From SDG Interconnections to Policy Coherence: A Systems Thinking Framework for Integrated Decision-Making

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Article

From SDG Interconnections to Policy Coherence: A Systems Thinking Framework for Integrated Decision-Making

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Abstract

This article develops a systems-thinking framework to analyze and govern interconnections among the Sustainable Development Goals (SDGs). Contemporary policy challenges, including food insecurity, climate change, water and energy security, inequality, urbanization, and conflict, are treated as complex systems characterized by feedback loops, delays, cross-sector dependencies, and unintended consequences. Drawing on a structured literature review, qualitative case analysis, and framework synthesis, the article translates core systems concepts into an operational workflow for coherent policy decision-making. The framework combines causal-loop analysis, leverage-point identification, cross-sector coordination, adaptive monitoring, and iterative learning. Two illustrative policy arenas, Zero Hunger and Climate Action, demonstrate how a systems lens can reveal reinforcing and balancing feedback loops, clarify synergies and trade-offs among SDGs, and support more coherent interventions. The article contributes to systems research by connecting conceptual tools from systems thinking with practical governance mechanisms for SDG implementation. It also identifies institutional, methodological, political economy, and financing barriers that limit adoption and proposes strategies for embedding systems analysis into policy design, budgeting, evaluation, and adaptive governance.

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1. Introduction

Decision-makers today face a daunting array of interconnected challenges – from violent conflicts and persistent hunger to resource depletion, political polarization, and climate change – that are deeply intertwined. Progress on one problem often influences many others, sometimes in unexpected ways. For example, the convergence of the COVID-19 pandemic, armed conflicts, and climate change has recently reversed decades of poverty reduction, forcing hundreds of millions back into extreme poverty [1]. Likewise, conflict remains the most significant driver of acute hunger worldwide – 117 million people were driven into crisis-level hunger by conflict in 2022 [2] – while climate-related disasters and economic disruptions exacerbate food insecurity. The United Nations' 2030 Agenda for Sustainable Development [3] explicitly recognized these interdependencies by adopting 17 Sustainable Development Goals (SDGs; [4]) as an indivisible framework that integrates social, economic, and environmental dimensions. However, traditional, siloed policy approaches have struggled to address such messy and interlinked issues [5]. A more integrative paradigm is needed. This introduction presents a case for systems thinking – a framework that views the world as a network of interrelated systems – as critically important for crafting effective, coordinated policy responses to complex, large-scale crises.

At its core, systems thinking means focusing on relationships, dynamics, and the "big picture" rather than isolating problems into their parts. Classic definitions emphasize that a system is an

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interconnected set of elements coherently organized to achieve a specific goal [6]. In other words, issues such as war, hunger, or climate change cannot be understood – let alone solved – in isolation, because each is embedded in a larger system of causes and effects. As systems theorist Donella Meadows noted, "You can't navigate well in an interconnected, feedback-dominated world unless you take your eyes off short-term events and look for long-term behavior and structure; unless you are aware of false boundaries and bounded rationality; unless you take into account limiting factors, nonlinearities and delays." [6] (p. 87). In a system, intervening in one area can yield unintended consequences elsewhere. For decision-makers, this implies that addressing interconnected challenges requires a whole-system, cross-sectoral perspective that transcends traditional institutional boundaries [7]. Indeed, the 2030 Agenda itself was a response to the limits of siloed development models, calling for "whole-of-government" and "whole-of-society" perspectives that map causal relations across sectors and scales. Simply put, today's large-scale crises demand coordinated solutions. Marcos Neto of UNDP frames the convergence of nature loss, climate change, poverty, inequality, and insecurity as a multidimensional planetary crisis, emphasizing that these interconnected challenges require coordinated, system-wide responses rather than isolated interventions [8].

Over the past decades, both scholars and international organizations have increasingly argued that systems thinking is not just an academic exercise but a practical necessity for sustainable development [9,10]. Seminal efforts, such as Jay Forrester's system dynamics models [11] and the Club of Rome's Limits to Growth study [12], pioneered the use of integrated simulations to understand planetary sustainability challenges. Those works warned that unchecked economic and population growth could trigger resource scarcities and environmental collapse – insights that proved prescient and underscored the value of long-range foresight. Recent sustainability scholarship has highlighted the limitations of conventional policy paradigms in addressing systemic change, positioning systems thinking as an increasingly important approach for navigating complex and interconnected challenges [10,13]. The following sections explore how a systems perspective can illuminate the linkages among large-scale crises, align policies with the SDGs' integrated vision, and ultimately drive more coherent and effective action. First, the landscape of interconnected challenges will be examined to illustrate why siloed solutions fall short and why systems thinking is urgently needed.

This article contributes to systems research by translating core concepts such as feedback, interdependence, leverage points, system structure, and adaptive learning into a transferable framework for SDG-oriented policy design. Rather than treating the SDGs as a list of separate targets, the article conceptualizes them as a coupled policy system in which interventions in one domain can generate reinforcing effects, balance responses, delay consequences, and produce cross-scale spillovers. The proposed framework is intended to support decision-makers in moving from general recognition of interdependence toward concrete procedures for mapping interactions, prioritizing leverage points, coordinating institutions, and adjusting policy through iterative learning.

The article's main contribution is not to restate that the SDGs are interconnected, but to operationalize this interconnection as a repeatable systems thinking workflow for policy design, coordination, monitoring, and adaptive learning. In doing so, it positions systems thinking not only as an interpretive lens but also as a decision-support logic for translating interdependencies among the SDGs into coherent policy processes.

2. Materials and Methods

The study used a qualitative framework-development design that combined a structured literature review, illustrative case analysis, and conceptual synthesis. The aim was not to produce a statistical meta-analysis or a predictive model, but to construct a transferable systems thinking workflow for integrated SDG policy decision-making. The methodological logic was abductive: concepts from systems theory and sustainability governance were first identified in the literature, then examined through two illustrative policy arenas, and finally synthesized into a staged workflow

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that links diagnosis, mapping, leverage-point identification, implementation, monitoring, and adaptive learning.

2.1. Structured Literature Review

The review drew on peer-reviewed articles, policy reports, and seminal systems-thinking texts related to sustainable development, policy coherence, adaptive governance, causal-loop analysis, system dynamics, and the Water-Energy-Food nexus. Web of Science, Scopus, ERIC, and Google Scholar were searched using combinations of the terms systems thinking, policy coherence, SDG interlinkages, adaptive management, causal loop diagrams, system dynamics, and Water-Energy-Food Nexus. The search emphasized work published from 2000 onward, while retaining foundational systems sources where required for conceptual grounding.

Titles and abstracts were screened for relevance to systems perspectives in governance and sustainable development. Sources were retained when they addressed at least one of the following: conceptual frameworks for systems thinking; methods for mapping or modeling interdependencies; empirical or policy evidence on integrated SDG implementation; or barriers and enabling conditions for policy coherence. The retained sources were coded for systems concepts, analytic tools, governance mechanisms, evidence of cross-sectoral interaction, and reported implementation challenges.

Coding focused on five analytical dimensions: (1) the systems concept used, such as feedback, delay, interdependence, leverage point, boundary, or adaptation; (2) the policy function associated with that concept, such as diagnosis, prioritization, coordination, implementation, monitoring, or learning; (3) the type of SDG interaction addressed, including synergy, trade-off, spillover, or cross-scale dependency; (4) the governance mechanism proposed or observed; and (5) the barriers limiting systems-oriented implementation. These dimensions provided the basis for comparing sources and for translating recurring concepts into the workflow components developed in Section 2.3.

2.2. Illustrative Case-Study Analysis

Two policy arenas, Zero Hunger (SDG 2) and Climate Action (SDG 13), were selected because they involve well-documented interdependencies with poverty, inequality, conflict, water, energy, land use, urbanization, and institutional capacity. The cases were used illustratively rather than as exhaustive comparative case studies. For each arena, policy documents, implementation reports, and evaluation studies were examined to identify recurring feedback loops, positive interactions, trade-offs, and potential leverage points.

Causal-loop reasoning was used to organize the case evidence. The analysis focused on reinforcing loops, balancing loops, delayed effects, and cross-sector dependencies that are likely to be missed by single-sector policy analysis. This procedure allowed the cases to function as analytical demonstrations of the framework rather than as stand-alone empirical evaluations.

2.3. Framework Synthesis

Insights from the literature review and case analysis were synthesized into a systems-thinking workflow for the integrated design of SDG policies. The synthesis identified six recurring building blocks: problem framing, stakeholder and boundary mapping, causal-loop analysis, leverage-point identification, coordinated implementation, and adaptive monitoring and learning. These building blocks were then organized into the workflow presented in Figure 1, which is intended as a practical bridge between systems scholarship and policy design. The workflow is not intended as a linear checklist, but as an iterative policy cycle. Problem framing and stakeholder mapping define the system boundary; interlinkage mapping and causal-loop analysis make feedback relations and trade-offs visible; leverage-point identification supports prioritization; coordinated implementation translates the analysis into institutional action; and adaptive monitoring enables revision as system behavior changes over time.

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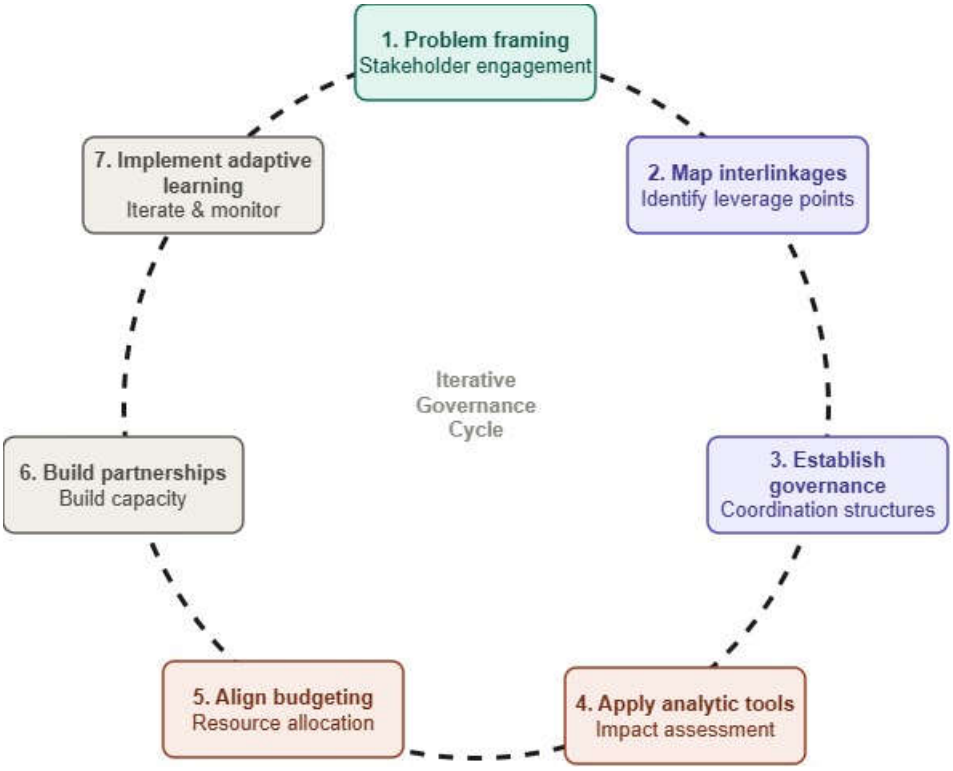

Figure 1. Systems-thinking workflow for integrated SDG policy decision-making. The workflow connects problem framing, stakeholder and boundary mapping, causal-loop analysis, leverage-point identification, coordinated implementation, monitoring, and adaptive learning into an iterative policy cycle.

2.4. Analytical Boundaries and Use of Illustrative Cases

The framework is intended as a conceptual and procedural synthesis rather than as a universal predictive model. The two policy arenas were selected to demonstrate how the workflow can be applied to highly interconnected SDG domains, not to provide exhaustive empirical evaluations of SDG 2 or SDG 13. Their function is therefore illustrative and analytical: they show how feedback loops, trade-offs, cross-sector dependencies, and leverage points can be made visible through a systems lens. This boundary is important because the framework is designed to support decision-making under complexity, where causal relations are often partial, context-dependent, and subject to revision through monitoring and learning.

3. Interconnected Global Crises: Why Siloed Solutions Fall Short

From a policy perspective, today's crises do not occur in isolation; they interact within a complex world system. Conflict and instability (SDG 16), for example, exacerbate hunger (SDG 2) by disrupting food production and markets, as seen in war-torn regions of Africa and the Middle East, where millions face famine [14]. Hunger and poverty, in turn, breed grievances that can fuel further unrest, creating a vicious cycle of conflict (Figure 2). Climate change (SDG 13) is a threat multiplier that intensifies many other problems: droughts and extreme weather undermine agriculture and water supplies, worsening hunger and water scarcity (SDG 6). Meanwhile, climate stress on livelihoods can contribute to migration and social tensions that spark conflict [15]. At the same time, conflict and weak governance hinder effective climate action and environmental management. In 2023, nearly 75% of the world's forcibly displaced people lived in countries highly exposed to climate-related hazards, illustrating the tragic feedback loop between instability and climate vulnerability [16]. These examples illustrate how interconnected challenges form an interdependent web of cause and effect. The International Science Council highlights the systemic nature of contemporary global

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challenges, noting that domains such as geopolitics, energy, climate, food, and social security are interconnected, allowing progress or setbacks in one area to affect others [17].

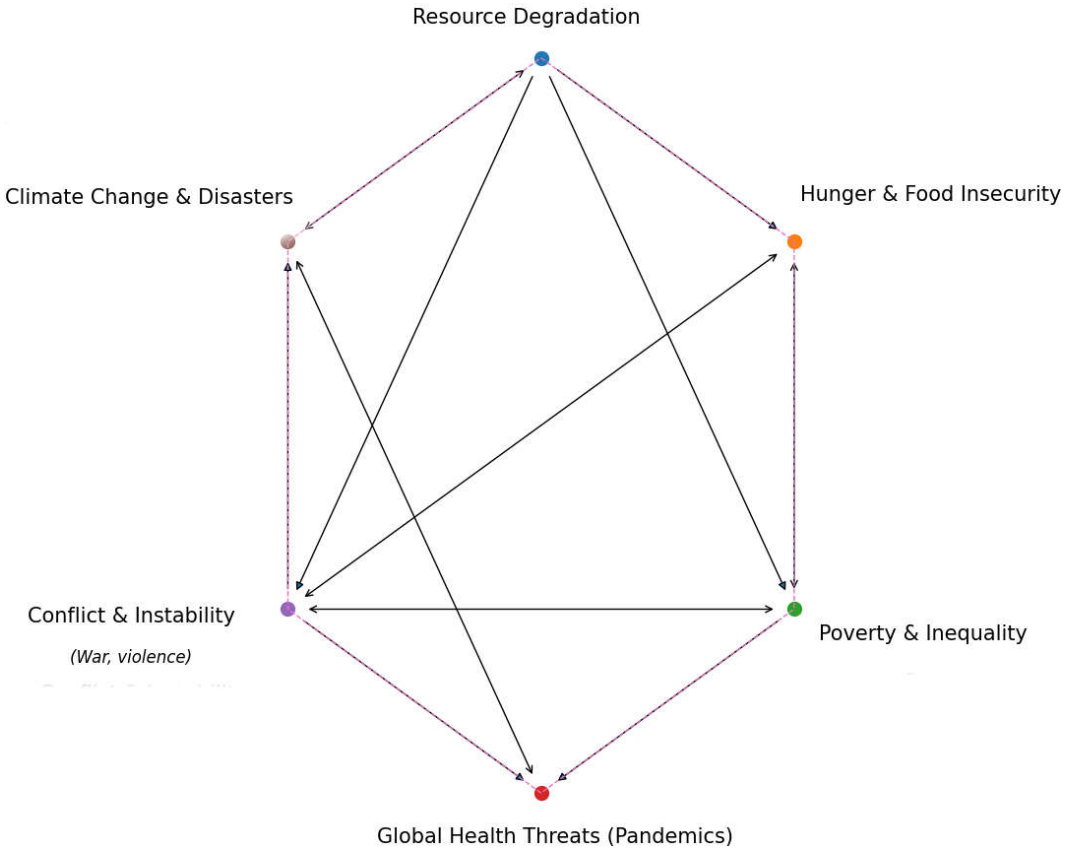

Figure 2. Global challenges form an interconnected web. Issues like conflict, hunger, climate change, resource degradation, poverty, and health crises reinforce one another, creating a complex world system. Each node (challenge) is linked to multiple others, illustrating why isolated responses often fail to achieve their goals. Uni-directional arrows (–>) show one-way influence (A affects B), while bi-directional arrows (<–>) indicate mutual feedback loops where each challenge both drives and is driven by the other.

Crucially, the Sustainable Development Goals themselves are deeply interdependent. The 17 SDGs integrate cross-cutting issues, such as peace, inequality, sustainable consumption, urbanization, and climate change, reflecting the reality that these must be addressed together. For instance, poverty eradication (SDG 1) cannot be achieved without also addressing hunger, health, education, and inequality (SDGs 2, 3, 4, 10) in tandem. Recent data underscore how progress on one goal supports – or constrains – others. The COVID-19 crisis pushed an estimated 122 million more people into hunger between 2019 and 2022, eroding gains in SDG 2 and making the goal of Zero Hunger by 2030 increasingly elusive [18]. Notably, the U.N. attributes this setback to multiple crises, including the pandemic, climate disasters, and conflicts such as the war in Ukraine [18]. Similarly, global extreme poverty (SDG 1) experienced its first rise in two decades due to the same converging crises. The World Bank attributes the recent reversal in poverty reduction to the combined pressures of COVID-19, conflict, and climate change, which have pushed hundreds of millions of people into poverty, including populations that had previously escaped extreme deprivation [1]. In short, shocks in one domain reverberate across the entire SDG spectrum.

Even challenges traditionally viewed as separate have systemic links. Public health threats (SDG 3), such as the COVID-19 pandemic, were not only health crises but also economic, social, and governance crises, as they strained economies (SDG 8), deepened inequalities (SDG 10), and tested institutions and trust (SDG 16). The pandemic's impact on education (over 1.5 billion children affected by school closures) set back quality education (SDG 4) gains by years, illustrating how a

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single systemic shock can undermine multiple development objectives. Gender inequality (SDG 5) is another cross-cutting factor – for example, women's disproportionate job losses and care burdens during COVID-19 have long-term effects on poverty and well-being. Conversely, empowering women and girls yields multiplier effects: as the UN notes, achieving SDG 5 is integral to all 17 Goals, because only by securing women's rights and opportunities across all sectors will the world reach the SDGs [19]. In short, no goal stands alone.

Natural resource pressures exemplify the interconnected nature of large-scale risks. Modern consumption and production patterns (SDG 12) have led to unsustainable resource extraction, driving environmental crises (SDGs 13, 14, 15). The UN Environment Programme reports that the extraction and processing of materials, fuels, and food are responsible for approximately half of global greenhouse gas emissions, driving over 90% of biodiversity decline and water stress [20]. Resource depletion has reached alarming levels – worldwide extraction of natural resources has more than tripled since 1970 [20], contributing to climate change, deforestation, fishery collapses, and pollution. These environmental stresses ultimately impact human welfare: for example, degraded land and water resources threaten food security and livelihoods, potentially sparking instability and conflict over scarce resources. UNEP identifies material extraction as a central contributor to climate change and biodiversity loss, warning that these impacts are likely to intensify without a systemic shift in how resources are used and consumed [20]. This highlights that issues of energy (SDG 7), water (SDG 6), food (SDG 2), and ecosystem health (SDG 15) are tightly coupled – a concept often referred to as the Water–Energy–Food Nexus. Policymakers are increasingly recognizing that ensuring water, energy, and food security must be pursued together, rather than pursued through competing agendas.

Figure 3 schematically illustrates the water–energy–food nexus. Each sector relies on the others: agriculture (food) needs water for irrigation and energy for farm machinery and fertilizer production; energy systems need water for cooling thermal plants and generating hydropower, while energy access enables water treatment and distribution; and water extraction and use (for farms or power plants) can affect resource availability and ecosystem health. These bidirectional links mean that siloed decisions (e.g., expanding water-intensive crops or biofuel production without regard for water and energy impacts) can create negative feedback loops, such as water shortages or food price spikes, undermining multiple goals. Conversely, joint planning can yield 'win-win' outcomes. For example, investing in solar-powered irrigation (linking SDG 7 and SDG 2) can improve crop yields while reducing emissions and conserving water through precision control. The nexus perspective has become a practical tool for policymakers to coordinate strategies across ministries of agriculture, water, and energy, ensuring that solutions are optimized for the system as a whole rather than for individual sectors [7,21].

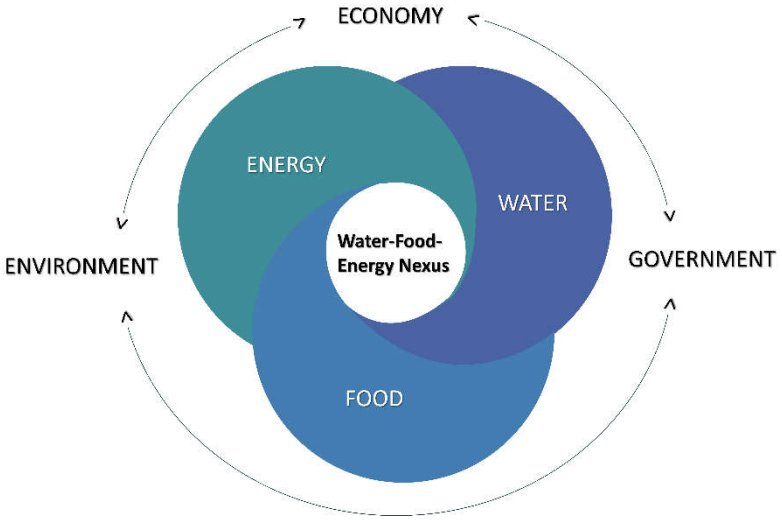

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Figure 3. The Water–Energy–Food Nexus as an example of systemic interdependence. Water, energy, and food systems are mutually linked: water is essential for energy production (e.g., cooling power plants and hydropower) and for agriculture; energy is required for pumping water and producing fertilizers for farming; and agriculture impacts water through irrigation use and runoff. Integrated policies can harness synergies (e.g., renewable energy for water pumping, efficient irrigation) and avoid trade-offs.

Today's linked challenges form an interdependent web of relationships. Key issues at hand are messy and interlinked – securing food, energy, and water for a growing population, tackling stubborn inequalities, addressing climate change and rapid urbanization, managing finite resources, and ending conflict cannot be accomplished in isolation [4]. Fragmented, single-issue interventions too often solve one problem only to exacerbate others, or they miss opportunities for cross-cutting benefits. The evidence from the SDG era so far is sobering: despite pockets of progress, many goals are off-track due to cumulative, interacting crises [17,18]. The 2024 UN report on the SDGs states that "While acknowledging the contribution of development partners in building national data and statistical capacity, a system-wide orientation to such support is crucial to prevent silos and duplicated efforts" [22] (p. 7). It has become abundantly clear that if policymakers continue to work in silos, they will remain confounded by unintended effects and trade-offs arising from the wider system [23,24]. In the next section, I turn to systems thinking as a guiding framework for navigating this complexity. By understanding the structures and feedback loops that connect large-scale issues, leaders can better identify leverage points where interventions yield wide-ranging benefits and anticipate potential pitfalls. In short, systems thinking provides the analytical lens and tools needed to design policies that reflect the real-world interconnectedness of sustainable development challenges.

4. Systems Thinking: A Holistic Framework for Sustainable Development

Faced with interdependent crises, policymakers are increasingly embracing systems thinking as a framework for understanding and managing complexity. Systems thinking entails looking at the whole system – the web of relationships, feedback loops, and underlying structures – rather than isolating individual components. This approach marks a shift from linear, reductionist problem-solving to a relational, dynamic understanding of policy issues [24]. In practical terms, systems thinking helps identify how progress in one area affects other areas (synergies or trade-offs), locate root causes rather than symptoms, and highlight leverage points for effective intervention [7,25]. As an example, instead of treating a spike in hunger as a standalone food supply issue, a systems perspective would examine connections to poverty, conflict, climate shocks, market dynamics, and more – revealing which factors drive the outcome and where policy can have the greatest impact across the system.

One of the foundational principles of systems thinking is feedback. Systems are characterized by feedback loops in which process outputs feed back into the process as inputs, potentially reinforcing or counterbalancing change. A classic example is the poverty–hunger–conflict cycle mentioned earlier: conflict creates hunger by disrupting production and aid, and hunger in turn breeds instability and conflict—a reinforcing feedback loop that can trap regions in a downward spiral. Figure 4 depicts this loop schematically. Such mutually causal processes are standard in social systems [26]. Positive (reinforcing) feedback can lead to vicious cycles or, conversely, virtuous cycles (e.g., economic growth and innovation feeding each other), while negative (balancing) feedback provides stability or resistance to change. Recognizing feedback loops allows policymakers to anticipate knock-on effects of interventions. For instance, a well-intentioned policy to subsidize biofuels might trigger a feedback loop of rising food prices (by diverting crops to fuel production), leading to increased hunger and unrest – unless mitigating measures are in place. Understanding these dynamics is essential: a quick fix in one part of a system can create problems elsewhere over time if feedback is ignored.

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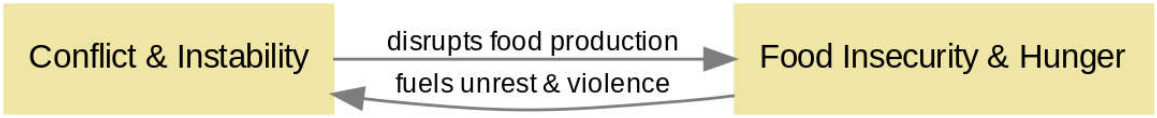

Figure 4. A feedback loop between conflict and hunger. Conflict and instability disrupt food production and distribution, resulting in increased food insecurity and hunger. In turn, severe hunger and resource scarcity can fuel grievances, social unrest, and violence, which worsen conflict. This reinforcing cycle illustrates how two problems can lock a system in a self-perpetuating loop – and why breaking such a cycle requires integrated strategies (e.g., coupling peacebuilding with food security programs).

Another key concept in systems thinking is the idea of system structure driving behavior. Rather than blaming isolated events or individual actors, a systems lens asks what systemic structure is producing these outcomes? Donella Meadows used the metaphor of an iceberg: visible events (e.g., a famine, a blackout, a protest) are just the tip, supported by patterns/trends beneath the surface and, deeper still, by systemic structures (like laws, institutions, resource distribution) and underlying mental models or paradigms [6]. Policymakers tend to react to events, but systems thinking urges looking downstream at patterns and upstream at structures and mindsets. For example, recurring food crises might indicate structural issues in a food system (land tenure, supply chains, transboundary price volatility) and prevailing paradigms (e.g., "production at all costs") that need change. By addressing structural drivers, policies can have far more lasting and widespread impact than by continually reacting to symptoms. Meadows famously proposed a hierarchy of "leverage points" in systems – places where a slight shift can lead to significant changes [25]. Changing incentives, information flows, or the underlying goals of a system is a high-leverage intervention, whereas tweaking parameters (such as increasing food aid) is often a low-leverage fix if the root causes remain unchanged [27]. This insight is directly relevant to sustainable development. For instance, empowering women through education and rights (altering social structures and norms) has greater leverage in reducing poverty and hunger than short-term income transfers, because it changes the system's trajectory over generations.

In practice, systems thinking provides concrete methodologies and tools that public officials can use for planning and analysis. One widely used tool is systems mapping, such as Causal Loop Diagrams (CLDs) or influence maps, which visually chart the elements of a system and their interconnections [7,9]. By engaging stakeholders to map out, say, an entire food system – including producers, consumers, markets, infrastructure, climate factors, health impacts, etc. – planners can identify feedback loops and potential alignments or conflicts among policies. This mapping aligns with the approach advanced in Nature's editorial work on food systems, which frames systems change as a process of identifying the relevant actors, mapping the relationships among them, and examining how those relationships shape one another and influence system-level outcomes [9] (pp. 293–294). In other words, a thorough systems map lays the groundwork for coordinated interventions. Similarly, the United Nations has promoted "SDG interaction scorecards" and network analysis to help governments see how progress on one target can enable or hinder others [7,24]. For example, analytical tools such as the SDG Positive interactions tool (developed by the Stockholm Environment Institute) enable decision-makers to score and visualize the influence of each SDG on others in each context. Using such a tool in Sweden, researchers found that progress on Sustainable Cities (SDG 11) yielded broad positive impacts across many SDGs, whereas some goals were more isolated or even in trade-off relationships [24]. These insights enable more intelligent prioritization – leveraging high-impact goals and managing trade-offs explicitly, rather than inadvertently undermining one goal by pursuing another.

Beyond qualitative mapping, quantitative modeling and simulation are powerful components of a systems view. System dynamics models, pioneered by Jay W. Forrester and Donella Meadows, simulate the behavior of complex systems over time using stocks, flows, and feedback loops [6,11].

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Policymakers use such models to test scenarios and "what if" questions: for instance, cross-sector assessment models (IAMs) project how simultaneous changes in energy, land use, technology, and policy might influence climate outcomes and development indicators through 2050. The Limits to Growth world model [12] was an early instance that simulated planetary population, industrial growth, resource depletion, and pollution, showing that business-as-usual growth would eventually overshoot planetary limits and cause declines, whereas structural changes could achieve long-term equilibrium. Today's models are more detailed but convey a similar message: piecemeal progress is easily canceled out by counteracting forces in the system. The International Institute for Applied Systems Analysis (IIASA), for example, coordinates the World in 2050 initiative, which uses systems models to chart pathways to achieve all SDGs in unison [28]. Their analyses indicate that integrated strategies (e.g., combining climate mitigation with inequality reduction and sustainable consumption) are needed – a narrow focus on one goal (like climate) without considering others is likely to fail or cause new problems.

Systems thinking is also informing new modes of governance and decision-making processes. Methods like scenario planning and futures foresight help leaders consider multiple interacting trends and uncertainties, rather than planning for a single expected future [29]. For example, city planners use exploratory scenarios to integrate land-use, transportation, and climate-resilience plans, recognizing that urban sustainability (SDG 11) involves complex systems of housing, mobility, energy, and social dynamics. Multi-criteria analysis and nexus assessments are increasingly used to evaluate policy options across multiple objectives (for example, assessing an energy policy's impacts on air quality, jobs, and emissions). In public health, the COVID-19 pandemic has spurred calls for "One Health" approaches —a systems framework that links human health, animal health, and ecosystem health. By treating them as a single interconnected system (e.g., monitoring how wildlife trade and land-use change can lead to zoonotic diseases), One Health exemplifies the systems thinking needed to prevent future pandemics [30]. Indeed, a review of the United States' pandemic response revealed that the strategy lacked a holistic, systems-oriented approach, resulting in fragmented efforts [31]. The lesson is that aligned preparedness – bridging health, environment, agriculture, and governance – is essential for effective risk management.

In sum, systems thinking equips policymakers with both a mindset and a toolbox for tackling the SDGs through a joint lens. It encourages looking beyond immediate events to the underlying structure of problems, mapping and modeling the interconnections among issues, and seeking "whole-system" strategies that maximize cross-sector gains and wider benefits. This approach aligns closely with the concept of Policy Coherence for Sustainable Development (PCSD) enshrined in SDG Target 17.14, which urges governments to work across silos and scales [32]. As Dr. François Fortier writes, implementing the 2030 Agenda "requires comprehensive methods that can identify a large number of connections – including causal relationships and interdependent feedback loops – between the SDGs and targets" [7] (p. 2), so that policymakers can focus on key drivers and avoid being easily overwhelmed. In practice, this means using systems analysis to foster "whole-of-government" integration both horizontally (across sectors) and vertically (from local to international). The following sections will illustrate how such a systems orientation can be applied to real-world policy challenges and the tangible benefits it offers in advancing multiple SDGs simultaneously.

5. Applying Systems Thinking to SDGs: Case Studies

5.1. Case 1: Zero Hunger and Food System Resilience (SDG 2)

Achieving Zero Hunger (SDG 2) – one of the most critical and challenging goals – vividly demonstrates the need for a systems thinking approach. Hunger is not merely about producing enough food; it is the result of a multi-causal food system involving agriculture, economics, health, climate, and governance. As Nature editorial observed, "Systems thinking is crucial to achieving targets such as zero hunger and better nutrition because it requires considering the way in which food is produced, processed, delivered and consumed, and looking at how those intersect with human health, the environment, economics and society" [9] (p. 293). In other words, ending hunger

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means tackling all aspects of the food system – from farm to table and across related sectors. This broad logic is vital because the drivers of hunger span multiple Sustainable Development Goals: poverty and inequality (SDG 1 and 10), conflict and instability (SDG 16), climate change (SDG 13), water and land resources (SDGs 6 and 15), and others. Traditional anti-hunger policies often focused narrowly on increasing food production or providing food aid. While important, those measures alone have proven insufficient to eradicate hunger, especially when other systemic factors counteract them. In fact, despite significant advances in agricultural science and nutrition programs, the number of undernourished people worldwide has been rising since 2015, reaching about 735 million in 2022 [18]. This reversal is widely attributed to interacting stresses: conflicts, economic slowdowns, and climate-induced crop failures have outpaced isolated gains in yield or distribution.

A systems analysis reveals several feedback loops and linkages in the food security challenge. Figure 4 (earlier) highlighted one such loop between conflict and hunger. In many hunger hotspots, war and violence decimate crops, markets, and aid delivery, which leads to food scarcity and malnutrition; this human suffering can then fuel further unrest, creating a self-reinforcing cycle. Breaking this cycle requires integrated peacebuilding and food interventions – for illustration, combining humanitarian food relief with conflict resolution efforts and rebuilding of agricultural livelihoods, rather than treating them separately. Another systemic nexus is between hunger and climate change. Climate-related shocks (droughts, floods, heatwaves) are escalating and directly drive acute food crises in vulnerable regions by wiping out harvests and livestock (impacting SDG 2 and SDG 13) [33]. But there is also a two-way relationship: unsustainable farming practices and land use change contribute to climate change (through deforestation, methane emissions, etc.), which in turn further destabilizes food systems – a vicious circle. Responses such as climate-smart agriculture, drought-resistant crops, and early warning systems exemplify a systems framing in which agricultural policy is closely aligned with climate adaptation and environmental conservation (SDGs 2, 13, and 15 in combination).

Moreover, food security is tightly linked with poverty and inequality. Poor and marginalized communities suffer the highest rates of hunger, and even within households, women and children often face greater nutritional deficits (connecting SDG 2 with SDGs 1, 5, and 10). Economic policies, social safety nets, and gender empowerment initiatives, therefore, play a significant role in reducing hunger. For example, cash transfer programs or crop insurance can help buffer the economic shocks that cause families to cut meals; empowering women farmers with land rights and access to credit can boost food production and improve family nutrition. These are systemic levers: they change underlying conditions rather than just treating immediate hunger [34]. Countries that have succeeded in dramatically cutting hunger – such as Brazil in the 2000s with its Fome Zero (Zero Hunger) strategy [35] – did so by implementing a comprehensive package of measures: combining food assistance, support for smallholder farmers, school meals, nutrition education, and poverty reduction in a coherent manner across ministries. This reflects policy coherence: aligning agricultural policy with social protection and economic inclusion.

Systems thinking also helps identify leverage points in the food system. Illustratively, analysts have noted that reducing food waste (approximately one-third of all food is lost or wasted) could significantly enhance global food availability and sustainability, targeting SDG 12 to achieve SDG 2. Another leverage point is improving the productivity of smallholder farms and enhancing market access. Millions of small farmers operate far below their potential due to a lack of technology, extension services, or infrastructure; investments in those areas can create positive ripple effects – raising incomes (SDG 1), increasing food supply (SDG 2), and even curbing rural-to-urban migration by making farming viable (affecting SDG 11). However, a systems lens cautions that boosting production without considering distribution and affordability will not, by itself, solve hunger. Thus, leverage may lie in governance and equity: ensuring that food gets from surplus areas to deficit areas, that the poor can afford it, and that safety nets catch those who fall through the cracks. These insights align with the outcomes of the United Nations Food Systems Summit [36], which emphasized the need to transform food systems as connected systems to be more inclusive, sustainable, and resilient.

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The benefits of systems thinking in this domain are evident. By addressing hunger through a multi-sector lens, policies can create wider gains. In one case, sustainable agroforestry programs can sequester carbon (climate mitigation, SDG 13) while improving food and income (SDG 2 and 1) and conserving biodiversity (SDG 15). Urban farming and rooftop gardens can enhance urban food security, provide green spaces that support SDG 11 on sustainable cities, and even moderate urban heat, contributing to climate adaptation. Meanwhile, anticipating cascading risks, such as how a pandemic might disrupt large-scale food supply chains, allows for contingency planning (e.g., maintaining emergency grain reserves, which is both a hunger and resilience strategy). In short, joined-up food-system policies are far more robust and impactful than siloed approaches. The Nature editorial put it succinctly: achieving zero hunger requires tackling all facets of the food system and understanding how they intersect with other domains [9]. Thanks to systems thinking, initiatives like the UN World Food Programme's resilience programming now explicitly link food assistance with climate adaptation, disaster risk reduction, and peacebuilding in fragile states [37]. Such integrated efforts will be vital to end hunger sustainably, especially in an era when conflict and climate threats loom large.

5.2. Case 2: Climate Action as a Cross-Cutting Opportunity (SDG 13)

Climate change (SDG 13) exemplifies a transboundary challenge that is fundamentally systemic, both in causes and interventions. Greenhouse gas emissions come from virtually every sector (energy, transport, industry, agriculture, land use), and climate impacts affect all aspects of human and natural systems. Therefore, climate action cannot succeed in a silo. Conversely, if implemented effectively, climate mitigation and adaptation can generate mutually reinforcing outcomes that drive progress across multiple SDGs. Systems thinking is essential for realizing this opportunity by designing climate measures that also advance development, equity, and environmental sustainability, rather than viewing climate in isolation as purely an emissions problem.

A systems view of climate highlights multiple wider advantages of climate policies. For example, accelerating the transition to clean energy (SDG 7) not only reduces carbon emissions, but it also improves air quality and public health (SDG 3), creates green jobs and economic opportunities (SDG 8), and can improve energy access in underserved areas (supporting SDG 1 on poverty, SDG 10 on reduced inequalities). Evidence indicates that climate action and SDG achievement can reinforce one another, with progress in one agenda supporting the other [38]. In fact, additional outcomes of climate actions often directly contribute to SDG targets, and studies suggest that the wider gains outweigh the trade-offs in most cases. For example, investments in renewable energy and energy efficiency are typically win-win: they cut emissions and pollution (good for climate and health) and can reduce energy costs in the long run (good for economies and consumers). One cited illustration is achieving universal electricity access in sub-Saharan Africa (SDG 7) by 2030 [39], which would cost significantly more without climate policies than with them, because climate policies drive clean energy investments that also expand access more efficiently. These findings underscore that an integrated orientation to the Paris Agreement and the SDGs can significantly advance both agendas.

Systems thinking also helps identify and manage trade-offs that do arise. Not all climate actions automatically benefit all Sustainable Development Goals (SDGs) – there can be tensions (for example, a policy to expand biofuel crops might compete with food crops, thereby impacting SDG 2, as mentioned). By mapping these interactions, decision-makers can adjust plans to mitigate adverse side effects. The UN report on climate–SDG interactions notes that many barriers to capturing positive relationships are institutional – e.g., climate and development policies being made in separate silos, or a lack of knowledge and data on cross-impacts. Overcoming these barriers through collective governance (e.g., joint climate–development measures, integrated financing mechanisms) is itself a recommendation of the report [38]. It calls for greater institutional coordination and policy coherence so that climate action is designed in tandem with development goals, rather than traded off against them. One practical strategy is the concept of "climate-resilient development pathways" used in the IPCC Sixth Assessment, which emphasizes combining mitigation and adaptation with measures to

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eradicate poverty and inequality. This exemplifies systems thinking by framing climate action and sustainable development as interdependent dimensions of the same broader transformation.

A real-world case illustrating systems thinking in climate policy is the push for nature-based responses. Protecting and restoring ecosystems (SDG 15: Life on Land, and SDG 14: Life Below Water) can simultaneously sequester carbon (climate mitigation), buffer communities from floods and storms (climate adaptation, SDG 11 resiliency), support livelihoods like fishing and ecotourism (SDG 1 and 8), and preserve biodiversity. Illustratively, restoring mangrove forests in coastal areas is an integrated solution that simultaneously addresses climate resilience, economic development, and environmental goals. Another case is sustainable urban planning: cities contribute heavily to emissions, but they also offer opportunities for aligned responses, such as public transit and green infrastructure. Systems logic in cities means treating housing, transport, energy, waste management, and social inclusion as a single coupled system. The wider effects are clear – efficient public transit (trains, buses, bike lanes) cuts emissions (SDG 13), reduces air pollution and respiratory diseases (SDG 3), saves commuters time and money (SDG 8 and 11), and often improves social equity by benefiting those who cannot afford cars (SDG 10). Conversely, failing to consider these linkages can entrench problems: car-centric urban sprawl may reduce emissions in one area only to increase travel emissions and exclude the poor.

Importantly, systems thinking encourages long-term, transformative interventions rather than incremental fixes. On climate, this means not just tweaking at the margins but fundamentally shifting energy, transport, and food systems into sustainable pathways. The Planetary Sustainable Development Report 2023 (GSDR) identified key transformations needed in energy, food, urban development, and more – and provided tools for understanding how to trigger them [40]. It emphasizes that an integrated approach that strengthens alignment between climate and development is crucial to keeping both the SDGs and the Paris Agreement on track. Systemic change often involves coalition-building across society (governments, businesses, communities) – a reflection of the fact that dynamic systems can seldom be shifted by a single actor. In climate action, we see this in the rise of multi-stakeholder partnerships (SDG 17), such as city alliances, private-sector climate pledges, and community energy projects, that work in concert with national policies. These partnerships are effective when they share a systems framing – aligning efforts toward common shared goals rather than isolated targets.

To summarize, climate change action exemplifies the power and necessity of systems thinking. By viewing climate plans through a holistic lens, public leaders can capture substantially greater returns (improving health, jobs, equity, and security) while avoiding pitfalls (such as unintended harm to food security or ecosystems).

The two illustrative cases demonstrate how the proposed workflow can translate broad SDG interdependencies into more specific policy design considerations. Table 1 summarizes how the same systems-thinking components operate across the two policy arenas. The table is not intended as a full comparative evaluation of SDG 2 and SDG 13, but as a compact demonstration of how problem framing, feedback identification, trade-off analysis, leverage-point selection, governance coordination, and adaptive monitoring can be applied consistently across different SDG domains.

Table 1. Application of the systems thinking workflow to Zero Hunger and Climate Action. The table shows how the same framework components can be used to identify feedbacks, trade-offs, leverage points, governance needs, and monitoring priorities across two SDG policy arenas.

Workflow component	Zero Hunger / SDG 2	Climate Action / SDG 13
Problem framing	Hunger as food-system vulnerability, not only food shortage	Climate action as cross-sector transformation, not only emissions reduction
Key feedbacks	Hunger–poverty–conflict; climate shocks–food insecurity	Energy transition–health–jobs; climate impacts–poverty–adaptation

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Main trade-offs	Production gains vs distribution, affordability, land/water stress	Biofuels vs food security; mitigation priorities vs equity
Leverage points	Social protection, women farmers, food waste reduction, resilient agriculture	Clean energy, nature-based solutions, urban mobility, resilient development pathways
Governance need	Agriculture, social protection, water, conflict prevention	Climate, energy, health, transport, urban planning
Monitoring and learning indicators	Food prices, nutrition, conflict risk, climate shocks	Emissions, air quality, access, equity, adaptation outcomes

6. Barriers to Adopting Systems Approaches in Governance

Despite the clear advantages of systems thinking, public institutions often struggle to adopt joint practices. Entrenched practices and structures favor siloed decision-making, presenting several key barriers to systems-oriented policy. Identifying and addressing these barriers is crucial if we are to implement the kind of cross-cutting responses described above. Below, major obstacles are outlined – including institutional "silos", short-term planning horizons, knowledge gaps, and political economy challenges – and how they impede progress on the SDGs.

Institutional fragmentation ("silo mentality") – Governments are typically organized into sector-based ministries and agencies, such as health, agriculture, energy, and finance, each with its own mandate, budget, and lines of accountability. This structure often leads to "siloed policy development, fragmented institutional arrangements, misaligned priorities, and duplication of work" [41] (p. 2). Agencies focus on their narrow objectives and performance indicators, which can discourage collaboration or consideration of broader impacts. For example, a transportation department might pursue a highway project to meet mobility goals, while the environmental department pursues emissions reductions separately. Without integration, the highway could increase emissions and counteract climate goals. A debate piece in Sustainable Earth Reviews notes that even when technical capacities and funding are in place, "implementation often remains siloed and fragmented" [41] (p. 1) due to disconnects among sectors and actors. Silos also emerge between levels of government – local, regional, national – complicating vertical coherence. This lack of coordination is a primary reason why the SDGs' coherent ambition is not being fully realized. A 2022 study found that the SDGs have so far failed to significantly advance policy integration, as international and domestic institutions have largely remained in silos despite the rhetoric of "indivisibility" [42]. Overcoming institutional silos requires deliberate governance innovation: multi-sector task forces, joint budgeting processes, cross-ministerial incentives, and leadership from the center of government to align policies with a unified vision (as illustrated on the right side of Figure 5). Without breaking silos, policy coherence for sustainable development (PCSD) remains an uphill battle [4,7].

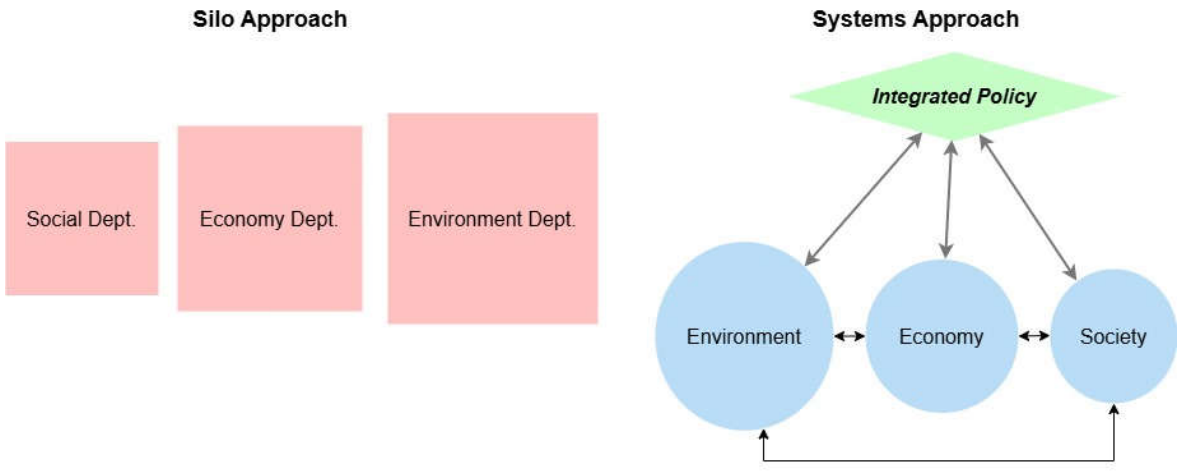

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Figure 5. Siloed vs Systems Approaches in government organizations. (Left) In a conventional silo lens, separate ministries or departments (e.g., Social, Economy, Environment) plan and act independently, often with fragmented or even conflicting agendas. (Right) In a systems view, a shared policy framework aligns sectors toward common goals, facilitated by coordination mechanisms (e.g., a central unit for sustainable development strategy). The systems orientation breaks down institutional barriers and encourages multi-sector collaboration, as represented by the "multi-sector policy" node that connects the objectives of Environment, Economy, and Society.

Short-term and single-issue focus – Political and budgeting cycles tend to be short, with annual budgets and electoral terms of 4–5 years [43]. In contrast, many systemic interventions yield gains over longer horizons and affect multiple sectors [44]. This can bias officials toward quick wins in one sector rather than adopting whole-system interventions, whose advantages, although larger, accrue over time. It also means that thorny cross-cutting issues, such as climate adaptation or disaster preparedness, that do not fit neatly within one ministry's remit may be overlooked. Furthermore, layered systems analysis can be resource- and time-intensive, whereas politicians often demand immediate results and simple narratives. The result is a temptation to implement siloed, narrowly targeted programs that yield rapid outcomes (e.g., a quick increase in crop yields), even if they cause unintended harm (such as environmental degradation) in the long run—a classic case of fixing symptoms rather than addressing the underlying causes. As Le Blanc et al. [45] note, merely recognizing that "'everything is connected'… is not useful as a policy message" (p. 26) without practical tools, so policy actors often revert to compartmentalized messages. Additionally, media and public pressure often address problems one at a time (e.g., an energy crisis or a crime wave), reinforcing siloed responses. Overcoming this requires strong leadership to maintain a long-term systems view and new accountability frameworks that reward interdepartmental outcomes (in one case, evaluating ministers on boundary-spanning SDG progress, rather than just sectoral metrics). Some countries are experimenting with well-being budgeting or SDG budgeting, which forces ministries to plan jointly for cross-cutting results, attempting to counteract short-term silo incentives.

Knowledge and methodological gaps – For many public officials, systems thinking is a new paradigm that may lack clear guidelines in day-to-day work. Traditional training in economics or public policy often emphasizes reductionist analysis, including ceteris paribus assumptions, single-variable models, and linear planning tools. The absence of a "shared multidimensional framework and practical methodology" for coherent policy design has been noted as a barrier [7]. While academic literature on SDG interlinkages has grown since 2015, this knowledge does not always translate into civil service practice. Planners may lack access to models that quantify trade-offs, or the necessary data may be missing to feed them. Indeed, a UN climate–SDG report identifies limited data and indicators for assessing climate–SDG connections across levels and sectors, including adaptation and resilience measures, as a significant barrier to collaborative action [38]. In developing countries, especially, limited analytic capacity and sector-specific donor funding can reinforce silos – each sector sticks to its own indicators and reporting requirements. There is also the challenge of complexity: systems analysis can be computationally and conceptually interdependent, which may deter its uptake. Public officials might feel overwhelmed by the "too many factors" problem. To address this, capacity-building and tools are needed. The UN, OECD, and other organizations have begun offering training in systems thinking and policy coherence. Methods like participatory systems modeling [46], which engage stakeholders in collectively mapping interlinkages, make the process more intuitive and foster a shared understanding. Still, the gap between siloed expertise and aligned knowledge remains a significant hurdle [7].

Political economy and vested interests – Systems measures can face resistance from groups that benefit from the status quo or fear losses from integration. Siloed structures often come with entrenched "turf" and resource allocations. Ministries may guard their budgets and influence, viewing whole-government collaboration as a potential threat to their autonomy or funding [44]. Likewise, interest groups (e.g., industry lobbies, labor unions, NGOs) are often organized around

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specific sectors or single issues, advocating for their cause without necessarily considering the interests of others. An energy lobby might push for coal subsidies to boost job creation (SDG 8), while environmental groups oppose them due to climate concerns (SDG 13). A systems logic that seeks a just transition with retraining programs for coal workers requires bridging these competing interests—a politically delicate task. Sometimes, coherent interventions require confronting powerful interests; for example, shifting to sustainable food systems might necessitate changing subsidy regimes and corporate practices in agriculture, which can provoke pushback. Political will is necessary to address these challenges and effectively communicate the broader effects of change. Moreover, whole-system policies can create winners and losers across sectors, raising questions of fairness and compensation. For example, if a coordinated water-energy policy raises water prices to incentivize conservation (benefiting sustainability), it may harm farmers' income in the short term. Governments must manage such trade-offs with complementary measures, such as support for farmers. The complexity of determining who wins and who loses in system reforms can make politicians hesitant. To overcome this, governance actors should employ inclusive, participatory processes, as recommended by methods such as living labs and co-design [41], so that stakeholders co-own the responses and trade-offs. Additionally, demonstrating successful cross-sectoral pilots can build broader political support by showcasing tangible co-returns.

Limited cross-domain financing mechanisms – Financing structures often mirror silos, making it hard to fund cross-cutting initiatives. Government budgets are allocated by departments, and international aid is often sector-specific. A linked program (e.g., an urban resilience project combining housing, transport, and green spaces) might have trouble securing funding because parts of it fall under different budget lines or donor categories. The UN climate–SDG report cited "lack of funding to analyze and finance more joined-up policy actions" as a barrier [15]. Traditional cost–benefit analyses may undervalue broader gains accruing outside the initiating sector, leading to underinvestment in whole-system responses. However, innovative financing is emerging, such as pooled SDG funds that encourage proposals spanning several sectors, or "budget tagging" of SDG targets [47] to identify and coordinate spending across ministries. The OECD has urged governments to use budgeting and procurement as levers for policy coherence [48]. Without reforms in financing, even well-designed multi-sector plans can stall at the implementation stage due to rigid funding pipelines.

Lastly, cultural and mindset barriers should not be underestimated. Embracing systems thinking requires a shift in how public leaders define success and strategy problems. It calls for humility about uncertainty (since multi-causal systems are not fully predictable) and openness to collaborate across disciplines. This may clash with bureaucratic culture or political instincts that favor certainty and control within one's domain. If a public manager has spent a career optimizing one sector, it can be challenging to suddenly consider a broader picture where their sector might need to compromise for the greater good. Overcoming this mindset barrier involves leadership from the top (setting expectations for combined results) and building a culture of learning and adaptability. Some governments have created "strategic foresight" or "whole-of-government" units to inject systems thinking into planning processes, signaling that systems thinking is a valued approach. Education and training also play a role: introducing systems thinking in public administration curricula and executive training helps cultivate a new generation of systems-aware policy professionals.

While the logic of systems thinking is compelling, significant institutional and practical hurdles impede its widespread adoption in governance. Breaking down silos, lengthening planning horizons, filling knowledge gaps, and aligning incentives are all necessary steps. The presence of these barriers explains why, despite the agreement in principle that the SDGs are interdependent, implementation often reverts to business as usual. Encouragingly, awareness of these challenges is growing. The UN's 2023 independent report on climate and SDGs urges tackling these obstacles precisely – from knowledge and data gaps to rigid institutions – to unlock collective action [15]. Likewise, scholars and practitioners are actively debating how to foster "epistemically connected coalitions of actors" and "shared foundations" for systems perspectives [41]. The following section will build on this

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analysis to recommend concrete plans for policy actors to institutionalize systems thinking and achieve more unified, coherent policymaking for sustainable worldwide development.

7. Recommendations: Toward Integrated and Coherent Policymaking

Overcoming the above barriers and fully leveraging systems thinking will require deliberate changes in policy processes, institutional design, and leadership methods. In this final section, we present recommendations for officials to foster joint policymaking that treats linked challenges as connected problems and supports effective responses. These recommendations are presented in a neutral, evidence-based tone, yet carry a persuasive imperative: to meet the SDGs amid large-scale turbulence, governments must evolve their planning and action, using systems thinking as a central organizing principle. The following actionable steps can guide that evolution:

1. Establish High-Level Mechanisms for Policy Coherence and Systems Coordination. National administrations should establish or strengthen institutions tasked explicitly with breaking down silos and enforcing joint planning. This could take the form of a high-level SDG or sustainability council chaired by the head of government, an inter-ministerial task force, or a "chief systems strategist" role within the executive. The OECD calls such arrangements "SDG accelerators" that align economic, social, and environmental policies [48]. For example, some countries have established "whole-of-government" SDG units in the Prime Minister's office or cabinet office to vet policies for alignment with multiple goals. These bodies can use tools such as Interdepartmental Impact Assessments [49], which require that any major policy proposal be evaluated for its impacts (positive or negative) on all relevant SDGs, not just the proposing ministry's domain. By institutionalizing a comprehensive review process, governments ensure that no policy is made in isolation. As a benchmark, SDG Target 17.14 explicitly urges all countries to "enhance policy coherence for sustainable development", reflecting transboundary consensus on this need [32]. Leaders should take that target seriously by empowering central agencies to coordinate and resolve inter-ministerial conflicts to enable system-wide responses. Additionally, aligning national development plans or COVID-19 recovery plans with the SDGs coherently sends a clear signal. Some nations have produced "Voluntary National Reviews" [50] that map how each Sustainable Development Goal (SDG) links to the actions of different ministries. This exercise can itself expose gaps and overlaps, as addressed at the UN High-Level Political Forum on Sustainable Development [51]. The key is top-level commitment: without leadership from Presidents, Prime Ministers, and Cabinets insisting on boundary-spanning collaboration, bureaucratic inertia will maintain silos.

2. Integrate Systems Thinking into Budgeting and Financing Frameworks. Funding drives action. Public authorities should adapt budgeting processes to support cross-sectoral initiatives. One lens is "program-based budgeting" around thematic outcomes (e.g., climate resilience, food security) that inherently involve multiple departments, rather than being purely sector-based. This way, a budget program for "rural resilience" might pool resources from agriculture, water, environment, and social ministries, and require shared planning. Some countries have introduced SDG budgeting tags, marking each budget line against SDG targets to identify areas for better alignment. Internationally, donors and development banks can promote multi-sector projects by offering blended finance windows that reward multi-sector outcomes. In one case, the Green Climate Fund has financed programs that link climate adaptation to livelihoods and ecosystem restoration, encouraging countries to design projects that deliver multiple benefits. Nationally, finance and planning ministries should develop investment appraisal guidelines that account for broader social and environmental gains. Illustratively, when evaluating an infrastructure project, account for its environmental and social co-impacts in monetary terms. This encourages the selection of projects with positive system-wide returns. Furthermore, establishing challenge funds or innovation grants for aligned interventions can spur creative pilot projects that span sectors (such as a grant call for "healthy and green cities" that brings together urban planners, health authorities, and environmental experts). By tying money to integration, governments send a powerful message and overcome one of

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the barriers cited: the lack of funding for collaborative action [15]. In summary, finance is a lever: adopting "budget coherence" is as important as policy coherence.

3. Build Capacity and Tools for Systems Analysis in Government. Public administrations should invest in training officials and developing analytical tools to enable systems thinking in practice. This includes capacity-building programs on systems mapping, scenario planning, and complexity science for policy analysts and managers. Multilateral bodies (UN, World Bank, etc.) and national training schools can partner to provide workshops and toolkits, sharing methodologies such as those discussed (e.g., causal loop diagramming, SDG interaction scoring). Some public authorities have begun such efforts: for example, the United Nations System Staff College offers courses on "Policy Coherence and Systems Thinking for Sustainable Development" to planners [52]. Making these mainstream in public administration curricula will normalize collaborative practices. Additionally, improving data systems and knowledge platforms is critical. National administrations should enhance data sharing across ministries and develop indicator frameworks to monitor gains and trade-offs. The use of dashboards that track interrelated metrics (for example, energy, air quality, and health outcomes) can inform policy actors about system-wide progress. Investing in computational models and decision-support systems is also recommended. Accessible versions of system dynamics models or GIS-based scenario tools can be adapted to meet local planning needs. For example, Kenya developed a cross-domain SDG model to evaluate how interventions in one sector affect other sectors, helping to prioritize investments [53,54]. International support can help countries acquire and customize such models. Furthermore, establishing multidisciplinary advisory bodies (including scientists, economists, engineers, and community representatives) can provide governance actors with a more comprehensive understanding of system linkages. In essence, public institutions must supply their teams with the know-how and instruments to "think across corners"; otherwise, calls for integration remain abstract.

4. Foster Multi-Stakeholder Partnerships and Whole-of-Society Collaboration. Dynamic systemic issues cannot be solved by the government alone – they require collective action by the private sector, civil society, and communities in partnership with public policy. Therefore, public agencies should actively cultivate multi-stakeholder partnerships (SDG 17) focused on whole-government outcomes. This might involve establishing platform initiatives around key nexus areas – one illustration is a national "Climate and Food Security Council" that brings together agriculture companies, farmers' groups, climatologists, nutrition experts, and local officials to co-design interventions for climate-resilient agriculture. Such platforms enable knowledge sharing and collective problem-solving that a single agency could not achieve. The Partnering Initiative has noted that the Planetary Goals demand "new ways of working… cross-domain conversations are now becoming broader and more strategic", moving beyond traditional silos like CSR or isolated projects [55,56]. Public agencies can facilitate this by convening stakeholders and supporting the brokering of partnerships. Moreover, community-level engagement is crucial for capturing local system dynamics and ensuring that measures address real needs. UNDP emphasizes "putting local communities at the heart of structural change", advocating locally-led development as central to effective implementation of SDGs, climate, biodiversity, and land restoration targets. Public officials should decentralize decision-making where appropriate (the subsidiarity principle) and empower local authorities with the resources and flexibility to implement consistent responses on the ground. For example, city public authorities, being closer to citizens, can pilot interdepartmental initiatives (such as combining housing upgrades with energy retrofits and job training in a disadvantaged neighborhood). National administrations should enable and scale up local successes through supportive policies and funding. Additionally, traditional and indigenous knowledge systems often embody relational reasoning (e.g., indigenous land management that simultaneously cares for the environment, community, and spiritual values); incorporating these perspectives can enrich mainstream policy with tested whole-system responses [8]. In short, leveraging partnerships and bottom-up leadership breaks the silo mentality not just within government but between government and society, aligning all actors towards shared goals.

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5. Reform Monitoring, Evaluation, and Incentives to Reward Integration. "What gets measured gets done" (often attributed to management educator and author Peter Drucker) holds true in governance. Thus, countries should adapt their monitoring and evaluation frameworks to focus on interdepartmental outcomes and policy coherence. This could include developing boundary-spanning indicators (e.g., a "Sustainable Cities Index" that integrates transport, housing, environment, and health metrics for SDG 11) and tracking policy coherence indicators (e.g., the number of shared programs across ministries or progress on SDG linkages identified as priorities). The UN High-Level Political Forum could encourage countries to report not only on individual SDGs but also on how they address SDG interlinkages and Target 17.14 on policy coherence. At the domestic level, performance contracts for senior officials can incorporate goals for collaboration – in one case, a target that the health ministry must achieve specific outcomes in partnership with the environment ministry (like reduction in air-pollution-related illnesses). Estonia, for example, included explicit objectives for aligned digital governance across ministries, tying success to budget allocations [57]. Similarly, civil service awards or recognition can be given for successful boundary-spanning projects, signaling esteem for cross-departmental teamwork. Evaluation processes for projects should assess spillover effects – did an education project also improve community cohesion or gender equality? If so, capture those advantages in the evaluation narrative and cost-benefit analysis. Multilateral development banks are increasingly using "SDG impact assessments" for their loans [58], looking at multiple goal impacts, and this practice should be expanded. By integrating building considerations into accountability and incentive systems, policy actors and implementers will pay more attention to them in their daily work.

6. Embrace Adaptive Learning and Scenario Foresight in Policymaking. Given the complexity of world systems, policies must be treated as experiments in a learning process. Public institutions should adopt adaptive management practices by implementing whole-system policies at a pilot scale, closely monitoring them, learning from successes and failures, and adjusting accordingly [59]. This iterative learning mindset is common in environmental management and should be applied more broadly to SDG policy. Scenario planning exercises should be institutionalized – for illustration, by running regular simulations of how different system-wide shocks (such as pandemics, financial crises, or climate events) could affect national SDG trajectories, and stress-testing the resilience of policy plans. The COVID-19 pandemic was a harsh lesson in the importance of preparation for systemic shocks. Foresight units in government can help anticipate emerging issues (such as the impact of AI on jobs or water-food crises) and analyze them in a cross-sectoral manner. The Global Sustainable Development Report 2023 provides a framework for considering transformative levers over time [40]; public leaders can use such frameworks to chart flexible pathways in the face of uncertainty. Importantly, this adaptive framing should include revisiting and revising national development plans and climate plans to ensure coherence, rather than locking in siloed plans for long periods. Continuous stakeholder engagement in this learning cycle is also key, as it brings diverse perspectives to interpreting outcomes and developing responses.

7. Communicate and Demonstrate the Outcomes of Systems Thinking. Ultimately, political leaders and policy advocates should convey to the public and stakeholders why joined-up practices are superior, utilizing evidence and narratives that resonate with them. Often, the general public or lower-level officials may not immediately recognize the advantages of broad, cross-sectoral plans—they might view them as too broad or vague. It is crucial to highlight concrete examples and "early wins" in which systems thinking resolved problems that siloed orientations could not. For instance, explaining how a combined health-economic response to COVID-19 saved both lives and livelihoods [1] or how a climate-smart agriculture program improved farmers' incomes while reducing emissions [60] helps build trust in the cross-sectoral strategy. Storytelling that connects the dots (e.g., linking a local flood incident to upstream deforestation and climate change, then to a new linked watershed management policy) can make whole-government connections tangible. Moreover, emphasizing the cost of inaction or fragmented action is persuasive: demonstrate how failing to adopt a systems lens can lead to policy failure or increased costs (as when separate policies unknowingly undermine one

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another). High-profile international reports and national audits can reinforce this by quantifying the losses resulting from incoherence. By making the case publicly, leaders can garner broader support for necessary reforms, such as those to budgeting or institutional mandates discussed above. Transparency in goals, such as publishing a well-aligned national SDG roadmap and reporting progress, builds credibility. Ultimately, widespread understanding and buy-in are essential because systems transformations require collective effort and often involve difficult choices. If people understand the whole-system rationale, they are more likely to accept short-term sacrifices for long-term, shared gains.

8. Conclusions

In conclusion, moving toward structured, systems-oriented policymaking is both an ambitious and a necessary endeavor in our era. The recommendations above chart a path for public institutions and stakeholders to operationalize systems thinking: through institutional alignment, innovative financing, capacity building, partnerships, reoriented incentives, adaptive learning, and effective communication. Adopting these will help ensure that policies for sustainable development are joined-up across sectors and scales, thereby maximizing impact. The old silo method leaves societies vulnerable and inefficient in their responses. By contrast, a systems-oriented lens enhances resilience and effectiveness, seeking mutually reinforcing gains that propel progress on multiple fronts [15]. For example, a 2023 UN report [34] emphasized that achieving the SDGs and securing climate stability are interdependent goals, urging that both be pursued simultaneously. This sentiment applies broadly: peace, prosperity, and the planet are deeply interlinked.

Encouragingly, the tools and knowledge for implementing systems thinking are more widely available than ever, and some early adopters have demonstrated their value. It is now incumbent on officials to scale up these practices. Looking ahead, we must remember that time is of the essence. "There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all," the IPCC warned in its 2023 synthesis report [61] (p. 24). Seizing that opportunity will require nothing less than unified, transformative action across all sectors of society. Systems thinking is the key to unlocking that transformation. By embracing a system-wide view, aligning policies with the coupled reality of the Sustainable Development Goals, and acting with a consistent purpose, public officials can navigate complexity and drive the structural changes necessary to overcome the interdependent challenges we face. The reward will be a world that is not only more efficient in problem-solving but also more just, resilient, and sustainable for future generations.

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