

Constructing and Evaluating the Green Growth Index for India

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Abstract - India is one of the world's fastest-growing economies; nevertheless, its development trajectory is hindered by increasing environmental costs, entrenched gender inequalities, and governance challenges that standard GDP metrics do not capture. This study formulates and evaluates a Green Growth Index (GGI) for India by adapting the African Green Growth Index (AGGI) methodology, originally established by Kararach et al. (2018) for the African Development Bank. The index comprises 48 indicators categorized into five weighted dimensions: socioeconomic context (20%), environmental and resource productivity (30%), natural asset base (25%), gender inclusion (10%), and governance (15%). Indicators are standardized using min-max scaling and aggregated through expert-weighted linear summation. The conclusive GGI score for India is 50.30 out of 100. Its strongest performance is in environmental and resource productivity (20.05/30), driven by comparatively low per capita carbon intensity and a growing renewable energy sector. The principal shortcoming is in gender inclusion (2.44/10), reflecting limited female workforce participation, constrained parliamentary representation, and a virtually absent presence of female ministers. Governance receives a mediocre score of 8.00 out of 15, indicating widespread institutional shortcomings. The document situates India's performance within the regional context, specifies policy objectives, and proposes a replicable baseline for tracking India's shift towards green growth.

Keywords: Green Growth Index, India, composite indicators, environmental sustainability, gender inclusion, governance, South Asia

1 INTRODUCTION

There are several features that make India stand out in a unique manner when compared to other developing countries around the world. For instance, India is the most populous country in the world and the fifth largest country in terms of nominal gross domestic product (GDP). Furthermore, India is one of the quickly growing major economies of the world. Simultaneously, India is among the largest emitters of carbon dioxide. In addition, India has some of the most polluted cities in the world, and there are more than 400 million individuals in the country who lack proper access to clean fuels for cooking purposes.

This is an inadequate representation in traditional economic indices. The growth rates presented via GDP growth figures do not capture the exhaustion of natural capital resources, inclusion in growth or strength in institutional governance needed to ensure that promises made in the green growth paradigm continue. There is therefore a need for a composite measure that captures the economic, environmental, social and institutional factors in one unified index. This is what the green growth literature has been concerned about in the last two decades. The best approach to this has been the African Green Growth Index (AGGI) created by the African Development Bank (AfDB) and adopted in 22 countries by Kararach et al. (2018) [1]. The five-fold measure that encompasses the socioeconomic foundation, environmental and resource productivity, natural asset base, gender participation, and governance, is a useful indicator given the challenges of data in emerging economies and the Indian environment specifically. The goal here is to establish the base performance score for India and assess its performance on all five dimensions.

2. CONCEPTUAL AND THEORETICAL FOUNDATIONS

2.1 Green Growth as a Policy Framework

The concept of green growth became widely accepted as a development paradigm following the global financial crisis of 2008, as it was adopted by leading international organizations, such as the OECD, the World Bank, and UNEP, as both a recovery tool and a sustainable framework for the future.[2]According to the OECD's pivotal 2011 report, green growth is defined as a strategy that promotes economic growth while avoiding environmental degradation and resource depletion, and, therefore, challenges the traditional paradigm according to which environmental protection and economic growth cannot coexist.[3]

Green growth came into vogue as a development model after the global financial crisis of 2008, when such leading international organizations as the OECD, the World Bank, and UNEP started adopting green growth as both a recovery policy and a sustainable development model.[2]According to the OECD's seminal 2011 report, green growth is a strategy for developing economies without creating any environmental destruction or resource depletion, thus refuting the traditional paradigm of conflict between economic growth and environmental preservation.[3]

2.2 Why Composite Indicators?

Composite indicators integrate several factors from different dimensions to form an aggregated score that makes them ideal for measuring complex ideas like green growth. According to Nardo et al. (2005), a composite indicator is defined as the mathematical integration of different indicators that represent the characteristics of a concept being studied [6]. The strengths of composite indicators have been widely acknowledged: they make multidimensional information easier to understand by decision-makers and citizens, help analyze issues within nations, and enable performance evaluation [7].

2.3 India's Green Growth Context

India's problem of green growth is special in both the scale and complexity of environmental issues. Environmental indicators indicate that India accounts for about 7% of global CO₂ emissions, but per capita emissions are considerably smaller compared to other developed nations and China. The country has set ambitious goals for renewables, with plans to install 500 gigawatts worth of non-fossil fuel power capacities by 2030 and an increasing share of renewables within the energy mix. At the same time, coal is still the leading source of power generation, and industrial energy intensity is higher than the world average.[9]

Gender inequality in Indian society is another pressing topic regarding development. Currently, the percentage of females in the labour force in India is only 28%, among the lowest figures worldwide for a major economy, although women in parliamentary representation and administrative positions remain underrepresented despite significant advances made lately. In terms of governance indicators, India ranks high on regulatory quality and rule of law compared to its neighbours but low on political stability and control of corruption.

3. METHODOLOGY

3.1 Adaptation of the AGGI Framework

According to Kararach et al. (2018), AGGI consists of 48 indicators distributed across five dimensions, which further have thematic subdimensions. These five dimensions are socio-economic context and growth attributes, environmental and resource efficiency, assessment of the natural assets inventory, gender, and governance. The classification of AGGI used without any modifications is utilized in the current study. Kararach et al. emphasized that there is no quick applicability of the international standards in regional studies without considering the relevance of the indicators in the local context [1]. However, the use of the whole set of 48 indicators by India was justified because of its importance for a fast-growing emerging economy facing major environmental and governance issues, as observed in numerous studies.

3.2 Index Structure and Mathematical Formulation

The formula for GGI for India can be stated as the weighted composite of five dimensions. Each dimension index is the weighted linear combination of the sub-dimension index, and each sub-dimension index is a weighted linear combination of the normalized individual indicator. This approach to index formulation guarantees that the composite index will have an overall assessment at all hierarchical levels.

The overall GGI is expressed as $GGI = \sum_i w_i D_i$, where w_i are the dimension weights and D_i are the dimension index scores.

Each dimension index is computed as $D_i = \sum_j w_{ij} SD_{ij}$, where SD_{ij} are the sub-dimension scores. Each sub-dimension score is given by $SD_{ij} = \sum_k w_{ijk} I_{ijk}$, where I_{ijk} are the normalised indicator values.

The weights at each level are constrained such that $\sum_i w_i = 1$, $\sum_j w_{ij} = 1$, and $\sum_k w_{ijk} = 1$.

3.3 Data Sources, Normalisation, and Weighting

Secondary data were obtained from the World Bank Development Indicators, International Energy Agency Energy Statistics, FAO Global Forest Resources Assessments, World Health Organization Health Observatory Data, and United Nations Development Programme Human Development Report.

Indicators are provided in various shapes and units, necessitating their standardization before aggregation.

Min–Max normalisation procedure was used to standardize each indicator on a scale of 0 (lowest achievement) to 100 (highest achievement), using the equation:

$$v^{new} = \frac{v - \min(x)}{\max(x) - \min(x)} \times (new_{max} - new_{min}) + new_{min}$$

Expert weighting, employed by Kararach et al. (2018)), was executed as outlined below: Economic and social conditions account for 20%, environmental and resource productivity for 30%, natural asset base for 25%, gender for 15%, and governance for 15%. The chosen weights underscore the significance of environmental decoupling in any substantive assessment of green growth, while preserving the index's multifarious character. Kararach et al. assert that the weighting of individual indicators within composite indicators is a contentious issue in the literature, and the determination of expert weights should be viewed as a debatable albeit reasoned opinion rather than an objective result [1].

4. RESULTS AND DISCUSSION

4.1 Overall Score and Regional Benchmarking

The value for GGI of India is 50.30 of a possible 100. This value suggests that it has achieved moderate success in maintaining sustainable growth within its borders. The above statement represents an aspect where success has been experienced in some areas while in other cases there is still room for improvement. This can be attributed to the complexity of attaining sustainable development in large and diversified economies.

Table 1. India's GGI Score Across Five Dimensions

Dimension	Max Score	India's Score	% of Max
Socioeconomic Context	20.00	8.78	43.9%
Environmental and Resource Productivity	30.00	20.05	66.8%
Natural Asset Base	25.00	11.03	44.1%
Gender Inclusion	10.00	2.44	24.4%
Governance	15.00	8.00	53.3%
TOTAL GGI	100.00	50.30	50.3%

4.2 Socioeconomic Context (Score: 8.78/20)

With India scoring a 8.78 out of 20 on the socioeconomic front, there is evidence that it has reached the level of lower-middle in terms of its economic growth performance. There have been several positive developments in India since the late 1980s, which include an increase in employment and per capita income levels, largely due to the dominant role of the service industry. In addition to that, there has been a substantial improvement in the rate of literacy.

The determinants that affect India's score in this dimension can be equally illuminating. The youth dependency ratio of India indicates an extensive young population which, while providing India with a possible demographic dividend, places enormous strain on healthcare, educational, and infrastructure systems. While infant mortality rates have been reduced, they remain above the regional average. Health spending per individual is exceedingly low relative to international standards, and malnutrition remains widespread, especially in infants under the age of five years. These socio-economic limitations are crucial to the success of green growth initiatives, since they influence India's ability to finance its green technology and regulations.

4.3 Environmental and Resource Productivity (Score: 20.05/30)

Productivity of environment and resources is the most important component at 30 percent and represents the largest area of relative success for India. India scores 20.05 out of 30 here. This is unexpected, especially for people who know about India's environmental problems and need for energy, but it can be explained by looking at per-capita figures instead of absolute emissions. Per capita CO₂ emissions in India are much smaller than those in China and developed nations, and India has relatively higher energy intensity in terms of GDP.

The renewable energy aspect stands out in its importance. India has pumped a lot of money into solar and wind energy in the past ten years, which has seen a marked increase in the percentage of renewables contributing to total electricity production. In line with the OECD green growth strategy, the development represents the movement towards low carbon, efficient use of resources, which serves as a key feature of green growth performance. But India's score under this category must not be seen as a reflection of its environmental record. The low per capita carbon intensity, among other things, indicates India's growing economy rather than environmental efficiency. As India's economy develops and becomes more industrialized, sustaining this figure will require more conscious government efforts to avoid increasing carbon intensity with economic productivity.

4.4 Natural Asset Base (Score: 11.03/25)

With a score of 11.03 out of 25, India receives a fourth place position in terms of its natural wealth score, indicating significant pressure on the environment. About 24 percent of India's land area is covered by forests, which is roughly stable because of efforts at afforestation; nevertheless, the increase has not been significant. India has a large amount of arable land because of its agricultural-based economy, but its freshwater withdrawals per capita are considerably above average compared to other nations in the area. This indicates the heavy reliance on its freshwater resources due to the agricultural, industrial, and domestic sectors in its country of 1.4 billion people. Protection areas are crucial. India has set aside a large percentage of its land for biodiversity protection through the creation of national parks, wildlife sanctuaries, and biosphere reserves. However, implementation of these laws may be poor, making the rapid emergence of biodiversity extinction possible in ecologically sensitive areas. Disaster risk assessments reveal India's substantial susceptibility to climate-induced threats, including floods in the northern and northeastern regions and droughts in central and peninsular areas, leading to considerable human and economic detriment while directly threatening the natural resource foundation vital for sustainable green development.

4.5 Gender Inclusion (Score: 2.44/10)

The inclusion of gender in India's case has a value of 2.44 out of 10, making it the most deficient aspect and ranking India last among the six-country sample regionally. This issue requires close attention because it indicates a fundamental characteristic of Indian society that should not be overlooked by any efforts geared toward sustainable development. Some factors influencing the inclusion of gender are clear. India has one of the lowest labour force participation rates for women at 28.3 percent among countries of comparable economic size and development status. In parliament, women occupy just 14 percent of the seats, lower than China's 27 percent and even less than South Africa's and Namibia's 33 percent, considering an African comparison. Cabinet seats occupied by women stand at 5.6 percent. While having relatively low HIV infection rates among women is beneficial, it is nullified by the barriers to their labor and political participation.

The inclusion of gender into the GGI can be theoretically explained. According to AGGI theory, as well as the literature produced by the OECD and World Bank on green growth, green growth without women taking an active part in economic life, decision-

making processes, and governance cannot be called sustainable or progressive. In fact, women suffer most from environmental problems, especially those occurring in rural areas because of their heavy dependence on nature for subsistence. As they have no role in formal economic and political structures, their skills, tastes, and needs are not taken into account in developing green policies.

4.6 GOVERNANCE (SCORE: 8.00/15)

With a governance score of 8.00/15, there appears to be moderate governance capacity in India concerning fostering green growth. The governance capacity of countries may be analyzed using the five governance indicators of the World Bank to get an elaborate perspective. While India has excellent scores in regulatory quality and voice and accountability, as expected from a democracy with a fairly efficient regulatory regime, the scores of political stability and the absence of violence leave much to be desired owing to problems in internal security and sociopolitical stability. In terms of corruption control, India has a well-established legislative and administrative framework to deal with corruption problems, although the enforcement may not always be consistent.

The importance of good governance in relation to fostering green growth cannot be overlooked since it determines the efficiency of both policy-making and its enforcement. India's experience with environmental regulations is a case in point. Although it has put into place fairly comprehensive environmental laws and policies such as the National Environment Policy and the Environment Protection Act, there is still a huge problem in their enforcement.

5. POLICY IMPLICATIONS

This study provides a five-dimensional framework, which describes clear policy objectives for India. The conclusions and recommendations have been developed based on the outcomes of the study and the corresponding pattern of indications. Maintaining and further developing the renewables energy transition: India's relatively high score on the environmental productivity indicator is due to its growing renewable energy industry. In order to preserve this advantage amid economic growth, it is important to continue the active use of renewable energy sources, while systematically reducing the role of coal in the power generation sector and decarbonizing industrial sectors. If no changes occur, GDP growth might lead to deterioration in indicators of the per-capita emissions intensity. Fixing the gender inclusion gap problem as an essential structural issue: The insufficient performance of India on the gender inclusion indicator reflects certain structural problems related to women's participation in the labor market and politics. Improving the participation of women in governance institutions through the use of the existing reservation mechanisms at the local level could present an effective way forward. Improving the effectiveness of environmental governance and enforcement systems: It is evident from the performance of governance in India that the capacity of institutions is a significant constraint to the successful implementation of green growth strategies. Strengthening the enforcement regime, improving coordination among ministries, and increasing transparency during the process of environmental clearance are crucial steps. Improving data infrastructure and building capacities for environmental economic accounting can contribute to evidence-based policy making. Protecting and restoring the basic resources: The natural endowment in India is under increasing pressure, especially when it comes to water sources and biological diversity. It is important for policymakers to intervene in sectors like sustainable irrigation, proper ground water management, and ecological zones.

6. CONCLUSION

This article has established and evaluated a Green Growth Index (GGI) for India, providing a comprehensive assessment of its performance in all aspects of sustainable development. India's aggregate score of 50.30 out of 100 reflects a transitional phase, indicating significant progress coupled with persistent structural challenges. The research reveals three primary findings. India's significant prowess in environmental productivity is contingent upon the continuous expansion of renewable energy and sustained efforts to mitigate emissions alongside economic growth. Secondly, gender inclusion is a critical structural vulnerability, requiring extensive and coordinated policy interventions instead of incremental changes. The quality of governance, while moderate, remains a constraint on the effective implementation of environmental policies. The GGI developed in this study provides a significant reference for tracking India's green growth trajectory over time. Consistent updates employing fresh data may enhance the assessment of policy initiatives' impacts across multiple dimensions. The framework demonstrates the significance of multidimensional green growth measurement techniques in the Indian context, offering a systematic tool for evaluating progress toward sustainable and inclusive development.

7. FUTURE SCOPE OF RESEARCH

There are several directions that can be explored further concerning future studies related to the Green Growth Index of India. For example, developing a subnational Green Growth Index will help explore different states in India, which will make this information much more useful for policymakers to use. Second, assessing the index once every three to five years could help determine the change in India's development path. Third, conducting an analysis of the gender gap in labor force participation is expected to yield results concerning low women's participation in the labor market. Adding indicators such as groundwater stress and air pollution will enhance the study.

8. LIMITATIONS OF CURRENT STUDY

The assessment of the green growth performance of India presents a valuable point of reference; however, there are a number of problems associated with it. To begin with, the study largely relies only on secondary data obtained from global sources; this means that there is no recognition of the significant differences existing between regions of India. Secondly, there is a potential issue related to the application of min-max scaling based on selection of peers since it influences India's ranking. Thirdly, the subjective weighting approach can result in different rankings, which requires future validation. Fourthly, some important measures such as employment in the informal sector and air pollution are not included into the framework.

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