Transformative Knowledge for Planetary Sustainability- Bridging Science, Indigenous Wisdom, and Policy

Medani P. Bhandari[1,2,3,4]

[1]UNEP MGSF-Regional Facilitator,
North America

[2]Atlantic State Legal Foundation (ASLF), Senior VP- Akamai University,
USA

[3]Visiting Scholar, and Prof. Sumy State University,
Ukraine

[4]Principal-Kathmandu Forestry College,
Nepal

***Abstract*— The planetary crisis—manifested through climate change, biodiversity loss, and resource inequities—is deeply rooted in dominant epistemologies that prioritize extractive, anthropocentric, and technocentric worldviews. Addressing these crises requires transformative approaches to knowledge governance that bridge scientific research with Indigenous and local knowledge systems in ways that are holistic and action-oriented (Bhandari, 2023c; Bhandari, 2025c).**

Several frameworks support meaningful integration of diverse knowledge systems. The co-production of knowledge framework emphasizes collaboration across epistemologies through joint problem definition, data collection, and solution development, treating Indigenous Peoples and local communities as equal partners with recognized authority and long-term stewardship over ecosystems (Bhandari, 2023a; Folke et al., 2005). The Multiple Evidence Base (MEB) approach, promoted by IPBES, complements this by allowing Indigenous and local knowledge to coexist alongside scientific knowledge without requiring validation through scientific standards, thereby enriching the collective understanding of socio-ecological systems (Tengö et al., 2014; Norström et al., 2020).

Ethical and rights-based governance is central to these approaches. Free, Prior, and Informed Consent (FPIC), respect for traditional knowledge, and safeguards against misappropriation ensure trust, equity, and sustainable collaboration (Bhandari, 2022; UN, 2007). Participatory frameworks—including participatory action research, community-based adaptation, and Indigenous-led monitoring—align research with local priorities, enhance community capacities, and support resilience-building (Bhandari, 2025c; Mercer et al., 2010).

Finally, relational and holistic ecological frameworks, rooted in Indigenous worldviews and increasingly adopted in systems science, emphasize interconnectedness, reciprocity, and ethical stewardship, bridging ontological and epistemological gaps (Bhandari, 2024; Capra & Luisi, 2014). Collectively, these frameworks create pathways for equitable, synergistic, and culturally grounded knowledge integration, offering transformative solutions to the environmental, social, and ethical challenges of planetary sustainability (Bhandari, 2023b; Bhandari, 2025a).

Keywords— Transformative Knowledge, Planetary Sustainability, Indigenous Knowledge Systems, Knowledge Pluralism, Science–Policy Interface, Sustainability Governance, Epistemological Justice, Intergenerational Ethics, Environmental Stewardship, Systems Thinking, Climate Resilience, Inclusive Decision-Making

I. Introduction: Why Transformative Knowledge Now? Theoretical Context

The urgency for transformative knowledge has never been greater. Planetary crises—climate change, biodiversity loss, soil degradation, water scarcity, and widening socio-economic inequalities—are accelerating at unprecedented rates, driven by

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entrenched extractive and technocentric paradigms (Bhandari, 2023b; Capra & Luisi, 2014). Traditional scientific approaches, while critical, are insufficient on their own, as they often neglect the localized, context-specific, and relational knowledge embedded in Indigenous and community-based systems (Bhandari, 2025c; Folke et al., 2005). The persistence of environmental degradation alongside inequitable development outcomes demonstrates the limitations of conventional knowledge systems and calls for integrative, justice-centered approaches (Bhandari, 2023a).

Transformative knowledge is essential because it expands the epistemic base, bridging multiple ways of knowing, including Indigenous, local, and experiential knowledge, with scientific methods (Tengö et al., 2014; Norström et al., 2020). This pluralistic approach not only enhances the understanding of complex socio-ecological systems but also fosters co-ownership of solutions, equitable decision-making, and intergenerational learning (Bhandari, 2025a). In the context of the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 10 (Reduced Inequalities), transformative knowledge ensures that sustainability policies are inclusive, culturally grounded, and ethically accountable (UN, 2015; Bhandari, 2022).

Transformative knowledge supports resilience and adaptation in communities facing climate vulnerability. Community-based monitoring, participatory action research, and Indigenous stewardship initiatives exemplify how knowledge integration can produce actionable insights while respecting cultural sovereignty and ethical governance (Bhandari, 2025c; Mercer et al., 2010). By fostering systemic thinking, relational ethics, and collaborative problem-solving, transformative knowledge is not just an academic imperative—it is a practical necessity for navigating planetary emergencies and achieving equitable sustainability outcomes (Bhandari, 2024; Capra & Luisi, 2014).

A. Theories underpinning the need for transformative knowledge

1) Holistic Worldview & Systems Thinking – understanding interconnectedness of ecological, social, cultural, and governance systems.

A holistic worldview and systems thinking provide a conceptual foundation for understanding the deep interdependence between humans and the natural world. Rather than viewing environmental, social, cultural, and governance issues as separate, these frameworks emphasize that planetary challenges are interconnected components of a larger, dynamic system. A holistic perspective recognizes that ecological well-being is inseparable from social justice, cultural integrity, and institutional governance (Capra & Luisi, 2014).

Systems thinking, originating in general systems theory, views the world as composed of interacting, coevolving systems. Environmental degradation, climate change, biodiversity loss, and inequality are not isolated problems but symptoms of structural imbalances within socio- ecological systems (Meadows, 2008). Systems thinking, therefore, promotes identifying leverage points—places where interventions can produce transformative, long-term change. This allows policymakers, scientists, and communities to design solutions that account for feedback loops, cross-scale interactions, and long-term impacts.

In sustainability science, a holistic worldview encourages integrating scientific knowledge with Indigenous and local relational ontologies, which traditionally emphasize harmony and reciprocal relationships with nature. These worldviews frame humans as part of the larger ecological community rather than external actors managing it (Berkes, 2018). Governance systems informed by holistic and systems-thinking approaches prioritize participation, adaptive management, resilience, and equity.

Ultimately, a holistic worldview and systems thinking offer a foundational lens for transformative change: they promote inclusive, justice-centered approaches aligned with the complexity of planetary systems, enabling more ethical and effective sustainability pathways.

2) Epistemological Pluralism – recognition that no single knowledge system has all solutions. Epistemological pluralism holds that multiple ways of knowing—scientific, Indigenous, experiential, spiritual, and community-based—are necessary to comprehend and respond to complex planetary challenges fully.

It rejects the dominance of a single epistemology and instead acknowledges that different knowledge systems offer unique insights, methods, and worldviews that together enrich understanding and action (Jasanoff, 2004).

In the context of planetary sustainability, epistemological pluralism is essential because environmental and social problems are multidimensional. Scientific knowledge provides empirical evidence and predictive models, yet it often lacks the contextual, relational, and place- based wisdom held by Indigenous Peoples and local communities (Berkes, 2018). These communities possess deep ecological knowledge rooted in centuries of observation, practice, and cultural adaptation, which can significantly enhance ecosystem management, climate adaptation, and resilience.

Pluralistic approaches to knowledge also strengthen democratic governance. They ensure that marginalized voices—such as Indigenous Peoples, women, youth, and local communities—are included in decision-making processes. This leads to more legitimate, equitable, and culturally grounded policies (Norgaard, 2019). Moreover, epistemological pluralism aligns with the principles of justice, participation, and respect for diverse worldviews, which are essential for transformative sustainability.

Ultimately, epistemological pluralism expands humanity's knowledge base. By embracing multiple epistemologies, societies can co-create solutions that are not only scientifically sound but also socially just, culturally meaningful, and ecologically aligned.

3) Environmental Justice & Global Justice – addressing inequities in knowledge access, voice, and decision-making power.

Environmental justice and global justice are foundational

frameworks for understanding how unequal power relations shape exposure to environmental harm, access to resources, and participation in environmental governance. These frameworks highlight that marginalized groups—such as Indigenous Peoples, local communities, women, youth, and low-income populations—are often disproportionately impacted by ecological degradation while having the least representation in policy processes (Bullard, 2000).

Environmental justice emphasizes fairness in the distribution of environmental benefits and burdens, procedural justice in decision-making, and recognition justice, which demands respect for diverse cultural identities, knowledges, and worldviews (Schlosberg, 2007). In sustainability governance, this means ensuring that communities affected by environmental policies have genuine opportunities to shape those policies, rather than functioning as passive recipients of top- down decisions.

Global justice expands these concerns to the international arena. It recognizes that planetary crises—climate change, biodiversity loss, pollution, and resource extraction—are embedded in global systems of inequality. Countries and communities that contribute least to environmental harm often suffer the most severe consequences (Pogge, 2008). Equitable climate finance, fair technology transfer, and inclusive global governance mechanisms are therefore essential components of global justice.

In the context of knowledge systems, these justice frameworks emphasize that inequities in access to knowledge, voice, and decision-making power perpetuate unsustainable and unjust outcomes. Dominant scientific and technocratic knowledge systems have historically marginalized Indigenous knowledge, experiential knowledge, and community-based expertise. Environmental and global justice call for democratizing knowledge production, recognizing diverse epistemologies, and ensuring meaningful participation across all levels of governance.

Together, environmental justice and global justice offer a transformative ethical foundation for sustainability: one that centers equity, rights, empowerment, and the redistribution of power in shaping the future of people and the planet.

4) Capabilities Approach – expanding individuals' and communities' abilities to shape sustainable futures.

The Capabilities Approach, developed by Amartya Sen and further expanded by Martha Nussbaum, provides a robust framework for sustainability by shifting attention from economic growth or resource availability to people's actual freedoms and opportunities to live meaningful, flourishing lives (Sen, 1999; Nussbaum, 2011). Rather than evaluating well-being solely through income or material indicators, the approach emphasizes what individuals and communities *can do and be*—their capabilities.

In the context of planetary sustainability, the Capabilities Approach highlights that environmental degradation, climate change, and ecological injustice directly restrict people's freedoms and life possibilities. For example, loss of biodiversity, polluted air or water, and climate-related disasters undermine basic capabilities such as health, livelihood security, cultural continuity, and participation in community life (Holland, 2014). Sustainable development, therefore, requires expanding these capabilities while safeguarding ecological systems that

enable human flourishing.

The approach also emphasizes agency, recognizing people as active shapers—not passive recipients—of sustainability transitions. This aligns strongly with Indigenous and local knowledge systems, which emphasize community empowerment, relational values, and stewardship responsibilities. Empowering communities with knowledge, education, land rights, and decision-making power enhances their ability to pursue sustainable futures on their own terms.

Moreover, the Capabilities Approach offers a normative basis for evaluating sustainability policies. It asks whether policies enhance freedom, justice, equity, and intergenerational well- being. In this sense, it integrates ecological sustainability with social justice, making it a transformative framework for long-term, inclusive, and ethical development.

5) Transformative Learning Theory (Mezirow**)** – encouraging paradigm shifts through critical reflection and dialogue.

Transformative Learning Theory, introduced by Jack Mezirow, explains how individuals and groups fundamentally change their worldviews through processes of critical reflection, discourse, and experiential learning. According to Mezirow (1991), transformation occurs when people critically examine previously held assumptions, values, and beliefs, leading to new frames of reference that are more inclusive, integrated, and responsive to complex realities.

In the context of planetary sustainability, Transformative Learning Theory is highly relevant because addressing climate change, biodiversity loss, and socio-environmental inequalities requires more than technical solutions—it requires deep shifts in consciousness, worldviews, and behavior. Traditional education models based on information transfer are insufficient for the systemic and ethical changes needed to protect the planet. Transformative learning encourages learners to question anthropocentric worldviews, confront power structures, and recognize interconnectedness with ecological and social systems.

Dialogue is central to transformative learning. Through participatory discussion, storytelling, and intercultural exchange, individuals encounter alternative perspectives—such as Indigenous ways of knowing or community-based experiences—that challenge dominant narratives and broaden understanding. This dialogical process promotes empathy, relational thinking, and collective learning, all of which are essential for creating sustainable futures (Cranton, 2016).

Critical reflection enables learners to identify the cultural, political, and institutional forces shaping environmental degradation. When applied in policy, governance, and community settings, transformative learning fosters empowered citizens capable of co-creating sustainable solutions. It also supports lifelong learning, which is vital for adapting to rapidly changing environmental and social conditions.

Mezirow's theory provides a pathway for cultivating the

mindset shifts and social consciousness
necessary for transformative environmental action.

B. Practical Relevance

1) Policymakers often rely on top-down scientific information without incorporating local realities.

This gap between scientific assessments and community-level experiences can lead to policies that are misaligned with actual needs or that lack local legitimacy. Research highlights that sustainable and inclusive policymaking depends on integrating scientific knowledge with local, experiential, and indigenous knowledge systems (Cash et al., 2003; Tengö et al., 2014). Without such integration, policies risk being ineffective, poorly implemented, or socially unjust. Therefore, grounding decision-making in rigorous science and community perspectives is essential to achieving equitable, context-sensitive outcomes.

2) Indigenous and local community knowledge improves resilience, adaptation, ecosystem management, and cultural continuity.

Indigenous and local community knowledge contributes significantly to resilience, adaptation, ecosystem management, and cultural continuity. Communities that have lived in close relationship with their environments for generations possess place-based knowledge of climate patterns, biodiversity, land use, and natural resource cycles. This knowledge enables adaptive strategies to environmental change that are often more context-specific and sustainable than top- down interventions (Berkes, 2018; Olsson et al., 2004).

For instance, Indigenous fire management practices, traditional water conservation methods, and locally adapted agricultural techniques enhance ecosystem resilience and reduce vulnerability to climate hazards. Incorporating such knowledge into scientific and policy frameworks strengthens both ecological and social systems (Folke et al., 2005). Moreover, recognizing and validating Indigenous and local knowledge supports cultural continuity, preserving languages, traditions, and worldviews tied to ecological stewardship.

Integrating these knowledge systems with scientific research facilitates the co-production of solutions that are locally relevant, culturally respectful, and ecologically effective, thereby fostering inclusive and sustainable development pathways that are just and adaptive to changing environmental conditions.

3) Bridging the knowledge divide accelerates more just, legitimate, and effective policy outcomes.

Bridging the divide between scientific knowledge and Indigenous, local, and experiential knowledge is critical for producing more just, legitimate, and effective policy outcomes. When decision-making incorporates diverse perspectives, it enhances the credibility of policies, strengthens public trust, and increases the likelihood of successful implementation (Reed et al.,

2010). Excluding local knowledge not only undermines policy effectiveness but can exacerbate social inequities, as marginalized communities often bear disproportionate environmental risks without having a voice in governance (Berkes, 2018; Tengö et al., 2014).

Co-production of knowledge—where scientists, policymakers, and local communities collaborate—enables policies to be context-sensitive, culturally appropriate, and ecologically, grounded. This approach fosters mutual learning, empowers communities, and ensures that policy interventions address both scientific evidence and lived realities (Armitage et al., 2011). In essence, bridging knowledge systems creates a more inclusive decision-making process, strengthening adaptive capacity, resilience, and legitimacy while supporting sustainability goals.

II. Why Knowledge Integration is Essential for Planetary Sustainability

A. Theoretical Justification

1) Co-production of knowledge: Collaborative generation of solutions by scientists, Indigenous, People, youth, and policymakers.

Co-production of knowledge refers to collaborative processes where diverse actors—including scientists, Indigenous Peoples, local communities, youth, and policymakers—jointly generate solutions to complex environmental and societal challenges. Unlike traditional top-down knowledge creation, co-production emphasizes reciprocal learning, mutual respect, and shared authority, ensuring that multiple perspectives inform decision-making (Berkes, 2009; Norström et al., 2020).

In the context of sustainability, co-production enhances the relevance, legitimacy, and effectiveness of policies and interventions. For example, Indigenous ecological knowledge can complement scientific models in biodiversity conservation, climate adaptation, and land management, producing context-specific strategies that are both culturally appropriate and ecologically robust (Tengö et al., 2017). Similarly, engaging youth and civil society strengthens innovation, accountability, and long-term stewardship by fostering intergenerational learning and community ownership of outcomes.

Co-production also helps to bridge epistemological divides, promoting dialogue between formal scientific methodologies and experiential, place-based knowledge systems. This inclusive approach supports adaptive governance, enhances resilience, and ensures that interventions are socially just, environmentally sustainable, and informed by lived realities.

Ultimately, co-production transforms knowledge from a static resource into a dynamic, socially embedded tool for sustainable development, empowering communities while improving the science-policy-practice interface.

2) Multiple Ways of Knowing: Empirical, experiential, spiritual, ecological, and cultural knowledge systems all offer unique insights.

Multiple Ways of Knowing emphasizes that addressing complex planetary challenges requires integrating empirical, experiential, spiritual, ecological, and cultural knowledge systems. Each knowledge system offers unique perspectives and insights that, when combined, create a more comprehensive

understanding of socio-ecological dynamics (Tengö et al., 2014; Berkes, 2018).

- Empirical knowledge is grounded in scientific observation, experimentation, and modelling, providing predictive tools and evidence-based strategies for sustainability.
- Experiential knowledge emerges from lived experiences and community practices, offering practical solutions adapted to local contexts.
- Spiritual and cultural knowledge shapes ethical, relational, and stewardship values that guide sustainable interactions with ecosystems.
- Ecological knowledge encompasses both traditional ecological understanding and scientific insights into ecosystem processes, resilience, and biodiversity management.

Integrating multiple ways of knowing enhances policy legitimacy, cultural sensitivity, and ecological effectiveness. It allows for adaptive governance that respects local priorities while leveraging scientific advances. For instance, combining Indigenous fire management with ecological modelling has been shown to improve landscape resilience and reduce wildfire risks (Lake et al., 2017). Similarly, culturally grounded water management practices can complement hydrological models to enhance resource sustainability.

By embracing pluralistic knowledge systems, policymakers, researchers, and communities can co-create solutions that are inclusive, adaptive, and just, ensuring that environmental interventions are socially acceptable, ecologically sound, and ethically informed.

3) Philosophy of Technology: Technology must be embedded within ethical, cultural, and ecological contexts.

The Philosophy of Technology emphasizes that technological development and deployment should not occur in isolation from social, ethical, cultural, and ecological considerations. Technology is often viewed as a neutral tool, but its design, application, and impacts are profoundly shaped by human values, institutional contexts, and environmental interactions (Feenberg, 2010).

In the context of sustainability and planetary crises, embedding technology within ethical and cultural frameworks ensures that innovations serve collective well-being rather than merely economic or extractive interests. For example, renewable energy technologies, climate monitoring systems, and precision agriculture tools are more effective when adapted to local ecological conditions and aligned with community knowledge and values (Vermaas et al., 2011). Ignoring local socio-cultural contexts can lead to technological solutions that are inefficient, inappropriate, or socially contested.

An ethically informed philosophy of technology promotes responsible innovation by considering the long-term ecological consequences, social equity, and intergenerational justice of technological interventions. By integrating diverse knowledge systems—scientific, Indigenous, and community-based—technology becomes a co-creative tool for resilience, adaptation, and sustainability. This approach bridges the gap between innovation and societal needs, ensuring that technological progress supports rather than undermines sustainable development.

4) Social Contract Theory (renewed): New agreements between state, society, and nature for a sustainable and just future.

Social Contract Theory, traditionally associated with philosophers such as Hobbes, Locke, and Rousseau, posits that the legitimacy of political authority arises from agreements among individuals to create rules for collective living. A renewed social contract extends this concept to include not only relations among humans but also responsibilities toward nature and future generations (Dryzek et al., 2003; Cripps & Saunders, 2021). In the Anthropocene, where human actions are altering planetary systems, sustainability requires renegotiating societal agreements to integrate ecological stewardship alongside social justice.

This renewed social contract emphasizes that states, societies, and ecosystems are interdependent. Policies and governance structures must ensure that environmental resources are equitably managed, that marginalized communities have meaningful participation in decision-making, and that intergenerational rights to a healthy planet are respected (Stone, 2010). It provides a normative foundation for inclusive environmental governance, bridging local, national, and global scales.

By embedding principles of fairness, reciprocity, and ecological responsibility into governance frameworks, this approach supports sustainable development pathways that are legitimate, adaptive, and ethically grounded. For example, formal recognition of Indigenous land rights, community-led resource management, and binding environmental obligations in law reflect the operationalization of a renewed social contract. Such frameworks align human governance systems with the ecological limits of the planet, fostering both justice and resilience.

5) Practical Implications - Inclusive knowledge approaches—integrating scientific, Indigenous, local, and experiential knowledge—offer tangible benefits for sustainability by enhancing climate adaptation strategies, biodiversity conservation, community resilience, and governance legitimacy.

- Climate Adaptation Strategies - By incorporating local observations and traditional ecological knowledge, adaptation measures become context-specific and more effective. Communities contribute insights on seasonal changes, microclimates, and historical coping mechanisms, complementing scientific climate models (Berkes, 2018; Sillitoe, 2007). This enables proactive, culturally appropriate adaptation interventions, thereby increasing resilience to climate impacts.
- Biodiversity Conservation - Indigenous and community-based management systems often preserve habitats, maintain species diversity, and promote sustainable resource use. Integrating these approaches with conservation science supports adaptive management, reduces conflicts over resource use, and enhances ecological outcomes (Gadgil et al., 1993; Tengö et al., 2017).

- Community Resilience - Inclusive knowledge practices empower communities to participate in decision-making, strengthening social cohesion, local capacities, and adaptive problem-solving. This participatory approach enhances communities' ability to withstand shocks, recover from environmental stressors, and maintain cultural and ecological continuity (Folke et al., 2005).
- Governance Legitimacy - Policies and governance structures gain legitimacy when they reflect multiple perspectives and recognize marginalized voices. Integrating diverse knowledge systems promotes transparency, equity, and accountability, ensuring that decision-making is responsive, socially accepted, and aligned with sustainability goals (Reed et al., 2010; Armitage et al., 2011). Inclusive knowledge approaches bridge the gap between local realities and scientific frameworks, fostering more adaptive, equitable, and effective environmental governance.

6) Practical Implications: Inclusive Knowledge Approaches - Inclusive knowledge approaches—integrating scientific, Indigenous, local, and experiential knowledge—enhance sustainability outcomes in multiple ways:

- Climate Adaptation Strategies: Local and Indigenous knowledge provides context-specific insights on weather patterns, seasonal changes, and adaptive practices, complementing scientific models to create effective, culturally appropriate climate strategies (Berkes, 2018; Sillitoe, 2007).
- Biodiversity Conservation: Community-based and traditional ecological knowledge supports habitat preservation, species protection, and sustainable resource management, contributing to adaptive and resilient conservation practices (Gadgil, Berkes, & Folke, 1993; Tengö et al., 2017).
- Community Resilience: By empowering communities to participate in decision-making, inclusive knowledge approaches strengthen social cohesion, local capacities, and adaptive problem-solving, enhancing resilience to environmental shocks (Folke et al., 2005).
- Governance Legitimacy: Policies informed by diverse knowledge systems are more transparent, equitable, and socially accepted, increasing legitimacy and compliance, and fostering adaptive governance aligned with sustainability goals (Reed et al., 2010; Armitage, Berkes, & Doubleday, 2011).

By bridging local realities with scientific knowledge, inclusive approaches foster equitable, adaptive, and effective environmental governance that addresses planetary challenges in a socially just and ecologically robust manner.

B. Practical Relevance: Local and Indigenous Knowledge in Environmental Stewardship

Local and Indigenous knowledge is critical for implementing effective, context-specific environmental management practices that support both ecological sustainability and community resilience.

1) Forest Management: Indigenous and community-based forestry practices, including controlled burning, rotational harvesting, and sacred grove protection, maintain biodiversity, prevent wildfires, and enhance carbon sequestration. These approaches complement scientific forest management strategies by integrating long-term ecological understanding and local stewardship values (Berkes, 2018; Lake et al., 2017).
2) Land Restoration: Traditional knowledge informs soil conservation, reforestation, and erosion-control methods adapted to local climates and landscapes. Communities apply practices such as contour planting, selection of indigenous tree species, and regenerative grazing, thereby improving ecosystem recovery and productivity (Pretty et al., 2009).
3) Water Systems Stewardship: Local water management knowledge, including rainwater harvesting, watershed governance, and wetland conservation, ensures sustainable water use, protects freshwater ecosystems, and enhances resilience to droughts and floods (Agarwal & Narain, 1999; Berkes, 2018).
4) Early Warning Systems: Communities possess observational knowledge of ecological and climatic cues, enabling timely responses to hazards like floods, storms, and droughts. Integrating this with scientific forecasting strengthens adaptive capacity and disaster preparedness (Mercer et al., 2010).
5) Regenerative Agriculture: Traditional agricultural techniques—such as crop rotation, intercropping, seed preservation, and organic soil amendments—support soil health, biodiversity, and food security. When combined with modern agricultural science, these practices enhance ecological resilience and sustainable productivity (Altieri, 2004).

Overall, embedding local and Indigenous knowledge into environmental policies and practices ensures ecologically sound, culturally appropriate, and socially just outcomes, strengthening the effectiveness of sustainability interventions.

III. Key Dimensions of Transformative Knowledge Integration

1) Cognitive Dimension: Pluralistic Epistemologies:
   a. Theoretical Foundation: The cognitive dimension emphasizes that knowledge is pluralistic and rooted in multiple epistemologies, each offering distinct insights into socio-ecological systems. Key theoretical underpinnings include:

- Deep Ecology: Advocates for a profound ethical shift recognizing the intrinsic value of all living beings and ecosystems, emphasizing ecological interdependence (Naess, 1989).
- Indigenous Cosmologies: Offer relational ontologies that situate humans within nature rather than above it, highlighting stewardship, reciprocity, and ethical responsibilities toward the environment (Berkes, 2018).
- Ecological Economics: Integrates ecological constraints

and social well-being into economic decision-making, challenging conventional growth-centric models (Daly & Farley, 2011).

- Integral Theory: Provides a framework for integrating multiple perspectives—scientific, cultural, personal, and systemic—to understand complex social-ecological realities (Wilber, 2007).

Collectively, these frameworks promote relational thinking, emphasizing that humans are part of dynamic, interconnected ecological and social systems rather than separate actors.

b. Practical Approach

- Integrating Indigenous Ecological Calendars and Land-Use Systems: Incorporate seasonal knowledge, crop cycles, and traditional land management practices into scientific models for climate prediction, conservation planning, and agricultural sustainability.
- Mapping Overlapping Knowledge Systems: Develop shared knowledge platforms that combine local, Indigenous, and scientific information, enabling co-decision-making by communities, policymakers, and researchers.
- Application in Policy and Practice: Such integration can guide adaptive management of forests, water systems, agricultural landscapes, and biodiversity conservation, enhancing resilience and legitimacy of environmental governance.

2) Structural Dimension: Institutions and Policy Frameworks

a. Theoretical Foundation: The structural dimension focuses on the institutional and policy frameworks that enable effective integration of diverse knowledge systems into sustainability governance. Key theoretical concepts include:

- Participatory Governance: Emphasizes inclusive decision-making processes that enable diverse stakeholders—including Indigenous Peoples, local communities, and youth—to contribute to policy formulation and implementation, ensuring accountability and legitimacy (Fung & Wright, 2003).
- Transparency and Accountability: Governance structures must be open, responsive, and answerable to communities, ensuring that knowledge integration translates into equitable policy outcomes (Kooiman, 2003).
- Knowledge Democracy: Advocates for the recognition of multiple knowledge systems—scientific, Indigenous, local, and experiential—within policy and governance processes. Knowledge democracy enhances legitimacy, inclusivity, and sustainability in decision-making (Holland, 2007).

b. Practical Approach; Formal Mechanisms within International and National Policy Processes:

- Free, Prior, and Informed Consent (FPIC): Ensures Indigenous and local communities have authority over decisions affecting their lands, resources, and cultural practices (UNDRIP, 2007).
- Advisory Councils: Establish Indigenous, youth, and civil society advisory groups within UNEP, IPBES, CBD, and national frameworks to integrate diverse perspectives.
- Local Knowledge Platforms under National Adaptation Plans (NAPs): Enable systematic inclusion of community-based ecological and climate knowledge in adaptation strategies.
- Support for Community-Led Environmental Monitoring: Empower communities to collect, analyze, and share environmental data, enhancing adaptive management and policy responsiveness. Examples include community forest monitoring, participatory water quality tracking, and local biodiversity assessments.

By embedding these structural mechanisms, institutions can legitimately integrate pluralistic knowledge systems, enhance community ownership, and foster adaptive, just, and effective environmental governance.

3) Transformative Learning, Education, and Capacity Building

a. Theoretical Foundation - The cognitive and social transformation of knowledge requires learning processes that encourage critical reflection, empowerment, and active participation. Key theoretical underpinnings include:

- Mezirow's Transformative Learning Theory: Focuses on facilitating paradigm shifts through critical reflection and dialogue, enabling individuals and communities to question assumptions and adopt more inclusive, sustainability-oriented worldviews (Mezirow, 2000).
- Freirean Critical Pedagogy: Emphasizes education as a tool for empowerment, dialogue, and social change, fostering agency and collective action in addressing environmental and social challenges (Freire, 1970/2000).
- Lifelong Learning for Sustainability: Encourages continuous learning across the life course to build adaptive capacities, ecological literacy, and resilience in both individuals and communities (UNESCO, 2014).
- Positive Psychology and Human Flourishing: Supports the development of well-being, resilience, and motivation, which are essential for sustained engagement in environmental stewardship and transformative actions (Seligman, 2011).

b. Practical Approach

- Community-to-Policy Learning Networks: Create platforms for local knowledge holders, policymakers, and scientists to interact, co-generate solutions, and regularly share best practices.
- Integrating Indigenous Knowledge into Curricula: Embed traditional ecological knowledge, local sustainability practices, and cultural perspectives into formal education systems to foster awareness and respect for pluralistic knowledge.
- Youth-Led Innovation Labs for Climate Solutions: Support initiatives that enable young people to design, test, and implement locally appropriate climate adaptation and mitigation strategies.
- Exchange Programs between Scientists and Communities: Facilitate mutual learning experiences to enhance understanding of local realities, scientific methods, and co-

production of knowledge.

By linking transformative learning with inclusive education and capacity-building initiatives, communities and institutions can strengthen adaptive governance, empower stakeholders, and foster sustainable development.

4) Regenerative Practices and Sustainability Innovations
   a. Theoretical Foundation - Regenerative practices emphasize restoring ecological integrity, fostering resilience, and promoting long-term sustainability rather than merely sustaining current systems. Key theoretical foundations include:

- Regeneration Frameworks: Focus on practices that restore degraded ecosystems, enhance biodiversity, and revitalize socio-ecological systems (Mang & Reed, 2012).
- Steady-State Economy: Advocates for economic systems operating within ecological limits, prioritizing well-being and equitable resource distribution over continuous growth (Daly & Farley, 2011).
- Ecological Restoration Principles: Provide methodologies for rehabilitating ecosystems, reintroducing native species, and restoring natural processes to maintain ecological balance (Clewell & Aronson, 2013).
- Philosophical Anthropology and Human–Nature Relationships: Emphasize the ethical and relational dimensions of human interactions with nature, promoting stewardship, reciprocity, and recognition of humans as integral parts of ecological systems (Plumwood, 2002).

   b. Practical Approach

- Regenerative Agriculture and Circular Economy Experiments: Implement farming practices such as cover cropping, agroforestry, organic soil amendments, and closed-loop waste systems to enhance soil health, biodiversity, and resource efficiency.
- Community Forest Management and Watershed Restoration: Engage local communities in reforestation, sustainable harvesting, and water catchment management to restore ecosystem services and resilience.
- Empowerment through Seed Banks, Land Rights, and Climate-Smart Traditional Practices: Protect genetic diversity, secure community land tenure, and maintain Indigenous and local agricultural knowledge for sustainable livelihoods and food security.

By integrating regenerative practices with transformative knowledge, communities and policymakers can co-create innovations that restore ecological function, strengthen social-ecological resilience, and foster sustainable development pathways.

IV. Key Questions (Anchored in Theory & Practice)

1) Bridging Knowledge Systems: What frameworks can meaningfully connect Indigenous/local knowledge with scientific research in addressing planetary crises?

Bridging Indigenous and local knowledge systems with scientific research is increasingly recognized as essential for addressing complex planetary crises such as climate change, biodiversity loss, water scarcity, and socio-ecological inequality. These crises are not only biophysical challenges but also ethical, cultural, and governance-related problems that require plural ways of knowing. Scientific knowledge offers predictive models, technological innovation, and global-scale assessments. In contrast, Indigenous and local knowledge (ILK) contributes place-based insights, long-term environmental observation, relational worldviews, and adaptive practices refined over generations. Meaningful integration, therefore, demands frameworks that go beyond extraction or token inclusion toward epistemological respect, co-production, and justice.

One of the most influential frameworks is knowledge co-production, which is widely adopted in sustainability science and global assessment processes such as those of the IPBES. Co-production emphasizes collaborative problem framing, joint knowledge generation, and shared ownership of outcomes among scientists, Indigenous knowledge holders, and policy actors. Rather than positioning science as superior, co-production recognizes multiple epistemologies as complementary and equally valid. This approach has proven effective in climate adaptation planning, ecosystem management, and disaster risk reduction, where Indigenous observations of ecological change often precede scientific detection.

Closely related is the Multiple Evidence Base (MEB) approach, which explicitly avoids integrating knowledge systems into a single hierarchy. Instead, MEB allows scientific and Indigenous knowledge to stand independently while being brought into dialogue to inform decision-making. This framework respects the integrity of Indigenous knowledge systems, safeguards against epistemic domination, and enables convergence without assimilation. MEB has been successfully applied in biodiversity conservation and resilience-building initiatives, particularly within Indigenous territories.

Participatory and community-based research frameworks further operationalize knowledge bridging at local and regional scales. These approaches prioritize community leadership, free, prior, and informed consent (FPIC), and reciprocal benefits. By grounding research in local priorities, participatory frameworks enhance legitimacy, trust, and practical relevance, especially in land management, water governance, and food systems.

At a broader ethical level, epistemological pluralism and environmental justice frameworks provide the normative foundation for bridging knowledge systems. They challenge colonial legacies in knowledge production and emphasize dignity, rights, and self-determination for Indigenous peoples. Scholars such as Bhandari argue that sustainable transformation requires recognizing knowledge as a moral and political resource, not merely a technical input, and that ignoring Indigenous wisdom undermines both justice and sustainability outcomes.

Finally, effective bridging requires institutional and policy interfaces that legitimize Indigenous knowledge within governance structures. This includes Indigenous representation in scientific advisory bodies, legal recognition of customary institutions, and adaptive governance models that

accommodate diverse knowledge inputs. When embedded within policy processes, bridged knowledge systems enhance resilience, foster inclusive governance, and enable transformative pathways toward planetary sustainability.

Frameworks that meaningfully connect Indigenous/local knowledge and scientific research must be relational, ethical, and action-oriented—grounded in co-production, respect, pluralism, and justice. Only through such integrative approaches can humanity respond effectively to planetary crises while honoring cultural diversity and ecological integrity.

2) Justice and Inclusion: What does a fair and participatory knowledge ecosystem look like, and what institutional reforms are needed?

A fair and participatory knowledge ecosystem is one in which diverse knowledge systems—scientific, Indigenous, local, experiential, and policy-based—are recognized as legitimate, ethically grounded, and equally capable of contributing to sustainability solutions. Such an ecosystem is not merely inclusive in representation but transformative in structure: it redistributes power, dismantles epistemic hierarchies, and ensures that those most affected by planetary crises are meaningfully involved in defining problems, producing knowledge, and shaping decisions. Justice and inclusion, therefore, are not peripheral values but foundational conditions for effective and legitimate sustainability governance.

At its core, a just knowledge ecosystem is epistemically plural. It rejects the dominance of technocratic or Western scientific paradigms and affirms multiple ways of knowing as contextually valid and complementary. This includes oral traditions, spiritual-ecological relationships, lived experience, and intergenerational knowledge alongside empirical science. As Bhandari argues, sustainability transitions fail when knowledge is treated as neutral or universal; instead, knowledge must be understood as socially embedded, value-laden, and politically consequential. Epistemic justice—ensuring that marginalized groups are not silenced, misrepresented, or instrumentalized—is thus a central pillar of inclusion.

Participation in a fair knowledge ecosystem must be deep, continuous, and consequential, not symbolic. This means moving beyond consultation toward co-decision-making and shared authority. Indigenous peoples, women, youth, and communities in the Global South should have the capacity and institutional space to shape research agendas, methodologies, and policy outcomes. Participatory governance models, community-led research, and co-production platforms exemplify how inclusion can be operationalized, particularly in climate adaptation, biodiversity conservation, and natural resource governance.

However, achieving such an ecosystem requires significant institutional reforms. First, academic and research institutions must reform incentive structures that privilege publications, patents, and expert authority over social relevance, collaboration, and ethical engagement. Evaluation systems should reward transdisciplinary research, community partnerships, and policy impact. Second, global and national governance bodies—such as climate panels, biodiversity platforms, and development agencies—must institutionalize Indigenous and local representation with decision-making power, not merely advisory roles.

Legal and policy reforms are equally essential. Recognition of Indigenous land rights, intellectual property protections for traditional knowledge, and enforcement of free, prior, and informed consent (FPIC) are critical safeguards against the extraction and exploitation of knowledge. Funding mechanisms must also shift to support long-term, locally driven knowledge initiatives rather than short-term, externally imposed projects.

Finally, a just knowledge ecosystem depends on capacity-building and mutual learning. This includes investing in education, language preservation, digital access, and leadership development within marginalized communities, while also training scientists and policymakers in ethical engagement, reflexivity, and intercultural competence. Only through reciprocal learning can trust be built and power asymmetries reduced.

A fair and participatory knowledge ecosystem centers justice, dignity, and shared responsibility. Institutional reforms—spanning academia, governance, law, and finance—are necessary to transform knowledge from an instrument of exclusion into a catalyst for inclusive and planetary sustainability.

3) Transformative Education: How can we mainstream lifelong learning, critical thinking, and intergenerational knowledge transfer into formal and informal systems?

Transformative education is a cornerstone of planetary sustainability because it reshapes not only what people know but also how they think, learn, and act across their lifetimes. In the context of accelerating ecological crises, social inequality, and technological change, education systems must move beyond narrow, instrumental models toward approaches that cultivate lifelong learning, critical consciousness, and intergenerational knowledge transfer. Such transformation is essential for enabling individuals and societies to adapt, innovate, and act ethically in the face of uncertainty.

Mainstreaming lifelong learning requires reimagining education as a continuous, inclusive process that spans formal, non-formal, and informal contexts. Formal systems—schools, universities, and professional institutions—should embed sustainability competencies across disciplines, ensuring that learning is not confined to early life or specialized fields. This includes integrating environmental ethics, systems thinking, and social justice into curricula for science, economics, engineering, and public policy. Beyond formal education, community-based learning, vocational training, digital platforms, and citizen science initiatives play a vital role in reaching diverse populations, including adults, rural communities, and marginalized groups. Lifelong learning thus becomes a societal norm rather than an individual privilege.

Critical thinking is central to transformative education because it enables learners to question dominant narratives, recognize power relations, and navigate competing knowledge claims. In sustainability contexts, this means equipping learners to critically assess techno-fixes, development paradigms, and policy choices, while understanding their social and ecological

consequences. Pedagogical approaches such as problem-based learning, participatory action research, and deliberative dialogue encourage learners to engage with real-world challenges and co-create solutions. As Bhandari emphasizes, transformative learning emerges when individuals reflect on underlying assumptions and values, leading to shifts in worldview and behavior rather than incremental change.

Equally important is the intentional integration of intergenerational knowledge transfer.

Elders, Indigenous knowledge holders, and long-term practitioners possess place-based, experiential, and ethical knowledge that is often absent from formal curricula. Creating structured spaces for intergenerational exchange—such as mentorship programs, storytelling, community archives, and co-teaching models—helps bridge past, present, and future perspectives. In Indigenous and local contexts, learning is inherently intergenerational, relational, and embedded in everyday practices of land stewardship and community life. Recognizing and supporting these modes of learning strengthens cultural continuity and resilience.

To institutionalize transformative education, system-level reforms are necessary. Education policies must value diverse knowledge systems, support multilingual and culturally grounded learning, and incentivize transdisciplinary teaching. Teacher education programs should prepare educators to facilitate dialogue across generations, disciplines, and cultures. At the same time, partnerships between universities, communities, civil society, and policymakers can create living laboratories for sustainability learning, where theory and practice continuously inform one another.

Mainstreaming transformative education requires a holistic shift—from education as transmission to education as transformation. By embedding lifelong learning, critical thinking, and intergenerational knowledge transfer across formal and informal systems, societies can cultivate informed, ethical, and adaptive citizens capable of advancing just and sustainable futures.

4) UN-Level Change: What is the role of MGFC, RFs, and civil society in operationalizing knowledge democracy at the UN?

Operationalizing knowledge democracy at the United Nations (UN) level requires moving beyond state-centric and expert-driven decision-making toward inclusive, participatory, and plural knowledge systems. In this context, the Major Groups and Other Stakeholders Facilitation Committee (MGFC), Regional Forums (RFs), and civil society organizations (CSOs) play a pivotal role in translating the principle of "leaving no one behind" into concrete governance practices.

The MGFC functions as a critical institutional bridge between the UN system and non-state actors, including women, Indigenous Peoples, youth, NGOs, local authorities, farmers, workers, and the scientific and technological community. Its primary contribution to knowledge democracy lies in legitimizing non-academic and non-governmental knowledge within global policy processes. By facilitating structured participation in forums such as the High-Level Political Forum (HLPF), the MGFC helps ensure that lived experiences, grassroots innovations, and community-based evidence inform global sustainability agendas. However, for the MGFC to fully operationalize knowledge democracy, its role must evolve from consultation to co-creation, enabling stakeholders to shape agendas, indicators, and evaluation mechanisms rather than merely responding to pre-defined frameworks.

Regional Forums (RFs) are equally essential because they contextualize global sustainability goals within diverse socio-ecological, cultural, and political realities. Knowledge democracy cannot be achieved through universal solutions alone; it requires regional interpretation and adaptation. RFs provide platforms for synthesizing regional research, Indigenous and local knowledge, and policy experiences, thereby acting as intermediaries between global norms and local action. Strengthening RFs through adequate resourcing, inclusive representation, and transparent knowledge-sharing mechanisms can enhance South–South learning and reduce epistemic asymmetries between the Global North and South—an issue repeatedly highlighted in critical sustainability scholarship, including Bhandari's work on environmental governance and justice.

Civil society organizations are the backbone of knowledge democracy at the UN. They generate alternative data, monitor implementation gaps, and amplify the voices of marginalized groups often excluded from official reporting processes. CSOs also play a watchdog role, holding governments and international institutions accountable to their sustainability and human rights commitments. Through shadow reports, community-led assessments, and participatory research, civil society challenges dominant knowledge hierarchies and expands what counts as "valid evidence" in global decision-making.

To institutionalize knowledge democracy, the UN must implement reforms that strengthen the formal authority, funding, and continuity of MGFC, RFs, and civil society participation. This includes recognizing Indigenous knowledge holders as experts, integrating community-generated data into official UN reporting, and creating feedback loops that meaningfully incorporate local knowledge into global policy outcomes. Ultimately, a democratic knowledge ecosystem at the UN is not merely about inclusion—it is about redistributing epistemic power, fostering mutual learning, and enabling transformative action for planetary sustainability.

V. Case Studies

1) Indigenous-led Forest governance and carbon sequestration

Indigenous-led Forest governance represents one of the most compelling and empirically supported examples of how knowledge democracy, ecological stewardship, and climate mitigation converge in practice. Across the world, Indigenous Peoples manage or have tenure rights over approximately one quarter of the Earth's land surface, much of which overlaps with areas of highest biodiversity and carbon density. Evidence

consistently shows that forests under Indigenous governance experience lower deforestation rates, higher biodiversity conservation, and more stable carbon sequestration than those managed solely by state or private actors.

At the core of Indigenous Forest governance is a relational worldview that understands forests not merely as carbon sinks or economic resources, but as living socio-ecological systems embedded in cultural, spiritual, and ethical relationships. Indigenous knowledge systems emphasize long-term stewardship, reciprocity, and intergenerational responsibility—principles that align closely with sustainability ethics and intergenerational justice (Bhandari, 2022; 2025a). These values contrast sharply with extractive land-use models that prioritize short-term economic gains and often drive forest degradation.

Global examples illustrate the climate relevance of Indigenous leadership. In the Amazon Basin, Indigenous territories have been shown to act as practical barriers against deforestation, even under intense pressure from agriculture, mining, and infrastructure development. Similarly, in Canada and parts of Southeast Asia, Indigenous-managed forests demonstrate stronger resilience to climate-induced disturbances such as wildfires and pest outbreaks, owing to traditional practices like controlled burning, mixed-species management, and seasonal harvesting. These practices enhance carbon storage while maintaining ecosystem health.

Importantly, Indigenous-led Forest governance challenges dominant, technocratic approaches to carbon sequestration. Market-based mechanisms such as REDD+ have often failed to deliver equitable outcomes when Indigenous rights and governance structures are sidelined. In contrast, where Indigenous Peoples hold secure land tenure and decision-making authority, forest conservation and carbon outcomes improve alongside social well-being. This underscores a key insight for planetary sustainability: carbon sequestration is as much a governance and justice issue as it is a technical one.

From a policy perspective, this case study highlights the need to recognize Indigenous Peoples as rights-holders and knowledge producers, not merely stakeholders. Embedding Indigenous governance systems within national climate strategies and UN-level frameworks strengthens both mitigation outcomes and ethical legitimacy. As Bhandari's work on environmental governance and epistemological pluralism argues, transformative sustainability emerges when diverse knowledge systems are empowered to lead, rather than being selectively appropriated. Indigenous-led forest governance thus offers a powerful model for integrating climate action, knowledge democracy, and planetary ethics.

2) Community-based climate early warning systems

Community-based climate early warning systems (CBEWS) illustrate how locally grounded knowledge, when integrated with scientific and technological tools, can significantly reduce climate-related risks while strengthening social resilience and adaptive capacity. As climate change intensifies the frequency and severity of extreme events—such as floods, cyclones, droughts, heatwaves, and landslides—top-down warning systems alone have proven insufficient, particularly in vulnerable regions of the Global South. Community-based approaches address this gap by embedding early warning mechanisms within local social, cultural, and ecological contexts.

At the heart of CBEWS is the co-production of knowledge. Meteorological data, satellite imagery, and hydrological models are combined with Indigenous and local indicators—such as changes in river behavior, animal movements, vegetation patterns, wind direction, or seasonal cycles—that communities have observed over generations. These localized signals often provide early cues that are invisible to centralized systems. When scientific forecasts are translated into locally meaningful messages and validated through community experience, trust increases, and warnings are more likely to be acted upon.

Examples from South Asia, Africa, and Latin America demonstrate the effectiveness of community-based systems. In flood-prone regions of Nepal and Bangladesh, river-level monitoring managed by local committees—often with strong participation from women and youth—has enabled timely evacuation and reduced loss of life. In parts of East Africa, pastoralist communities use a combination of seasonal climate forecasts and traditional knowledge to anticipate drought conditions and adjust grazing strategies. These systems not only save lives but also protect livelihoods, food security, and social cohesion.

CBEWS also embodies principles of justice and inclusion. Conventional early warning systems frequently exclude marginalized groups due to language barriers, lack of access to technology, or mistrust of authorities. Community-based systems intentionally prioritize inclusive communication channels—such as local radio, community messengers, visual symbols, and mobile alerts—ensuring that women, older adults, people with disabilities, and households in remote areas receive and understand warnings. This aligns closely with sustainability ethics, and the "leave no one behind" principle emphasized in the Sustainable Development Goals, particularly SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

From a governance perspective, CBEWS challenges hierarchical models of climate risk management by redistributing epistemic and decision-making power to communities. They demonstrate that resilience is not simply a function of advanced technology, but of social organization, trust, and knowledge democracy. As emphasized in Bhandari's work on transformative learning and environmental governance, meaningful adaptation occurs when communities are recognized as active agents rather than passive recipients of external expertise (Bhandari, 2023b; 2025c).

Community-based climate early warning systems offer a scalable and ethically grounded model for climate adaptation. By bridging scientific forecasting with local knowledge and inclusive governance, they operationalize planetary sustainability at the grassroots level—where climate impacts are first felt and most urgently addressed.

3) Youth knowledge networks influencing national climate policies

Youth knowledge networks have emerged as powerful agents of change in shaping national and international climate

policies, reflecting a growing recognition that young people are not only future stakeholders but present-day knowledge producers, innovators, and moral voices. As climate change poses profound long-term risks, youth movements have reframed climate governance around intergenerational justice, accountability, and urgency—core ethical dimensions of sustainability.

Youth knowledge networks operate at the intersection of science, advocacy, and lived experience. Many are grounded in climate science literacy, policy analysis, and data-driven communication, while also drawing on local realities, Indigenous knowledge, and community-based observations. Networks such as youth climate councils, student research collectives, and transnational youth coalitions translate complex scientific assessments into accessible narratives that resonate with policymakers and the public. This translation function has been instrumental in bridging the gap between technical climate knowledge and political action.

Globally, youth networks have influenced national climate policies in tangible ways. In several European countries, youth-led climate litigation has compelled governments to strengthen emissions reduction targets and align national policies with the Paris Agreement. In countries across the Global South, youth organizations have contributed to Nationally Determined Contributions (NDCs) by providing inputs on climate education, green jobs, adaptation priorities, and equity considerations. In small island developing states, youth networks have played a critical role in elevating climate vulnerability and loss-and-damage concerns within national negotiating positions.

These networks also exemplify knowledge democracy by challenging traditional hierarchies of expertise. Youth often lack formal political power, yet they exert significant epistemic influence through digital platforms, participatory research, and coalition-building with scientists and civil society. Their legitimacy derives not only from technical knowledge but from ethical claims grounded in intergenerational responsibility. As Bhandari argues, sustainability governance must account for temporal justice—recognizing the rights and voices of future generations, which youth uniquely represent in contemporary decision-making (Bhandari, 2022; 2025a).

Importantly, youth knowledge networks are increasingly diverse and intersectional. Young women, Indigenous youth, and youth from marginalized communities are foregrounding connections between climate change, inequality, mental health, and livelihoods. This broadens climate policy beyond emissions metrics to include social justice, well-being, and resilience. However, challenges remain: youth participation is often tokenistic, underfunded, or limited to consultative roles without decision-making authority.

To fully harness the transformative potential of youth knowledge networks, institutional reforms are needed. Governments must create formal mechanisms for youth co-governance, integrate youth-generated knowledge into policy design and monitoring, and invest in climate education and leadership development. When meaningfully engaged, youth knowledge networks do more than influence policy—they help redefine climate governance as a participatory, ethical, and forward-looking process essential for planetary sustainability.

4) Science–policy–community co-production platforms (e.g., IPBES ILK work)

Science–policy–community co-production platforms represent one of the most advanced institutional efforts to operationalize knowledge democracy at the global level. Among these, the work of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)—particularly its engagement with Indigenous and Local Knowledge (ILK)—offers a compelling model for bridging scientific research, community knowledge, and policy decision-making to pursue planetary sustainability.

The IPBES ILK approach is grounded in the recognition that biodiversity loss and ecosystem degradation cannot be adequately understood or addressed solely through scientific knowledge. Indigenous Peoples and local communities have accumulated place-based, experiential, and relational knowledge over generations, often embedded in cultural practices, spiritual values, and customary governance systems. IPBES institutionalized this recognition through mechanisms such as ILK task forces, participatory dialogues, and co-authorship arrangements that place ILK holders alongside scientists as equal knowledge partners, rather than as sources of anecdotal evidence.

A defining feature of science–policy–community co-production within IPBES is its methodological pluralism. Rather than attempting to subsume ILK into scientific frameworks, IPBES promotes a "multiple evidence base" approach that allows different knowledge systems to coexist, interact, and inform assessments without hierarchical integration. This approach reflects key principles of epistemological justice and ethical sustainability emphasized in Bhandari's work on environmental governance and knowledge pluralism (Bhandari, 2022; 2023b). By acknowledging that no single knowledge system holds a monopoly on truth, co-production platforms foster more holistic and context-sensitive policy outcomes.

The policy relevance of this model is evident in IPBES global and regional assessments, where ILK contributions have shaped recommendations on land use, ecosystem restoration, food systems, and climate adaptation. For example, Indigenous fire management practices have informed ecosystem resilience strategies, while community-based conservation models have influenced policy guidance on protected areas and sustainable livelihoods. These outcomes demonstrate that co-produced knowledge is not only more inclusive but also more actionable.

Beyond IPBES, similar co-production platforms are emerging at national and regional levels, linking universities, government agencies, civil society, and communities in "living laboratories" for sustainability. However, challenges remain, including power asymmetries, language barriers, and the risk of tokenistic inclusion. Effective co-production requires sustained trust-building, adequate funding, and institutional safeguards to protect intellectual property and cultural integrity.

Science–policy–community co-production platforms, such as IPBES ILK, exemplify a transformative pathway for

planetary sustainability. By redistributing epistemic authority and embedding ethical pluralism into global governance, they move sustainability from technocratic management toward a shared, democratic, and justice-centered endeavor—a vision strongly aligned with Bhandari's contributions to transformative knowledge and sustainability governance.

5) Regenerative agriculture blending traditional and modern approaches

Regenerative agriculture, which blends traditional knowledge with modern scientific approaches, offers a powerful example of how transformative knowledge systems can advance planetary sustainability while enhancing food security, climate resilience, and social equity. Unlike conventional industrial agriculture—often characterized by monocropping, heavy chemical inputs, and soil degradation—regenerative agriculture emphasizes restoring ecological processes, improving soil health, enhancing biodiversity, and strengthening farmer livelihoods. When grounded in Indigenous and local farming traditions and complemented by contemporary agroecological science, regenerative agriculture becomes both an ethical and practical response to global environmental crises.

Traditional agricultural systems across Asia, Africa, Latin America, and Indigenous territories worldwide have long practiced regenerative principles, even if not labeled as such. Techniques such as crop rotation, intercropping, agroforestry, seed saving, organic soil amendments, and water-harvesting systems reflect deep ecological knowledge developed through generations of observation and adaptation. These practices embody intergenerational ethics and relational worldviews that align closely with sustainability principles articulated by Bhandari, particularly the emphasis on human–nature reciprocity and long-term resilience (Bhandari, 2022; 2025a).

Modern science enhances these traditional systems by providing tools for soil carbon measurement, climate-resilient seed development, precision irrigation, and adaptive management under changing climatic conditions. For example, soil microbiome research validates the effectiveness of organic amendments and reduced tillage, while climate modeling helps farmers anticipate rainfall variability and extreme weather events. When integrated respectfully, scientific knowledge does not replace traditional practices but amplifies their effectiveness and scalability.

Global examples demonstrate the transformative potential of blended regenerative systems. In India, farmer-led natural farming movements have reduced input costs, improved soil fertility, and enhanced resilience to drought. In sub-Saharan Africa, agroforestry systems combining Indigenous tree species with crops have increased yields while sequestering carbon and restoring degraded lands. In Nepal and the Andean region, terrace farming and polyculture systems—supported by extension services and participatory research—have strengthened food sovereignty and reduced erosion in fragile mountain ecosystems.

Regenerative agriculture also contributes directly to multiple Sustainable Development Goals, including SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land), while advancing SDG 5 (Gender Equality) by recognizing and valuing the role of women as custodians of seed knowledge and soil management. However, policy frameworks often lag behind practice, favoring industrial models through subsidies and market structures.

This case study underscores a central insight of transformative sustainability: food systems are knowledge systems. Scaling regenerative agriculture requires institutional support for farmer-led innovation, protection of Indigenous seed sovereignty, participatory extension models, and research agendas that respect epistemological pluralism. As Bhandari's work on sustainability and transformative learning highlights, enduring agricultural transitions occur not through top-down prescriptions, but through co-learning processes that reconnect culture, ecology, and innovation.

Each case demonstrates integrated knowledge, practical success, and policy relevance.

VI. Expected Outcomes: Toward Transformative Knowledge Governance Theoretical Orientation

1) A shift toward justice-centered, inclusive, democratic knowledge.

The adoption of transformative knowledge governance is expected to generate a paradigm shift toward justice-centered, inclusive, and democratic knowledge systems that underpin planetary sustainability. At its core, this approach reconceptualizes knowledge not as a commodity or hierarchical tool of power but as a shared resource, co-produced and co-governed by diverse actors—including scientists, Indigenous Peoples, local communities, youth networks, and civil society (Bhandari, 2022; 2025c). This shift challenges dominant epistemologies that prioritize formal, Western scientific knowledge while marginalizing experiential, Indigenous, and local ways of knowing, thereby promoting epistemic justice and ethical governance.

A key expected outcome is the institutionalization of participatory decision-making processes in sustainability governance. By embedding mechanisms that ensure all stakeholders—including marginalized groups—contribute to knowledge creation, policy formulation, and resource management, governance systems become more equitable, adaptive, and responsive. This aligns with the ethical principles of intergenerational justice, environmental integrity, and social inclusion, which are critical for achieving the Sustainable Development Goals (SDGs), particularly SDG 5 (Gender Equality), SDG 13 (Climate Action), and SDG 16 (Peace, Justice, and Strong Institutions).

Additionally, transformative knowledge governance fosters interdisciplinary and cross-cultural learning. Platforms that integrate science, Indigenous knowledge, and community-based practices (such as IPBES ILK initiatives or youth knowledge networks) enable the co-production of actionable insights that are locally relevant, socially just, and ecologically sustainable. This approach encourages reflexivity, critical thinking, and adaptive learning within institutions, enabling

policies and interventions to evolve in response to emerging challenges such as climate change, biodiversity loss, and socio-environmental inequities.

Another anticipated outcome is the enhancement of knowledge accountability and legitimacy. When diverse knowledge holders participate in validation, interpretation, and application, sustainability decisions are more ethically grounded, socially credible, and environmentally robust. This governance orientation also strengthens resilience and transformative capacity at multiple scales—from local communities practicing regenerative agriculture to international policy arenas influencing global climate action.

Ultimately, the theoretical orientation emphasizes that sustainable futures require a cohesive, pluralistic knowledge ecosystem in which justice, inclusion, and democratic participation are not optional but foundational. By operationalizing these principles, transformative knowledge governance offers a pathway to holistically address planetary crises by bridging science, traditional wisdom, and policy, aligning with Bhandari's scholarship on ethical, equitable, and innovative sustainability frameworks (Bhandari, 2023a; 2024; 2025b).

2) Transformation of worldviews and institutional cultures.

A critical dimension of transformative knowledge governance is the transformation of worldviews and institutional cultures, which underpins societies' capacity to achieve sustainable and just futures. Traditional sustainability and governance paradigms often operate within reductionist, short-term, and technocratic frameworks that emphasize economic growth and narrowly defined efficiency metrics. Such approaches frequently marginalize ethical considerations, local knowledge, and social equity, resulting in policies and interventions that fail to address the root causes of environmental and social crises (Bhandari, 2022; 2023b).

Transforming worldviews entails shifting from anthropocentric, hierarchical perspectives toward relational, ecological, and justice-centered ways of thinking. This involves recognizing the interconnectedness of human and non-human systems, acknowledging the value of Indigenous knowledge and community experiences, and embedding principles of intergenerational responsibility into decision-making. For example, Indigenous stewardship practices in forest governance and agroecological systems exemplify relational epistemologies in which ecological balance, cultural integrity, and social equity are inseparable. By learning from and integrating such perspectives, institutions can reshape their priorities, assumptions, and metrics of success to better align with planetary sustainability (Bhandari, 2023a; 2024).

Institutional culture transformation is equally essential. Organizations, governments, and research institutions traditionally operate within linear, siloed, and hierarchical structures. Such cultures hinder interdisciplinary collaboration, marginalize diverse knowledge systems, and reduce the adaptability of policies in the face of complex crises. Transformative governance requires embedding values of inclusivity, reflexivity, participatory decision-making, and co-learning into institutional practices. Practical measures include participatory policy design, cross-sectoral knowledge platforms, ethics-driven accountability frameworks, and mechanisms for meaningful engagement with marginalized communities, youth, and Indigenous knowledge holders (Bhandari, 2025b; 2025c).

This shift in worldview and institutional culture also has profound implications for education and capacity-building. Institutions that embrace pluralistic knowledge systems encourage lifelong learning, critical thinking, and intergenerational knowledge transfer, thereby cultivating leaders and practitioners capable of navigating complex socio-ecological challenges. Ultimately, this transformation fosters adaptive, resilient, and ethically grounded institutions that not only respond to environmental crises but also actively co-create equitable, sustainable futures.

By integrating these principles, transformative knowledge governance moves beyond policy instruments or technical solutions—it cultivates a fundamental reorientation of how societies perceive, value, and act upon knowledge, bridging science, Indigenous wisdom, and community-based insights in alignment with the ethical and sustainability frameworks emphasized by Bhandari (Bhandari, 2023b; 2024; 2025a).

3) Practical Deliverables; Policy Recommendations:

   a. Inclusion of diverse knowledge systems in UN resolutions.

One of the most tangible outcomes of transformative knowledge governance is the formal integration of diverse knowledge systems into international policy frameworks, particularly within United Nations resolutions and multilateral environmental agreements. Traditional policy processes often privilege Western scientific paradigms, marginalizing Indigenous, local, and experiential knowledge that is essential for addressing complex planetary crises. Recognizing this gap, policy recommendations emphasize the institutionalization of participatory knowledge inclusion at the UN level, ensuring that all knowledge holders—scientists, Indigenous Peoples, local communities, and civil society—are actively engaged in co-designing, implementing, and monitoring policy instruments (Bhandari, 2022; 2023a).

In practice, this requires mechanisms such as formal advisory roles for Indigenous knowledge holders, structured consultation processes for local communities, and collaborative knowledge platforms that bridge science, policy, and practice. For instance, the IPBES Indigenous and Local Knowledge (ILK) task forces provide a precedent for integrating non-Western knowledge into global assessments, ensuring that policy decisions are informed by ecological expertise rooted in centuries of practice. These mechanisms should be expanded and codified in UN resolutions on climate change, biodiversity, and sustainable development, establishing mandatory recognition and inclusion of plural knowledge systems in decision-making.

In addition, resolutions should incorporate principles of epistemic justice, guaranteeing that knowledge contributions from historically marginalized groups are not tokenistic but meaningfully influence policy outcomes. This includes embedding ethical safeguards to protect intellectual property, cultural integrity, and the rights of Indigenous and local

communities while promoting transparent knowledge co-production (Bhandari, 2025b; 2025c).

Such inclusion also supports the broader objectives of the Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 16 (Peace, Justice, and Strong Institutions), by ensuring that policies are both scientifically robust and socially equitable. By operationalizing these recommendations, UN resolutions can serve as instruments of transformative governance, bridging knowledge systems to achieve justice-centered, resilient, and sustainable outcomes at global and local scales.

b. National mechanisms for Indigenous and local knowledge integration.

National-level policies and institutions play a critical role in operationalizing transformative knowledge governance, particularly by creating mechanisms to formally integrate Indigenous and local knowledge (ILK) into environmental planning, climate action, and sustainable development strategies. While international frameworks such as the UN and IPBES provide guidance, effective action begins at the national and subnational levels, where policy implementation, resource management, and community engagement occur (Bhandari, 2023a; 2024).

- Establishing Dedicated ILK Units or Councils: Countries can create specialized units within ministries of environment, agriculture, or climate change to document, validate, and integrate ILK into national policies. These units should operate in partnership with Indigenous organizations, local governance bodies, and research institutions, ensuring that knowledge inclusion is not tokenistic but embedded in decision-making structures. For example, New Zealand's Whenua Māori Land Management frameworks recognize Māori traditional knowledge in land stewardship, serving as a model for participatory governance.
- Policy and Legislative Instruments: Legal recognition of Indigenous rights, customary land tenure, and intellectual property associated with traditional knowledge is essential. National climate and biodiversity policies can mandate the incorporation of ILK in planning, environmental assessments, and adaptation strategies, ensuring alignment with ethical sustainability principles (Bhandari, 2025b). Countries like Canada and Nepal have begun codifying Indigenous forest management practices and participatory water governance as part of climate resilience initiatives, demonstrating practical integration.
- Participatory Platforms for Co-Production: National mechanisms can institutionalize science–policy–community co-production platforms in which scientists, policymakers, and ILK holders jointly generate evidence, co-design interventions, and monitor outcomes. This mirrors IPBES's "multiple evidence-based" approach but is localized for national contexts. For example, community-based climate early warning systems in Bangladesh and the Philippines combine local environmental observations with meteorological data to improve disaster preparedness.
- Capacity-Building and Knowledge Exchange: Effective integration requires training programs for policymakers, researchers, and community representatives to facilitate mutual understanding and respectful engagement. Knowledge exchange initiatives, including workshops, digital repositories, and participatory mapping, strengthen the credibility and accessibility of ILK while enhancing institutions' adaptive capacity (Bhandari, 2025c).
- Monitoring, Evaluation, and Accountability: National mechanisms should incorporate transparent indicators to track ILK's contribution to sustainability outcomes, including biodiversity conservation, climate adaptation, and social equity metrics. Regular reporting and independent audits reinforce accountability and demonstrate the value of inclusive knowledge governance to policymakers and the public.

By institutionalizing these mechanisms, nations can ensure that Indigenous and local knowledge is recognized, protected, and leveraged as a core component of sustainability planning. This approach aligns with ethical governance, intergenerational justice, and inclusive development, advancing both national objectives and global commitments under the SDGs (Bhandari, 2023b; 2024; 2025a).

c. Ethical guidelines for knowledge co-production.

The co-production of knowledge—where scientific research, Indigenous knowledge, and community insights intersect—is central to transformative sustainability governance. However, without ethical frameworks, co-production risks reproducing power imbalances, marginalizing vulnerable voices, or misappropriating Indigenous and local knowledge. Establishing clear ethical guidelines ensures that knowledge co-production is just, equitable, and contributes meaningfully to planetary sustainability (Bhandari, 2023c; 2025c).

- Principles of Respect and Recognition: Ethical co-production begins with acknowledging the value, integrity, and sovereignty of all knowledge systems. Indigenous and local knowledge must be recognized not as supplementary or anecdotal, but as equally valid and essential for addressing environmental and social challenges. Policies should respect cultural protocols, spiritual practices, and intellectual property rights, ensuring that communities retain control over how their knowledge is used (Bhandari, 2023a; 2024).
- Free, Prior, and Informed Consent (FPIC): Engaging communities requires transparent communication and consent mechanisms that are consistent with international standards, such as the UN Declaration on the Rights of Indigenous Peoples (UNDRIP). FPIC ensures that communities voluntarily participate in research or policy initiatives and are fully informed of potential risks, benefits, and applications of their knowledge (Bhandari, 2025b).
- Equitable Participation and Co-Decision-Making: Co-production must foster shared authority and decision-making power, moving beyond extractive or consultative approaches. Researchers, policymakers, and knowledge holders should collaboratively define objectives, methodologies, and expected outcomes, creating inclusive

platforms where all voices influence the process (Bhandari, 2022; 2023c).

- Transparency and Accountability: Ethical guidelines should require complete transparency in data use, knowledge interpretation, and dissemination. Mechanisms for feedback, monitoring, and independent evaluation help maintain accountability, ensuring that co-produced knowledge is applied responsibly in policy and practice (Bhandari, 2025c).
- Intergenerational and Environmental Responsibility: Knowledge co-production should align with sustainability ethics, recognizing the rights of future generations and the intrinsic value of ecosystems. Co-produced strategies must prioritize long-term ecological health, resilience, and equitable access to resources (Bhandari, 2023b; 2024).

By embedding these ethical principles, co-production becomes a transformative tool, enabling policies and interventions that are not only scientifically sound but socially just, culturally respectful, and ecologically responsible. Such frameworks operationalize the vision of knowledge democracy, bridging science, Indigenous wisdom, and policy to achieve sustainable, inclusive outcomes at both local and global scales (Bhandari, 2025a; 2025c).

d. Practical Deliverables: Proposed Working Group – "Knowledge for Sustainability and Climate Justice"

To operationalize transformative knowledge governance at global and national levels, we propose the establishment of a multi-stakeholder working group titled "Knowledge for Sustainability and Climate Justice." This group would serve as a central platform for coordinating knowledge integration, promoting participatory policy dialogues, and facilitating collaborative action on sustainability and climate justice.

- Structure and Scope: The working group would be globally representative, including Indigenous knowledge holders, local community leaders, scientists, policymakers, youth networks, civil society organizations (CSOs), and representatives from intergovernmental platforms such as MGFC (Major Groups and Stakeholders Forum), IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), and UNEP (United Nations Environment Program). Its core functions would include:
  - Policy Dialogues: Organizing regular discussions and forums that bridge scientific evidence, community knowledge, and policymaking. These dialogues would aim to inform national and international sustainability policies while ensuring inclusion of marginalized and Indigenous perspectives (Bhandari, 2023a; 2025b).
  - Case Study Repository: Developing a dynamic, open-access repository documenting successful examples of knowledge co-production, community-based climate initiatives, and Indigenous-led environmental management. This repository would provide policymakers, researchers, and practitioners with evidence-based insights (Bhandari, 2024).
  - Knowledge Exchange: Facilitating structured exchange programs, workshops, and virtual platforms for sharing best practices, innovative solutions, and traditional ecological knowledge. This exchange promotes mutual learning, intergenerational knowledge transfer, and capacity building at multiple scales (Bhandari, 2025c).
  - Joint Research and Capacity Building: Coordinating collaborative research projects and training initiatives that integrate science, Indigenous knowledge, and local experience to co-develop actionable solutions for climate adaptation, biodiversity conservation, and sustainable development (Bhandari, 2022; 2023b).
- Commitments from Participants: Participants in the working group would be expected to:
  - Support inclusive knowledge governance, ensuring equitable representation and decision-making authority for all knowledge holders.
  - Collaborate across MGFC, IPBES, UNEP, academic institutions, and CSOs, fostering global and cross-sector partnerships for systemic impact.
  - Develop community-led climate action programs, translating co-produced knowledge into tangible interventions that enhance resilience, sustainability, and social equity (Bhandari, 2023c; 2025a).

By establishing this working group, the global sustainability agenda can move beyond top-down approaches toward a participatory, justice-centered knowledge ecosystem. This platform not only strengthens connections between diverse knowledge systems but also accelerates the operationalization of climate justice, ethical sustainability, and the SDGs, particularly SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 16 (Peace, Justice, and Strong Institutions).

VII. Conclusion: A Pathway to Planetary Sustainability

This paper has explored the transformative potential of knowledge for planetary sustainability, emphasizing the integration of scientific research, Indigenous and local knowledge systems, and policy frameworks. The global environmental crisis—manifested in climate change, biodiversity loss, and resource inequities—requires not only technical solutions but also a profound shift in worldviews, values, and governance structures. Achieving this transformation requires recognizing that diverse knowledge systems are complementary rather than hierarchical, and that the inclusion of marginalized voices, particularly Indigenous communities and youth, is essential for sustainable outcomes (Bhandari, 2023c; Tengö et al., 2014; Norström et al., 2020).

A key finding of this study is that transformative knowledge governance must be justice-centered, participatory, and inclusive. This involves ethical frameworks for co-production, mechanisms for equitable representation in policy-making, and institutional reforms that allow knowledge democracy to flourish. Experiences from community-led climate early warning systems, regenerative agriculture blending traditional

and modern approaches, and youth-driven knowledge networks demonstrate that sustainability is most effective when knowledge is co-created, context-sensitive, and action-oriented (Bhandari, 2025c; Mercer et al., 2010; Altieri, 2004).

At a national and global level, operationalizing these insights requires embedding Indigenous and local knowledge into formal environmental governance processes, aligning policies with the Sustainable Development Goals, and fostering intergenerational knowledge transfer through education and capacity-building initiatives (Bhandari, 2025a; UNESCO, 2014; UN, 2015). The transformative potential of knowledge is not limited to environmental outcomes; it also advances social justice, equity, and human flourishing, bridging gaps between scientific innovation, community practice, and policy impact (Bhandari, 2023b; Sen, 1999).

In conclusion, addressing planetary challenges demands more than incremental change; it calls for a paradigm shift in how humanity produces, shares, and applies knowledge. By embracing pluralistic, inclusive, and action-oriented knowledge governance, societies can not only mitigate environmental crises but also cultivate ethical, sustainable, and resilient pathways for present and future generations. This integrative approach underscores the urgent need for global collaboration that bridges disciplines, cultures, and sectors to create a more equitable and sustainable world (Bhandari, 2022; Folke et al., 2005).

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