhan, 2015; Nanda & Pring, 2013). Today, the sustainable management of freshwater ecosystems stands as one of the most critical public policy challenges of the 21st century. The global water crisis is acute, with billions lacking access to safe drinking water and proper sanitation, a situation continuously exacerbated by climate change and environmental degradation (Cooley et al., 2014; Global Water Partnership, 2009).

Recognizing that government decisions regarding water and land use have severe, cross-cutting consequences, international frameworks from the Millennium Development Goals to the Sustainable Development Goals (SDGs) have explicitly positioned environmental sustainability and the integration of climatic policies as fundamental pillars for human survival and economic development (UN, 2015; UN, 2019). This global imperative is particularly pressing in developing nations like Ethiopia, where the reliance on natural variabilities intersects with significant institutional capacity constraints (ORCD, 2018). The Ethiopian government has long recognized this reality; the 1995 Constitution guarantees the right to a clean and healthy environment (Art. 44) and mandates responsible governance for the sustainable use of natural resources (Art. 40, 89). Following this, foundational directives such as the Ethiopian Environmental Policy (1997) and the Water Resources Management Policy (1999) were formulated to optimize socio-economic benefits while mitigating negative ecological impacts (FDRE-HPR, 2000; EPA, 1997). Over the decades, Ethiopian environmental policy discourse has evolved from protectionism and large-scale rehabilitation narratives toward participatory natural resource management and climate-resilient green economies (Keeley & Scoones, 2000; Stave & Kopainsky, 2017; Hirpha et al., 2021).

Despite these comprehensive legislative frameworks, the translation of national policy into localized ecological stability remains a formidable challenge, epitomized by the escalating crisis in the Lake Tana Basin. Located in the northwest highlands of the Amhara National Regional State (ANRS), Lake Tana is Ethiopia's largest freshwater body and the primary source of the Blue Nile. Spanning an area of 3,050 square kilometers, the lake is a vital socio-economic lifeline that directly supports the livelihoods of millions of people through agriculture, fisheries, potable water, and hydropower generation (Bires

& Raj, 2019; Dejen et al., 2017; Vijverberg et al., 2009). Furthermore, the basin is a designated UNESCO Biosphere Reserve and a cradle of Ethiopian cultural heritage, hosting over 35 historic island monasteries that serve as custodians of indigenous forest biodiversity (Kalmbach, 2017; Mccann, 2017).

Yet, this irreplaceable ecosystem is currently facing an existential threat driven by severe anthropogenic pressures. Rapid agricultural expansion, overgrazing, and unregulated urban development have triggered massive deforestation and land-cover changes across the watershed (Adom, 2024; Nampak et al., 2018; Nawaz et al., 2010). Consequently, accelerated soil erosion has led to critical delta siltation, most notably at the mouth of the Gilgel Abbay River, which threatens aquatic habitats and compromises the lake's water storage capacity (Worklul et al., 2018; Engdaw et al., 2024; Amare & Wubneh, 2017). This physical deterioration is catastrophically compounded by the unchecked proliferation of the invasive water hyacinth (Eichhornia crassipes), locally known as Emboch . Fueled by nutrient-rich agricultural runoff and untreated urban wastewater, this alien weed has devastated native fish populations, obstructed local water transport, and severely compromised regional food security (Dersseh et al., 2019; Dersseh, Tilahun, et al., 2020; Damtie & Mengistu, 2022; Seid & Getenet, 2017).

While the physical manifestations of Lake Tana's degradation are highly visible, the root cause lies in a systemic failure of environmental governance and public policy execution. Public policy is inherently problem-oriented and requires a multidisciplinary approach to coordinate efforts across multiple agencies at national, state, and local levels (Anderson, 2003; Birkland, 2011; Gerston, 2010). In the context of complex ecological crises, traditional administrative structures often prove inadequate, necessitating Environmental Policy Integration (EPI). EPI a concept that gained widespread recognition following the 1987 Brundtland Report and the 1992 Rio Earth Summit posits that sustainable development cannot be achieved unless environmental objectives are deeply embedded into the decision-making processes of sector-specific policies, such as agriculture, energy, and transport (Persson, 2004; Runhaar et al., 2014; Liberatore, 1997).

Theoretical perspectives on EPI emphasize the need to move beyond narrow, end-of-pipe regulations toward holistic, cross-sectoral governance that evaluates policy alternatives from a general perspective rather than in isolation (Underdal, 1980; Lafferty & Hovden, 2003; Nilsson & Persson, 2003). However, at Lake Tana, policy integration remains underdeveloped and inconsistently applied. Government bureaus frequently operate in administrative silos, pursuing conflicting mandates. For instance, while regional environmental protection agencies attempt to safeguard the ecosystem, agricultural bureaus

promote input-intensive farming that exacerbates runoff, and water ministries alter natural hydrology for hydroelectric projects, prioritizing immediate economic gains over long-term ecological sustainability (Dejene & Cochrane, 2019; Solomon, 2017; Bezabih, 2009).

More critically, this fragmented, top-down bureaucratic approach has systematically marginalized the local communities who reside along the lake's shores. The literature on public policy firmly establishes that effective governance requires not only horizontal and vertical integration among state actors but also the inclusion of diverse non-governmental stakeholders through policy networks (Sandström, 2008; Tosun & Lang, 2017). At the grassroots level, this inclusion relies on "social capital" the networks of relationships, trust, cooperative norms, and civic engagement that enable societies to act collectively (Scrivens & Smith, 2013; PRI, 2005; Lins et al., 2017). Research demonstrates that when communities are informed and empowered, their social capital acts as a powerful catalyst for collective conservation action, fostering ownership and the adoption of sustainable practices (Ostrom, 2009; Pretty & Ward, 2001; Reed, 2008). Integrating local knowledge with scientific research ensures that conservation strategies are not only grounded in empirical evidence but also aligned with the cultural and environmental insights of the community, fostering more resilient outcomes (Irahola et al., 2022; Sterling et al., 2017; Hage et al., 2010). Yet, environmental management at Lake Tana remains an exclusionary enterprise (Stave et al., 2017).

This marginalization creates a profound paradox of conservation at Lake Tana. On one hand, local communities, whose livelihoods depend intimately on the lake, possess a deep, lived understanding of the ecological collapse and exhibit an exceptionally high willingness to engage in and financially support conservation efforts. On the other hand, state-led initiatives treat them as passive subjects rather than active partners, rarely consulting them during policy design or project implementation. When institutions fail to consult the public prior to intervention, it breeds apathy, frustration, and the ultimate failure of localized efforts, such as the uncoordinated manual clearing campaigns against the water hyacinth (Dersseh et al., 2022; Hanibal et al., 2020).

To systematically analyze this paradox, this study is anchored in a conceptual framework that links macro-level policy integration with micro-level human dimensions. To unpack the structural deficits of government policy, the study utilizes the four-dimensional conceptualization of policy integration proposed by Candel and Biesbroek (2016): policy frame, subsystem involvement, policy goals, and policy instruments. However, to understand why these structural policies fail at the grassroots level, this macro-framework must be bridged with the psychometric Knowledge, Attitude, and Practices (KAP)

paradigm (Salas-zapata et al., 2018; Dunn, 2018). Translating integrated policy from a conceptual ideal into tangible action depends entirely on resolving the "knowledge-practice gap" among local actors. If a community possesses a strong pro-environmental attitude but lacks systemic knowledge of, or inclusion in, government policy mechanisms, their potential to enact sustainable practices is severely restricted by systemic barriers. Therefore, effective policy integration must be conceptualized not merely as the alignment of government legal instruments, but as a continuous, cyclical dialogue that harmonizes state administrative action with grassroots KAP.

While previous studies on Lake Tana have extensively documented its hydrological decline, LULC dynamics, and macro-institutional fragmentation (Amare & Wubneh, 2017; Damtie et al., 2017; Tesfaye, 2023), there remains a critical gap in the empirical literature regarding the psychometric dimensions of the marginalized grassroots stakeholders in the context of policy integration. Existing research frequently points to weak coordination but rarely quantifies the specific cognitive and behavioral disconnects between state intent and community reality. To address this empirical gap, this paper investigates the untapped social capital and the impacts of grassroots marginalization in the Lake Tana Basin. Utilizing a robust empirical dataset of 391 shoreline households, alongside qualitative insights from local stakeholders, this study aims to: (1) evaluate the extent of community marginalization in current policy formulation and environmental project execution; (2) assess the local community's Knowledge, Attitudes, and Practices (KAP) using advanced psychometric modeling to quantify the disconnect between their willingness to act and their actual participation; and (3) propose an inclusive, community-based management framework that bridges the gap between top-down state policies and bottom-up environmental stewardship. Ultimately, this research argues that reversing the ecological collapse of Lake Tana cannot be achieved through bureaucratic restructuring alone; it requires a fundamental paradigm shift that places the untapped social capital of local communities at the very center of environmental policy integration.

Materials and Methods

Study Area Description

The study was conducted in the Lake Tana Basin, located in the northwest highlands of the Amhara National Regional State, Ethiopia. Geographically positioned between latitudes 10°58’ to 12°47’ N and longitudes 36°45’ to 38°14’ E, Lake Tana covers an area of approximately 3,050 square kilometers at an

elevation of 1,830 meters above sea level (Bires & Raj, 2019; Vijverberg et al., 2009). The lake and its adjacent floodplain wetlands (such as Fogera and Dembia) serve as vital ecological and socio-economic hubs. They support a predominantly agrarian population engaged heavily in smallholder subsistence farming, traditional fishing, and eco-tourism. This study explicitly focused on the shoreline communities because these populations occupy the frontlines of the lake's environmental collapse. While they are the primary custodians of local social capital, they are also the most directly impacted by the severe socio-economic fallout of the lake's degradation, including the rapid expansion of the invasive water hyacinth (Eichhornia crassipes), accelerating delta siltation at tributary mouths, and severe land degradation driven by upstream deforestation (Dejen et al., 2017; Worklul et al., 2018).

Research Paradigm and Design

To effectively untangle the complex paradox of high community willingness versus systemic grassroots marginalization, this study was grounded in a pragmatist research paradigm. Pragmatism embraces methodological diversity, rejecting strict adherence to a single epistemological stance in favor of utilizing the most practical approaches to address complex, real-world public policy issues. Consequently, a convergent mixed-methods design (Creswell & Creswell, 2018) was adopted. This design facilitated the simultaneous collection and independent analysis of quantitative psychometric data and qualitative human narratives. The integration of these diverse datasets during the interpretation phase enabled a triangulated, holistic assessment of the cognitive, behavioral, and administrative disconnects between top-down environmental policy formulation and grassroots realities.

Population and Sampling Strategy

To capture the perspectives of the marginalized grassroots stakeholders, a multi-stage, purposive, and systematic random sampling strategy was employed. First, three distinct kebeles (local administrative units) along the Lake Tana shoreline were purposively selected based on their exposure to environmental degradation, specifically water hyacinth infestation: Shiha-Gomengie and Lemba-Arbaytu (representing heavily infested zones) and Kunzila (serving as a non-infested comparative zone).

To ensure the sample accurately reflected the targeted socio-ecological dynamics, the sampling frame within these kebeles was rigorously refined to include only households possessing land adjacent to or directly interacting with the lake environment. This resulted in a total target population of 3,635

households across the three kebeles. The base sample size was determined using Yamane's (1973) formula at a 95% confidence level with a 0.05 margin of error:

$$\mathbf{n}=\frac{N}{1+N\,(e^2)}$$

Where:

n = is the sample size,
N = is the total population
e = is the desired level of precision (also known as the margin of error).

While the formula yielded a base requirement of approximately 360 respondents, the final sample size was proactively adjusted to 391 participants to account for potential non-responses and to ensure robust proportional allocation across the zones (102 from Lemba-Arbaytu, 99 from Shiha-Gomengie, and 190 from Kunzila). Systematic random sampling was then utilized to select the final 391 household heads or adult representatives for data collection.

Data Collection

Quantitative Data: Primary quantitative data were collected using a structured Knowledge, Attitude, and Practice (KAP) questionnaire specifically tailored for the local communities. The instrument utilized a graded, 5-point Likert scale (ranging from 0 = "I do not have/know" to 4 = "Very strongly"). The questionnaire was divided into three core constructs: (1) *Knowledge*, which evaluated the community's understanding of regional environmental policies, coordination mechanisms, and state monitoring schemes; (2) *Attitude*, which measured intrinsic willingness to participate in and financially support conservation; and (3) *Practice*, which assessed actual participation levels in environmental initiatives and state consultation processes.

Qualitative Data: To contextualize the quantitative psychometric findings and capture the lived, nuanced experiences of marginalization, two Focus Group Discussions (FGDs) were conducted. The primary community FGD engaged 24 members (divided into two groups of 12) from the heavily impacted kebeles. Additionally, in-depth key informant interviews were held with local fishermen, farmers, and traditional community leaders to capture historical narratives regarding the socio-economic impacts of ecological decline and the historical failure of state-led consultation and policy integration.

Data Analysis Methods

Psychometric Analysis (IRT): The quantitative KAP survey data were rigorously evaluated using Item Response Theory (IRT), specifically employing the Graded Response Model (GRM), utilizing STATA (Version 15). The GRM is uniquely suited for ordered categorical responses, allowing for the precise, latent measurement of psychological traits rather than relying on crude sum scores (Wang & Wang, 2020). The model estimates two critical parameters: the discrimination parameter (α), which measures an item's ability to sharply differentiate between respondents with varying levels of the latent trait (e.g., environmental attitude), and the difficulty/threshold parameter (β), which represents the specific trait level required for a respondent to endorse a particular response category. Prior to IRT modeling, Exploratory Factor Analysis (EFA) using Principal Axis Factoring with Promax (oblique) rotation was conducted in IBM SPSS (Version 27) to verify the underlying construct dimensionality of the KAP items. Data integrity was strictly maintained by screening for univariate and multivariate outliers utilizing Mahalanobis distance thresholds (Tabachnick & Fidell, 2020). Internal consistency and reliability of the extracted factors were confirmed via Cronbach's alpha.

Qualitative Analysis: Qualitative transcripts from the interviews and FGDs were subjected to systematic thematic analysis. The data were transcribed, coded, and categorized to identify recurring conceptual patterns related to institutional exclusion, policy inconsistency, perceived government inaction, and the presence of localized ecological knowledge. This thematic output was iteratively cross-referenced with the IRT difficulty parameters to explain why specific environmental practices were highly desired by the community but structurally difficult to execute.

Results

Baseline Institutional Assessment and Grassroots Marginalization

To establish the context of the "top-down" policy environment and assess the baseline of community inclusion in Lake Tana's environmental governance, respondents (n=391) from the shoreline communities were surveyed regarding their awareness of, and involvement in, state-led conservation initiatives. The findings, derived from the survey on stakeholder involvement, reveal a stark operational paradox between the community's intrinsic willingness to participate and their actual systemic marginalization by regional policymakers.

An overwhelming 93% (f=363) of the surveyed community members expressed a direct, affirmative willingness to pay or contribute personal resources to save Lake Tana from environmental degradation. Despite this

exceptionally high level of grassroots willingness, actual integration into state-led policy processes was found to be critically low, reflecting an exclusionary administrative approach. Less than half of the respondents (45%, f=176) reported ever being formally consulted by policymakers or government institutions regarding the management of Lake Tana. Furthermore, 78.3% (f=306) stated that government stakeholders do not ask for local input or evaluate existing community needs before unilaterally implementing new environmental projects.

Awareness of coordinated, multi-institutional environmental efforts is similarly deficient among the grassroots populace. Only 38.4% (f=150) of respondents had ever noticed any coordinated conservation efforts among the various government and non-government institutions working on Lake Tana, and a mere 36.6% (f=143) had ever participated in a meeting coordinated by these institutions. Consequently, the majority of the community (65.2%, f=255) perceived the conservation actions emanating from government stakeholders as highly inconsistent.

Educational and capacity-building outreach, a critical prerequisite for policy integration, was also found to be inadequate. Only 26.9% (f=105) of respondents had received any environmental conservation training from government institutions, and even fewer (22.8%, f=89) had received training from non-governmental organizations (NGOs). Qualitative data obtained through Focus Group Discussions (FGDs) with local fishermen corroborated these survey metrics. Participants expressed profound frustration regarding their exclusion from state interventions, particularly concerning the unchecked spread of the invasive water hyacinth (Eichhornia crassipes). One respondent summarized the collective sentiment: “Lake Tana was very useful for the country, but the weed called water hyacinth came, and the government didn’t coordinate to remove it for us... Now, all that is gone.” Another resident highlighted the lack of sustained capacity building, noting: “The way Lake Tana is managed feels like an overlook. Machines come and go, but no one stays to teach us or help build our skills.”

Community Knowledge, Attitude, and Practice (KAP) Assessment

To further unpack the human dimensions of this policy failure, the study utilized advanced psychometric modeling to evaluate the Knowledge, Attitudes, and Practices (KAP) of the marginalized grassroots stakeholders.

Overall KAP Profile

The aggregate KAP scores for the Lake Tana shoreline communities were evaluated against a neutral test value of 2 (on a Likert scale ranging from 0 to 4) using one-sample t-tests to determine statistical significance.

The overall knowledge level concerning regional environmental policies, stakeholder coordination, and integration mechanisms was reported as critically poor. The mean knowledge score was 1.73 (D = 0.97), falling significantly below the neutral test value ($t = -5.40$, $df = 388$, $p < .001$, 95% CI [-0.36, -0.17]). In sharp contrast to their deficient policy knowledge, the community demonstrated a highly positive attitude toward policy integration and collaborative environmental conservation. The mean attitude score was 2.40 (SD = 0.76), which significantly exceeded the test value ($t = 10.57$, $df = 390$, $p < .001$, 95% CI [0.33, 0.48]).

Despite this strong positive attitude, the self-reported practice level reflecting the community's actual application of sustainable practices and their ability to participate in integrated environmental management was moderate. The mean practice score was 1.94 (SD = 0.93), which showed no statistically significant difference from the neutral test value ($t = -1.24$, $df = 388$, $p = 0.216$, 95% CI [-0.15, 0.03]). This profile mathematically isolates an "attitude-practice gap," where high willingness is bottlenecked by low knowledge and moderate execution.

Psychometric Analysis of Knowledge Items

Prior to Item Response Theory (IRT) modeling, Exploratory Factor Analysis (EFA) utilizing Principal Axis Factoring with Promax rotation was conducted on the knowledge items. The EFA revealed a strong single-factor structure, explaining 67.44% of the total variance with an eigenvalue of 7.42. The construct exhibited high internal consistency, yielding a Cronbach’s alpha of 0.95.

Analysis of the raw response frequencies highlighted specific knowledge deficits within the community. The highest frequencies of "I do not know" (score = 0) responses were recorded for items regarding the existence of strong monitoring schemes to evaluate green activities (43%), awareness of harmonized actions among stakeholders (33%), and knowledge of the necessary public institutions currently working on Lake Tana (30%). Conversely, respondents showed slightly better familiarity with the basic concept of coordinated green activities, where 35% reported a "moderate" level of knowledge.

IRT utilizing the Graded Response Model (GRM) was applied to further evaluate the psychometric properties of the knowledge construct. The discrimination parameters (a) which measure how sharply an item differentiates between respondents of varying knowledge levels were exceptionally high

across all items, ranging from 1.27 to 4.40. The item regarding knowledge of "strong monitoring schemes" exhibited the highest discrimination (a = 4.40). The difficulty/threshold parameters (b) for this item indicated that respondents required a relatively low level of latent knowledge to cross the initial threshold (b_1 = -0.35), but required a significantly higher level of knowledge to strongly endorse it (b_4 = 1.55).

Conversely, items related to understanding the broader impact of active community participation on policy outcomes exhibited lower discrimination (a = 1.27 to 1.34) and highly negative initial threshold parameters (b_1 = -3.35). This suggests that a basic theoretical understanding of the value of community participation is uniformly held across the sample, making it statistically easy to endorse, even among respondents with otherwise severely limited policy knowledge.

Psychometric Analysis of Attitude Items

The EFA for the attitude dimension yielded a single major factor accounting for 57.88% of the variance (eigenvalue = 4.63). The internal reliability was robust, with a Cronbach's alpha of 0.89, confirming a highly cohesive community perspective regarding the necessity of collaborative environmental management.

Response patterns across the 5-point scale (ranging from 0 = "I do not have this attitude" to 4 = "I have this attitude very strongly") indicated a strong grassroots consensus. A significant portion of respondents "strongly" or "very strongly" preferred that stakeholders create wider knowledge of regional policies (56% combined), advocated for coordinated efforts across disparate institutions (58% combined), and preferred that all government institutions act as a single, unified entity to mitigate the lake's problems (65% combined). The highest level of endorsement was recorded for the active participation of the community in the effective implementation of green and off-farm activities, with 68% of respondents either "strongly" (43%) or "very strongly" (25%) supporting this participatory approach.

The GRM analysis of the attitude items yielded high discrimination parameters, effectively capturing the nuances of the community's desires. The preference for "creating wider knowledge of regional policies" showed the strongest discrimination (a = 2.99), indicating it is a highly effective metric for distinguishing respondents with deeply held pro-environmental attitudes. The preference for "institutional coordination" also demonstrated high discrimination (a = 2.62). The difficulty parameters (b) for items advocating for active community participation were highly negative at the lowest threshold (b_1 = -3.30), mathematically confirming that a minimal level of latent pro-

environmental attitude is required for a shoreline resident to endorse the desire for community involvement. However, endorsing this attitude "very strongly" required a moderate to high trait level (b_4 = 0.80).

Psychometric Analysis of Practice Items

The EFA of the practice dimension identified a strong single-factor model accounting for 65.02% of the total variance (eigenvalue = 5.28). Internal consistency was exceptional, with a Cronbach's alpha of 0.92. The practice items asked respondents to indicate their level of endorsement (from 0 = "I cannot practice/suggest" to 4 = "I practice/suggest very strongly") for specific structural and behavioral interventions.

Response frequencies for these intended or suggested practices revealed high levels of support for fundamental structural changes to Lake Tana's governance. The highest endorsement was observed for the suggestion that all institutions should "work as one entity," with 40% "strongly agreeing" and 8% "very strongly" agreeing. Strong support was also recorded for active community participation in mitigating lake problems (39% strongly agree) and implementing coordinated green activities (31% strongly agree). However, notable resistance or a perceived lack of capacity was recorded regarding the establishment of formalized evaluation mechanisms. Specifically, 33% of respondents selected the lowest response option ("I cannot practice/suggest") regarding the creation of formalized platforms where communities evaluate the implementation of government projects, and 28% indicated an inability to enforce policymakers to take community views into account.

The GRM IRT parameters for the practice items demonstrated very high discrimination values across the board, ranging from 2.14 to 5.09. The item evaluating the suggestion to "create wider knowledge on regional policies" exhibited the highest discrimination (a = 5.09), followed closely by the suggestion to have a "coordinated effort to implement green activities" (a = 4.84). The difficulty parameters (b) across the practice items spanned a wide and revealing range. The data indicated that while endorsing generalized institutional coordination is statistically "easy" (exhibiting highly negative b_1 thresholds, such as -1.64), endorsing specific, formalized democratic mechanisms such as establishing community-led project evaluation platforms requires a significantly higher latent trait level of practical engagement, with higher positive thresholds at the upper boundaries (b_4 = 1.64).

Discussion

The sustainable governance of complex socio-ecological systems like Lake Tana requires more than just the formulation of state-level policies; it necessitates the active synchronization of institutional mandates with grassroots social capital. The findings of this study expose a profound paradox in the environmental management of Lake Tana: a vast, untapped reservoir of community willingness to conserve the ecosystem is being systematically stifled by exclusionary, top-down bureaucratic practices. By triangulating quantitative psychometric data with qualitative stakeholder narratives, this discussion unravels how the failure to achieve Environmental Policy Integration (EPI) at the grassroots level manifests in profound administrative and ecological dysfunction.

The Paradox of Untapped Social Capital and State Marginalization

The most striking revelation of this study is the severe disconnect between the local community's pro-environmental attitudes and their actual integration into state-led policy mechanisms. The survey results demonstrate an overwhelming reservoir of social capital, with 93% of shoreline respondents expressing a willingness to financially contribute to the lake's preservation. Social capital defined by the networks of relationships, trust, cooperative norms, and civic engagement within a society is a fundamental prerequisite for effective public policy implementation (PRI, 2005; Scrivens & Smith, 2013). However, the data reveals that regional policymakers are critically failing to harness this asset. Over 78% of the community reported never being consulted regarding environmental projects, and 61.6% have never witnessed coordinated institutional conservation efforts.

This administrative marginalization cultivates a top-down, rather than collaborative, conservation approach, which inevitably disempowers the community and detaches them from the outcomes of environmental projects. The literature strongly corroborates that when local communities are treated as passive subjects rather than active partners, public trust erodes, and policy enforcement becomes nearly impossible. As Pretty and Ward (2001) emphasize, community involvement, particularly when well-informed and coordinated, significantly enhances the effectiveness of environmental conservation initiatives. Similarly, Ostrom (2009) notes that informed, integrated communities are far more likely to engage in sustainable practices and voluntarily support policy enforcement. At Lake Tana, the failure of institutions to establish collaborative platforms has resulted in a perceived lack of harmonized action (noted by 65.2% of respondents), reflecting findings by Folke

et al. (2005) that uncoordinated, siloed institutional efforts consistently lead to suboptimal outcomes in environmental management.

The frustration stemming from this marginalization is palpable among local resource dependents. As highlighted in the qualitative focus group discussions (FGDs), local fishermen and farmers directly attribute the loss of their livelihoods not just to the biological invasion of the water hyacinth (Eichhornia crassipes), but to the government's failure to coordinate an inclusive, proactive response. The community correctly perceives environmental and economic problems as inextricably linked a core tenet of sustainable development that the fragmented state bureaucracy has yet to operationalize. When state institutions bypass local stakeholders, localized mitigation efforts, such as uncoordinated manual weed clearing campaigns, ultimately fail because they lack the sustained civic ownership required for long-term success (Dersseh et al., 2022; Hanibal et al., 2020).

Unpacking the Attitude-Practice Gap: Insights from IRT

The psychometric evaluation of the community's Knowledge, Attitudes, and Practices (KAP) provides a precise diagnostic understanding of exactly where policy integration breaks down at the grassroots level. The data reveals a classic "attitude-practice gap": while the community holds highly positive attitudes toward collaborative environmental protection (M=2.40), their actual knowledge of regional policies (M=1.73) and their subsequent implementation of sustainable practices (M=1.94) remain critically constrained.

The application of Item Response Theory (IRT), specifically the Graded Response Model (GRM), adds crucial empirical nuance to this gap. The high discrimination parameters (alpha) across the attitude items indicate that the community is not monolithic or apathetic; they can sharply differentiate between effective, coordinated governance and disjointed, isolated interventions. For instance, community preference for "institutional coordination" yielded an exceptionally high discrimination value, proving that respondents possess a sophisticated understanding of what good governance should look like. Furthermore, the highly negative difficulty/threshold parameters (b) for endorsing active community participation suggest that it requires very little underlying persuasion for the community to want to be involved. Statistically, they are primed and ready to act.

Therefore, the deficit in the "practice" dimension is not rooted in a lack of community willingness, but rather in structural barriers imposed by a lack of knowledge and exclusionary governance. As Dunn (2018) articulates in the context of policy analysis, a non-integrated knowledge base severely weakens the effectiveness of policy integration, as stakeholders cannot act upon policies

they do not understand or from which they are structurally excluded. The severe knowledge gap regarding monitoring schemes (43% lacking knowledge) and institutional mandates (30% lacking knowledge) highlights the urgent need for targeted environmental education and communication. Bamberg et al. (2015) underscore that environmental education plays a vital role in shifting attitudes into concrete behaviors. Without state-sponsored mechanisms to translate the community's high pro-environmental attitudes into actionable, knowledge-based practices, the community remains trapped in a state of high willingness but low operational capacity (Reed, 2008; Salas-zapata et al., 2018).

Institutional Fragmentation and the Protector vs. Polluter Paradigm

The marginalization of the community is further compounded by the horizontal fragmentation of the state institutions themselves. Effective Environmental Policy Integration (EPI) requires that environmental objectives be prioritized across all government sectors. However, the qualitative and survey data indicate that Lake Tana is governed by a fragmented bureaucracy operating in silos.

As noted by Dejene and Cochrane (2019) and Bezabih (2009), government bureaus frequently operate with conflicting mandates. While the Lake Tana Protection Agency and the Environment Bureau are legally tasked with safeguarding the ecosystem, their efforts are routinely undermined by the Bureau of Agriculture (which promotes input-intensive farming that exacerbates nutrient runoff) and the Ministry of Water and Energy (which prioritizes hydroelectric outputs over ecological flow). This creates a toxic “Protector vs. Polluter” paradigm within the government itself.

When the state fails to integrate horizontally across its own ministries, the resulting policy chaos trickles down vertically, severely impacting the local community. For example, the qualitative data revealed that the eradication of native Dengel (papyrus) grass which historically served as a vital bio-filter and cultural resource was largely due to unregulated agricultural encroachment sanctioned by non-integrated land-use policies. Because government institutions prioritize sectoral economic growth without integrating ecological boundaries, the state fails to deploy a cohesive management plan. Consequently, the local community is left to navigate conflicting regulations, leading to the erosion of public trust and the acceleration of environmental degradation (Stave et al., 2017).

Theoretical Contributions to Environmental Policy Integration (EPI)

This study makes a significant theoretical contribution to the discourse on Environmental Policy Integration (EPI), particularly within the context of developing nations. Traditional EPI scholarship originating largely from European and Global North contexts has heavily conceptualized integration as an inter-ministerial or bureaucratic process. Frameworks by Lafferty and Hovden (2003) and Persson (2004) predominantly focus on the vertical integration of national policies to local agencies, and the horizontal integration across state sectors (e.g., aligning agriculture and environment ministries).

While Candel and Biesbroek's (2016) widely utilized framework outlines four critical dimensions of integration (policy frame, subsystem involvement, policy goals, and instruments), this study demonstrates that applying these dimensions strictly to formal state actors is fundamentally insufficient in contexts where institutional capacity is weak. By integrating the EPI framework with the psychometric KAP paradigm and social capital theory, this research advances a more inclusive theoretical model of policy integration.

Specifically, this study argues that "subsystem involvement" (Candel & Biesbroek, 2016) must be theoretically expanded beyond government ministries and formal NGOs to explicitly include the localized social capital of grassroots communities. In developing nations, the state frequently lacks the financial, technological, and infrastructural reach to enforce environmental regulations unilaterally (Tesfaye, 2023; Macpherson et al., 2018). Therefore, EPI cannot be achieved merely by harmonizing the legal texts of different administrative bureaus. True policy integration is a sociopolitical process that must actively bridge the attitude-practice gap at the community level.

By utilizing Item Response Theory (IRT) to quantify the precise cognitive and behavioral thresholds of community stakeholders, this study provides a novel methodological approach to diagnosing EPI failures. It proves empirically that policy integration fails not because the community rejects environmental goals (the policy frame), but because the state fails to deploy inclusive policy instruments that empower the community to act. Consequently, this study shifts the theoretical paradigm of EPI from a strictly bureaucratic alignment to a participatory co-management model, asserting that in resource-constrained environments, grassroots social capital is the most critical, yet systematically underutilized, instrument for environmental policy integration.

Conclusion and Policy Implications

Conclusion

The escalating environmental degradation of Lake Tana Ethiopia's largest freshwater ecosystem and a UNESCO Biosphere Reserve represents a critical failure of public policy implementation rather than a mere ecological inevitability. In summary, the environmental degradation of Lake Tana is inextricably linked to the systemic marginalization of its shoreline communities. The findings of this study unequivocally demonstrate that despite the existence of macro-level environmental policies, the failure to engage the immense social capital and pro-environmental attitudes of the local populace renders state interventions ineffective.

This study sought to unravel the complex dynamics of Environmental Policy Integration (EPI) in developing country contexts, specifically examining the disconnect between macro-level state mandates and micro-level grassroots realities. By triangulating quantitative psychometric data with qualitative stakeholder narratives, this research exposes a profound "paradox of conservation": a vast, untapped reservoir of community social capital is being systematically marginalized by a fragmented, top-down bureaucratic regime.

At the core of this physical degradation is a systemic administrative failure. While national frameworks like the Ethiopian Environmental Policy emphasize sustainable development, regional implementation is crippled by conflicting institutional mandates. Development-focused bureaus act as de facto polluters, overriding the conservation efforts of marginalized environmental agencies. More critically, this siloed approach has completely alienated the shoreline communities.

The psychometric assessment utilizing Item Response Theory (IRT) quantified a severe "attitude-practice gap" among the grassroots populace. Despite an overwhelming 93% of the community expressing a willingness to financially contribute to the lake's preservation demonstrating exceptional pro-environmental attitudes and immense social capital their actual practical engagement remains low. This deficit is not born of apathy, but of structural exclusion: 78% of the community reported never being consulted regarding environmental projects, resulting in a critical lack of knowledge regarding regional policies and monitoring schemes.

Ultimately, this study advances the theoretical conceptualization of Environmental Policy Integration in developing nations. It empirically demonstrates that EPI cannot be achieved solely through the bureaucratic alignment of government ministries. True policy integration requires participatory co-management. When state institutions bypass the social capital of local communities, conservation efforts become disjointed, reactionary, and fundamentally unsustainable.

Policy Implications

Overcoming the severe ecological challenges facing the basin requires an urgent departure from top-down, siloed administration. Policymakers must bridge the knowledge-practice gap by institutionalizing community participation, ensuring that local stakeholders are no longer treated as passive victims of ecological collapse, but are empowered as central architects in the integrated environmental governance of the Lake Tana Basin. Based on the empirical findings, the following actionable policy recommendations are proposed:

Institutionalize Community-Based Management and Co-Governance

The current top-down administrative structure must be reformed to integrate local stakeholders directly into the decision-making process. The government must formulate and operationalize joint committees or task forces at the kebele (local) level that include traditional leaders, fishermen cooperatives, and farming associations. By formally embedding these groups into the design and evaluation phases of environmental projects, policymakers can harness the 93% of the community willing to engage in conservation. Furthermore, traditional ecological knowledge must be recognized and codified into modern conservation strategies.

Overcome the Knowledge-Practice Gap through Targeted Education

To bridge the severe attitude-practice gap identified by the IRT analysis, regional bureaus must pivot from punitive, reactive measures to proactive capacity-building. Sustained public awareness and environmental education campaigns should be launched to translate the community's high positive attitudes into actionable practices. This includes integrating localized environmental education into school curricula and utilizing community platforms to disseminate clear, accessible information regarding regional environmental laws, land-use zoning, and invasive species management. Empowering the community with knowledge transforms them from passive subjects into active, informed stewards of the ecosystem.

Establish a Unified, Cross-Sectoral Policy Framework

To resolve the conflicting mandates between "protector" and "polluter" institutions, the Amhara National Regional State (ANRS) must establish a

legally binding, overarching framework for Lake Tana that supersedes isolated sectoral goals. The Lake Tana and Other Water Bodies Protection and Development Agency (LTWBPDA) must be elevated from a peripheral, underfunded office to a central coordinating authority with statutory power to veto agricultural, urban, or infrastructural projects that violate established ecological baselines. Environmental considerations must be systematically integrated into the planning and budgetary processes of all relevant sectors, including agriculture, energy, and tourism, ensuring that economic development does not cannibalize ecological survival.

Implement Ecosystem-Based Regulatory Enforcement

The lack of a well-defined legal boundary has allowed unregulated human activities to decimate the lake's shoreline. Policymakers must urgently draft and enforce specific legislation defining a protected buffer zone around Lake Tana. This requires allocating adequate financial resources and technical authority to enforcement agencies to halt illegal shoreline farming, unregulated urban waste discharge, and wetland encroachment. Furthermore, a robust, centralized monitoring, reporting, and verification (MRV) database must be established to evaluate the long-term effectiveness of conservation initiatives and adaptively manage emerging threats in partnership with the community.

References

Adom, R. K. (2024). An Assessment of the Implications of Deforestation and Climate Change on Rural Livelihood in Ghana: A Multidimensional Analysis and Solution-Based Approach. Environmental Management, 1124–1144 . https://doi.org/10.1007/s00267-024-02053-6

Amare, S., & Wubneh, B. (2017). Land Use Distribution and Change in Lake Tana Sub Basin. In Social and Ecological System Dynamics: Characteristics, Trends, and Integration in the Lake Tana Basin, Ethiopia (pp. 357–373). Springer. https://doi.org/10.1007/978-3-319-45755-0

Anderson, J. E. (2003). Public Policymaking: An Introduction (5th ed.). Nelson Education, Ltd.

Bamberg, S., Rees, J., & Seebauer, S. (2015). Collective climate action: Determinants of participation intention in community-based pro-environmental initiatives. Journal of Environmental Psychology, 43 (234), 155–165.

Bezabih, E. (2009). Socio-economics of biodiversity of lake tana basin ethiopia .

Bires, Z., & Raj, S. (2019). Determinants of environmental conservation in Lake Tana Biosphere Reserve, Ethiopia. Heliyon, 5 (2019). https://doi.org/10.1016/j.heliyon.2019.e01997

Birkland, T. A. (2011). An Introduction to the Policy Process: Theories, Concepts, and Models of Public Policy Making (3rd ed.). Routledge Taylor & Francis Group.

Bueren, E. van. (2019). Environmental policy. Britannica . https://www.britannica.com/topic/environmental-policy#ref314946

Candel, J. J. L., & Biesbroek, R. (2016). Toward a processual understanding of policy integration. Policy Sciences, 49 (3), 211–231. https://doi.org/10.1007/s11077-016-9248-y

Choudhary, M. P., & Chauhan, G. S. (2015). Environmental Degradation: Causes, Impacts and Mitigation. ResearchGate, July .

Cooley, H., Ajami, N., Ha, M. L., Srinivasan, V., Morrison, J., Donnelly, K., & Christian-Smith, J. (2014). Global water governance in the twenty-first century. The World's Water, 8 , 1–18.

Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). SAGE Publications, Inc.

Damtie, B., Boersma, E., & Stave, K. (2017). Introduction: Regional Challenges and Policy Questions. In K. Stave, G. Goraw, & A. Shimelis (Eds.), Social and Ecological System Dynamics Characteristics, Trends, and Integration in the Lake Tana Basin, Ethiopia (pp. 479–521). Springer. https://doi.org/10.1007/978-3-319-45755-0_28

Damtie, Y. A., & Mengistu, D. A. (2022). Water Hyacinth (Eichhornia crassipes (Mart.) Solms) Impacts on Land-Use Land-Cover Change Across Northeastern Lake Tana. Journal of the Indian Society of Remote Sensing, 50 (6), 975–986. https://doi.org/10.1007/s12524-022-01504-z

Dejen, E., Wassie, A., & Vijverberg, J. (2017). The Decline of the Lake Tana (Ethiopia) Fisheries: Causes and Possible Solutions. Land Degradation and Development, 28 (6), 1842–1851. https://doi.org/10.1002/ldr.2730

Dejene, M., & Cochrane, L. (2019). Policy Coherence and Social Protection in Ethiopia. Societies , 9(4), 1–15. https://doi.org/10.3390/soc9010019

Dersseh, M. G., Melesse, A. M., Tilahun, S. A., Abate, M., & Dagnew, D. C. (2019). Water hyacinth: Review of its impacts on hydrology and ecosystem services—Lessons for management of Lake Tana. In Extreme Hydrology and Climate Variability (Vol. 1824). Elsevier Inc. https://doi.org/10.1016/B978-0-12-815998-9.00019-1

Dersseh, M., Tilahun, S., Worqlul, A., Moges, M., Abebe, W., Mhiret, D., & Melesse, A. (2020). Spatial and Temporal Dynamics of Water Hyacinth and Its Linkage with Lake-Level Fluctuation: Lake Tana, a Sub-Humid Region of the Ethiopian Highlands. Water, 12 (1435), 1–15.

Dersseh, M. G., Steenhuis, T. S., Kibret, A. A., Eneyew, B. M., Kebedew, M. G., Zimale, F. A., ... & Tilahun, S. A. (2022). Water Quality Characteristics of a Water Hyacinth Infested Tropical Highland Lake: Lake Tana, Ethiopia. Frontiers in Water, 4 , 1–17. https://doi.org/10.3389/frwa.2022.774710

Desta, G., & Bantider, A. (2017). Inter-Institutional Strategy for Sustainable Development, Protection, and Utilization of the Lake Tana Sub-Basin and its Resources . Water and Land Resource Center.

Dunn, W. N. (2018). Public Policy Analysis: An Integrated Approach (6th ed.). Taylor & Francis.

Engdaw, F., Fetahi, T., & Kifle, D. (2024). Land use/land cover dynamics in the northern watershed of lake Tana: implications for water quality. Frontiers in Environmental Science, 12 , 1–17. https://doi.org/10.3389/fenvs.2024.1426789

EPA. (1997). Environmental Policy of Ethiopia . Environmental Protection Authority.

FDRE-HPR. (2000). Ethiopian Water Resources Management Proclamation - Proclamation No. 197/2000 . Federal Negarit Gazeta, 1250–1261.

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. Annual Review of Environment and Resources, 30 , 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Gerston, L. N. (2010). Public Policy Making Process and Principles (3rd ed.). Taylor & Francis Group.

Global Water Partnership. (2009). Global water security .

Hage, M., Leroy, P., & Petersen, A. C. (2010). Stakeholder participation in environmental knowledge production. Futures, 42 (3), 254–264. https://doi.org/10.1016/j.futures.2009.11.011

Hanibal, L., Frankl, A., Dessie, M., Poesen, J., Adgo, E., & Nyssen, J. (2020). Consolidated sediment budget of Lake Tana, Ethiopia (2012–2016). Geomorphology, 371 , 107434. https://doi.org/10.1016/j.geomorph.2020.107434

Hirpha, H. H., Mpandeli, S., Bantider Dagnew, A., Chibsa, T., & Abebe, C. (2021). Assessing the integration of climate change adaptation and mitigation into national development planning of Ethiopia. International

Journal of Climate Change Strategies and Management, 13 (3), 339–351. https://doi.org/10.1108/IJCCSM-07-2020-0082

Irahola, D. A., Mora-Motta, A., Barbosa Pereira, A., Bharati, L., Biber-Freudenberger, L., ... & Youkhana, E. (2022). Integrating scientific and local knowledge to address environmental conflicts: the role of academia. Human Ecology, 50 (5), 911–923. https://doi.org/10.1007/s10745-022-00344-2

Kalmbach, E. (2017). Establishment of the Lake Tana Biosphere Reserve within the UNESCO World Network of Biosphere Reserves. AESS Interdisciplinary Environmental Studies and Sciences Series , 523–544. https://doi.org/10.1007/978-3-319-45755-0_29

Keeley, J., & Scoones, I. (2000). Knowledge, Power and Politics: The Environmental Policy-Making Process in Ethiopia. The Journal of Modern African Studies, 38 (1), 89–120.

Lafferty, W., & Hovden, E. (2003). Environmental Policy Integration: Towards an Analytical Framework. Environmental Politics, 12 (3), 1–22. https://doi.org/10.1080/0964401041233130825 4

Liberatore, A. (1997). The integration of sustainable development objectives into EU policy-making: barriers and prospects. In The politics of sustainable development .

Lins, K. V., Servaes, H., & Tamayo, A. (2017). Social Capital, Trust, and Firm Performance: The Value of Corporate Social Responsibility during the Financial Crisis. Journal of Finance, 72 (4), 1785–1824. https://doi.org/10.1111/jofi.12505

Macpherson, E., Erin O'Donnell, Godden, L., & O'Neill, L. (2018). Lessons from Australian Water Reforms: Indigenous and Environmental Values in Market-Based Water Regulation. Reforming Water Law and Governance , 213–234. https://doi.org/10.1007/978-981-10-8977-0

Mccann, J. C. (2017). Bahir Dar and the Lake Tana Basin: Historical Phases of Growth and Ecology. Springer. https://doi.org/10.1007/978-3-319-45755-0

Nampak, H., Pradhan, B., Mojaddadi Rizeei, H., & Park, H. J. (2018). Assessment of land cover and land use change impact on soil loss in a tropical catchment by using multitemporal SPOT-5 satellite images and Revised Universal Soil Loss Equation model. Land Degradation and Development, 29 (10), 3440–3455. https://doi.org/10.1002/ldr.3112

Nanda, V. P., & Pring, G. (2013). International Environmental Law and Policy for the 21st Century (Vol. 9, 2nd Rev.). Martinus Nijhoff Publishers.

Nawaz, N. R., Bellerby, T., Sayed, M., & Elshamy, M. (2010). Blue Nile Runoff Sensitivity to Climate Change. Open Hydrology Journal, 4 (25), 137–151.

Nilsson, M., & Persson, Å. (2003). Framework for Analysing Environmental Policy Integration. Journal of Environmental Policy & Planning, 5 (4), 333–359. https://doi.org/10.1080/1523908032000171648

ORCD. (2018). Policy Coherence for Sustainable Development 2018: Towards Sustainable and Resilient Societies . OECD Publishing. https://doi.org/10.1787/9789264301061-en

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. Science, 325 (5939), 419–422. https://doi.org/10.1126/science.1172133

Persson, Å. (2004). Environmental Policy Integration: An Introduction . Policy and Institutions.

Poppe, L., Frankl, A., Poesen, J., Admasu, T., Dessie, M., Adgo, E., Deckers, J., & Nyssen, J. (2013). Geomorphology of the Lake Tana basin, Ethiopia. Journal of Maps, 9 (3), 431–437. https://doi.org/10.1080/17445647.2013.801000

Pretty, J., & Ward, H. (2001). Social capital and the environment. World Development, 29 (2), 209–227. https://doi.org/10.1016/S0305-750X(00)00098-X

PRI. (2005). Social Capital as a Public Policy Tool: Project Report . http://hdl.handle.net/1880/43196

Rathwell, K. J., & Armitage, D. (2015). Bridging knowledge systems to enhance governance of the environmental commons: A typology of settings. Ecology and Society, 19 (2).

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. Biological Conservation, 141 (10), 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

Runhaar, H., Driessen, P., & Uittenbroek, C. (2014). Towards a Systematic Framework for the Analysis of Environmental Policy Integration. Environmental Policy and Governance, 24 (4), 233–246. https://doi.org/10.1002/eet.1647

Salas-zapata, W. A., R, L. A., & Cardona-arias, J. A. (2018). Knowledge, Attitudes and Practices of Sustainability: Systematic Review 1990–2016. Journal of Teacher Education for Sustainability, 20 (1), 46–63. https://doi.org/10.2478/jtes-2018-0003

Sandström, A. (2008). Policy Networks . Luleå University of Technology.

Scrivens, K., & Smith, C. (2013). Four Interpretations of Social Capital: An Agenda for Measurement . OECD Statistics Working Papers, 6(55).

Seid, A., & Getenet, B. (2017). Exotic and Invasive Plants: Water Hyacinth. In Social and Ecological System Dynamics (pp. 257–279). Springer. https://doi.org/10.1007/978-3-319-45755-0_17

Setegn, S. G., Srinivasan, R., Dargahi, B., & Melesse, A. M. (2009). Spatial delineation of soil erosion vulnerability in the Lake Tana Basin, Ethiopia. Hydrological Processes, 23 (26), 3738–3750. https://doi.org/10.1002/hyp.7476

Solomon, A. (2017). Environmental Protection in the Lake Tana Basin. In K. Stave, G. Goraw, & A. Shimelis (Eds.), Social and Ecological System Dynamics: Characteristics, Trends, and Integration in the Lake Tana Basin, Ethiopia (pp. 433–452). Springer. https://doi.org/10.1007/978-3-319-45755-0_26

Stave, K., Goshu, G., & Aynalem, S. (2017). Social and Ecological System Dynamics Characteristics, Trends, and Integration in the Lake Tana Basin, Ethiopia . Springer.

Stave, K., & Kopainsky, B. (2017). System Dynamics as a Framework for Understanding Human—Environment Dynamics. In Social and Ecological System Dynamics (pp. 40–51). Springer. https://doi.org/10.1007/978-3-319-45755-0_3

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., ... & Porzecanski, A. L. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. Biological Conservation, 209 , 159–171. https://doi.org/10.1016/j.biocon.2017.02.008

Tabachnick, B. G., & Fidell, L. S. (2020). Using Multivariate Statistics (7th ed.). Pearson Education, Inc.

Tesfaye, A. (2023). Water Security Problems of Lake Tana and Its Possible Management Options: A Review. East African Journal of Environment and Natural Resources, 6 (1), 473–490. https://doi.org/10.37284/eajenr.6.1.1631

Tosun, J., & Lang, A. (2017). Policy integration: mapping the different concepts. Policy Studies, 38 (6), 553–570. https://doi.org/10.1080/01442872.2017.1339239

UN. (2015). The Millennium Development Goals Report 2015 . United Nations. https://doi.org/978-92-1-101320-7

UN. (2019). The Sustainable Development Goals Report 2019 . United Nations.

Underdal, A. (1980). Integrated marine policy. What? Why? How? Marine Policy, 4 (3), 159–169. https://doi.org/10.1016/0308-597X(80)90051-2

Vijverberg, J., Sibbing, F. A., & Dejen, E. (2009). Lake Tana: Source of the Blue Nile. Monographiae Biologicae, 89 , 163–192. https://doi.org/10.1007/978-1-4020-9726-3_9

Wang, J., & Wang, X. (2020). Structural Equation Modeling: Applications Using Mplus. In Routledge International Handbook of Advanced Quantitative Methods in Nursing Research . Wiley. https://doi.org/10.4324/9781315517971-24

Worklul, A., Dile, Y., Ayana, E., & Solomon Kibret. (2018). Soil erosion in Ethiopia- the story of Gilgel Abay delta . Global Coalition for Lake Tana Restoration.

Yamane, T. (1973). Statistics: An Introductory Analysis (3rd ed.). Harper and Row.