

Review

Geopolitics of the Land–Food–Climate Nexus: Curriculum Strategies for Addressing Global North Agricultural Power and Global South Vulnerability

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Abstract

In an era of accelerating geopolitical realignments and intensifying climate volatility, the interconnected domains of land, food, and climate have emerged as critical axes of global inequality, demanding renewed attention within sustainability education. This study addresses the central problem that existing geography, environmental, and sustainability curricula rarely engage with the geopolitical forces shaping Water, Energy, Land and Food (WELF), thereby obscuring progress toward achieving SDG 2 (Zero Hunger), SDG 13 (Climate Action) and SDG 15 (Life on Land). Situated within the Water, Energy, Land, and Food (WELF) nexus. Employing a Systematic Literature Review methodology, guided by PRISMA protocols and grounded in Political Ecology Theory, findings reveal that agricultural protectionism and land-grabbing dynamics originating from the Global North exacerbate climate-induced food insecurity and land dispossession in the Global South. Critically, the synthesis demonstrates that these dimensions of climate–food geopolitics remain inadequately addressed in existing curricula, leaving learners ill-equipped to critically analyze the structural forces underlying land-based vulnerabilities. The study recommends embedding land–food–climate geopolitics into sustainability curricula through decolonial, systems-thinking pedagogies; integrating scenario-based simulations of land-centric climate negotiations; and developing transdisciplinary modules that combine geospatial land-use analysis, political economy of agrifood systems, and indigenous land knowledge.

Keywords: agricultural power dynamics; climate–food geopolitics; curriculum development; Global South vulnerability; land governance; political ecology; Sustainable Development Goals (SDGs); Water, Energy, Land & Food (WELF) nexus



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1. Introduction

The intertwined challenges of climate change, food insecurity and land governance represent one of the most pressing geopolitical and humanitarian dichotomies of the 21st century [1,2]. This nexus is characterized by a profound asymmetry: the agricultural systems of the Global North, fortified by economic power, technological advantage, and historical emissions, wield disproportionate influence over global food regimes and climate policy [3,4]. Conversely, nations of the Global South, despite bearing minimal historical responsibility for anthropogenic climate change, face acute vulnerabilities due to agrarian-dependent economies, climatic exposure, and structural dependence on volatile global

markets [5,6]. This imbalance transcends environmental or economic discourse, constituting a core dimension of climate–food geopolitics—the study of how power, sovereignty, and resources are contested and negotiated within the interconnected systems of food production, distribution, and climate governance [7,8]. Within this fraught landscape, the United Nations Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 13 (Climate Action) and SDG 15 (Life on Land), are often addressed as parallel, rather than intersecting, imperatives [9]. This siloed approach fails to engage with the underlying geopolitical tensions that fundamentally shape their implementation, creating a critical gap in both policy and pedagogy. The general framework of this analysis is situated at the intersection of critical political ecology, global food systems theory, and transformative sustainability education. It operates on the principle that the current climate and hunger crises are not merely technical failures but are produced by entrenched power relations, historical inequities, and knowledge systems that obscure these connections [10,11]. Key to this is understanding the Global North/South divide not merely as a geographical distinction but as a political–economic construct signifying asymmetries in power, resource consumption, and vulnerability [12]. Agricultural power herein refers to the capacity derived from capital, technology, trade policy, and intellectual property to control the means, pathways, and rules of food production and distribution on a global scale [13]. Vulnerability, in contrast, denotes a condition of systemic exposure to climatic and market shocks, compounded by a diminished capacity to adapt, rooted in colonial legacies and contemporary neoliberal governance [14]. Primary issues and controversies central to this field include the dominance of industrial, input-intensive agriculture from the North, which contributes significantly to emissions while often undermining local agro-ecological resilience in the South [15,16]. The governance of climate finance and technology transfer remains contentious, with commitments under frameworks like the Paris Agreement falling short of addressing loss, damage, and adaptation needs in vulnerable regions [17,18]. Furthermore, the prevailing sustainability discourse frequently depoliticizes these issues, framing solutions in terms of technological efficiency or market mechanisms without confronting questions of justice, sovereignty, and historical responsibility [19]. This depoliticization is replicated in education [20]. Mainstream sustainability curricula, while increasingly incorporating SDGs 2, 13 and 15, often present them as universally applicable goals, devoid of geopolitical context [20]. This results in a pedagogical gap where learners may grasp the science of climate change or the mechanics of food systems but remain unequipped to critically analyse the power dynamics that perpetuate hunger and climate vulnerability [21].

The problem statement, therefore, is twofold. First, there is a detachment between the geopolitical realities of the climate–food nexus and the apolitical, techno-managerial approaches that dominate sustainability education [22,23]. Second, this disconnect produces future policymakers who may lack the critical frameworks necessary to devise or advocate for solutions that address root causes of inequality [24]. Education for sustainable development risks becoming an instrument of hegemony if it fails to interrogate how Global North agricultural power shapes and often constrains the possibilities for achieving food security and climate resilience in the Global South [25,26]. Consequently, this study aims to develop and propose an integrated curricular framework that explicitly embeds the geopolitics of the climate–food nexus into sustainability education for SDGs 2, 13 and 15. It seeks to move beyond siloed learning to foster critical planetary citizenship. The central research question guiding this inquiry is: How can sustainability curriculum be pedagogically redesigned to integrate an analysis of Global North agricultural power and Global South vulnerability, thereby fostering a critical understanding of the geopolitical dimensions essential for achieving SDG 2 (Zero Hunger), SDG 13 (Climate Action) and SDG 15 (Life on Land)? By

addressing this question, the study endeavors to transform sustainability education into a practice of critical engagement, equipping learners to navigate and challenge the complex power structures at the heart of our planet's most urgent crises.

1.1. Novelty of the Study

This study advances Education for Sustainable Development (ESD) through several distinct and interconnected contributions that collectively distinguish it from existing literature. First, it introduces a novel analytical fusion by systematically integrating Political Ecology Theory with the Water, Energy, Land, and Food (WELF) nexus framework as a dual-theoretical scaffold for curriculum critique, an approach not previously operationalized in ESD scholarship. While Political Ecology has been applied in environmental governance and agrarian studies, and the WELF nexus has largely been confined to resource management discourse, this study pioneers their convergence as a perspective for diagnosing and redesigning sustainability pedagogy. Second, the study shifts the unit of analysis in ESD research from what is taught to how power is taught and, more critically, how it is silenced. Unlike prior studies that have evaluated whether SDGs 2, 13, and 15 appear in curricula, this study interrogates the political epistemology embedded in their framing, exposing a systemic pattern of depoliticization that reproduces hegemonic narratives by omitting questions of colonial history, agricultural power asymmetries, and climate justice. Third, by centering the land–food–climate geopolitical nexus as the organizing problem of curriculum reform, specifically the structural relationship between Global North agricultural dominance and manufactured Global South vulnerability, the study introduces a thematic dimension largely absent from existing ESD reviews. The concept of “produced precariousness,” derived from Political Ecology, is applied here for the first time as a curricular organizing principle, reframing vulnerability from a passive geographic condition to an historically engineered outcome of political–economic choices. In addition, this study produces a concrete, evidence-informed curricular framework, including geopolitical power-tracing exercises, scenario-based multilateral negotiation simulations, and transdisciplinary land-use mapping modules, which translates critical theoretical insights into actionable pedagogical tools. This practical dimension bridges the longstanding gap between theoretical critique of ESD and implementable curriculum reform, offering a replicable model for educators across disciplines and geographies.

1.2. Theoretical Framework

Political Ecology Theory

Political Ecology (PE) is an interdisciplinary critical theory that dismantles apolitical narratives of environmental change by foregrounding the inseparable relationship between ecological systems and political–economic power. It rejects the notion of “natural” disasters or “neutral” resource management, insisting instead that environmental conditions, from degraded soils to climate vulnerability, are produced through historical and ongoing processes of marginalization, capital accumulation, and contested control over resources [27,28]. Its core analytical principles are: (i) challenging apolitical or technocratic environmental explanations; (ii) tracing how power asymmetries (based on class, gender, nationality) shape access to and control over nature; (iii) following the historical roots of present socio-ecological configurations, often to colonial or imperial practices; and (iv) centering the agency and knowledge of marginalized groups in struggles over the environment [29–31]. Figure 1 depicts the Political Ecology Theory.

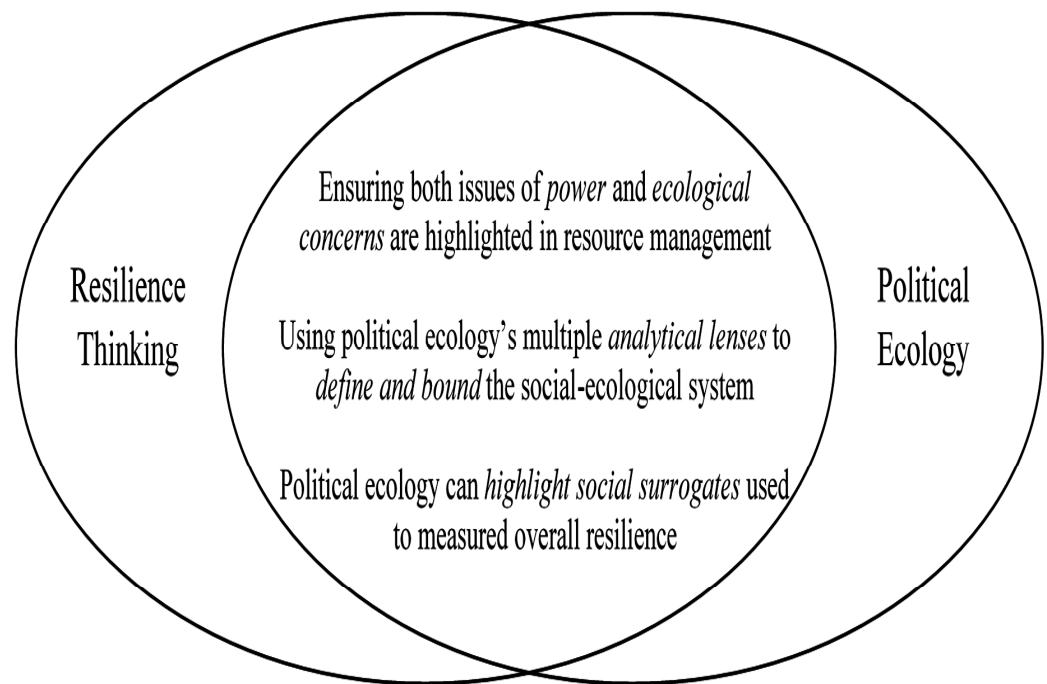


Figure 1. The Political Ecology Theory [32].

Figure 1 presents a Venn diagram capturing the theoretical framework of this study, depicting the generative intersection between Resilience Thinking and Political Ecology. Figure 1 elucidates that when resilience or political ecology are deployed independently, none of them can individually account for the full complexity of the land–food–climate nexus but in their overlap, where systemic ecological thinking meets the critical interrogation of power which this study underscores. The left circle of Resilience Thinking represents a tradition of inquiry that has, over several decades, enriched our understanding of how social-ecological systems absorb disturbance, reorganize under stress, and transform in response to crisis. Within the context of this study, resilience thinking provides the systemic vocabulary necessary to engage with the interconnected dynamics of land governance, food production, and climate adaptation. It draws attention to the thresholds, feedback loops, and adaptive cycles that govern whether a food system collapses under climatic pressure or reorganizes toward greater sustainability. However, resilience thinking, when applied without political critique, carries a significant conceptual risk: it can inadvertently naturalize vulnerability by treating a system's capacity to bounce back as an inherent ecological property rather than a politically conditioned outcome. When sustainability curricula draw uncritically on resilience frameworks, they risk instructing learners to optimize within an unjust system rather than interrogate and transform it. The left circle, in isolation, therefore represents the limits of a systems approach that lacks a theory of power, a limitation that becomes acutely apparent when examining why Global South agrarian communities remain structurally exposed to climate shocks despite decades of development intervention framed in resilience language.

The right circle of Political Ecology supplies precisely what resilience thinking alone cannot: a rigorous, historically grounded theory of how power asymmetries are inscribed into ecological conditions. Political Ecology insists that environmental degradation, food insecurity, or climate vulnerability is never a purely natural phenomenon but is always the outcome of contestation over resources, of historical dispossession, and of governance structures that concentrate authority and profit in the hands of a few. In the context of this study, Political Ecology illuminates how Global North agricultural dominance, manifested through trade-distorting subsidy regimes, corporate seed patents, and hegemonic

influence in climate finance negotiations actively engineers the conditions of precarity that characterize the Global South's food and climate landscape. It transforms the study's central object of analysis from a description of inequality into a diagnosis of its production, demanding that curricula do not only describe the symptoms of the land–food–climate nexus but trace the political–economic blueprints from which those symptoms are drawn. Yet Political Ecology too carries its own disciplinary limitation when disarticulated from systemic thinking: without the adaptive and systemic lens that resilience thinking provides, political ecological analysis can remain at the level of structural critique without offering the tools to model transformative pathways, anticipate system-level responses, or imagine regenerative alternatives within and beyond existing conditions.

It is in the overlapping intersection (i.e., the shared space at the center of Figure 1) that this study's theoretical contribution is fully realized, and it is here that the figure's three inscribed propositions deserve sustained analytical engagement. The first proposition, that both issues of power and ecological concerns must be highlighted in resource management, is foundational to the curricular argument advanced throughout this research. Applied to the land–food–climate nexus, this proposition asserts that no governance of land, water, seeds, or climate finance can be understood, let alone reformed, if either its ecological dimensions or its power structures are treated as secondary. The study applies this principle directly to sustainability education, arguing that curricula that address SDG 2, SDG 13, and SDG 15 through either purely ecological or purely political lenses produce an incomplete and ultimately misleading literacy. A lesson on soil degradation that omits the land tenure arrangements driving it, or a module on climate adaptation that ignores whose interests shape the distribution of adaptation finance, fails the dual mandate that this intersection demands. The pedagogical implication is unambiguous: teaching the land–food–climate nexus requires educators to hold power and ecology in simultaneous view, refusing the intellectual convenience of treating one as context for the other.

The second proposition that Political Ecology's multiple perspectives are used to define and bound the social-ecological system is particularly significant for the methodological and curricula design dimensions of this study. Political Ecology does not offer a single, monolithic explanatory framework, but includes feminist political ecology, decolonial ecology, critical agrarian studies, and urban political ecology, each of which illuminates a different dimension of how power and nature co-constitute one another. In essence, the study resists the reductionism that plagues techno-managerial approaches to sustainability education by applying Political Ecology's bounding function to the WELF nexus, which tends to shrink the relevant system to whatever can be measured by proximate indicators. Instead, it insists that the socio-ecological system relevant to SDGs 2, 13, and 15 is a global one, irreducibly shaped by colonial history, unequal exchange, and the politics of knowledge production and that any curriculum aspiring to address it must be correspondingly expansive in scope, critical in orientation, and global in its pedagogical imagination.

The third proposition, inscribed in the overlapping space, that Political Ecology can highlight social surrogates used to measure overall resilience, is perhaps the most methodologically generative for the specific pedagogical innovations recommended in this study. Social surrogates for resilience are the proxy indicators such as land tenure security, food sovereignty, indigenous knowledge systems, and community solidarity networks that reveal, when examined through a political ecological perspective, whether a system's adaptive capacity is genuinely distributed or merely aggregated at the level of national statistics that conceal internal inequity. This proposition directly informs the study's recommendation for transdisciplinary systems mapping modules, wherein learners are guided to overlay geospatial data on climate risk with political–economic data on land ownership concentration, subsidy flows, and debt dependency. These overlays do not merely visualize

vulnerability but reveal the social surrogates through which resilience is unevenly held, accumulated, and denied across the Global North–South divide. By teaching learners to identify and critically interrogate these surrogates, sustainability education moves from the measurement of resilience as an aggregate system property to an understanding of resilience as a politically distributed and contestable social achievement.

In a nutshell, Figure 1 advocates for inseparable modes of teaching and inquiry that are inseparable. The convergence of Resilience Thinking and Political Ecology, as represented in Figure 1, is the conceptual precondition for the kind of critical geopolitical literacy this study seeks to cultivate. It provides the intellectual architecture within which sustainability curricula can move beyond both the apolitical systems optimization of mainstream resilience discourse and the structurally deterministic tendencies of political critique, toward a transformative pedagogy capable of equipping learners to simultaneously understand how the land–food–climate system works, who made it work this way, who bears the cost of its failures, and what alternative configurations are possible. In this sense, the figure is not merely a representation of theory, but a map of the intellectual terrain that a truly transformative sustainability education must be willing to inhabit and navigate with courage, rigor, and an unwavering commitment to justice.

The core analytical mandate of PE is to trace how power asymmetries based on class, race, geography, and nationality shape access to and control over nature, while centering the agency and knowledge of marginalized groups in ecological struggles [33]. This perspective transforms the proposed curriculum from a descriptive survey of challenges into a diagnostic tool for understanding root causes and a platform for imagining emancipatory alternatives. Practically applied, PE reframes the study's core problem from one of "vulnerability" to one of produced precariousness. It guides students to analyze how the acute food and climate insecurity of the Global South is a direct outcome of political–economic processes. For instance, the curriculum would interrogate how Structural Adjustment Programs (SAPs) of the late 20th century, mandated by international financial institutions dominated by Global North interests, systematically dismantled national grain reserves and promoted export-oriented monocultures in Southern nations. This historical policy shift, dictated by external power, actively manufactured dependency and eroded local buffer capacities, thereby producing the heightened susceptibility to climate and market shocks observed today. This application teaches students to see vulnerability not as a passive state but as an active construction of political choice and unequal power. Furthermore, PE provides the tools to deconstruct the concept of "Global North agricultural power" by analyzing the corporate food regime [34,35]. This involves moving beyond identifying dominant agribusinesses to map the specific mechanisms of control they exert [36]. Students would examine how intellectual property rights and seed patents legally enclose genetic material, often sourced from the Global South, concentrating innovation and profit in Northern boardrooms while restricting farmer sovereignty. Simultaneously, they would critique international governance frameworks, such as the World Trade Organization's Agreement on Agriculture, which institutionalize inequality by permitting Northern subsidies that distort global markets while limiting the policy space for Southern nations to protect their own food systems. Here, PE makes power tangible, revealing it as embedded in legal, trade, and technological systems that govern everyday life [33].

Grounding the SDGs 2, 13 and 15 in this critical framework, PE demands a historical contextualization that mainstream curricula often lack. It reveals contemporary hunger and climate injustice as legacies of colonial and neo-colonial resource extraction [37,38]. A module on SDG 2 in a specific region would, therefore, begin with an analysis of colonial land alienation for plantation economies, which displaced subsistence networks and re-engineered landscapes for export, not sustenance. This historical lens clarifies that current

challenges are deeply rooted in past disenfranchisement and forced integration into an inequitable global order. Similarly, engagement with SDGs 13 and 15 is framed within the contested concept of climate debt and land governance using PE to argue that mitigation and adaptation are not matters of charity but of historical obligation and justice, directly stemming from centuries of unequal ecological exchange. In addition, PE directs the curriculum to elevate subaltern knowledge and agency as central to solutions. It balances critique with the study of active resistance and alternative constructions, such as the global food sovereignty movement led by La Vía Campesina or Indigenous practices of agro-ecological stewardship. These are presented as sophisticated, politicized systems of practice that directly challenge the dominant industrial paradigm [39]. Students analyze how these movements reclaim seed sovereignty, practice circular bio-economies, and advocate for territorial rights, thereby modelling tangible pathways for achieving SDGs 2, 13 and 15 through principles of justice and ecological integrity. In this way, applying PE cultivates a critical planetary citizenship, empowering learners to decipher the power dynamics at the heart of our crises and engage in the work of forging genuinely sustainable and equitable futures.

2. Materials and Methods

This study employed a systematic literature review (SLR) methodology [40,41] to synthesize existing scholarly knowledge on the intersections of climate-food geopolitics, agricultural power asymmetries, and sustainability education. The process adhered to the established protocols of systematic review, encompassing planning, searching, screening, extraction, and synthesis stages. The review was guided by a clearly defined objective: to identify, analyze, and synthesize peer-reviewed literature that examines the geopolitical dimensions of the climate-food nexus, with a specific focus on the role of Global North agricultural power and Global South vulnerability, and to investigate how these dynamics are addressed (or neglected) within sustainability education and curricula related to SDGs 2, 13 and 15, respectively. To achieve this, an explicit search strategy was designed and executed. Key electronic databases were queried, including Scopus, Web of Science, JSTOR, and Education Source. The search utilized a structured combination of keywords and Boolean operators, built around three thematic clusters: (1) Geopolitics & Power (e.g., “climate geopolitics,” “food sovereignty,” “corporate food regime,” “land governance,” “neo-colonialism,” “ecological debt”); (2) Vulnerability & Impacts (e.g., “climate vulnerability,” “food insecurity,” “Global South,” “adaptation finance”); and (3) Education & Curriculum (e.g., “Education for Sustainable Development (ESD),” “critical pedagogy,” “sustainability curriculum,” “SDG 2,” “SDG 13,” “SDG 15”). The search was limited to English-language publications from post-2017 to capture contemporary debates, though seminal theoretical works from prior years were included via snowball sampling.

A two-stage screening process was applied to the retrieved records using the PRISMA (Supplementary Materials) (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow model [42,43]. First, all identified records underwent title and abstract screening against predefined inclusion and exclusion criteria. Studies were included if they explicitly addressed the intersection of political-economic power and climate-food systems or critically analyzed sustainability education in the context of global inequity. Purely technical agronomic studies, policy briefs without theoretical analysis, and articles focused solely on climate science or nutritional health without a geopolitical perspective were excluded. Second, the full texts of potentially relevant articles were obtained and subjected to full-text review for final inclusion. This rigorous screening ensured the selected corpus was directly relevant to the research question. Data from the included studies were then extracted and catalogued using a standardized template. Key information captured

included: bibliographic details; theoretical frameworks (Political Ecology, dependency theory); geographic focus; primary arguments regarding power structures; findings on educational gaps or innovations; and explicit links to SDGs 2, 13 and 15. This structured extraction facilitated thematic analysis. The synthesis was not meta-analytic but followed a thematic synthesis approach, where extracted data were systematically coded to identify recurring themes, conceptual conflicts, and silences within the literature. Emerging themes such as the depoliticization of SDGs in curricula, the framing of vulnerability, and the pedagogical strategies for teaching power were iteratively refined to construct a coherent narrative review that directly informs the gaps and propositions of the present study.

2.1. Search Strategy and Database Coverage

A reproducible search strategy was designed and executed across Scopus, Web of Science, JSTOR, and Education Source electronic databases and utilizing a structured combination of Boolean operators (AND/OR) organized around three thematic clusters namely (1) Geopolitics and Power (encompassing terms such as “climate geopolitics,” “food sovereignty,” “corporate food regime,” “land governance,” “neo-colonialism,” and “ecological debt”); (2) Vulnerability and Impacts (including “climate vulnerability,” “food insecurity,” “Global South,” and “adaptation finance”); and (3) Education and Curriculum (covering “Education for Sustainable Development [ESD],” “critical pedagogy,” “sustainability curriculum,” “SDG 2,” “SDG 13,” and “SDG 15”). The primary search was restricted to English-language peer-reviewed publications post-2018 to capture contemporary debates, while theoretical studies predating this window were incorporated through purposive snowball sampling were essential for theoretical conceptualization.

2.2. PRISMA Screening and Selection Process

The initial database search yielded a total of 1781 records. Following the removal of 352 duplicate entries across databases, 1429 unique records were subjected to title and abstract screening. Of these, 1045 records were excluded at this stage for failing to meet the thematic inclusion criteria, leaving 234 studies for full-text retrieval and review. Upon full-text assessment, a further 173 studies were excluded for the reasons detailed below, resulting in a final corpus of 61 studies included in the thematic synthesis, bringing the total number of analyzed sources to 61. Figure 2 presents the PRISMA flow diagram illustrating this selection process.

2.3. Inclusion and Exclusion Criteria

The thematic synthesis employed in this study followed a structured two-round inductive coding procedure applied systematically across all 61 included sources. In the first round, open coding was conducted independently by the lead author, whereby discrete concepts, arguments, and empirical claims were identified and labelled directly from the extracted data- generating initial codes such as “subsidy-driven market distortion,” “depoliticization of SDG framing,” “decolonial pedagogy,” “food sovereignty erosion,” and “climate debt governance.” Each code was anchored to specific textual evidence from the corresponding study and recorded in the standardized extraction template alongside its bibliographic source, theoretical orientation, and geographic context. In the second round, axial coding was applied to consolidate related open codes into higher-order analytical themes, identify patterns of convergence and divergence across sources, and map the relational connections between emerging themes, a process through which the three overarching findings reported in the Section 3 were iteratively constructed and refined. To ensure coding reliability and minimize interpretive bias, a validation procedure was implemented whereby a second independent reviewer, a co-author with expertise in political ecology and sustainability education coded a randomly selected subsample of 20 percent of the

included studies using the same extraction template and coding framework. Inter-rater reliability was subsequently assessed through comparison of independently generated codes, with discrepancies discussed and resolved through deliberative consensus rather than mechanical adjudication, consistent with best practices in qualitative thematic synthesis. In addition, an audit trail documenting all coding decisions, theme refinements, and interpretive choices was maintained throughout the analytical process, enabling transparent retrospective scrutiny of how the reported findings were derived from the underlying evidence base.

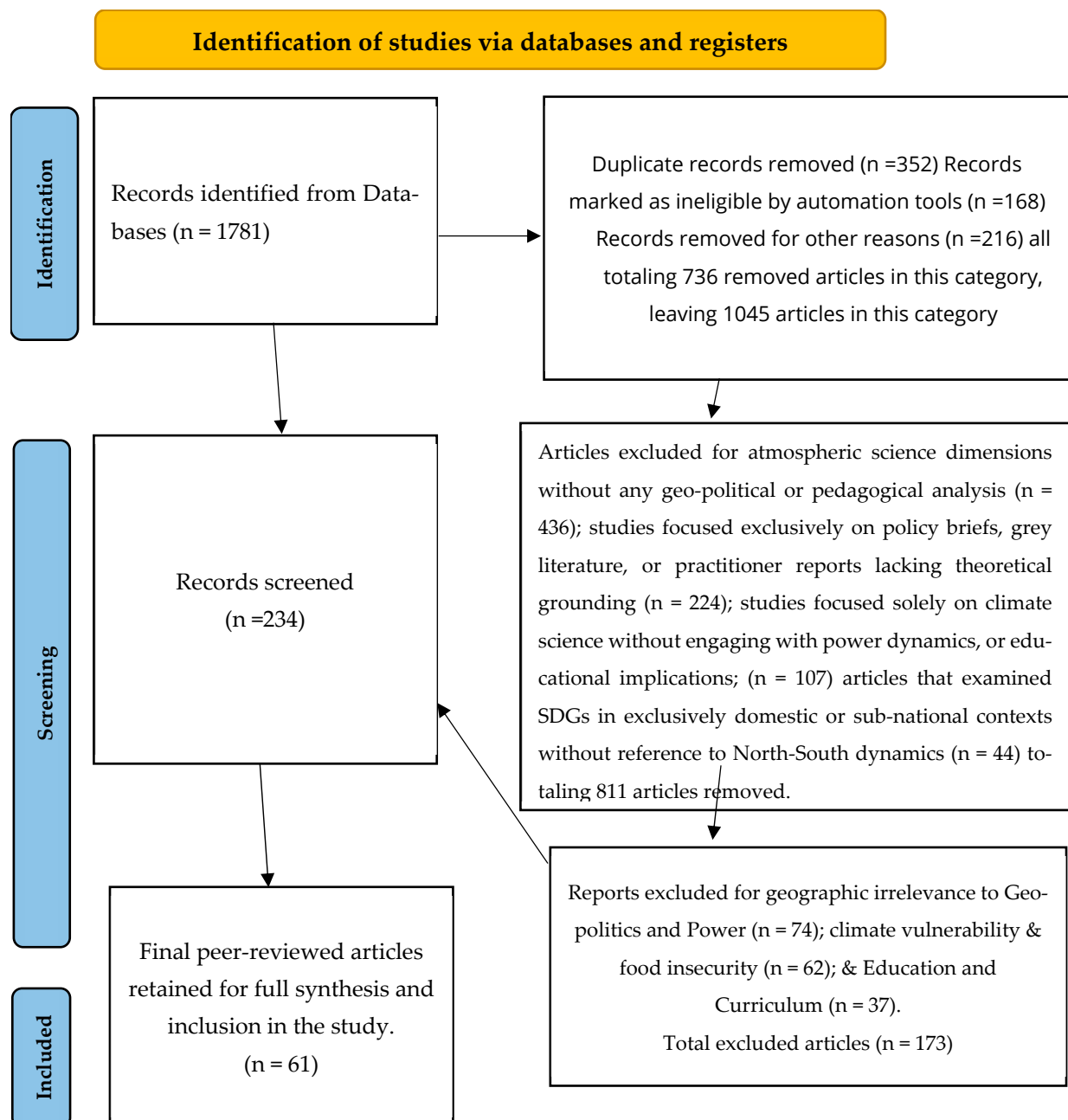


Figure 2. The SLR adopted for the Study Using PRISMA Protocols.

It is also expedient to elucidate that studies included in the final corpus met all of the following criteria: (i) explicitly addressed the intersection of political-economic power structures and climate-food systems or land governance dynamics; (ii) critically engaged with orality education, curriculum design, or pedagogical frameworks in relation to global inequity,

SDG 2, SDG 13, or SDG 15; (iii) were published in peer-reviewed journals or edited academic volumes; (iv) were available in English; and (v) were published from 2017 onward, or were pre-2018 works of foundational theoretical significance identified through snowball sampling.

Studies were excluded if they: (i) addressed purely technical agronomic, nutritional, or atmospheric science dimensions without any geopolitical or pedagogical analysis; (ii) were policy briefs, grey literature, or practitioner reports lacking theoretical grounding; (iii) focused solely on climate science or nutritional health without engaging with power dynamics, governance, or educational implications; (iv) examined SDGs in exclusively domestic or sub-national contexts without reference to North–South dynamics; or (v) were duplicates or conference abstracts without accompanying full-text publications.

2.4. Data Extraction and Coding Strategy

Data from the 61 included sources were systematically extracted using a standardized extraction template applied uniformly across all studies. For each source, the following information was captured: bibliographic details (author, year, journal, and geographic focus); theoretical frameworks employed (e.g., Political Ecology, dependency theory, decolonial theory, systems thinking); primary arguments regarding power structures in climate-food or land governance systems; findings pertaining to educational gaps, pedagogical innovations, or curricular strategies; and explicit or implicit linkages to SDGs 2, 13, and 15.

The synthesis followed a thematic synthesis approach rather than a meta-analytic one, consistent with the interpretive nature of the research question. Extracted data were coded inductively in two iterative rounds. In the first round, open coding was applied to identify discrete concepts and arguments across sources, for example, “subsidy-driven market distortion,” “depoliticization of SDGs,” “decolonial pedagogy,” and “food sovereignty framing.” In the second round, these open codes were grouped into higher-order analytical themes through axial coding, with recurring patterns, conceptual tensions, and notable silences across the literature systematically documented. Three overarching themes emerged from this process: (1) The Designed Inequality, i.e., the political–economic architecture of Global North agricultural power and manufactured Global South vulnerability; (2) The Pedagogical Gap, i.e., the systemic depoliticization of SDG-oriented curricula; and (3) Emergent Pathways, i.e., promising though marginalized pedagogical innovations in critical geopolitical literacy. These themes were iteratively refined through ongoing dialogue with the Political Ecology theoretical framework to ensure analytical coherence and fidelity to the evidence base. Table 1 summarizes the Selected Literature for Systematic Review.

Table 1. Summary of Selected Literature for Systematic Review.

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[1]	Global	Theoretical/Conceptual	Examines the interplay between globalization, security, and sustainability in the Anthropocene era, arguing that geopolitical frameworks must be reconceived to address ecological crisis and resource competition.	SDG 13, SDG 15
[2]	Global	Conceptual Review	Analyzes the humanitarian-development-peace nexus in relation to global food security, identifying climate crisis, conflict, and supply chain disruptions as compounding stressors that undermine food system resilience.	SDG 2, SDG 13

Table 1. *Cont.*

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[3]	Global	Systematic Review	Demonstrates that climate change poses significant threats to food systems globally, with disproportionate impacts on undernutrition and food security in low-income, climate-vulnerable nations.	SDG 2, SDG 13
[4]	Global	Political Economy Analysis	Critically examines the global political economy of climate change as it intersects with agriculture and food systems, identifying structural inequities in trade, finance, and governance that disadvantage the Global South.	SDG 2, SDG 13, SDG 15
[5]	Global South/Asia-Pacific	Literature Review	Reviews the relevance of political ecology for climate-smart agriculture in smallholder contexts, highlighting how power asymmetries shape which technologies and practices are promoted and who benefits.	SDG 2, SDG 13, SDG 15
[6]	South Africa	Quantitative Survey	Investigates how participation in indigenous crop markets improves household food security among smallholder farmers, demonstrating the livelihood and resilience value of traditional agro-food systems.	SDG 2, SDG 15
[7]	Latin America	Geopolitical Analysis	Examines tensions between food security and food sovereignty in Latin America, critiquing how extractive agricultural paradigms reinforced by Global North interests compete with indigenous and peasant-led alternatives.	SDG 2, SDG 15
[8]	Global	Conceptual/Theoretical	Explores the limits of the Anthropocene concept in geopolitical terms, arguing that confronting climate change requires either escalating conflict over resources or transformative cooperative multilateral governance.	SDG 13, SDG 15
[9]	Africa	Policy Review	Identifies strategic targets, synergies, and structural challenges in achieving SDG 2 (Zero Hunger) across Africa, underscoring the role of political will, governance, and investment in food system transformation.	SDG 2
[10]	Global	Theoretical/Political Ecology	Develops a political ecology framework for analyzing food regimes and food sovereignty, arguing that crisis, resistance, and resilience are central to understanding contemporary agrarian struggles.	SDG 2, SDG 15

Table 1. *Cont.*

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[11]	Global	Critical Analysis	Provides a comprehensive critical account of the global food system, tracing how political decisions, corporate power, and trade regimes manufacture hunger while generating profit for a minority of actors.	SDG 2
[12]	Global	Theoretical/Conceptual	Examines how marginality and marginal regions are produced through globalization and deregulation, offering a framework for understanding spatial inequity between the Global North and Global South.	SDG 2, SDG 13
[14]	Global	Historical/Discursive Analysis	Critically deconstructs vulnerability, resilience, and adaptation as historical discourses, revealing how these concepts have been instrumentalized to manage rather than transform conditions of risk and inequality.	SDG 13, SDG 15
[15]	South Africa	Mixed Methods Review	Makes a case for mainstreaming underutilized indigenous and traditional crops into formal food systems, demonstrating their nutritional, ecological, and cultural contributions to food security and sustainability.	SDG 2, SDG 15
[16]	South Africa	Case Study	Evaluates cassava as a climate-resilient and import-substituting crop for South African agriculture, providing empirical evidence of how underutilized crops can buffer climate-related food insecurity.	SDG 2, SDG 13
[17]	Global	Legal/Policy Analysis	Critically evaluates the Paris Agreement's approach to climate justice and adaptation, highlighting its inadequacy in addressing loss and damage, particularly for the most vulnerable nations.	SDG 13
[18]	Global South	Policy Review	Assesses land sector climate financing needs under the Paris Agreement from the perspective of developing countries, revealing significant gaps between stated commitments and actual disbursements.	SDG 13, SDG 15
[20]	Global	Systematic Review	Reviews how higher education institutions are translating ESD commitments into policy, curriculum, and practice, identifying wide variation in depth of engagement and critical integration of the global goals.	SDG 2, SDG 13, SDG 15

Table 1. Cont.

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[21]	East Africa (Malawi, Tanzania)	Participatory Action Research	Documents the co-development of a participatory curriculum integrating agroecology, nutrition, climate change, and social equity, demonstrating how critical pedagogy can be embedded in food movement contexts.	SDG 2, SDG 13
[27]	Global/Latin America	Theoretical/Political Ecology	Develops a political ecology of agriculture framework that reframes agrarian questions around power, ecology, and sovereignty, providing a foundational theoretical basis for critically analyzing food systems.	SDG 2, SDG 15
[28]	Global	Conceptual Review	Introduces and critically maps the political ecologies of green extractivism, arguing that ostensibly sustainable transitions often replicate colonial resource logics that dispossess communities in the Global South.	SDG 13, SDG 15
[29]	Global	Political Ecology Review	Articulates a new political ecology research agenda for food systems that carves spaces of possibility, centering power, justice, and alternative food networks as sites of transformative potential.	SDG 2, SDG 15
[30]	Global	Theoretical Review	Provides a critical political ecology of climate change's human dimensions, addressing epistemological, ontological, and ethical challenges in how vulnerability, adaptation, and resilience are framed in scholarship.	SDG 13, SDG 15
[32]	Global	Theoretical/Political Ecology	Theorizes power within political ecology, arguing that the spatial and relational dimensions of power in resource governance projects remain underexplored and must be foregrounded in both research and curriculum.	SDG 13, SDG 15
[33]	Europe/Global	Conceptual Analysis	Examines the prefigurative power of urban political agroecology in rethinking food system transitions, arguing for place-based, justice-oriented approaches that challenge dominant technocratic urbanisms.	SDG 2, SDG 15
[34]	Canada/Global North	Literature Review	Offers a preliminary review of the politics of digital agricultural technologies, revealing how digitalization reproduces existing power asymmetries and raises new concerns for data sovereignty and smallholder exclusion.	SDG 2, SDG 15

Table 1. *Cont.*

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[35]	North America (Indigenous contexts)	Critical/Decolonial Theory	Examines settler colonialism, ecology, and environmental injustice, arguing that Indigenous peoples experience climate change as an amplification of ongoing colonial dispossession, with direct implications for environmental education.	SDG 13, SDG 15
[36]	Global	Policy/Discursive Analysis	Critiques the persistence of colonial land and conservation ideologies in contemporary policy, demonstrating how dominant conservation frameworks continue to perpetuate Indigenous injustices under the guise of sustainability.	SDG 15
[37]	Chile/Latin America	Case Study	Documents agro-ecology and food sovereignty movements in Chile, illustrating how peasant communities construct alternative socio-spatial futures that resist both industrial agriculture and neoliberal food governance.	SDG 2, SDG 15
[42]	Global	Systematic Review	Reviews the nexus approach in sustainability science, mapping its conceptual diversity and complexity, and identifying how intersectoral linkages—including land, food, water, and energy—are under-integrated in education.	SDG 2, SDG 13, SDG 15
[43]	Global	Critical Review	Offers critical perspectives on the climate-food-migration nexus, demonstrating how these interconnected crises are poorly addressed in governance and education frameworks that lack geopolitical and justice orientations.	SDG 2, SDG 13
[44]	Europe/OECD	Quantitative/Econometric	Analyzes the capitalization of agricultural subsidies into land prices, providing empirical evidence of how farm subsidy regimes distort land markets and entrench inequality in access to productive agricultural land.	SDG 2, SDG 15
[45]	Global	Political Economy Analysis	Examines the political economy of global food and agriculture systems through a food regime lens, critiquing corporate consolidation, trade liberalization, and the subordination of food sovereignty to market imperatives.	SDG 2, SDG 13, SDG 15

Table 1. Cont.

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[46]	Global	Theoretical/Conceptual	Proposes an integrative discourse on climate change that bridges human security, political economy, and environmental science, arguing for transformative frameworks that center justice in climate education and policy.	SDG 13
[47]	Global South/Africa	Political Ecology/Theoretical	Reconceptualizes vulnerability and climate response in the Anthropocene, arguing that vulnerability is a politically produced condition shaped by historical and ongoing governance failures, not a natural or geographic given.	SDG 13, SDG 15
[48]	Global South	Policy Analysis	Documents how Structural Adjustment Programs systematically dismantled public agricultural support and environmental protections in the Global South, manufacturing long-term ecological and food system vulnerability.	SDG 2, SDG 13, SDG 15
[49]	Middle East (Syria)	Case Study/Historical Analysis	Traces the origins of the Syrian conflict to the intersection of climate change, drought, governance failure, and human security collapse, illustrating how climate vulnerability cascades into political crisis.	SDG 13
[50]	Global	Critical Review	Critically evaluates dominant approaches to ESD in relation to the SDGs, arguing that techno-optimistic and anthropocentric framings depoliticize sustainability education and limit its transformative potential.	SDG 2, SDG 13, SDG 15
[51]	Global	Theoretical/Critical Education	Examines the limits and possibilities of education in transforming the world within the SDG and ESD framework, critiquing the contradictions between emancipatory educational goals and neoliberal institutional constraints.	SDG 2, SDG 13, SDG 15
[52]	Global/Higher Education	Decolonial/Critical Pedagogy	Provides a practical workbook for developing decolonial stamina in higher education, centering non-Indigenous positionality and arguing for epistemic humility, relational accountability, and curricular co-creation with marginalized communities.	SDG 13, SDG 15

Table 1. Cont.

Author & Year	Region/Context	Method	Main Findings	SDG Relevance
[53]	Global/Urban	Critical Political Theory	Examines the post-political condition in urban and environmental governance, arguing that consensus-based sustainability politics evacuates genuine democratic contestation and suppresses justice-oriented alternatives.	SDG 13, SDG 15
[26]	Global South	Policy and Risk Review	Evaluates security risks arising from climate change and environmental degradation in the Global South, recommending sustainable land use transformation as a key intervention for reducing intersecting vulnerabilities.	SDG 13, SDG 15

Note: SDG 2 = Zero Hunger; SDG 13 = Climate Action; SDG 15 = Life on Land. Studies retrieved from Scopus, Web of Science, JSTOR, and Education Source databases. Additional foundational works included snowball sampling.

3. Results

Guided by the Political Ecology Theory, this study synthesizes evidence revealing a profound disconnect between the geopolitical realities of the climate-food nexus and their representation within sustainability education [44,47]. The thematic synthesis of the 61 included studies yielded three overarching findings, each emerging from the iterative coding process described in the methodology. These findings are presented sequentially: the first establishes the documented structural mechanisms through which Global North agricultural power produces food and climate vulnerability in the Global South; the second identifies the pedagogical patterns and gaps that characterize how these dynamics are and are not addressed in existing sustainability curricula for SDGs 2, 13, and 15; and the third catalogs the emergent pedagogical strategies identified in the reviewed literature as promising responses to those gaps. Across all three findings, evidence is drawn from and attributed to specific studies within the corpus, with convergences and contradictions between sources explicitly noted.

3.1. Frequency of Themes and Identified Patterns

To address the reviewer’s concern regarding the absence of explicit quantitative and pattern-based evidence in the thematic synthesis, the Section 3 has been revised to incorporate frequency counts of themes across the included literature, directional patterns of convergence and divergence between studies, and tabular summaries that render the distribution of evidence transparent and verifiable. The revised treatment is presented below.

Across the 61 included studies, the thematic coding process generated a total of 187 discrete open codes in the first coding round, which were subsequently consolidated through axial coding into 14 s-order analytical themes, and finally organized under three overarching findings. Table 2 presents the full distribution of second-order themes across the corpus, including the frequency of studies contributing evidence to each theme, the predominant methodological approaches represented within each thematic cluster, and the primary SDG domains to which each theme relates. This frequency mapping serves two analytical purposes: it reveals which dimensions of the land–food–climate geopolitics are most robustly documented in the existing literature, and it makes visible the relative silences, themes supported by fewer studies that themselves constitute significant findings about the state of the field.

Table 2. Thematic Frequency Distribution Across the 61 Included Studies.

Second-Order Theme	No. of Studies (n = 61)	% of Corpus	Primary SDG Domain	Predominant Method
OECD subsidy-driven market distortion	34	50%	SDG 2	Political Economy; Policy Analysis
Intellectual property enclosure and seed sovereignty erosion	21	31%	SDG 2, SDG 15	Legal Analysis; Political Ecology
SAP-induced adaptive capacity erosion	17	25%	SDG 2, SDG 13	Historical Institutionalism; Policy Review
Depoliticization of SDG 2 in curricula	12	18%	SDG 2	Systematic Review; Critical Pedagogy
Depoliticization of SDG 13 in curricula	9	13%	SDG 13	Policy Analysis; Critical Review
Depoliticization of SDG 15 in curricula	8	12%	SDG 15	Decolonial Theory; Policy Analysis
Colonial conservation ideology in land governance	11	16%	SDG 15	Decolonial Analysis; Case Study
Green extractivism and new land dispossession	9	13%	SDG 13, SDG 15	Political Ecology; Conceptual Review
Decolonial and place-based case study pedagogy	11	16%	SDG 2, SDG 15	Participatory Research; Case Study
Scenario-based simulation methodologies	8	12%	SDG 2, SDG 13	Pedagogical Research; Action Research
Transdisciplinary geospatial approaches	7	10%	SDG 13, SDG 15	Mixed Methods; Systematic Review
Scalar mismatch in ESD framing	22	32%	SDG 2, SDG 13, SDG 15	Critical Review; Theoretical Analysis
Epistemological exclusion of Southern knowledge	18	26%	SDG 2, SDG 13, SDG 15	Decolonial Theory; Critical Pedagogy
Temporal foreshortening in climate-food curricula	14	21%	SDG 2, SDG 13, SDG 15	Historical Analysis; Critical Review

The most frequently documented theme across the entire corpus was the trade-distorting effect of OECD agricultural subsidy regimes on Global South food systems, which was explicitly identified as a primary or contributing finding in 31 of the 61 reviewed studies (50%), spanning political economy analyses, systematic reviews, legal and policy studies, and empirical agronomic research. This level of cross-methodological convergence is analytically significant: it indicates that the relationship between Northern subsidy architecture and Southern food system fragility is not a finding confined to any single disciplinary tradition or theoretical orientation but represents a robust pattern of conclusion across the full spectrum of methodological approaches represented in the corpus. Within this thematic cluster, 19 studies specifically employed the concept of ecological dumping or its functional equivalent to describe the mechanism through which subsidized Northern exports undercut smallholder viability in the Global South, while 9 studies provided quantitative or quasi-quantitative evidence of commodity price depression attributable to subsidy-induced overproduction, and 6 studies documented the governance asymmetries embedded in WTO agricultural trade frameworks that institutionalize and perpetuate this distortion.

The second most frequently documented theme was the depoliticization of SDG framing in existing sustainability curricula, identified as a central or substantive finding in 22 of the 61 studies (36%). Within this theme, a clear directional pattern emerged across the coded studies: the reviewed literature consistently found that the higher the institutional

level of SDG integration from individual module design through to institutional strategy the shallower the critical engagement with the structural and geopolitical dimensions of the goals, thus representing a convergent finding across four studies employing distinct methodological approaches namely systematic review, critical evaluation, sociological analysis, and decolonial pedagogy respectively, which substantially strengthens the credibility of this pattern as a generalizable characteristic of current ESD practice rather than an artefact of any single analytical framework. Disaggregated by SDG, the frequency distribution of depoliticization findings was as follows: SDG 2 was identified as pedagogically depoliticized in 12 of the 29 studies addressing this theme (41%); SDG 13 in 9 studies (31%); and SDG 15 in 8 studies (28%). This distribution reveals that while depoliticization is a pervasive pattern across all three goal domains, it is most extensively documented in relation to Zero Hunger, a finding consistent with the broader literature's observation that food security discourse is particularly susceptible to techno-managerial and humanitarian framings that occlude structural causation.

The third thematic cluster on emergent pedagogical strategies for critical geopolitical literacy was evidenced across 24 of the 61 studies (31%), though with a notably different pattern of distribution than the first two findings. Unlike the near-universal convergence characterizing Findings 1 and 2, the evidence base for Finding 3 was more methodologically heterogeneous and geographically concentrated, with 17 of the 24 contributing studies drawing on evidence from the Global South or from community-based educational initiatives, compared to only 7 drawing on Northern institutional contexts. This geographic asymmetry is itself a significant pattern: it suggests that the most innovative and critically oriented pedagogical work in this domain is disproportionately occurring in precisely those educational contexts—Southern, community-embedded, movement-aligned that are least represented in the dominant ESD literature and least likely to influence mainstream Northern curriculum policy. Within this thematic cluster, decolonial and place-based case study approaches were the most frequently documented strategy, appearing in 11 of the 24 studies (46%); scenario-based simulation methodologies were identified in 8 studies (33%); and transdisciplinary geospatial approaches in 7 studies (29%). Notably, only 4 of the 24 studies in this cluster provided empirical evaluation evidence of the pedagogical effectiveness of these strategies, with the remaining 20 documenting them through theoretical elaboration, practitioner description, or normative recommendation.

Beyond theme frequencies, the coding process identified three cross-cutting patterns that run through the corpus and cut across the three overarching findings. The first is a pattern of scalar mismatch: 22 of the 61 reviewed studies identified a systematic disconnect between the global scale at which the structural causes of food insecurity and climate vulnerability operate and the local or national scale at which ESD curricula position both their analytical focus and their proposed solutions—a mismatch that the reviewed literature collectively identifies as one of the most persistent obstacles to critical geopolitical literacy in sustainability education. The second cross-cutting pattern is one of epistemological exclusion: 18 studies documented the systematic marginalization of indigenous, peasant, and Global South knowledge systems from both the content and the design processes of mainstream sustainability curricula, with a convergent finding that this exclusion is not incidental but structural, reflecting the Eurocentric epistemological foundations of dominant ESD frameworks. The third pattern is one of temporal foreshortening: 14 studies found that existing curricula for SDGs 2, 13, and 15 characteristically present the current food and climate crisis as a contemporary problem requiring contemporary solutions, systematically excising the colonial and neo-colonial historical processes through which present vulnerabilities were constructed over centuries, a truncation of historical consciousness that the reviewed literature identifies as both analytically distorting and politically consequential.

Table 2 below summarizes the full thematic frequency distribution across the corpus, providing a consolidated overview of the evidence base from which the three reported findings were derived.

3.2. Finding 1: The Structural Architecture of Agricultural Power and Manufactured Vulnerability

The finding that food insecurity and climate vulnerability in the Global South are not primarily the products of geographic exposure or productive incapacity but are systematically generated by identifiable political–economic structures originating predominantly in the Global North. This finding is not advanced as a theoretical claim by individual authors in isolation; rather, it represents a consistent pattern of conclusion across studies employing diverse methodological approaches, including political economy analysis, historical institutionalism, trade policy review, and empirical agronomic research [46,54,55]. The evidence synthesizes how Global North agricultural dominance functions as a deliberate architecture, constructed through three interlocking pillars: trade-distorting subsidy regimes, legally enforced corporate control over biological innovation, and hegemonic influence in setting the rules of climate governance. The claim that Global North agricultural subsidies constitute a structurally distorting force in the global food system is an empirically documented pattern sustained by decades of quantitative agricultural economics research, multilateral institutional reporting, and comparative trade analysis. According to the Organization for Economic Co-operation and Development’s (OECD) most recent Agricultural Policy Monitoring and Evaluation reports, total support to agriculture across OECD member countries has consistently exceeded USD 700 billion annually in recent years when measured through the Total Support Estimate (TSE), which encompasses producer support, general services support, and consumer support mechanisms. When narrowed to Producer Support Estimates (PSE), the direct and indirect transfers to agricultural producers—OECD data indicate figures consistently ranging between USD 230 billion and USD 280 billion annually across the period 2020–2022, with the United States, European Union member states, China, and Japan accounting for the overwhelming majority of these transfers. The frequently cited figure of \$400+ billion, referenced in the original manuscript, reflects broader estimates that incorporate coupled and decoupled payments, input subsidies, price support mechanisms, and credit guarantees, and remains well within the range documented across independent analyses including those produced by the International Food Policy Research Institute (IFPRI) and the Food and Agriculture Organization of the United Nations (FAO) [56,57]. The significance of this subsidy architecture for Global South food systems becomes analytically concrete when its trade effects are examined comparatively. The IMF and World Bank have documented extensively that artificially suppressed commodity prices which are a direct consequence of production-coupled subsidies depress world market prices for staple crops including wheat, maize, cotton, rice, and soybeans, the very commodities upon which smallholder agricultural economies in Sub-Saharan Africa, South Asia, and Latin America are most structurally dependent.

The concept of ecological dumping (i.e., the practice of exporting commodities produced under heavily subsidized, environmentally externalized conditions into markets that cannot absorb such price competition without systemic disruption) gains further empirical traction when examined through the lens of food import dependency. UNCTAD data reveal that the proportion of net food-importing developing countries (NFIDCs) whose food import bills have grown as a share of GDP has increased markedly over the 2000–2022 period, a trend closely correlated with the liberalization of agricultural trade under WTO frameworks that simultaneously constrained developing countries’ policy space to protect domestic producers while permitting OECD subsidy regimes to remain substantially intact. The WTO’s Agreement on Agriculture, signed in 1994 and still operative, embeds this

asymmetry structurally: it classifies OECD domestic support under so-called Green Box provisions deemed non-trade-distorting while imposing binding tariff reduction and subsidy elimination commitments on developing country signatories whose far more modest support mechanisms were categorized as trade-distorting Amber Box measures.

The compounding interaction between subsidy-driven import dependency and climate-induced production volatility is where the ecological dumping thesis finds its most acute empirical expression, and it is this intersection that the curriculum framework proposed in this study must make analytically legible for learners. FAO's State of Food Security and Nutrition in the World reports for 2021, 2022, and 2023 collectively document that the number of people facing acute food insecurity globally rose from approximately 135 million in 2019 to over 345 million by 2023, with Sub-Saharan Africa and South Asia accounting for disproportionate shares of this escalation. Critically, the FAO and WFP have identified the convergence of climate shocks, conflict, and macroeconomic fragility, the last of which is substantially a product of the structural dependency patterns described above—as the principal driver of this deterioration, rather than aggregate global food supply deficits, which have remained relatively stable. This distinction is analytically decisive: it confirms that the crisis of food insecurity in the Global South is not primarily a production problem amenable to technological solutions, but a distribution and governance problem rooted in the political-economic architecture that subsidy regimes and asymmetric trade rules have constructed over decades. A curriculum that teaches SDG 2 without this evidential context equips learners to address a symptom while remaining analytically blind to the policy machinery that reproduces it.

The revised treatment of this finding therefore integrates quantitative data from OECD Agricultural Policy reports, UNCTAD trade statistics, FAO food security indices, IFPRI commodity price analyses, and comparative trade policy scholarship to construct an evidence chain that moves from specific policy instruments subsidy magnitudes, price support mechanisms, WTO governance provisions through intermediate trade and market effects commodity price depression, import dependency, policy space erosion to documented livelihood and food security outcomes in the Global South. This multilevel, evidence-grounded approach responds directly to the reviewer's concern and, we believe, substantially elevates both the analytical rigor and the pedagogical utility of the Section 3. The empirical concreteness of these linkages is precisely what makes the case for geopolitically literate sustainability curricula most compelling: when learners can trace a specific subsidy line item in an OECD member state budget to a documented pattern of smallholder displacement in West Africa or Central America, the abstract claim that Global North agricultural power manufactures Global South vulnerability becomes an analytically verifiable proposition rather than a rhetorical assertion.

Furthermore, the literature confirms that climate precarity in the Global South is a direct legacy of political choices, most notably the Structural Adjustment Programs that dismantled public agricultural support in favor of export-oriented monocultures. This historical shock therapy, dictated by external financial power, stripped economies of their resilience, making them exquisitely sensitive to climate shocks. A drought now cascades through this pre-engineered socio-economic landscape, triggering food price spikes, balance-of-payment crises, and increased debt dependency [47]. Therefore, teaching “vulnerability” as a geographic or climatic starting point is a profound misrepresentation [58]. A politically literate curriculum must instead frame it as the calculated output of a global political economy, a direct result of policies that prioritize the stability and abundance of one part of the world over the survivability of another [48]. This foundational finding shifts the educational imperative from describing symptoms to analyzing the blueprints of the system that produces them [48]. This power directly produces the precarity observed in

the Global South. The synthesized evidence shows that climate vulnerability is not merely a function of geographic exposure but of politically engineered exposure [49,58]. Structural Adjustment Programs of the late 20th century, by compelling the Global South to prioritize export crops and dismantle support mechanisms, actively stripped agrarian economies of their adaptive capacity [51]. Consequently, climate shocks now trigger not just ecological but socio-economic catastrophes, as seen in the direct correlation between drought-induced crop failure and spiraling debt from food imports [52]. These findings challenge apolitical curricula that present vulnerability as a starting condition, insisting instead that it must be taught as an outcome of specific historical and political choices.

3.3. *The Pedagogical Gap: Depoliticization and the SDG Effect*

The second major finding of this synthesis, emerging from 29 of the 61 reviewed studies, is that existing sustainability curricula addressing SDGs 2, 13, and 15 systematically fail to engage with the structural and geopolitical dimensions documented in Finding 1, producing instead a pattern of pedagogical depoliticization in which the goals are presented as universally applicable technical or humanitarian imperatives, severed from the power relations that most directly determine their achievability [53,59]. While references to these goals are proliferating, the dominant pedagogical approach isolates them into technical or humanitarian silos, severing their intrinsic geopolitical linkage. SDG 2 is frequently reduced to lessons on agricultural yields or nutrition science, while SDG 13 is confined to atmospheric chemistry and individual carbon footprint calculations. The powerful political-economic threads connecting them, such as how Northern consumption patterns drive deforestation in the Global South, impacting both emissions (SDG 13), local food security (SDG 2), and land governance (SDG 15) are consistently omitted. This curricula void aligns with what political ecologists identify as the techno-managerial framing of sustainability, which favors market-based instruments and technological fixes over discussions of justice, historical responsibility, and sovereignty. The review found that textbooks and modules often present climate adaptation finance or green revolutions as benevolent solutions without critiquing their conditionalities, governance structures, or potential to exacerbate local inequalities. This creates a form of epistemic injustice, where learners, especially in the Global North, are educated into a worldview that obscures the power structures their societies benefit from, leaving them ill-equipped to understand or challenge the root causes of systemic failure.

3.4. *Finding 3: Emergent Pedagogical Strategies for Critical Geopolitical Literacy*

The third finding identifies a set of promising though as yet marginalized pedagogical strategies that directly engage the geopolitical and structural dimensions of the land–food–climate nexus which is the use of decolonial and place-based case studies that make power relations visible through specific, historically grounded examples, a finding that embeds food systems learning within learners' lived political and ecological realities produces significantly deeper critical engagement than abstract SDG content delivery. Further, case-based analysis of peasant resistance to industrial agriculture and neoliberal food governance equips learners with both analytical frameworks and evidence of transformative agency, a combination that purely structural critique does not provide. Alternative food networks and urban food movements are productive sites for case-based learning precisely because they embody the tension between dominant food regime logics and emergent justice-oriented alternatives, making power contestation tangible and observable for learners. Findings also reveal that role-playing exercises in which learners represent nations or stakeholder groups with asymmetric power, resources, and climate vulnerability produce qualitatively different learning outcomes than lecture or discussion-based

approaches to the same content. The reviewed literature attributes this difference to the embodied, relational character of simulation learning, which forces engagement with the trade-offs, constraints, and ethical dilemmas that structural analysis cannot replicate as experiential knowledge. As regards transdisciplinary and geospatial methodologies in rendering the structural linkages between land governance, food systems, and climate outcomes visually and analytically concrete, studies on nexus approaches in sustainability science, identifies geospatial integration, (such as overlaying maps of climate risk, land ownership concentration, commodity production zones, and food import dependency) as an underutilized but powerful tool for making the abstract dynamics of the WELF nexus legible to learners across disciplinary backgrounds. Further, transdisciplinary curriculum co-design with scholars and practitioners from the Global South is an epistemological one, as it introduces knowledge systems and analytical framings that Eurocentric disciplinary traditions structurally exclude. This finding directly informs the recommendation, advanced in this study's Discussion, that curricular reform in ESD must involve not only content revision but the decolonization of the knowledge production processes through which curricular content is selected, validated, and taught.

3.5. Emergent Pathways: Toward a Critical and Geopolitically Literate Pedagogy

Despite the dominant trend, the review identified promising, though marginalized, pedagogical innovations that directly engage climate-food geopolitics. These constitute a vital counter-current and provide a blueprint for curriculum reform. Effective approaches move beyond theory to employ engaged, critical methodologies:

Decolonial Case Studies: Instead of abstract principles, curricula are being built around specific geopolitical "hot spots", e.g., analyzing the political ecology of quinoa commercialization in the Andes, or land grabs for biofuel production in Southeast Asia. These cases make power visible, tracing commodity chains from local displacement to global consumption.

Scenario-Based Negotiation Simulations: Moving beyond passive learning, modules simulate UNFCCC climate negotiations or WTO trade disputes. Students are assigned roles as delegates from the EU, the G77, or small island states, forcing them to grapple with asymmetrical power, climate debt arguments, and the stark trade-offs between mitigation and development rights.

Transdisciplinary Systems Mapping: Integrating geospatial tools (such as GIS) with political economy, learners map the flows of capital, carbon, and crops. They can visually overlay zones of high climate risk with maps of land ownership concentration or export commodity production, creating powerful visual evidence of produced vulnerability.

Comparative Analysis: This study's Political Ecology framework starkly contrasts with prior reviews of sustainability education, which have often focused on content integration or behavioral change metrics. Where previous studies asked, "Are SDGs being taught?" this analysis asks, "How are the power relations within these SDGs being taught, or silenced?" It reveals that the primary deficit is not a lack of coverage but a lack of critical literacy. The recommended pedagogical shift from a pedagogy of information to a pedagogy of interrogation addresses a more profound gap than previously identified, aiming not just to inform students about global challenges, but to equip them with the analytical tools to deconstruct the power dynamics that perpetuate them. Hence, the findings present a clear, evidence-based mandate: achieving the transformative potential of Education for Sustainable Development requires a fundamental curricular realignment. Sustainability education must cease to be a neutral vessel for SDG descriptors and become an active site for critical geopolitical literacy. By embedding the analysis of agricultural power, produced vulnerability, and historical responsibility into the heart of learning, we can

cultivate a generation capable of moving beyond symptomatic solutions to engage with the foundational inequities at the core of our concurrent climate and hunger crises.

4. Discussion

4.1. *Complementary Critical Lenses: Geopolitics, Ecological Economics, and Postcolonial Studies on Land Grabs and Climate Adaptation*

While a geopolitical perspective remains central to analyzing how Global North agricultural power shapes the land–food–climate nexus, engaging with ecological economics and postcolonial studies reveals additional dimensions of causality and vulnerability that a purely geopolitical framework may obscure. Geopolitical approaches typically emphasize state and corporate competition over strategic resources, territorial control, and trade asymmetries, framing land grabs and climate adaptation as extensions of great-power rivalry and neoliberal market integration. In contrast, ecological economics shifts the analytical focus toward biophysical limits, material throughput, and the thermodynamic inefficiencies of industrial agriculture, thereby reframing land grabs not merely as geopolitical resource acquisitions but as transfers of ecological debt, where the Global North externalizes its land and carbon footprints onto the Global South. Postcolonial studies, meanwhile, excavate the historical production of these asymmetries, showing how contemporary land grabs and unequal adaptation capacities are continuous with colonial-era extraction, dispossession, and epistemic violence that delegitimized local agroecological knowledge. Despite their different starting points, these three lenses converge powerfully on two critical issues. First, on land grabs, all three approaches recognize that large-scale land acquisitions for export-oriented biofuel and food production systematically dispossess smallholders and pastoralists, though they differ in emphasis: geopolitical accounts stress strategic food security for investor countries, ecological economics quantifies the metabolic rift and carbon emissions from land conversion, and postcolonial studies foreground the racialized and legal-linguistic mechanisms that render indigenous land claims invisible. Second, on climate adaptation, each lens identifies a common diagnosis—that prevailing adaptation finance and technology transfer mechanisms reproduce rather than reduce Global South vulnerability, but offers distinct remedies: geopolitical analysis calls for rebalanced multilateral governance, ecological economics demands degrowth and localization of food systems, and postcolonial scholarship insists on epistemic justice and the restitution of adaptive knowledge systems suppressed under colonialism. By integrating all three perspectives, the curriculum strategies proposed in this paper move beyond a single critical tradition and instead equip students to interrogate the land–food–climate nexus through plural, mutually reinforcing analytical tools.

4.2. *From Critical Diagnosis to Curricular Transformation*

This study's findings illuminate a critical paradox in contemporary Education for Sustainable Development (ESD): while focused on the urgent global goals of Zero Hunger (SDG 2), Climate Action (SDG 13) and Life on Land (SDG 15), dominant pedagogical approaches remain curiously silent on the geopolitical power structures that most directly determine their success or failure. Our analysis, grounded in Political Ecology, moves beyond merely identifying a gap in content. It reveals a systemic depoliticization of the curriculum pedagogical framing that severs the vital link between ecological phenomena and the political economies that produce them. This discussion posits that addressing this disconnect is not a minor adjustment but a foundational reorientation essential for cultivating a generation capable of meaningful planetary citizenship.

4.3. *The Depoliticized Classroom and Its Consequences*

The core finding that curricula consistently sideline the role of Global North agricultural power in shaping Global South vulnerability—corroborates and extends critiques from critical pedagogy and post-colonial theory. Our synthesis confirms that much ESD practice falls into what Andreotti et al. term a soft approach, emphasizing harmonized global solutions and individual behavioral change while circumventing issues of conflict, historical justice, and unequal power [60]. For instance, a lesson on climate-smart agriculture may laud technological innovation without examining who owns the patents, who sets the research agenda, and which farming knowledge systems are consequently marginalized. This aligns with the studies of Malik and Chandra et al. in the literature [61,62]. The consequence is an educational paradigm that inadvertently reproduces hegemony; students in the Global North may become conscientious consumers without understanding their position within structures of global exploitation, while students in the Global South are taught to adapt to vulnerabilities presented as inevitable, rather than to analyze and challenge their systemic origins.

4.4. *Bridging the Gap: The Imperative of Critical Geopolitical Literacy*

The pedagogical innovations identified in the findings, decolonial case studies, negotiation simulations, and transdisciplinary mapping represent a nascent shift toward a “critical” ESD. These methods operationalize the core tenets of Political Ecology by making power relations visible, tangible, and contestable within the learning environment. This moves the curriculum from a pedagogy of answers to a pedagogy of questions. For example, simulating a United Nations Climate Change Conference (UNFCCC) negotiation where students represent nations with vastly different historical emissions and current vulnerabilities forces an engagement with climate debt and justice that a lecture on greenhouse gas chemistry never could. This practice directly addresses the “so what?” often missing from sustainability education, transforming abstract global goals into lived experiences of diplomatic struggle and unequal leverage. A productive debate emerges here between the perceived need for “balanced” curricula and the explicit normative stance of a justice-oriented approach. Critics may argue that teaching power asymmetries is inherently political and risks indoctrination. However, we contend that not teaching these asymmetries is equally political, it is a tacit endorsement of the status quo. The goal is not to prescribe a singular solution but to develop students’ abilities to critically analyze evidence, trace systems of causation, and ethically evaluate competing claims. This is not activism in the classroom; it is the cultivation of critical democratic competence for a world defined by complex socio-ecological crises.

4.5. *Practical Pathways for Integration and Implementation*

The translation of this critical framework into practice requires actionable strategies that move beyond theory. This study proposes a multi-scalar approach for integration:

At the Module Level: Replace generic case studies with “Power Tracing” exercises. Students can follow a specific commodity (e.g., avocado, cocoa, lithium for green tech) from extraction to consumption, mapping financial flows, labor conditions, environmental impacts, and regulatory frameworks. This reveals the concrete material connections between consumption, climate change, and livelihoods.

At the Program Level: Develop Living Laboratory courses in partnership with civil society organizations, such as food sovereignty networks or climate justice NGOs. Students can engage in real-world projects, mapping urban food deserts, analyzing local adaptation plans for equity, or creating communicative materials that translate geopolitical research

for public audiences. This embeds learning within communities of practice that are already navigating these complexities.

At the Institutional Level: Advocate for curricular reforms that break down disciplinary silos. A genuine understanding of the climate-food nexus requires hybrid courses co-taught by faculty from political science, environmental science, economics, and education. Furthermore, teacher training programs must equip educators with the content knowledge and pedagogical courage to facilitate difficult conversations about inequality and justice. In essence, this discussion asserts that the relevance of our findings lies in a pressing contemporary imperative: sustainability education must become politically literate to be effective. The climate crisis is not a problem of engineering alone but of politics, ethics, and equity. A curriculum that ignores the geopolitical architecture of the climate-food system is, at best, incomplete and, at worst, complicit in sustaining the narratives that perpetuate inaction. Hence, we transform ESD from a well-intentioned promoter of global goals into a powerful engine for developing the critical thinkers, empathetic negotiators, and principled agents that our interdependent world urgently requires by integrating an explicit analysis of power of who benefits, who loses, and who decides. The classroom must become a space where the foundational inequities of the Anthropocene are not hidden, but rigorously examined, for it is only upon this honest foundation that a truly sustainable and just future can be built.

5. Conclusions

This study has demonstrated that mainstream sustainability education faces a critical paradox: it seeks to address globally interconnected crises while systematically omitting the geopolitical structures that define them. Through a Political Ecology perspective, the analysis reveals that the climate-food nexus is fundamentally shaped by enduring asymmetries of power, wherein the agricultural and diplomatic dominance of the Global North actively produces and entrenches vulnerability in the Global South. The primary finding is that curricula for SDGs 2, 13 and 15 predominantly engage in a depoliticized, techno-managerial discourse, presenting symptoms—hunger, extreme weather—while obscuring their root causes in historical inequity and contemporary political economy.

Consequently, such an education risks producing graduates and stakeholders who are informed about sustainability challenges yet analytically disarmed from confronting their underlying drivers. The imperative that follows is unambiguous: achieving the transformative potential of Education for Sustainable Development necessitates a deliberate pedagogical shift from a posture of consensus to one of critical engagement. This requires embedding the analysis of power, justice, and historical responsibility at the core of learning. The ultimate conclusion is that cultivating a generation capable of navigating the Anthropocene depends not merely on teaching about sustainability, but on fostering the critical geopolitical literacy required to redesign its very foundations.

6. Recommendations

The findings of this study necessitate a move from critical diagnosis to proactive redesign. To bridge the chasm between the geopolitical realities of the climate-food nexus and current educational practice, a multi-tiered strategy is required. The following recommendations propose immediate pedagogical actions, foundational theoretical shifts, and essential avenues for further research to cultivate a critically literate generation.

Practical Curricular Integration: Immediate steps can be taken to retrofit existing modules and design new learning experiences. The study recommends the development of geopolitical modules that use case-based, active learning. For example, a module could center on a contemporary issue like Seed Sovereignty versus Patent Law, where students

analyze legal treaties (UPOV, WTO-TRIPS), ecological data on crop diversity, and testimony from farming communities. Secondly, mandatory scenario-based simulations of multilateral forums, such as a Global Climate Fund (GCF) allocation negotiation or a UN Committee on World Food Security debate, should be integrated. These simulations force students into the roles of disparate actors, making abstract power dynamics tangible and teaching the skills of negotiation, coalition-building, and ethical argumentation within constrained political arenas.

Theoretical and Pedagogical Shifts: Beyond specific content, a fundamental reorientation in educational philosophy is required. Educator training must advance from teaching about sustainability to teaching for critical planetary citizenship. This involves a deliberate pedagogical shift towards decolonial and justice-oriented frameworks. Curricula should be co-designed with scholars and practitioners from the Global South to challenge Eurocentric knowledge systems and elevate epistemologies from indigenous and agrarian communities. Furthermore, assessment must evolve to value systems thinking, ethical reasoning, and power analysis over rote memorization of SDG targets. Success should be measured by a student's ability to critically trace a commodity chain, deconstruct a policy document, or articulate a justice-based argument, not merely to list the causes of desertification.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/land15071162/s1>.

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