

MEASURING GREEN GROWTH: INDICATORS, LIMITATIONS AND PATHWAYS FOR IMPROVED ASSESSMENT

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Abstract. The inadequacy of Gross Domestic Product (GDP) as a measure of progress in the face of climate change and inequality has propelled the concept of green growth to the forefront of policy and academic discourse. However, translating this concept into a measurable reality presents significant challenges. This paper provides a comprehensive critical review of prevailing green growth indicator frameworks advanced by major international organizations (OECD, UNEP, World Bank) and academic institutions. Through a comparative qualitative analysis and SWOT framework, we identify persistent limitations: fragmentation across economic, environmental and social dimensions; a persistent economic growth bias; severe data scarcities in developing countries and political resistance to metrics that challenge conventional growth narratives. Case studies of the EU Green Deal, China's abandoned Green GDP experiment, measurement challenges in Sub-Saharan Africa and Bhutan's Gross National Happiness index illustrate both the potential and the pitfalls of implementation. To address these gaps, this paper proposes a novel Green Growth Balanced Scorecard, a multidimensional composite framework designed to integrate four critical pillars: (1) Economic Sustainability, (2) Environmental Sustainability, (3) Social Sustainability and (4) Governance and Technological Capacity. We argue that effective measurement is not merely a technical exercise but a political and normative one, shaping policy priorities and either enabling or inhibiting a genuine transition. The paper concludes that for green growth to be a credible paradigm, its measurement must be robust, contextually adaptable and explicitly designed to guard against greenwashing and inequity, ultimately serving as a bridge between high-level goals like the SDGs and actionable national policy.

Keywords: *Green Growth, beyond GDP, sustainability indicators, measurement framework, sustainable development, green economy, political economy, policy monitoring.*

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1. Introduction

The 21st century has brought into sharp focus the limits of the traditional growth model, which has been largely assessed through Gross Domestic Product (GDP). From unprecedented heatwaves and biodiversity collapse to widening social chasms, the symptoms of a system in crisis are undeniable. While GDP has long been considered the gold standard for measuring national economic performance, it fails to account for environmental degradation, resource depletion and social inequality. The urgency of climate change, biodiversity loss and widening inequality has made it clear that new approaches are required to measure progress in ways that balance economic prosperity

with ecological sustainability and social justice. This context gave rise to the concept of green growth.

Green growth is defined by the Organization for Economic Co-operation and Development (OECD) as fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which human well-being relies (OECD, 2011). The concept aligns closely with sustainable development but emphasizes the compatibility between growth and environmental sustainability, highlighting how environmental stewardship can drive innovation, competitiveness and long-term resilience.

However, turning the concept of green growth into a measurable reality remains a major challenge. Policymakers, researchers and international organizations have struggled to establish indicators that adequately reflect the multidimensional nature of green growth. Current frameworks developed by the OECD, United Nations Environment Programme (UNEP) and World Bank have advanced the agenda, but they remain fragmented, data-intensive and often biased toward economic efficiency. Moreover, academic debates reveal deep disagreements about whether green growth is achievable in practice, particularly in light of planetary boundaries (Barbier, 2016; Hickel & Kallis, 2020).

This paper contributes to the literature by providing a comprehensive review of green growth indicators, critically assessing their strengths and limitations and proposing new pathways for improved measurement. The analysis includes international frameworks, scholarly perspectives and real-world case studies such as the European Union's Green Deal and China's Green GDP experiment. A comparative approach is used to identify gaps and opportunities, followed by proposals for a multidimensional composite framework that integrates economic, environmental, social and governance indicators.

2. Literature Review

GDP emerged in the 1930s as a tool for measuring national economic activity. While it provided a simple, standardized metric for growth, its limitations quickly became apparent. Kuznets (1934) one of the architects of GDP, warned against equating GDP with welfare. Despite these warnings, GDP became entrenched as the dominant policy benchmark.

By the 1970s, critiques intensified as environmental crises revealed GDP's blindness to ecological damage. The Club of Rome's "Limits to Growth" report (1972) argued that unchecked economic expansion could lead to ecological collapse. Later, scholars proposed Green GDP, which adjusted traditional GDP by deducting the costs of environmental degradation and natural resource depletion (Pearce & Atkinson, 1993). China experimented with Green GDP accounting in the mid-2000s, but political resistance and methodological difficulties led to its suspension (Wang & Gao, 2009).

The Brundtland Report (1987) popularized sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". This broadened the debate, emphasizing the integration of environmental, economic and social dimensions. However, operationalizing sustainable development proved challenging, leading to the development of numerous measurement initiatives such as the Human Development Index (HDI), Ecological Footprint and later, the Sustainable Development Goals (SDGs).

A significant and vocal branch of literature challenges the very premise of green growth. Arising from ecological economics and political ecology, the degrowth and post-growth movements argue that within a finite planetary system, perpetual economic growth, even if “greened”, is ultimately impossible (Hickel & Kallis, 2020). Scholars like Jackson (2019) posit that decoupling economic growth from environmental impacts at the scale and speed required to avoid climate breakdown is unsupported by historical evidence. Instead, they advocate for a paradigm shift away from growth as a primary objective and toward a focus on human well-being, equity and ecological stability within a “steady-state” economy. This critique is crucial as it frames the measurement challenge not just as a technical problem of adjusting GDP, but as a fundamental political and philosophical question about what society should value and optimize for. While this paper focuses on measuring green growth, this critical perspective serves as an essential reminder of the conceptual boundaries and potential contradictions within the paradigm itself.

3. Emergence of Green Growth Indicators

In the 2000s, international organizations began systematizing green growth measurement:

- *OECD Green Growth Indicators*: Introduced in 2011, structured around four themes: (1) resource productivity, (2) natural asset base, (3) environmental quality of life and (4) economic opportunities and policy responses. These indicators are comprehensive but require strong statistical capacity (OECD, 2014). Key examples include carbon productivity, freshwater resources abundance and population exposure to air pollution.

- *UNEP's Green Economy Metrics*: Defined the green economy as one that improves well-being and equity while reducing environmental risks. Indicators emphasize renewable energy, resource efficiency, green jobs and ecological resilience (UNEP, 2011). Core metrics often include the share of renewable energy in total energy use and green investment as a percentage of GDP.

- *World Bank's WAVES and Comprehensive Wealth*: Focuses on wealth accounting across produced, human, natural and social capital. The *Changing Wealth of Nations* reports quantify changes in wealth stocks, stressing long-term sustainability (World Bank, 2018). Its flagship indicator is Adjusted Net Savings (ANS), also known as Genuine Savings, which measures the true rate of savings in an economy after accounting for the depletion of natural resources and investment in human capital.

4. Academic Contributions

Academics have enriched the debate with both conceptual and empirical contributions. Notable examples include:

- *Ecological Footprint and Biocapacity* (Wackernagel & Rees, 1996). This metric compares human demand on nature (ecological footprint) with the biosphere's capacity to regenerate (biocapacity), providing a clear, if contested, measure of overshoot.

- *Environmental Performance Index (EPI)* by Yale and Columbia. A biennial index that ranks countries on 32 performance indicators across 11 issue categories covering environmental health and ecosystem vitality.

- *Inclusive Wealth Index (IWI)* by UNEP and UNU-IHDP (2014). This report moves beyond GDP and HDI to measure the social value of a nation's produced, human

and natural capital, offering a comprehensive view of long-term sustainability and well-being.

- Critical debates on whether “green growth” is a myth in light of ecological limits (Hickel & Kallis, 2020).

A consensus in the literature is that existing frameworks often neglect social equity and systemic ecological thresholds. Moreover, there is growing recognition of the role of technology, digitalization and governance quality in shaping green transitions (Zhang *et al.*, 2021).

5. Methodology

This study employs a comparative qualitative analysis of green growth indicator frameworks developed by the OECD, UNEP and World Bank, supplemented with academic indices such as the EPI and IWI. The analysis uses a SWOT (Strengths, Weaknesses, Opportunities, Threats) approach to assess the effectiveness of these frameworks. This method was selected over a quantitative meta-analysis due to the conceptual and normative nature of the frameworks, where a qualitative assessment is more suited to identifying thematic gaps, biases and synergies.

In addition, case studies are included to illustrate how indicators function in practice. The case studies were selected to provide triangulation and a global perspective: the EU represents an advanced, integrated economic bloc with a proactive policy; China is a major emerging economy with a famous failed experiment and Sub-Saharan Africa exemplifies the data capacity challenges of the Global South.

1. The European Union's Green Deal monitoring framework.

2. China's Green GDP initiative.

3. Green growth measurement challenges in developing countries (e.g., Sub-Saharan Africa).

4. Bhutan's Gross National Happiness (GNH): A Holistic Alternative. This case offers a contrasting, non-Western perspective that explicitly prioritizes multi-dimensional well-being over economic growth.

Finally, a proposal for a multidimensional composite framework is developed based on gaps identified in the literature and comparative analysis.

6. Findings and Analysis

Case Study 1: EU Green Deal Indicators. The *European Green Deal (2019)* is a flagship initiative to make Europe climate-neutral by 2050. Its monitoring framework integrates indicators across energy transition, emissions, biodiversity and social impacts. For example, the EU tracks share of renewable energy, energy efficiency, carbon intensity and green investment flows. A notable strength is the integration with SDGs, though challenges remain in capturing long-term resilience and social equity. The framework is supported by a robust statistical infrastructure (Eurostat), yet it still struggles to measure cross-border environmental externalities and the full social distribution of costs and benefits from the green transition.

Case Study 2: China's Green GDP Experiment. In 2004, China piloted *Green GDP accounting* by deducting environmental degradation costs from GDP. Initial results showed that growth was substantially overstated when environmental damage was included. Political backlash, concerns about economic slowdown and methodological

disputes led to its suspension in 2007 (Wang & Gao, 2009). This highlights the political economy barriers to adopting sustainability metrics that challenge growth narratives. The experiment revealed a core tension: when sustainability metrics threaten powerful political and economic interests, particularly in growth-dependent authoritarian systems, they are often sidelined or abandoned.

Table 1. Comparative Overview of Major Frameworks

Organization	Core Focus	Strengths	Weaknesses	Key Indicator Examples
OECD	Resource productivity, natural asset base, environmental quality, economic opportunities	Comprehensive, systematic, cross-country comparability	Data-intensive, limited social indicators	Carbon productivity, freshwater resources abundance
UNEP	Green economy metrics (triple bottom line)	Focus on equity and well-being	Vague, less operational clarity	% of renewable energy, green investment as % of GDP
World Bank	Wealth accounting (produced, human, natural, social capital)	Strong theoretical foundation, long-term sustainability	Valuation of ecosystems controversial, monetization issues	Adjusted Net Savings, value of forest resources
Academic indices (EPI, IWI)	Environmental performance, inclusive wealth	Innovative, alternative perspectives	Methodological inconsistencies, limited adoption	EPI score (0-100), IWI per capita

Case Study 3: Developing Countries (Sub-Saharan Africa). In many low and middle-income countries, green growth measurement faces severe data gaps. Statistical capacity is limited and environmental indicators are often unavailable or unreliable. For instance, countries in Sub-Saharan Africa struggle to track biodiversity loss, carbon intensity or resource productivity. Yet, these regions are also highly vulnerable to climate change, underscoring the need for international support and harmonization. This data poverty creates a vicious cycle: without reliable metrics, it is difficult to secure funding, design effective policies or track progress, further marginalizing these nations in the global green transition and perpetuating vulnerability.

Case Study 4: Bhutan's Gross National Happiness (GNH). Bhutan offers a radical alternative to growth-centric models. Its GNH index is a holistic development framework based on nine domains, including psychological well-being, health, education and crucially, *ecological diversity and resilience*. Environmental conservation is constitutionally mandated (60% forest cover must be maintained). While not a pure “green growth” metric, GNH demonstrates how well-being and environmental health can be institutionalized as the primary goals of policy, subordinating economic growth to these higher objectives. The challenges of quantifying well-being and the specificity of

Bhutan's context limit its direct transferability, but it serves as a powerful inspiration for building measurement systems that are explicitly normative and value-driven.

7. Limitations Identified

1. *Fragmentation*: Indicators remain siloed across economic, environmental and social dimensions. For example, a nation might score highly on the OECD's resource productivity metric while simultaneously experiencing a decline in the World Bank's inclusive wealth due to the rapid depletion of a specific natural resource, sending conflicting signals to policymakers.

2. *Economic bias*: Growth-centric frameworks dominate, while equity and justice receive less attention. The pressure to present a positive growth narrative often leads to the marginalization of indicators that might reveal trade-offs or unsustainable practices.

3. *Data scarcity*: Developing countries lack reliable, standardized data. This “data divide” exacerbates global inequalities, as countries most in need of robust monitoring systems are least equipped to develop them.

4. *Short-termism*: Many indicators track efficiency, not long-term resilience. A focus on annual improvements in carbon intensity, for instance, may overlook the systemic risk of passing irreversible ecological tipping points.

5. *Political resistance*: Governments may resist indicators that reveal unsustainable practices. As the China case study shows, indicators that challenge the core growth model face significant political economy barriers to adoption.

Table 2. SWOT Analysis of Existing Indicators

Strengths	Weaknesses	Opportunities	Threats
Comprehensive frameworks exist (OECD, UNEP, WB).	Fragmented and inconsistent metrics.	Integration of AI, big data and remote sensing.	Risk of greenwashing if weak indicators used.
Indicators cover economic, environmental and social dimensions.	Over-reliance on growth metrics.	Harmonization with SDGs and climate targets.	Political resistance to adopting new metrics.
Growing global interest and adoption.	Data gaps, esp. in developing countries.	Development of composite indices (dashboards).	Political resistance to adopting new metrics.

Proposals for New Measurement Approaches

To overcome existing limitations, this paper proposes a *Green Growth Balanced Scorecard* built around four dimensions:

1. Economic Sustainability

Rationale: To measure progress towards an economy that internalizes environmental costs and fosters green innovation.

- Green GDP (adjusted for environmental costs).
- Share of green investment in total investment.
- Innovation index for clean technologies.

New Proposed Indicator: Circular Economy Rate: Measuring the proportion of material input that is derived from recycled or reused sources, moving beyond productivity to track systemic circularity.

2. Environmental Sustainability

Rationale: To ensure the protection and enhancement of the natural asset base upon which all well-being depends.

- Carbon neutrality progress (emissions per capita and per unit GDP).
- Biodiversity health index.
- Ecosystem service index (monetary and non-monetary measures).

New Proposed Indicator: *Ecological Resilience Index*: A composite measure of the capacity of key ecosystems (e.g., forests, wetlands, coral reefs) to withstand and recover from shocks, addressing the short-termism of current metrics.

3. Social Sustainability

Rationale: To ensure that the green transition is just, equitable and improves the quality of life for all citizens.

- Share of green jobs in total employment.
- Environmental equity index (exposure to pollution, access to clean energy).
- Well-being metrics linked to environment (life expectancy, health outcomes).

New Proposed Indicator: *Just Transition Capacity Index*: Assessing policies and programs in place to support workers and communities dependent on high-carbon industries, measuring the social preparedness for transition.

4. Governance and Technological Capacity

Rationale: Effective institutions and technology are fundamental enablers of progress across all other dimensions.

- Quality of governance in environmental policy (rule of law, transparency). This could be measured by *Environmental Governance Index* synthesizing data on corruption, public participation and regulatory quality.
- Use of digital technologies (AI, big data, remote sensing) in sustainability monitoring. A new indicator could track a *National Environmental-Digital Integration Score*, assessing the use of real-time data for policy.

Challenge: The “digital divide” poses a significant threat, as this dimension risks widening gaps between high- and low-income countries unless paired with international technical cooperation.

This integrated framework provides a **dashboard tool** for policymakers, combining quantitative and qualitative indicators while remaining adaptable across contexts.

8. Discussion

The measurement of green growth is inherently political and normative. Indicators do not simply describe reality; they shape it by signaling what matters to governments, investors and citizens. Weak indicators risk enabling greenwashing, while strong, multidimensional indicators can support genuine transitions.

The Politics of Measurement and Global Equity. The development of these frameworks is not neutral. It is shaped by global power dynamics, where organizations from the Global North often set the standards. This can lead to a form of “indicator imperialism”, where the priorities and methodological choices of wealthy nations are imposed on the Global South, which may have different developmental challenges and ecological contexts. Measurement systems must be co-designed through inclusive processes to ensure they are relevant and equitable. Without this, they risk perpetuating existing inequalities under a green veneer.

Beyond Monetization: The Challenge of Valuing Nature

A core tension lies in valuing ecosystem services. While monetization (as in World Bank wealth accounting) makes ecological loss legible to economists and policymakers, it is ethically and methodologically fraught. Reducing a complex, life-supporting ecosystem to a dollar value can be seen as commodifying nature. Alternatives like multi-criteria analysis or biophysical metrics (like the Ecological Footprint) avoid this but are less easily integrated into economic policy. A balanced approach that uses monetary valuation cautiously while prioritizing robust biophysical indicators is essential to avoid oversimplification.

Linking Green Growth to SDGs and Climate Policy

The Sustainable Development Goals (SDGs) provide a comprehensive framework that aligns with green growth. However, SDG monitoring has faced challenges of indicator overload (over 230 indicators) and uneven national capacities. A refined green growth framework could serve as a bridge, simplifying measurement while ensuring alignment with climate targets such as the Paris Agreement.

Role of Technology

New technologies offer unprecedented opportunities for real-time monitoring of green growth. Satellite data can track deforestation and emissions; big data analytics can assess energy use and consumption patterns; AI tools can integrate complex datasets into policy dashboards. These innovations can reduce data gaps, especially in developing countries. However, this depends on addressing the digital divide and ensuring open-access data protocols to prevent a new form of inequality based on data ownership.

9. Future Research Agenda

Future research should focus on:

1. Testing integrated frameworks in different contexts, including developing economies.
2. Improving valuation methods for ecosystem services, balancing monetary and non-monetary approaches.
3. Leveraging AI and digitalization to build dynamic dashboards for policymakers.
4. Exploring political economy dynamics, including resistance to adopting sustainability metrics.
5. Developing equity-sensitive indicators that ensure fairness in green transitions.
6. Investigating the potential for context-specific “dashboards” rather than one-size-fits-all indices, allowing for regional priorities and ecological boundaries to be reflected.

10. Conclusion

Green growth measurement remains a contested yet vital endeavor. Existing frameworks by the OECD, UNEP and World Bank have advanced the agenda but remain fragmented, growth-biased and limited by data availability. Case studies such as the EU Green Deal, China's Green GDP experiment, the challenges of the Global South and the alternative vision of Bhutan's GNH highlight both the potential and the profound political and technical challenges of measurement.

This paper has proposed a multidimensional composite framework - the Green Growth Balanced Scorecard, integrating economic, environmental, social and governance indicators. Such an approach can help policymakers move beyond GDP, guiding societies

toward sustainable, equitable and resilient futures. However, as the critiques of degrowth remind us, even improved measurement will not resolve the fundamental tensions if the underlying growth imperative remains unchallenged.

To succeed, measurement frameworks must be robust, transparent and globally harmonized, while also adaptable to national contexts. They must be developed through inclusive processes that account for global equity and avoid methodological imperialism. Ultimately, measuring green growth is not only a technical exercise but also a moral and political choice about what kind of future societies seek to build. The indicators we choose today will define the boundaries of the possible tomorrow.

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