GGGI

Green Growth Performance Measurement
Working Paper No. 3 | May 2020

GGGI's concept for the Green Growth Index: Comparative assessment of relevant global green growth indices

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GGGI's concept for the Green Growth Index: Comparative assessment of relevant global green growth indices

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1. Introduction

Green Growth and Green Economy are a multidimensional and interdisciplinary concept, with several organizations currently developing their own methodology to study, measure, and communicate how countries progress towards greening their economy. As despite being widely used, there is no universally accepted definition of the two concepts (Schmalensee 2012, Green Growth Knowledge Platform [GGKP] 2013, United Nations Department of Economic and Social Affairs [UNDESA] 2012), leading to the coexistence of several interpretations and the development of different frameworks.

Both Green Economy and Green Growth have been defined as "umbrella notions", as they encompass various concepts such as human well-being, the use of natural resources and efficiency, ecosystem services as well as many other sustainability thematics (Loiseau et al 2016). Therefore the green economy approach covers a large set of economic policies and models based on literature often starting from different perspectives (UN Secretary General 2010). This broad characterization and subsequent ambiguity of the concept can be traced back to its origin, first introduced by Pearce et al. (1989) in the report *Blueprint for a Green Economy* that coined the term without providing a clear-cut definition. Thus, despite being an old concept in the academic word, the Green Economy concept was not applied in economic policies for the next 20 years (Loiseau et al. 2016). However in 2008, following the global financial crisis, there was regained momentum within international development debates on the concept resulting in several international organizations building their own frameworks and definitions around a "green economy" (Marino-Saum et al. 2019). UNDESAS' "Guidebook to Green Economy" (2012) identifies as many as 13 different Green Economy or Green Growth definitions designed by international actors and governments. More recent works includes as many as 140 definitions related to green growth or green economy (Merino-Saum et al. 2019). For instance, various definitions are described by the Green Economy Coalition (2012), United Nations Conference on Trade and Development (UNCTAD 2011), World Bank (WB 2011) and Organization for Economic Co-operations and Development (OECD 2011). Each signifying the need for environmental protection, as well as creating resilient and resource efficient economies in order to maintain social wellbeing for future generations. Although having a slightly different emphasize on what aspect of green growth should be prioritized, such as 'greener economies', 'reducing environmental risk' or 'understanding ecological limits'. Currently, one of the most internationally recognized definitions is from the United Nations Environment Programme (UNEP 2011), which labels Green Economy as one where human well-being and equality are improved while the environment is protected.

Similarly, several initiatives for measuring Green Economy and Green Growth have also been developed. The measures proposed adhere to the four categories based on their structure: composite indices, dashboard of indicators, footprints, and adjusted measures. For example, UNEP's Green Economy Progress (GEP) Index and the Yale Environmental Performance Index fall in the category of composite indices, constituted by a set of indicators synthetized into a single index on the base of strong analytical frameworks. The most known dashboard of indicators, which consists of a long list of variables, were developed by Eurostat (Sustainable Development Indicators) and the OECD (Green Growth Indicators). It is also relevant to mention footprint measures such as the Global Ecological Footprint and the Carbon Footprint, which are based on accounting models measuring the human impact on the environment. Finally, Inclusive Wealth Index and Adjusted Net Savings that fall into the category of adjusted measures, which correct existing economic variables by internalizing the social and environmental costs.

Each of these measuring approaches have different forms of complexity from data availability and requirements, methodology and comparability of indicator scores thereby influencing the applicability of specific indicator frameworks within various countries. Data availability can be a major limitation for all these measures, due to difficulty in the level of aggregation, capacity and technical knowledge and costs of data collection (Schmidt-Traub et al. 2017; Sustainable Development Solutions Network 2015). Additionally, challenges arise in users comparing various green growth frameworks based on their methodology approaches and units of measurement. For example, footprint measures such as the Global Ecological Footprint uses their own metric unit such as biocapacity per person (Lin et al. 2018), while composite indices generally provide a single unit value to represent green growth progress. Methodologies for calculating these frameworks can also vary such as the use of accounting systems in the Inclusive Wealth Index (UNEP 2018) compared to a weighted method for the GEP Index (PAGE 2017b). By having multiple ways green growth is presented and measured, users are then unable to identify a clear outcome on green growth progress which is consistent among different frameworks. Thus, arising the need for global collaboration to amend these challenges to provide a universally accepted definition and framework which has been advocated by the Green Growth Knowledge Platform (GGKP), a global network of international organizations led by the OECD, UNEP, United Nations Industrial Development Organization (UNIDO), World Bank (WB), and Global Green Growth Institute (GGGI).

Working with this intent to provide a well-defined measure for Green Growth, the Global Green Growth Institute has developed a concept and measuring framework focused on the cooperation and collaboration among multiple institutions. GGGI aims at strengthening the teamwork among organizations via two lines of work. First, in the way in which the index is designed, by close collaboration with several authorities and professionals through regional and international workshops as well as expert group consultations that GGGI held in the last years. This resulted in GGGI contributing a new composite index which is widely accepted but also strongly linked to all the other global indices. Second is in harmonizing the existing measurement and reporting of indicator metrics.

This report aims to make a comparative assessment of the existing indices measuring green growth and enhance collaborations between the institutions that design them. Understanding the commonalities and differences among the available measures is a key element for sharing the efforts and achieving broader outcomes. In order to analyze the relationship between GGGI's Global Green Growth Index and other indicators there will be a greater focus on qualitative than quantitative features. Comparisons will be based on definitions, frameworks, and design processes. The methodologies for developing the index are not part of this report and available elsewhere (e.g., Acosta et. al. 2019). The purpose of the comparison is to look at the similarities among measures that can be used to engage in positive collaborations as well as explore their differences to understand the value added of each indicator. Also, possible future common works will be identified and strategies to achieve it will be developed. The report is structured as follows: Section 2 explains in detail the methods and foci of assessment; Section 3 presents the core of the comparison exercise, including a subsection for each aspect of comparison; and Section 4 provides a summary and concluding remarks.

2. Analytical approach

2.1 Foci of assessment

The objective of this assessment is to understand the similarities and differences among indicators on the following three aspects: definitions, frameworks, and design processes (Figure 1). Identifying similarities among indicators is crucial for policy purposes to encourage discussion and collaboration among institutions. The first focus of the assessment is the definition of Green Growth chosen by the Institution, with special attention given to whether a specific working (or practical) definition is adopted. The second focus deals with frameworks – conceptual and institutional. On the conceptual level, the indices are compared with respect to structure design and the division into indicator categories and sub-categories, showing each institution's standpoint on how to approach the multidimensional concept of green growth and the relationship among variables. On the institutional level, the relationships of the indicators to the Sustainable Development Goals or other globally accepted set of targets are assessed. And finally, the third focus is the development process of the index and the range of institutions that collaborated during the process, which indicates of the degree of openness of the design procedure. Table 1 provides a brief description of the aspects of comparisons for each assessment focus.

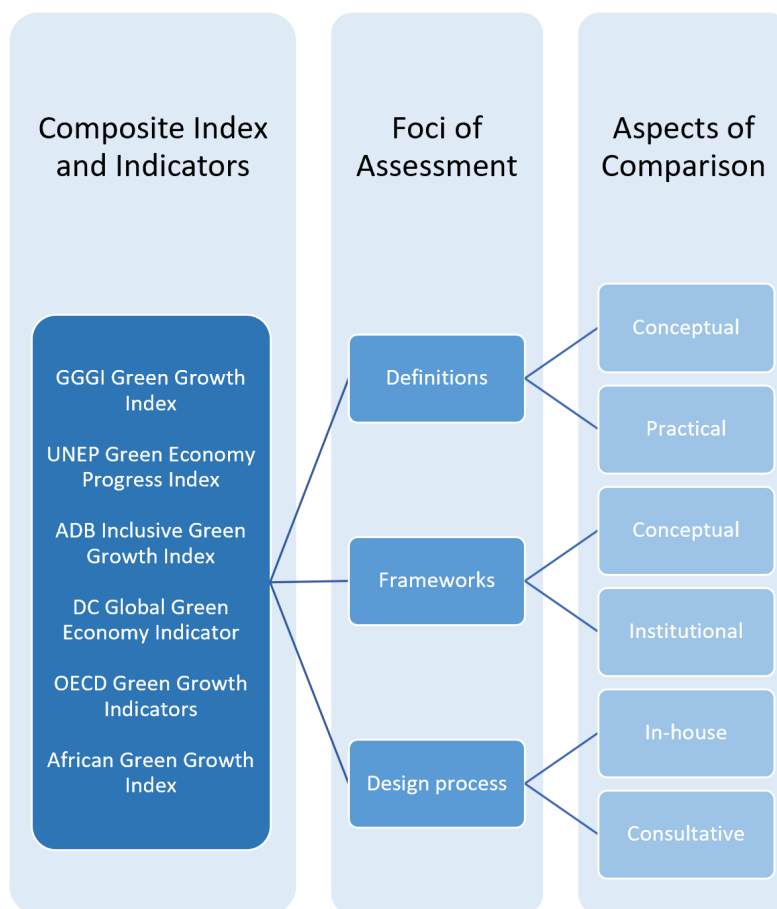Figure 1 Foci of the comparative assessment

Table 1 provides a brief description of the aspects of comparison for each assessment focus.

Foci	Aspects	Description
Definitions	Theoretical	The abstract definition of Green Growth by various institutions.
	Practical	The measurable variables (indicators) that are the building-blocks for Green Growth indices.
Frameworks	Conceptual	The steps required to develop and measure each Green Growth index.
	Institutional	The linkage of each Green Growth index to well recognised institutional frameworks for global engagement and integration.
Design processes	In-house	Internal development of the index, following specific guidelines for index concepts and data evidence. Typically does not utilise external consultation in the development process.
	Consultative	Collaborative development of the index with engagement from multiple different stakeholders and institutions.

2.2 Methods of assessment

2.2.1 Criteria for selection of indices

The set of indices included in the report were chosen through a careful selection process designed to include only the most relevant measures for comparison with the GGGI Green Growth Index. The steps for the selection process are as follows:
1. relevance to green growth concepts
2. type of measurement approaches
3. coverage of sustainability dimensions
4. year and frequency of publication

For step 1, an initial list of existing efforts to measure green growth was drawn from GGKP's (2016) working paper, 'Measuring Inclusive Green Growth at the Country Level: Taking Stock of Measurement Approaches and Indicators' and updated with recent initiatives. This list was generated from a literature review which identified the most recent green growth-related measurement approaches that were not included in the GGKP's list.

Selected indicators were chosen based on their aim to provide a comprehensive overview of green growth with a multi-national scope. The exclusion of country-specific indices is due to the incomparability to multi-national indices because of their intended purpose to address specific country level problems that are dependent on the country's socioeconomic realties and statistical office data availability.

For step 2, the measurements identified from step 1 were categorized into different approaches[2], which include the following:
- Composite indices
- Dashboard of indicators
- Footprints
- Adjusted economic measures of GDP

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[2] These were adopted by the GGKP (2016) from the work of Stiglitz, Sen and Fitoussi (2010).

Table 2 provides the list of measurements that belong to these four types of approaches. Since GGGI's Green Growth Index belongs to a "composite index" approach, only measurements in this category were carried over to the next step. In step 3, the completeness of sustainability dimensions (i.e., social, economic, and environmental) in the composite indices were checked. Out of the 13 composite indices listed in Table 2, six composite indices were excluded from the selection process because they cover only economic or environmental dimensions of sustainability. In step 4, additional three composite indices were excluded because they were outdated or not updated anymore.

Table 2 List of green growth related measurement approaches

Types of measurement approach	Name of measurement	Reason for inclusion/exclusion within the comparison exercise
Composite Index	Green Economy Progress Index (PAGE 2017)	Included
	Yale Environmental Performance Index (Emerson et al. 2012)	Excluded. It only considers the environmental side.
	World Economic Forum's Sustainability-adjusted Global Competitiveness Index (Greenhill 2011)	Not included. It focuses on the level of productivity and competitiveness of an economy, rather than the green growth.
	Notre Dame Global Adaptation Index (ND-GAIN 2013)	Excluded. It focuses especially on countries' climate adaptation performances.
	Global Green Economy Index (Dual Citizen LCC 2014)	Included
	Fondazione Eni Enrico Mattei's Sustainability Index (Eboli 2011)	Excluded. It is not updated anymore.
	South Pacific Applied Geoscience Commission's Environmental Vulnerability Index (SOPAC 2005)	Excluded. It is not updated anymore.
	OECD Better Life Index (OECD 2013)	Excluded. It is more apt for measuring well-being rather than green growth.
	Ocean Health Index (Halpern et al. 2012)	Excluded. It is not updated anymore.
	Happy Planet Index (Abdallah et al. 2012)	Excluded. It is more apt for measuring well-being rather than green growth.
	Climate Change Performance Index (Burck, Marte and Bals 2018)	Excluded. It considers solely the environmental side.
	Africa Development Bank's African Green Growth Index (Jha et al. 2018).	Included

	Asian Development Bank's Inclusive Green Growth Index (IGGI) (Kararach et al. 2018).	Included
Dashboard of Indicators	OECD Green Growth Indicators (2017)	Partly included due to relevance of the framework (i.e. links to SDGs)
	Eurostat Sustainable Development Indicators (Eurostat 2019)	Excluded
Footprints	Global Ecological Footprint (Global Footprint Network 2017)	Excluded
	CO2 emissions embodied in international trade (OECD 2015)	Excluded
	Global Resource Footprint (Tukker et al. 2014)	Excluded
	Carbon footprint (UNEP 2014)	Excluded
	Water footprint (Hoekstra and Mekonnen 2012)	Excluded
Adjusted Measures	Inclusive wealth (Managi and Kumar, 2018)	Excluded
	Index of Sustainable Economic Welfare (Daly and Cobb 1989)	Excluded
	Genuine Progress Indicator (Talberth, Cobb, and Slattery 2007)	Excluded
	Adjusted net savings (Hamilton & Clemens 1999)	Excluded

At the end of the selection process, four composite indices were identified for comparison with GGGI's Green Growth Index, including the Inclusive Green Growth Indicator (IGGI) by the Asian Development Bank (ADB), the Green Economy Progress (GEP) Index designed by the United Nations Environment Programme (UNEP), the Global Green Economy Index designed by Dual Citizen LLC (DC), and the African Green Growth Index (AGGI) by the African Development Bank (AfDB). The Green Growth Dashboard of Indicators by the OECD were included in the analysis of frameworks due to its relevance in linking indicators to SDGs. The selected green growth related measurements for comparative assessment are briefly described below:

GGGI's Global Green Growth (GGG) Index: The GGG Index, which was developed by the GGGI in 2019, is a component of GGGI's Green Growth Performance Measurement framework and linked to a Simulation Tool to support the integrated assessment of impacts of green growth policies at the national level. The Index is benchmarked against the SDG targets.

ADB's Inclusive Green Growth (IGG) Index: The IGG Index was designed by ADB in 2018 to focus on measuring green growth performance of developing countries in Asia. However, it can also be applied to all country and regional settings and at all levels of development.

UNEP's Green Economy Progress (GEP) Index: The GEP Index is a measure of progress toward green economy developed in 2017 by UNEP under the Partnership for Action on Green Economy (PAGE) a coalition of five UN agencies supporting countries' transition to green growth. The measurement framework designed by UNEP includes the GEP Index, a dashboard of indicators, and the country ranking (GEP+).

AfDB's African Green Growth (AGG) Index: The pilot version of the AGG Index was proposed by AfDB in 2018 and is currently modified in collaboration with the GGGI. It was developed to support the 2013-2022 Bank's Strategy, which focuses on the two objectives to improve the quality of growth across the African continent: inclusive growth and transition to green growth.

DC's Global Green Economy (GGE) Index: The GGE Index was first developed in 2010 by the Dual Citizen LLC, a consultancy company based in the United States. It is the only composite index for measuring green economy performance that has been consistently updated in the past years (every two years).

OECD's Green Growth Dashboard: The OECD Green Growth Dashboard of indicators was designed by the OECD in 2011 to measure and monitor the progress of OECD countries in their green growth transition.

2.2.2 Methods for comparison

A. DEFINITIONS

Green Growth and Green Economy are complex concepts established from the three pillars of sustainability (environmental, social and economic). While many recognize the term Green Growth, there is still no common definition resulting in institutions involved in green growth measurement formulating guidelines to help nations and organizations assess their progress towards transitioning to a green economy.

One of the milestones in this field, the OECD 'Handbook on Constructing Composite Indicators' (Nardo et al. 2005), advocates choosing a clear working definition so it can also be properly measured. Thus, in our comparison, the definitions will be analyzed to understand what the institutions mean by green growth (**theoretical**) and what exactly they aim to measure (**practical**). Then, we assessed whether the indices focus on all three pillars of green growth or only emphasize a specific angle of the green growth narrative. Table 3 presents the definitions which were compared for the five composite indices and one dashboard. The results of the assessment are discussed in section 3.1 Definitions.

Table 3 Green economy and green growth definitions

Index	Definitions
GGGI's Global Green Growth (GGG) Index	Theoretical: "Green growth is a development approach that seeks to deliver economic growth that is both environmentally sustainable and socially inclusive. GGGI seeks opportunities for economic growth that are: low-carbon and climate resilient, prevent or remediate pollution, maintain healthy and productive

	ecosystems, create green jobs, reduce poverty and enhance social inclusion." (GGGI 2017) Practical: "Green Growth Index measures country performance in achieving sustainability targets including Sustainable Development Goals, Paris Climate Agreement, and Aichi Biodiversity Targets for four green growth dimensions – efficient and sustainable resource use, natural capital protection, green economic opportunities and social inclusion." (Acosta et al. 2019)
UNEP's Green Economy Progress (GEP) Index	Theoretical: A green economy is "An economy that results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities." (UNEP, 2011) Practical: "An Inclusive Green Economy is a pathway designed to address three main global challenges, namely: (a) persistent poverty; (b) overstepped planetary boundaries; and (c) inequitable sharing of growing prosperity" (PAGE, 2017).
ADB's Inclusive Green Growth (IGG) Index	No specific definition. "The IGGI was designed to measure progress on inclusive and environmentally sustainable growth at the national level" (Jha et al., 2018).
AfDB's African Green Growth (AGG) Index	Theoretical: Green growth is "the promotion and maximization of opportunities from economic growth through building resilience, managing natural assets efficiently" (AfDB 2018).
DC's Global Green Economy (GGE) Index	No specific definition.
OECD's Green Growth Dashboard	Theoretical: "Green growth is about fostering growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. Governments that pursue policies designed to promote green growth need to catalyse investment and innovation that underpin growth and give rise to new economic opportunities" (OECD, 2011).

B. FRAMEWORKS

Conceptual Framework

As previously discussed, the structure of the composite index needs to be selected carefully and designed according to a precise conceptual framework that reflect as closely as possible what the institution aims to measure. Such theoretical underlying model is necessary in order to incorporate individual indicators into an aggregate measure that is valid and meaningful (Nardo et al. 2005, Freudenberg 2003). Concepts of measurability, validity, and degree of

substitutability among variables have been outlined as important structural components during the development process.

For instance, the OECD Handbook (Nardo et al. 2005) states a range of recommendations in relation to framework development such as the importance of measurable variables and sub-components. As well as selecting individual indicators and weights that are reflective of the relative significance and dimensions of the overall composite (Nardo et al. 2005, Freudenberg 2003). This is important as unless variables can be quantitatively or qualitatively measurable over time this will impact the index's scientific credibility and quality to accurately provide information on green growth progress (UNEP 2014). Additionally, without relatable indicators linked to green growth, the index data will not be useful for decision making or policy development (Nardo et al. 2005).

The handbook further suggests dividing the multi-dimensional index into several sub-groups and to describe any existing linkages of each sub-group theoretically or empirically to the greatest extent possible (Nardo et al. 2005). As sub-groups do not need to be independent of each other, these linkages are helpful to improve user understanding of the underlying concept and motivation behind development of the composite index. Such as reflecting the complexity and inter-connections associated with sustainability or green growth terms. By also defining these group relationships, it is also useful in assisting developers on assigning relative weightings across different index factors (Nardo et al. 2005).

Theoretical frameworks are also influenced by data availability and biasness. A report from Nardo et al. (2005a) highlights that each theoretical framework is restricted and validated by the accessibility and availability of current information. Therefore, model systems will be both a reflection of some of the characteristics of a real system as well as subjected to the scientific biasness of observations. These limitations should be specifically outlined and transparent to users.

Another consideration is the substitutability of indicators and variables within the conceptual framework. This relates to the degree to which one type of asset can be substituted for another, either with another natural asset or human or produced capital (GGKP 2013) and provides additional information on the index's view on the notion of green growth. For example, if a level of natural capital depletion can be substituted for more green economic opportunities or a higher degree of social inclusion. But substitution can also occur within each green growth dimension. Composite indicators usually allow some degree of substitutability among variables and dimension, but this can be limited by an appropriate choice of the aggregation method (for example, geometric aggregation reflects some degree of non-compensability between individual indicators, while linear aggregation does not). A non-compensatory aggregation method is preferable when all goals are equally important and this is especially true when the different dimensions are included (inputs and outputs; physical, social, and economic variables; assets and stock variables) (Nardo et al. 2005)

Following these guidelines, each indicator will be assessed by looking at the categories selected and the linkages connecting the variables and sustainability pillars. Furthermore, the category or index weightings will be examined to understand the degree of substitutability chosen by each indicator.

Institutional framework

The proposed indicators should be included within a well-recognized institutional framework to be effective and reach international audiences. Article 57 of the declaration 'The Future We Want!' proposes to adopt the United Nations (UN) principles as a guiding framework, stating: "*We aim that policies for green economy in the context of sustainable development and poverty eradication should be guided by and in accordance with all the Rio Principles, Agenda 21 and the Johannesburg Plan of Implementation and contribute towards achieving relevant internationally agreed development goals, including the Millennium Development Goals.*"

In accordance with the UN agenda, this assessment will consider whether the index design adopts the framework suggested by the Sustainable Development Goals (SDGs). By utilizing the SDGs framework, all the organizations can work together to address the same targets agreed at during the UN Conference on Sustainable Development (Rio+20). Currently, many organizations have used variables from the list proposed by the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development, resulting in similar target goals and enhancing comparability among the measures.

Other than the SDGs institutional framework, it will be examined whether the proposed indicators adopt any environmental targeting system, such as the Aichi targets for biodiversity (UNEP 2010), the Paris goals for climate action (UNFCC 2015), the Sendai framework for disaster reduction (UNISDR 2015), and any other available framework for economic targeting.

C. DESIGN PROCESSES

In selecting indicators, other actors in the green economy field might be engaged such as experts from other institutions, national governments, and private sectors. For example, UNEP encourages participation from stakeholders in indicator selection to assist in the process of issue identification. This is one of three indicator typologies, classified by UNEP, as they are necessary to identify issues to be addressed through green economy policies and are more easily recognized by stakeholders such as national representatives (UNEP 2014). For example, it is stated

"*given the cross-sectoral nature of the analysis and implementation steps proposed, the use of existing indicators across various data sources is encouraged, as well as the involvement of a broad set of stakeholders, to support the design and implementation of a coherent and inclusive green economy strategy*" (UNEP 2014). In a similar way, the OECD Handbook supports the adoption of a fitness-for-purpose principle when selecting the variables, so that the choice is guided by the final users' needs (Nardo et al. 2005).

On the other hand, other institutions adopt an internal process guided by strict methodological rules and theoretical principles or data evidence, without leaving room for external consultation. This design procedure requires more effort into developing a strong guiding framework and adopting a structure soundly anchored to a well-defined definition. Such method coincides with the steps suggested by UNEP for designing the other three types of indicators: policy formulation, policy assessment, and policy monitoring and evaluation. Designing an index for policy formulation involves setting policy objectives, identifying possible policy options, and setting associated targets. Also, it requires the analysis of qualitative and quantitative information as well as the projections of economic and biophysical simulation

models. This highly scientific and data driven design can be beneficial for countries to understand their priorities and needs based on their index scores and the distance from their defined targets.

In the assessment, the indicators will be grouped according to the strategy employed and possible improvement will be identified.

3. Results and discussion

3.1 Definitions

The Global Green Growth Institution defines green growth as a development approach that seeks to deliver economic growth that is both environmentally sustainable and socially inclusive. It also specifies the sectors where economic expansion can be made greener, focusing on instruments that can achieve objectives of climate resilience, pollution abatement and prevention, ecosystem protection, social welfare, and green employment. It presents the three pillars of sustainability, emphasizing the need for countries to consider a switch to a more sustainable growth path. The GEP Index by UNEP also emphasizes the necessity for countries to move towards more sustainable and inclusive growth. Although its underlying United Nations Environment Programme definition focuses more on highlighting the threats that should be avoided such as poverty, environmental exploitation, and inequality. Providing a different viewpoint from the GGGI that chooses to feature the tools required to move towards a sustainable economy. While others, such as the OECD (2011) have identified the role of the environment as an asset, with its degradation being a risk to populations as natural capital is important for survival. Focusing on actions aimed as investment and innovation that policy makers need to undertake to achieve green growth. The African Development Bank (2018) also focuses on activities, by providing an operational definition highlighting maximizing economic growth opportunities through enhancing agricultural productivity, promoting sustainable infrastructure and the efficient management of natural assets.

Each of these definitions provides a clear, detailed and working framework to guide subsequent index development meeting the recommendations by the OECD Measurement Framework of adopting a clear defining formula. Though they each show how variations in phrasing impact the overall tone of the discussion of green growth and its defining characteristics as well as the institution's view on the topic.

Adopting a different approach, the Asian Development Bank and Dual Citizen developed their indices from definitions that are more open to interpretation. For example, a simple and generalised definition was selected by the ADB where "*the IGGI was designed to measure progress on inclusive and environmentally sustainable growth at the national level*" (Jha et al. 2018). Leading to interpretation that the ADB is more focused on contributing to the measurement issues surrounding sustainability indices instead of solely green growth. Likewise, the Dual Citizen Institute does not explicitly offer a definition of green growth in designing its Global Green Economy Index (GGEI). Rather (a declaration of intent), that its index will help contribute to the information and capacity building of sustainability to improve and inform national policy makers and governments.

From this analysis, evidence shows that while a long list of different green economy definitions has been produced, there are similar links between those used by international organizations (GGKP 2013). Nevertheless, each definition has an individual focal point, differentiating it from the others. This will impact the development of frameworks to include various sub-indicators relative to each index.

3.2 Frameworks

3.2.1 Conceptual framework

National efforts to monitor green growth progress is often achieved through extensive lists of indicators and variables. A relevant example is the 231 variables suggested for tracking the progress toward the SDGs, listed in the 2017 *Resolution Adopted by the General Assembly.* However, while a large set of variables is important in measuring green growth progress, it does not easily provide information of whether progress has been achieved (GGKP 2013). Selecting the best indicators to measure green growth depends on the trade-off between the quantity of aspects covered and increasing complexity of the composite index, which is addressed by building a rigorous conceptual framework. The frameworks of each index were compared to identify similarities and differences towards measuring green growth (Table 4).

The IGGI was divided into economic growth, social equity and environmental sustainability adopting a three-pillar structure. This compromised of a total of 28 individual indicators: seven for economic growth, 14 for social equity and seven for environmental sustainability. An initial analysis suggests that measuring social equity is important within the IGGI, with twice the number of indicators covering many of the main challenges of social inclusion such as access to basic services, employment, education, health, poverty, and inequality. The individual indicators included within each category are mostly standard and there is little overlap among pillars. For example, economic growth is measured predominately by only economic variables such as gross domestic product (GDP), trade and government debt as there is an omittance of variables green growth concepts such as green investment, trade, and employment. This highlights that the ADB chose an independent structure to develop its green growth metric by separately measuring each sustainability tier. Each pillar is equally weighted and aggregated linearly into the composite index, allowing for a complete substitution among variables and categories. To resolve this, the ADB has designed the Balanced Inclusive Growth Index that corrects the IGGI score by the measuring the gap between the three pillars and reducing the index value for countries with very divergent performances. This results in the calculation of a new index composed for four aspects: 1) the environment, (2) economic opportunities, (3) inclusiveness, and (4) balance among the previous three.

Table 4 Indices' structure and sub-division into the three pillar of green growth

Data	Environmental	Social	Economic	Other
Global Green Growth Index	**Efficient and Sustainable resource use** 1.Ratio of primary energy supply to GDP 2.Renewable energy 3.Water use efficiency 4.Freshwater withdrawal 5.Soil organic carbon content 6.Organic Agriculture 7.Domestic material consumption per GDP 8.Material Footprint per capita **Natural Capital Protection** 9.Air pollution 10.Unsafe Water source 11.Municipal Solid Waste per capita 12.CO2 Emissions per capita 13.Non-CO2 Emissions per capita 14.Non-CO2 Emissions in agriculture per capita 15. Protected Biodiversity Areas 16.Share of forest area 17.Soil biodiversity 18.Red list index 19.Tourism 20. Terrestrial and marine protected areas	21. Access to water and sanitation 22.Access to electricity 23.Internet and mobile 24.Seats held by woman in national parliament 25.Financial institution account, female 26.Equal gender pay laws 27. Income Inequality 28.Access to water, sanitation and electricity, urban to rural ratio 29.Youth not in education, employment or training 30. Pension Coverage 31. Healtcare access and quality index 32. Population living in slums	33.Adjusted Net Savings 34.Environmental Exports 35.Green Employment in manufacturing 36.Environmental Patents	
Green Economy Performance	1.Air pollution,	9.Access to basic services	15.Green trade	

Measurement Framework (Indicators in italics are part of the dashboard)	2.Protected areas (marine and terrestrial), *3.Volume of freshwater,* *4.Land Use,* *5.Ecological footprint,* *6.GHG Emissions* *7.Emission of Nitrogen,* *8. Inclusive Wealth Index*	10.Gender inequality 11.The Palma ratio 12.Pension coverage 13.Education 14. Life expectancy	16.Green technology innovation 17.Renewable energy supply 18.Energy use 19.Material footprint per capita	
Inclusive Green Growth Index	**Environmental Sustainability** 1.Natural resource rent 2.Renewable freshwater resources 3.Water Productivity 4.Air Pollution 5. CO2 per GDP 6.Energy Intensity of primary energy 7.Use of renewable energy	**Social Equity** 8.Employment to population ratio 9.Life expectancy gender gap 10.Primary enrolment gender gap 11.Labor force participation 12. Life expectancy at birth 13.Infant mortality rate 14.Access to improved sanitation 15.Access to improved water 16.Access to electricity 17.Gini coefficient on inequality 18.Poverty gap 19.Means year of schooling 20.Primary completion rate 21.Political participation gap	**Economic growth** 22.GDP per capita growth rate 23.Inverse CV of GDP per capita growth 24.Trade openness 25.HH Market Concentration Index 26.Age dependency ratio 27.Adjusted net savings 28.Gross general government debt	
African Green Growth Index (dimensions in bold, themes underlined)	**Monitoring the natural asset base** <u>Land, Forest, Agriculture</u> 1.Arable and Cropland 2.Forest 3.Total protected area	**The socioeconomic context and characteristics of growth** <u>Demographics</u> 12.Population density 13.Population, growth rate,	**The socioeconomic context and characteristics of growth** <u>Economy</u> 31.Real GDP Index	**Gender** 38.Prevalence of HIV (female), 39.Female adults with HIV, 40.Labour force (female), 41.Literacy rate, adult (female),

	Water 4. Water efficiency Disaster Risk 5.Total number of events 1900–2014 6.Total number of people affected 1900–2014 **Environmental and resource productivity** Emissions 7.Production-based CO2 intensity 8.Production-based CO2 emission Energy 9. Energy intensity 10.Renewable energy supply 11.Renewable electricity	14. Population dependency ratio 15.% rural population 16.Employment creation Health 17.Infant mortality 18.Life expectancy 19.HIV/AIDs prevalence 20.Hospital beds 21.Malnutrition prevalence 22.Health expenditure per capita Education 23.Literacy rate, adult 24.Literacy rate, youth Poverty 25.Gini coefficient, 26.Population below $2 Infrastructure and Access 27.Internet Access 28.Access to electricity 29.Access to water 30.Access to improved sanitation facility	32.Agriculture, % GDP 33.Industry, % GDP 34.Services sector, as% GDP 35.GDP per capita 36. GDP growth rate 37.GDP purchasing power parity	42.Seats held by women in national parliaments, 43. Women in ministerial level positions **Governance** 44.Political stability 45. Government effectiveness 46.Regulatory quality 47.Rule of law 48.Control of corruption
Global Green Economy Index	**Environment** 1.Air quality 2.Water 3.Biodiversity and habitat 4.Fisheries 5.Forests 6.Agriculture **Efficiency Sector** 7.Building 8.Transport 9.Energy 10.Tourism 11.Resource Efficiency		**Market and Investments** 12.Renewable Energy investment 13.Cleantech Innovation 14.Corporate Sustainability 15.Green Investment facilitation	**Leadership and Climate Change** 16.Head of State 17.Media Coverage 18.International Forums 19.Climate Change Performance

Note: For a complete description of the variables, refer to the Annex 1.

Another index that used a three-pillar structure was the GEP Index. The composite index aims at expressing the degree of progress made by countries towards greening their economy. UNEP suggests that progress towards achieving the selected indicators promotes the creation of a new generation of capital (natural, physical, human, or social). This capital will serve as the production inputs of environmentally friendly goods and services through consumption, investment, trade, and public spending and is further aimed to simulate the economic transformation needed for reaching the goals of eradicating poverty and sharing global prosperity within planetary boundary limits. Overall, 13 indicators are used to measure progress in achieving the transition towards an inclusive green economy (PAGE 2017). Differing from the IGGI, this index chose to integrate more environmental aspects within the other pillars, specifically in the economic tier such as substituting GDP for green technology innovation and green trade. This portrays a more multi-dimensional concept of green growth that is consistent with the UNEP's definition. Regarding the aggregation of single indicators within the overall index, the GEP weights relatively more such variables where countries are initially starting in a disadvantaged position and the weighting system is country-specific. Furthermore, this index is a part of the GEP Measurement Framework which also includes a 'sustainability dashboard' focused on capturing long term sustainability progress, primarily associated with global planetary boundaries and environmental thresholds. No compensation is allowed within the variables that compose the dashboard of sustainability, which monitors key stocks of capital that are priorities to sustain life on the planet. This reflects the idea that any loss in these key stocks of capital should not be compensated by increasing another stock of capital.

Other institutions have preferred to increase the number of pillars introducing more sub-groups to focus on additional green growth aspects. For example, the GGG Index utilises a four categorical structure, with resource efficiency, natural capital protection, social inclusion and green economic opportunities having a combined total of 36 variables. The GGGI perspective is that these categories collaboratively contribute towards green growth. Specifically, resource efficiency and natural capital protection lead to a productive, sustainable ecosystem while inclusive growth is developed through directing efforts into green economic opportunities and social inclusion (Acosta et al., 2019). The addition of green economic opportunities is like the GEP Index, with both organisations expressing the importance in linking environmental and economic aspects together to achieve sustainable outcomes. Although, out of the 36 indicators only four of these represent green economic opportunities, alluding to a challenge in finding appropriate measurable variables to be used within the index which may be the result of difficulties in separating green economic sectors and investments from traditional economic indicators. Variables within the GGG index are partially substitutable as they are aggregated with a three-level system that ensures that as the level of aggregation increase, the level of substitutability decrease. This reflects the principle that variables within a similar category are substitutable (for example, the share of freshwater withdrawal can compensate a limited water use efficiency). Instead, limited compensation is allowed between variables that belongs to different categories within a pillar or to different pillars (environmental, economic, social).

There are five dimensions encompassed within the AGGI: socio-economic context and characteristics of growth, environmental and resource productivity, monitoring the natural asset base, gender, and governance. Variations in the AGGI from other indices includes dividing the environmental pillar into natural capital (agriculture, water) and economic-environmental

(energy intensity, renewable energy, production-based CO_2) sub-groups as well as incorporating a new pillar that measures indicators related to gender inclusion and government. These areas were chosen by the African Development Bank as the AGGI also was constructed with a strong regional focus and to reflect specific requirements of African countries (Kararach et al., 2016). Additionally, this framework has more social indicators with a greater emphasis on health-related measures, for instance malnutrition or HIV prevalence, health expenditure per capita and number of hospital beds. This highlights a linkage between the AGGI and IGGI where measuring social inclusion may be a higher priority within these international financial institutions. However, linear aggregation among variables allows for a perfect substitutability so a low score in the social pillar can be compensated by higher scores in the economic and environmental ones and vice-versa.

Finally, the GGEI is also an index that focuses on governance indicators within its framework, explaining that political leadership through international forums, policy, and media help to mainstream climate change issues and promotes green investment (Dual Citizen LLC 2014). It varies the most from the other indices by not including any social indicators instead having pillars of efficiency sectors, market and investment, environment, and leadership and climate change. One consideration for this is that GGEI was developed by Dual Citizen and is the only private sector developed index in this analysis. The transition away from the traditional view of green growth may be due to a different demand from stakeholders, which are more focused on sustainability within industry and markets. Another difference is the higher usage of qualitative variables included within the GGEI by accounting for dimensions involving leadership. This was also observed within the AGGI that also had a category for governance). As emphasized within both these indices, this category is important to include when measuring green growth due to the influence governance has on developmental policy implementation and public perception on green growth issues. Though the inclusion of qualitative variables influences the measurability of these dimensions and overall index as they will be affected by bias, as there is no set measurable quality for these types of variables. One way this is has been adjusted within both these indices is through indicator weightings, and discussions with expert stakeholders. Therefore, both the GGEI and AGGI have lower category weights assigned to these qualitative indicators.

From this analysis, it shows the many ways to measure green growth and emphasizes the challenge in accounting for each sustainability tier in conceptual frameworks. As while composite indicators are useful in summarising multi-dimensional realities and are relatively easy to interpret, they unavoidably require some degree of substitutability among variables, even when this should not be the case. One of these shortcomings is masking the inclusion of some green growth dimensions, increasing the difficulty of identifying proper remedial action because of the aggregation of indicator variables (Nardo, M. et al. 2005). As within all the indices, there were issues with balancing dimensions particularly having an equal number of variables across all sustainability pillars that would affect overall aggregated scores. Although there were some examples by UNEP, ADB and GGGI working in the direction of including companion measures to correct the weaknesses of adopting a composite index.

3.2.2 Institutional framework

When selecting the variables to include in their metrics, GGGI, UNEP, and ADB chose to explicitly address the SDGs (Table 5). This involved either opting for data which directly relates to one of the 17 goals proposed at the UN Conference on Sustainable Development, or picking

among the list of variables as a result of the Global indicator framework for the Sustainable Development Goals and targets meeting. These institutions provide detailed tables linking data included in the composite indices with the relative goal. For example, one of the preeminent goals of ADB's work is to measure the sustainable development goals, as they have recognized that many countries have calibrated their development priorities to the SDGs targets. Therefore, one of the overarching principles of the IGGI is to "leave no one behind" aligning to the central tenet of the SDG framework. Specifically, the IGGI can track country performance on 12 out of the 17 SDGs through its 28 measures at the national level.

In the same way, the GGG Index is designed following the SDGs recommendations. As the aim of the GGGI Refreshed Strategic Plan 2015-2020 is to support the GGGI member governments to achieve the commitments expressed in their Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs) (GGGI 2017). In the index structure, this is reflected by the fact that the data included in the GGGI metrics covers 15 out of the 17 sustainable goals. Likewise, UNEP developed its measurement framework with the specific goal of monitoring the SDGs and supporting the measurement and implementation of the 2030 Sustainable Development Agenda. The 13 variables included in the GEP Index cover as many as 14 SDGs. These indices share an additional approach of including the institutional or scientific frameworks by employing internationally recognized sources to define the variables' thresholds. The GGGI and UNEP's indices not only measure the countries performance towards the intended direction of growth, but also calculate the variables' distance from a target. They each do this differently, for example, with GGG Index using a two-step approach which first calculates the score for each variable and then relates them to the selected targets. On the other hand, the GEP Index includes the targets within its metrics in a complex index design which weights variables differently according to the initial distance from the target.

When available, the GGGI further chooses its benchmarks deriving from policies or specific biophysical limits. Their targeting sources include the SDGs principles, the planetary boundaries by Rockström, and the work by the Sustainable Society Index and the United Nations Development Program (Acosta et al. 2019). Similarly, the GEP Index employs internationally recognized scientific sources in targeting its environmental data and adopting thresholds on air pollution from the World Health Organization, material footprint per capita from the work of Bringezu (Possible Target Corridor for Sustainable Use of Global Material Resources) and protected areas from Aichi Biodiversity Targets. Finally, the index follows the planetary boundaries methodology in its Dashboard of Sustainability, with the purpose of acknowledging whether planetary boundaries have been overstepped or not.

Following a different approach, the AGGI, the GGEI, and the OECD indicators do not specifically target the goals or adhere to a specific institutional framework, even if they use many of the same variables of the other indices. Thus, distinguishing them from the other indices. This is especially true for the African Growth Index; whose 48 indicators cover many of the SDGs even though it is not specifically mentioned. While the OECD indicators were designed before the 2015 SDG Rio+ meeting and therefore follow the Millennium Development Goals principles. The Dual Citizen is the only institution within this analysis that does not explicitly comply with any institutional framework.

Table 5 Linkages with SGDs for three indicators

SDGs	Inclusive Green Growth Index (AfDB)	Green Economy Progress Index (UNEP)	Green Growth Index (GGGI)
1. No Poverty. End poverty in all its forms everywhere	Poverty Gap	Pension Coverage, Access to basic services	Income inequality, Pension Coverage
2. Zero Hunger. End hunger, achieve food security and improved nutrition and promote sustainable agriculture			Organic Agriculture
3. Good health and well-being. Ensure healthy lives and promote well-being for all at all age	Life expectancy, Infant mortality, life expectancy gap	Maternal Mortality Ratio, Adolescent birth rate, Life expectancy, PM 2.5, Access to basic services	Healtcare access and quality index, Unsafe Water source
4. Quality education. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for al	Primary completion rate, mean years of schooling, primary education enrollment gap.	Gender Inequality Index, Mean years of schooling	
5. **Gender equality.** Achieve gender equality and empower all women and girls	Political participation gap	Female and male shares of parliamentary seats (Gender Inequality Index)	Seats held by women in national parliaments, Financial institution account (female), Equal gender pays law
6. **Clean water and sanitation.** Ensure availability and sustainable management of water and sanitation for all	Access to improved water and sanitation, water productivity, renewable water resources	Access to water, Access to sanitation	Water use efficiency, Freshwater withdrawal, Unsafe Water source, Access to water and sanitation, urban to rural ratio
7. **Affordable and clean energy.** Ensure access to affordable, reliable, sustainable and modern energy for all	Access to electricity, energy intensity, renewable energy	Access to electricity, Renewable energy sources, Energy use	Access to water and sanitation, urban to rural ratio, Access to water, sanitation and electricity, urban to rural ratio, Renewable energy, Ratio of primary

			energy supply to GDP
8. **Decent work and economic growth.** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for al	Real GDP per capita growth and its coefficient of variation, employment to population ratio, labor force participation gap, age dependency ratio	Trade in environmental goods, Material footprint per capita	Domestic material consumption, Material footprint per capita, Financial institution account (female), Youth not in education, employment or training
9. **Industry, innovation and infrastructure.** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Carbon dioxide emissions		Green Employment in manufacturing, Internet broadband and mobile subscriptions
10. **Reduced inequalities.** Reduce inequality within and among countries	Gini coefficient	Palma ratio, Pension coverage	Equal gender pay laws, Income inequality
11. **Sustainable cities and communities.** Make cities and human settlements inclusive, safe, resilient and sustainable	Air pollution	Air pollution	Air pollution, Population living in slums, Municipal Solid Waste per capita
12. **Responsible consumption and production.** Ensure sustainable consumption and production patterns	Adjusted net savings, natural resources rent	Material Footprint per capita, Green patents	Environmental Exports, Environmental Patents, Adjusted net savings, Tourism and recreation in coastal and marine areas, Organic Agriculture, Material footprint per capita, Domestic material consumption per GDP
13. **Climate action.** Take urgent action to combat climate change and its impacts			CO2 emissions per capita, Non-CO2 emissions per capita, Non-CO2 emissions in

			agriculture per capita
14. **Life below water.** Conserve and sustainably use the oceans, seas and marine resources for sustainable development		Nitrogen emissions, Marine protected areas	Terrestrial and marine protected areas, Share of Key Biodiversity Areas covered by protected areas
15. **Life on land.** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss		Terrestrial protected areas, Land use, Terrestrial protected areas	Share of Key Biodiversity Areas covered by protected areas, Share of forest area, Red list index, Average soil organic carbon content, Soil biodiversity, Terrestrial and marine protected areas
16. **Peace, justice and strong institutions.** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels			
17. **Partnerships for the goals.** Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	Public debt, trade openness, trade dispersion		Internet broadband and mobile subscriptions

Note: For a complete description of the variables, refer to the Annex 1.

3.3 Design Processes

The design process for building a new measure can follow procedures ranging from two extremes (Table 6). On one side of the extreme, some indicators are targeted to the needs and requests of the final users, following a fitness-for-purpose principle open to consultation with stakeholders. On the other side, there are indices whose design is completely internal and guided by strict theoretical principles.

The AGGI undoubtedly falls into the *fitness-for-purpose* category, as it is clearly stated in the pilot version: *"Although simplicity is a key attribute in the development of green growth indicators, it must also be able to capture the imagination of users/stakeholders, in this case the African governments, development agencies (including banks), industry, labour and many others"* (Kararach et al. 2018). The AGGI is very much dependent on the suggestions of a group of qualified experts and panellists, both in the choice of the variables and their weightings. The latter, which in this pilot version have been chosen according to experts 'evaluation due to limited time, is intended to be further refined as the result of a *"consultative process with various stakeholders to capture the diverse context and priorities among member states and sometimes applies advanced statistical methods."*

On the other side of the spectrum, the choices in IGGI have been made through an internal process involving expert economists of the ADB. The methodological process is very rigorous and constructed based on a well-defined narrative. The ADB Report states clearly the principle followed for each step of the design process such as the included variables were selected according to policy relevance, data availability, country coverage, and access to data; equal weighting was chosen for its simplicity, transparency, and broad acceptance. Importantly, each procedural step is supported by careful reporting of the scientific literature on which the choices are based upon. Similarly, the GGEI by Dual Citizen rests entirely in an internal design procedure. The version proposed in the first edition has been built by a group of experts and then constantly revised by adding new variables, without involving external stakeholders or countries. Yet differently from ADB, Dual Citizen does not provide a detailed background for its building process, which appears more subject to experts' individual opinions.

Finally, the GGGI and the UNEP adopt a mixed structure, with GGGI putting more emphasis on the consultative process and UNEP focusing more on defining the principles that the index needs to adhere to. As explained by the GGGI technical report (Gunderson and Anastasia 2018), *"The GGPM Project follows two complementary strategies to enhance policy relevance of the Green Growth Index – stepwise scientific approach and consultative process with stakeholders. The former deals with a rigorous research to understand the complexity and multi-dimensionality of green growth, while the latter entails consultations to understand the national and regional contexts that influence green growth policies."* The final GGG Index design results from a long process of trial and error starting with the design of a pilot version in 2016 which was then submitted to several regional representatives and green economy experts until it reached its definitive structure. The regional workshops involved mostly government officials who work on green growth issues and can competently report their countries' needs and lessons from in-country green growth planning experience. Indeed, the aim of the intense work of regional consultation undertaken by GGGI is to ensure the policy relevance of its new-built indicator. In addition to this, another strand of the consultative process involved the participation of green growth and modelling specialists from international organizations whose expertise was employed for defining the structure of the index itself.

In a different way, the GEP Framework (Index, Dashboard, Ranking) is the outcome of an intense theoretical and methodological effort from experts from UNEP and academia, which results in a complex index design. The choices of included variables and the methodology of aggregation follow a series of careful analytical assumptions. However, before finalizing the index, consultations were done and the report itself is published as part of PAGE – a joint initiative by the UNEP, the International Labour Organization, the United Nations Development Programme, the United Nations Industrial Development Organization and the

United Nations Institute for Training and Research. Moreover, a wide group of experts including the GGKP, the OECD, and other non-government organization representatives were invited to propose comments and suggestions during the two workshops. Their comments and suggestions were considered and translated into structural modification and addition of variables; whose details can be found in the Application Report of PAGE (2013).

Table 6 Different design approaches

In-house	Mixed	Consultative *(fitness for purpose)*
Inclusive Green Growth Index (ADB) Global Green Economy Index (Dual Citizen)	Global Green Growth Index (GGGI) Green Economic Progress Index (UNEP)	African Green Growth Index (AfDB)

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Annex 1 Description of the variables

Global Green Growth Index

1. Ratio of primary energy supply to GDP: Ratio of total primary energy supply to GDP (MJ per $2011 PPP GDP)

2. Renewable energy: Ratio of total primary energy supply to GDP (MJ per $2011 PPP GDP)

3. Water use efficiency: Water use efficiency (USD per m3)

4. Freshwater withdrawal: Share of freshwater withdrawal to available freshwater resources (Percent)

5. Soil organic carbon content: Average soil organic carbon content (Tons per hectare)

6. Organic Agriculture: Share of organic agriculture to total agricultural land area (Percent)

7. Domestic material consumption per GDP: Total domestic material consumption (DMC) per unit of GDP (DMC kg per GDP)

8. Material Footprint per capita: Total Material footprint (MF) per capita (MF tons of capita)

9. Air pollution: PM2.5 air pollution, mean annual population-weighted exposure (Micrograms per m^3)

10. Unsafe Water source: DALY rate due to unsafe water sources (DALY lost per 100,000 persons)

11. Municipal Solid Waste per capita: Municipal solid waste (MSW) generation per capita (Tons per year per capita)

12. CO2 Emissions per capita: Ratio of CO2 emissions, excluding AFOLU to population (Metric tons per capita)

13. Non-CO2 Emissions per capita: Ratio of non-CO_2 emissions excluding AFOLU to population (Tons per capita)

14. Non-CO2 Emissions in agriculture per capita: Ratio of non-CO_2 emissions in agriculture to population (Gigagrams per 1,000 persons)

15. Share of Key Biodiversity Areas covered by protected areas: Average proportion of Key Biodiversity Areas covered by protected areas (Percent)

16. Share of forest area: Share of forest area to total land area (Percent)

17. Soil biodiversity: Soil biodiversity, potential level of diversity living in soils (Index)

18. Red list index: Red list index (Index)

19. Tourism: Tourism and recreation in coastal and marine areas (Score)

20. Terrestrial and marine protected areas: Share of terrestrial and marine protected areas to total territorial areas (Percent)

21. Access to water and sanitation: Population with access to safely managed water and sanitation (Percent)

22. Access to electricity: Population with access to electricity and clean fuels/technology (Percent)

23. Internet and mobiles: Fixed Internet broadband and mobile cellular subscriptions (Number per 100 people)

24. Seats held by woman in national parliament: Proportion of seats held by women in national parliaments (Percent)

25. Financial institution account, female: Ratio of female to male with account in financial institution, age 15+ (Percent)

26. Equal gender pay laws: Getting paid, covering laws and regulations for equal gender pay

27. Income Inequality: (Score) Inequality in income based on Atkinson (Index)

28. Access to water, sanitation and electricity, urban to rural ratio: Ratio of urban to rural, access to safely managed water/sanitation and electricity (Percent

29. Youth not in education, employment or training: Share of youth not in education, employment or training, aged 15-24 years (Percent)

30. Pension Coverage: Proportion of population above statutory pensionable age receiving pension (Percent)

31. Healthcare access and quality index: Healthcare access and quality index (Index)

32. Population living in slums: Proportion of urban population living in slums (Percent)

33. Adjusted Net Savings: Adjusted net savings, minus natural resources and pollution damages (Percent GNI)

34. Environmental Exports: Share of export of environmental goods (OECD and APEC class.) to total export

35. Green Employment in manufacturing: (Percent) Share of green employment in total manufacturing employment (Percent)

36. Environmental Patents: Share of patent publications in environmental technology to total patents (Percent)

Green Economy Measurement Framework

1. Air pollution: PM2.5 pollution mean annual exposure (micrograms per cubic meters)

2. Protected areas (marine and terrestrial): Sum of terrestrial protected area (% of total land area) and marine protected area (% of territorial waters)

3. Volume of freshwater: Freshwater withdrawal (m3 /capita/year)

4. Land Use: Land use (share of land used for permanent crops)

5. Ecological footprint: Ecological Footprint (global hectares/capita)

6. GHG Emissions: Greenhouse gas emissions, excluding land-use change and forestry (CO2e/capita/year)

7. Emission of Nitrogen: Nitrogen emissions (kg/capita/year)

8. Inclusive Wealth Index: Inclusive Wealth Index (millions of constant 2005 US$/capita)

9. Access to basic services: Composite measure created by the average access to three basic services with key social and environmental implications: Access to improved water sources

(% of total population), Access to electricity (% of total population), Access to sanitation facilities (% of total population)

10. Gender inequality: Gender inequality index (A composite measure reflecting inequality in achievements between women and men across three dimensions: (a) reproductive health; (b) empowerment; and (c) the labour market)

11. The Palma ratio: Ratio of the richest 10% of the population's share of income divided by the share of the poorest 40%

12. Pension coverage: Share of population above statutory pensionable age receiving an old age pension, by contribution and sex

13. Education: Average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level

14. Life expectancy: number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life

15. Green trade: Export of environmental goods according to OECD and APEC (% of total export)

16. Green technology innovation: patent publication in environmental technology by filing office (% of total patents)

17. Renewable energy supply: Share of renewable energy supply (of total energy supply)

18. Energy use: Energy use (kg of oil equivalent) per USD 1,000 GDP (constant 2011 PPP)

19. Material footprint per capita: Raw material consumption of used biotic and abiotic materials (tons/person)

Inclusive Green Growth Index

1. Natural resource rent: Natural resource rent (% of GDP)

2. Renewable freshwater resources: Renewable freshwater resources per capita (cubic meters)

3. Water Productivity: Water Productivity (constant 2010 $)

4. Air Pollution: Air pollution (% of population with exposure)

5. CO2 per GDP: CO2 emission per GDP (constant 2010 $)

6. Energy Intensity of primary energy: Energy intensity (mega joule per constant 2011 purchasing power parity [PPP] GDP)

7. Use of renewable energy: Use of renewables (% of total energy consumption)

8. Employment to population ratio: Employment-to- population ratio (%)

9. Life expectancy gender gap: Life expectancy gender gap

10. Education gender gap: Primary education enrollment gap (% points)

11. Labor force participation gap: Labor force participation gap (% points)

12. Life expectancy at birth: Life expectancy at birth (years)

13. Infant mortality rate: Infant mortality rate (per 1,000 live births in a given year)

14. Access to improved sanitation: Access to improved sanitation (%)

15. Access to improved water: Access to improved drinking water (%)

16. Access to electricity: Access to electricity (%)

17. Gini coefficient on inequality: Gini coefficit on inequality

18. Poverty gap: Poverty gap (%)

19. Means year of schooling: Mean years of schooling

20. Primary completion rate: Primary completion rate (%)

21. Political participation gap: Political participation gap (% points)

22. GDP per capita growth rate: GDP per capita growth rate

23. Inverse CV of GDP per capita growth: Inverse coefficient of variation, real GDP per capita growth

24. Trade openness: Sum of exports and imports in percentage of GDP

25. HH Market Concentration Index: Hirschman-Herfindahl ndex

26. Age dependency ratio: Percentage of people younger than 15 or older than 64 to the working-age population

27. Adjusted net savings: Adjusted net savings (% of gross national income [GNI])

28. Gross general government debt: Public debt (% GDP)

African Green Growth Index

1. Arable and Cropland: Arable and cropland, % total land area

2. Forest: Forest, % total land area

3. Total protected area: Total protected area (marine and terrestrial)

4. Water efficiency: Water efficiency (water withdrawals per capita) (m3 per capita per annum)

5. Total number of events 1900−2014: Total number of events 1900−2014

6. Total number of people affected 1900−2014: Total number of people affected 1900−2014

7. Production-based CO2 intensity: Production-based CO_2 intensity, tonnes per capita

8. Production-based CO2 emission: Production-based CO_2 emissions, index 1990=100

9. Energy intensity: Energy intensity, tons per capita

10. Renewable energy supply: Renewable energy supply, % TPES (Total Primary Energy Supply)

11. Renewable electricity: Renewable electricity, % total electricity generation

12. Population density: Population density, inhabitant per km2

13. Population, growth rate: Population, growth rate

14. Population dependency ratio: Population, dependency ratio

15. % rural population: % rural population

16. Employment creation: Employment creation (economically active employed to those in the cohort)

17. Infant mortality: Infant mortality

18. Life expectancy: Life expectancy

19. HIV/AIDs prevalence: HIV/AIDs prevalence (Age 15–49)

20. Hospital beds: Hospital beds

21. Malnutrition prevalence: Malnutrition prevalence (weight)

22. Health expenditure per capita: Health expenditure per capita

23. Literacy rate, adult: Literacy rate (adult education)

24. Literacy rate, youth: Literacy rate (youth)

25. Gini coefficient: Gini coefficient

26. Population below $2: Population below $2

27. Internet Access: Internet Access

28. Access to electricity: Access to electricity (% of households with access)

29. Access to water: Access to water (access to improved water source)

30. Access to improved sanitation facility: Access to improved sanitation facility

31. Real GDP Index: Real GDP, Index 1990=100

32. Agriculture, % GDP: Agriculture, % GDP

33. Industry, % GDP: Industry, % GDP

34. Services sector, as% GDP: Services sector, as% GDP

35. GDP per capita: GDP per capita

36. GDP growth rate: GDP growth rate

37. GDP purchasing power parity: GDP purchasing power parity

38. Prevalence of HIV (female): Prevalence of HIV, female (% ages 15–24)

39. Female adults with HIV: Female adults with HIV (% of population ages 15+ with HIV)

40. Labour force (female): Labour force, female (% of total labour force)

41. Literacy rate, adult (female): Literacy rate, adult female (% of females ages 15 and above)

42. Seats held by women in national parliaments: Proportion of seats held by women in national parliaments (%)

43. Women in ministerial level positions: Proportion of women in ministerial level positions (%)

44. Political stability: Political stability and absence of violence/terrorism

45. Government effectiveness: Government effectiveness

46. Regulatory quality: Regulatory quality

47. Rule of law: Rule of law

48. Control of corruption: Control of corruption

Global Green Economy Index

1. Air quality: Measures population weighed exposure to fine particulate matter and percentage of the population burning solid fuel for cooking

2. Water: Tracks how well countries treat wastewater from households and industrial sources before releasing it back into the environment

3. Biodiversity and habitat: Assesses countries' fishing practices - both the use of heavy equipment and the size of the catch

4. Fisheries: Assesses countries' fishing practices - both the use of heavy equipment and the size of the catch

5. Forests: Measures the loss in forest area from 2000 to present using satellite-derived data

6. Agriculture: Assesses policies related to the effects of intensive agriculture, specifically nitrogen use efficiency and nitrogen balance

7. Building: LEED certification of commercial building

8. Transport: Emissions from transport and 10-year trend

9. Energy: Renewable electricity as a percentage of national total

10. Tourism: Ranking of national tourism ministry efforts

11. Resource Efficiency: National recycling rates

12. Renewable Energy investment: Country attractiveness for RE investment

13. Cleantech Innovation: Business climate for cleantech innovation

14. Corporate Sustainability: Adoption of sustainability reporting by top 3 national companies (market

capitalization)

15. Green Investment facilitation: National efforts to faciliate green investment

16. Head of State: Head of State's advocacy for green issues

17. Media Coverage: Positive media coverage of national green economy

18. International Forums: National positions & statements in international forums

19. Climate Change Performance: Performance on climate change (emissions per capita, emissions per unit GDP, emissions per unit primary energy)

GGPM Working Paper Series

Working Paper No. 1 Measuring performance in achieving Sustainable Development Goals to protect natural capital (January 2020)

Working Paper No. 2 Building a global framework for green growth based on comparative assessments of green growth indices and expert opinions of policy makers (March 2020)

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