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When Does Traditional Ecological Knowledge Influence Ecosystem-based Adaptation? Evidence from Seven Villages in Southern Lao PDR

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Abstract

Ecosystem-based Adaptation is widely promoted across the Mekong region, and policy consistently endorses the use of local knowledge. Yet evidence rarely demonstrates whether Traditional Ecological Knowledge (TEK) shapes adaptation decisions. This study examined how TEK is integrated into EbA planning and practice in the Siphandone islands of Khong District, Champasack Province, Lao PDR. A qualitative comparative multiple-case design was applied to seven villages, organized into a Tourism-Heavy Cluster and a Remote, Dam-Impacted Border Cluster, drawing on seven village in-depth interviews, seven focus group discussions, three institutional key-informant interviews, structured field observation, and documentary review Integration was assessed against a decision-point standard, defined as the traceable influence of TEK on site selection, species choice, infrastructure design, enforcement, and monitoring. Three contributions follow. First, participants across all seven villages reported that ecological indicators long relied upon no longer correspond dependably to seasonal events, while those indicators retain cultural meaning, a condition termed here ecological disorientation, a concept developed in this study rather than an established category. Because the evidence rests on qualitative accounts rather than systematic ecological validation, this describes reported reliability, not measured predictive skill. Second, TEK influence was traceable in Fish Conservation Zone enforcement, strongest where formal no-take rules were reinforced by the moral sanction of Phid-Heet, and in riparian species selection and irrigation source management, but not in formal planning, budgeting, or monitoring indicator design; erosion pathways likewise diverged by cluster, indicating that uniform EbA packages fit this landscape poorly. Third, and theoretically, integration cannot be inferred from participation: it is observable only where knowledge demonstrably alters an identifiable decision. The study therefore offers TEK-EbA scholarship a transferable standard distinguishing consultation from influence, and evidence from an inland riverine setting under-represented in a literature dominated by coastal, Pacific-island, and upland cases. It concludes that TEK-EbA integration is feasible but conditional, depending on whether institutions permit local knowledge to change decisions rather than merely record it, and on solar-powered water riparian.

Keywords: Traditional Ecological Knowledge; Ecosystem-based Adaptation; Knowledge Co-production; Adaptive Governance; Climate ResilienceResilience

1. Introduction

Inland riverine landscapes of the Lower Mekong Basin are being reshaped by climate variability, transboundary hydrological change, fishery decline, and rapid livelihood transition. Basin-wide assessment projects average annual warming of 0.3 to 3.3 °C by 2060,

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alongside wide uncertainty in seasonal rainfall and river flow, and identifies communities dependent on the traditional bounty of the Mekong as those most exposed (Mekong River Commission, 2017). Hydropower operation compounds this exposure by altering flood pulses, sediment movement, water levels, and fish migration independently of season (Ly et al., 2023). In the Siphandone landscape of southern Lao PDR, communities dependent on fisheries, riverbank cultivation, and seasonal ecological signals face these pressures alongside dam-regulated discharge, expanding commercial tourism, and externally supported adaptation interventions.

Ecosystem-based Adaptation (EbA) is increasingly promoted as a response to such compound risk because it mobilises biodiversity and ecosystem services to reduce vulnerability while sustaining livelihoods (Munang et al., 2013; Vignola et al., 2009). To qualify as EbA rather than as relabelled conservation, an intervention must help people adapt to an identified climate hazard, actively use ecosystem services as the operative mechanism, and form part of a broader adaptation strategy spanning planning, financing, implementation, and monitoring (FEBA, 2017; UNEP, 2024). Siphandone is an appropriate setting in which to examine whether these requirements are met in practice. It is a 485 km² riverscape of channels, rapids, deep pools, and flooded forest that supports approximately 200 aquatic species and the livelihoods of more than 100,000 people, and it now hosts nearly 70 Fish Conservation Zones, flooded-forest management, fish-catch monitoring, and a multi-sectoral adaptation action plan (WWF-Laos, 2025).

Adaptation policy routinely endorses the participation of local communities and the use of Traditional Ecological Knowledge (TEK), understood as cumulative, place-based knowledge produced through long-term interaction with ecosystems (Berkes et al., 2000; Huntington, 2000). A persistent gap remains, however, between endorsement and evidence. Reviews of EbA practice show that indigenous and traditional knowledge is widely acknowledged yet frequently reduced to environmental information, with little demonstration that it altered project decisions (Nalau et al., 2018). Regional work approaches the same gap from the opposite direction, documenting that TEK is eroding under hydro-social rupture without establishing whether institutions absorbed it before its reliability weakened (Tran et al., 2025), while Lao evidence identifies an adaptation-response gap in which inherited knowledge supports seasonal planning but proves insufficient when events exceed historical experience (Phompila et al., 2025). The problem addressed here is therefore not the presence of TEK but its influence.

These three ideas are treated here as nested rather than parallel. TEK supplies the situated content: observations, indicators, and norms generated through long-term interaction with a specific river system (Berkes et al., 2000). Knowledge co-production specifies the process through which that content meets scientific and administrative knowledge on comparable terms (Lemos and Morehouse, 2005; Norström et al., 2020). Adaptive governance describes the institutional conditions, including polycentric authority, social learning, and responsiveness to ecological feedback, under which such processes can actually alter management (Folke, 2006; Folke et al., 2005). Integration is accordingly defined in this study as the incorporation of TEK into an adaptation process such that a decision is made differently than it otherwise would have been, and influence is the observable trace of that difference.

This definition rests on a graded distinction running from participation, meaning presence in a process, through consultation, meaning being asked, incorporation, meaning being recorded, and co-production, meaning jointly generating knowledge, to influence, meaning changing an outcome. Only the final step constitutes integration in the sense used here. The decision-point standard is the operational expression of that definition rather than an instrument devised for this case: the knowledge-to-action literature holds that knowledge becomes usable when institutions actively manage the boundary between knowledge and action, and that the test of such management is whether salient, credible, and legitimate knowledge demonstrably enters decisions (Cash et al., 2003; Reed et al., 2014). Applying the standard at five points, namely site selection, species choice, infrastructure design, enforcement, and monitoring, renders the presence or absence of that trace auditable.

Three further gaps sharpen this problem. First, EbA measures for inland freshwater systems remain less

developed than their coastal and forest counterparts, and Lao EbA research has concentrated on watershed-scale modelling rather than on the village-level decisions through which adaptation is actually delivered (Pal et al., 2025). Second, guidance holds that ecosystem knowledge should enter the adaptation cycle at risk assessment, prioritization, financing, implementation, and monitoring, yet monitoring systems in practice privilege output counts such as zones established or trees planted, which cannot reveal whether local knowledge informed design (Terton and Greenwalt, 2021). Third, environmental narratives in Lao PDR have at times rested on assumptions about local land use that field evidence subsequently contradicted, which underlines the risk of planning without grounded local observation (Lestrelin et al., 2012). Where communities are consulted but their observations do not alter design, adaptation risks reproducing top-down management under participatory language, forfeiting both technical fit and social legitimacy.

The significance of this study lies in converting a widely affirmed but weakly evidenced claim into a traceable account. Theoretically, it extends social-ecological systems and adaptive governance perspectives to an inland riverine-island setting that is under-represented in a literature dominated by coastal, Pacific-island, and upland cases (Folke et al., 2005; Ostrom, 2009). Conceptually, it shifts analytical attention from TEK presence to TEK influence by applying a decision-point standard consistent with knowledge co-production principles (Norström et al., 2020). Practically, it offers district and provincial planners cluster-differentiated evidence on where local knowledge already shapes adaptation and where it does not, and it supports monitoring frameworks that track knowledge integration rather than output delivery alone. These contributions are relevant beyond Siphandone to riverine adaptation across the wider Mekong Basin, where similar governance conditions apply.

This study tested the proposition that TEK-EbA integration is conditional rather than automatic, and that it can be observed only where local knowledge demonstrably changes specific adaptation decisions. Three questions guided the work: what forms of river-related TEK exist across the seven study villages and how are they changing; through which formal and informal processes is TEK integrated into EbA; and what institutional, socio-cultural, and governance conditions explain differences in integration between contrasting village clusters.

2. Materials and Methods

2.1 Population and sample group

A qualitative comparative multiple-case design was used, with the village as the unit of analysis and cross-case comparison as the analytical mechanism (Yin, 2018). The study population comprised seven villages in Khong District, Champasack Province, together with the district and project personnel responsible for adaptation programming in that landscape. Villages were selected through maximum-variation purposive sampling and organized into two analytical clusters. The Tourism-Heavy Cluster comprised Donedeth, Donekhone, and Donexom (546 households; 3,731 residents). The Remote, Dam-Impacted Border Cluster comprised Donephapheng, Hangsadam, Hangkhone, and DoneAn (279 households; 1,627 residents). The study began with tourism-connected villages and was deliberately expanded when early fieldwork produced thematically convergent but analytically narrow evidence. The 3:4 distribution was an outcome of that expansion rather than a predetermined quota. The three tourism-connected villages constitute the full set of settlements in the study area in which commercial riverfront tourism is the dominant livelihood influence, so the Tourism-Heavy Cluster could not be enlarged without diluting the defining cluster characteristic. On the remote, dam-affected side, cases were added sequentially until successive villages ceased to yield new analytical content: Donephapheng, Hangsadam, and Hangkhone converged on fishery decline and rule-based conservation, while DoneAn was retained as a fourth case because it presented a configuration absent from the preceding three, combining vegetation-based erosion control with constructed infrastructure. Sampling stopped at seven villages because further candidate cases replicated conditions already documented. Within each village, participants were purposively selected as information-rich cases (Creswell and Poth, 2017): elders, experienced fishers, and recognized socio-ecological memory holders for individual interviews, and active resource users including riverbank gardeners, farmers, and mixed-livelihood households for group

discussion. Sample size was determined by comparative case design and by thematic saturation rather than by a fixed numerical target, since the village constituted the case.

2.2 Instruments

Four instruments were applied, supported by documentary review. Two interview forms are distinguished throughout. In-depth interview (IDI) guides were used with village elders, experienced fishers, and recognized socio-ecological memory holders to elicit experiential, place-based knowledge of long-term ecological change, including fish abundance, flood timing, biological indicators, erosion, and the transmission of local knowledge. Key-informant interview (KII) guides were used with institutional actors, comprising one technical officer of the District Agriculture and Environment Office and two WWF-Laos project staff. They covered formal planning, project implementation, technical validation, policy constraints, and the institutional recognition of TEK. A focus group discussion (FGD) guide structured collective discussion of environmental change, livelihood adaptation, riparian restoration, Fish Conservation Zone governance, and perceived barriers to adaptation. A structured observation checklist recorded visible site conditions, including bank erosion, riparian vegetation, conservation zones, solar-powered water infrastructure, and cultivation plots. All guides were semi-structured, preserving comparability across cases while allowing locally specific issues to emerge, and were reviewed by the academic supervisor before deployment to confirm alignment with the research questions and conceptual framework.

2.3 Data collection

Fieldwork was conducted in April 2026 through coordinated village visits. Each visit opened with an introduction to village authorities, followed by one IDI and one FGD, structured non-participant observation, and informal site walks where appropriate. Each FGD comprised four to six participants. Institutional KIIs were scheduled separately, after the village rounds, to permit triangulation between community and institutional accounts. Fieldwork generated seven village IDIs, seven FGDs representing approximately 28 to 42 community participants, three institutional KIIs, observation records for all seven villages, and documentary material from project and district sources. Data were recorded through field notes, interview notes, discussion summaries, and audio recording where consent was granted. Participation was voluntary and informed consent was obtained; village and institutional identities are reported only at the level agreed with participants. Lao-language material was transcribed and translated as an analytical rather than a mechanical step, and terms whose meaning does not survive direct translation, notably Phid-Heet, Pa Khai, and Kai Nam, were retained in the original with explanation. All records were indexed by village, instrument, date, and participant category to support the audit trail.

2.4 Data analysis

Analysis followed a six-step qualitative procedure: organizing and preparing data; reading for general meaning; two-cycle coding, in which in-vivo coding preserved Lao ecological terms before deductive coding linked evidence to analytical concepts; generating themes; representing themes; and interpreting meaning. Coding and thematic analysis were conducted manually, using Excel-based analytical matrices rather than qualitative analysis software. such as NVivo or MAXQDA. Manual coding was adopted deliberately: the corpus was small enough to be managed without dedicated software, and the in-vivo retention of Lao ecological terminology required translation decisions to be weighed case by case rather than handled through automated text matching. The matrices were indexed by village, instrument, and analytical construct. so that coding remained consistent across cases and traceable to source material. Each village was first analyzed as a self-contained case. A structured cross-cluster stage then compared each analytical construct side by side across the two clusters, rating integration as strong, partial, or weak against the decision-point standard, and testing rival explanations before any comparative conclusion was retained. Because the study is qualitative, no statistical model, experimental blocking, or significance testing applies. Trustworthiness was addressed through triangulation across IDIs, FGDs, institutional KIIs, observation, and documents; thick description of each village context; and a coded audit trail linking raw evidence to themes. Reflexivity concerning the researcher's professional affiliation with a conservation organization was maintained by systematically comparing community and institutional

accounts and by retaining critical evidence of project implementation.

3. Results

Village-level results are summarized in Table 1, which rates each village first on perception of EbA-relevant knowledge and then on implementation of EbA measures.

Table 1. Village-level comparison of EbA perception and implementation across the seven study villages

Village	Cluster	Perception	Implementation	Dominant TEK forms	Key point
Donedeth	Tourism-Heavy	Moderate	Low	Fish habitat, riparian vegetation	Erosion recognised; uptake blocked by tourism and private land use
Donekhone	Tourism-Heavy	High	Moderate	Fish migration, seasonal cues	Active FCZ practice; constrained by hydrological uncertainty
Donexom	Tourism-Heavy	High	Moderate	Fish, riverbank vegetation	Clearest knowledge-to-action gap; weak activation
Donephapheng	Remote, Dam-Impacted	High	Moderate	Fishery, conservation TEK	FCZ management and riparian bylaws in place
Hangsadam	Remote, Dam-Impacted	High	Moderate	Fish conservation, livelihoods	Strongest rule orientation; pilot candidate
Hangkhone	Remote, Dam-Impacted	High	Moderate	Native vegetation, rice exchange	Practical adaptation; technical and resource limits
DoneAn	Remote, Dam-Impacted	High	High	Vegetation-based erosion control	Hybrid green-grey EbA; lead pilot candidate

Perception denotes recognition of EbA-relevant ecological knowledge; implementation denotes observed application of EbA measures. Ratings derive from thematic coding of IDI, FGD, and observation data, April 2026

3.1 TEK content and perceived change

TEK remained active in all seven villages but had lost predictive reliability. In DoneAn, participants reported that frog calls no longer announced the onset of rain; in Hangkhone, Maeng Nguang cicada calls and forest-mosquito abundance had lost seasonal precision; in Donekhone, rice transplanting had shifted later into July and August. Heat stress reached approximately 42 °C in Donephapheng. Indicators retained cultural meaning while their ecological correspondence weakened.

3.2 Erosion pathways

Erosion drivers differed systematically by cluster. In tourism-exposed villages, participants attributed bank instability to boat-wake waves, hotel backfilling, and riverfront development; field observation in Donexom recorded erosion extending approximately 20 meters inland near the temple road. In dam-affected villages, erosion was associated with regulated water-level fluctuation and the loss of Pa Khai flooded-forest habitat, with Hangkhone reporting comparable bank loss.

3.3 Fishery decline and Fish Conservation Zone governance

Catch decline was severe and multi-causal. Participants reported falls from approximately 10 kg to 2 kg per day in Donephapheng and from approximately 40 kg to 4 kg per day in Hangsadam. Alongside dam-regulated hydrology, respondents and the district informant identified electrofishing, improved gear, the Lee-trap fishery, and cross-border poaching. Fish Conservation Zone compliance was reported as strongest where formal no-take rules were reinforced by consecration ceremonies and by Phid-Heet, which frames violation as moral and spiritual transgression.

3.4 Infrastructure and TEK-based bio-engineering

Solar-powered water systems, micro-canals, and lined cultivation plots were operating in several villages, with groundwater-fed systems in Hangsadam and Donexom and river-fed systems elsewhere. Respondents linked effectiveness to water-source conditions and to the use of native riparian species, including Kai Nam, Lao Luang, bamboo, and Phak Bong Nam, for bank stabilization. Empirical exemplars underlying Sections 3.3 and 3.4 are summarized in Table 2.

Table 2. Empirical exemplars of fishery decline, Fish Conservation Zone governance, and infrastructure-TEK interaction (Sections 3.3 and 3.4)

Theme	Village or site	Cluster	Reported evidence	Attributed driver or mechanism
Fishery decline	Donephapheng	Remote, Dam-Impacted	Daily catch reported to have fallen from approximately 10 kg to 2 kg	Dam-regulated hydrology acting alongside local harvesting pressure
Fishery decline	Hangsadam	Remote, Dam-Impacted	Daily catch reported to have fallen from approximately 40 kg to 4 kg	Dam-regulated hydrology acting alongside local harvesting pressure
Harvesting pressure	Across study villages	Both clusters	Electrofishing, improved gear, the Lee-trap fishery, and cross-border poaching identified by respondents and the district informant	Decline is multi-causal and extends beyond upstream hydrology
FCZ compliance	Villages with active conservation zones	Both clusters	Compliance reported as strongest where formal no-take rules were reinforced by consecration ceremonies and by Phid-Heet	Cultural sanction reinforcing formal rule; violation framed as moral and spiritual transgression
Water source	Hangsadam; Donexom	Remote, Dam-Impacted; Tourism-Heavy	Solar-powered water systems drawing on groundwater, with micro-canals and lined cultivation plots	Effectiveness linked by respondents to water-source conditions
Water source	Remaining villages with systems in operation	Both clusters	Solar-powered water systems drawing on river water	Effectiveness linked by respondents to water-source conditions
Bank stabilization	Across study villages	Both clusters	Use of native riparian species, including Kai Nam, Lao Luang, bamboo, and Phak Bong Nam	TEK-based species selection applied to riparian bio-engineering

Entries summarize accounts reported in Sections 3.3 and 3.4 and derive from IDI, FGD, institutional KII, and observation data, April 2026. Quantities are as reported by participants and were not independently measured. No verbatim interview extracts are reproduced.

3.5 Decision-point integration

Traceable TEK influence was concentrated in Fish Conservation Zone enforcement, riparian species selection, and irrigation source management. Institutional respondents described established participatory mechanisms, including free, prior and informed consent, community climate-vulnerability assessment, and participatory assessment. No evidence was found, however, that TEK altered final technical design, budget allocation, or monitoring indicator selection.

4. Discussion

That indicators remain culturally meaningful while losing predictive accuracy supports interpreting TEK as social-ecological memory rather than fixed information (Berkes et al., 2000; Ostrom, 2009). Programmes that document indicators without testing whether their ecological correspondence still holds risk preserving the form of local knowledge while losing its function. This is consistent with evidence that local knowledge erodes under hydro-social rupture (Tran et al., 2025) and extends it by showing that loss of reliability can precede loss of transmission.

Erosion pathways diverged by cluster, indicating that uniform EbA packages are poorly suited to this landscape: degradation driven by tourism infrastructure and private riverfront development requires different ecological and governance responses from degradation driven by regulated discharge and habitat loss. This supports guidance that EbA be targeted and embedded in a wider adaptation strategy rather than applied as a standard menu (FEBA, 2017; Terton and Greenwalt, 2021) and provides an empirical basis for cluster-differentiated planning.

The clearest theoretical contribution concerns the difference between consultation and integration. Participatory mechanisms were present in the district project cycle, yet TEK influence stopped short of design, budget, and monitoring decisions. Read through knowledge co-production, integration cannot be inferred from participation; it must be demonstrated at identifiable decision points (Norström et al., 2020). This addresses the concern that adaptation literature praises local knowledge without tracing its institutional uptake (Huntington, 2000; Nalau et al., 2018) and offers a transferable standard for assessing whether integration has occurred.

Phid-Heet indicates that TEK carries normative and institutional resources, not only ecological content: where formal rules were reinforced by cultural sanction, compliance was reported as stronger, consistent with adaptive governance accounts of polycentric enforcement (Folke et al., 2005). The claim is bounded. Cultural governance depends on shared belief, weakens under acute livelihood pressure, and can also constrain adaptation, as where taboo discourages planting of species.

Finally, high perception alongside lagging implementation reframes the operational problem: the constraint is not absent knowledge or absent participation channels, but absent pathways carrying knowledge into resource decisions. Attributing fisheries decline solely to upstream hydrology would likewise overstate a single driver, since local harvesting pressures act alongside regulated discharge.

Institutionalizing a decision-point standard need not require a new monitoring system. Three low-cost adjustments would fit existing district practice. First, the participatory assessments already conducted under free, prior and informed consent could close with a short written record naming which local observations were adopted, which were set aside, and on what technical grounds, appended to documentation that district staff already produce. Second, the annual village development planning cycle provides an existing decision point at which that record can be read into budget deliberation, so that knowledge enters where allocation is decided rather than after design is fixed. Third, existing output indicators could carry one qualitative field recording whether local knowledge altered siting, species choice, or scheduling, which converts a count into a traceable claim without introducing a separate reporting instrument (Terton and Greenwalt, 2021). Each measure attaches to a process already in place, so the additional administrative cost falls on documentation rather than on new data collection. The binding constraint is likely to be technical validation

capacity rather than paperwork, since setting aside a local observation requires a stated reason.

5. Conclusion

Local ecological knowledge in these seven river communities has not disappeared, but the natural signs people once relied on to predict seasons, floods, and fish movements no longer behave as they did. The knowledge remains meaningful, while its practical reliability has weakened. At the same time, community awareness of how healthy river systems protect livelihoods is high, yet action on the ground lags behind that awareness in almost every village studied.

Local knowledge shapes adaptation most clearly where communities enforce their own fishing rules, choose which riverbank plants to grow, and decide how to manage water for gardens and fields. It has far less influence over formal plans, budgets, and the indicators used to judge whether a project has succeeded. Adaptation efforts in this landscape are therefore workable but conditional, and they depend on whether institutions allow community knowledge to change decisions rather than simply record it.

Two implications follow for practice in similar river settings. Adaptation support should be designed differently for communities facing tourism pressure than for those facing dam-related change, because the causes of damage differ. And community knowledge, together with the customary and spiritual practices that give local rules their authority, should be built into planning and monitoring from the outset, including through village pilots and local school teaching, so that knowledge is carried forward rather than gradually lost.

Taken together, these implications point to a single integrated socio-cultural approach rather than a set of separate measures. Built infrastructure such as solar-powered water systems, planting with native riverbank species, and the customary rules that give local decisions their authority are most effective when designed as one package: infrastructure supplies water when seasonal signs no longer give reliable warning, native vegetation stabilises the banks on which that infrastructure depends, and cultural governance provides the everyday compliance that neither engineering nor formal regulation secures on its own. Combining the three is the approach this study proposes for the Siphandone landscape, and it is the form of support most likely to endure once external projects end.

6. Conflict of Interest

The author certifies that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript. The author is employed by WWF-Laos, which supports adaptation programming in the study landscape; this affiliation is disclosed in the Materials and Methods section and was addressed through reflexive comparison of community and institutional accounts.

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