PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

INDICATORS FOR AN INCLUSIVE GREEN ECONOMY

2020 MANUAL FOR ADVANCED TRAINING

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Advanced Training on Measuring Progress with Green Economy Indicators

You may already have taken the Introductory Training on Green Economy Indicators that introduced the use of indicators for measuring the state of a society in terms of an Inclusive Green Economy (IGE). While the Introductory Training essentially described static, cross-sectional measurement systems, this training focuses on measuring progress over time toward an IGE. This course builds on the concepts and processes described in the Introductory Training. It focuses particularly on the application of the Partnership for Action on Green Economy's (PAGE) Green Economy Progress (GEP) Measurement Framework. The GEP Measurement Framework has been supported by PAGE and developed by its partner UN agency, the United Nations Environment Programme (UN Environment). This framework provides a methodology for comparing performance on IGE over time.

The GEP Measurement Framework makes several important perspectives on measuring progress toward an IGE possible. First, it describes how progress (or regress) on a single indicator can be measured. Second, it provides a method for combining multiple indicators of progress into the GEP Index, a weighted aggregate measure of progress to improve human well-being. Third, it creates the Dashboard of Sustainability, which presents a small number of crucial indicators on the sustainability of key stocks of natural and social capital. The Dashboard indicators monitor where efforts to improve human well-being approach stand relative to planetary boundaries: Do they remain within these boundaries, or are they overstepping them?

The GEP Measurement Framework is designed as a tool for countries to gauge their progress and monitor policy impacts. Countries can choose indicators that reflect their priorities, in accordance with their own narrative of an IGE. The Framework may also be used across countries for international benchmarking.

This course closes with a detailed look, in sessions 4 and 5, at the global application of the GEP Measurement Framework, conducted to test the methodology as well as to provide a global overview and to compare where countries stand on IGE progress.

Intended learning outcomes of the advanced course

- Participants understand in depth the concepts, methodology and application of the GEP Measurement Framework.
- Participants can systematically select indicators for a customized country application.
- Participants understand how countries' progress can be compared in a global application of the GEP Measurement Framework.
- Participants can simulate application of the GEP Measurement Framework during a tailored application.

The global application compares the periods 2000–2004 and 2010–2014 in 105 countries:

- For individual indicators, on average, countries made the greatest progress in reducing energy use and gender inequality, improving education and increasing life expectancy. Progress has been less in areas such as material footprint and air pollution. Indeed, in many countries these indicators have regressed.
- Overall, for the GEP Index, 83 of the 105 countries achieved progress. Countries in the Middle East and North Africa and in South Asia made the most progress but started from a lower point than countries in other regions. Countries in East Asia and the Pacific region suffered the most regress.
- In contrast to general progress made on the GEP Index, the Dashboard of Sustainability shows that, on average, countries' sustainability indicators have regressed and often overstepped planetary boundaries.

The course consists of five sessions and a group exercise. It usually takes 10–15 hours.

Slides highlighting the main points covered in this manual are available for review and presentation at (https://www.un-page.org/resources/green-economy-learning/training-manuals-indicators-green-economy-policymaking).

Session 1. Concepts in Measuring Green Economy Progress

- Moving "beyond GDP"
- Building a better measure of progress

Session 2. The Green Economy Progress (GEP) Measurement Framework – Methodology

- Individual and multi-dimensional views
- Four objectives of the GEP Measurement Framework
- Measuring progress in the single indicator case
- Targets and thresholds
- Measuring progress in the multidimensional case: the GEP Index
- The necessity of a dashboard
- Aggregating the information from the Dashboard and the GEP Index to create the GEP+ ranking

Session 3. Selecting Indicators for Country-level Applications

- Introduction
- Salience
- Parsimony (similarity matrix)
- System-wide influence

Session 4. Indicators for the Global Application of the GEP Measurement Framework

- A demonstration: the global application
- Indicators for the global application: selection criteria
- Mapping the choice of indicators with the Inclusive Green Economy narrative
- Components of the GEP Index
- Dashboard of Sustainability indicators
- Indicators for which increases promote progress ("goods") and indicators for which decreases promote progress ("bads")
- Targets and thresholds

Session 5. Results of the Global Application of the GEP Measurement Framework

- Results for progress in the single indicator case
- The GEP Index: measuring progress in the multidimensional case
- The Dashboard of Sustainability: measuring progress against planetary boundaries
- GEP+: overall country ranking using the GEP Index and the Dashboard of Sustainability

Session 1. Concepts in Measuring Green Economy Progress[1]

Key points

- A measure of well-being that improves upon GDP would track both current flows of consumption (and other sources of well-being) and the sustainability of those sources for future well-being.
- Well-being can be considered sustainable if future generations enjoy well-being at least as great as that of this generation.

Moving "beyond GDP"

Measuring human progress and its sustainability is a challenging task, fraught with myriad statistical and real-world complexities.

The most widely used method to evaluate economic progress is the Gross Domestic Product (GDP). However, as is well known, GDP paints an incomplete picture of well-being – for several reasons.

First, GDP tracks aggregate economic activity; it is insensitive to the distribution of the gains and losses of economic activity across the individuals in society. Second, it is not adjusted for the depletion of existing natural, physical, human and social assets. Third, it does not track factors that matter for well-being but lie outside of the sphere of market transactions.

Some of what GDP tracks does not matter for well-being, and some of what matters for well-being is not tracked by GDP. Moreover, even those parts that "matter" for human well-being (e.g., higher income and consumption, more years of education and better health) are evaluated "on average" and without regard to their distributional characteristics or their sustainability. One quickly arrives at the conclusion that, rather than try to "repair GDP" to correct for these faults, we need entirely different measures to evaluate societal well-being.

> The search for alternatives to GDP has expanded greatly through the availability of new data and methodologies.

The first global Human Development Report in 1990 introduced the Human Development Index (HDI) as an alternative to GDP that puts people at the centre. The HDI has since become a widely used measure of human progress that is better connected to the lives of people than GDP.

The search for alternatives to GDP for measuring progress has expanded greatly through the availability of new data and methodologies, including subjective measures of human wellbeing. The Better Life Initiative, developed by the Organisation for Economic Cooperation and Development (OECD), is among the efforts to better understand what is important to people's lives. OECD has been particularly influenced by the Stiglitz–Sen–Fitoussi Commission (2010), which concluded that a broader range of indicators of wellbeing and social progress should be used alongside GDP. The Report of the United Nations Secretary-General's High-level Panel on Global Sustainability (2012) also emphasized that the international community should measure development beyond GDP, and it recommended

[1] José Pineda prepared this session.

the creation of a new index or set of indices that incorporates elements of sustainability.

Building a better measure of progress

The task of developing and testing such measures belongs to the field of welfare economics, the subfield of economic theory that encompasses social choice theory, the theory of fair allocation and cost-benefit analysis. The exercises carried out in this field are heavily subjective, by necessity. There are often difference views regarding how to carry out those measurements, depending on philosophical positions about what matters most for well-being.

In principle, however, one can identify relatively simple and uncontroversial ethical postulates that a measure of wellbeing should satisfy. These principles would underpin the desired measure $W(t)$. Think of $W(t)$ as a function $W(y(t))$ that depends on a profile of consumption flows (or other sources of well-being), $y(t)$, for the individuals belonging to generation t.

Alongside such a measure, one would want a second measure, $dV^*(t)$, to track the sustainability of such well-being. Imagine that, apart from agreement that W is the proper indicator of generational well-being, there is also agreement that intergenerational well-being can be evaluated via the function

$$V(y) = \int_t^{\infty} W\big(y(\tau)\big)\, e^{-\mu(\tau-t)} d\tau \qquad [1]$$

where $\mu>0$ reflects either the risk of extinction of mankind or a discount factor on future generations. This formula calculates a discounted sum of the measures of well-being of different generations. This certainly is not the only way to aggregate intergenerational well-being and to account for extinction risk, but debating this is not crucial for our purposes.

The evolution of the consumption flows $y(\tau)$ for the members of each generation τ, starting with generation t, depends on what happens to key physical, natural and other stocks $K(\tau)$. Then, given an initial condition $K(t)$ for those stocks, one can compute a projected joint trajectory for these consumption flows and stocks. If we denote such a trajectory for the consumption flows by $y^*(K(t))$,we can evaluate intergenerational well-being along such a trajectory by replacing the value of those consumption flows in expression [1] as follows: $V(y^*(K(t)))$, which for simplicity we can call $V^*(t)$. Let us now compute the change, $dV^*(t)$, in such an intergenerational evaluation as follows:

$$dV^*(t) = \sum_j \frac{\partial V^*}{\partial K_j(t)} \cdot dK_j(t) \qquad [2]$$

where $\frac{\partial V^*}{\partial K_k(t)}$ tracks how a change in stock k affects intergenerational well-being, and $dK_j(t)$ tracks the change in stock j for generation t. Notice that expression [2] is a weighted sum of the changes in the set of relevant stocks, where the weights correspond to the importance of each of those stocks for intergenerational well-being.

Present well-being $W(t)$ can be said to be sustainable if future generations experience well-being that is at least as great as that enjoyed by the current generation, that is, if $W(\tau)$ is at least as large as $W(t)$ for the members of each generation τ following generation t. If present well-being $W(t)$ is sustainable, then $dV^*(t)$ is positive.

> Well-being is *sustainable* if future generations experience well-being at least as great as that enjoyed by the current generation.

In other words, we establish that, if $dV^*(t)$ is negative, then present well-being $W(t)$ is not sustainable. A future generation will necessarily have a level of well-being below that of the present generation, $W(t)$.

Thus, the ideal set of indicators for a comprehensive evaluation of a country's current economic situation and its sustainability might be the profile.

$$\langle GDP, W(t), dV^* \rangle$$

To see how this profile could be used in practice, let us look at its expected behaviour in the case of an unexpected negative shock to physical capital. If the economy increases its work intensity to try to compensate for lost capital, this effort will register as more GDP, but the W index will drop, "sending the correct message that the initial catastrophe was definitely not a blessing. However, under this kind of reaction, the dV^* index can correctly tell us that, thanks to this temporary effort, sustainability is not threatened: The current generation pays its share of the bill generated by the catastrophe." (Fleurbaey and Blanchet 2013, p. 60)

If, instead, the economy does not try to reconstitute its lost capital and aims instead to maintain its pre-catastrophe standard of living, as measured by W then the resulting message sent can be a decrease in economic activity, as measured by GDP, due to the fact that there is less capital available for production. Then, the sustainability of the level of well-being W depends on whether, before the shock, the economy was above a strictly sustainable path. If, however, the economy was close to strict sustainability and the shock is large, then the dV^* index would tell us that the level W is no longer sustainable. "This is the correct expression of the fact that the bill will have to be paid, sooner or later." (Fleurbaey and Blanchet 2013, p. 60)

As attractive as all this sounds, we face serious practical difficulties in the computation of the panel $\langle GDP, W(t), dV^* \rangle$. Even if we were to include in the GDP measure all that we ought to include, and if we were agreed on a methodology for calculating the well-being index W, we still face multiple layers of uncertainty that make it very difficult to accurately calculate dV. We cannot escape the fact that assessing sustainability is predicting the future.

> In assessing sustainability, we face not only a measurement problem but also a forecasting problem.

We face not only a measurement problem, but also a forecasting problem.

We learn, however, from this theoretical exercise that at the very least we ought to be:

(D1) identifying as many of the ingredients that matter for present well-being in order to estimate the extent to which countries are making progress in their levels of well-being;

(D2) identifying as many of those assets that matter for future well-being, their current stocks and the measurement of how they evolve over time;

(D3) equipped, where possible, with relevant information about what we think to be critical thresholds for the stocks of those assets;

(D4) prepared with the understanding that it will be nearly impossible to combine all these into a synthetic indicator of sustainability, or of sustainable development, in a manner that will satisfy all constituents (Fleurbaey and Blanchet, 2013, p. 249).

These four elements, D1 through D4, which we call the basic desiderata in what follows, become the starting point for building the Green Economy Progress (GEP) Measurement Framework.

> A minimal requirement for gauging sustainability is to know the threshold quantity of stocks needed to maintain well-being at current levels.

The logic behind the desiderata is the following: D1 is about identifying the profile of consumptions flows, $y(t)$, that matter in the evaluation of present well-being. D2 is about the identification of the changes in the relevant stocks, $dK_j(t)$, critical for the computation of any indicator of sustainability dV^*. Ideally, we would have for each such stock that would enter into the computation of dV^*, a measure of how the stock affects intergenerational well-being. But, since this is bound to be difficult to obtain, a minimal requirement would be to know the thresholds for those stocks below which their marginal intergenerational value would be very high or very low. This is the rationale behind D3. To see the rationale behind D4, we note that technological, ethical and environmental uncertainties make precise calculation of dV^* very difficult. "Doubts about our ability to build an all-purpose scalar index of sustainability are too strong…. This suggests concentrating efforts on a well-defined set of warning indicators covering separately the various dimensions of sustainability" (Fleurbaey and Blanchet 2013, p. 249). The GEP Measurement Framework does this with the Dashboard of Sustainability (see Session 2, section VI).

Resource: Herrero et al. 2018.

Review and discussion questions for Session 1

- Why is GDP unsatisfactory for measuring society's well-being?
- Why should sustainability be included in a measure of well-being?
- What is the meaning of a threshold value of a natural stock?

Session 2. The Green Economy Progress Measurement Framework – Methodology[2]

Key points

- The GEP Measurement Framework focuses on change over time, asking whether countries are making progress against targets or regressing, given critical sustainability thresholds.
- The Framework allows for measuring progress on individual indicators and also aggregates indicators, weighted to emphasize those needing the most improvement, into the **GEP Index**.
- In the Framework methodology, countries have *targets* that will move them toward, or keep them progressing on, the right side of sustainability *thresholds*.
- The **Dashboard of Sustainability** reports where indicators of certain crucial stocks stand relative to planetary boundaries, thus complementing the GEP Index.
- Information from the GEP Index and weighted Dashboard indicators can be aggregated into the **GEP+ country rankings**.

I. Individual and Multi-dimensional Views

Two preliminary considerations must be flagged before presenting the theoretical framework for the Green Economy Progress (GEP) Measurement Framework. First, it is not possible to quantify everything that ideally should be measured. Second, not all measurable variables can be reasonably aggregated into a single number. These considerations imply that indices can provide only a partial estimate of the performance that we wish to evaluate. Complementing a single index number with a dashboard of other indicators might be the most useful approach. A comprehensive index (e.g., the Human Development Index) may help paint a synthesized picture of how certain aspects of interest are evolving as a whole. In contrast, a dashboard of indicators only provides complementary information to complete the picture painted by the index (see section VI).

The theoretical framework of GEP Measurement Framework looks at progress in two ways: green economy progress on single indicators and multidimensional green economy progress through the GEP Index. Progress on a single indicator measures country achievements for that particular indicator and, thus, informs the country of its performance in one particular area of development. By comparison, the GEP Index measures progress in the transition towards an Inclusive Green Economy (IGE) by aggregating individual progress across dimensions and weighting the results to make the index comparable among and within countries.

The Framework looks at progress in two ways – through single indicators and through the GEP Index.

[2] José Pineda prepared this session.

The particular value of the GEP Index is that it:

1. **identifies key dimensions** associated with an IGE, each of which may be approximated by one or several variables;
2. **focuses on progress** made, i.e., the changes rather than the levels; and
3. measures progress relative to some standards, i.e., **targets and thresholds**. ("Targets" refer to desired changes, whereas "thresholds" define critical levels.)

The GEP Index refers to the evolution of the green components in economic process measures rather than to sustainable growth or human development (as measured by the Human Development Index, for example). This emphasis involves some radical choices, in particular putting GDP aside as a reference variable and instead substituting green components, such as green trade or green innovation.

The GEP Index relies on quantitative measures rather than on market values for its key inputs. There are two reasons for this. First, using market prices to value the elements under consideration is not adequate because market prices reflect demand and supply forces, which are clearly dominated by developed and large emerging countries. Second, in any case, most green economy variables refer to goods and services for which there are no well-established markets.

Resource: PAGE 2017a

FOUR OBJECTIVES OF THE GEP MEASUREMENT FRAMEWORK

The GEP Measurement Framework intends to achieve four objectives:

The first objective is to **contribute to monitoring progress in implementing the sustainable development goals (SDGs)** through direct links with selected SDGs. It will help to monitor progress toward specific SDG targets and support measurement and implementation of the 2030 Sustainable Development Agenda.

Four objectives of the GEP Measurement Framework

1. Help monitor progress toward the SDGs
2. Assess national progress
3. Inspire and inform policymaking
4. Compare countries

The second objective is to **assess progress towards national goals in priority areas**. The framework allows countries to include national indicators and targets in their "customized GEP" measurement framework to track progress in specific areas. The GEP Measurement Framework can serve as a signal to countries to change their development paths by designing or reforming national policies to promote the transition to an IGE. By tracking their green economy progress over time, countries can evaluate how fast they are able to achieve specific targets and so measure the speed of their movement towards an IGE.

Third, the GEP Measurement Framework **brings transparency and accountability to policymaking** and draws public attention to sustainable development challenges and highlights the importance of achieving progress in an integrated manner across a range of IGE concerns. It can reveal both the challenges in reducing reliance on carbon fuels and the opportunities to become resource-efficient and socially inclusive. Thus, it may serve to inspire policymakers and to galvanize civil society to push for more ambitious IGE agendas. It may also help policymakers to identify policy gaps where more resources are required to increase the speed and scope of making their economies greener and more inclusive.

Finally, when applied across countries, the GEP Measurement Framework can **compare countries' efforts** toward the transition to an IGE. The GEP Measurement Framework helps countries assess where they stand, relative to other countries, in key IGE areas.

MEASURING PROGRESS IN THE SINGLE INDICATOR CASE

The GEP Measurement Framework uses a set of green economy indicators to measure progress against targets. Progress is measured for each individual indicator and, where there is valid policy substitutability (e.g., when progress in an area can compensate, even partially, for regress in another area), each of these indicators is aggregated into a composite index across dimensions, the GEP Index (see section V of this session).

> Each **individual** indicator is measured as the ratio between the actual change observed and the desired change.
>
> In the **multidimensional** case, progress is measured by aggregating progress across indicators for each country into the composite GEP Index.

Green economy progress on each individual indicator is measured as the ratio between the actual change observed and the desired change with respect to a target for that indicator. Green economy progress in the multidimensional case is measured by the aggregation of progress across indicators for each country into a composite index. This index provides an overall picture of progress achieved by each country and allows cross-country comparisons within peer groups of countries. For a meaningful comparison across indicators within a country and across countries, a weighting system combines progress across different indicators and emphasizes the areas most in need of improvement. This is, in essence, the GEP Index.[3]

To define progress formally, let us suppose initially that progress is evaluated for only one country based on a single indicator. Focusing on progress amounts to defining achievements and targets in terms of changes. Note that the effect on the measure of progress in the case of "goods" and "bads" will be different: Increasing the amount of a "good" will increase the measure of progress, whereas increasing the amount of a "bad" will decrease it.

Let y^1,y^0 stand for the current and the initial reference values of the variable that approximates the dimension under consideration, and let $dy = y^1 - y^0$. Progress (p) with respect to the initial reference value is defined as follows:

$$p_{goods}(y^1, y^0) = \frac{dy}{y^0}, \; p_{bads}(y^1, y^0) = \frac{d(-y)}{y^0}$$

Progress in this dimension is simply the corresponding rate of growth or reduction of the variable.

Now, let y^* denote the desired value of the variable, and call $dy^* = y^* - y^0$. Then, the **target** will be given by:

$$s_{goods}(y^*, y^0) = \frac{dy^*}{y^0}, \; s_{bads}(y^*, y^0) = \frac{d(-y^*)}{y^0}$$

Therefore, applying the evaluation formula in this special case gives the following expression of progress:

$$Progress = \begin{cases} \frac{p_{goods}(y^1, y^0)}{s_{goods}(y^*, y^0)} = \frac{dy}{dy^*} = \frac{y^1 - y^0}{y^* - y^0} \\ \frac{p_{bads}(y^1, y^0)}{s_{bads}(y^*, y^0)} = \frac{d(-y)}{d(-y^*)} = \frac{y^0 - y^1}{y^0 - y^*} \end{cases} \quad [3]$$

That is, progress in the single indicator case corresponds to the ratio of the actual to the desired increments (for the case of "goods") or reductions (for the case of "bads"). The progress measure for "bads" is obtained by reversing that of the "goods", both in the numerator and in the denominator.

The progress function is increasing and linear in y^1 for the case of "goods" and decreasing and linear in y^1 for the case of "bads". The derivative of the progress function with respect to y^0 is positive when $y^1 > y^*$ and negative otherwise. Trivially, the function is decreasing in y^*. The index is above or below 1 depending on whether actual progress is above or below the target. It is negative in the case of regress (see box below).

[3] See PAGE (2017a), Annex I.A for a discussion of properties in the basic model and a proof of the characterization result.

For change over time, an index value of "0" means no change, so the indicator stayed at the initial state, and "1" means that the indicator reached its target. Thus:		
Index = 1	*means*	the target was met.
Index >1	*means*	the target was exceeded.
Index >0 and <1	*means*	progress was made but the target was not met.
Index = 0	*means*	the situation did not change.
Index <0	*means*	regression occurred.

International comparisons for each indicator can be made directly by comparing either countries' rates of achievement or their progress made on each indicator. How progress is calculated for a particular case will be discussed in Session 5, section II, with the specific example of Colombia.

TARGETS AND THRESHOLDS

Progress is synonymous with moving in the "right" direction; therefore, any observed change in an indicator will be assessed against both a target and a threshold. A target is a goal to be pursued, while a threshold is a limit not to be exceeded. Both can be set at the country level. (The global application described in Session 4, section VII suggests one way to set them.)

A **target** is a goal to be pursued, while a **threshold** is a limit not to be exceeded.

Note that in this framework the threshold, denoted by t, plays no apparent role. Progress for any indicator is simply the ratio between actual and desired change. Therefore, the choice of y^*, the target, is an important decision of the evaluation protocol.

There is a way to combine these two aspects, the choice of the target and making the threshold do play a role. It is the following in the case of "goods":

$$y^*=max\{t,\lambda y^0\},\lambda>1$$

It is the following in the case of "bads":

$$y^*=min\{t,\beta y^0\},\beta<1$$

Notice that λ is the desired proportion by which we would like the indicator to grow (this is why is greater than 1), given that it is a good. In contrast, β is the desired proportion by which we would like the indicator to decrease (this is why is lower than 1), given that it is a bad. This formulation indicates that countries must pursue a desirable change, or target y^*, set to keep them, or put them, on the "right" side of the threshold (or, at a minimum, a target of reaching the threshold). For "goods" countries should never be below the threshold in the final period, whereas for "bads" they should never be above the threshold in the final period. Even if countries are already on the "right" side of the threshold, they should still be making progress, and λ and β need to be determined (see Session 4, section VII).

Even if countries are already on the "right" side of the threshold, they should still be making progress.

This formulation provides a method of setting targets in which the threshold is a relevant element. The rationale of this method of defining y^* is the following: In the case of "goods", any reasonable target can be expressed as $y^*=\lambda y^0$, with $\lambda>1$ (i.e., an increase in the initial value of the variable). This is appropriate as long as $\lambda y^0>t$, i.e., when a country is above the threshold. Otherwise, one should require that $y^*=t$, as t is the minimum admissible value. In other words, for "goods", if a country is initially below the threshold and multiplying this value by more than 1 still results in a value lower than the threshold value, then the target for this country should be to at least reach the threshold.

In the case of "bads", the reasoning is symmetrical. A target takes the form $y^*=\beta y^0$, with $\beta<1$ (i.e., a decrease in the initial value of the variable). This is appropriate provided that $\beta y^0 < t$, i.e., a country is below the threshold. Otherwise, one should require that $y^* = t$, as t is the maximum admissible value.

Once the target is formulated this way, the following expression is obtained:

$$Progress = \begin{cases} \frac{dy}{dy^*} = \frac{y^1 - y^0}{max[t, \lambda y^0] - y^0}, \ \lambda > 1 \\ \frac{d(-y)}{d(-y^*)} = \frac{y^0 - y^1}{y^0 - min[t, \beta y^0]}, \ \beta < 1 \end{cases} \qquad [3']$$

The function of progress is always increasing and linear in y^1 in the case of "goods" and decreasing and linear in y^1 in the case of "bads". The derivative of progress with respect to y^0 depends on whether $y^* = t$ or $y^* = \lambda y^0$, but in either case it is negative in the case of "goods" and positive in the case of "bads", whenever $y^* \neq t$ (i.e., in the case of "goods", lower initial values yield a higher value of "Progress" for each given progress). When $y^* = t$, the derivative of "Progress" with respect to y^0 is positive if $y^1 > t$, zero if $y^1 = t$ and negative otherwise. In other words, crossing the threshold in the right direction pays a dividend. Trivially, "Progress" is decreasing in y^* in the case of "goods" and increasing in the case of "bads".

The index is a positive number in the case of progress and negative in the case of regress. It takes on a value above or below 1 depending on whether actual progress is above or below the target. That is, when the index is equal to 1, this means the country has met its target. When it is greater than 1, the country has exceeded its target. For a single indicator, any progress made can be compared across countries by simply comparing the progress functions, keeping in mind that different countries may have different targets. This means that comparisons with other countries can always be made, given the common element provided by the threshold.

When the index is equal to 1, this means the country has met its target. When it is greater than 1, the country has exceeded its target.

MEASURING PROGRESS IN THE MULTIDIMENSIONAL CASE: THE GEP INDEX

The GEP Measurement Framework combines indicators with weak sustainability into the GEP Index. That is, progress on one of these indicators might compensate to some extent for regression on another indicator. For example, within the GEP index, for a given set of weights, a positive value in one or many of the indicators could be enough to compensate for a negative value in another indicator; this implies that there is substitution across indicators.

For a composite index, such as the GEP Index, a normative weighting system helps make the index understandable and relevant to policymaking. The normative weighting system must not only recognize that all indicators are potentially of equal importance, but it must also take into account local and global contexts that may make some indicators more important than others. The requirement for policy relevance, both locally and globally, adds complexity to the weights but increases the usefulness of the index in setting policy priorities. The complexity comes from the combination of two competing forces: (i) the need for flexibility of weights in order for them to be different for each country, depending on local characteristics, and (ii) the need for comparisons along the different dimensions of the data across indicators and across countries – that is, for comparisons of each indicator across countries, across indicators within a country and the combined comparison. The GEP Index resolves this complexity with a weighting system that allows progress to be analyzed for each particular indicator in all three dimensions – across countries, across indicators within a country and overall across countries.

Now let:

$$p_{goods}(\cdot) = \frac{dy_j}{y_j^0} = \frac{y_j^1 - y_j^0}{y_j^0}, \qquad p_{bads}(\cdot) = \frac{d(-y_j)}{y_j^0} = \frac{y_j^0 - y_j^1}{y_j^0}$$

where sub-index j refers to a particular indicator, $j \in J$, where $J = G \cup B$ is the set of indicators, consisting of "goods", G, and "bads", B (with the understanding that $G \cap B = \emptyset$).

The weighting used to construct the GEP Index is performed in two steps. A first weighting is applied to $Progress$ $(\frac{dy_j}{dy_j^*})$ (in the case of "goods" and $\frac{d(-y_j)}{d(-y_j^*)}$ in the case of "bads" to give greater weight to the progress of countries that are on the "wrong" side of the threshold (below the threshold for "goods" and above the threshold for "bads"). Consequently, for each indicator the corresponding weight $\hat{\pi}_j$ is set as the ratio between the initial level of the variables y_j^0 and threshold t_j:

$$\hat{\pi}_j = \begin{cases} \frac{t_j}{y_j^0}, & if\ j \in G \\ \frac{y_j^0}{t_j}, & if\ j \in B \end{cases}$$

The GEP index gives greater weight to the progress of countries on the "wrong" side of the threshold.

This formulation gives more weight to progress in countries that are starting at a disadvantaged position on an indicator with respect to the threshold but are making efforts to overcome such a situation.[4] It also provides countries with an initial idea of where to place priorities. (The more the country is in a disadvantaged initial position vis-à-vis the relevant threshold (that is, the higher $\frac{t_j}{y_j^0}$), the more weight given to change in the indicator.) This weighting can be interpreted as an incentive to focus on improving those indicators in which a country is relatively worse off (i.e., further from the threshold).

Applying the model in the case of different weights for different indicators, the following expression for the (not yet normalized) GEP Index is obtained:

$$GEP = \sum_{j \in G} \hat{\pi}_j \frac{dy_j}{dy_j^*} + \sum_{j \in B} \hat{\pi}_j \frac{d(-y_j)}{d(-y_j^*)} \qquad [4]$$

The second step in the weighting is to normalize (or re-weigh) the $\hat{\pi}_j$ to obtain the weights, π_j, that take into consideration the importance of progress in one indicator vis-à-vis the others. This reweighting will indicate the relative importance of one indicator compared with the others and enables aggregation of indicators within a country (to create the GEP Index) as well as comparison of results across countries and across indicators within a country.[5] Let π_j denote the weight attached to indicator j in the aggregate composite GEP Index, with $\sum_{j \in J} \pi_j = 1$.

Normalized weights then are defined as follows:

$$\pi_j = \frac{\hat{\pi}_j}{\sum_{j \in J} \hat{\pi}_j}$$

Finally, the following expression for the GEP Index is obtained:

$$GEP = \sum_{j \in G} \pi_j \frac{dy_j}{dy_j^*} + \sum_{j \in B} \pi_j \frac{d(-y_j)}{d(-y_j^*)}$$

This is equivalent to the expression (after substituting the expression for the normalized weights):

$$GEP = \frac{1}{\sum_{j \in G} \frac{t_j}{y_j^0} + \sum_{j \in B} \frac{y_j^0}{t_j}} \times \left[\sum_{j \in G} \frac{t_j}{y_j^0} \frac{dy_j}{dy_j^*} + \sum_{j \in B} \frac{y_j^0}{t_j} \frac{d(-y_j)}{d(-y_j^*)} \right] \qquad [4']$$

The double weighting system allows the GEP Index both to assess how far a country is from the threshold and to evaluate the relative importance of one area (indicator) with respect to the others from the country's perspective. This is a real advantage of the GEP methodology, because it informs national and global action. As time passes and the country's situation evolves, weights in the GEP Measurement Framework will adjust to reflect the new set of priorities. This feature makes the GEP Index (compared with indexes with fixed/common weighting for all countries) well-suited to support policy design and monitoring.

4 It is important to note that, for a country experiencing regress in an indicator in which it is initially already disadvantaged with respect to the relevant threshold, this weighting system will give that regress significant weight. In other words, the weighting system provides signals on policy priorities.

5 The first weighting indicates the relevance of the progress made in each of the areas, as captured by the indicators; in contrast, the second weighting makes it possible to establish comparisons within and across countries (given that the sum of all weights is equal to 1).

The GEP Index assesses both a country's distance from the threshold and the relative importance of each indicator.

Finally, to assess GEP relative to planetary boundaries, the progress achieved in the GEP Index indicators is compared with progress made in the indicators of the Dashboard of Sustainability. The purpose is to highlight whether planetary boundaries have been overstepped. It should be noted that the thresholds of indicators in the Dashboard and of some indicators in the GEP Index are determined on the basis of scientific literature, while other thresholds in the GEP Index are empirically determined (see Session 4, section VII).ù

THE NECESSITY OF A DASHBOARD

It is important to remember that the GEP Index is not intended to be a "sustainable development index" nor an index of "progress" adjusted for sustainability.[6] Assessing sustainability is an exercise that involves the future and, therefore, is primarily and unavoidably a forecasting exercise. Making a correct and complete assessment of sustainability would require meeting some challenging prerequisites: (i) a correctly specified dynamic stochastic model of the economy and the environment; (ii) a correct assessment of present and future preferences for the inhabitants of all countries; (iii) a procedure to rank social states within generations; (iv) a correct assessment of the degree of substitutability among the different forms of human, social, economic and environmental capital in generating well-being; and (v) a determination of how stringent sustainability tests should be (e.g., sustainability as "future welfare better than current welfare" versus sustainability as "no decrease from current welfare"). If these prerequisites could be met, and under some regularity conditions, one would deem the current socioeconomic path sustainable if and only if $dV(t) \geq 0$ [7] where:

$$dV(t) := \sum_k p_k \cdot ds_k\,(t) \qquad [5]$$

and (p_k) are the normatively determined "shadow prices" associated with human, social, economic and environmental capital stocks (s_k).

Correctly and completely assessing sustainability would be a forecasting exercise requiring a depth of knowledge that we are unlikely to achieve.

This measurement exercise would be demanding in practice, and questions remain whether it would be possible to produce the "correct" sustainability assessment and shadow price system. Given the difficulty of forecasting, it is very unlikely that this exercise would be widely accepted as a guide for policy – a problem that is at the core of how to take into account not just the well-being but also the preferences of individuals yet to be born.

One way to proceed in light of these challenges is to remain agnostic about prices and simply keep track of the changes in the stocks, ds_k, and present those changes in a dashboard for each country. This more modest approach is compatible with: (i) an explicit acceptance of the intrinsically limited substitutability between the different forms of capital under consideration and, even if substitutability were not limited, (ii) the extraordinary difficulty, both ethical and technical, in identifying the proper trade-offs between forms of capital, as discussed above.

Notwithstanding that those shadow prices are hard to pin down, we must do what we can to assess the importance of the changes taking place in these stocks. We could present relevant thresholds that (according to the scientific literature) are desirable/not desirable to cross and, in addition, targets that will serve to measure progress towards meeting certain social, economic or environmental goals.

6 For a method to create an assessment of development adjusted by sustainability, see Pineda (2012).

7 This implies a non-decreasing discounted utilitarian sum of generational utility, i.e., economic paths along which intergenerational well-being does not decline. For more information, see Fleurbaey and Blanchet (2013).

This is the objective of the Dashboard of Sustainability, in combination with the GEP Index.

Could one dispense with the index–dashboard dichotomy by simply adding the Dashboard variables into the Index? This approach does not seem appropriate. Imagine having an index of "sustainability-adjusted well-being" that acted like the GEP Index with regards to the variables that matter for present well-being but that penalizes growth in variables that threaten the sustainability of that well-being. Any such index may end up classifying countries having, say, low life expectancy and low greenhouse gas emission together with countries with high life expectancy and high greenhouse gas emissions. In fact, however, their positions clearly need to be differentiated[8] if we adopt the principle that "we consider it our moral duty not to impose on future generations any form of sacrifice that we do not accept for ourselves."[9]

AGGREGATING INFORMATION FROM THE DASHBOARD AND THE GEP INDEX TO CREATE THE GEP+ RANKING

The variables in the GEP Index contribute, in a comprehensive way, towards the measurement of the welfare or development of the present generation and also communicate some, but limited, information on its sustainability. Variables related to the $sustainability$ of development are placed in the Dashboard. Just as progress was calculated for each indicator y in the GEP Index, it is calculated for each indicator K in the Dashboard as $\frac{dK_j}{dK_j^*}$ for all relevant indicators $j=1,\dots,J$.

> The GEP Index focuses on measuring the welfare of the present generation.
>
> The Dashboard of Sustainability reports on sustainability for future generations.

However, for the Dashboard indicators, it is critical to understand not only progress but also how this progress relates to the sustainability thresholds. The latter gives us specific information about the importance of this progress. For example, if two countries experienced similar progress, but one country was already on a sustainable path while another country's path was not sustainable (that is, it had overstepped the sustainability threshold), progress for the second country should be considered more important for the overall progress of this country, and the planet, towards an IGE.

To capture both the extent of progress and its starting point, we multiply progress on each dashboard indicator with a weight according to the initial condition to the threshold, $\hat{\pi}_j$ (explained previously in section V). This weighting requires an additional modification to the GEP Index in order to allow for comparability between the measures of progress of the GEP Index and the Dashboard indicators (now multiplied by the weight). To facilitate the comparison needed to construct this combined GEP+ ranking, we must multiply the GEP Index by the average of the weights, $\hat{\pi}_j$, of each of its 13 indicators. These modifications allow for a comparable **achievement profile** of each country in the sample.

For one country f, "x" is an *achievement profile* vector of dimension (J+1), which is given by the GEP Index multiplied by the average of $\hat{\pi}_j$ across its indicators and a set of weighted progress measures of the J dashboard $\langle \frac{dK_1}{dK_1^*}\hat{\pi}_1, \dots, \frac{dK_J}{dK_J^*}\hat{\pi}_J \rangle$.

Therefore, $\mathrm{x} = \left(GEP * average\hat{\pi}_j{}^x, \langle \frac{dK_1^x}{dK_1^{x*}}\hat{\pi}_1, \dots, \frac{dK_J^x}{dK_J^{x*}}\hat{\pi}_J \rangle \right)$

Although, for the reasons explained above, the GEP Index should not be combined with the Dashboard of Sustainability as a composite measure of sustainable development, the information from the two instruments can, nonetheless, tell us which countries are in more favourable positions than others.

[8] For more on this, see Fleurbaey and Blanchet (2013, p. 21).

[9] Fleurbaey and Blanchet (2013, p. 50).

This methodology allows us to rank all Index–Dashboard profiles but not to combine the index and dashboard information into a synthetic index. The ranking is produced by applying the Protective Criterion, which allows us to order countries in terms of their worst achievement but considering only the dimensions on which they differ. When comparing countries' progress based on the GEP Index and the Dashboard, countries are ranked according to their least-performing type of progress, based on the principle of *Priority to the Worst Achievement*. This methodology sends the policy message that a country making substantial progress on only a few aspects of an IGE will not necessarily be doing better than one that is moving forward in all areas. Ranking countries based on the area in which they are making the least progress gives countries the incentive to implement a more balanced and integrated policy approach that is aimed at moving forward across the broad spectrum of an IGE. This methodology serves a double purpose for countries undertaking IGE action: It allows them to learn about their relative green economy performance while also informing them of how their least-performing areas of progress compare with the achievements of other countries.[10] (For GEP+ country rankings from the global application of the GEP Measurement Framework, see Session 6, section 4.)

> In the GEP+ ranking, countries are ranked by their least-performing type of progress. This gives countries the incentive to implement a more balanced and integrated policy approach aimed at moving forward across the broad spectrum of an IGE.

Review and discussion questions for Session 2

- What are the differences between the progress measures that contribute to the GEP Index and the Dashboard of Sustainability indicators? Why are both important?
- What is the advantage of measuring a country's progress as the ratio between the actual change observed and the desired change?
- What is the meaning of a GEP Index score between 0 and 1?
- How does weighting give greater importance to the indicators that need the most improvement? Why is this useful?
- How can the GEP+ calculations be used – and how can they not be used?

10 This method of creating the ranking limits the incentives for substitution across equally important aspects of an Inclusive Green Economy; it also creates incentives to progress in all aspects and penalizes any partial view that concentrates on only a few policy areas.

Session 3. Selecting Indicators for Country-level Applications[11]

Key points

- Non-technical criteria for selecting GEP indicators are hard to operationalize. Because their application unavoidably involves subjectivity; inclusive and transparent tools that structure the selection process are helpful.
- The criterion of **salience** most often plays a critical role in indicator selection. More than with any other criterion, applying the criterion of salience requires involving the stakeholders in the selection process.
- The criterion of **parsimony** avoids potential redundancies among indicators. We suggest using the "similarity matrix" in the selection process to reduce redundancies.
- **System-wide influence** is one of the few selection criteria that focuses on interrelationships among indicators. We explain how to apply several tools developed in the field of scenario analysis to help select GEP indicators.

I. Introduction[11]

The green economy (GE) is a multi-faceted concept that addresses several multidimensional issues, such as human well-being, resource efficiency, social equity and production/consumption-based environmental impacts, to cite a few. The degree of emphasis that GE policies and initiatives put on these various considerations differs across institutional contexts (academia or policymaking, for example), geographical regions (see box below) and epistemological perspectives (Merino-Saum et al. 2020).

Due to the multidimensionality of a GE and its specificity to context, no universal, "one-size-fits-all" measurement framework can adequately track progress towards GE in every country (UNEP 2012; UNESCAP 2013; OECD 2014; GGKP 2016). Hence, countries must select indicators according to their own political priorities, societal challenges and technical capacities.

Given this backdrop, the indicators used in the global application of the GEP Measurement Framework, described in later sessions of this course, should be recognized as the result of a specific selection process tailored to compare the efforts toward a GE made by a large panel of countries (n=105). To maximize the number of countries included, data coverage and data accessibility were two key selection criteria (PAGE 2016) (see Session 4, section II). This set of criteria may be a source of inspiration for country-tailored GEP applications, but it should not be replicated automatically at national levels, as if measurement were applied in a social and institutional vacuum. For illustration, the indicator "access to basic services", which is included in the GEP Index, might be pertinent for most developing countries, but it might not be relevant in European or North American countries. Similarly, "freshwater withdrawal" might be a key metric in most Mediterranean countries, where water availability is a crucial concern, but it might not be so important in northern European countries, where water quality is probably more an issue than water quantity.

[11] Albert Merino-Saum prepared this session.

Key green economy priorities across regions

"In fast-growing Asian and Pacific nations, such as China, where development needs are still pressing, issues related to equitable access to resources, energy and resource efficiency, pollution and emissions control are increasingly high on the agenda. In resource-rich African countries, the efficient and sustainable management of natural assets could be of priority concern. In Latin America, with a large urban population and critical ecosystems, urban development and transport as well as land and water management may be viewed as critical metrics. In low-lying countries in South Asia with large coastal populations that are highly vulnerable to climatic impacts, resilience may be a top priority."

Source: GGKP (2016: 2)

The GEP Measurement Framework is a flexible approach that allows for country-specific indicator sets but, at the same time, provides a uniform methodology and a common understanding of the GE concept. Hence, countries applying the GEP Measurement Framework can select different indicators, but they will all adopt the dual system on which the framework relies – the GEP Index and the Dashboard of Sustainability – which avoids assuming total substitutability between indicators (i.e., weak sustainability[12]). They also will adopt the particular weighting system on which the GEP Index relies, which attributes more importance to domains where countries must make the most progress to achieve targets.

This chapter can help national officials select the GE indicators most suitable for their countries when implementing the GEP methodology. As emphasized in the introductory manual, dozens of selection criteria might be considered in the process of selecting a manageable and finite set of GE indicators (see Session 4 in the introductory course manual). Depending on the goals, the participants and the means available for developing the measurement framework, some criteria will be more pertinent and efficient than others to orient the indicator selection process.

In practice, technical selection criteria such as data availability, statistical accuracy and predictive power often have taken priority over more societal–political criteria such as salience and resonance. This is partly due to the difficulty of making such societal–political criteria operational without adding excessive subjectivity into the analysis. Indeed, indicator initiatives are supposed to be value-free and as objective as possible – even if selection processes and aggregation of indicator values are affected by inherently subjective methodological choices.

In this session we explain how some of these less technical criteria might be implemented – if not objectively, at least in a systematic and structured way. More specifically, we will consider how the criteria of (i) **salience**, (ii) **parsimony**, and (iii) **system-wide influence** might be made operational and become the basis for indicator selection processes in customized GEP applications at the country level.

Three criteria for indicator selection

salience

parsimony

system-wide influence

SALIENCE

Salient indicators are those that best cover the key issues characterizing the system under study. If indicators are not salient, a measurement framework can provide only a partial picture of the problem at hand and unavoidably will provide inaccurate information to decision-makers and the public. Thus, salience is an essential criterion in indicator selection.

[12] See introductory course manual, Session 3, section 1.A.

Salience is a relative notion. That is, an indicator is salient when it is judged to be more to the point than others. As such, determining salience requires establishing a system of comparative relationships (preferences) among candidate indicators and selecting only some of them. Given the complexity, uncertainty and ambiguities that characterize sustainability and GE issues, it is widely recommended in both academic and policymaking circles to involve key actors (e.g., national agencies or departments, scientists, industry representatives, civil society) in identifying salient indicators. Indeed, asking participants what the most salient indicators are gives them an active role that helps warrant the legitimacy of the selected indicator set and to guarantee its acceptance by potential users. In fact, the best way to avoid future criticisms of an indicator-based initiative is to involve stakeholders in the process and to assign to them the responsibility for choosing some indicators over others.

> It is widely recommended to involve key actors in identifying salient indicators.

Involving participants at this stage is crucial, but it is challenging. Inputs from participants are often contradictory and provoke debates, either mathematical or dialectical. Ways of structuring are needed to deal with such diverse inputs.

> Ways of structuring the process are needed to deal with stakeholders' diverse inputs.

The South African case study presented in the introductory manual addressed salience through a three-step process (Session 4, section V):

(i) Each participant explored the catalogue of potential indicators and selected his or her preferences. Thus, each participant suggested an indicator set.

(ii) Facilitators collected the participants' sets of indicators and condensed them into a common short list of indicators based on which indicators the participants mentioned most often and gave priority.

(iii) Participants discussed the collective list and validated it. Nine participants from five national departments participated in the process.

As the starting point, participants reviewed an Excel catalogue of 270 candidate indicators compiled from sets used by various South African public institutions. Local actors had asked to build the indicator set only on existing indicators. Participants selected up to 20 of these indicators and designated up to five as key. To structure their selection process, participants sought to select the indicators that would best gauge South Africa's progress toward the Sustainable Development Goals (SDGs).

Indicator selection could have been structured differently. In this particular case, both the participants and the facilitators considered the SDGs typology the most appropriate, due to its (intuitive) thematic reasoning and the political attention that it is currently attracting worldwide. The main point when dealing with large sets of candidate indicators is to provide participants with some logical structure so that they can deal with the diversity of potential metrics.

Participants suggested 65 different indicators in total – 24% of the initial list. Of course, more than one participant chose some of these indicators (Table 1). The most frequently chosen indicator was "green growth contribution to economic growth", selected by six participants.

Facilitators then applied a pragmatic scoring system to assess salience: Each time a participant suggested an indicator, it received one point. If selected as a key indicator, it received three points. After adding up the points for each, only those with at least three points were kept. Such filtering led to a set of 33 indicators (Table 1) – 12% of the initial number.

Table 1 Indicators selected by consultation in the South African case study

Indicators	Salience score	No. of times designated as key	No. of participants who selected
Green growth contribution to economic growth	**14**	4	6
Climate change adaptation frameworks	**13**	4	5
GHG emissions	**13**	4	5
CO2 emissions	**11**	3	5
Electricity produced from renewable sources	**9**	3	3
Life expectancy	**7**	2	3
Renewable power generation	**7**	2	2
Total employment	**7**	2	3
Water use efficiency	**7**	1	5
Amount of renewable energy at annual operating capacity (by type of technology)	**6**	1	4
Terrestrial Biodiversity Protection Index	**6**	2	2
Unemployment rate (by sex, age and persons with disabilities)	**6**	1	4
Environmental costs related to the provision of resource-based services	**5**	1	3
Green patents	**5**	1	3
Implementation of National Strategy for Sustainable Development and Action plan	**5**	1	3
Municipal waste diverted from landfills for recycling	**5**	1	5
Population relying primarily on clean fuels and technology	**5**	1	3
Renewable energy share in total final energy consumption	**5**	1	3
Energy efficiency improvements	**4**	1	4
Environmental education, awareness and voluntary activism	**4**	1	2
Expansion and implementation of environmental sectors	**4**	1	2
Gini coefficient	**4**	1	2
Greening of municipalities	**4**	1	2
Population that uses solar energy as their main source of energy	**4**	1	2
Priority Area Air Quality Indices (PAAQIs) (PM10 and SO2)	**4**	1	4
Annual mean levels of fine particulate matter (PM2.5 and PM10) in cities	**3**	1	1
Green investment (finance/capital/incentives/subsidies)	**3**	1	1
Major rivers with healthy ecosystems meeting resource quality objectives	**3**	1	3
Population achieving a set level of proficiency in (a) literacy and (b) numeracy skills (by sex)	**3**	1	1
Population using services for safely managed drinking water	**3**	1	1
Population with access to electricity	**3**	1	1
Poverty Gap Index	**3**	1	1
Research and development expenditure (by public and private sources)	**3**	1	1

Source: PAGE (2019, forthcoming).

PARSIMONY (SIMILARITY MATRIX)

As many scholars have emphasized, indicators should be limited to the minimum number that will serve the purposes at hand (Spangenberg et al. 2002; Hezri 2004; Reed et al. 2006). Whatever the system assessed (a city, a region, a country, an economic sector; etc.), it should be represented with as much simplicity as possible (Binder et al. 2010). Having more than just enough indicators might discourage participation, reduce accuracy in reporting and confuse communication to policymakers and the public (Moller and MacLeod 2013).

The fewer indicators, the better.

How can we make parsimony operational? In the introductory manual, we briefly presented the similarity matrix and its application in the South African case study (Session 4, section 5). In this advanced manual, we will present in depth all the steps needed to build such a matrix, and we will explain how practitioners can use the similarity matrix to reduce the number of potential indicators in preliminary sets.

The key idea behind the similarity matrix is to categorize candidate indicators by considering the information they convey, instead of focusing merely on their labels (which might be misleading) or on the data they are carrying. The similarity matrix shows, in a simple way, how similar in meaning the two indicators in each pair of indicators are. Given that GE indicators generally relate to complex and multi-dimensional problems, their informational substance can be fully understood only by looking through several complementary lenses. In the application illustrated here, these multiple perspectives are embedded in the "Green Cube" (Merino-Saum et al. 2018) (see also the introductory course manual, Session 2, section IV). The Green Cube addresses three key questions:

1. **What** natural resources (NRs) do human societies use?
2. **Which** environmental functions (EFs) do human societies prioritize?
3. **Why** are these resources used – e.g., to reach which SDG?

Additional and/or alternative lenses might be applied, depending on the focus that practitioners decide to take. For instance, some of the conceptual frameworks presented in Session 3 of the introductory manual (such as the drivers–pressures–state–impact–responses (DPSIR) model) could be used to look at the indicators. The key point at this stage is to consider indicators from several complementary vantage points.

In the following sections we will describe: how the three typologies – SDGs, NRs and EFs – can be applied (sub-section III.A); how such applications can be structured into a common framework (III.B); and how such a framework can serve as a basis for checking parsimony (III.C).

A. Screening indicators by SDGs, NRs and EFs

Sustainable Development Goals. If the dimensions of the Green Cube are deemed pertinent, we suggest that practitioners first screen and categorize indicators according to the SDGs. Their thematic reasoning makes them easily understandable and applicable. That said, although the SDGs are now well documented and widely used by institutions, corporations and academics, ambiguities still exist about their specific meanings (Hák et al. 2016). Therefore, any implementation of the UN SDGs framework will involve a certain degree of subjectivity and assumptions about how their achievement would look. To deal with this, and to reduce potential biases, we suggest remaining as close as possible to the indicator classification suggested by the UN SDGs framework (which specifies 169 targets and 232 indicators).[13] For candidate indicators that are not in the UN SDGs indicator list, we suggest that practitioners look for the most closely related SDG targets or corresponding indicators. Table 2 illustrates a categorization of indicators not in the SDGs indicators list to the SDGs.

Resource: Merino-Saum et al. (2018).

[13] https://unstats.un.org/sdgs/indicators/indicators-list/

Table 2. Illustrative examples of GE indicators screened across the SDGs

Sustainable Development Goal	Related indicators
1. No poverty	• Proportion of population earning below US$1 per day • Fragility and exposure of human and economic activity in disaster-prone areas
2. Zero hunger	• Food security • Gross nutrient balances in agriculture (N, P)
3. Good health and well-being	• Exposure to air pollution • Life expectancy
4. Quality education	• Literacy rate • Educational attainment level and access to education
5. Gender equality	• Gender Inequality Index • Level of income (by sex)
6. Clean water and sanitation	• Domestic water use per capita (relative to basic requirement) • Freshwater abstractions (withdrawals)
7. Affordable and clean energy	• Electricity production from renewable sources • Percentage of electricity market opening
8. Decent work and economic growth	• Labour productivity • Employment in the environmental goods and services (EGS) sector
9. Industry, innovation and infrastructure	• Environmental patents • Investment in environmentally sound technologies
10. Reduced inequalities	• Gini coefficient • Palma ratio
11. Sustainable cities and communities	• Exposure to environmental noise • Municipal waste collection and treatment
12. Responsible production and consumption	• Raw materials consumption (RMC) • Index of natural resources
13. Climate action	• Average percentage of annual Emissions Trading System allowances to be auctioned • Legal, institutional and financial conditions to implement disaster risk management policies
14. Life below water	• Countries' fishing practices – both use of heavy equipment and size of the catch • Nutrients in transitional, coastal and marine waters
15. Life on land	• Natura 2000 and nationally designated nature areas • Normalized Difference Vegetation Index
16. Peace, justice and strong institutions	• Human Rights Index • Participation in decision making
17. Partnerships for the Goals	• National positions and statements in international forums • Trade in environmental goods and services (EGS) sector (absolute, share, rates of change)

Source: Merino-Saum et al. (2018).

Natural resources. Natural resources (NRs) are here understood as "aspects of the natural world that have the capacity to produce goods and services that contribute to welfare" (IRP 2017). They can be categorized in different ways, ranging from narrow sets focusing on raw materials to broader typologies encompassing multidimensional services provided by natural ecosystems (see, for instance, Moll et al. 2005; Huysman et al. 2015). The typology suggested here is the one applied by Merino-Saum et al. (2018) in their systematic analysis of GE indicators. It consists of 11 categories. One of these – NA, #11 – encompasses all indicators that are not related to natural resources. Another – Unspecific resources, #10 – is a residual category for indicators that broadly but clearly refer to NRs. Table 3 shows examples of indicators that reflect these natural resource areas.

NR-based typologies are most often applied to environmental indicator sets or resource management monitoring systems, both of which have narrower scopes than sustainability or GE measurement frameworks. Hence, the application of NR typologies to GE indicators is not self-evident and might require adjustments. GE indicator sets include many more social, institutional and political indicators and are often linked to NRs in an unspecific manner. As a consequence, most of the indicators might fall into the "unspecific resources" category. To overcome this problem, an "unspecified resources" category can be disaggregated into a more or less detailed list of thematic sub-categories, such as waste, finance, macroeconomic data and infrastructures (Table 4). Such a sub-typology does not describe any more NR types than Table 3 does. Rather, it distinguishes issues or topics defined by the participants in the indicator selection process.

Table 3. Illustrative examples of GE indicators screened across natural resources

Natural resources	Examples of related indicators
1. Abiotic materials (minerals, metals, ores and fossil fuels)	• Fossil fuel subsidies • Mineral and fossil fuel resources • Percentage of gas market opening
2. Biotic materials (crops, livestock, fish, timber and biomass)	• Forest resources • Current agricultural area under various crops • Total fisheries production
3. Unspecific materials (indicators relating indistinctly to more than three materials)	• Domestic Material Consumption (DMC) • Material productivity • Raw Material Consumption (RMC)
4. Water (freshwater and seawater)	• Ground water extraction as percentage of total available water resources • Water stress • Bathing water quality
5. Air	• Nitrogen emissions (NOx) • SOx emission per capita • Number of people hospitalized due to air pollution
6. Land and soil	• Land take per GDP unit • Population living on degraded land • Topsoil loss from agricultural land
7. Biodiversity	• Area of undisturbed natural ecosystems • Minimum area to be set aside for biodiversity protection • Biodiversity proportion of patent portfolio

Natural resources	Examples of related indicators
8. Abiotic renewable energy resources (solar, wind, hydrological, geothermal sources, etc.)	• Combined onshore wind, photovoltaic and biomass energy potentials • Electricity generated using non-fossil fuels • Renewable energy incentive
9. Unspecific energy resources (indicators relating indistinctly to more than three energy resources)	• Percentage of European Investment Bank loans for energy projects • R&D expenditure for energy technology as % of GDP • Energy footprint
10. Unspecific resources (indicators relating indistinctly to more than three resources)	• Ecological Footprint • Environmental Impact Assessment (EIA) policy • Value of ecosystem services
11. NA (indicators not related to any of the resources listed above)	• Pension coverage • Population (%) rating satisfaction with life as 7+ on scale of 0–10 • Under 5 mortality rate

Source: Merino-Saum et al. (2018).

Table 4. Disaggregating the "unspecific resources" category – illustrative examples

Inductive categories	Related indicators
1. Human resources	Environmentally induced health problems and related costs Passenger transport demand
2. Macroeconomic data	Gross Value Added (GVA) in environmental goods and services (EGS) sector Environmentally Adjusted Multi-Factor Productivity (EAMFP)
3. R&D – innovation	Environmental patents R&D for environment (GBAORD) spending)
4. Infrastructures	Buildings meeting «green» standards Tourist overnight stay density
5. Waste and recycling	Recycled packaging waste (as percentage of total packaging waste) Waste treatment (landfilled/incinerated/composted)
6. Private financial resources	International financial flows of importance to green growth EGS sector investment
7. Green sector and sustainable practices	Corporate social responsibility incentives and policy Adoption of sustainability reporting by top three national companies (market capitalization)
8. Risk and vulnerability	Production of chemicals, by hazard class Population's exposure to natural or industrial risks and related economic losses
9. Public measures	Environmentally related taxation Policies for distribution and use of income/taxes from natural resource use
10. Greenhouse gas emissions	Greenhouse gas intensity CO_2 emissions
11. Others	Ecological Footprint Value of natural resource stocks

GBOARD = Government budget outlays or appropriations for research and development
Source: Merino-Saum et al. (2018).

If the NR-based typology becomes too complex, the level of detail might be modified. For instance, categories 1 to 3 can be grouped into a common one: "materials". Typologies are flexible and should be used considering the context for the screening (e.g., research projects versus policymaking processes).

Environmental functions. Environmental (or ecosystem) functions were defined first by de Groot (1992) as the "capacity for natural processes and components to provide goods and services that satisfy human needs, directly or indirectly". This concept has subsequently been used and adapted in various studies, including the Millennium Ecosystem Assessment (MEA 2003). Also, some of these environmental functions are mentioned in the OECD's conceptual framework for green growth (OECD 2017). There are various presentations of these functions; see, for instance, de Groot (2006) and Ekins (2011).

The typology used in this study is based on the five S's suggested by O'Connor (2000):

1. **Source:** indicators expressing the capacity to provide resources for human activity, such as energy, water, forestry products or food (among many others);
2. **Sink:** indicators relating to the regulating capacity of ecological systems (e.g., absorption and/or neutralization of pollutants or waste);
3. **Site:** indicators referring to the ability to provide space to support human activities, including all forms of land use (habitation, for instance) and space used for transportation infrastructure;
4. **Life Support:** indicators describing the capacity to provide habitat for refuge and reproduction to non-human communities (fauna and flora);
5. **Scenery:** indicators referring to the cultural, scientific, aesthetic, recreational or symbolic value of ecological systems;
6. **NA:** indicators not related to any of the functions listed above.

Table 5 presents examples of indicators that reflect these categories of environmental functions.

Table 5. Illustrative examples of GE indicators screened across environmental functions

Environmental functions	Example of related indicators
1. Source	• Net present value (NPV) of production potential of agricultural land • Land use for permanent crops • Proportion of fish stocks overexploited or collapsed
2. Sink	• Waste generation • Level of harmful chemicals in drinking water • Greenhouse gas emissions
3. Site	• Urban sprawl • Fragility and exposure of human and economic activity in disaster-prone areas • Freight transport demand
4. Life Support	• Coral reef • Species abundance and distribution • Wildlife resources
5. Scenery	• Bathing water quality

Source: Merino-Saum et al. (2018).

Applying the typologies. These three typologies (or others of their choice) should be applied sequentially, i.e., focusing first on one typology and screening all candidate indicators through it before screening based on another typology. Indeed, each typology requires a particular way of approaching indicators, and so it might be challenging to jump from one typology to another for each indicator.

Practitioners should apply each typology to all indicators before moving to the next typology.

In some cases, how indicators relate to typologies is not obvious, and controversies and doubts might emerge. To avoid excessive subjectivity, practitioners with different backgrounds and various fields of expertise should be involved in this task. If time and budget permit, each contributor should screen the indicators, put the results together individually and then discuss them in a group working session.

In typologies of non-exclusive categories, the same indicator might link to more than one category. For instance, "protected areas" can be classified as related to SDG 14 [Life below water] and to SDG 15 [Life on land]. To reduce complexity, indicators should be limited to no more than three categories in the same typology. Of course, these procedural rules can be adapted to each particular case, but they should be clearly stated and collectively agreed before the screening starts.

From a practical point of view, the screening might be done by filling in basic Excel spreadsheets. The exercise does not require sophisticated software or applications. Technicalities should not become an obstacle to inclusiveness.

B. Bringing together the screening results: the similarity matrix

Once candidate indicators have been screened across the selected typologies, practitioners must integrate the results into a common structure. That is the aim of the similarity matrix (Table 6), in which indicators are compared with each other through a pair-wise analysis: Each cell states how many categories (in terms of SDGs, NRs and EFs) the two indicators have in common. The number of corresponding categories might be expressed numerically or, as in Table 6, through a colour intensity code. Results can be normalized by considering the total number of mentions that each indicator receives in the screening process.

Filling in the similarity matrix is not a complex exercise, but it may be time-consuming. We advise practitioners to use filters in the Excel screening database.

C. Filtering indicators based on the parsimony criterion

The similarity matrix highlights pairs of indicators with the most categories in common (i.e., pairs with the highest numerical values or the darkest colours in the matrix). There is no predefined critical threshold (maximum number of shared categories) that automatically implies that two indicators are redundant. The limit will depend on several factors, such as the number of candidate indicators considered at this stage of the selection process, the number of indicators that the final set should contain (if a maximum exists for technical reasons) or the level of detail that the assessment is seeking. (Country and local measurement frameworks generally require higher similarity thresholds than those developed for the global scale.)

To help weed out redundancies, the similarity matrix highlights pairs of indicators with the most categories in common.

In the South African case study, the scale of analysis (national) and the number of indicators (both screened and targeted) led facilitators to classify as potential redundancies those pairs of indicators in three or more corresponding categories (indicated in darkest green in Table 6). Use of this threshold led to the clusters described in the introductory manual

(Session 4, Table 6). The facilitators presented the clusters to the local participants and suggested a shortened list of 21 indicators (from the previous list of 33).

Practitioners are urged to the leave the decisions about removing, keeping or aggregating the indicators to the actors involved in the selection process and to adopt a holistic view when considering potential clusters. The function that each indicator plays within an entire set might be influenced by the removal of certain other indicators. For example, an indicator might become the only one pertaining to a particular SDG, NR or EF.

Table 6. Extract from the similarity matrix built for the South African case study

	Climate change adaptation frameworks	Greenhouse gas emissions	CO_2 emissions	Electricity produced from renewable sources	Water use efficiency	Life expectancy	Total employment	Renewable power generation	Amount of renewable energy at annual operating capacity (by type of technology)	Unemployment rate (by sex, age and persons with disabilities)	Terrestrial Biodiversity Protection Index	Municipal waste diverted from landfills for recycling	Environmental costs related to the provision of resource-based services	Green patents	Implementation of National Strategy for Sustainable Development and Action Plan	Population with primary reliance on clean fuels and technology	Renewable energy share in total final energy consumption	Energy efficiency improvements
Green growth contribution to economic growth	lightest					lightest	medium			medium		lightest	lightest	lightest	medium			
Climate change adaptation frameworks		lightest	lightest								medium							
Greenhouse gas emissions			darkest									lightest		lightest				
CO2 emissions												lightest		lightest				
Electricity produced from renewable sources					lightest			darkest	darkest				lightest			medium	darkest	medium
Water use efficiency																		
Life expectancy							medium			medium					medium			
Total employment										darkest					medium			
Renewable power generation									darkest				lightest			medium	darkest	medium
Amount of renewable energy at annual operating capacity (by type of technology)													lightest			medium	darkest	medium
Unemployment rate (by sex, age and persons with disabilities)															lightest			
Terrestrial Biodiversity Protection Index																		
Municipal waste diverted from landfills for recycling													lightest	lightest	lightest			
Environmental costs related to the provision of resource-based services														lightest	lightest			
Green patents															lightest			
Implementation of National Strategy for Sustainable Development and Action Plan																		
Population with primary reliance on clean fuels and technology																	medium	medium
Renewable energy share in total final energy consumption																		medium

Key: lightest green = present in one category; medium green = present in two categories; darkest green = present in three or more categories
Source: authors' elaboration.

SYSTEM-WIDE INFLUENCE (INFLUENCE MATRIX)

Another way to reduce the number of candidate indicators is by putting aside those that are less embedded in the system under study, i.e., those that neither influence the other indicators nor are influenced by them. Such indicators are isolated and disconnected from the others, which generally reveals their peripheral role regarding the problem at hand.

System-wide influence is a key selection criterion because it focuses on interrelations among indicators, in contrast to almost all other selection criteria. Indeed, measurement frameworks too often conceive of indicators as independent pieces of information and pay no attention to their mutual influences (Wiek and Binder 2005; Binder et al. 2012).

> Uniquely, "system-wide influence" focuses on interrelations among indicators.

A. Filling in the influence matrix

To shed light on the relationships among candidate indicators, practitioners can use several methods and tools, most of them coming from the field of scenario development and analysis, where identifying key driving forces and understanding how variables interact are critical issues. One of these methods is called the "influence matrix" (also known as the "impact matrix" and the "cross-impact matrix"). This is a square matrix consisting of two identical axes that list the candidate indicators in the same order. Each cell expresses the intensity with which one indicator influences the other.

> The influence matrix reports how much each indicator influences and is influenced by each of the other indicators.

Although values are expressed quantitatively, the degree to which indicators influence each other is primarily assessed qualitatively. The scale used to translate such qualitative scores into numerical values varies among authors and applications. In the basic example presented in Table 7, the scale is as follows: 0 means no influence; 1 means weak influence; and 2 means strong direct influence. The cells express the strength of influence of row indicators on individual column indicators. Thus, for instance, indicator "env. 1" has no influence on "env. 2", but it strongly influences "soc. 2" (as shown in the "Env. 1 row). "Env. 1" is strongly influenced by "soc. 1", "soc. 2" and "eco. 2" (as shown in the "Env. 1 column).

Table 7. Influence matrix applied to an indicator selection process

		ENV.		SOC.		ECO.		Active sum
		Env. 1	Env. 2	Soc. 1	Soc. 2	Eco. 1	Eco. 2	
ENV.	Env. 1		0	0	2	1	0	3
	Env. 2	0		0	0	1	0	1
SOC.	Soc. 1	2	1		1	1	1	6
	Soc. 2	2	0	1		2	0	5
ECO.	Eco. 1	0	1	0	0		0	1
	Eco. 2	2	0	1	1	0		4
Passive sum		6	2	2	4	5	1	

Key: 0 = no influence; 1 = weak influence; 2 = strong influence

Source: author's elaboration (adapted from Wiek & Binder (2005)).

Influence matrices might be filled in by either actors or experts (or both). In some cases an external facilitator might be needed to support the appraisal process and record the results. As a general rule, matrices are filled in by each participant individually and then combined into a common matrix. Such aggregation might be achieved mathematically or through participatory methods (the latter being more time-consuming but generally yielding greater perceptions of legitimacy). When several participants fill in the matrix together, they can discuss and/or vote on indicator interactions.

When rating how indicators influence each other, both facilitators and participants should be aware of several key points (Scholz and Tietje 2002). First, participants must consider only direct influences among indicators. It is particularly important not to include in the assessment the indirect effects an indicator might have via any other indicator in the matrix. For illustration, in Table 7 "env.1" is strongly influencing "soc.2", which is in turn influencing "soc.1". But influence matrices should not contain the (indirect) influence that "env.1" is having on "soc.1" through "soc.2". Second, filling in the influence matrix is about identifying causalities, not correlations (this point refers partly to the previous one). Finally, when rating indicators' influence, participants must keep in mind the specific scales (both temporal and geographical) and the social–institutional contexts being considered, rather than considering in the abstract how an indicator generally influences the others.

B. Calculating active and passive sum scores

For each indicator, practitioners can easily calculate its "active sum" score; i.e., the global influence that each indicator has on all other indicators in the matrix. To do that, they simply add the values in the same row. For instance, in Table 7 the influence that "env. 1" has on other indicators is 3 (=0+0+2+1+0). Symmetrically, we can also estimate the extent that each indicator is influenced by all the others. To do that, we calculate its "passive sum" score by adding the values in a same column. For "env. 1" in Table 7, the passive sum score is 6 (=0+2+2+0+2).

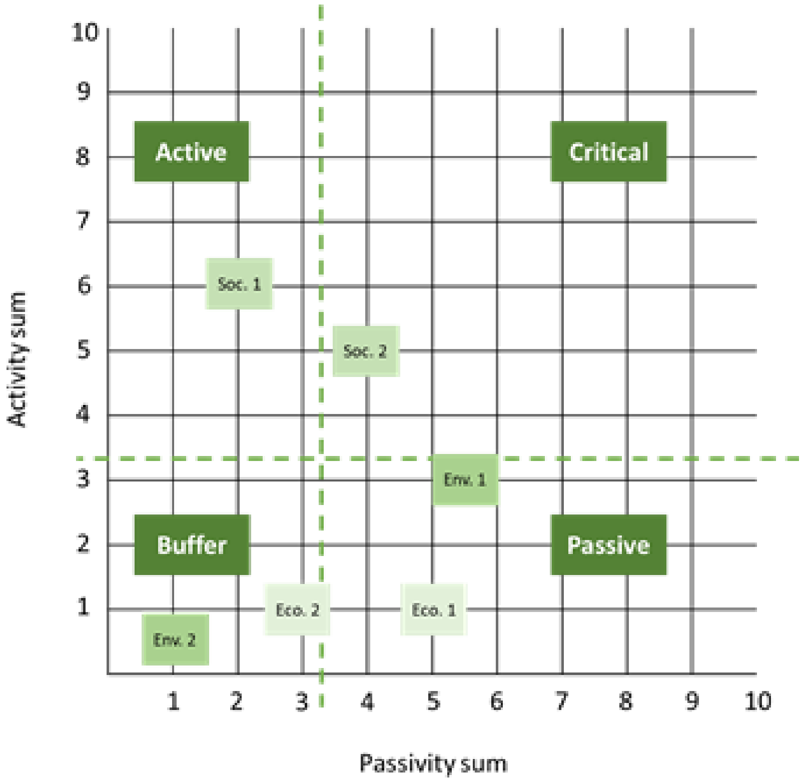
C. Distinguishing indicators according to their system-wide influence

Once all active and passive sum scores have been calculated for all candidate indicators, these scores can be grouped into four categories according to their system function. Ambivalent (or critical) indicators are those highly influenced by other indicators and themselves highly influence the system. Thus, they play key roles in the system. In contrast, buffer indicators are those hardly influenced and having hardly any influence on other indicators. Their connectedness to the rest of the system is slight, and they might be creating noise in the assessment. Passive indicators are those highly sensitive to the others. Their evolution is largely determined by trends and/or shocks in other metrics. Typically, such indicators refer to variables at the very end of sequential phenomena or concatenation effects, such as "output" magnitudes or "result" categories. For instance, in the DPSIR model passive indicators will most often be categorized as "impact" (I) or "response" (R) (see Session 2 in the introductory manual). Finally, active indicators drive the system and explain to a large extent how the other indicators behave. Their analysis helps to understand how the system works and might evolve. Their inclusion in the final set is highly recommended.

Active indicators drive the system. They should be included in the final indicator set.

Different formulas and software might be applied to distribute the indicators across these four categories. One simple and intuitive way is by considering active and passive sum scores relative to the mean value estimated for the entire list of candidate indicators. Figure 2 illustrates this with the indicators considered in Table 7 and Figure 1.

Figure 2. **Grid distribution of indicators based on active and passive scores**



Source: author's elaboration (adapted from Scholz and Tietje (2002) and Wiek and Binder (2005)).

Review and discussion questions for Session 3

- Why should countries not simply adopt the indicators used in the global application of the GEP Measurement Framework to monitor GE progress at the national scale?
- How can salience be collectively assessed in GE indicator selection processes?
- Why does parsimony need a multi-dimensional perspective? How can we systematically check parsimony in GE indicator sets?
- How can the interactions of indicators be integrated into the selection process as an additional criterion?

Session 4. Indicators for the Global Application of the GEP Measurement Framework[14]

Key points

- Indicators for the GEP Index were chosen for:
  - pertinence to GE issues
  - data coverage
  - data accessibility and,
  - for the Dashboard of Sustainability, representing a planetary boundary.
- These indicators seek to measure impacts of policies and investment on persistent poverty, overstepped planetary boundaries and inequitable sharing of prosperity – the three challenges addressed by an Inclusive Green Economy.
- The 13 indicators cover environmental trade and patents, energy use and renewable energy, access to basic services, efficiency of production and consumption, air pollution, protection of natural areas and aspects of social development and equity.

I. A Demonstration: the Global Application

In 2017, the Partnership for Action on Green Economy (PAGE) applied the GEP Measurement Framework to a panel of 105 countries, representing 86 per cent of the world's population in 2013 (PAGE 2017b). This study tested the Framework to (1) demonstrate the validity of the methodology, (ii) improve its design and (iii) enrich analysis for green economy policymaking. The study compared progress toward a green economy in the context of global thresholds between the periods of 2000–2004 and 2010–2014. The remainder of this course presents the methods and results of this global application.

The global application shows the feasibility, usefulness and power of the Framework at the global level and, by extension, at the country or local level. A country can assess its own progress between the two time periods by analysing and assessing the country-specific results from the global application. Annex I illustrates such an analysis for South Africa.

The need for comparable data for as many countries as possible in two time periods imposed limits on what indicators could be used in the global application. In applying the Framework, countries may want to consider the indicators used in the global application. Using these same indicators may make it possible, for example, to use the latter time period in the global application (2014) as the initial time period for comparison with more recent data, thus gauging continuing progress.

[14] José Pineda prepared this session.

At the same time, however, countries will want to consider whether other indicators speak to issues of particular local importance. The approach described in Session 3 will facilitate indicator selection. When countries make these choices, the merits of both international comparability and tailoring to national context deserve consideration.

INDICATORS FOR THE GLOBAL APPLICATION: SELECTION CRITERIA

The following selection criteria were used to decide which indicators should be included in the GEP Measurement Framework:[15]

1. **Salience.** Selected indicators should be related to a specific challenge that an IGE seeks to address and/or to a category of the new generation of capital. The indicators should capture policy outcomes in areas where policymakers could invest more resources to green their economies and make them more inclusive (e.g., access to basic services).
2. **Data coverage.** For indicators to compare countries' progress in greening their economies, they must adequately cover all regions and national levels of development and a span of time – that is, observations for at least two time periods. The two periods considered in the GEP Index initially are 2000–2004 and 2010–2014. The data for each of these five-year periods are averaged around these years.[16] This approach was chosen based on the availability of comparable data and because it takes time for green economy indicators to fully reflect policy changes. For the sake of simplification, the averaged data over 2000–2004 will be referred to as "2004" and the averaged data over 2010–2014 will be referred to as "2014". The temporal frame can be updated as more recent data become readily accessible.
3. **Data accessibility.** Data should be publically available through international organizations with the mandate to collect and harmonize global databases or, in some cases, from nongovernmental organizations with excellent records of accomplishment in the regular production of indicators (e.g., the World Resources Institute and the Global Footprint Network). This will allow the results of the global application to be replicated, tested and expanded.
4. **Planetary boundaries.** Finally, indicators in the Dashboard of Sustainability should be widely recognized as representing a planetary boundary (e.g., land, water, emissions) and have an estimated threshold value derived from the literature.

Notably, it was not possible to include some indicators of interest in the GEP Index, either because they are still at a preliminary stage of development (e.g., green jobs) or because data are proprietary (e.g., renewable energy investments).

Resource: PAGE (2017b).

MAPPING THE CHOICE OF INDICATORS WITH THE INCLUSIVE GREEN ECONOMY NARRATIVE

An IGE promotes investments and policies that stimulate the supply of environmentally friendly goods and services and create conditions that enable these new goods and services to be absorbed by the economy. As one of the main levers of transformation to an IGE, policy outcomes must seek to balance the new aggregate supply – more resource efficient and less polluting – and more sustainable aggregate demand to achieve a new economic equilibrium. When combined with the accumulation of a new generation of capital that promotes the production of environmentally friendly goods and services, enabling policies have the potential to create multidimensional benefits both on the supply side – for example, new economic opportunities, reduced environmental impacts, social improvements and new jobs – and on the demand side, increasing the overall capacity

15 The selection criteria for the global application differ from those recommended in the previous session for country-specific applications. For the global application, the need to obtain comparable data for the same time periods from as many countries as possible made the criteria of accessibility and coverage paramount.

16 For most indicators 2000–2004 and 2010–2014 averages are used. However, for social indicators that are measured less often, averages between 1997–2004 and 2005–2014 are used. In a future version of the GEP measurement framework, other years could be included if data are available.

of the economy to absorb the new green goods and services.

An IGE promotes the creation or capacitation of a new generation of capital that includes natural capital, low-carbon resource-efficient physical capital, human capital with modern and green skills and social capital that ensures equity and inclusiveness. The Forum for the Future has articulated and defined these concepts.[17]

The GEP Measurement Framework is, however, not limited to the production sphere. It also encompasses indicators[18] that are linked to addressing poverty eradication and overstepped planetary boundaries and, thus, to public spending in these domains. Figure 1 presents an overview of the indicators in the GEP Measurement Framework[19] mapped to the IGE analytical framework.

COMPONENTS OF THE GEP INDEX

Based on the IGE analytical framework, the GEP Index aggregates 13 multidimensional indicators[20] associated with the three challenges addressed by an IGE – persistent poverty, overstepped planetary boundaries and inequitable sharing of growing prosperity. These indicators aim to capture key components in the transition to an IGE that are related to policy and investment effects on the new aggregate supply and aggregate demand.[21] Each indicator also meets the data requirements mentioned in section I: time, country coverage and public accessibility. Annex II describes, step-by-step, how to calculate the GEP Index using Stata statistical software.

Table 1 provides a brief description (including country coverage and source) for each of the 13 indicators in the GEP Index.

17 For more information see https://www.forumforthefuture.org/project/five-capitals/overview.

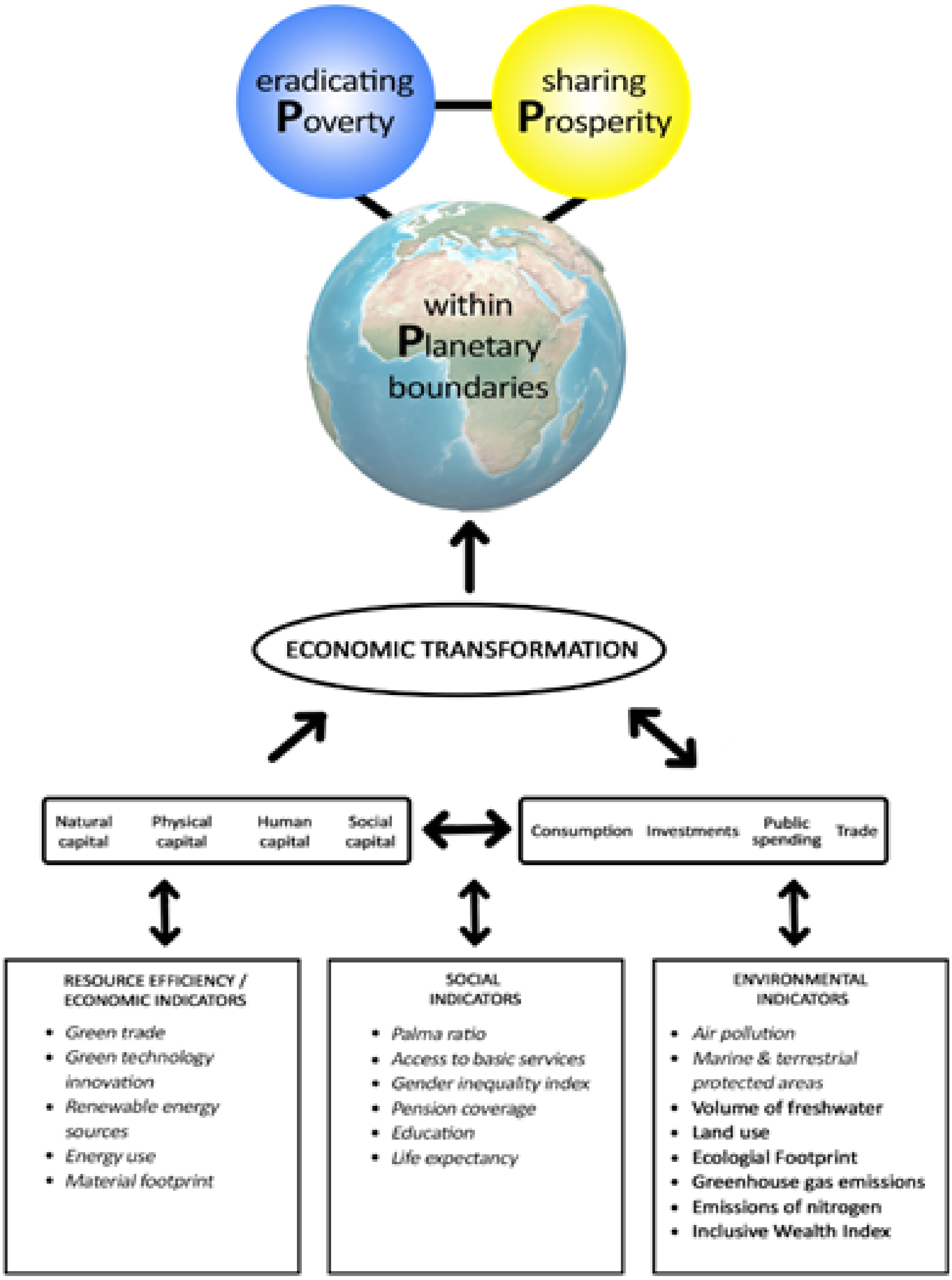
18 Indicators in the GEP Index are outcome (or performance) indicators that are affected by policy choices. The GEP Index aims to monitor their evolution over time. By contrast, most of the indicators in the Dashboard of Sustainability are state indicators because monitoring stocks, in order to assess whether progress respects planetary boundaries, is the main focus of the Dashboard.

19 As shown in Figure 1 in UNEP (2017).

20 Shown in italic in Figure 1.

21 This is one method for balancing policy outcomes captured by green economy indicators between aggregate demand and aggregate supply. It is, however, not the only option, as some indicators can be related to impacts on both the aggregate supply and aggregate demand sides. Moreover, general equilibrium effects are not considered here.

Figure 1. Indicators in the GEP Measurement Framework in relation to the Inclusive Green Economy analytical framework



Note: Figure created by the authors. Indicators in italic are included in the GEP Index, those in bold are in the Dashboard of Sustainability.

Table 1. Components of the GEP Index

Indicator	Description	Country coverage	Data source
Green trade	Export of environmental goods (% of total export)	128	Internal calculations using data from UN Comtrade, OECD, APEC, UN Environment
Environmental patents	As a measure of green technology innovation, patent publication in environmental technology, by filing office (% of total patents)[22]	61	WIPO
Renewable energy sources[23]	Share of renewable energy supply (as percentage of total energy supply)[24]	129	Internal calculations using WDI data
Energy use	Energy use (kg of oil equivalent) per USD 1,000 GDP (constant 2011 PPP)	132	WDI
Palma ratio	Ratio of the richest 10% of the population's share of income divided by the share of the poorest 40%	121	Internal calculations from WDI and OECD data
Access to basic services	A composite measure of average access to three basic services with key social and environmental implications: access to improved water sources (% of total population),[25] access to electricity (% of total population), access to sanitation facilities (% of total population)	197, 211, 198, respectively	WDI
Air pollution	Mean annual exposure to PM2.5 pollution (micrograms per cubic metres)	186	WDI

22 According to WIPO classifications, "Environmental technology … covers a variety of different technologies and applications, in particular filters, waste disposal, water cleaning (a quite large area), gas-flow silencers and exhaust apparatus, waste combustion or noise absorption walls. However, it is not possible to define measuring of environmental pollution by IPC codes in a clear cut way." See Schmoch (2008), p.14, for more information.

23 Development of renewable energy sources could have negative impacts on the environment, e.g., reduction of dead biomass in ecosystems. However, it is believed that the overall potential benefits of developing renewable energy sources outweigh the potential costs.

24 Percentage of total energy supply that comes from constantly replenished natural processes, including solar, wind, biomass, geothermal, hydropower and ocean resources, and some waste. It also includes the production of nuclear energy in 30 countries. The indicator is composed of the sum of two variables: 1. Combustible renewables and waste (as a percentage of total energy) comprise solid biomass, liquid biomass, biogas, industrial waste and municipal waste, measured as a percentage of total energy use (available at http://data.worldbank.org/indicator/EG.USE.CRNW.ZS); 2. Alternative and nuclear energy (as a percentage of total energy).

25 FAO data on wastewater were also explored (http://www.fao.org/nr/water/aquastat/data/query/results.html). However, these data have poor time coverage. For our purposes this is a significant limitation.

Indicator	Description	Country coverage	Data source
Material footprint	Amount of materials that are required for final demand in a country (tons/person)	175	International Resource Panel, UN Environment
Marine and terrestrial protected areas	Sum of terrestrial protected area (% of total land area) and marine protected area (% of territorial waters)[26]	145 and 195, respectively	UN Environment WCMC via UN Environment GRID
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	129	UNDP[27]
Pension coverage	Share of population above statutory pensionable age receiving an old age pension, by contribution and sex	102	ILO
Education (mean years of schooling)	Average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level	170	UNDP[28]
Life expectancy	The number of years a newborn infant would live if patterns of mortality prevailing at the time of its birth were to stay the same throughout its life	200	WDI[29]

Abbreviations: OECD = Organisation for Economic Cooperation and Development; APEC = Asia–Pacific Economic Cooperation; WIPO = World Intellectual Property Organization; WDI = World Development Indicators; GPD = gross domestic product; PPP = purchasing power parity; WCMC = UN Environment World Conservation Monitoring Centre; GRID = UN Environment Global Resource Information Database; UNDP = United Nations Development Programme; ILO = International Labour Organization.

Source: PAGE (2017b).

[26] The value of the measure of progress for this dimension is the simple average of the two components taken separately (because each component has its own threshold).

[27] HDRO calculations based on data from: UN Maternal Mortality Estimation Group (2013), UNDESA (2013a), Inter-Parliamentary Union (IPU) (2013), Barro and Lee (2013), UNESCO Institute for Statistics (2013) and ILO (2013a). For further information see http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf.

[28] Derived from: Barro and Lee (2014), UNESCO Institute for Statistics (2015) and HDRO estimates based on data on educational attainment from UNESCO Institute for Statistics (2015) and Barro and Lee (2014). For further information see http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf.

[29] Derived from male and female life expectancy at birth from sources such as: (1) United Nations Population Division. World Population Prospects; (2) United Nations Statistical Division. Population and Vital Statistics Report (various years); (3) Census reports and other statistical publications from national statistical offices; (4) Eurostat: Demographic Statistics; (5) Secretariat of the Pacific Community: Statistics and Demography Programme; and (6) United States Census Bureau: International Database. For further information see http://data.worldbank.org/indicator/SP.DYN.LE00.IN.

DASHBOARD OF SUSTAINABILITY INDICATORS

The Dashboard of Sustainability monitors key stocks of capital that are priorities to sustain life on the planet. Loss in these key stocks of capital cannot be compensated for by increasing another stock of capital. Therefore, progress in these areas must be assessed for each indicator individually; they cannot be combined in an aggregate index. The Dashboard of Sustainability keeps track of the long-term sustainability of these factors, complementing the assessment of green economy progress in the GEP Index. Progress or regress made on the dashboard indicators is measured against thresholds that reflect planetary boundaries (Table 2). Thus, the Dashboard helps to put progress measured by the GEP Index in a sustainability perspective. This is important: Any improvement in current human wellbeing should not come at the expense of future wellbeing.

To allow comparison of progress between the GEP Index and the Dashboard, the sample of countries for the Dashboard indicators is restricted by the sample of countries covered by the GEP Index – 105 countries between 2004 and 2014. (Session 5, section V focuses on joint analysis of the GEP Index and the Dashboard indicators for these 105 countries.)

The criteria for selecting the Dashboard indicators are the same as for the GEP Index indicators, but a fourth criterion applies: The indicators should concern a planetary boundary for which a threshold can be established on the basis of the best available scientific knowledge.

After a literature review looking for the largest country coverage possible, the GEP Measurement Framework included just six indicators in the Dashboard. These are:

1. greenhouse gas emissions per capita
2. nitrogen emissions per capita
3. share of land used for permanent crops
4. freshwater withdrawal per capita[30]
5. the Inclusive Wealth Index
6. the Ecological Footprint.

The planetary boundaries framework of Rockström et al. (2009) identifies nine areas of crucial importance to maintain the sustainability of life on the planet. For seven of these, Rockström et al. (2009) were able to quantify a threshold by identifying control variables and setting specific boundary values. Given the precautionary principle, planetary boundaries were set at what was considered a "safe distance" from the threshold estimated using the best available science (Nykvist et al. 2013). Thresholds for nitrogen concentrations, freshwater use[31] and land use were determined as the national-level counterparts of planetary boundaries (by dividing total estimates by either global population or by global terrestrial area).[32]

[30] The authors acknowledge the shortcoming that, except for the Ecological Footprint, the indicators in the Dashboard take a production/territorial perspective and not a consumption (footprint) perspective. Data on carbon, water, land and energy footprints were explored through the Carbon Footprint of Nations (http://carbonfootprintofnations.com) and the Water Footprint Network (http://waterfootprint.org). While the country coverage is good, no time series are available. Therefore, it was decided to keep production/terrestrial indicators to reflect planetary boundaries in this global application of the GEP Measurement Framework.

[31] An indicator that could have been included instead is water scarcity. However, data on freshwater use were available for more countries. For future thematic studies of the GEP measurement framework, water scarcity indices could be included in the analysis of green economy progress for a sub-set of countries.

[32] The blueDot Project (http://bluedot.world/) has calculated national planetary boundaries for six of nine planetary boundary indicators for 42 countries. These are, however, mainly OECD and other developed countries. This study aims for a balance between developed and developing country coverage and, therefore, has prioritized national-level boundaries based on downscaling global estimates. A future study of GEP could use the blueDot estimates of national-level boundaries.

The threshold for greenhouse gas emissions per capita is based on projections by the Intergovernmental Panel on Climate Change (IPCC). The IPCC currently estimates the cap for greenhouse gas concentrations (measured in CO2 equivalents) at roughly 450 parts per million (ppm) in order to limit global average warming to 2 degrees Celsius. This corresponds to an average of two tonnes of carbon dioxide equivalent (tCO2e) per capita per year and would amount to a 50 per cent reduction in global emissions by 2050 from 1990 levels (United Kingdom Committee on Climate Change 2008).

The Ecological Footprint[33] threshold is based on the earth's biological capacity, measured as the amount of biologically productive land and water available per person.[34]

Finally, the Dashboard of Sustainability also includes the Inclusive Wealth Index (UNU-IHDP and UN Environment 2014) to take into account changes in the overall stocks of capital. The "threshold" used for the Inclusive Wealth Index is that it does not show a negative change (that is, human and natural assets are not being depleted).

Table 2 presents the indicators in the Dashboard of Sustainability, their coverage and their sources.[35]

Figure 2 presents a graphic of Index and Dashboard indicators.

Table 2. Dashboard of Sustainability indicators

Indicator	Country coverage	Threshold	Data source
Freshwater withdrawal (m3/capita/year)	79	585 m3/capita/year	WDI
Greenhouse gas emissions, excluding land-use change and forestry (CO2 e/capita/year)	104	2 tons/capita/year	CAIT[36], World Resources Institute
Nitrogen emissions (kg/capita/year)	102	5 kg/capita/year	FAO through UN Environment GRID
Land use (share of land used for permanent crops)	104	15% land use for permanent crops	FAO through UN Environment GRID
Ecological Footprint (global hectares/capita)	92	1.72 global hectares/ capita	Global Footprint Network
Inclusive Wealth Index (millions of constant 2005 USD/ capita)	100	Non-negative change	UNU-IHDP and UN Environment

Abbreviations: WDI = World Development Indicators; CAIT = Climate Analysis Indicator Tool (World Resources Institute); FAO = Food and Agriculture Organization; GRID = UN Environment Global Resource Information Database; UNU-IHDP = United Nations University – International Human Dimensions Programme on Global Environmental Change.

Source: PAGE (2017b).

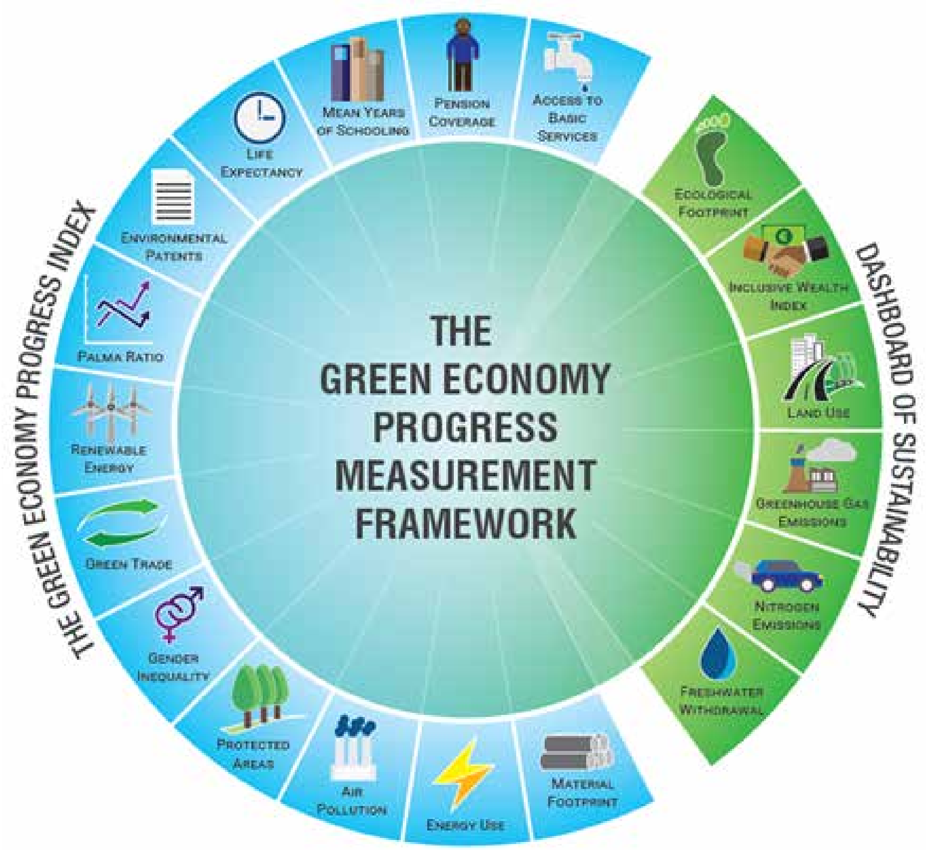
33 The Ecological Footprint has been widely used for communication purposes, although it is not supported by the broad scientific community. It is used in this study because it is available for a wide range of countries and time periods.

34 For more information, see http://www.footprintnetwork.org/. Data are for 2011.

35 The coverage of 105 countries is restricted by the calculation of the GEP index. The number does not represent full coverage by any of the indicators in the Dashboard.

36 CAIT Climate Data Explorer, available at https://cait.wri.org/

Figure 2. Indicators in the global application of the Green Economy Progress Measurement Framework



Source: PAGE (2017b).

"GOODS" AND "BADS"

The GEP Measurement Framework makes a distinction between "goods" and "bads". When the amount of "goods" increases, society is making progress towards an IGE. When the amount of "bads" increases, society is moving further from an IGE (i.e., society is regressing). For example, an increase in inequality will, by definition, reduce inclusiveness and reduce current human wellbeing. (This is why an increase in this indicator will be associated with a regress.) Therefore, inequality is considered a "bad". In contrast, an increase in the share of green trade is associated with potential economic and employment opportunities and will result in progress towards an IGE. Therefore, green trade is considered a "good". Table 3 lists the 19 indicators of the GEP Measurement Framework according to their effect on the outcome of progress.

Table 3. Classification of indicators in the GEP Measurement Framework

"Goods"	"Bads"
Green trade	*Energy use*
Green innovation (environmental patents)	*Inequality (Palma ratio)*
Renewable energy	*Air pollution*
Access to water/sanitation/electricity	*Material footprint*
Protected areas	*Gender inequality*
Education	**Greenhouse gas emissions**
Life expectancy	**Freshwater withdrawal**
Pension coverage	**Land use**
Inclusive Wealth Index	**Nitrogen emissions**
	Ecological footprint

Note: Indicators in italic are included in the GEP Index, those in bold are in the Dashboard of Sustainability.

Source: PAGE (2017b).

TARGETS AND THRESHOLDS

To aid policymaking, the GEP framework suggests a data-driven approach to setting targets for improvement on the GEP Index indicators and for setting thresholds for the indicators on both the GEP Index and the Dashboard of Sustainability. These goals and thresholds are calculated through comparison with countries at a similar level of human development. This approach helps to keep the targets and thresholds realistic and achievable.

A. Targets

In practice, the target y^* is determined for each country by calculating the λ[37] (for a "good") or the β (for a "bad") using a relevant comparison group (e.g., countries with similar levels of human development according to the Human Development Index (HDI)). The idea is to multiply each country's initial value, y^0, with the value of λ or β (depending on whether y is a "good" or a "bad") achieved by the 10 per cent most improved countries in the relevant comparison group.

This data-driven approach helps to set targets that are ambitious but feasible according to the characteristics of the relevant comparison group of countries.

The temporal period considered for the calculation of the GEP Index is 2004–2014. A target, y^*, will be defined as $y^*=\lambda y^0$ (in the case of a "good" and if $y^0>t$) and $y^*=y^0$ (in the case of a "bad" and if $y^0<t$), where t is the threshold.

> For a "good" a country's target is to reach the level of the 10 per cent most improved countries among those with similar HDI levels.

As noted, for a "good", a country's target is calculated on the basis of the 10 per cent most improved countries in the distribution.[38] That is, a country should set the target of increasing y to at least as much as the 10 per cent most improved- countries in its comparison group have done. Similarly, for a "bad", the country should set its target to reduce y as much as

[37] For a "good" λ represents the ratio between the final (y^1) and initial (y^0) values for each indicator for the 90th percentile of the distribution of countries.

[38] A country's target is calculated by multiplying its initial value with the λ of the 10 per cent best performing countries.

achieved by the 10 per cent best performing countries in the comparison group.[39]

B. Thresholds

The thresholds of indicators in the Dashboard and of some indicators in the GEP Index are **determined on the basis of scientific literature**, while other thresholds in the GEP Index are empirically calculated, as described below. In the GEP Index internationally recognized scientific sources are used for environmental indicators, including recommendations on air pollution from the World Health Organization (WHO 2014); on material footprint per capita from Bringezu (2015); and on protected areas from Aichi Biodiversity Targets (Leadly et al. 2014).

As for **thresholds not based on scientific literature**, the value of the threshold for "goods"[40] is set at the value of the 25th percentile of the distribution in 2004. Countries should never go below the value achieved by the bottom 25 per cent of countries in 2004 for this indicator. Similarly, for "bads" the value of the threshold is set at the value of the 75th percentile of the distribution in 2004. Countries should never go above the value achieved by the bottom 75 per cent of countries in 2004 for these indicators.

For "goods" the value of the threshold is set at the value of the 25th percentile of the distribution in 2004.

Finally, to assess GEP within planetary boundaries, the progress achieved in the GEP Index indicators is compared with the progress made in the indicators of the Dashboard of Sustainability. The purpose of this comparison is to highlight whether planetary boundaries have been overstepped.

Review and discussion questions for Session 4

- How do the indicator selection criteria for the global application constrain the analysis?
- Of the 13 indicators that contribute to the GEP Index, which report on the physical environment? On population access to resources and services? On social inclusiveness and equity?
- Which one of the six Dashboard indicators is a "good" rather than a "bad"?
- What are the two ways that thresholds are determined?

[39] For a "bad" β represents the ratio between the final (y^1) and initial (y^0) values for each indicator for the 10th percentile of the distribution. A country's target is calculated by multiplying its initial value with the β of the 10 per cent best performing countries.

[40] Note that the Inclusive Wealth Index is the only "good" on the Dashboard of Sustainability. The five other indicators are "bads". See Table 3.

Session 5. Results of the Global Application[41]

Key points

- Countries made greatest progress in reducing energy use and gender inequality, improving education and increasing life expectancy. Progress has been less – and many countries have regressed – in areas such as material footprint and air pollution.
- On the overall GEP Index, 83 of the 105 countries made progress.
- The Dashboard of Sustainability shows that, on average, countries' sustainability indicators regressed and often overstepped planetary boundaries.

I. Results for Progress in the Single Indicator Case (GEP Index)

Given data availability, the global application was able to apply the GEP Measurement Framework to calculate progress for 13 indicators for the two data points of analysis, 2004 and 2014, for a total of 105 countries.[42] Table 1 presents summary statistics for these 13 indicators (later aggregated into the GEP Index; see section II). On average, progress by countries in the sample was greatest on the indicators measuring education, life expectancy, gender inequality and energy use (meaning that education and life expectancy increased while gender inequality and energy use decreased). At the same time, material footprint and air pollution saw, on average, the most substantial regressions (that is, material footprint and air pollution increased).

Countries made most progress in education, life expectancy, gender inequality and energy use.

[41] José Pineda prepared this session.

[42] For some indicators cut-off values were used, for example for a country starting at a very high level and for which it is almost impossible to achieve further progress (e.g. a country with more than 97 per cent of access to basic services), or if the country started at a very low level for which achievements may be magnified because of data measurement problems (e.g. a country starting with 0.1 per cent access to basic services and that achieved a 0.2 per cent coverage). In these extreme cases, the value was substituted by a missing value for the corresponding indicator and progress was measured based on achievements in the remaining indicators.

Table 1. Progress on an Inclusive Green Economy, by indicator – full sample

Variable	Number of observations	Mean	Standard Deviation	Minimum	Maximum
Material footprint	104	−1.83	5.57	−52.53	1.43
Air pollution	105	−0.13	0.89	−5.70	1.23
Protected areas	101	0.15	0.35	−0.04	2.44
Energy use	102	0.37	0.46	−1.43	2.03
Green trade	93	0.10	0.30	−0.28	1.61
Environmental patents	54	0.13	0.98	−0.92	5.98
Renewable energy	101	0.04	0.36	−0.78	1.11
Palma ratio	96	0.06	0.68	−2.04	1.74
Gender inequality	98	0.39	0.30	−0.28	1.46
Access to basic services	71	0.38	0.23	−0.05	1.00
Mean years of schooling	103	0.39	0.25	−0.42	1.04
Pension coverage	66	0.22	0.96	−4.55	2.19
Life expectancy	103	0.39	0.20	−0.32	1.48

Source: PAGE (2017b).

Table 2 present the progress made in these single indicators for the 20 countries with the highest average progress on all indicators. Table 3 presents the results for the 20 countries with the lowest average progress.

Table 2. Progress toward an Inclusive Green Economy for the 20 countries with the highest average progress, by indicator

	Material footprint	Air pollution	Protected areas	Energy use	Green trade	Environmental patents	Renewable energy	Palma ratio	Gender inequality	Access to basic services	Mean years of schooling	Pension coverage	Life expectancy
Cyprus	0.04	0.08	0.01	0.37	0.51	5.98	0.82		0.19		0.38	0.42	0.19
Poland	−0.31	0.36	0.63	0.74	0.06	0.30	0.71	1.68	0.38	−0.01	0.21	0.83	0.36
Tunisia	0.13	0.07	0.08	0.44	0.56		0.20	0.88	0.64	0.47	0.95		0.25
Slovenia	−0.11	0.32	2.30	0.39	0.02	−0.35	0.12	0.11	1.00		0.08		0.56
Paraguay	−0.18	0.76	0.11	0.36			−0.11	0.60	0.35	0.87	0.81		0.30
Norway	−0.11	1.23	0.21	−0.03	0.11	0.17	−0.05	0.80	0.55		0.28	1.00	0.39
Switzerland	−0.08	0.35	0.08	0.55	−0.02	0.59	0.04		1.03		0.49		0.53

	Material footprint	Air pollution	Protected areas	Energy use	Green trade	Environmental patents	Renewable energy	Palma ratio	Gender inequality	Access to basic services	Mean years of schooling	Pension coverage	Life expectancy
Dominican Republic	0.79	0.50	−0.04	1.00	0.29		−0.16	0.47	0.08	0.13	0.43		0.32
Namibia	−0.42	1.10	0.50	0.07	0.13		−0.41	0.24	0.30	0.63	0.28	0.87	0.66
Slovak Republic	−0.64	0.39	0.34	1.19	0.02	0.88	0.07	0.21	0.42		0.38		0.31
Ireland	0.26	−1.37	0.29	0.60	0.10	0.52	1.11	0.49	0.63		0.41		0.51
Italy	0.09	0.23	0.37	0.21	0.02	−0.68	1.00	0.29	1.02		0.39	0.46	0.46
Austria	−0.06	0.36	0.00	0.19	0.05	−0.06	0.37	0.07	0.84		0.51	1.00	0.37
Peru	−0.28	0.24	0.31	0.04	0.24	0.55	−0.33	1.02	0.39	0.61	0.29		0.53
Philippines	−0.50	−0.11	0.00	0.87	1.16		−0.16	0.54	0.32	0.53	0.30		0.23
El Salvador	0.02	−0.28		0.39	0.36		−0.05	1.00	0.37	0.38	0.61	0.04	0.31
Thailand	−1.12	−0.02	0.03	−0.08	0.21		0.06	0.36	0.42	0.44	0.50	2.19	0.42
Portugal	−0.10	−0.38	0.02	0.39	0.10	−0.43	0.46	0.73	0.63		0.55	1.00	0.43
Germany	0.03	0.35	0.19	0.50	0.06	0.14	0.25	−0.45	0.92		0.70		0.33
Czech Republic	−0.19	0.40	0.16	0.72	0.07	0.24	0.57	0.16	0.82		−0.42		0.39

Source: PAGE (2017b). Empty cells are missing values.

Table 3. Progress toward an Inclusive Green Economy for the 20 countries with the lowest average progress, by indicator

	Material footprint	Air pollution	Protected areas	Energy use	Green trade	Environmental patents	Renewable energy	Palma ratio	Gender inequality	Access to basic services	Mean years of schooling	Pension coverage	Life expectancy
Ghana	−2.85	0.04	0.00	0.71	0.01		−0.34	−0.58	0.12	0.63	0.24	0.07	0.34
Zambia	−1.58	−0.78	0.03	0.91			0.07	−1.33	0.09	0.15	0.21	0.21	0.53
Mali	−2.98	0.02	0.24		0.00			0.42	0.12	0.18	0.22	0.06	0.31
South Africa	0.03	−0.59	0.11	0.25	−0.05	−0.67	−0.16	−2.04	0.27	0.71	0.27		−0.21
Algeria	−3.12	0.03	0.08	−0.15	0.01	−0.66			0.63	−0.05	0.74	0.27	0.26
Costa Rica	0.35	−4.37	0.03	0.03	0.03		0.22	−0.29	0.52	0.35	0.09	0.39	0.22
Yemen, Rep.	−1.93	0.03	0.07	−0.42			−0.04	−0.84	0.22	0.25	0.38		0.20

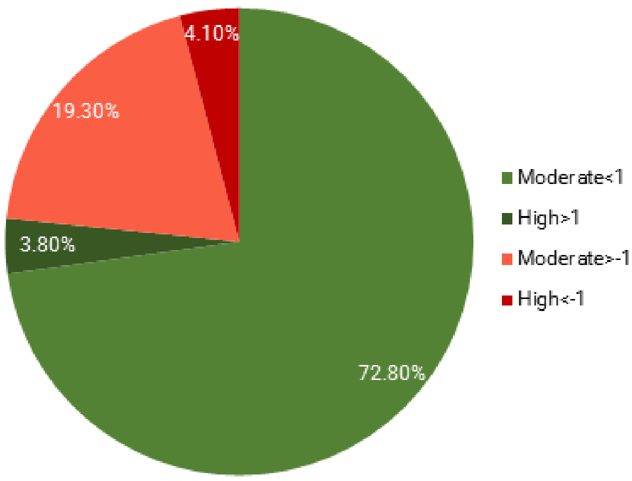
	Material footprint	Air pollution	Protected areas	Energy use	Green trade	Environmental patents	Renewable energy	Palma ratio	Gender inequality	Access to basic services	Mean years of schooling	Pension coverage	Life expectancy
United States of America	0.17	0.09	0.02	0.53	−0.02	−0.13	0.17	−0.86	0.11		0.14	−2.95	0.23
Angola	−4.78	−0.61	0.00	1.00			−0.44	1.74		0.39	0.11	0.20	0.28
Indonesia	−3.89	0.03	0.26	0.53	0.00		−0.14	−0.97	0.26	0.50	0.34	0.09	0.47
Georgia	−3.99	−0.13	0.00	0.82	−0.01	−0.44	−0.36	−0.18		0.34	0.17	0.50	0.31
Albania	−6.43	0.33	0.23	0.86	−0.08		0.10	0.26	0.91	0.24	0.22	−1.13	0.40
Latvia	−0.62	−5.70	0.08	0.45	0.06		0.13	−0.22	0.24	0.00	0.66		0.39
Vietnam	−6.58	−0.05	0.05	−0.14	0.38		−0.61	0.17	0.19	0.80	0.98		0.25
Azerbaijan	−4.08	0.17	0.04	2.03	−0.28		0.36	−0.50		0.60	0.14	−4.55	0.59
Benin	−5.78	0.02	0.02	−0.59	0.06		−0.40	−0.73	0.18	0.18	0.32	0.32	0.36
Tajikistan	−8.64	0.22	0.05	1.17			−0.06	0.16	0.27	0.25	−0.05	−0.65	0.53
Cambodia	−12.5	0.02	0.06	0.75			−0.36	−0.04	0.40	0.49	0.75	0.75	1.48
Mongolia	−13.6	0.09	0.01	0.66			−0.51	−1.48	0.29	0.53	0.33	1.00	0.66
Moldova	−52.5	0.45		0.62	0.08	1.00	0.10	0.82		0.34	0.63	−0.67	0.24

Source: Authors' calculations. Empty cells are missing values.

Countries made progress in 77 per cent of the indicators in the GEP Index (Figure 1). They made moderate progress (values between 0 and 1) in 73 per cent of indicators, while they beat their targets in 4 per cent of indicators (values >1). At the same time, however, countries regressed in one fourth of the indicators, with substantial declines (values <−1) in slightly more than 4 per cent of these indicators.

Countries made progress in 77 per cent of the indicators.

Figure 1. Percentage of progress and regress on Inclusive Green Economy indicators, 105 countries



Source: PAGE 2017b.

Note: progress in green, regressions in red. Average percentages for 105 countries.

For most countries, over the time periods compared (2004 and 2014), progress has been most significant on life expectancy, gender inequality, protected terrestrial areas and energy use. While indicators on material footprint, renewable energy, air pollution, Palma ratio, green trade and environmental patents show the highest number of countries with regressions.

THE GEP INDEX: MEASURING PROGRESS IN THE MULTIDIMENSIONAL CASE

A positive value of the GEP Index indicates a country's overall progress (i.e., the weighted sum of positive changes in "goods" and negative changes in "bads" outweighs the weighted sum of negative changes in goods and positive changes in "bads"), while the opposite is true for a negative value. Table 4 summarizes statistics for the 13 indicators[43] in the GEP Index calculated for the 105 countries. More than 75 per cent of these countries made overall progress, as indicated by positive values in green. The average country experienced progress, although there were some countries that experienced substantial regress. The median value of the sample is 0.12, with the bottom 10 percentile having a value lower than −0.09 and the 90 percentile having a value of 0.37. Figure 4 presents the kernel distributions of the GEP Index for the entire sample, excluding the only country for which regress was more than −0.99, which constitutes a move in the "wrong" direction by 100 per cent or more from the desired change or target. The distribution of the GEP Index is relatively symmetrical around 0, with a small positive skew.

More than 75 per cent of 105 countries made overall progress.

Table 4. Summary statistics of the GEP Index

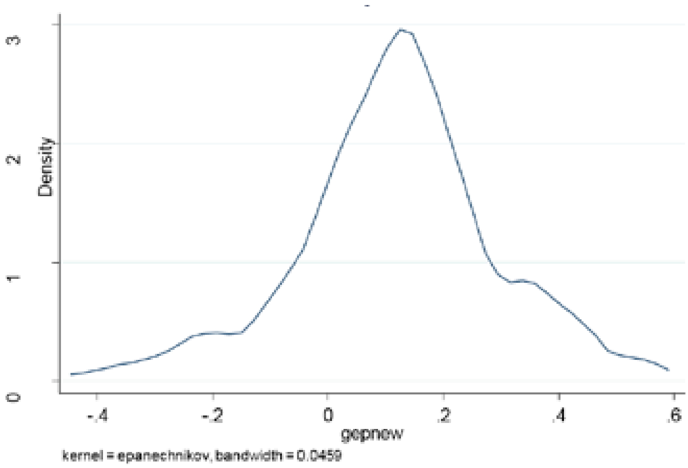
	Number of observations	Mean	Standard Deviation	Minimum	Maximum
GEP Index	105	0.11	0.20	-0.99	0.55

Percentiles	1%	5%	10%	25%	50%	75%	90%	95%	99%
GEP Index value	**−0.40**	**−0.22**	**−0.09**	0.02	0.12	0.20	0.37	0.39	0.52

Source: PAGE (2017b).

[43] The availability of indicators was reviewed to determine the sample of countries: Only 11 countries had all 13 indicators; 48 countries had 12 or more indicators; 88 countries had 11 or more indicators, while 105 countries (the selected sample) had 10 or more indicators. For countries with missing values, weighting in the GEP Index is adjusted.

Figure 4. GEP Index kernel density estimate



Source: PAGE 2017b.

Note: Sample of 104 countries, excluding the one country with GEP <−0.99. The shape of the distribution for the entire sample of 105 countries is similar to this one, for 104 countries; the left tail is longer when the outlier is included.

The GEP Index is computed in two steps, following equations [4] and [4'] in Session 2, section IV.[44] Consider Colombia as an example. The indicator showing the most significant regress is material footprint. The initial condition of Colombia's indicator already exceeded the sustainability threshold (y_0=6.10 versus t=5). Under these conditions the target value is at least the threshold; this is why the target and threshold are both 5. However, the final value increased, moving Colombia further from the sustainability threshold for this indicator (a move in the wrong direction, implying ,regress, y_1=7.87 versus t=5). Following equation [4'], the non-normalized weights $\hat{\pi}$ for Colombia are computed first (fifth row of Table 5). For the case of material footprint this weight is 1.22, indicating that the initial value exceeds the threshold by 22 per cent and progress is needed in this area. Second, the normalized weights π are computed (sixth row of Table 5) by dividing each weight $\hat{\pi}$ by the sum of the weights $\hat{\pi}$. For the case of material footprint, this second weight is 0.12, indicating that making progress in this indicator should be a priority (in fact, for Colombia the second weights indicate that reducing income inequalities, increasing protected areas and reducing material footprint are the most important priorities, together accounting for almost 40% of the total weight used to calculate the GEP Index).

The weighting system for Colombia illustrates some interesting aspects of the methodology. Colombia is experiencing regress in four of the 13 indicators and progress in nine of the 13. For material footprint (one of the indicators showing regress), the weight is relatively high and the regress was substantial. (The value less than −1 indicates that the change in absolute value was greater than the target but in the opposite direction.) This component alone contributes −0.19 to the GEP Index (0.12*−1.62=−0.194); this is more than 10 times the contribution of the indicator with the largest progress, energy use (0.04*0.46=0.018). Thus, the Colombian example illustrates how the GEP weighting system gives information about priorities a country might adopt based on targets.

Following equation [4'] in Session 2, section IV, the GEP Index is calculated by multiplying the normalized weights π by each value of progress on each indicator and summing these values. The resulting value of the GEP Index for Colombia is −0.02.

Figure 5 shows the values of the GEP Index for each of the 105 countries in the sample[45]. Most of the countries are above the 0 line, meaning that they are making progress towards an IGE. However, some countries regressed substantially, e.g., Mongolia (MNG) and Uruguay (URY).

Figure 6 maps the GEP Index for the 105 countries in the sample. The 83 countries that made progress are presented in green. The darker the green, the greater the progress toward an IGE, as measured by the GEP Index. Many countries that have made the most progress are developing countries. The 22 countries that experienced regress are presented in red, with the darker red areas indicating countries with the most substantial regression.

> Many of the countries that have made the most progress towards an IGE are developing countries.

[44] See PAGE (2017b). Annex II of this manual describes the computation steps in detail.

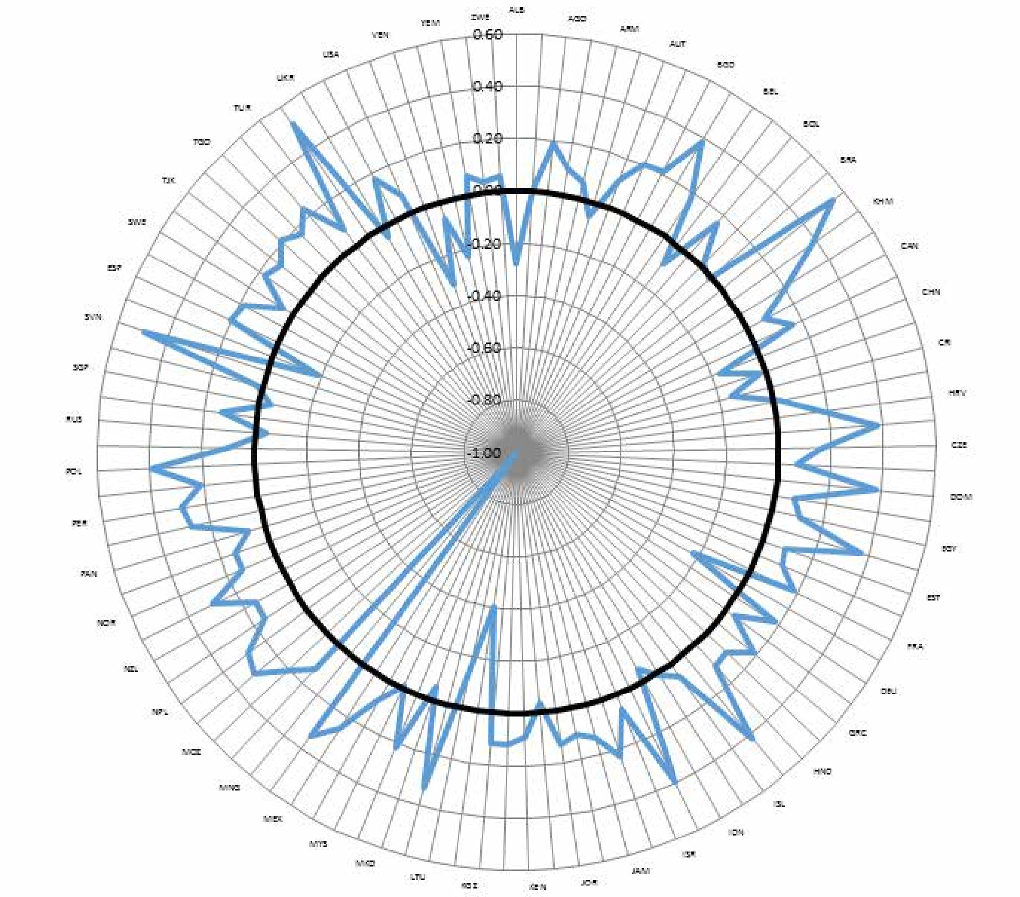
[45] See Annex IV of PAGE (2017b) for the values of the GEP index and progress on individual indicators for all countries in the sample. [https://www.un-page.org/green-economy-progress-measurement-framework.](https://www.un-page.org/green-economy-progress-measurement-framework)

Table 5. Example of the computation of the GEP Index for Colombia

	Material footprint	Air pollution	Protected areas	Energy use	Green trade	Environmental patents	Renewable energy	Palma ratio	Gender inequality	Access to basic services	Mean years of schooling	Pension coverage	Life expectancy
Initial value, y_o	6.10	5.26	12.21	72.59	0.90	0.010	24.92	2.21	0.51	86.03	6.5	13.80	71.09
Final value, y_1	7.87	5.41	18.48	61.83	0.49	0.014	22.94	2.07	0.46	88.76	7.18	23.00	73.14
Target	5.00	4.50	67.44	49.03	3.58	0.02	41.53	1.57	0.35	100	8.85	70.56	76.74
Threshold, t	5.00	10.00	13.50	179.09	0.47	0.008	5.42	1.57	0.59	57.92	4.16	5.50	62.02
Weights $\hat{\pi}$	1.22	0.53	1.33	0.41	0.52	0.82	0.22	1.41	0.88	0.67	0.71	0.40	0.87
Weights π	0.12	0.05	0.13	0.04	0.05	0.08	0.02	0.14	0.09	0.07	0.07	0.04	0.09
Progress	−1.62	−0.19	0.10	0.46	−0.15	0.41	−0.12	0.23	0.30	0.20	0.29	0.16	0.36

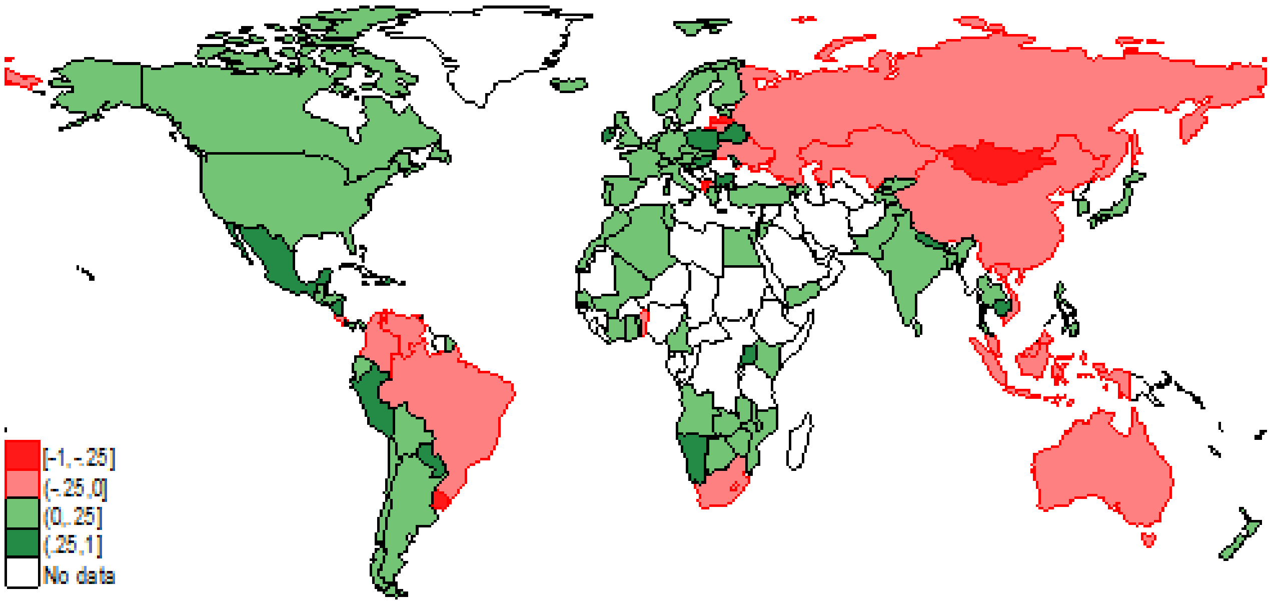
Source: PAGE (2017b).

Figure 5. GEP Index (sample of 105 countries)



Source: adapted from PAGE (2017b).

Figure 6. **GEP Index for 105 countries**



Source: PAGE (2018b).

Table 6 presents the results for countries grouped by their scores on the Human Development Index (HDI) for the entire sample of 105 countries.[46]

Table 6. **GEP Index by HDI groups, sample of 105 countries**

HDI group	Number of observations	Mean	Standard deviation	Minimum	Maximum
Very high	37	0.16	0.14	−0.16	0.49
High	28	0.04	0.21	−0.40	0.55
Medium	22	0.09	0.30	−0.99	0.38
Low	18	0.14	0.13	−0.09	0.52

Source: PAGE (2017b).

46 The sample of 105 countries with values of the GEP index is divided across HDI groups as follows: 37 countries with very high HDI scores, 28 countries with high scores, 22 countries with medium scores and 18 countries with low scores. The four categories of Human Development Index scores used in Tables 6–8 are obtained using the cut-offs 0.800 for Very High, 0.700 for High and 0.550 for Medium. See UNDP (2014).

Table 7 presents the results grouped by region for the entire sample of 105 countries.[46]

Table 7. GEP Index by region, 105 countries

	Number of observations	Mean	Standard deviation	Minimum	Maximum
MENA	6	0.11	0.08	0.00	0.23
EAP	8	−0.08	0.42	−0.99	0.38
ECA	13	0.10	0.23	−0.28	0.55
LAC	19	0.12	0.18	−0.32	0.38
South Asia	5	0.16	0.10	0.07	0.28
Sub-Saharan Africa	17	0.12	0.16	−0.19	0.52
Developed countries	37	0.14	0.17	−0.40	0.49

Source: PAGE (2017b).

Abbreviations: MENA = Middle East and North Africa; EAP = East Asia and the Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; "Developed" are all countries with very high HDI (>0.8) that do not belong to any of these regions.

The results across regions and human development groups reveal important differences. The left panel of Figure 7 suggests some observations about regional differences:

- Results among countries are most diverse in the regions of East Asia and the Pacific (EAP), Latin America and the Caribbean (LAC) and Europe and Central Asia (ECP).
- East Asia and the Pacific is the region where most countries experienced regress (negative GEP Index) – five countries experiencing regress compared with three making progress. This result is driven mostly by substantial increases in the per capita material footprint of these countries.
- Countries in South Asia and in the Middle East and North Africa are leading green economy progress; all of them have positive GEP Index values.

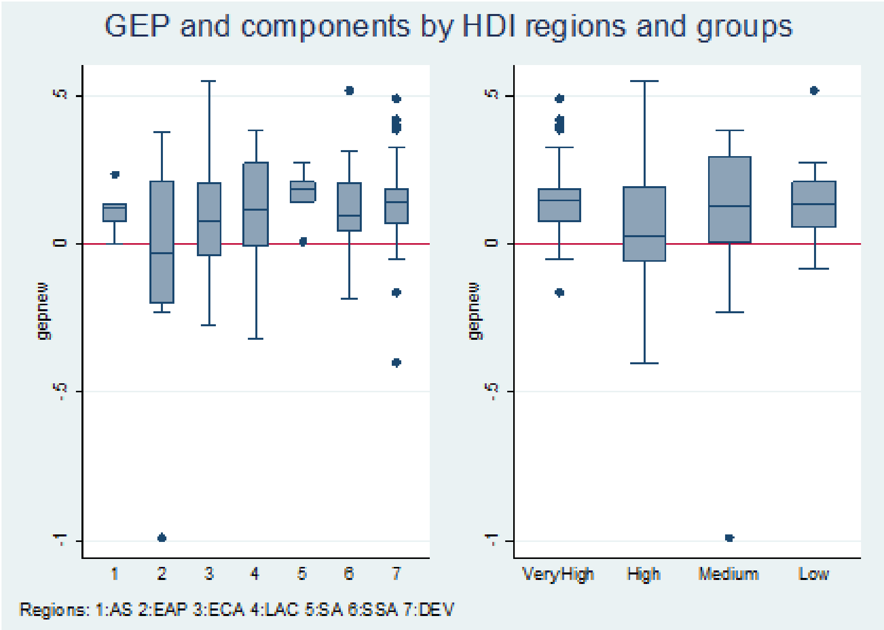
Countries in South Asia and in the Middle East and North Africa are leading green economy progress.

- Half of the countries in Latin America and the Caribbean, sub-Saharan Africa and the very high HDI countries have made green economy progress.
- The best performing sub-Saharan African country outperforms the best performing South Asian countries and Middle East and North African countries.

In terms of HDI group variations (right panel of Figure 7), results are particularly mixed for the high HDI group: 50 per cent of these countries show a regress (with an average value of −0.13 for the countries experiencing regress and a median value for the group of 0.03). However, in the other HDI groups the majority of countries experienced progress – 34 of 37 countries in the very high HDI group, 18 of 22 countries in the medium HDI group and almost all countries (17 of 18) in the low HDI group, with median values of the GEP Index of 0.15, 0.13 and 0.14, respectively.

[47] The sample of 105 countries with a value of the GEP index is divided across regions as follows: 6 countries in Middle East and North Africa; 8 countries in East Asia and the Pacific; 13 countries in Europe and Central Asia; 19 countries in Latin America and the Caribbean; 5 countries in South Asia; 17 countries in sub-Saharan Africa; and 37 countries considered developed (all countries with HDI very high, i.e., greater than 0.8).

Figure 7. GEP Index results by region and HDI group



Source: PAGE (2017b).

Note: The regions in Figure 7, left panel, are: 1) Middle East and North Africa; 2) East Asia and the Pacific; 3) Europe and Central Asia; 4) Latin America and the Caribbean; 5) South Asia; 6) sub-Saharan Africa; and 7) All countries with very high HDI (HDI>0.8) that do not belong to any of these regions (UNDP 2014). The four categories of human development achievement (right panel) were grouped according to the HDI values using the cut-offs of 0.800 for Very High, 0.700 for High and 0.550 for Medium.

THE DASHBOARD OF SUSTAINABILITY: MEASURING PROGRESS AGAINST PLANETARY BOUNDARIES

This section presents progress in the Dashboard of Sustainability indicators (using the same methodology used to measure progress for an individual indicator) for the 105 countries for which it was possible to calculate the GEP Index.[48]

The Dashboard indicators paint a darker picture than the GEP Index. On average, countries are experiencing regress in the dashboard indicators (Table 12). In other words, on average countries are exceeding planetary boundaries. The only indicator for which the majority of countries are making progress is the Inclusive Wealth Index, with an average progress of 0.31. One striking result, represented by minimums less than −1 in Table 8, is that, across all indicators, some countries are experiencing substantial regress (progress lower than −1). Also, no country has a progress value greater than 1 (that is, exceeding the target) for greenhouse gas emissions, one of the areas in which there are significant global concerns in terms of environmental sustainability (Rockstrom et al. 2009).

On average, countries are exceeding planetary boundaries.

[48] See PAGE (2017b) Annex IV for complete results of the dashboard indicators for the 105 countries in the sample.

Table 8. Summary of dashboard indicators (sample of all 105 countries with GEP Index)

Indicator	Number of observations	Mean	Standard deviation	Minimum	Maximum
Freshwater withdrawal	79	−0.07	1.65	−10.93	1.28
Greenhouse gas emissions	104	−0.31	0.68	−3.74	0.84
Emissions of nitrogen	102	−0.35	1.11	−5.07	1.48
Land use	104	−0.31	1.03	−4.24	1.54
Ecological Footprint	92	−0.34	0.82	−4.95	1.02
Inclusive Wealth Index	100	0.31	0.52	−1.11	1.84
Inclusive Wealth Index (natural capital only)	100	−5.84	7.48	−26.41	5.21

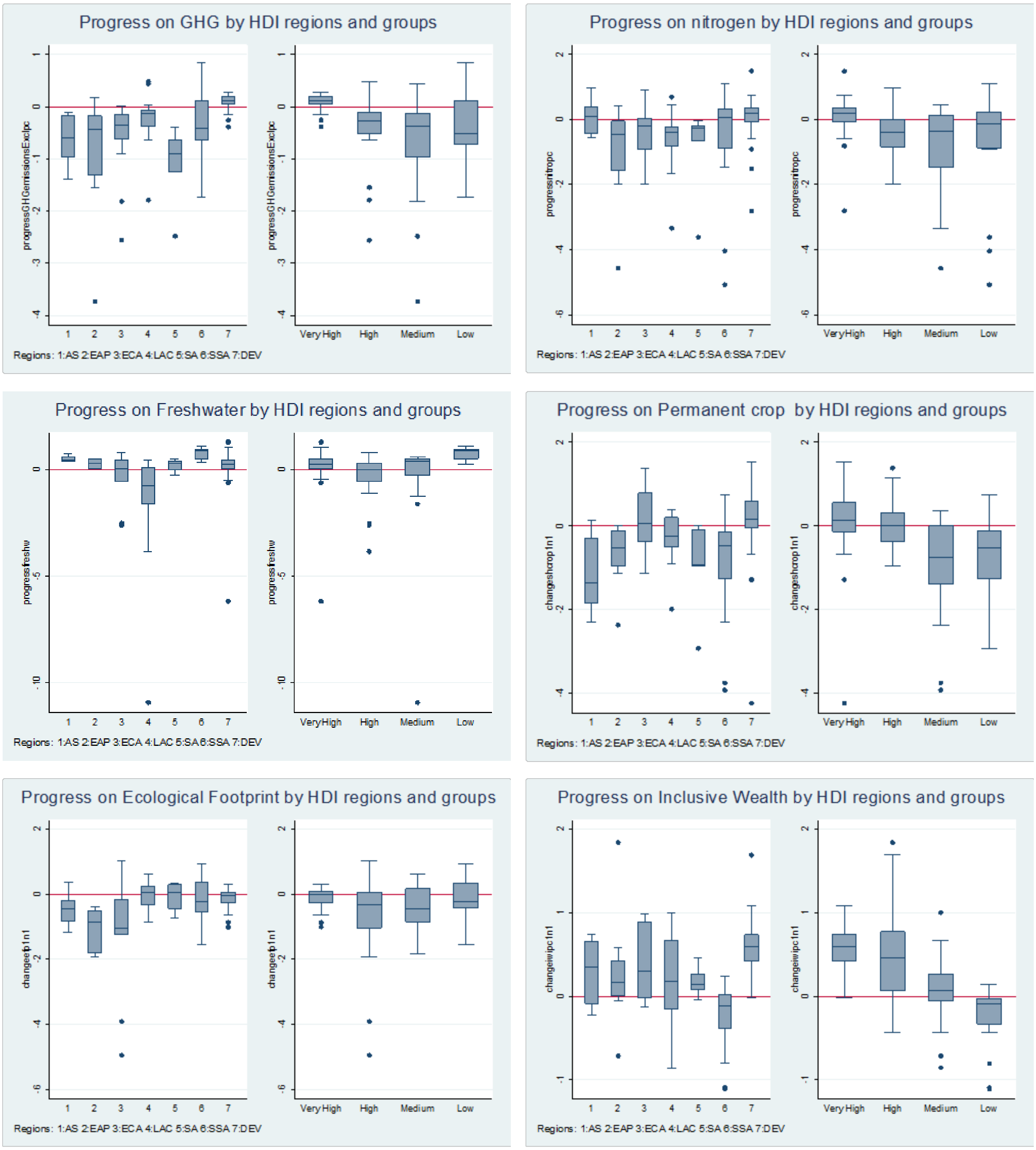
Source: PAGE (2017b).

As Figure 8 shows, there are major differences in progress made on the dashboard indicators by region and by HDI group. In particular, there are important differences among groups for indicators for which the majority of countries are regressing, such as greenhouse gas emissions and Ecological Footprint. In the case of greenhouse gas emissions, most of what progress did take place occurred in very highly developed countries. For Ecological Footprint the worst performance is concentrated in East Asia and the Pacific and in Europe and Central Asia. Heterogeneous patterns can be observed for some other indicators, such as the Inclusive Wealth Index: Most of the regions made progress on the Inclusive Wealth Index, but sub-Saharan African countries experienced regress.

There are simlarities as well as differences among HDI groups. Most countries in the different HDI groups made progress in freshwater withdrawal (reducing freshwater withdrawal).[49] However, the majority of countries across HDI groups regressed in their Ecological Footprint. With respect to the share of land used for permament crops, progress was achieved mostly in the very high HDI group, while regress was seen mostly in the medium and low HDI groups (and there were mixed results for the high HDI group). As for the Inclusive Wealth Index, again the very high HDI group made the most progress, while each sucessive HDI group made progressively less progress (due mostly to the regress of countries in the sub-Saharan Africa region).

[49] In the high HDI countries group, the number of countries with progress and regress were equal (nine countries each).

Figure 8. Progress on dashboard indicators by regions and HDI groups



Source: PAGE 2018b.

Note: The regions in Figure 8, left panels, are: 1) Middle East and North Africa; 2) East Asia and the Pacific; 3) Europe and Central Asia; 4) Latin America and the Caribbean; 5) South Asia; 6) sub-Saharan Africa; and 7) all countries with very high HDI (HDI>0.8) that do not belong to any of these regions (UNDP 2014). The four categories of human development achievement (right panels) were grouped according to the HDI values using the cut-offs of 0.800 for Very High, 0.700 for High and 0.550 for Medium. Abbreviations: HDI = Human Development Index; GHG = greenhouse gases.

GEP+: OVERALL COUNTRY RANKING USING THE GEP INDEX AND THE DASHBOARD OF SUSTAINABILITY

The Protective Criterion allows us to order countries in terms of their worst achievement. It can be used to produce a ranking of all GEP Index–Dashboard profiles but not to combine the GEP Index and Dashboard information into a synthetic index (UNEP 2017). The use of the Protective Criterion gives an intuitive answer to the question: Which country is making the most overall progress? The Protective Criterion helps to simplify comparing countries in a multidimensional setting and has the advantage of synthesizing the information in a meaningful way by comparing countries based on the indicator on which they have made the least progress.

Due to sample restrictions, only the results for the Dashboard indicators of greenhouse gas emissions, nitrogen emissions and share of land used for permanent crops are presented in this section; samples of at least 100 countries for the 2004 and 2014 periods are available for these indicators.[50] PAGE (2017b) Annex V presents the full ranking results.

Only 17 countries in our sample made progress (or no regress) in the three Dashboard of Sustainability indicators and also had positive GEP Index scores. Comparisons among similar countries seem more useful than this statistic, however. Table 9 presents the results for the top four countries in each HDI group, showing how the Protective Criterion works in determining the ranking within each HDI group.[51,52] In the Very High HDI group, all four top countries have made progress on all indicators. Cyprus has the highest rank because its smallest progress, in land use, is higher than the least progress of any other country in this group. In the case of the High HDI group, Jamaica is the country with the highest ranking because it is the only country in this group with all indicators showing progress. In the Medium HDI group, there is no country with progress in all indicators, but Dominican Republic is the top-ranked country because its regress on greenhouse gas emissions is the smallest regress among all indicators showing regress in the countries in this group. Finally, in the Low HDI group, Zimbabwe is the country with the highest ranking because it is the only country in this group with all indicators showing positive or zero progress. The rest of countries in this group have experienced regress in at least some indicator.

> Only 17 countries made progress (or no regress) on both the GEP Index and the three Dashboard indicators.

50 Including freshwater withdrawal would reduce the sample size to 74 countries.

51 The sample of 100 countries is distributed across HDI groups as follows: 34 Very High, 27 High, 21 Medium and 18 Low.

52 Remember that the values use to calculate the GEP+ are the GEP index multiplied by the average of across its indicators and a set of weighted progress of the Dashboard $\{\frac{dK_1}{dK_1^*}\hat{\pi}_1, \dots, \frac{dK_J}{dK_J^*}\hat{\pi}_J\}$; for more information, see UNEP (2017).

Table 9. GEP+ profiles ranked using the Protective Criterion (top four countries per HDI group)

HDI group	Rank	Country	Progress: GHG emissions	Progress: nitrogen emissions	Progress: land use	GEP Index	Protective criterion
Very high	1	Cyprus	0.5566	0.5971	**0.1800**	0.5862	0.1800
	2	Portugal	0.9080	0.7315	0.1120	**0.0999**	0.0999
	3	Spain	1.3180	1.7082	**0.0873**	0.2118	0.0873
	4	Italy	0.9423	1.9024	**0.0664**	0.2598	0.0664
High	1	Jamaica	1.1022	0.4906	0.1682	**0.1256**	0.1256
	2	Azerbaijan	**−0.1942**	0.0018	0.0010	0.2512	−0.1942
	3	Jordan	**−0.2369**	2.1228	0.0080	0.1523	−0.2369
	4	Venezuela, RB	**−0.3027**	0.3700	0.0227	−0.0497	−0.3027
Medium	1	Dominican Republic	**−0.2539**	-0.2341	0.0000	0.2801	−0.2539
	2	South Africa	**−0.3429**	0.6564	−0.0059	−0.1977	−0.3429
	3	Philippines	0.1430	0.3621	**−0.3572**	0.1978	−0.3572
	4	Honduras	**−0.3793**	0.6753	−0.1613	0.1329	−0.3793
Low	1	Zimbabwe	0.9104	0.2037	**0.0000**	0.0530	0.0000
	2	Senegal	0.2000	0.0080	**−0.0052**	0.1607	−0.0052
	3	Cameroon	0.8613	0.0657	**−0.1058**	0.2448	−0.1058
	4	Mali	**−0.1776**	1.7463	−0.0061	0.1931	−0.1776

GHG = greenhouse gases

Note: Observations in bold indicate the minimum value among the four indicators in each country. The ranking is based on the following four categories: (a) greenhouse gas emissions; (b) nitrogen emissions; (c) the share of land used for permanent crops; and (d) the GEP Index. If the categories considered changed, the ranking would vary as well. Note that each dashboard indicator is multiplied by its weight, while the GEP Index is multiplied by the average of the weights (see UNEP 2017).

Source: PAGE (2017b).

Review and discussion questions for Session 5

- Which individual indicators in the GEP Index improved in the most countries? Which regressed in the most countries?
- Which regions showed the best progress on the GEP Index?
- Which Dashboard indicators made the most progress? Which regressed most?
- In general, did countries make better progress on the GEP Index or on the Dashboard of Sustainability? What does this imply for sustainable development?

Conclusion

This Advanced Training on Measuring Progress with Inclusive Green Economy (IGE) Indicators has presented an in-depth continuation of the Introductory Training on Green Economy Indicators, which introduced the use of indicators for measuring the state of a society in terms of an Inclusive Green Economy (IGE). This course has gone deeper into the conceptual underpinnings of the GEP Measurement Framework and how it contributes to the "beyond GDP" measurement agenda. In addition, it has explained how progress (or regress) on a single indicator can be measured and how these indicators can be combined into the GEP Index, with its weighting system. The manual also has described how to measure progress on a Dashboard of Sustainability and how to combine this information with the GEP Index to create a system for ranking countries that is informative to policymakers.

The advanced training has illustrated the main characteristics of IGE indicators and how local actors can develop a finite set of metrics for an actual application. To this end, the course has provided operational criteria and methods to select the most suitable indicators at the country level. It explains how countries can choose indicators that reflect their priorities, in accordance with their own narrative of an IGE, and how the Framework could be used across countries for international benchmarking.

The final sessions of the advance training have focused on illustrating how the GEP Measurement Framework serves as a tool for countries to gauge their progress and monitor policy impacts. It has presented the results of a global application of the GEP Measurement Framework, conducted for the periods 2000–2004 and 2010–2014 in 105 countries (PAGE 2017). The GEP Measurement Framework builds both the GEP Index, which is a composite of 13 indicators, and the Dashboard of Sustainability, which presents six separate environmental sustainability indicators. These sessions explained the methodological choices made for the global application, discussing the method for setting goals for improvement and thresholds not to be exceeded.

Finally, the hands-on exercise gave participants the opportunity to replicate the calculations for the global application and to describe, in narrative form, the results for a particular country. Working through this exercise should help to assure that participants take full ownership of the methodology. Since this training manual not only provides participants with the conceptual tools to master the methodology but also the practical application to fully replicate results, participants should understand the details of the GEP Measurement Framework well enough to adapt the methodology to their context and to apply it.

Hands-on Exercise: Applying the GEP Measurement Framework[53]

Key points

- Participants carry out the Stata calculations to generate the GEP Index using the same sample as for the GEP global application.
- Participants prepare and deliver a brief oral report on their findings, suitable for presentation to policymakers for a selected country.

This exercise consists of two main phases. First, after the selection of key indicators, and with in-depth understanding of concepts presented on Session 2, participants will understand and replicate the calculations shown in Session 4 of this manual. Second, participants will prepare and deliver a brief oral report on their findings, suitable for presentation to policymakers for a selected country selected from the sample of the GEP Measurement Framework global application.

Materials: For this exercise a computer with the statistical software Stata is needed. The exercise will need this manual (sessions 2, 4 and the annexes), as well as the Stata .dta and .do files used for the GEP global application, which are available online at https://www.un-page.org/resources/green-economy-learning/training-manuals-indicators-green-economy-policymaking.

Estimated total time: 3 hours

Stata calculations and presentation of results

STEP 1. PRESENTATION OF STATA CODE FOR TWO INDICATORS (ONE GOOD AND ONE BAD)

Depending on the availability of computers, participants could work either individually or in small groups (up to three persons per computer). Groups should be formed according to the countries to be analyzed in the second part of this exercise. If all participants select the same country, groups could be formed freely by participants.

Trainers will explain Annex II. Stata calculations for the GEP Index, discussing its content line by line. The trainer will present the two individual examples of indicators selected in Annex II, making sure that participants understand the calculations and how they relate to Session 2 of the manual. The trainers will then explain how the GEP Index and the GEP+ country rankings are constructed, following Annex II. This first task might take at least 60 minutes.

[53] José Pineda prepared this exercise and the annexes.

STEP 2. REPLICATION OF GLOBAL RESULTS USING STATA

Participants will use the Stata .dta and .do files from the GEP global application to replicate the results discussed in section 4 of PAGE. The Green Economy Progress Measurement Framework – Application (2017). The trainers will be available to answer participants' questions. This second task might take at least 60 minutes.

STEP 3. BRIEF ORAL REPORT ON THEIR FINDINGS

Trainers will explain Annex I as a potential example of a country report based on the results of applying the GEP Measurement Framework methodology. The oral report should be modelled on the report for South Africa presented in Annex I. Each group's presentation should be 7–10 minutes, with 3–5 minutes of questions and answers with other participants and/or the trainer (depending of the number of participants). This third task might take at least 60 minutes for preparation and presentations.

Annex I. Interpreting the Results for South Africa under the Global Application of the GEP Measurement Framework

The GEP Measurement Framework[54] offers a double lens to look at progress towards an Inclusive Green Economy (IGE) – by assessing progress from both individual and multi-dimensional perspectives. The GEP Measurement Framework is composed of the GEP Index, the companion Dashboard of Sustainability indicators and the GEP+ ranking.

The GEP Index reflects weighted progress achieved by countries with respect to targets, set within relevant thresholds, across a combination of social, economic and environmental indicators. The Dashboard of Sustainability indicators monitor progress toward sustainability of well-being. Finally, the GEP+ ranking of countries compares progress based on the GEP index and the Dashboard, based on their least-performing progress. The global application of the GEP Measurement Framework was done for a sample of 105 countries coomparing 2004 and 2014 (taking averages for each indicator between 2000–2004 as the "start" period and averages for indicators between 2010–2014 as the "end" period, due to data restrictions). This annex presents in detail the results of the application for South Africa.[55]

Interpretation of the results and how to use them for policymaking

The GEP Measurement Framework offers the possibility of analysing results not only at the aggregate level (using the Index) but also at the level of individual indicators. In this regard a simple way to see whether South Africa has made progress in a particular area is to review whether the value of the index of the concerned indicator is positive, indicating progress, or negative, indicating regress.

Table 1 shows that South Africa made progress on six of 12 total indicators (indicators with positive value, shown on top row). These six indicators are material footprint, protected areas, energy use, gender inequality, access to basic services and mean years of schooling.

In addition, if the value of the index for a particular indicator is higher than 1, it means that progress in this area exceeded the target, whereas a value above 0 but lower than 1 indicates that progress was made but fell short of the target. Note that none of the six indicators that made progress has a value greater than 1, meaning that progress did not reach the established target. Access to basic services is one area where progress was close to the target.

South Africa experienced regress on the remaining six indicators for which data were available (that is, the index has a negative value for the variable). These indicators are air pollution, green trade, environmental patents, renewable energy, income inequality measured by the Palma ratio and life expectancy.

The weights *($\hat{\pi}$)* of the GEP index (third row of the table) provide us with another dimension for interpreting the results. If the weight value is greater

54 http://un-page.org/resources/macroeconomic-policymaking/green-economy-progress-measurement-framework

55 For the complete set of data for South Africa, see PAGE (2017a).

Table 1. GEP Index and progress on individual indicators for South Africa

	Material Footprint	Air pollution	Protected area	Energy use	Green trade	Environmental patents	Renewable energy	Palma ratio	Gender inequality	Access to basic services	Mean years of schooling	Pension coverage	Life expectancy	GEP Index
Progress	**0.03**	**−0.59**	**0.11**	**0.25**	**−0.05**	**−0.67**	**−0.16**	**−2.04**	**0.27**	**0.71**	**0.27**	**-**	**−0.21**	
Weights $\hat{\pi}$	*0.14*	*0.06*	*0.21*	*0.11*	*0.01*	*0.07*	*0.03*	*0.10*	*0.07*	*0.06*	*0.04*	-	*0.09*	−0.19
Weights π	*1.79*	*0.72*	*2.70*	*1.44*	*0.08*	*0.90*	*0.38*	*1.31*	*0.87*	*0.79*	*0.52*	-	*1.12*	

Note: Progress in bold. Weights in italic. Dashes indicate missing values.

Source: PAGE (2017). The Green Economy Progress Measurement Framework – Application.

than 1, it is the result of one of two things: (a) the initial condition was exceeding the threshold for an indicator that is a "bad" (and must be kept below a certain critical threshold) or (b) the initial condition was below the threshold for an indicator that is a "good" (and must be kept above a certain critical threshold).

The results for the weights $\hat{\pi}$ indicate that South Africa is within the threshold for seven of the 12 indicators (e.g., the initial level of air pollution was below the critical threshold, the share of renewable energy was above the critical threshold, gender inequality was below the critical threshold, etc.). The areas in which South Africa is beyond the threshold are material footprint (e.g., the initial condition is 1.79 times higher than the critical threshold), protected areas, energy use, income inequality (Palma Ratio) and life expectancy. Thus, progress is more urgent in the indicators for which the weight *(*$\hat{\pi}$*)* of the GEP index is greater than 1, since this indicates that these areas are not sustainable under the business-as-usual scenario.

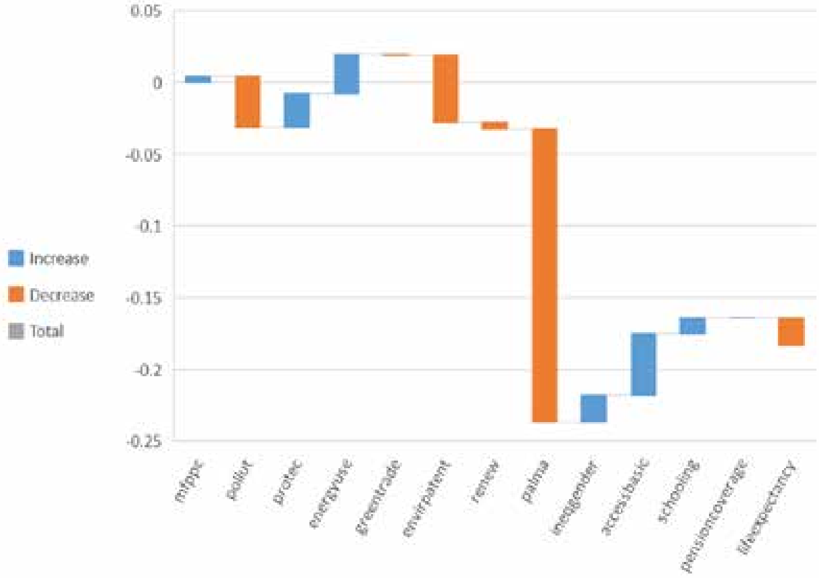
With these indicators progress will be more important, which is why the weights π (second row) are higher.[56] Of these five critical areas, South Africa made progress in three (material footprint, protected areas and energy use), but it regressed in life expectancy and even more so in income inequality.

Regressions under indicators with high weights, such as income inequality (Palma ratio) and life expectancy, induced the value of the GEP Index of South Africa to be −0.19. For instance, if South Africa had not experienced regression on income inequality, and given the performance of other indicators as they currently are, the GEP Index would have been positive. This shows how important it is for South Africa to reduce income inequality; not only does it exceed the threshold, but also it experienced significant regression that pushed the overall GEP Index into the negative. In fact, for the current policymaking process, making progress on income inequality in South Africa will be ever more important, since it is exceeding the critical threshold by an increasing margin (from 1.31 times for the period 2000–2004 to 1.94 times for the period 2010–2014).[57] Figure 1 shows the contribution of each indicator to the final GEP index, highlighting the importance of progress (increase) in access to basic services and the regress (decrease) in the Palma ratio.

56 This weight is a final re-weighting, so it gives information of priorities across the different indicators. The first weight ($\hat{\pi}$) gives information at the indicator level with respect to the critical threshold, while the second weight (π) gives information about priorities across indicators. Indicators will receive a higher second weight the higher their first weight (the further they are from the critical threshold).

57 In South Africa the Palma ratio moved from 2.054 in 2000–2004 to 3.049 in 2010–2014.

Figure 1. Waterfall figure for South Africa



Source: PAGE (2017a).

In terms of progress on the Dashboard of Sustainability indicators and the GEP+ ranking, Table 2 shows that South Africa experienced progress on nitrogen emissions and regress on land use and greenhouse gas emissions. The performance in greenhouse gas emissions is the least progress for South Africa, which is why this value was used to determine its GEP+ ranking.

When South Africa is compared with other countries of similar human development levels (medium Human Development Index (HDI) group), the country ranked second among the 21 countries.[58]

Table 2. Rank GEP+ rank using the Protective Criterion, South Africa

Country	Progress Greenhouse gas emissions	Progress Nitrogen emissions	Progress Land use	GEP Index	Protective Criterion	Rank	HDI group
South Africa	-0.343	0.656	-0.006	-0.198	−0.343	2 (of 21)	Medium

Note: Observations in bold indicate the minimum value among all categories. The ranking is based on four categories: (a) greenhouse gas emissions; (b) nitrogen emissions; (c) the share of land used as permanent crops; and (d) the GEP Index. Note that each dashboard indicator is multiplied by its weight, while the GEP Index is multiplied by the average of the weights (see PAGE 2017a).

Source: PAGE (2017a).

[58] Dominican Republic is ranked first in this group, with a regress in greenhouse gas emissions of -0,254, regress in nitrogen emission of -0,234, zero progress on land use (0,000) and a GEP index of 0,280. If South Africa makes progress –or at least no regress– on greenhouse gas emissions, given the performance of Dominican Republic, it would rank first in the group of medium HDI countries.

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http://un-page.org/files/public/gep_methodology.pdf

Annex II. Stata calculations for the GEP Index

This section presents examples of how to calculate the GEP Index. In particular, the section will review and make brief comments to the Stata code created by Jose Pineda to accompany the calculations done for the PAGE publication "Green Economy Progress Measurement Framework – Application" (PAGE 2017b).[59]

SECTION 1. CALCULATIONS FOR INDIVIDUAL INDICATORS

The section follows Section 3.1 of "Green Economy Progress Measurement Framework – Methodology" (PAGE 2017a). It shows examples of the Stata code for calculations of PROGRESS for an indicator that is a "bad" (an indicator for which progress requires a reduction in its value) and for an indicator that is a "good" (an indicator for which progress requires an increase in its value). The first example is the calculation of progress for a "bad": material footprint per capita (abbreviated in the Stata code as mfppc). The second example is the calculation of progress for a "good": green trade (abbreviated in the Stata code as greentrade2).

Calculations are done in the form of a loop, because the structure will be copied in a simpler manner to other indicators. This facilitates running that the text in Stata without a problem). (Below, a preceding asterisk (*) indicates a comment.)

* Example 1: Stata code with comments for material footprint per capita

```
global varlist "mfppc"

foreach var of global varlist {
```

**** Calculations for the threshold***

*** Here the distribution of the indicator in the initial period (y^0) is used to explore its properties with the command sum (which will be used in case we do not have evidence of a relevant threshold).**

```
sum  hd_`var' if year==2000 , detail

gen t`var'1n1=5
```

*** For this indicator there is scientific evidence for the threshold from Stefan Bringezu (2015), "Possible target corridor for sustainable use of global material resources". Resources 4, 25–54; doi:10.3390/resources4010025.**

**** Calculations for the target***

```
sort countryname year

gen bhat`var'=hd_`var'/hd_`var'[_n-10] if year==2010
```

*** Setting the initial target using the entire distribution. (Since this is a "bad", the target is a reduction; this is why we select the percentile 10.) This is the default; it will be replaced only if there is a more ambitious target (from the relevant country comparison group):**

```
sum bhat`var', detail

gen bhat`var'1n=r(p10) if year==2010

gen yhat`var'1n=bhat`var'1n*hd_`var'[_n-10] if
year==2010
```

*** Setting the target based on the relevant comparison group of countries with similar levels of human development (given the HDI group, 1 to 4) (There are countries in the sample without HDI group. They are included in the group HDIgroup2013==., see below.):**

```
sort countryname year
```

[59] Data for the global application of the GEP Measurement Framework can be found at: http://un-page.org/resources/macroeconomic-policymaking/green-economy-progress-measurement-framework.

```
sum bhat`var’ if HDIgroup2013==1, detail
gen bhat`var’1nvh=r(p10) if year==2010 & HDIgroup2013==1
gen yhat`var’1nvh=bhat`var’1nvh*hd_`var’[_n-10] if year==2010 & HDIgroup2013==1

sort countryname year
sum bhat`var’ if HDIgroup2013==2, detail
gen bhat`var’1nh=r(p10) if year==2010 & HDIgroup2013==2
gen yhat`var’1nh=bhat`var’1nh*hd_`var’[_n-10] if year==2010 & HDIgroup2013==2

sort countryname year
sum bhat`var’ if HDIgroup2013==3, detail
gen bhat`var’1nm=r(p10) if year==2010 & HDIgroup2013==3
gen yhat`var’1nm=bhat`var’1nm*hd_`var’[_n-10] if year==2010 & HDIgroup2013==3

sort countryname year
sum bhat`var’ if HDIgroup2013==4, detail
gen bhat`var’1nl=r(p10) if year==2010 & HDIgroup2013==4
gen yhat`var’1nl=bhat`var’1nl*hd_`var’[_n-10] if year==2010 & HDIgroup2013==4

sort countryname year
sum bhat`var’ if HDIgroup2013==., detail
gen bhat`var’1n0=r(p10) if year==2010 & HDIgroup2013==.
gen yhat`var’1n0=bhat`var’1n0*hd_`var’[_n-10] if year==2010 & HDIgroup2013==.
```

*** Replacing the common target with the relevant group target if the relevant group is more ambitious:**

```
replace yhat`var’1n= yhat`var’1nvh if bhat`var’1nvh<1 & (bhat`var’1n>bhat`var’1nvh) & HDIgroup2013==1
replace yhat`var’1n= yhat`var’1nh if bhat`var’1nh<1 & (bhat`var’1n>bhat`var’1nh) & HDIgroup2013==2
replace yhat`var’1n= yhat`var’1nm if bhat`var’1nm<1 & (bhat`var’1n>bhat`var’1nm) & HDIgroup2013==3
replace yhat`var’1n= yhat`var’1nl if bhat`var’1nl<1 & (bhat`var’1n>bhat`var’1nl) & HDIgroup2013==4
replace yhat`var’1n= yhat`var’1n0 if bhat`var’1n0<1 & (bhat`var’1n>bhat`var’1n0) & HDIgroup2013==.
gen ystar`var’1n=yhat`var’1n if year==2010
```

*** If the target is above the threshold, we require that at least the threshold should be achieved (in order to be sustainable).**

```
replace ystar`var’1n=t`var’1n1 if t`var’1n1<yhat`var’1n & year==2010
gen z`var’1n1=hd_`var’[_n-10]-ystar`var’1n if year==2010
```

*** To create the first weight for the GEP:**

```
gen weight`var’1n1=.
sort countryname year
replace weight`var’1n1= hd_`var’[_n-10]/t`var’1n1 if year==2010
```

*** To calculate progress for the indicator (this variable will later be renamed in the code):**

```
gen change`var’1n1=-ch_hd_`var’/z`var’1n1
gen gep`var’1n11 = (-ch_hd_`var’)/z`var’1n1

sort countryname year
gen hd_`var’1n1_00= hd_`var’[_n-10] if year==2010
```

*** To do calculate progress and see how progress relates to the threshold:**

```
gen gep`var’1n12 =gep`var’1n11
gen dum`var’pos=0 if gep`var’1n12>0 & gep`var’1n12!=.
replace dum`var’pos=1 if gep`var’1n12>=1 & gep`var’1n12!=.
```

```
gen dum`var'post=0 if gep`var'1n12>0 & gep`var'1n12!=.

replace dum`var'post=1 if gep`var'1n12>0 & gep`var'1n12!=. & hd_`var'1n1_00>=t`var'1n1 & hd_`var'<=t`var'1n1 & year==2010

replace dum`var'post=2 if gep`var'1n12>0 & gep`var'1n12!=. & hd_`var'1n1_00>t`var'1n1 & hd_`var'>t`var'1n1 & year==2010

replace dum`var'post=3 if gep`var'1n12>0 & gep`var'1n12!=. & hd_`var'1n1_00<t`var'1n1 & hd_`var'<t`var'1n1 & year==2010


gen dum`var'neg=0 if gep`var'1n12<=0 & gep`var'1n12!=.

replace dum`var'neg=1 if gep`var'1n12<=-1 & gep`var'1n12!=.

gen dum`var'negt=0 if gep`var'1n12<=0 & gep`var'1n12!=.

replace dum`var'negt=1 if gep`var'1n12<=0 & gep`var'1n12!=. & hd_`var'1n1_00<=t`var'1n1 & hd_`var'>=t`var'1n1 & year==2010

replace dum`var'negt=2 if gep`var'1n12<=0 & gep`var'1n12!=. & hd_`var'1n1_00>t`var'1n1 & hd_`var'>t`var'1n1 & year==2010

replace dum`var'negt=3 if gep`var'1n12<=0 & gep`var'1n12!=. & hd_`var'1n1_00<t`var'1n1 & hd_`var'<t`var'1n1 & year==2010
```

*** Here we rename the variable to give it a name according to the methodology ("Progress"):**

```
gen progress`var'=change`var'1n1

replace weight`var'1n1=. if year==2010 & progress`var'==.
```

*** To see the results and easily store them in the Excel file:**

```
gsort -change`var'1n1

list countryname  hd_`var'1n1_00 hd_`var' ch_hd_`var' ch_r_hd_`var' ystar`var'1n t`var'1n1 progress`var' dum`var'pos dum`var'neg dum`var'post dum`var'negt if year==2010 & gep`var'1n12!=.

gsort -change`var'1n1

bro countryname   hd_`var'1n1_00 hd_`var' ch_hd_`var' ch_r_hd_`var' ystar`var'1n t`var'1n1 progress`var' dum`var'pos dum`var'neg dum`var'post dum`var'negt if year==2010 & gep`var'1n12!=.

}
```

*** Example 2: Stata code with comments for green trade (greentrade2)**

```
global varlist "greentrade2"

foreach var of global varlist {
```

**** Calculations for the threshold***

*** Here the distribution of the indicator in the initial period (y0) is used to explore its properties with the command sum (which will be used in case we do not have scientific evidence for a relevant threshold, as is the case for this particular indicator). Since this indicator is a "good", we use the 25 percentile of the 2000 distribution as the minimum threshold for this indicator to be sustainable:**

```
sum  hd_`var'_00 if year==2010 , detail

gen t`var'1n1=r(p25)
```

**** Calculations for the target***

```
sort countryname year

gen ahat`var'=hd_`var'/hd_`var'_00 if year==2010
```

*** Setting the initial target using the entire distribution. (Since this is a "good", the target is a reduction; this is why we select the percentile 90.) This is the default; it will be replaced only if there is a more ambitious target (from the relevant country comparison group).**

```
sum ahat`var', detail

gen ahat`var'1n=r(p90) if year==2010

gen yhat`var'1n=ahat`var'1n*hd_`var'_00 if year==2010
```

*** Setting the target based on the relevant comparison group of countries with similar levels of human development (given the HDI group, 1 to 4). (There are countries in the sample without HDI group they are included in the group HDIgroup2013==., see below.):**

```
sort countryname year
sum ahat`var’ if HDIgroup2013==1, detail
gen ahat`var’1nvh=r(p90) if year==2010 & HDIgroup2013==1
gen yhat`var’1nvh=ahat`var’1nvh*hd_`var’_00 if year==2010 & HDIgroup2013==1

sort countryname year
sum ahat`var’ if HDIgroup2013==2, detail
gen ahat`var’1nh=r(p90) if year==2010 & HDIgroup2013==2
gen yhat`var’1nh=ahat`var’1nh*hd_`var’_00 if year==2010 & HDIgroup2013==2

sort countryname year
sum ahat`var’ if HDIgroup2013==3, detail
gen ahat`var’1nm=r(p90) if year==2010 & HDIgroup2013==3
gen yhat`var’1nm=ahat`var’1nm*hd_`var’_00 if year==2010 & HDIgroup2013==3

sort countryname year
sum ahat`var’ if HDIgroup2013==4, detail
gen ahat`var’1nl=r(p90) if year==2010 & HDIgroup2013==4
gen yhat`var’1nl=ahat`var’1nl*hd_`var’_00 if year==2010 & HDIgroup2013==4

sort countryname year
sum ahat`var’ if HDIgroup2013==., detail
gen ahat`var’1n0=r(p90) if year==2010 & HDIgroup2013==.
gen yhat`var’1n0=ahat`var’1n0*hd_`var’_00 if year==2010 & HDIgroup2013==.
```

*** Replacing the common target with the relevant group target if the relevant group is more ambitious:**

```
replace yhat`var’1n= yhat`var’1nvh if ahat`var’1nvh>1 & (ahat`var’1n<ahat`var’1nvh) & HDIgroup2013==1
replace yhat`var’1n= yhat`var’1nh if ahat`var’1nh>1 & (ahat`var’1n<ahat`var’1nh) & HDIgroup2013==2
replace yhat`var’1n= yhat`var’1nm if ahat`var’1nm>1 & (ahat`var’1n<ahat`var’1nm) & HDIgroup2013==3
replace yhat`var’1n= yhat`var’1nl if ahat`var’1nl>1 & (ahat`var’1n<ahat`var’1nl) & HDIgroup2013==4
replace yhat`var’1n= yhat`var’1n0 if ahat`var’1n0>1 & (ahat`var’1n<ahat`var’1n0) & HDIgroup2013==.
gen ystar`var’1n=yhat`var’1n if year==2010
```

*** If the target is below the threshold, we require that at least the threshold should be achieved (in order to be sustainable):**

```
replace ystar`var’1n=t`var’1n1 if t`var’1n1>yhat`var’1n & year==2010
gen z`var’1n1=ystar`var’1n-hd_`var’_00 if year==2010
```

*** To create the first weight for the GEP:**

```
gen weight`var’1n1=.
sort countryname year
replace weight`var’1n1= t`var’1n1/hd_`var’_00 if year==2010

sort countryname year
gen hd_`var’1n1_00= hd_`var’_00 if year==2010
```

**** To calculate progress for the indicator (this variable will later be renamed in the code):***

```
gen change`var’1n1=ch_hd_`var’/z`var’1n1
gen gep`var’1n11 = (ch_hd_`var’)/z`var’1n1
```

*** To eliminate observations whose initial values are too small and that may lead to spuriously large changes:**

```
replace change`var’1n1 =. if hd_`var’1n1_00<.1614555
replace gep`var’1n11 =. if hd_`var’1n1_00<.1614555
```

*** To calculate progress and see how progress relates to the threshold:**

```
gen gep`var'1n12 =gep`var'1n11

gen dum`var'pos=0 if gep`var'1n12>0 & gep`var'1n12!=.

replace dum`var'pos=1 if gep`var'1n12>=1 & gep`var'1n12!=.


gen dum`var'post=0 if gep`var'1n12>0 & gep`var'1n12!=.

replace dum`var'post=1 if gep`var'1n12>0 & gep`var'1n12!=. & hd_`var'1n1_00<=t`var'1n1 & hd_`var'>=t`var'1n1 & year==2010

replace dum`var'post=2 if gep`var'1n12>0 & gep`var'1n12!=. & hd_`var'1n1_00>t`var'1n1 & hd_`var'>t`var'1n1 & year==2010

replace dum`var'post=3 if gep`var'1n12>0 & gep`var'1n12!=. & hd_`var'1n1_00<t`var'1n1 & hd_`var'<t`var'1n1 & year==2010


gen dum`var'neg=0 if gep`var'1n12<=0 & gep`var'1n12!=.

replace dum`var'neg=1 if gep`var'1n12<=-1 & gep`var'1n12!=.


gen dum`var'negt=0 if gep`var'1n12<=0 & gep`var'1n12!=.

replace dum`var'negt=1 if gep`var'1n12<=0 & gep`var'1n12!=. & hd_`var'1n1_00>=t`var'1n1 & hd_`var'<=t`var'1n1 & year==2010

replace dum`var'negt=2 if gep`var'1n12<=0 & gep`var'1n12!=. & hd_`var'1n1_00>t`var'1n1 & hd_`var'>t`var'1n1 & year==2010

replace dum`var'negt=3 if gep`var'1n12<=0 & gep`var'1n12!=. & hd_`var'1n1_00<t`var'1n1 & hd_`var'<t`var'1n1 & year==2010
```

*** Here we rename the variable to give it the name according to the methodology (Progress):**

```
gen progress`var'=change`var'1n1

replace weight`var'1n1=. if year==2010 & progress`var'==.
```

*** To see the results and easily store them in the Excel file:**

```
gsort -change`var'1n1

list countryname  hd_`var'1n1_00 hd_`var' ch_hd_`var' ch_r_hd_`var' ystar`var'1n t`var'1n1 progress`var' dum`var'pos dum`var'neg dum`var'post dum`var'negt if year==2010 & gep`var'1n12!=.


gsort -change`var'1n1

bro countryname   hd_`var'1n1_00 hd_`var' ch_hd_`var' ch_r_hd_`var' ystar`var'1n t`var'1n1 progress`var' dum`var'pos dum`var'neg dum`var'post dum`var'negt if year==2010 & gep`var'1n12!=.

}
```

SECTION 2. CREATION OF THE GEP INDEX

This section follows Section 3.2 of “Green Economy Progress Measurement Framework – Methodology” (PAGE 2017a). It will create the GEP Index.

*** To create an indicator for the number of countries with at least X number of indicators. It is critical to set the minimum number of indicators to calculate the GEP index (in our case a minimum of 10 of 13):**

```
egen numindgep= rownonmiss(changemfppc1n1 changepollut1n1 changeprotec1n changeenergyuse1n1 changegreentrade21n1 changeenvir_patent1n1 changerenew1n1 changepalma11n1 changeinequalitygender1n1 changeaccess1n1 changeschooling_new1n1 changepensioncoverage1n1 changelifeexpectany1n1)

sum numindgep if year==2010 & numindgep>=9 & numindgep!=.

sum numindgep if year==2010 & numindgep>=10 & numindgep!=.

sum numindgep if year==2010 & numindgep>=11 & numindgep!=.

sum numindgep if year==2010 & numindgep>=12 & numindgep!=.

sum numindgep if year==2010 & numindgep>=13 & numindgep!=.
```

*** To explore the properties of progress with the restricted sample of minimum 10 of 13 indicators:**

sum numindgep changemfppc1n1 changepollut1n1 changeprotec1n changeenergyuse1n1 changegreentrade21n1 changeenvir_patent1n1 changerenew1n1 changepalma11n1 changeinequalitygender1n1 changeaccess1n1 changeschooling_new1n1 changepensioncoverage1n1 changelifeexpectany1n1 if year==2010 & numindgep>=10 & numindgep!=.

**** To do the aggregation***

*** To produce the second weighting for the comparison among countries:**

egen weightprotec1n1=rowmean(weighttprot1n1 weightmprot1n1) if year==2010 & numindgep>=10 & numindgep!=.

egen sumweight=rowtotal(weightmfpp c1n1 weightpollut1n1 weightprotec1n1 weightenergyuse1n1 weightgreentrade21n1 weightenvir_patent1n1 weightrenew1n1 weightpalma11n1 weightinequalitygender1n1 weightaccess1n1 weightschooling_new1n1 weightpensioncoverage1n1 weightlifeexpectany1n1) if year==2010 & numindgep>=10 & numindgep!=.

global varlist "mfppc1n1 pollut1n1 protec1n1 energyuse1n1 greentrade21n1 envir_patent1n1 renew1n1 palma11n1 inequalitygender1n1 access1n1 schooling_new1n1 pensioncoverage1n1 lifeexpectany1n1"

foreach var of global varlist {

gen weight`var'n = (1/sumweight)*weight`var' if year==2010 & numindgep>=10 & numindgep!=.

}

global varlist "mfppc1n1 pollut1n1 protec1n1 energyuse1n1 greentrade21n1 envir_patent1n1 renew1n1 palma11n1 inequalitygender1n1 access1n1 schooling_new1n1 pensioncoverage1n1 lifeexpectany1n1"

foreach var of global varlist {

gen gep`var'n11 = weight`var'n*change`var' if year==2010 & numindgep>=10 & numindgep!=.

}

**** The creation of the GEP index***

egen gepnew=rowtotal(gepmfppc1n1n11 geppollut1n1n11 gepprotec1n1n11 gepenergyuse1n1n11 gepgreentrade21n1n11 gepenvir_patent1n1n11 geprenew1n1n11 geppalma11n1n11 gepinequalitygender1n1n11 gepaccess1n1n11 gepschooling_new1n1n11 geppensioncoverage1n1n11 geplifeexpectany1n1n11) if year==2010 & numindgep>=10 & numindgep!=.

SECTION 3. THE CREATION OF THE GEP+

This section follows Section 3.4 of "Green Economy Progress Measurement Framework – Methodology" (PAGE 2017a). It will create the GEP+. Notice that, for the indicators of the Dashboard of Sustainability indicators, the same procedure as in Section 3.1 (at the beginning of this note) was applied for each indicator.

*** Using the first weight for the dashboard (y0/t):**

gen changeGHGemissionsExclpc1n1w=changeGHGemissionsExclpc1n1*weightGHGemissionsExclpc1n1

gen changenitropc1n1w=changenitropc1n1*weightnitropc1n1

gen changeshcrop1n1w=changeshcrop1n1*weightshcrop1n1

*** Now, weighting the GEP index by the mean weight:**

egen meanweight=rowmean(weightmfppc1n1 weightpollut1n1 weightprotec1n1 weightenergyuse1n1 weightgreentrade21n1 weightenvir_patent1n1 weightrenew1n1 weightpalma11n1 weightinequalitygender1n1 weightaccess1n1 weightschooling_new1n1 weightpensioncoverage1n1 weightlifeexpectany1n1) if year==2010 & numindgep>=10 & numindgep!=.

gen gepneww=gepnew*meanweight

**** To create the GEP+:***

```
egen combine3w1=rowmin(changeGHGe
missionsExclpc1n1w changenitropc1n1w
changeshcrop1n1w gepneww)  if gepnew!=.
& changeGHGemissionsExclpc1n1!=.  &
changenitropc1n1!=. & changeshcrop1n1!=.
```

*** To create the ranking of countries:**

```
gsort -combine3w1
```

```
egen rankcombine3w1=rank(-combine3w1)  if
gepnew!=. & changeGHGemissionsExclpc1n1!=. &
changenitropc1n1!=. & changeshcrop1n1!=.
```

*** To export the results to Excel:**

```
bro countryname HDIgroup2013
changeGHGemissionsExclpc1n1
changeGHGemissionsExclpc1n1w
weightGHGemissionsExclpc1n1 changenitropc1n1
changenitropc1n1w weightnitropc1n1
changeshcrop1n1  changeshcrop1n1w
weightshcrop1n1 gepnew gepneww  combine3w1  if
gepnew!=. & changeGHGemissionsExclpc1n1!=. &
changenitropc1n1!=. & changeshcrop1n1!=.
```

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PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

The Partnership for Action on Green Economy brings together the expertise, convening power and networks of five UN agencies – UN Environment, the International Labour Organization, the UN Development Programme, the UN Industrial Development Organization and the UN Institute on Training and Research – to support countries and regions in addressing one of the most pressing challenges of the 21st century: transforming their economies and financial systems into drivers of sustainability and social equity. The Partnership supports countries in reframing economic policies and practices around sustainability to foster economic growth, create income and jobs, reduce poverty and inequality, and strengthen the ecological foundations of their economies.

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