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Adaptive self-organization in swidden agriculture

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ABSTRACT

More than forty years ago, Michael Dove (1983) traced persistent myths about swidden agriculture to a "political economy of ignorance." A polarization of "good" and "bad" perceptions of swidden was sustained, he argued, because it served the interests of the powerful, and it remains entrenched today even as theory, methods, and data have improved markedly. This essay argues that a second, epistemological problem may contribute to the persistence of these myths: the dominant epistemological approaches to swidden research talk past one another. First, drawing on Barker and Fraser's (2023) concept of the "unraveled rope," I examine the argument structure of three swidden case studies spanning distinct disciplines and opposing normative poles. In each, the empirical work is sound, but argument defects exist: the conclusion misrelates the evidence to undefended value premises, overstating what the data can support about whether swidden is good or bad for the forest. Second, I conduct a targeted review of the swidden scholarship that shows how this polarization may reflect a deeper disjuncture between top-down and bottom-up research traditions, neither of which fully explains how small-scale societies shape large-scale forests. Third, I propose adaptive self-organization as an integrative framework connecting community-level decisions to emergent, landscape-scale dynamics. Synthesizing two decades of my own research, I

> *organizing coupled human-nature system and offers an epistemological counterpart to the political economy of ignorance Dove diagnosed a generation ago.*

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Introduction

Swidden agriculture involves an annual pattern of forest clearing, burning, cultivation, harvesting, and planting, followed by longer fallow periods when natural ecosystem processes restore above-ground biomass, species diversity, and soil fertility. It is best understood as a socioecological prototype that takes many forms in different parts of the world and throughout the entirety of the last 10,000 years of human history. Many renowned anthropologists have studied swidden, including Harold Conklin (1957), Clifford Geertz (1963), Michael Dove (1983, 2015), William Balée (2013), and James Scott (2009). Even Carl Linnaeus, the inventor of the modern system of scientific taxonomy, studied swidden in subarctic Sweden (Linnaeus, 1775, cited in Dove, 2015). A common thread in this scientific literature is that "swidden-is-good" for the forest – that is, it can be practiced sustainably, and, under some circumstances, it can sustain human populations without degrading the environment. In recent years, appreciation for swidden's resilience and adaptive capacity has grown, and there is growing appreciation for its importance in conservation (Ziegler, 2011). But when it comes to swidden, the elephant in the room is *slash-and-burn* – a dysphemism (negative epithet) reflecting the widely-held perception that "swidden-is-bad" for the forest. This bias persists both in society-at-large (e.g., New York Times, 1990), and applied fields like environmental conservation, rural development, and climate change policy (REDD+).

In the 1983 article, "Theories of swidden agriculture, and the political economy of ignorance," Michael Dove debunks several myths that appeared in both scientific discourses and in society-at-large about the communities that use swidden. These persistent misunderstandings incorrectly assume that swidden communities own land communally, waste environmental resources, and remain isolated from regional, national, and global economies and trade networks. Dove argued against each of them in turn and suggested that their persistence in science and society was likely because they supported the interests of groups with the most political and economic capital, at the expense of those without – the

swidden cultivators themselves (Dove, 1983). Despite some improvement, the situation remains largely the same a generation later. While powerful political interests undoubtedly remain a critical factor, global climate concerns are arguably worse, and theory, methods, and data available to swidden scholars have improved markedly. Given this, why would the polarization in discourses surrounding swidden continue to persist, and why has scientific research failed to provide an alternative to a polarized debate where both sides appear to talk past each other? Here, I explore whether the historical production of research shaped and sustained the ongoing polarization of swidden in science. For the purposes of this essay, I will set aside Dove's insight about the political ecology of swidden agriculture and focus on the question of its epistemological foundations; specifically, whether any *normative values* about swidden are properly related to *empirical claims* in publications about swidden.

The article proceeds as follows: Section 2 uses a logic-based method from philosophy to diagnose whether normative bias undermines a study's scientific integrity using *argument analysis*, which breaks arguments into their explicit empirical premises and value premises and tests whether its conclusions logically follow (Barker & Fraser, 2023). Due to the detailed nature of argument analyses, I selected three case studies spanning normative poles, and across three disciplines: history, remote sensing, and anthropology. To foreshadow the results, the section identifies the possibility of normative bias across perspectives and disciplines, and the section ends by proposing the question explored in the following sections: *Did the normative polarization of swidden studies result from the historical absence of theoretical models that could explain how small-scale societies consisting of tens or hundreds of people could sustainably interact with or "manage" (sensu lato) large-scale natural environments?*

The literature on swidden is vast; it spans many disciplines, and there is a recent bibliometric review (Li & Nath, 2024). Given this, the goal of Section 3 is to identify key themes and theoretical tensions using a "top-down/bottom-up" framework. Top-down swidden studies are defined as using demographic, technological, or spatial models and/or theoretical frameworks and a more deductive approach to analyze empirical patterns using generalizable laws or principles. In contrast, bottom-up studies are defined as using a more inductive approach involving fine-grained and contextual data to identify causal mechanisms, typically in localized contexts. Like most classification systems, any one study is unlikely to map perfectly to either category, and of course, other classification schemes could also be used: logical form(s) (inductive, abductive, and/or deductive), geographic region, temporal period, or academic discipline. However, this top-down/bottom-up review framework appears to highlight a

previously unidentified epistemological disjuncture that may contribute to the persistence of normative polarization in swidden studies.

Building on this observation, Section 4 proposes that the concept of *adaptive self-organization* may provide an alternative to top-down and bottom-up approaches. Adaptive self-organization predicts that low-level interactions may relate to higher-order emergent properties of coupled human-nature systems. The mathematical rules governing the dynamics of complex adaptive systems were discovered in the last decades of the 20^th^century (Bak et al., 1987; May, 1976), and J. Stephen Lansing subsequently introduced the concept of complex adaptive systems to anthropology (Lansing, 2003). This section begins with a summary of general principles and a concise framework for studying Adaptive Self-Organization (ASO) in swidden agriculture. I then synthesize over a decade of my own research into adaptive self-organizing swidden that provides preliminary support for this approach.

In the conclusion, I return to the questions raised here in the introduction and briefly discuss whether adaptive self-organization is just a different model of swidden, or whether it can help overcome the epistemological limitations that may have characterized previous swidden research.

Identifying normative bias in swidden scholarship

Recently, philosopher Matthew Barker and biologist Dylan Fraser (2023) identified a previously unrecognized problem in conservation research regarding faulty argumentation. In this section, I explore whether this problem extends to the literature on swidden agriculture. They defined the *unraveled rope problem* as a class of scientific arguments about conservation that are structurally flawed because they define fallacious relationships between empirical results and the normative values and premises that underlie their conclusions. They write,

> "...just as strands of rope must be properly and intricately wound with each other so that the rope supports its load, empirical aspects and value aspects of an argument must relate intricately and properly if the argument is to support its conclusion."

When I first read this paper, I became intrigued to apply its approach to swidden research because one of the examples the authors use to illustrate the unraveled rope problem involves agriculture and forest biodiversity (Vellend et al., 2007; Vellend, 2019). I will paraphrase Barker and Fraser's (2023) summary here: The original study (Vellend, 2007) analyzed the effect of historic-period agricultural land use on beta diversity in eleven forest landscapes in north-eastern North America and Europe. It found a pattern of landscape homogenization in forest

plant communities and a reduction of beta diversity among recent forest patches, when compared to older growth forest patches. The paper drew scholarly attention and was cited to support the claim that agriculture diminishes forest biodiversity at landscape scale. However, in a later reflection (2019), Vellend reflected on this use of his work and observed that subsequent studies often drew broader conclusions from his earlier work than what his original 2007 study design would actually support. The study compared the beta diversity among forest patches between two classes (recent- and old-growth forest), yet the argument was extended to make a claim that agriculture reduced diversity at the landscape scale (gamma diversity). Not only is this claim unsupported by the original research design, Vellend noted that this landscape perspective may actually support *theopposite* conclusion because a landscape containing both ancient and recent forest patches may therefore be more heterogeneous and biodiverse than a landscape containing only ancient or recent forest separately (see Barker & Fraser, 2023, Figure 2).

Barker and Fraser suggest that the reason the research community inappropriately extrapolated the conclusions of the 2007 study was because they likely held an unconscious normative bias that "humans are bad for nature" and they labeled this family of defects in scientific argumentation *ironic community bias*. it is defined as a normative bias in a research community that carries conclusions beyond what individual studies establish, without any explicit argument supporting a broader claim, and in the opposite direction (hence, *ironic*). In addition to ironic community bias, Barker and Fraser identified five other families of argument defects, which for the sake of brevity are summarized in the first column of Table 1. Vellend et al. (2007) is concerned with the effects of historical-period field agriculture on forest diversity in temperate ecotones; therefore, its stated conclusions at the between-patch level do not directly extend to swidden forests. However, the study's argument structure, argument defects, and substantive conclusions about the relationship between patch-level field observations and landscape biodiversity are recognizable in swidden scholarship.

The three case study analyses that follow are intended to identify the unraveled rope problem in swidden research and to identify some of its characteristics. The first article by David Henley (2011) is a historical study using mostly qualitative methods, drawing on colonial-era records and first-person reports from Dutch officers of small-scale swidden agriculture in 18^th^ century Sulawesi. Molinario et al. (2015) use remote sensing classifications and fragmentation analysis to map modern cultivation patterns across the Democratic Republic of Congo, to characterize the effects of swidden on core forested areas. And Ross (2011) is a quantitative study in historical ecology and archaeology that uses modern forest surveys to test how ancient Maya land use practices affect modern forest biodiversity. Taken together, these articles illustrate top-down and bottom-up approaches to swidden research: Molinario et al.'s (2015) use of remote sensing is

an example of a top-down approach; Henley (2011) uses detailed first-person historical accounts, illustrating a bottom-up approach; and Ross' (2011) use of detailed archaeological settlement maps as a sampling framework also illustrates a bottom-up approach. With respect to normative premises, Ross (2011) represents swidden-is-good, while Henley (2015) and Molinario et al. (2015) represent swidden-is-bad. These studies were specifically chosen because the structures of their arguments are sufficiently transparent to permit close analysis, and because they represent distinct disciplines, methodologies, and different normative premises.

Detailed argument analyses for each of the case studies are presented in turn and then synthesized at the end of the section. For each study, an analytic summary and assessment of the risk of each argument defect family is presented in Table 1.

Table 1. *Summaries of argument analysis of three swidden case studies from history, remote sensing, and anthropology. Empirical and value premises are labeled A1, A2, B1, etc.. Evaluation criteria: "Present" means the defect is clearly identifiable in the argument structure and materially weakens support for the conclusion. "Risk" means that the defect is not fully realized but the argument structure creates conditions under which it is likely to be read as committing it; "Absent" means that the argument handles this dimension adequately (not observed).*

Analytic summary and defect families (Barker and Fraser 2023)	"Swidden Farming as an Agent of Environmental Change: Ecological Myth and Historical Reality in Indonesia" (Henley 2011)	"Forest cover dynamics of shifting cultivation in the Democratic Republic of Congo: a remote sensing-based assessment for 2000–2010" (Molinario, Hansen, and Potapov 2015)	"Modern tree species composition reflects ancient Maya 'forest gardens'" (Ross 2011)

Analytic Summary – an overview of the main argument in the study, including how the value and empirical premises relate to and support the conclusion. Presented in modus ponens form where variables P and Q represent value and empirical premise:	Swidden conservation incompatibility argument	Swidden forest-perforation argument	Forest-garden conservation argument
A. If P then Q B. P. ("therefore") C. Q.	A. If traditional swidden farming (1) relied on short fallow cycles under conditions of low population density and abundant land, and (2) it permanently replaced natural tropical forest with lower-diversity anthropogenic vegetation, then traditional swidden farming is fundamentally incompatible with nature conservation. B. Traditional swidden farming in northern Sulawesi (1820–1950) relied on short fallow cycles (avg. 5–6 years) for this entire period; population pressure started low during this period and increased without causing a change in fallow cycle duration; and Dutch officers observed that natural tropical forest was replaced with lower-diversity anthropogenic vegetation. - C. Traditional swidden farming is fundamentally incompatible with nature conservation.	A. If (1) primary forest core areas have special ecological value, (2) agricultural clearing expands beyond established agricultural complexes, and (3) "Wall-to-wall" remote sensing observations can substitute for local qualitative knowledge in assessing the dynamics of shifting agriculture at national scale, then this constitutes a conservation concern requiring management intervention. B. Between 2000–2010, remote sensing documents forest cover loss expansion in the DRC beyond established agricultural areas: rural complexes grew 10.2%, perforated forests grew 74.4%, and core forest declined 3.8%. C. Forest perforation growth in the DRC constitutes a conservation concern requiring management intervention.	A. If (1) ancient agricultural practices increase the abundance of economically useful species, (2) modern forest composition bears a detectable signature of these practices, then conservation programs should incorporate social-ecological history. B. At El Pilar, economically useful species are more abundant in areas with high density archaeological settlement, and less abundant in areas will low density archaeological settlement. C. Mesoamerican conservation programs should incorporate social-ecological history including areas with evidence of ancient agricultural practices.

Is–ought fallacy — when an argument extends an inference from only descriptive content to value-laden normative content.	**Present** — The conclusion that swidden must be treated as a deforestation agent incompatible with conservation (C) is presented as following from the empirical findings (B) in the study, but this logical jump is not supported without first accepting the non-equivalence of sustainability and conservation, and the greater importance of conservation over agriculture, neither of which are adequately defended.	**Present** — The paper moves from empirical remote sensing analysis (A3) to normative concerns about conservation (A1) without explicit bridge premises; the analysis cannot distinguish between proximate drivers of land cover change (clearing for household demand) and ultimate drivers (conflict forcing households to migrate), inserting a layer of normative inference between observing forest loss in satellite images and concluding the need for policy regulating shifting agriculture.	**Risk** — The conclusion moves from observing a forest composition difference between ancient settlement zones to a conservation mandate without an explicit bridging premise; not fully present because the argument is built on the normative premise (A) that human well-being is dependent on biodiversity preservation, but the supporting argument for this claim is thin relative to the empirical case (B).
Derelict normative premises — when normative premises that are required for argument to be deductively valid are in fact absent.	**Present** — Premise A1 is stated in one sentence without sub-argument or engagement with competing frameworks; Premise A2 is never acknowledged despite doing essential work to support conclusion C.	**Present** — At least three normative premises related to "swidden is bad" are implicit and insufficiently defended: that all core forest fragmentation is destructive (A1); that national-scale remote sensing is sufficient for forest management (A3); and forest carbon accounting (REDD+) is a locally-appropriate policy objective.	**Present** — The value-laden premise (A1) is asserted, not argued. The load-bearing premise that a shift toward human-useful species at equal overall diversity counts as a conservation benefit is never defended, even though it is the most contestable step linking the data to the policy conclusion.

Ironic community bias — when bias manifests at the level of the research community, rather than at the level of an individual study; also, when results from an individual study do not support or in some cases even support a conclusion opposite to a community's views.	**Present** — Author diagnoses idealist bias in the "swidden is good" literature, then reproduces a mirror-image "swidden is bad" normative prior without seriously considering alternatives; Map 3 may constitute a Vellend-style patch/landscape scale inference mismatch, and description of water buffalo-pastoralism references integral logic and both could support alternative swidden-is-good interpretations. Additionally, uncritical use of colonial-period observations may amplify observer bias into community bias.	**Present** — Author cites evidence on conflict-driven displacement in DRC affecting shifting cultivators, yet the results of the analysis are not considered under this alternative causal driver, which could provide a different, and potentially the opposite, conclusion. The paper cites "swidden-is-good" literature but then does not consider it seriously and instead filters the classification results through a "swidden-is-bad" normative prior.	**Present** — Literature review is heavily weighted toward swidden-is-good normative prior, without even treatment of swidden-is-bad. A swidden-is-good variant of the Vellend-style patch/landscape scale inference mismatch exists: While the "humans are good for the forest" prior may have made a landscape-scale analysis seem unnecessary, a combined-mosaic (gamma-scale) analysis could have lent the conservation claim additional support for higher biodiversity rather than equal diversity but it was never undertaken; or alternatively, it could have shown that the abundance increases in high-density areas were statistically insignificant at larger scales of analysis.

Action argument conflation — when an argument improperly conflates the roles played by probabilities of possible outcomes with the magnitudes of value those outcomes would have.	**Risk** — The evidence for forest-grassland conversion in the Poso region is assigned disproportionate weight relative to its geographic extent, and the scope of the conclusions.	**Present** — The paper conflates two distinct probability-magnitude questions: the probability that observed clearings represent permanent conversion versus cyclical swidden disturbance, and the probability that shifting cultivators, rather than conflict, mining, or logging, are the agent responsible for the observed spatial pattern. Both are unresolved by the data and methodology analysis, yet the policy recommendation treats both as settled.	**Risk** — Regional policy is recommended without assessing the probability that the El Pilar pattern generalizes across Mesoamerica, or the value magnitude of forest-garden knowledge relative to alternative conservation strategies; the probability–magnitude structure of the action claim is unexamined.

Value unclarity due to language — when key terms blend empirical and normative meanings without acknowledgement, allowing normative content to enter and guide the argument.	**Present** — The paper uses the terms "monotonous", "scholarly amnesia," "permanent deforestation," "traditional," "fundamentally incompatible," "itinerant" and "destruction" which carry hidden normative meanings that obscure the argument's inferential structure.	**Present** — Terms used encode a "swidden-is-bad" normative prior: "shifting agriculture" (which implies itinerant), "carving fields out of forest," "impacts," "wall-to-wall coverage" (used to dismiss the importance of localized qualitative data), "abandonment," and "forest cover loss" (versus the terms 'change' or 'dynamics' that are used in the title). The choice to label forest clearings and as "forest cover loss" in Figures 1, 5 and 7 and the phrase "of particular concern" in the abstract all indicate the language unclarity and the potential for blending values and empiricism.	**Present** — Key terms carry undeclared normative loading: "forest garden" (the swidden-is-good normative inverse of "slash-and-burn"), the terms "mature forest" and "functional equivalent of old-growth" are applied despite acknowledging selective logging; and, forest existing in "intimate association with humans" conveying an emotional relationship.

Value unclarity due to logic — when unaddressed logical implications of the argument logically imply value-laden conclusions that are never stated, clarified, or related back to the empirical premises that are supposed to support them.	**Present** — The non-equivalence of sustainable swidden and conservation (P1) does not logically entail the conclusion of fundamental incompatibility (C) (e.g., due to ironic community bias), but the argument treats it as if it does.	**Present** — Research questions embed both the normative conclusion about policy implications and the undefended causal attribution to shifting cultivators (ignoring proximate/ultimate distinctions). Also, research results are presented in Introduction section ("However, we show...)" signaling circular logic (results motivating research questions that generated those results...), also indicating that values may be driving argument form.	**Present** — The argument carries a value-laden conclusion that it never states or connects to its premises. By treating the compositional difference between settlement zones as conservation-relevant, the paper implies that a forest reshaped toward human-useful species is as much or more worth conserving than one that is not. This is a judgment about the purpose of conservation, and it follows from the argument even though it is never made explicit or related back to the empirical findings that are supposed to support it.

Case study #1: Henley (2011)

Swidden Farming as an Agent of Environmental Change by David Henley (2011) is described as a direct challenge to the proposition that swidden farming is ecologically benign. The study analyzes an original dataset of Dutch colonial records from northern Sulawesi (1820–1950), and it tests the hypothesis that swidden fallow periods should be long (and therefore sustainable) when demographic pressure is low, and land is abundant. First, the author uses a dataset of 41 archival observations of fallow cycle durations to calculate an average interval of 5–6 years. He assesses this as inadequate for complete forest recovery, especially under the low demographic pressure that characterized Sulawesi during this period. Second, he reports historical accounts of vegetation and forest cover from colonial sources (e.g., "monotonous"[1] to support the claim that swidden permanently replaced natural tropical forest with lower-diversity anthropogenic vegetation. Third, he argues that the combination of swidden and

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semi-domesticated water buffalo pastoralism produced irreversible fire-climax grasslands due to intensive land use. Ultimately, based on the evidence and analyses, the author concludes that swidden farming is fundamentally incompatible with nature conservation, and that conservation policy must abandon the "ecologically noble savage" narrative.[2] The article is rich with unique historical data from the Dutch colonial period, clearly written, and an important contribution to swidden scholarship. However, an argument analysis suggests several shortcomings related in particular to derelict normative premises and ironic community bias.

Critically, the paper's conclusion rests on an undefended definitional claim that conservation *requires* the preservation of intact natural forest: agriculture, no matter the level, intensity, or manner it is conducted, cannot coexist with conservation. This is an instantiation of the *swidden-is-bad* normative premise, and it is derelict because it is stated but is never defended or supported, and alternatives to it are never considered. For example, after presenting the primary archival evidence of short fallow cycles and forest degradation, the author writes,

> "During the pre-colonial and colonial periods, the fact that the population was still small by modern standards meant that the proportion of the total natural forest cover lost to swidden cultivation (and other human land uses) was still limited: just over a quarter in 1941. Map 3 shows the approximate distribution of the deforested areas around that date. It is also true that even within the populated enclaves, small areas of permanent semi-natural forest were sometimes preserved for ritual purposes or as timber reserves. Nevertheless, traditional swidden farming practices in northern Sulawesi clearly did not involve any kind of symbiosis with the natural forest. On the contrary, they involved the destruction of that forest and its replacement by completely different, man-made ecosystems that were much less rich and diverse."[3]

This conclusion that *swidden was not symbiotic* is derelict because the data premises provided by Dutch historical records, although novel and unique, are sparse and potentially subject to observer bias. The author's observation that the population was small compared to the total amount of land available is presented as inconsequential to the larger argument, and there is no mention at all of successional dynamics, community ecology, or the role of disturbance, which are all reasonable considerations for a more even-handed assessment of symbiosis.

2. See (Hames, 2007) for a comprehensive review of the "ecologically noble savage" debate.
3. Page 540.

Therefore, the conclusions rest more heavily on an unstated and undefended premise, *swidden-is-bad*.

The omission of evaluating his own data under alternative normative premises reveals additional argument defects. While evidence of short fallow cycles under conditions of low population density and ample land may appear dispositive under the *swidden-is-bad* premise, interpreting the same evidence under *swidden-is-good* exposes a case for ironic community bias.It operates at two levels: First, a Vellend-style scale mismatch is evident. Henley's archival observations are recorded at the ecological patch level (specific villages and sub-districts) while the paper's own regional maps (Maps 2 and 3) show that large portions of northern Sulawesi remained uninhabited or forested throughout the study period, and these data are not integrated into the argument. Second, the coexistence of spatially concentrated, short-cycle intensive cultivation with low regional population pressure permits a land-sparing interpretation that the paper does not acknowledge and which could support the interpretation that the full Sulawesi landscape, comprising both anthropogenic and primary forest patches, was higher in diversity than either considered alone. In other words, if spatial considerations were integrated into the argument under a neutral reading, it could support a landscape-scale interpretation compatible with forest conservation that is the opposite of Henley's conclusion, and therefore it is an example of ironic community bias.

The author applies careful source criticism to the availability and coverage of the records he obtained from Dutch colonial archives; however, the same care is not given to the ecological content of the observations it contains. Qualitative vegetation descriptions of fallow land of "monotonous appearance" containing "just four or five species of large tree" are treated as ecological evidence for permanent biodiversity loss, despite being produced by administrators and a government botanist operating within a colonial framework that routinely characterized indigenous land use as unproductive. The only place in the text where the author acknowledges observer positionality is in noting that "even sceptical Dutch colonial observers"[4] conceded that non-expanding swidden area could be farmed sustainably. Yet, this observation is deployed to strengthen his empirical argument that non-expanding areas were limited, rather than to flag the possibility of colonial bias, leaving unexamined the possibility that the same skeptical disposition inflated negative assessments of fallow vegetation quality. This may represent a deeper form of ironic community bias: Henley's authorial normative prior that *swidden-is-bad* may have led him to accept colonial ecological judgments uncritically, without evaluating them for potential bias in

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their own right, or considering whether those same observations, read under an alternative premise, might support different conclusions.

A derelict normative premise also appears in another, subtle way: the author appears aware that arguments require normative premise because he frames the paper almost entirely in opposition to the *swidden-is-good*community's own premise that swidden is ecological sustainable and therefore compatible with nature conservation: He writes that "*...its premise – that ecological sustainability is equivalent to, or at least compatible with, nature conservation – is flawed*"[5]. However, this self-awareness does not remove the derelict normative premise: This clear statement of the author's replacement premise that conservation is fundamentally incompatible with agriculture is stated only after twenty-five pages of empirical elaboration, without examining the definition of conservation that it encodes, and without considering whether the data are consistent with alternative explanations.

Overall, the article contains archival data that is original, relevant to swidden, and important; however, argument analysis suggests that its structure does not support the broad conservation policy conclusion it advances. The paper's most consequential contribution is a historically bounded, geographically specific patch-level dataset; however, these data are limited in scope and unexamined normative biases regarding agriculture-nature incompatibility, patch/landscape scaling problems, lack of critical assessment of colonial observer bias, and failure to seriously consider alternative interpretations of the data suggest that the paper contains inferential jumps that indicate the untangled rope problem.

Case study #2: Molinario et al. (2015)

Molinario et al.'s (2015) article is titled *Forest cover dynamics of shifting cultivation in the Democratic Republic of Congo: a remote sensing-based assessment for 2000–2010*. It analyzes morphological image processing of 30–60 m resolution remote sensing data from 3 points in time to produce national-scale forest fragmentation maps and track the expansion of rural agricultural communities (defined as "rural complexes") and isolated forest perforations that can be seen in core primary forest areas. Over the study period, the authors find that rural complexes grew 10.2%, isolated forest perforations grew 74.4%, and core forest declined 3.8%. The authors characterize the substantial increase of perforated forest as "of particular concern" in the abstract and attribute this phenomenon to shifting cultivators moving away from established communities. They position their framework as essential for REDD+ baseline accounting and national land-use planning, particularly because of the relatively undeveloped characteristic of DRC forests, in comparison to other nations with intact tropical forests such as Brazil or Indonesia. The paper was an important methodological

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contribution, and remote sensing is an important approach for studying swidden agriculture. However, argument analysis identifies three principal defect families: derelict normative premises, ironic community bias, and value unclarity due to language.

The most pervasive are derelict normative premises. The paper's central premise is that primary forest clearings that are outside established agricultural zones and inside core primary forest areas are more damaging than clearings within existing rural complexes. This is consistent with swidden-is-bad and it functions as the load-bearing normative premise of the entire argument. The term "rural complex" is grounded in published literature and defined as "a characteristic mosaic of active and fallow fields and secondary forest regrowth, found along the network of roads and rivers" (pp. 2). However, there is little discussion or literature review of alternatives such as sustainable or enhancement effects of forest clearing within rural complexes or in primary forest areas from the *swidden-is-good* normative perspective, and without an alternative hypothesis, it is impossible to evenly evaluate the argument and evidence. So, the premise is derelict because the negative environmental effects of swidden damage is implicit and not sufficiently defended, and therefore normative priors are required to support downstream conclusions.

The second defect is ironic community bias, which manifests in at least two different ways. First, the paper cites the swidden-is-good literature and depicts the full regenerative swidden cycle in Figure 2, yet it never engages with these hypotheses sufficiently to evaluate them. Likely, this occurs because of the limitations of the remote sensing dataset; however, this is not acknowledged directly in the paper, suggesting that a swidden-is-bad normative bias supports inferences drawn from remote sensing data. Second, the paper fails to distinguish between proximate and ultimate drivers of deforestation. The paper's own Introduction acknowledges that remote sensing data cannot distinguish shifting cultivation from charcoal production, logging, mining, or conflict-driven displacement, and it cites evidence that armed conflict drove internally displaced populations into the interior forests of the eastern provinces where perforation growth was highest. Attributing forest perforation growth in that area to shifting cultivators in the Discussion then substitutes a proximate land-cover actor for the ultimate political and socioeconomic drivers the authors themselves identify, leaving the policy conclusion resting on an undefended and potentially misattributed causal premise. In this case, the possibility for conclusion reversal is plausible because the data are potentially as consistent with a conflict-displacement explanation as with voluntary swidden expansion. Finally, the 10-year, 3-time-point dataset cannot capture the full fallow cycle (typically 8–20 years), meaning the paper quantifies clearing events, not forest trajectories*.* Thisdefect is in essence a temporal version of the Vellend-style patch/landscape scale mismatch defect, but where the mismatch relates to short-term annual

remote sensing observations and the long-term decadal/centennial scale observation times that would be needed for proper inference about swidden recovery dynamics.

Lastly, value unclarity via language occurs throughout the paper, which indexes a swidden-is-bad normative prior. The term "shifting cultivation" itself implies an itinerant, migratory character; "forest cover loss" is used rather than a more even-handed "forest cover change"; the viscerally worded phrase "carving agricultural fields out of primary and secondary forest" is used in the very first sentence of the abstract, rather than more straightforward phrases such as "clearing" or "impacts". Nearly all these terms encode a one-directional, human-negative framing, when other more value-neutral terms could have been used. Tellingly, the paper described a methodological trade-off that substitutes remote sensing observations for local qualitative knowledge of swidden in DRC using the phrase "wall-to-wall remote sensing observations". This peculiar word-choice appears to connote that satellite data is omniscient and empirical, and implicitly dismisses qualitative data as the opposite, even though it is exactly this type of nuanced, fine-grained grounded information that would be needed to more accurately resolve the question of proximate and ultimate causality of forest cover patterns. These phrases and others throughout the paper encode a swidden-is-bad normative prior and obscure logical gaps about causal effects which are ultimately used to logically support policy recommendations.

Taken together, these argument defects do not invalidate all of Molinario et al.'s contribution; the spatial modelling and fragmentation analysis is novel and technically sound, but the presence of these defects means the argument's normative conclusion regarding conservation concern and policy needs is not logically entailed by the empirical results alone, and instead lies on a swidden-is-bad normative prior, and therefore that the paper's influence on REDD+ and swidden policy discourses may rest on foundations that are more value-dependent than the scientific presentation implies.

Case study #3: Ross (2011)

Where Henley and Molinario approach swidden from the swidden-is-bad pole, Nanci Ross' (2011) study, *Modern tree species composition reflects ancient Maya "forest gardens" in northwest Belize*, approaches it from swidden-is-good. Ross measured and identified plant species in dozens of forest plots divided between areas with dense ancient Maya settlements and others with little or none, and used statistical analyses to determine that while species diversity was the same between settlement areas, species composition differs significantly between the two. This difference is statistically significant, and it is largely independent of soil characteristics. A key result is that economically useful "forest garden" species remain more abundant in areas where ancient settlement was dense, even

a millennium after abandonment. From this, Ross concludes that Maya forest gardens should inform contemporary Mesoamerican conservation and sustainable-development models. Ross's study is important because it provides rigorous quantitative evidence for long-term positive ecosystem enhancement resulting from swidden agriculture. Nevertheless, argument analysis identifies four principal defect families: value unclarity via language, derelict normative premise, ironic community bias, and value unclarity via logic.

The most telling is value unclarity via language. The term "forest garden" is drawn from Anabel Ford's research program at El Pilar (Ford & Nigh, 2016), and it is the normative inverse of "slash-and-burn": whereas the dysphemism encodes swidden as a destructive process and "swidden" attempts an unbiased and descriptive normative loading, "forest garden" encodes a sense of cultivation and care of and for the forest. This relabeling begins its normative work in the title of the article before any evidence is presented, and related terms throughout the article compound the effect. The sampled forests are called "mature" and the "functional equivalent of old-growth," even though the author acknowledges selective logging of mahogany and other tree species throughout the colonial period; also, the Mesoamerican forest is described as existing in "intimate association with humans." All these phrases embed the sense that human activity likely has a positive effect on forests, and at worst it is benign.

The second defect is a derelict normative premise related to claims about the conservation implications of the observed compositional differences between low and high settlement zones. The data and analyses support the compositional difference resulting from the substitution of economically useful species in high-density settlement areas, but what is never argued is why a shift toward human-useful species at equal diversity should count as a conservation benefit that is worth building policy upon. The empirical finding is sound and honestly reported; but the normative premise that would connect it to the conservation conclusion is simply assumed.

The third defect is ironic community bias, but in the context of a swidden-is-good prior that appears to lead to a variant of the Vellend-style scale mismatch. The author collects evidence at the plot level within a single archaeological reserve but pitches the conclusion at the scale of Mesoamerican conservation policy, which is a scale-mismatch that is likely shared and supported by the community of swidden-is-good scholars and those who value archaeological preserves and forest conservation. The more interesting point, though, is not this normative over-reach but what was never attempted analytically: Similar to Vellend (2007), the paper fails to perform a landscape-scale analysis, even though such an analysis could have lent the conservation argument additional, legitimate support. A forest composed of compositionally distinct high- and low-density patches is, in principle, more heterogeneous than either alone, so combining them

could plausibly reveal the kind of diversity gain that the plot-level data do not. The swidden-is-good prior appears to have made this analysis seem unnecessary if the effect of ancient forest gardens on modern forests' composition already felt established, but an additional line of support that would ground it at the landscape scale more securely was simply never undertaken. Interestingly, this result is the inverse of the swidden-is-bad variant; here, the directionality of the normative positive premise aligns with the counterfactual outcome, yet it is still ironic because a stronger argument for landscape enhancement *could have been built* but was not. Alternatively, a landscape-scale analysis could have shown that the abundance of economically useful species in high-density areas was statistically insignificant at larger scales of analysis. But in either case, it would have provided more even evaluation of the central hypothesis and helped to avoid ironic community bias.

As with the two previous cases, these defects do not diminish Ross's empirical contribution: the study design is rigorous, the edaphic control careful, and the demonstration of a persistent anthropogenic signature in forest composition a genuine advance in historical ecology. Here, the unraveled rope appears not in the science but in the inferences for conservation that are derived from it.

Synthesis: the unraveled rope in three examples of swidden literature

Henley (2011), Molinario et al. (2015), and Ross (2011) were all published in reputable journals, passed rigorous peer review, and have been cited and built upon in the years since. Henley's Dutch colonial fallow dataset is unique and important, Molinario's spatial fragmentation typology was a genuine advance for large-scale forest monitoring, and Ross's demonstration of a persistent anthropogenic signature in forest composition is a real contribution to historical ecology and swidden studies. The three studies are separated by discipline, method, geography, and historical period, and they sit at opposite normative poles: Henley and Molinario at swidden-is-bad, and Ross at swidden-is-good. All three papers appear to contain indications of the unraveled rope problem. Crucially, the argument defects identified here are not scientific or editorial mistakes, and peer review is not designed to catch them; they are subtle normative embeddings that arise in the ordinary course of knowledge production: in choosing research questions, in selecting which literature to engage, and in deciding which analyses are worth running. While three case studies cannot establish how widespread the problem is across the swidden corpus, they may help identify patterns that recur across both poles.

The first shared pattern is a derelict normative premise. In each study, an undefended assumption about whether swidden-is-good or swidden-is-bad does load-bearing work in the structure of the argument, yet it is never directly stated

or defended as a premise. In Henley and Molinario, the assumption runs in the swidden-is-bad direction: that clearing outside established agricultural zones is categorically degrading, and that primary forest is the appropriate baseline against which human land use is measured, respectively. In Ross, the same structural move runs in the opposite direction: the conclusion that forest-garden composition should inform conservation policy rests on the unstated premise that a shift toward human-useful species, at equal overall diversity, is a conservation good. The pole differs, but the defect is identical–a value-laden premise carrying the conclusion while remaining invisible to the argument, and therefore undefended.

The second shared pattern is ironic community bias, and here the comparison across poles reveals that this defect is not restricted to a negative prior. In Barker and Fraser's (2023) original treatment, ironic community bias is illustrated at one pole only: a research community holding the prior that humans are bad for nature failed to observe evidence for the opposite conclusion at the landscape scale (i.e., that agriculture could increase gamma diversity). Here, at the swidden-is-bad pole, a negative prior also led researchers to over-read the evidence: Henley extends patch-level vegetation descriptions to a landscape-scale claim of forest destruction that his own regional map complicates, and Molinario attributes forest perforation to shifting cultivators when the same data are consistent with conflict-driven displacement. Interestingly, at the swidden-is-good pole, the prior works in reverse. Ross' data lent itself to a landscape-scale analysis treating the high- and low-density plots as a single compositional mosaic, and this could have lent additional support for forest enhancement, but it was never undertaken. One explanation for why is that the swidden-is-good prior provided the author and community sufficient support for the broader inference, even though a stronger argument possibly even showing higher levels of landscape-scale gamma diversity when high- and low-density settlement areas were combined. In other words, ironic community bias in the swidden-is-good case may have left a stronger argument unbuilt, which is the same scale-mismatch mechanism and logical defect but in the opposite direction and therefore also ironic.

Taken together, the three cases support a tentative general conclusion: swidden studies at both normative poles show signs of the unraveled rope problem, with evidence for most of the defects families identified by Barker, and particularly derelict normative premises, value unclarity due to language, and ironic community bias. A Vellend-style scale mismatch problem appears to be a particularly common concern in swidden studies, likely due to the importance of cross-scale spatial and temporal dynamics in swidden agriculture and the methodological difficulties for linking them. This does not mean the science in these studies is unsound. In every case, the empirical contribution survives the analysis intact; what unravels is the inference from empirical findings to

statements about normative conclusions, theoretical implications, and policy recommendations.

A top-down / bottom-up review of swidden scholarship

Despite its overt simplicity, swidden agriculture remains an enduring topic of research because of its ubiquity across continents, cultures, ecosystems, and time. Explaining the social and ecological determinants of swidden's persistence and the scale and extent of its environmental signature is a classic socioenvironmental problem. The fact that swidden continues to inspire researchers and instigate debate is an indication of the true complexity of its coupled human and environment dynamics. The literature on swidden is voluminous, and a recent review summarized its history and development (Li and Nath 2024). Instead of conducting a comprehensive review, the goal here is to use epistemology to frame a targeted review of the swidden literature that highlights two main perspectives for explaining its general processes and patterns. As far as I am aware, a top-down / bottom-up framework has never been applied systematically to swidden research[6]. I introduce it here because it highlights a previously unidentified epistemological disjuncture that may contribute to the persistence of normative polarization in swidden studies that was identified in the previous section, and because this organization provides a bridge to the discussion of adaptive self-organization that follows in Section 4.

A top-down approach to swidden research emphasizes general laws or principles related to demographic growth, environmental capacity, agricultural technology, large-scale spatial models and theoretical frameworks, and a more deductive approach to analyze empirical patterns using generalizable laws or principles. For example, Meggers (1954) built on Malthusian ideas about the limits of food production to argue that societies using swidden agriculture in nutrient-limited tropical environments would not develop sociocultural complexity, an idea that ignited a lively debate (Coe, 1957; Hirshberg & Hirshberg, 1957; Meggers, 1957). In more recent iterations, demographic models have been used to calculate the carrying capacity of specific swidden systems; for example, by deriving regional population limits from yield data and land availability (e.g., Schwartz & Corzo, 2015); or by using global remote sensing analysis to map swidden extent and decline across entire continents (Heinimann, 2017). In this approach, the

6. This top-down / bottom-up framework is similar to one used for a review of ecosystem food pyramid research that identified theoretical trends in community ecology between a bottom-up resource-based hypothesis, and a top-down consumer-based hypothesis for determining the biomass patterns across food pyramids (Leroux and Loreau 2015). Here, I develop a novel top-down/bottom-up framework for epistemology in swidden, a prototypical coupled human and natural system. Accordingly, the mechanisms and patterns in coupled systems are different and more varied because they incorporate human demography, energetics, and cultural factors, in addition to forest community ecology. Whereas Leroux and Loreau's (2015) framework is ontological, describing the direction of causal force in ecosystems, mine is epistemological, describing the direction of explanatory inference in swidden scholarship.

explanatory movement is always from the general to the particular: landscape- and population-scale parameters set the terms within which swidden societies operate, and local variation is interpreted as an expression of those larger constraints.

In contrast, bottom-up swidden studies are rooted in ethnographic and environmental fieldwork traditions that suggest human-environment relationships related to swidden are best understood through fine-grained, inductive case studies, rather than deduction from general laws or principles. For example, Conklin's classic (1957) study of Hanunóo agriculture involved months of fieldwork and used ethnographic and ethnoscientific methods to record swidden crops, document fallow cycles, and, based on this evidence, he argued that swidden agriculturalists develop intimate, co-evolved relationships with their local environments. Rappaport's fieldwork with the Tsembaga Maring (1968) used a similar ethnographic approach to show that the Kaiko ritual cycle actively regulates land use, pig populations, and forest recovery. In the bottom-up tradition, the explanatory movement is from the particular to the general: causal mechanisms are identified at the community and patch scale, and broader patterns are built inductively from the richness of local observation.

Swidden scholarship spans numerous disciplines including, to cite just a few examples, anthropology (Conklin, 1957; Dove, 1985; Rappaport, 1968;), archaeology (Bogaard, 2004; Iversen 1941; Rösch, 2002), history (Henley, 2011; Otto & Anderson, 1982; Sivaramakrishnan, 1995), demography (Boserup, 1965; Fearnside, 1986; Turner, 1977), ecology and environmental science (Bruun, 2009; Lawrence, 2010; Nye & Greenland, 1960), forestry (Lanly, 1982; Ruthenberg, 1971), geography (Fox & Vogler, 2005; Padoch, 2007), remote sensing (Heinimann, 2017; Li et al., 2014), conservation (Ziegler, 2011; Chazdon, 2014; Padoch & Pinedo-Vasquez, 2010), rural livelihood and development (Thrupp, 1997; Dressler, 2017; Vliet & Nathalie, 2012), and global climate change policy (Mertz, 2009; Ziegler, 2012). This disciplinary diversity itself suggests that the overt simplicity of swidden techniques belies its variability and complexity in culture, geography, history, and its modern significance.

Table 2 provides a chronological summary of the development of classic and influential studies in swidden scholarship, including a qualitative assessment of whether each study represents a top-down or bottom-up approach.[7] Notably, there are strong currents of research in both top-down and bottom-up epistemological traditions from very early on through the present. This ongoing dialectic itself suggests that the practice of swidden may be more complicated than captured by

7. Methodologically, my goal in Table 2 is to select seminal works and to characterize them by overall epistemological approach and research tradition. Often, articles and monographs (which are less constrained for space) contain discussions of both top-down factors such as demographic growth, globalization, state power, and the broad sweep of history, and bottom-up details from case studies, local dataset, and ethnographic and ethnohistorical context. Thus, the epistemological classification reflects the most general epistemological category that reflects the research tradition of the work.

either approach alone. I suggest that this may occur because neither approach in isolation can adequately explain how any identified patterns or processes relate to patterns and processes from the other approach.

For example, many top-down swidden studies report swidden fallow length to diagnose sustainability. Foundational research established a threshold where cycles less than around 7-8 years indicated environmental overuse (Carneiro, 1960; Nye & Greenland, 1960), and this is often used to determine whether a particular community, or regional case study, is sustainable or unsustainable (Henley, 2011). With respect to human factors, a top-down approach usually provides insight into broad-scale drivers such as population growth or decline, and outcomes like ecosystem-scale sustainability or collapse. However, the framework is less effective in predicting how individuals, households, or communities act at local scales, including farming and land use decisions, related social norms, or belief systems. In other words, in top-down models, understanding agency is usually secondary to understanding large-scale patterns and processes.

Orthogonally, bottom-up studies provide detailed qualitative and quantitative data about individual knowledge, beliefs, and household farming activity patterns. For example, an important study by Scott Atran linked local ethnobiological knowledge and settlement history in Itzá Maya, Q'eqchi' Maya, and Mestizo communities in the lowlands of Belize and Guatemala to measurable community-level resource management outcomes; however, like most bottom-up studies, the specificity of the data (species identifications and medicinal uses) makes it difficult to generalize these results to other cultures or regions of the world. In general, the case study approach provides rich localized and contextual data, but the approach often makes it difficult or impossible to make predictions at higher levels in the system.

Table 2. *Chronological summary of classic and influential studies in swidden scholarship; the table provides the citation, a brief summary of its place in the theoretical trajectory, a prediction or key inference, the study system, methods or data, and assessment of top-down / bottom-up epistemological orientation.*

Citation	History	Prediction / Inference	System	Methods / Data	Orientation
Linnaeus (1775)	Earliest systematic field documentation of swidden that establishes a bottom-up observational tradition (Dove 2011)	Local swidden practices are rational, place-specific adaptations to particular environmental conditions that must be understood on their own terms	Sámi territory, subarctic Sweden	Direct field observation; ethnographic reconstruction	Bottom-up
Malthus (1803)	Founding demographic premise of the top-down tradition	Population growth will outpace food production, generating resource scarcity and social instability	General / theoretical	Demographic reasoning; comparative historical argument	Top-down
Meggers (1954)	First application of environmental determinism to tropical swidden; defines a top-down theoretical human population carrying capacity	Nutrient-limited tropical environments determine maximum sociocultural complexity achievable by swidden societies	Amazonia; tropical forests globally	Comparative ethnological argument	Top-down

Conklin (1957)	Founding empirical study of the bottom-up tradition; establishes local social and ecological knowledge as the primary objects of analysis	Swidden agriculturalists develop intimate, co-evolved relationships with local environments expressed in fine-grained classification systems invisible to outside observers	Hanunóo, Philippines	12 months ethnographic fieldwork; ethnoscientific plant classification	Bottom-up
Boserup (1965)	Dynamic variant of the Malthusian premise; reframes population pressure as driver of innovation rather than collapse	Increasing population pressure shortens swidden fallow cycles and triggers agricultural intensification	General / theoretical	Comparative historical and agronomic argument	Top-down
Rappaport (1968)	Key mechanistic elaboration of the bottom-up tradition; introduces social regulation as an explicit causal mechanism	Local ritual cycles actively regulate land use, herd size, and forest recovery, functioning as homeostatic mechanisms	Tsembaga Maring, Papua New Guinea	Long-term fieldwork; quantitative ecosystem analysis	Bottom-up

Brush (1975)	Synthesis of use of carrying capacity concept in anthropology and critique of underlying equilibrium and homeostasis assumptions.	Carrying capacity calculations oversimplify human-environment interactions	Synthesis	Comparative review	Top-down
Dove (1983)	Political economy turn; introduces state power and colonial legacies as structuring variables invisible to both top-down and bottom-up approaches	Negative characterizations of swidden reflect state interests in legibility and resource control rather than objective assessments of environmental impact	Borneo; Southeast Asia broadly	Ethnography; historical political economy	Bottom-up / political economy
Balée (1994)	Founding statement of the historical-ecology approach to swidden; argues that large portions of Amazonian forest are anthropogenic artifacts of long-term indigenous management	Cumulative swidden-fallow cycles increase forest diversity and abundance of economically valuable species over centuries, making apparent "wilderness" forest a cultural product rather than a pristine baseline	Amazonia (Ka'apor, eastern Amazonia)	Ethnobotany; forest inventory; historical reconstruction	Bottom-up / historical ecology

Scott (2009)	Extends Dove's political ecology to a pan-regional comparative scale; introduces swidden as a technology of non-legibility	Swidden is a deliberate political strategy by upland peoples to resist state incorporation, not a primitive or transitional agricultural form	Southeast Asia	Comparative historical analysis; political geography	Bottom-up / political ecology
Atran et al. (2002)	Flagship empirical study linking local traditional ecological knowledge to measurable community-level resource management outcomes	Shared folk-ecological knowledge structures collective swidden practices, producing conservation outcomes at community scale	Itzá Maya, Petén, Guatemala and Belize	Garden experiments; ethnobiological surveys; cross-cultural comparison	Bottom-up
Schwartz & Corzo (2015)	Modern carrying capacity study; applies top-down demographic framework to bottom-up field data; challenges neo-Malthusian collapse narratives	Traditional milpa agriculture in Petén could sustainably provision 3–4 million people using 60% of available land, contradicting post-1960s Mayanist consensus	Petén, Guatemala	Field counts; yield surveys; demographic calculation	Hybrid (top-down dominant)

Mertz et al., eds. (2009)	Special issue in Human ecology that marks a policy-driven inflection point (Li & Nath 2024) away from the slash-and-burn deforestation narrative toward re-examination of swidden's rationality and sustainability, catalyzed by UN-REDD and free Landsat data	The dominant slash-and-burn narrative is a historically contingent product of policy pressure and technological limitation, not an objective assessment of swidden's environmental impact	Southeast Asia; global review	Multi-disciplinary special issue; comparative synthesis	Hybrid

The top-down / bottom-up framework is only intended as a loose classification, as many studies, and most recent ones, address – or at least cite – both types of causal factor. However, it is epistemologically difficult to connect top-down and bottom-up dynamics to infer patterns and processes at the other level because the causal relationships that connect sociocultural, behavioral, and trophic levels in swidden systems are also what complexity scientists call non-linear: small changes at one level produce disproportionate change at other levels. Crucially, these non-linear relationships are also located not within either level but in the couplings between them. This is true both of systems involving human languages, culture, and coupled human-and-natural systems (Lansing, 2003), as well as environmental systems where landscape-scale spatial dynamics, community ecology, trophic networks, and nutrient cycling dynamics which are all essential elements of complex forest ecosystems (Arroyo-Rodríguez, 2017; Messier, 2015).

In non-linear systems, changes in one direction sometimes become difficult to reverse. For example, the average fallow length was intended to provide a quantifiable way to assess whether a swidden forest was sustainable or if it was likely to decline. By this logic, simply increasing the fallow length (through whatever measure) should increase sustainability and the forest should recover, but this is not what happens in practice. Forests can tolerate a significant degree of disturbance, but then rapidly shift toward grassland or pasture. But when exactly this transition occurs is notoriously hard to predict. The reason for this is that there are certain environmental niches, landscape patterns, keystone species, social norms, and cultural practices that are disproportionately important – eliminate these and the system may not recover. But top-down and bottom-up approaches are poorly suited to identify such connections: keystone species such as jaguar or tapir help maintain diversity through their behavior and feeding patterns. Customary cultural practices encourage swidden farming patterns that preserve these crucial ecosystem functions. Measured from one level alone, with

the linear or equilibrium-based statistics that each approach typically uses, relationships of this kind looks proportional and steady.

Not only do top-down and bottom-up approaches appear to look past each other, but they may also assign more causal significance to the aspects of swidden systems that each can see, which risks misattributing cause to whichever level happens to be in view. This is likely the reason the scale mismatch, ironic community bias, and derelict normative premise argument defects appeared prominently in each of the article analyses in Section 2; the scale mismatch defect in particular reflects a scalar gap between top-down and bottom-up approaches. Because these case studies span both of the top-down and bottom-up epistemologies that organize the wider literature (Table 2), the unraveled rope problem is unlikely to be confined to these three studies, but is instead a feature of the top-down and bottom-up traditions that structure the field. A key premise of this review is that neither the top-down nor the bottom-up approach working alone can explain how small-scale societies with simple technology can interact with complex forest ecosystems. Neither can they predict the great sociocultural variability of swidden systems past and present, or the range of possible positive and negative ecosystem outcomes. These conclusions suggest the need for a theoretical framework capable of connecting low-level interactions to macro-level outcomes without reducing or oversimplifying either one or the other.

As a corrective to this historical disjuncture in swidden studies, I propose that the concept of adaptive self-organization may reconcile top-down and bottom-up approaches and explain how small-scale swidden societies navigate complex multi-scale dynamics in community forests and swidden landscapes. In emergence, low-level interactions among agents – guided by social norms, labor reciprocity, and local ecological knowledge identified in bottom-up swidden studies – can produce and regulate large-scale forest dynamics without any top-down institution coordinating them. The spatial and temporal signatures of these emergent socioecological patterns are only legible at landscape scale and across full swidden disturbance-recovery cycles. These low-level interactions generate patterns that most top-down swidden do not look for, and the large-scale patterns are invisible in bottom-up studies. If swidden research has been structurally biased along epistemological approaches and by the unraveled rope problem, then perhaps a new framework grounded in adaptive self-organization offers not just a better description of swidden, but a corrective to any accumulated normative biases in the scientific record.

Adaptive self-organization in swidden agriculture

J. Stephen Lansing introduced the concept of adaptive self-organization to anthropology (Lansing, 2003), and he developed a comprehensive research program using it to analyze the coupled social and ecological dynamics of irrigated rice agriculture, one of the major agricultural systems. His long-term research program investigates irrigated rice cultivation in Bali to explain how the independent scheduling decisions of farmers in local rice temples (subaks) support reliable harvests and landscape-scale pest management through social and ecological feedback rather than top-down planning (Lansing & Kremer, 1993; Lansing, 2012; Lansing, 2017). Importantly, much of this body of research integrates both top-down and bottom-up approaches: Balinese archaeology demonstrates nearly 1,000-year history of subak coordination; research in Dutch archives indicates how community management of irrigation schedules was invisible to colonial administrators; analysis of social norms, linguistic grammar, syntax, and register reflect egalitarian management of subaks; analysis of the lontar palm shows how the traditional Balinese calendar and religion provides a symbolic framework for ecosystem management; analysis of the effects of the Green revolution during the modern period shows how the subaks recover from external shocks; agent-based models of subak system and irrigation management practices show how small-scale farming communities can manage complex, engineered irrigation landscapes; and remote sensing analysis of irrigation cycle synchronization provides an empirical link between household crop choices to watershed-scale spatial patterns. Taken together, Lansing's research program provides a culturally relevant and historically contextualized explanation of sustainable terrace rice agriculture in Bali using principles from adaptive self-organization.

However, the coupled dynamics of swidden agriculture are different. Balinese irrigated rice terraces are intricately engineered but spatially bounded. In contrast, swidden mosaics are human-natural landscape gradients that are spatially extensive. But the same fundamental questions apply: can this coupled human and natural system self-organize from the bottom up to support good harvests and sustainability, and under what conditions can this occur? Perhaps adaptive self-organization can address this and help answer other outstanding questions about the persistence, resilience, and dynamics of swidden agriculture.

The adaptive self-organization swidden framework introduced here benefits from concepts about forest complexity, history, and scale from historical ecology developed by William Balée (2006), and anthropogenic disturbance and ecosystem enhancement from Rebecca Bliege-Bird (2015). It rests on two central premises: First, swidden can be conceived as a *coupled human and natural system* (Liu,

2007) consisting of biological elements (people, plants, animals, communities, and forests) and social elements (knowledge, social practices, norms, and history) that interact across multiple scales in space and time. Second, the dynamics of these components can be explained using the concepts of *adaptive self-organization*, originally developed in physics (Bak et al., 1987) and computer science (Holland, 1995; Holland, 2014), subsequently applied to anthropology (Lansing, 2003), and interpreted for general scientific audiences (Fisher, 2009; Mitchell, 2009). The central concept is *emergence*, which formalizes the colloquialism, "the whole is more than the sum of its parts" (Fisher, 2009). This suggests that systems, when viewed from the top-down, will exhibit macroscopic properties, patterns, and behaviors that are invisible when the system is viewed from the bottom-up; conversely, when the system is viewed from the bottom-up, the only properties, patterns, and behaviors that can be seen relate to the interactions among individuals (agents), which affect higher-order system properties in aggregate. How then can swidden farmers steer the system when they have incomplete environmental information of the forest and limited ability to affect its trajectory?

Donnella Meadows defines *leverage points* as "places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything" (Meadows, 1999). Structure, agency, rules, and norms can all create system-level changes. Most swidden communities are small, rely on common property resources, have few or weak governance institutions, and interact with large-scale forest ecosystems that are themselves complex adaptive systems (Arroyo-Rodríguez, 2017; Messier, 2015). As shown in Section 3, both top-down and bottom-up approaches have yielded significant insights into swidden agriculture across disciplines, yet an epistemological gap remains between the two most common approaches. What has been missing is a framework for understanding the social and ecological dynamics of interactions between these approaches, across scales of analysis, and among them. Identifying leverage points may be one way to understand how swidden farmers may use them to maintain the system in favorable configurations. Thus, critical questions for adaptive self-organization in swidden agriculture are (1) how the agency of swidden farmers affects the macroscale patterns that are observed in swidden forests, and (2) identifying leverage points that can guide and maintain the coupled system in a favorable state where harvests are good and sustainable, despite the size, complexity, and inherent unpredictability of swidden forests. To address this, Table 3 relates concepts from adaptive self-organization to some key research questions regarding swidden agriculture. Here, the historical distinction between top-down and bottom-up

approaches is discarded because adaptive self-organization offers an integrative approach.

Table 3. *Core adaptive self-organization concepts and relevance to swidden systems*

Concept	Relevance in Swidden Systems
Agent behavior & decision rules	Swidden households are the primary agents, making decisions about field size, site selection, fallow length, and labor allocation based on ethnoecological knowledge, social norms, and local environmental conditions. Understanding what behavioral rules agents follow and how those rules vary across cultural, demographic, and ecological contexts is foundational to any adaptive self-organization model of swidden agriculture.
Social, ecological & coupled networks	Labor reciprocity networks, kinship ties, knowledge-sharing relationships, and connections beyond the local community (e.g., tax and forestry officers, non-governmental actors) are structural features of swidden societies that modulate system-level outcomes. Ecologically, the spatial network of swidden patches (connectivity, fragmentation, and synchronization) shapes seed dispersal, forest recovery, and biodiversity. In coupled systems, the interaction between social network structure and ecological network dynamics are critical interactions.
Emergent properties	Landscape-scale patterns including forest mosaics, patch-size distributions, and fallow cycling regimes are not designed or centrally coordinated but emerge from the aggregated decisions of swidden households. Swidden tenure systems, labor institutions, and land classification norms may similarly emerge from decentralized interactions among individuals and households rather than explicit collective design.
Spatial, temporal, and cross-scale dynamics	Swidden operates simultaneously at the scale of individual household fields, the community forest, villages, regions, and the regional landscape, with processes at each scale feeding back on the others. Closely related cross-scale questions regarding alpha, beta, and gamma diversity exist in landscape ecology, but often require adaptation to socioecological systems. Understanding how local fallow decisions produce detectable regional and global land cover signatures, and how external pressures at regional or state scales propagate downward to constrain household behavior are core cross-scale questions.

Non-linearity, path dependence & leverage points	The relationship between key swidden variables including fallow length and forest recovery, population density and sustainability, disturbance intensity and biodiversity are frequently nonlinear, with critical thresholds beyond which trajectories diverge. Sociocultural, institutional and political histories are inherently non-linear and non-time reversible and they shape which pathways are available to a swidden system at any given point in time, making social history path dependence central to understanding both resilience and collapse. Leverage points include social norms, local institutions, customary ecological knowledge, land tenure systems, economically valuable and ecologically important plant and animal species, and ecosystem disturbance and modification.

Evidence and progress

This section summarizes results from two decades of research into swidden agriculture. My project, initially inspired by Lansing's investigations of irrigated rice agriculture in Bali (Lansing, 1994), involved fieldwork in Belize, lab-based research, significant interdisciplinary collaboration, and it resulted in a sequence of publications and the adaptive self-organized swidden framework outlined in Table 3.

This synthesis is organized by (1) *swidden agency*, where ethnography, ethnohistory, and graduated sanctioning reveal ways individuals and households make key decisions related to swidden farming; (2) *swidden emergence*, where village labor networks, landscape ecology, and remote sensing expose patterns that arise from those aggregated patterns of behavior; and (3) *non-linear swidden dynamics*, where human-nature coupling creates leverage points that connect processes and patterns across spatial and temporal scales. In every case, the synthesis highlights key results from my research program and epistemological considerations to highlight how my research program has explored cross-scale interactions, coupled-system dynamics, and emergence throughout my research program.

Swidden agency: Individuals, households, and social norms

Downey (2010) is the earliest study in my research program, and it is ethnographically descriptive. It grew directly from extended fieldwork in the Toledo District, Belize, which involved participant observation with farmers, interviews, a household survey, and agricultural mapping. It documents a social fissure in one of the villages to illustrate how swidden labor exchange networks provided adaptive capacity. Although the study was originally framed around resilience theory, it contains ethnographic accounts of individual farming behavior and decision-making about when and where to farm and who to help with the labor-intensive swidden activities. The central questions it addresses is at the

agent level: when a farmer needs help with swidden labor, who does he ask, and who agrees to help? The study uses a multi-village household survey, and it finds that the answer turns on social norms rather than formal village institutions: the day-to-day work of swidden is organized through reciprocal labor exchange. The Maya spiritual system encodes a rich symbolic representation of the forest commons in the Tzuultaq'a, the spirits of the hills and valleys who must be appeased through ritual before planting, hunting, or gathering (Hatse & Ceuster, 2001). However, the fieldwork suggested that Maya religion remained epiphenomenal, not a cyclical system of ritual regulation as Conklin found (Conklin, 1957). While religious conversion had undermined religious solidarity in the village (Schackt, 1986), I suggest that a better explanation is that for those who follow it, the Maya spiritual system supports social norms by a parallel symbolic association that helps to protect the forest commons. The ethnography showed that the real restraint appeared to lie in the social norms governing reciprocal swidden labor exchange. Requests judged as an acceptable use of the forest are honored, whereas requests perceived as a violation, such as an inordinately large field destined for the market, can be quietly refused, delayed, or under-supplied. Here, grounded in ethnographic observation, I first proposed the hypothesis that Ostrom's graduated sanctioning (Ostrom, 1990) could operate through swidden labor exchange networks rather than through formal governance. This hypothesis was later tested experimentally in the Milpa Game (Downey et al., 2020) and incorporated into agent-based models to analyze how these agent-based decisions relate to village-scale social networks and emergent swidden mosaic patterns in remote sensing data (Downey et al., 2023; Downey et al., 2026; Tverskoi et al., 2025).

Downey et al. (2020), entitled "The Milpa Game," analyzed empirical evidence about farmer decision-making from a public goods game that was framed to simulate swidden labor exchange in an experimental context, as well as qualitative post-game interview data about players' reactions. We used these data to test the graduated sanctioning hypothesis from Downey (2010) and concluded that social norms related to labor exchange support more sustainable environmental outcomes: games that incorporated culturally familiar social norms were more sustainable, while games without such framing quickly depleted common-pool resources. We validated these results with follow-up interviews and reported interviewee responses which supported the game's cultural relevance and players' understanding of the social and ecological dynamics it represents. These quotations, together with the quantitative data from the experiment, support Ostrom's theoretical prediction about the role of graduated sanctioning in maintaining sustainability in small-scale societies with common-pool resources

(Ostrom, 1990). In this paper, we show that it operates at the level of an individual farmer, and in the context of swidden labor exchange networks.

Swidden emergence: social networks, settlements, and landscape ecology

Initially, I located the study area in the Toledo District, Belize, in part because of clearly visible swidden mosaic pattern in Google Earth imagery on one side of the Belize/Guatemala border, and a landscape dominated by cattle pasture on the other: something different was happening in the Maya communities in Belize. With this as a point of departure, Downey (2010) proposed that household-level labor exchange decisions might be an important leverage point and aggregate into something larger. But it was only by reconstructing the labor-exchange network for each village and comparing them across the historical village settlement sequence that this became visible. The network diagrams in that article show how the dyadic choices of individual farmers, to grant or withhold labor, aggregates into a village-scale structures with measurable properties of reciprocity, hierarchy, and connectedness. In this sense, the structure village labor network is an emergent property of many local exchanges among farmers rather than a product of collective planning. The social fissure that was documented ethnographically made this especially clear: when roughly half the households from this small village departed, the network did not collapse but reorganized around the farmers who remained, recovering its structure rather than dissolving, and adapting over time. Read at the emergent level, this was preliminary evidence that village cohesion in a swidden system can be self-organizing, sustained by the ongoing pattern of labor exchange rather than by any governing institution.

Downey (2015) is an ethnohistorical analysis of the modern period of Maya history, and it uses life history interviews and archival research to provide detailed social and historical context for understanding how colonialism related to the agricultural patterns that were visible from space in the early 2000s. It asks three questions, all of which initially appear to reflect a top-down approach relating settlement patterns, demography, and colonialism: (1) When and where were Maya villages established during the modern period (1800–present)? (2) How did historical factors and British colonialism relate to Maya village settlement patterns during this period? And (3) Is environmental carrying capacity or colonial expansion a better explanation for the observed settlement patterns? While these questions reflect a top-down approach, the methods and data (life history interviews and a catchment analysis of colonial-period birth and baptism records) reflect a bottom-up approach to understanding history (Thompson, 2016). Ultimately, the study came to many of the same conclusions as Dove (1983) about the importance of the political economy of swidden agriculture in Sulawesi: in Belize, British plantation development into the interior of the Toledo District was the ultimate cause of the observed village settlement patterns. In addition, the study tests this quantitatively by reconstructing the district's demographic,

settlement, and land-use history and concludes that a "village budding model" based on swidden agriculture and assumptions of low environmental carrying capacity is a poorer explanation than colonial history for the observed patterns. On the surface, this study may appear overtly "top-down"; however, a life-history and village demography approach was one way to address the non-linearity and path-dependence that are inherent in the social history of the Maya communities in Toledo.

In Downey et al. (2023), we analyze high-resolution remote sensing data from two villages. Remote sensing is a common and explicitly top-down approach in swidden studies, so several methodological decisions helped this study address spatial and temporal scales and complexity: first, the scanning platform (long-range unmanned aerial vehicles) and a 4-band optical sensor designed for agriculture provided higher resolution multi-spectral data than available from commercial satellite platforms at the time; second, we scanned the entire community forest around both villages to capture both swidden use areas (18,000+ acres) at a high enough spatial resolution to analyze plant and tree biodiversity; third, we collected historical swidden fallow land use data with farmers from the village with immediate knowledge of community swidden forests and used it to classify the remote sensing data; fourth, we used methods from ecoinformatics to infer plant and tree diversity across the classified swidden mosaics and compared them to swidden disturbance patterns. This methodology quantifies swidden landscape patterns like other top-down remote sensing swidden studies, but it is also sensitive to cross-scale spatial patterns and temporal dynamics. Ultimately, the study reaches a counter-intuitive conclusion: intermediate levels of swidden cultivation enhance plant and tree diversity, rather than decrease it, suggesting that controlling swidden disturbance patterns may be a leverage point farmers use to manage complex forest ecosystems.

In Scaggs et al. (2026), we replicate the top-down remote sensing finding from Downey et al. (2023) and generalize it globally by analyzing swidden mosaics from 18 societies across the Neotropics, equatorial Africa, and Southeast Asia. Across these sites, the relationship between disturbance and vegetation diversity is generally hump-shaped, peaking at intermediate levels of disturbance where recently cleared, fallow, and mature forest are intermixed, confirming the Belize forest-enhancement result at a global scale. The paper's principal theoretical contribution, however, is to explain why this pattern arises. Although the analysis is itself a top-down, landscape-scale remote sensing study, it accounts for the global pattern by pointing to finer-scale ecological processes operating within the forest: mature forest acts as a reservoir from which plant diversity spills into neighboring disturbed patches, so that the diversity of any given area depends on how much mature forest surrounds it and how that forest is arranged across the landscape. In this way, the study makes a cross-scale inference, linking a pattern visible only from above to dispersal processes operating on the ground, and

showing that a swidden landscape's capacity to sustain diversity depends not merely on how much mature forest remains, but on how it is spatially organized relative to regrowing vegetation.

Non-linear swidden dynamics and leverage points

We use computer modeling to analyze the non-linear dynamics of swidden systems by simulating plausible landscape-scale patterns to identify leverage points. Modeling is a creative process and, crucially, many of the modeling decisions (what to include) were informed by ethnographic fieldwork. Tverskoi et al. (2025) generalizes the empirical findings of The Milpa Game (Downey et al., 2020) into a formal, theoretical agent-based model of swidden as a coupled human and natural system. Where Downey et al. (2020) showed experimentally that social norms of labor exchange can sustain a common-pool forest, this model asks whether those same norms produce sustainability when farmers' decisions and the forest's response interact dynamically over time. The mechanism couples two social processes, labor reciprocity and normative reasoning that can trigger sanctions, to the forest's ecological response to disturbance. The model identifies three emergent regimes: low-intensity swidden, sustainable high-intensity swidden, and deforestation. The key result is that a sustainable high-intensity regime that maximizes both ecosystem services and harvest returns only evolves when reciprocity and normative reasoning are balanced: normative reasoning must condition helping strongly enough to prevent over-harvesting, while reciprocity must remain strong enough to prevent excessive sanctioning. This balance is robust to group size and resilient to environmental shocks, and it is most productive for forests and farmers alike when it produces an intermediate scale of forest disturbance. A defining difference from many top-down and bottom-up studies is that this theoretical model incorporates explicit premises for both *positive* and *negative* environmental outcomes. As a model of coupled dynamics, it demonstrates how local social norms and customary labor practices may give rise to emergent, system-level outcomes that either a top-down or bottom-up approach alone could not explain.

As far as I am aware, Downey et al. (2026) is the most complete analysis of adaptive self-organization in swidden agriculture, integrating top-down remote sensing, bottom-up ethnography, and an agent-based model into a single coupled-systems framework. I designed this study to be the capstone of the research program described above, where the top-down and bottom-up results from my earlier work are finally combined and tested against one another. The study opens by analyzing an 18-site global remote sensing dataset for a pattern called a power law (Clauset et al., 2009). Power-law distributions appear in self-organizing systems such as earthquake magnitudes, river networks, power grid failures, and social networks; when they appear, it can indicate that order is emerging from interactions at lower levels rather than being imposed from above. The study

finds this signature across most of the swidden mosaics. Unlike a normal distribution, a power law has no typical or average patch size; instead, the landscape is composed of a mix of patch sizes spanning many scales, and it is this spatial diversity, rather than any single characteristic field size, that the analysis treats as ecologically and economically meaningful.

A power law alone, however, cannot identify its cause, because many different processes can generate one. So, to test whether swidden farming could produce it, we developed an agent-based model that brings together three processes. First, we model forest ecology: a cleared patch regrows fastest when it is surrounded by mature forest that supplies its seeds, so the forest benefits most from an intermediate level of disturbance that is neither so small that little changes, nor so heavy that the seed source is lost (Kéfi, 2007). Second, we model the social norms of labor reciprocity and normative reasoning described above (Downey et al., 2020; Tverskoi et al., 2025), which determine whose clearing requests are honored, and which keep disturbance within this sustainable middle range rather than tipping the system toward deforestation. Third, we model field placement: each year a farmer decides whether to clear beside an existing field or in a new location away from others, a decision I observed directly during fieldwork in Belize and that Dove documented in his ethnography of Kantu's bird augury (Dove, 1993). It is this third decision that generates the power law. When farmers repeatedly clear beside existing fields, a single new clearing will occasionally bridge two separate patches into one much larger patch, creating a cascade that limits itself, because the enlarged patch then restricts further clearing nearby. Ultimately, the model reproduces the power law observed in the remote sensing data only when field placement and social norms operate together; when farmers instead place fields at random, the power law disappears. This convergence of an independent top-down measurement with a bottom-up model built from ethnographically grounded processes is, as far as I am aware, the strongest available evidence that swidden landscapes are adaptively self-organized: large-scale patterns visible only from above are generated by the local decisions of farmers acting from within. Tellingly, the field sizes farmers reported in a 2018 household survey show no such power law, confirming that the pattern arises from how fields are coordinated across the landscape, not from how large any individual farmer makes them.

Taken together, this body of research spans top-down and bottom-up approaches and blends research questions and methods to identify plausible social and ecological leverage points that may relate to emergent properties of the coupled human-nature swidden system. Notably, this was achieved not by inventing new methods but by remixing established techniques of data collection and analysis from anthropology, remote sensing, ecology, history, economics, physics, and applied mathematics. The ways they were connected were specific to swidden agriculture and guided by the core concepts of adaptive self-organization outlined

in Table 3. The evidence presented here is, of course, incomplete; however, it is suggestive that adaptive self-organization can help dissolve the top-down/bottom-up disjuncture in swidden research and provide a productive pathway forward for swidden studies.

Conclusion

The concepts underlying adaptive self-organization were developed only in the closing decades of the twentieth century (Bak et al., 1987; May, 1976), and it was not until early in the 21st century that Lansing adapted them to explain the persistence and resilience of irrigated rice agriculture in Bali (Lansing & Kremer, 1993; Lansing, 2012). This was long after the study of swidden had already divided into the top-down and bottom-up traditions described in Section 3, so for most of the history of swidden research, the dominant approaches were unsuited for connecting the low-level social and ecological interactions documented by bottom-up studies to the landscape-scale patterns measured by top-down studies. The absence of a generalizable and integrated framework for analyzing cross-scale dynamics among social and environmental elements during the 20th century may have contributed to the conflation of normative and empirical premises (an unraveled rope) that has limited our ability to adequately explain swidden's ubiquity and persistence in human history. Researchers surely understood better than most where their methodologies supported rigorous and well-defended conclusions and where they did not. However, they may have been less aware of filling epistemic gaps with accumulated normative claims from their disciplinary research traditions and society-at-large, as well as powerful political actors and funding agencies. If the unraveled rope problem does characterize swidden studies, it means that the absence of a principled way to explain how smallholder swidden activity connected to landscape-scale outcomes may have opened a pathway for unsupported normative premises to fill in. This would be an epistemological counterpart to "the political economy of ignorance" that Dove documented in 1983.

My goal in developing an adaptive self-organization framework for swidden agriculture is to provide an integrated way of investigating its social and ecological conditions, historical trajectories, and the full range of possible outcomes, including sustainability and deforestation. In doing so, this approach shifts the focus of study away from normative premises about whether swidden is generally good or generally bad for the forest, and towards understanding the conditions under which particular outcomes emerge. Critically, this reframing does not discard the insights of earlier scholarship. Environmental carrying capacity is a real property of any physical environment, even if its dynamics are difficult to quantify and swidden forests are no exception to this. But recognizing this complexity guides swidden studies toward a different set of questions that are

less concerned with classifying swidden as either sustainable or destructive, and more concerned with identifying the conditions, thresholds, historical pathways, and leverage points through which particular social and ecological outcomes can emerge. As such, the goal is to resituate existing methodologies in a coupled-systems framework that can be used to investigate integrated patterns, processes, and dynamics of swidden systems that we know less about.

This critical review does not claim to resolve the normative swidden-is-bad bias Dove attributed to politics; that lies beyond an epistemic framework for research into swidden. What it does offer is more modest. For most of swidden's research history, no model could explain how small-scale societies affect large-scale environments, and without such a model, polarized "good" and "bad" normative claims have gone unchallenged. Adaptive self-organization is a possible way forward. A single coupled-systems framework cannot resolve every tension in a literature as vast and varied as swidden studies. And much of the evidence supporting the adaptive self-organized swidden framework is drawn from my own research and therefore remains preliminary. Nevertheless, I suggest that adaptive self-organization offers swidden studies a way to integrate its long-divided traditions within a coherent explanatory framework, and in doing so provides new ways of understanding the resilience and variability that draw so many scholars to study it in the first place.

Disclosure of Delegation to Generative AI

The author declares the use of generative AI in the research and writing process. According to the GAIDeT taxonomy (Suchikova et al., 2025), the following tasks were delegated to GAI tools under full human supervision: literature search and systematization, development of experimental or research protocols, data analysis, drafting text proposals, proofreading, and editing. The GAI tool used was: Perplexity Pro Version 26.22.0 (25) with Claude Opus 4.8 Thinking. Responsibility for the final manuscript lies entirely with the author. GAI tools are not listed as authors and do not bear responsibility for the final outcomes. Declaration submitted by: Sean S. Downey.

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