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ONE HEALTH TO REFRAME THE SYSTEMIC PATHOLOGICAL STATE: RADICALLY QUESTIONING ECOLOGICAL AND SOCIAL ISSUES, WITH FOOD SYSTEMS AT THE FOREFRONT

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Abstract

One Health thinking reveals an inconvenient truth: the accumulation of global crises constitutes a systemic societal pathology - the combined overexploitation of nature and a substantial proportion of humanity, resulting in intertwined ecological and social debt. The 2014 Lancet-University of Oslo Commission stated that, in a society based on social justice and ecological responsibility, health is a precondition, an outcome and an indicator of sustainability, and should be adopted as a universal value and a shared political objective. Health must therefore be understood as a triple and reciprocal condition encompassing ecosystems, societies and individuals; so conceived, it is non-negotiable. This article argues that societies embracing systemic health create the conditions required to reverse the logic of business as usual, a transition from which nature, food systems and rural communities stand to benefit first. Systemic health thus provides a unique instrument for defining indicators that account for and amortize degraded social and ecological capital. Healthy agriculture and resilient food systems are essential to closing the gap between humans and nature. Legal scholarship bears an urgent responsibility in this transformation.

Key words*: food systems, planetary boundaries, social-ecological debt, soil-water-biomass, systemic health.*

1. SEVENTY YEARS IN A SCHIZOPHRENIC WORLD

When crises overlap and accumulate, and the language of health is invoked to interpret them, the conclusion is inescapable: our societies are profoundly unwell. Yet health - understood in systemic terms - remains a distant horizon for many people and their environments. While scientific reflection is intellectually vibrant, sometimes to the point of conceptual dispersion, political action - frequently reduced to economic metrics - lacks strategic vision.

1.1. Semantic and Operational Confusion

Over recent decades, calls for societal transformation have invoked a wide array of concepts: sustainable development, planetary boundaries, the Anthropocene and its Great Acceleration, the Great Transformation, metamorphosis, One Health and its variants, and ecological civilization (Negrutiu, 2024; Pincemin & Negrutiu, 2024). Although expressed through differing vocabularies and theoretical grammars, these narratives converge on a common premise: societies cannot exist outside nature; they are embedded within social-ecological systems.

These frameworks collectively challenge the excesses of a world (Flahault, 2008) that resists integration with ecological limits. However, their proliferation has not necessarily clarified public debate. Instead, conceptual fragmentation has often generated semantic confusion, weakening the coherence and resonance of initiatives undertaken locally (Figure 1). Such initiatives require synergy to reach critical mass in the face of entrenched institutional and economic structures.

The Sustainable Development Goals (SDGs) exemplify this difficulty. Comprising 17 goals and approximately 250 indicators, they present formidable challenges of conceptual integration and contextual implementation. Furthermore, positioning "green growth" as their foundational premise is increasingly problematic. The accelerating global demand for finite resources is incompatible with the ecological imperatives embedded in the SDGs (UNEP, 2015). Modelling approaches - including carbon budgeting, resource efficiency strategies,

technological innovation, and incentive frameworks - indicate that absolute decoupling of GDP growth (at annual rates of 2-3 per cent) from resource use remains unattainable under current growth paradigms (Dittrich et al., 2012; UNEP, 2016), despite partial relative decoupling of CO_2 emissions (Wang et al., 2021).

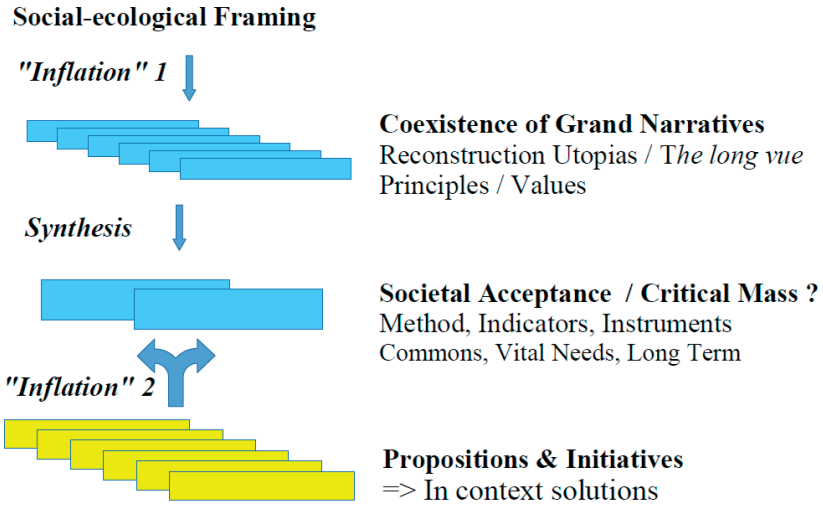

Figure 1. Schematic overview of the diversity of concepts, visions, programs, initiatives, and alternatives within the broader social-ecological approach spanning several decades after the Second World War. Among the proposals and initiatives, we can mention the Sustainable Development Goals (SDGs, 250 indicators) or the Pact for the Power to Live (66 organizations, https://www.pactedupouvoirdevivre.fr). These two categories are complementary. To operationalize the overarching narratives, a synthesis is necessary (i.e., harmonization, formatting, comparisons, and testing) to produce frameworks for implementation: methodology, dashboards/indicators, etc. The proposals and alternative solutions can then be deployed in context

Eisenmenger et al. (2020) demonstrate that the SDG architecture remains biased towards economic growth metrics-resource productivity, efficiency, and intensity—while neglecting absolute resource throughput. Ecological objectives are structurally subordinated, and implementation largely relies upon institutions historically associated with unsustainable resource exploitation. In short, the SDGs lack a coherent systemic understanding of social-ecological dynamics. Consequently, their capacity to address interconnected global crises remains limited.

1.2. Societal Pathology

Over the past seventy years (1948-present), this evolving conceptual landscape has unfolded alongside successive geopolitical crises (Table 1; Pincemin & Negrutiu, 2024). A longitudinal perspective reveals the syndrome of a patient unwilling to acknowledge illness. Many core diagnoses were articulated as early as the 1970s, notably in the Stockholm Declaration and the Club of Rome's Limits to Growth. Yet subsequent diplomatic agendas have multiplied, often reflecting conceptual diversification rather than systemic consolidation.

A comparison between evolving political discourse (Table 1, column 2) and geopolitical realities (Table 1, column 3) reveals a persistent disjunction. Scientific knowledge has progressed significantly, yet political imagination appears increasingly detached from biophysical constraints.

Several structural features characterize this systemic pathology:

First, political and diplomatic agendas that were relatively coherent and ecologically grounded in the 1970s have gradually evolved into narratives increasingly disconnected from material realities. This shift parallels the financialization of economic activity and the expansion of speculative logics (Hickel, 2019; Felli, 2016; Varoufakis, 2024). The pathology has thus become systemic.

Table 1. Based on the geopolitical transformations following the end of the Second World War and the Trente Glorieuses (1945-1972), the reality of the last 70 years is placed in historical perspective through the lens of institutional and diplomatic agendas and rhetoric (column 2) and of crises (column 3), which were primarily financial, energy-related, and epidemiological. The selection of examples is not exhaustive

Time and significance	Political and diplomatic agendas	Geopolitical crises
1945-1948 Foundations that are faltering today.	The Roosevelt years, implementation of post-World War II institutions and regulations.	WHO; ILO; IMF/WB; WTO / ex-GATT; Havana Charter; Human Rights Declaration; United Nations.
1970-1980 1972 - a pivotal year.	Stockholm Declaration 1972; Endorsed by U.N. General Assembly Resolutions 2994/XXVII, 2995/XXVII, and 2996/XXVII, 15 December 1972. Meadows Report 1972; Common Program of the Left in France 1972. Meadows Report: the social-ecological thinking is modeled and quantified.	Two oil shocks (1973 OPEC embargo; 1979 Iranian Revolution). Deterioration of economic indicators in OECD countries: inflation, growth rate, unemployment (1974-75). Rhetoric of the Davos Forum (1970-2026).
1981-1990 From one Earth to one world. China is launching its "world's factory." Economic and financial liberalization is beginning in the West.	World Charter for Nature, UN 1982; UNEP Recommendations on Chemical Pollutants 1984–85; Brundtland Report 1987; First IPCC Report 1990. Brundtland Report: Legal Principles for Collective Action and Institutional Change. Managing the Commons.	Structural adjustment programs and the crisis in developing countries in Africa and Latin America (1982-89). Famines in Ethiopia and the Sahel (1984-85). Interest rate and stock market crash, "Black Monday" 1987. Gorbachev launches Perestroika 1985; Fall of the Berlin Wall 1989.
1991-2000[1] Earth Summit. The right to development must equitably meet developmental and environmental needs of present and future generations.	Resource Management Act, New Zealand 1991; Rio Summit 1992 (MDG followed by SDG); Agenda 21. Rio - Global Partnership based on the principles of General Assembly resolution 44/228 of 22 December 1989.	The Gulf War 1990; Economic crisis (1990-93) and Monetary System crisis 1993. After 1993, new economy and economic stabilization. Asian and Russian crises (1997–98).
2001-2010[2] Consider the SDGs as an unfinished extension of the MDGs. Guarantee equity and dignity for all in a safe and restored living space on Earth.	The Aichi Biodiversity Targets 2010; Sustainable management of resources and equitable distribution through institutions. Poverty eradication is considered the greatest global challenge. Effective solutions at the local and global levels, and converging interests among stakeholders. Mad cow disease outbreak 2003. Strong development of digital technology, mapping of terrestrial and marine ecosystems.	September 11, 2001 attacks; Digital bubble and stock market crash (2001-02); Third oil shock (2003-05). War in Afghanistan (2001) and Iraq (2003). Subprime mortgage crisis and other crashes from 2007 to 2020, the Great Recession. Pandemics (2003, 2009). Strong economic growth in China and India. Global GDP doubled between 1998 and 2010.
2011-2020[3] A profound crisis of capitalism. The increase in material consumption is due to population growth, consumption trends mainly observed in developed economies, and the transformation of developing economies.	UNEP reports 2015, 2017, 2019; Planetary Boundaries and Planetary Health concepts 2015. WikiLeaks and Panama Papers 2011. Critical infrastructure (energy, buildings, transport, water supply, sanitation, and waste management) and the food supply sector contribute significantly to resource-related pollution worldwide and have negative impacts on the environment and human health.	Fukushima 2011. The Arab Spring. The COVID-19 pandemic 2020 and profound economic and migratory crises. Major social-economic effects. Extremism is gaining political ground (polarization). The crisis in Ukraine (> 2013). Social-economic crises in Latin America (> 2019). Democratic backsliding on the rise.
2021-2025[4,5] Transfer through trade etc. of all types of environmental and health impacts from high-income consumer countries to middle- and low-income countries.	NASEM 2021a, 2021b, 2023; EU Beyond Growth (the Green Plan) 2023. Emphasis on primary resources: land, water, and biomass. Long-term, science-based decision-making is recommended. Multi-indicator dashboards and remote sensing data are currently available to policymakers, contributing to the development of early warning, transparency, and accountability policies.	Wars in the Middle East and surrounding areas, in Ukraine, Sudan, and the Suez Canal region, are spilling over. A new form of imperialism is emerging, eroding morality, international law, and the social-ecological progress of previous decades. The rise of AI, with the release of ChatGPT and DeepSeek, is also a factor. Social networks and platforms have addictive and harmful effects: capturing and maximizing screen time, spreading propaganda, etc. The world population reached 8 billion in November 2022.

Abbreviations (in order of appearance)
WHO - World Health Organization; ILO - International Labor Organization; IMF - International Monetary Fund; WB - World Bank; WTO ex-GATT - World Trade Organization; IPCC - Intergovernmental Panel on Climate Change; EMS - European Monetary System and a more general awareness of the limits of capital movements; RMA - Resource Management Act; MDG - Millennium Development Goals; SDG - Sustainable Development Goals; UNEP - United Nations Environment Programme; NASEM - National Academies of Sciences, Engineering, and Medicine of the US - Nobel Prize appeal and report on sustainability science (synthesis inspired by Pincemin & Negrutiu, 2024 and https://en.wikipedia.org/wiki/2020s).

Second, the failure to amortize depleted natural and social capital - unlike conventional economic capital - has generated a dual debt: ecological and social. This debt transcends both planetary and societal boundaries (Moore, 2015; Dixson-Declève et al., 2022; Rockström et al., 2023; Gupta et al., 2023). Jason Moore's formulation of "cheap nature and cheap labour" captures the dynamic of short-term gains at the expense of long-term sustainability. Uniquely in evolutionary history, one species has effectively breached the implicit ecological "contract" governing energy flows and trophic chains (Williams et al., 2015; Jørgensen et al., 2023a). By appropriating disproportionate shares of terrestrial biomass and evading the biophysical "taxation" that makes the biosphere a condominium, humanity - embedded within its technosphere - has destabilized the regenerative cycles of the planet. The framework of Planetary Boundaries (Rockström et al., 2023) suggests that several critical thresholds have already been crossed. Disruptions now affect water, nitrogen, and carbon cycles, as well as terrestrial thermodynamics[1] (Gorshkov et al., 2004; Schramski et al., 2015), thereby compromising ecosystem functions, biodiversity, and derived ecosystem services.

Third, these excesses erode systemic resilience and regenerative capacity. State shifts-non-linear transitions between system configurations (Meadows et al., 2005; Barnosky et al., 2012) - are gaining momentum. Systems once considered robust are increasingly vulnerable (Hamant, 2023).

Fourth, resource scarcity, finitude, and substitutability dominate economic and geopolitical discourse. Yet demographic dynamics - deeply intertwined with resource pressures - remain politically sensitive and often marginalized (Mann, 2018). Over-extraction/-production/-consumption of resources translates into contemporary forms of predatory imperialism that unfold within a context of acute social-ecological tension. Resource conflicts both drive and are intensified by these tensions (Gabriel-Oyhamburu, 2011; Acemoglu et al., 2012; Jørgensen et al., 2023a; Farrell and Newman, 2024). This mutually reinforcing dynamic disproportionately affects countries already confronting poverty and structural vulnerability.

Fifth, although the relationship between pollution and health is widely acknowledged, global pollution levels continue to increase (Arguello Velazquez & Negrutiu, 2019; IPES-Food, 2017; Fuller et al., 2022). Expanding definitions of pollution - including ultra-processed foods, chemical additives, and performance-enhancing supplements - further aggravate the health burden. Industrial production now encompasses approximately 500,000 chemical substances (Brooks et al., 2020), many interacting in complex mixtures (the cocktail effect) whose cumulative impacts remain scientifically out of reach (Negrutiu, 2025a).

Within this context, the narrative of "systemic health" (Table 1) emerged comparatively late, gaining institutional prominence around 2015 and consolidating between 2021 and 2023 through work undertaken by the United States National Academies of Sciences in collaboration with the Chinese Academy of Sciences (NASEM, 2021a and b, 2023).

2. THE UNITED STATES NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE (NASEM): LAST-MINUTE WHISTLEBLOWERS

The reports of the United States National Academies of Sciences, Engineering, and Medicine (NASEM) on the progress and limitations of sustainability research represent a markedly transformative position during what has been described as a decisive decade (2020-2030) in the face of unprecedented global challenges. Their conclusions are noteworthy for both their diagnostic clarity and their normative ambition. The principal arguments may be summarized as follows:

1. The global crisis constitutes a vast, uncontrolled experiment on the Earth's life-

[1] The energy dynamics of the biosphere makes the Earth System operate as a space battery (Schramski et al., 2015). Human activities and energy extracted in the last few centuries have made it possible to build today's intensive economy, a "debt" economy on living and fossilized biomass. The former is the most critical because there is no substitute or replacement energy for the direct conversion of diffuse low-quality solar energy to high quality organic compound chemical energy stored in living biomass.

support systems. Human activities have altered biophysical processes at planetary scale without adequate understanding of systemic feedbacks.

2. Guiding the technological revolution is imperative. In aggregate, technological progress has accelerated planetary destabilization. Future innovation must be explicitly oriented towards social and ecological objectives, including infrastructural transformations (see also Sverdrup & Ragnarsdóttir, 2014).

3. Power structures remain insufficiently integrated into social-ecological science. The latter remains methodologically underdeveloped in analysing power dynamics across time-space scales.

4. A persistent disconnect exists between empirical urgency and electoral politics. Scientific evidence indicates accelerating risks, yet political responses remain constrained by short-term electoral cycles (see also Carney, 2015).

5. Measurement systems must move beyond GDP. Indicators reflecting the genuine well-being of both people and nature are required, and should be adopted by financial and business sectors. Economic, environmental, and social externalities must be appropriately internalized.

6. Planetary Health has reached a societal inflection point. The recognition of intimate interdependencies between human health, animal health, and ecological integrity is evolving from conceptual framework to actionable commons-based narrative.

7. Justice-focused equity is central. Structural economic, social, and political drivers of systemic lock-in must be dismantled.

8. Adaptation governance and transformative change require institutional redesign. Effective linkages between knowledge and action must operate across scales, while confronting barriers rooted in power asymmetries and vested interests.

Taken together, these observations suggest that shifting from a pathological diagnosis to a health-oriented framework reshapes the conceptual landscape and architecture underpinning sustainability discourses. It compels us to ask three foundational questions: What narrative? What vocabulary? What grammar[2]?

The framework of Planetary Boundaries, which has received sustained scientific and political attention in recent years (Dao & Friot, 2025), offers a scientifically robust system for defining biophysical limits. When considered in an integrated manner, planetary boundaries can be analytically regrouped around two systemic drivers: food systems and global pollution (Arguello Velazquez & Negrutiu, 2019). This reframing constitutes a conceptual shift. It clarifies both the sources of destabilization and the loci of intervention (Fenner & Scheringer, 2021; Negrutiu, 2025a). These two components operate synergistically and generate what may be termed a dual "health bubble": a set of slow, cumulative, and systemic risks that are often underestimated because of their insidious character. For example, the postwar massive proliferation of chemicals has become global and inescapable: humans and non-humans have become chemically transformed beings[3] (Thomas, 2014 and references therein). The health-bubble perspective also sheds new light on climate change and biodiversity erosion (Weathers et al., 2025). It follows that planetary boundaries alone[4] may not suffice to sustain a unifying grand narrative.

3. SYSTEMIC HEALTH: TOWARDS A GRAND NARRATIVE

These analyses converge in placing the concept of health at the centre of early twenty-first-century challenges. Health, in this sense, ranges from societal "care" (Serres, 2016), to persistent toxic contamination crises such as chlordecone pollution in the French West Indies (Santé Publique France, 2010; ANSES, 2024), to the COVID-19 pandemic, and the growing fragility of public health systems across the world.

The Lancet-University of Oslo Commission concluded that in a society grounded in social justice and ecological responsibility, health becomes simultaneously a precondition, an outcome, and an indicator of sustainability

[2] This is all the more important and urgent as the unravelling of political language taking place via ultraliberal-imperialist spheres is changing the grammar of recent decades (Miranda, 2026).

[3] "We are what we eat" joins hands with "We are our chemically altered environment" (see Section 6).

[4] Boundary values remain controversial for land use change or fresh water variables, as does the quantification of biodiversity loss, functional biosphere integrity, and global pollution (https://en.wikipedia.org/wiki/Planetary_boundaries; Dao & Friot, 2025). Furthermore, concerns have been raised about using boundaries in isolation. Also, there is the issue of whether economic and political control and management through thresholds would be meaningful.

(Ottersen et al., 2014). Health must therefore be recognized as a universal value and shared political objective. Similarly, Article 1 of the 2004 French Charter for the Environment affirms that everyone has the right to live in a balanced and healthy environment.

Health operates on multiple levels: it is a universal value, a normative metaphor, a political principle, a biological and environmental contingency, and a methodological framework encompassing diagnosis, evaluation, and prevention. Its societal resonance and political force derive from this multidimensionality. Health speaks to human dignity and to the commons; it legitimizes long-term collective interests even when these conflict with short-term economic gains.

This perspective is articulated in the "Manifesto for a Common Health" (Collart Dutilleul et al., 2023), the product of dialogue between legal scholars and natural scientists, and inspired by Michel Serres's The Natural Contract (1990). "Common health" is conceived as shared and reciprocal among individuals, societies, and the biosphere. It materializes the social-ecological paradigm according to co-existing frameworks: Planetary Health (Whitmee et al., 2015), One Health, Global Health, Ecohealth, and Full Health (Pleine Santé) (***Supplementary Panel 1***). While the Manifesto prioritizes "common health" over more institutionalized or sector-specific approaches, for analytical clarity this article adopts the broader term ***systemic health***, ensuring balanced treatment of ecological and social dimensions.

The Manifesto raises a series of foundational questions (Figure 2):

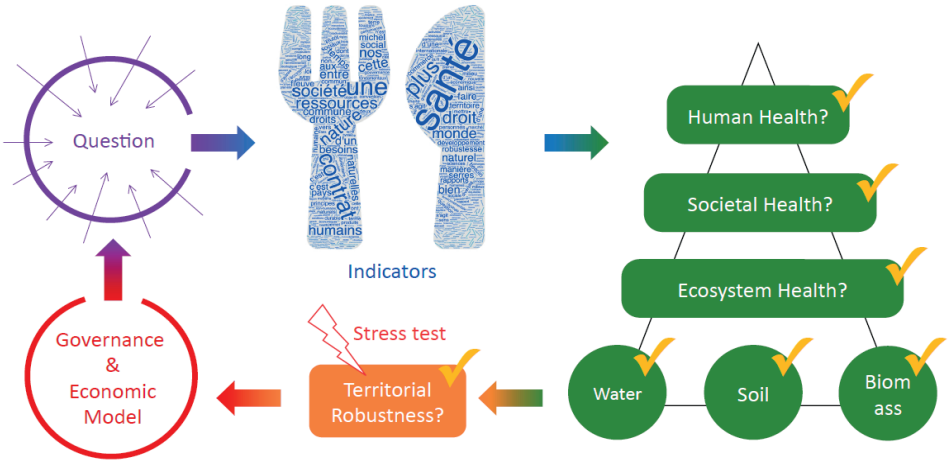

Figure 2. Systemic health is a way and a guide for inhabiting the Earth and its territories. It represents a profound paradigm shift. Outlined as a pyramid, the health of natural environments (water-soil-biomass) encompasses social and human health. At each stage, decisions must absolutely "check" the human, environmental, and social components of health. It is not a matter of imposing new rules, such as those advocated within the framework of Corporate Social and Environmental Responsibility, onto an existing economic model that has become obsolete, both socially and ecologically. On the contrary, it is the project itself, having undergone several cycles of health assessments, that builds a new, situated, and sustainable economic model. Nature and culture are prerequisites; the economic model is no longer a dogmatic input constraint, but an output rooted in our relationship with the world
(adapted from Collart Dutilleul et al., 2023)

What political and societal vision is required in the face of structural, institutional, economic, and environmental vulnerabilities?

Does systemic health prioritize preventive approaches over curative responses while guaranteeing most basic needs for all?

Can systemic health integrate society into ecological cycles, functions, and interactions?

Should the dominant rule of the market - which reduces natural resources to "supply" and human needs to "demand" - be reframed?

If "we are what we eat", should the political narrative shift from "farm-to-fork" towards "fork-to-farm", thereby aligning agri-food systems with public health (i.e., food democracy; see section 6.2)?

More fundamentally: what if health, rather than the market, were to guide the global economy (Laurent, 2020)?

4. SYSTEMIC HEALTH OVERTURNS THE LOGIC OF BUSINESS AS USUAL

Systemic health reconfigures the relationships between planetary boundaries, economic systems, and societal limits (Negrutiu, 2024). Rather than advocating degrowth *per se* (Jackson, 2009), it repositions the economy as a subsystem of the biosphere, tasked with balancing accessible resources against fundamental human needs (Collart Dutilleul et al., 2023). These needs correspond to those protected by human rights.

The appropriate equilibrium, therefore, is not between supply and demand, but between essential needs and available natural resources. This reframing clarifies the societal mission of markets: they must function within ecological constraints while ensuring equitable access to vital goods (to keep private profit and associated social-ecological debts in check).

Systemic health thus implies a renewed contractual framework. It seeks to balance what nature provides to human societies with what societies must return to nature. As the Manifesto observes, while the social contract historically aimed to pacify social relations by excluding violence and domination, it has failed to guarantee equitable pooling of vital resources. Yet ensuring effective access to resources necessary for collective well-being (***Supplementary Panel 2***) is the primary purpose of any legitimate contract. The challenge, therefore, is twofold: to utilize nature's resources prudently in satisfying human needs, and to mobilize human reason and institutional design to safeguard the needs of ecosystems. Human rights become effective only when they entail corresponding duties.

Health, initially mobilized as a corrective to economic logic, now extends to institutional and commercial governance. It informs climate policy, biodiversity protection, and economic reform. As Elizabeth Maruma Mrema (Deputy Executive Director of UNEP, UN Under-Secretary-General, and former Executive Secretary of the Convention on Biological Diversity) observed in 2023 (McKinsey, 2023): *you can do everything under the sun as far as climate actions and solutions are concerned, but if nature is not part of the equation, global warming will continue to increase to unimaginable levels.*

For systemic health to become operational:

- Indicators and protocols must be grounded in robust scientific methodologies; accurate measurement conditions prudent judgement.
- Scientific communities must organize their research questions and instruments in genuinely transdisciplinary ways, while integrating law and governance structures.
- Regulatory capacity must expand to integrate economic activity within social and ecological constraints.

Health constitutes therefore both a normative compass and a regulatory principle. In a finite physical world, systematic measurement of human activities and full accounting of their social and environmental costs become indispensable.

5. WHAT AND HOW TO MEASURE? INTEGRATED SOCIAL-ECOLOGICAL INDICATORS MAKE UP SYSTEMIC HEALTH

What societies choose to measure reflects what they value. A health-based approach enables the construction of assessment systems that are preventive, collective, and democratic, thereby safeguarding public and common goods while incorporating the interests of future generations. Systemic health must demonstrate tangible relevance for present generations if it is to sustain long-term legitimacy.

Renewed interest in social-ecological planning[5] (Ministère de la Transition écologique, 2023; Fofana & Hallosserie, 2024; Viennot, 2025; see also Thompson & Steiner, 1997) represents a good starting point for thinking about systemic health. Such planning strengthens long-term orientation, institutional legitimacy, and cross-sectoral coherence in science-policy interactions.

Experimental sciences can provide calibrated datasets tailored to legal and regulatory needs. However, significant limitations persist. Many large-scale data systems fail to meet standards of

[5] i.e., the integration of nature and humanity to create a healthy living environment through sustainable use of resources by adopting friendly materials, energy-saving technologies, recycling design, etc. It should be noted that the social dimension has not yet found its place in these planning mechanisms.

findability, accessibility, interoperability, and reusability - the FAIR principles (Wilkinson et al., 2016; Fairbrass et al., 2020; Argüello et al., 2022; Ramírez-Márquez et al., 2024). Political commitment to restructuring public data infrastructures is therefore urgent.

A couple of social-ecological evaluation frameworks illustrate operational feasibility. Together they embody the spirit and the letter of systemic health.

The Limits to Growth report to the Club of Rome (Meadows et al., 1972) pioneered integrated modelling of political, economic, social, and environmental systems based on resource finitude. Its recent update, ***Earth for All*** (Dixson-Declève et al., 2022), employs eleven synthetic parameters incorporating over 100 variables and feedback mechanisms. Its principal conclusion is unequivocal: reducing inequality is central to improving human well-being within planetary limits.

At national scale, New Zealand's ***Resource Management Act*** (1991) offers a pioneering example of integrated natural resource governance (Gow, 1997). Positioned at the apex of legislative hierarchy, it coordinates land, water, environmental, and economic law within a unified framework structured around the triptych "Avoid, Remedy, Mitigate". Compensation mechanisms were excluded. National environmental standards define long-term limits concerning water, estuaries, air, soil, biodiversity, and development.

At local scale, the Michel Serres Institute (Lyon) and the Lascaux Centre for Transition Studies (Bayonne) are developing integrated systemic health indicators applied, for example, at river basin level. Three interconnected dimensions are measured:

Public health. Starting from the definition that health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1948), we can directly use sets of indicators deployed at the international (WHO) or national (Health Agencies) level.

Societal health is addressed through the adjustment of basic needs to available resources (LASCAUX and CELT programs; Collart Dutilleul et al., 2023) and aims for social cohesion (see United Nations, 1994).

Ecosystem health refers to ecosystems' state or condition and involves maintaining their organization, functions, diversity, productivity, resilience to stress, and autonomy over time (Argüello et al., 2022).

The objective is to integrate these three dimensions into national accounting frameworks currently dominated by GDP. Approximately half of global GDP depends on healthy ecosystems, and 20 per cent of countries face risks of ecosystem collapse (Swiss Re, 2020).

To test the feasibility of this approach, the health component of ecosystems was experimentally assessed in the Rhône River basin using an ecosystem capital accounting method (Argüello et al., 2022). This research indicates that amortizing the consumed ecological capital in the Rhône River basin would negatively impact the region's current GDP by at least 30 per cent. This work is accompanied by the development of mathematical models establishing dependencies and causal relationships between the three categories of health indicators.

These models provide a better understanding of interacting drivers and constraints and can support multidimensional political and economic trade-offs. Thus, cost-benefit analyses between the three levels of health - and in particular between ecosystem health and societal health - can accurately inform decision-making. For example, environmental risks alone have been estimated to account for 23 per cent of global deaths and 22 per cent of disability-adjusted life years (Prüss-Üstün et al., 2017).

One may therefore ask: what would society look like if the amortization of ecological, social, and public health capital were fully internalized? It is at this juncture that agriculture and food systems assume central importance. Positioned at the intersection of ecosystem integrity, social organization, and human nutrition, they constitute the operational core of systemic health.

6. WHAT EXACTLY IS AGRICULTURE? CERTAINLY NO LONGER THE ADJUSTMENT VARIABLE OF OUR SOCIETIES

If systemic health is to become operational, it must engage directly with the sector that lies at the intersection of ecosystems, societies, and human survival: agriculture.

The Industrial Revolution and subsequent technological and infrastructural transforma-

tions have reshaped agriculture into an activity increasingly dependent upon industrial inputs, mechanization, synthetic fertilisers, fossil energy, and globalized supply chains. In many regions, these processes have marginalized small-scale farms and weakened rural communities. Since 2022, the global population has exceeded eight billion, while more than half of the planet's ecosystems are now heavily anthropized (Barnosky et al., 2012; Ellis, 2019). Under such conditions, tensions surrounding agriculture have reached unprecedented levels. Recent conflicts within the European Union and debates surrounding the Mercosur trade negotiations (2025-2026) illustrate how agriculture has become a focal point of geopolitical, ecological, and social contestation (Jublin & de Ravignan, 2026).

Historically, agriculture has functioned as the principal social, economic, and ecological adjustment variable of most human societies (Negrutiu, 2025b). This is paradoxical. Agriculture represents a paradigmatic case of social-ecological co-evolution and a defining feature of our species. Through domestication, systematic land-use transformation, and the construction of dedicated infrastructures, humans have continuously reshaped ecosystems (Jørgensen et al., 2023a). Cultural evolution initially conferred ecological advantage; over time, this advantage evolved into ecological dominance.

Today, agriculture (and therefore ecology) is inseparable from questions of national security and sovereignty. Yet it is simultaneously embedded in globalized markets that subordinate ecological and social considerations to short-term competitiveness and profits.

Agriculture thus embodies a dual character. It is a central driver of the "health bubble" described earlier - through land conversion, biodiversity loss, and resource depletion - but it also contains unique leverage points for systemic transformation (Schneider et al., 2023). For this reason, agriculture must constitute the starting point of any credible political and legal reorientation. In other words, translating into societal practice the principles "We are what we eat" and "Food is medicine" (here the microbiota comes in; see also Thomas, 2014) implies recognizing that food production is not merely an economic activity but a daily, universal necessity. Every individual depends on agriculture and food, every day.

6.1. The Ecological Dimension of Agriculture - Unique Physical Resources

Within the systemic health framework, agriculture is structured around three primary and interdependent physical resources: ***soil, water, and biomass*** (Figure 2). These resources form the material foundation of food systems and possess distinctive characteristics: they are renewable yet exhaustible, non-substitutable, and non-relocatable (Negrutiu et al., 2020). Despite their fundamental importance, and contrary to basic economic logic, their large-scale degradation is not amortized within prevailing economic systems. Their management is therefore not merely technical but profoundly political and legal, given their centrality to food security, food sovereignty, and food democracy.

Biomass. All living matter is biomass. Human beings themselves are biomass, composed of approximately 70 per cent water. Food is biomass transformed. Current levels of human appropriation of biomass - estimated at approximately 40 per cent globally - constitute a major driver of habitat destruction, land-use change, biodiversity erosion, declining agro-ecosystem productivity, and climate change (Urban, 2015; Barnosky et al., 2012; Steffen et al., 2015). The scale of this appropriation fundamentally alters trophic structures and ecological balances.

Soil. Soils represent one of the most complex and fragile outcomes of evolutionary processes. Soil ecosystem multifunctionality - mediating interactions among water, air, microorganisms, and plant life - renders soils indispensable yet vulnerable (Negrutiu et al., 2020). Agriculture is inseparable from soils. It entails the intentional production of biomass through alteration of vegetation cover and soil structure. Land conversion remains the principal direct driver of habitat transformation across more than 40 per cent of the Earth's terrestrial surface (Vanbergen et al., 2020). It has been described as the largest geoengineering operation ever undertaken by humanity (Verburg et al., 2015).

Water. Water scarcity and degradation have now entered a phase that may reasonably be described as post-crisis. Recent United Nations

assessments (Madani, 2026) employ unusually stark language: references to exhaustion of water resources (a "bankruptcy"), liquidation of natural capital, and the vulnerability of entire regions. More than four billion people experience severe water scarcity for at least part of the year. Water withdrawals and pollution increasingly exceed renewable inputs. Groundwater depletion, wetland loss, soil degradation, river modification, and glacial retreat impose damages that are either irreversible or repairable only at prohibitive cost. Humanity has entered what may be termed the age of hydrological irreversibility.

Taken together, agro-ecosystems represent a simplified and diminished form of nature: they are human-managed configurations of soil, water, and biomass. The manner in which these three resources are governed determines whether agriculture undermines or restores systemic health.

6.2. The Social Dimension of Food Systems - Peasants and Smallholder Farmers as Mediators with Nature

Food is a universal and indispensable resource, a vital individual and collective need (Supplementary Panel 2): it sustains life, labour capacity, and social organization. Yet food is more than caloric intake: it shapes power relations, cultural identity, and social cohesion.

The United Nations Special Rapporteur on the Right to Food, Olivier De Schutter (2017), observed that contemporary food systems simultaneously produce hunger, ill-health, and ecological degradation. One person in ten remains undernourished, while obesity and diet-related diseases escalate globally (Sundiang et al., 2025). The agri-food crisis thus encompasses multiple dimensions:

Moral: declining trust in industrial systems and erosion of dietary diversity;

Social: proletarianization, inequality, and economic marginalization of farmers;

Environmental: biodiversity loss and ecosystem degradation;

Political: disengagement and weakening of public regulatory authority;

Economic: concentration of power in oligopolistic agri-food corporations and expansion of liberalized trade regimes.

Initiatives such as the "Campaign to Improve the Nutritional Condition of Americans", supported by academic institutions, foundations, regulatory agencies, and members of the United States Congress (Food is Medicine Institute, 2025), illustrate attempts to reframe food as a public health intervention rather than a commodity. The "Food is Medicine" approach promotes dietary transformation as a therapeutic and cost-effective strategy for reducing healthcare expenditure and chronic disease burdens (Westcott, 2025).

Nevertheless, a substantial proportion of undernourished populations are, and that is the last straw, smallholder farmers, as well as residents of rural areas that depend upon small-scale agriculture for their livelihoods (Vanbergen et al., 2020). This underscores the persistent tension between globalized agricultural systems and local food security. Therefore no systemic health transition is possible without confronting structural inequalities.

As a matter of fact, systemic health reframes agriculture not as a mere production system, but as a social-ecological function. The propositions "We are what we eat" and "Food is medicine" fundamentally reconfigure social-ecological and political understandings of food. Food, currently treated as a commodity among others (Vivero Pol, 2013; Collart Dutilleul, 2018), becomes a collective health concern. The conventional "farm-to-fork" narrative, often deployed mechanically in policy discourse, may require inversion: a "fork-to-farm" democratic practice (i.e., food democracy; Collart Dutilleul, 2021) in which citizens' dietary choices shape agricultural and public health policies. Such a reorientation implies joint governance of the core resources underlying food production - land, water, and biomass (Negrutiu et al., 2019, 2020; Collart Dutilleul et al., 2023).

Ultimately, farm-to-fork precisely indicates how the distribution of power within food systems operates. It can be reduced to three interrelated controls and one challenge (see also IPES-Food, 2026): Control of physical resources; Control of information and data (BigTech and BigAg are tightening their grip on farming through Artificial Intelligence); Control of regulatory rules; Who is defining the problems and the solutions (with finance and public policies in the driving seat). In this configuration, the progressive privatization of nature becomes evident.

7. SYSTEMIC HEALTH, AN INSTRUMENT OF SOCIAL-ECOLOGICAL TRANSFORMATION TO PURGE THE SYSTEM

Transitioning from systemic pathology to systemic health requires dismantling the health bubble whose manifestations differ across societies. Systemic health operates simultaneously as narrative and instrument. It entails reconfiguring economic, political, and social organization, and relearning how to recognize ecological limits. The social dimension in a social-ecological perspective is paramount, because it enables coherently articulating social and political values. Ultimately it may decide the fate of a society (Morris, 2013; Thomas, 2014).

Health thus becomes a narrative of social cohesion, collective responsibility, and long-term orientation. It integrates economy within society, and society within ecology. The approach outlined here demonstrates how health can operationalize other social-ecological frameworks, including Planetary Boundaries and the Sustainable Development Goals. Health, resources, and robustness (Figure 2) thereby become foundational policy criteria, adaptable across territories and scales. In this perspective, local and global dimensions are not opposed; nor are short-term and long-term considerations. Instead, they form nested layers of responsibility (Collart Dutilleul et al., 2023; Negrutiu, 2025b). Health may also function as an antidote to ecological denial. Across societies, two enduring expectations persist: health and justice (Negrutiu, 2022). These aspirations are inseparable and demand collective framing of, to name just a few, poverty, climate change, and biodiversity loss within a reordered hierarchy of priorities.

Yet contemporary societies are marked by deep social-political polarization (Varoufakis, 2024; Oxfam, 2025). Current geopolitical tensions undermine social-ecological cooperation and work against the systemic health framework. Since humanity cannot exist outside nature, transformative questions must be posed within social-ecological space: Is agriculture an economic activity like any other? Is food a commodity like any other? Is a world without smallholder farmers conceivable or acceptable? To whom does nature belong?

Systemic health remains, therefore, a wager. It requires substantial collective effort and institutional redesign. Law occupies a central position in this undertaking (Negrutiu et al., 2019, 2023). Public institutions themselves face crisis under declining confidence in progress and scientific authority. The question arises: are they reformable (Frérot, 2016)?

Two trajectories emerge. One anticipates, prevents, and reorganizes societal systems to live within ecological constraints. The other ignores the "boomerang effect" of nature - whereby humanity now depends upon the systems it has destabilized. As Michel Serres (1990) wisely observed, we now depend on the things that depend on us. The message is clear: whatever humans do to the natural world finds its way back to humans.

In simplified terms, the central issue becomes whether an open legal framework can be designed in which social-ecological costs are systematically internalized. Such an approach would likely align economic activity with biospherical limits and would allow avoiding unduly disrupting the laws of Earth's thermodynamics. Systemic health resonates therefore with indigenous cosmologies, such as that of the Kogi people of Colombia, who conceive their mission as safeguarding the balance of the Earth for present and future generations (Julien, 2022; Pyhälä, 2024). Western science has developed tools to measure such balances; governance through law must now ensure that quantification serves justice rather than technocratic control (Supiot, 2015; Varoufakis, 2024).

The decisive constraint, however, is temporal. The present decade (2020-2030) has been identified as pivotal (NASEM, 2023; Negrutiu et al., 2023). Given existing planetary and societal boundaries[6], is there still time for

[6] Namely, a human population that has quadrupled since the 1950s, the institutional and organizational scale of human societies, the haphazard use of the technosphere, the burden of systemic health, the asymmetries and incongruities of social capacity and group behaviour (political and cultural values, short-termism/long-term view, cooperation/competition, unbridled consumption/self-limitation, collective learning, connectivity, and information overload, levels of inequity, deleterious geopolitical power games, etc.) (Jørgensen et al., 2023a, 2023b; Faerron Guzmán et al., 2025).

inaction, or even gradual adaptation? Or has humanity hit a demographic glass ceiling while engaging in an evolutionary trap - a trajectory characterized by unprecedented constraints of combined social organization, polarized cultural landscapes, and rates of change exceeding governance capacity (Hulme, 2020; Waring et al., 2023)?

This question remains open. Systemic health offers a framework for answering it - but only if it is translated from narrative into institutional practice.

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NOTES

(1) The ambiguity of the decade: Environmental protection and the precautionary principle must be an integral part of the development process, while avoiding penalties for international trade and investment.
(2) A conceptually poor decade, shaken by major crises.
(3) The decade of UNEP and social protests (Occupy Wall Street, demonstrations in Hong Kong, Algeria, Iran, the "yellow vests" in France, and school strikes for climate).
(4) The NASEM (National Academies of Sciences, Engineering, and Medicine) decade. Over the past fifty years, the world's population has doubled, raw material extraction has tripled, and gross domestic product has quadrupled, contributing to over 90 per cent of biodiversity loss and water stress, and accounting for approximately half of the impacts of climate change. Furthermore, global progress on the 2030 Agenda for Sustainable Development indicates that this agenda is "severely threatened" (2022). Academic science is being politically targeted.
(5) The new imperialism draws advantages from the capabilities of digital systems (particularly in the large-scale production of fake news), where the quantity of views on social networks generates value, and this occurs in all spheres of activity, including the sciences (NASEM, 2025). Quantity, enormity, and excess transform clicks into social facts, into something akin to truth. This constitutes a "collective fabrication of value" (Liogier, 2026).

Supplementary Panel 1. Comparative One Health and Planetary Health

The definitions and action plans they propose evolve and change over time (Lerner & Berg, 2017; Morand et al., 2020; Ruiz de Castañeda et al., 2023).

One Health tends to be exhaustive essentially on the public health aspects (human and animal health priority area) and has recently integrated a broad range of environmental aspects. The program is carried out by a quadripartite cooperation between the global international organizations WHO, WOAH (animal health), FAO, and UNEP. This is a political network operating in association with governmental, financial, economic partners, civil society organizations, joint program networks, education and training activities, with national targets and priorities across sectors. For example, the 200 research networks - concentrated so far in Europe - investigate emerging infections and novel pathogens, endemic infections and NTDs, antimicrobial resistance, and extreme weather, water, environmental degradation, food safety, and food and nutrition security.

Planetary Health has been initiated by the Lancet-Rockefeller Foundation commission and the Planetary Health Alliance is built on a strong academic network (400 universities, including Harvard, Oxford Martin School, Western, London School of Hygiene and Tropical Medicine, Sydney, California, Sunway), US and Chinese Academies, but also world leaders and experts from business, government (60 countries), and civil society organizations. The program is focused on teaching and training activities, and targets several environmental and health challenges (e.g., food systems and water, global pollution, climate, human pathologies).
The comparison highlights the fact that the main dimension that is apparently lacking or at least is not directly addressed is social health per se.

Supplementary Panel 2. Basic needs, accessible resources, and Societal Boundaries

Allocation of resources has been driven by a narrow economic-growth logic of development, cost recovery, and reliance on the market (Gupta & Lebel, 2020). Denying fair access to vital resources violates fundamental human rights and raises concerns about resource stewardship governance, with impacts on both social health and ecosystem health. While the adjustment of resources and needs is at the heart of business and family or community functioning, that concern is more discreet in public policies.
The essence of adjusting basic needs and resources implies considering the triptych "fundamental goods" (land, water, and wealth produced by natural resources, all of which are limited), "basic needs" (both economic and social, with food and health in the first place), and "fundamental rights" (the normative obligations of human rights). The latter is expressed in particular in the Draft Optional International Protocol on Economic, Social and Cultural Rights: "civil, cultural, economic, political, and social rights are universal, interdependent, and indivisible" (United Nations, 1994; Mahon, 2008). Therefore, resource justice becomes a pluralistic process about collective and individual relationships encompassing the distribution of rights and responsibilities on Common Pool Resources (distributive justice) and the role and ability of stakeholders to contribute to decision-making (procedural justice) (Ostrom, 2009; Wyborn et al., 2020).
Earth system justice is meant to allow living within biophysical boundaries in ways that enable fair access to essential resources and interrelated needs and services (Gupta & Lebel, 2020; Millward-Hopkins et al., 2020; Blake and Smith, 2022; Rockström et al., 2024). A just access to material resources concentrates on universal needs, such as food, water, energy, and infrastructures (e.g., housing, transport). This is based on international human rights principles extending to procedural and substantive justice (i.e., distributive, corrective, and restorative justice; Gupta et al., 2023), consisting of principles of equal distribution, meeting minimal needs

for all, and limiting excess resource use. They are likely to alleviate the unequal impacts of pollution, epidemics, or access to land, but also to address responsibilities for environmental degradation and disparities between countries, communities, and social and racial groups (Hickel et al., 2022).

There is significant work on what is considered a decent standard of living (Quality of Life, well-being; Costanza et al., 2007) that relates to social equity and protection, and to carrying capacity considerations (Mote et al., 2020). Human-rights advocates have long highlighted the imperative of ensuring every person's claim to life's essentials (sufficiency in dignity) and avoiding deprivations.

Gaining institutional power by articulating social well-being and ecological robustness sets focus on ***collective needs***. This can be a productive approach to resource reallocation by aligning equity in wealth (i.e., the adjustment of accessible resources and fundamental social and economic needs) with a responsible maintenance of the life-support capacities of the biosphere. Rights and responsibilities can be aligned (Rammelt et al., 2023).

The operationalization of the Earth justice framework targets access and allocation means, such as (1) access to information in decision-making, to civic space, legal remedies, minimum resources, and services, as well as (2) allocation of risks and harms, along with corresponding responsibilities for each of them. For example, access indicators have been established to quantify key material needs for food, water, energy, and infrastructure at two levels: escape from poverty and enabling a dignified life (Rammelt et al., 2023). Once evaluated, the minimum needs are integrated with the current levels of consumption figures and converted to planetary boundaries.

In summary, societal boundaries can become instrumental in promoting societal self-limitation with specifications debated according to sociocultural determinants implying institutional reframing of how goods, services, etc., are produced, distributed, and consumed (Brand et al., 2021). The difficulty with self-limitation at individual level lies in the fact that it has direct consequences: social marginalization or even (self)exclusion. Only a collective decision / option makes societal sense.

It is worth noting that societal boundaries have additional dimensions that embrace contrasting behavioural aspects, such as trust, immoderation, prestige. Of note, human needs expand with knowledge, technology, and material richness.