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Review of the SDG Index and Dashboards: An example of Japan's global ranking results

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Summary

The 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development came into force on 1 January 2016 and a comprehensive proposal of 230 SDG indicators was submitted to the United Nations Statistical Commission as a global starting point for the indicator framework for the SDGs and targets in February 2016. To ensure that the SDG indicators are used as practical tools, many organisations and national governments have been working on data, data analysis and setting indicators for monitoring progress at the national level.

Among these efforts, an unofficial SDG Index and its global ranking of 149 countries was published recently by the Bertelsmann Stiftung and the Sustainable Development Solutions Network (SDSN) to track SDG achievements and identify national priorities. The SDG Index report explains that the data and countries are selected based on criteria related to data availability, population size, and applicability of variables. The collected data is then tested using several statistical methods to ensure normal distribution, conduct rescaling, and remove extreme values. The rescaled data is then aggregated (by arithmetic mean) in two steps to derive index values at the individual SDG level as well as across all the SDGs.

The efforts to construct the SDG Index raise important questions about their ability to track performance over time and across countries. To shed light on this issue this paper reviews how the SDG Index arrives at the ranking results using Japan as an example. Ranked 18th out of 149 countries, Japan's SDG index was 75 on a scale of 0 to 100 (with higher values representing better performance) in 2016. Japan is already a high-level performer in many social and economic areas, particularly in SDG9 on resilient infrastructure, sustainable industrialisation and innovation. However, big gaps exist for SDG5 on gender equality and environment-related areas, including SDG12 on sustainable consumption and production, SDG13 on climate action, SDG14 on life below water, and SDG15 on life on land.

By cross-checking Japan's SDG performance in environmental areas with the 2016 world ranking of the Environmental Performance Index (EPI)[1], we found that the global ranking results from the two systems for some environmental issues such as biodiversity protection can diverge markedly due to different indicators used for the indexing systems. By using different indicators, which present different facets of the issue *per se*, e.g. the driving force, the state of the environment and policy responses, etc., the indexing and global ranking results can be very different.

[1] EPI is a world ranking system on environmental performance provided by Yale University (2016). The indexing framework includes three levels of hierarchical aggregation covering nine thematic issues and 20 individual indicators.

With a further review of the SDG indexing and global ranking system, we identified four practical issues and analysed their potential influences on the global ranking results.

i) The first and most critical issue is the big data gap, particularly the environmental data gap at the global level, which prevents using indicators and associated data to provide a complete picture of the target issues and therefore reduces the effectiveness of using the indicators as a practical tool.

ii) The second issue is the robustness of the indexing and global ranking results and the comparability among different indexing and global ranking systems. Rankings in indicator systems are influenced by the selection of indicators, availability of data and the indexing and weighting methods.

iii) The third issue involves the indexing method which aggregates the scores of individual indicators by their arithmetic mean value. First, it needs to be underlined that the SDGs and their targets are different things. Second, they are not equivalent to each other by the same proportionate interlinkage. Their interlinkages can be reinforcing, dependent, conflicting and compromising. The current indexing method ignores these two points and therefore brings a challenge to the results. A proper nesting structure for the SDGs, such as grouping the SDGs into the economic, social and environmental dimensions—the three major pillars of sustainable development—together with the weighting schemes which are developed based on scientific evidence, can be an alternative way. The OECD Handbook on Constructing Composite Indicators provides potentially helpful guidance and good practices for producing composite indices and index (OECD, 2008).

iv) The fourth practical issue is related to how to properly package the monitoring results and convey accurate messages to the target stakeholders. In particular, the basic assumptions and technical limitations and their associated impacts on the analysis and ranking results should be explicitly mentioned in a transparent and responsible manner to avoid misunderstanding.

The UN-proposed 230 SDG indicators presents a nice conceptual framework. To transform the SDG indicators into practical tools for measuring the progress in achieving the SDGs and their targets, the next step is to provide reliable and trackable data; establish better methodologies for analysing the data; and build good practices for reporting. Among these challenges, one priority for effective SDG monitoring should be strengthening the investment and capacity building in data collection related to the SDG indicators. This in turn requires deepening and broadening collaborations among UN organizations, academia and national governments.

Last but not least, it merits underlining that cross-national differences in the selection of indicators, data availability and methodologies makes the international comparison across countries inherently difficult. This implies that, at least initially, international comparison of the progress in achieving the SDGs will be limited. However, this should not prevent

monitoring country-based progress over time with due consideration for national circumstances and available resources.

Acknowledgements

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1. Introduction

The 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, adopted by the world leaders in September 2015, came into force on 1 January 2016. Embarking on a new path of human development to eradicate poverty everywhere and provide a better life for all over the next fifteen years, the 2030 Agenda and its 17 Goals require all countries and non-state actors to take action. Implementation will be central to achieving the SDGs and the effective review of progress and useful indicators will be equally important. Many organisations and national governments have been working on data, data analysis and setting SDG indicators for monitoring progress at the national level.

Among these efforts, an unofficial SDG Index and Dashboards and its global ranking of 149 countries was published recently by the Bertelsmann Stiftung and the United Nations Sustainable Development Solutions Network (SDSN) to track SDG achievements and identify national priorities (Sachs, et al., 2016). The purpose of this paper is to review the results of SDSN's SDG Index and Dashboards and the ensuing methodologies used, with particular focus on exploring the SDG scoring and indexing system using Japan's SDG global ranking results as an example.

An appropriate set of sound, trackable indicators will be the cornerstone for the follow-up and review of the 2030 Agenda for Sustainable Development. For this, the United Nations Statistical Commission established an Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) with a mandate to develop an indicator framework for the goals and targets (UNSD, 2016a). Since June 2015, the IAEG-SDGs has held several rounds of meetings and open consultations to develop the SDG indicator framework. In February 2016, the Group agreed on a set of 230 indicators "as a practical starting point", which was proposed to the UN Statistical Commission during the Commission's 47th Session (UNSD, 2016b). Together, these 230 indicators comprise a "global indicators framework" and the IAEG-SDGs is an open-ended process acknowledging that the challenge to determine the indicators for the SDGs will take time and should be open to new developments over the years. The Economic and Social Council (ECOSOC) of the United Nations has taken note of this framework at its 70th Session in June 2016 (UNSD, 2016b).

Even before the IAEG-SDGs was formed, another initiative - the UN (SDSN) - was launched in 2012 with an aim of mobilising "global scientific and technological expertise to promote practical problem solving for sustainable development", including the design and implementation of the SDGs (SDSN, 2016a). Underscoring that indicators will be the

cornerstone in monitoring the progress towards achieving the SDGs, SDSN conducted an intensive discussion and consultation process with various stakeholders for about a year and half, and in 2015 proposed a set of 100 Global Monitoring Indicators and suggestions for complementary indicators at the national level (SDSN, 2015).

In July 2016, the Bertelsmann Stiftung and SDSN, both deeply committed to the universal success in achieving the SDGs, jointly launched a preliminary unofficial SDG Index and Dashboards for tracking SDG progress at the country level and ensuring accountability (Sachs, et al., 2016). Although the IAEG-SDGs has made the proposal of the global indicators framework, it will take some time before these indicators are finalised. The initiative from the Berteslmann Stiftung and SDSN, however, rightfully considered that it will be useful and important for the countries to "get started on the SDGs with relevant data already at hand" (Sachs, et al, 2016). The SDG Index provides an initial step for 2015 at the country level whereas the Dashboards indicate a country's progress in achieving the SDGs.

Before looking deeper into SDSN's SDG Index and Dashboards, it is worth taking note of a few other approaches at national level which were initiated to support the data revolution under the 2030 Agenda for Sustainable Development. Some of them were launched even before the IAEG-SDGs made the proposal of the 230 SDG indicators. One such effort is the Post-2015 Data Test - a joint initiative from the Centre for Policy Dialogue and the Norman Paterson School of International Affairs in collaboration with the Southern Voice on Post-MDG International Development Goals and Partnership for African Social and Governance Research. Under this project, several low, middle and high income countries (Bangladesh, Canada, Ghana, Peru, Sierra Leone, Senegal, Tanzania, and Turkey) have been selected where a selected number of potential goals, targets and indicators have been applied to assess the data availability and to identify the opportunities and challenges related to the post-2015 framework (Post-2015 Data Test Homepage, 2016).

National governments in some countries have also been proactive in using the SDGs to guide national development plans and actions. Colombia, for example, is an "early leader" in this regard (SDSN, 2016b). As early as February 2015, Colombia passed a Presidential Decree to establish an Inter-Agency Commission for SDG preparation and implementation (Espey, 2015). The country has focused on aligning the national priorities of its governmental agencies. The Colombian national statistics office (DANE) took the lead in identifying the means for mapping the existing national level datasets with the SDG indicators, and to finding appropriate means to track these indicators (SDSN, 2016b).

This paper reviews SDSN's SDG Index and Dashboards by analysing Japan's SDG global ranking results. Section 2 of the paper looks at the methodology used in SDSN's SDG Index and Dashboard in comparison with other relevant composite indices. Section 3 focuses exclusively on Japan's SDG global ranking and discusses the compatibility with other global indexing systems. Section 4 raises and discusses some practical issues that may hinder the effective use of the Index as a practical tool. Section 5 concludes the paper.

2. SDSN's SDG Index and Dashboards: A summary on the methodology

The SDG Index and Dashboards is an initiative from the Bertelsmann Stiftung and SDSN which is built on a selected set of indicators using the most available data in a user-friendly and informative way. The SDSN's SDG Index (which, as of drafting this paper, is preliminary and unofficial) is a composite index generated by the arithmetic average of the scores estimated for individual indicators. A global ranking of countries based on their overall index score between 0 and 100 is made to reflect the initial status of countries on the SDGs (Sachs, et al., 2016). The SDSN's SDG Dashboards use a traffic light approach to indicate the SDGs and target areas that need particular attention and policy prioritisation for a given country. Both the SDG Index and the Dashboards use the same data.

Indeed, the development and use of composite indices are becoming increasingly important instruments for assessing broader socio-economic and environmental perspectives that can help in policy analysis as well as in effective public communication (Foa and Tanner, 2012; OECD, 2008). Many of these indices, such as the Human Development Index (HDI) of the United Nations Development Programme (UNDP) and the Better Life Index of the Organization for Economic Cooperation and Development (OECD) are referred to frequently in various research and policy documents. By their nature, composite indices 'summarise complex and multidimensional issues in a simple manner' and provide 'a single estimate' (Foa and Tanner, 2012), which can be useful for tracking progress and for comparing among various entities (e.g., countries).

Following the adoption of the 2030 Development Agenda and the SDGs, the Bertelsmann Stiftung and SDSN have also come up with a preliminary unofficial SDG Index that 'ranks countries regarding their initial status' based on available data up to 2015 (Sachs, et al., 2016). In addition, for each country, the SDG Dashboards attempt to identify the SDGs which need particular attention and policy prioritisation. This is a timely initiative which, as the developers stipulate, can provide important insights into the status and progress for each of the

countries included in the SDG Index.

As composite indices attempt to capture many - often indirectly related or not related at all - indicators through a single estimate, the methodology used for developing the indices, including how the indicators are selected and what kind of data has been used, could heavily influence the outcome. OECD (2008) provides a detailed step-by-step checklist for building composite indices.[2] Nonetheless, each of the currently-existing cross-country composite indices[3] has its own methodologies which reflect the purpose and nature of the respective index, scope and data coverage and so on. Since the SDG Index is very new, a proper understanding of the construction methodology, particularly in comparison with other frequently-referenced cross-country indices, will be helpful in interpreting the results.

2.1 UNDP Human Development Index[4]

In this sub-section, we briefly discuss the methodology used in developing UNDP's Human Development Index (HDI), a very popular and heavily-cited cross-country composite index. It will help us better understand and compare the methodology used in SDSN's SDG Index and Dashboards (presented in Section 2.2).

The HDI ranks countries on a scale of 0 to 1, with higher value representing higher development. It is the most widely-used comparative estimate of socio-economic development (Todaro and Smith, 2011). The UNDP defines the HDI as a 'summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living' (UNDP, 2016). A graphical representation of the dimensions, indicators and the dimension indices are presented in Figure 1.

[2] The checklist includes ten steps: i) Theoretical framework; ii) Data selection; iii) Imputation of missing data; iv) Multivariate analysis; v) Normalisation; vi) Weighting and aggregation; vii) Uncertainty and sensitivity analysis; viii) Back to the data; ix) Links to other indicators; and x) Visualisation of the results. For more details, see OECD (2008).

[3] A 2006 survey found a total of 165 such composite indices. For details, see Bandura and del Campo (2006). We assume that the number is much higher now.

[4] This part is largely based on UNDP (2015).

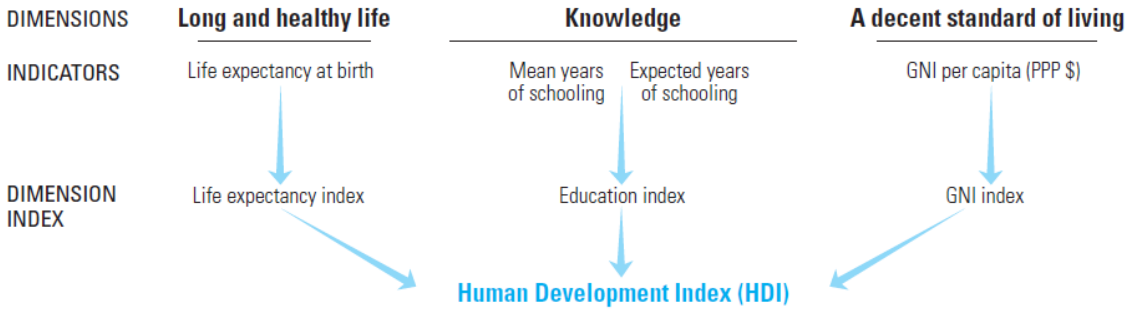

Figure 1 Graphical presentation of the calculation of the HDI

Source: UNDP (2013).

The calculation of the HDI follows two steps. In the first stage, indices for each of the three dimensions mentioned above are developed. The indicators used for these dimensions, including the minimum and maximum values, are presented in Table 1.

Table 1 Minimum and maximum values of the indicators used in the HDI

Dimension	Indicator	Minimum	Maximum
Health	Life expectancy (years)	20	85
Education	Expected years of schooling	0	18
	Mean years of schooling	0	15
Standard of living	Gross national income per capita (2011 PPP $)	100	75,000

Source: UNDP (2015).

The variable for standard of living is adjusted by taking the log of current income to reflect the diminishing marginal utility of income. The data for the indicators are gathered from various United Nations or other international bodies such as UNDESA, UNESCO, UNSD, the World Bank, and IMF. The dimension indices are then developed using the following formula:

$$Dimension\ \ index = \frac{actual\ \ value - minimum\ \ value}{maximum\ \ value - minimum\ \ value} \qquad (1)$$

In the second step, the three sub-indices are aggregated by using their geometric mean using the following equation.

$$HDI = (I_{Life}\ .I_{Education}\ .I_{Income})^{1/3} \qquad (2)$$

This geometric mean, ranging on a scale of 0 and 1, represents the HDI scores of the countries.

UNDP notes that the HDI reflects only some aspects of developmental to present a simplified index, but does not take into account several other aspects such as inequalities and poverty, human security, and empowerment (UNDP, 2015).[5] Nonetheless the HDI helps us improve our understanding of what development entails and how the countries covered by the Index are performing in terms of improving above and beyond more narrow measures of development such as gross domestic product (GDP).

2.2 SDSN's SDG Index and Dashboards

As with many other cross-country composite indices such as the HDI, the SDG Index also ranks the covered countries to reflect these countries' initial status on the SDGs. The methodology is described in details in Sachs, et al. (2016). A brief summary is presented below.

The Index includes a total of 79 SDG indicators, some of which are from the official IAEG-SDGs list of indicators. The indicators are selected on the basis of data availability, i.e. at least for 80% of all countries with a population greater than 1 million. A total of 149 out of 193 UN member states were included in the SDG Index. Similar to the selection of the indicators, the country coverage was based on the principle that selected countries should have at least 80% of the variables included.

The data for the SDG Index comes mostly from internationally comparable official statistics, though there are some instances where non-official sources are used. The developers further clarified that time series data were found to be too sparse and hence the SDG Index uses the data for closest available years to 2015.

SDSN's SDG Index and Dashboards report (Sachs, et al., 2015) explains that once the indicators are selected and data gathered, the Index is constructed in four consecutive steps. In the first step, several statistical tests (e.g. skewness test) are conducted using the raw data to assess the normal distribution of the variables in the SDG Index. The developers of the Index found that for a limited number of indicators, the assumption of normality did not hold. For making the data comparable, they rescaled the data on a scale of 0 to 100 (higher value representing better performance) by defining upper and lower bounds of the distribution. The rescaling formula used in the SDG Index is similar to the formula used in creating the dimension indices of HDI. Equation 3, taken from Annex 1 of SDSN's SDG Index and Dashboards report explains how the min-max normalisation is derived by rescaling the raw

[5] UNDP offers several other indices (such as the Inequality-adjusted Human Development Index and the Multidimensional Poverty Index) that reflect some of the other aspects of development.

data value.

$$x' = \frac{x - lower(x)}{upper(x) - lower(x)} \quad (3)$$

where *x* is the value of the raw data.

The effect of extreme values was minimised by removing the bottom 2.5 percentiles from the distribution.

In the final stage, the SDG Index was developed by a two-step aggregation of the rescaled variables, with first aggregation at the individual SDG level and then the second aggregation across the goals. Various aggregation options - nested CES functions, Leontief production function, geometric mean and arithmetic mean - were considered, but eventually the arithmetic mean (i.e. simple numerical average) was selected for the aggregation both at the SDG level as well as across the 17 SDGs. The developers of the SDG Index found this approach to have the benefit of 'giving the resulting index a natural and intuitive meaning' (Sachs, et al., 2016).

The SDG Dashboards use the same data but the aggregation methodology is different. For assessing a country's progress at the indicator level, each of the indicators is marked as green, yellow and red based on pre-defined thresholds. Then, for each of the SDGs, the Dashboards use the Leontief Minimum function for integrating the indicator scores, and thus the variable for which a country performs the worst defines the score for the respective SDG. The traffic light labelling is also used for the Goals, indicating that the red labelled Goals pose the most severe challenge for the country and require priority action.

3. Japan's SDG global ranking

3.1 Japan's SDG global ranking

Ranked 18th out of 149 countries, Japan's SDG index was 75 according to the 2016 global ranking of SDSN's SDG Index (Sachs, et al., 2016). Because the top 17 countries are all the member states of the Organisation for Economic Co-operation and Development (OECD), Japan ranked the equivalent to 18th among OECD countries which has an average index levelled at 75.3.[6] Moreover, in addition to the SDG Index for 149 countries, the Bertelsmann Stiftung and SDSN developed a separate Augmented SDG Index for OECD countries only. This

[6] This average is estimated by the authors of this report based on the OECD countries' scores provided in the SDG Index (and not in the Augmented SDG Index for the OECD countries). 34 out of 35 OECD countries are included in the SDG Index.

was done because better data availability for the OECD countries helped to include additional variables for that specific group. In the Augmented Index, Japan ranks 17 out of 34 countries with a score of 69.7. Although Japan's score is slightly higher than the average score for the group (68.95), it is low when we compare with the 1st ranked country (Sweden, score of 80.0).

With a closer look at the initial status in the 17 SDG areas (Table 2), we can see that, first, Japan is already a high-level performer in SDG1, SDG3, SDG4, SDG6, SDG7, SDG9, SDG10 and SDG11 in absolute terms with scores over 80 (indicated as green in Table 2). In particular, Japan is a high-level performer in SDG9 on resilient infrastructure, sustainable industrialisation and innovation.

Second, when compared with OECD average levels, Japan also performed well in the areas of SDG2, SDG8 and SDG16 (indicated as blue in Table 2) though there are still gaps from the perspective of absolute levels. However, Japan falls behind Sweden (the highest ranked country) for most of the SDGs (see Figure 2). It should nonetheless be noted that the scoring and ranking results for individual indicators, the indices for the SDGs and the SDG Index are fully dependent on the selection of indicators and the methodology for generating the composite index. This in turn suggests that practical issues related to the selection of indicators, data gaps and the indexing methodology can weigh heavily on the rankings. Some of the more relevant practical issues are discussed later in the paper.

Third, big gaps exist in the areas of SDG5 (Gender Equality), SDG12 (Sustainable Consumption and Production), SDG13 (Climate Action), SDG14 (Life below Water), SDG15 (Life on Land) and SDG17 (Partnerships for the Goals) which were scored around 70 or less (indicated as red in Table 2). The rankings suggest that particularly in the areas of SDG5, SDG14, SDG15 and SDG17, with scores less than 70, substantial efforts are required to make Japan's future development move onto a sustainable path.

The score of each SDG is calculated from several individual indicators. With a more detailed look at the individual indicators under SDG5, SDG12, SDG13, SDG14, SDG15 and SDG17 (Table 3), it can be seen that Japan ranked relatively low (marked in red in Table 3) at both global and OECD levels for such indicators as women in national parliaments (SDG5), female labour force participation (SDG5), CO_2 emissions from energy at the per capita level (SDG13), climate change vulnerability (SDG13), ocean health index on fisheries (SDG14) and Red List Index (SDG15). In particular, Japan could not even rank among the top 100 countries (out of 149) for the indicators of women in national parliaments, CO_2 emissions from energy at per capita level and Red List Index.

Table 2 Japan's SDG scores and comparison with Sweden and OECD average

SDG	Japan (Top 18th in the global ranking)	Sweden (Top 1 in the global ranking)	OECD
SDGs all	*75*	*84.5*	*75.3*
SDG1 (No Poverty)	100	100	99.87
SDG2 (Zero Hunger)	75.38	69.58	70.93
SDG3 (Good Health and Well-Being)	85.28	89.59	84.48
SDG4 (Quality Education)	83.94	85.03	85.96
SDG5 (Gender Equality)	59.61	87.53	74.69
SDG6 (Clean Water and Sanitation)	98.32	99.6	97.9
SDG7 (Affordable and Clean Energy)	87.65	96.06	88.07
SDG8 (Decent Work and Economic Growth)	76.54	64.41	69.38
SDG9 (Industry, Innovation and Infrastructure)	87.6	85.14	64.4
SDG10 (Reduced Inequalities)	82.17	100	80.12
SDG11 (Sustainable Cities and Communities)	82.73	92.44	85.29
SDG12 (Sustainable Consumption and Production)	70.83	80.07	71.39
SDG13 (Climate Action)	68.56	82.85	73.12
SDG14 (Life below Water)	42.62	65.85	52.57
SDG15 (Life on Land)	53.59	65.95	57.43
SDG16 (Peace, Justice and Strong Institutions)	78.07	81.47	69.25
SDG17 (Partnerships for Action)	41.37	91.43	50.55

Source: Compiled by the authors based on the data provided by the Index Map of SDSN's SDG Index and Dashboards (Bertelsmann Stiftung and SDSN, 2016)

Colour coding[7]: Green - areas that Japan is already a high-level performer in absolute terms; Blue - areas that Japan has certain gaps against the SDGs in absolute terms but better performance compared with OECD average levels; Red - areas that Japan needs improvement.

[7] The colour coding scheme is different from that used in the report of SDSN's SDG Index and Dashboards (Sachs, et al., 2016).

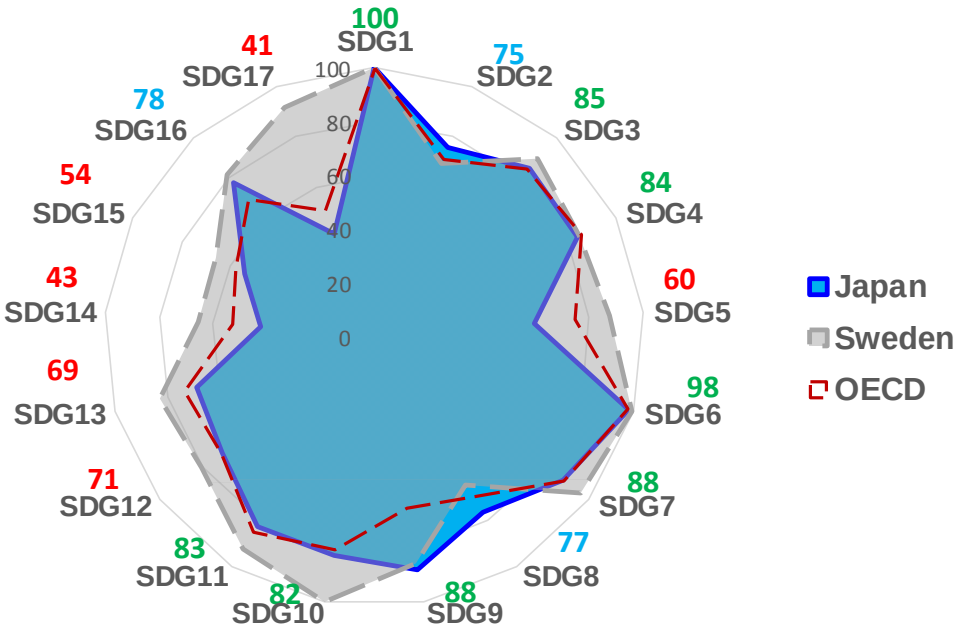

Figure 2 Japan's SDG performance as a chart

Source: Compiled by the authors based on the data in Table 2.
Colour coding: Follows the same scheme provided in Table 2.
Note: Numbers above each SDG are the scores based on the SDG Index.

In addition, Japan ranked relatively low among 34 OECD countries (marked in yellow in Table 3) against the indicators of female years of schooling (SDG5), unmet demand for contraceptives (SDG5), gender wage gap (SDG5), waste water treated (SDG12), ocean health index on clean waters (SDG14) and official development assistance (SDG17), though its performance in these areas at the global level was ranked within the top half. It can be found that while Japan performed well in most of the economic and social areas (except for SDG5 on gender equality), many challenges still remain for achieving environmental sustainability (i.e. the areas of SDG12, SDG13, SDG14 and SDG15), one of the three integral pillars of sustainable development.

Table 3 Japan's performance in five SDG areas by indicators and ranking

Indicator	Value	Top value	Bottom value	Score	Global ranking among 149 countries	OECD ranking among 34 countries
SDG5 Gender equality						
Women in national parliaments (%)	9.5	50	0	19	128	34
Female years of schooling (% male)	97	100	40.5	95	55	18
Female labour force participation (% male)	69.9	100	22.5	61	79	29
Unmet demand for contraceptives (%)	30.4	0	82.9	63	72	27
Gender wage gap (% male wage)	26.5	0	36.3	27	n/a	25/26
SDG12 Responsible consumption and production						
Wastewater treated (%)	71.3	100	0	71	25	23
Non-recycled municipal solid waste (kg/person/year)	1.4	0.7	2.4	59	n/a	15
SDG13 Climate action						
CO_2 emissions from energy (tCO_2/capita)	9.3	0	20.9	56	132	25
Climate change vulnerability (0-1)	0.1	0	0.4	75	76	31
SDG14 Life below water						
Ocean Health Index - Clean waters (0-100)	63.7	100	44.1	35	60	26/28
Ocean Health Index - Biodiversity (0-100)	90.4	100	66.4	71	22	12/28
Ocean Health Index - Fisheries (0-100)	29.0	100	2	28	98	27/28
Marine sites, completely protected (%)	34.8	100	0	35	27	11
Fish stocks overexploited or collapsed (%)	51.1	0	91.7	44	66	13
SDG15 Life on land						
Red List Index of species survival (0-1)	0.8	1	0.7	33	122	28
Annual change in forest area (%)	1.8	0.1	31	94	31	3
Terrestrial sites, completely protected (%)	26	100	0	26	54	16
SDG17 Partnership for the goals						
Official development assistance (% GNI)	0.2	1	0.1	11	18	18/28
Tax revenue (% GDP)	n/a	84.6	11	n/a	n/a	
Health, Education & R&D spending (% GDP)	17.5	23	5.1	69	18	16

Source: Compiled by the authors based on the data provided from the report and the website of SDSN's SDG Index and Dashboards (Sachs, et al., 2016; Bertelsmann Stiftung and SDSN, 2016).
Colour coding: Red: Indicators for which Japan ranked in the bottom half among 149 countries at the global levels and in the bottom half among 34 OECD countries. Yellow: Indicators for which Japan ranked in the top half among 149 countries at the global levels but in the bottom half among 34 OECD countries.

3.2 Environmental performance and compatibility with other global indexing systems

By cross-checking with another world ranking system provided by Yale University (2016) on environmental performance, the Environmental Performance Index (EPI), we found similar ranking for some individual indicators. However, at the same time some notable differences existed in the aggregate levels of the sub-indices due to using different indicators for the generation of the sub-indices.

The framework of the EPI is shown in Figure 3, which includes three levels of hierarchical aggregation across nine issues and about 20 individual indicators. Different from SDG13 (Climate Action), SDG14 (Life below Water) and SDG15 (Life on Land) which are directly linked with the environment, EPI measures the performance in achieving two broad objectives, environmental health and ecosystem vitality, covering nine issues including health impact, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat and climate and energy.

In 2016, Japan's EPI was 80.59, ranked 39th among 180 countries in the world and 29th among 35 OECD countries (Table 4). In particular, Japan performed well in the areas of health impact, water and sanitation, water resources, forests and biodiversity and habitat at the global level. However, except for water and sanitation and forests, Japan's performance was relatively low compared with their OECD peer countries.

On the other hand, Japan's EPI scores in the areas of air quality, agriculture, fisheries and climate and energy were relatively low, suggesting challenges that the country confronts in achieving sustainable development. Echoing earlier analysis on the SDG Index and indicators, particularly on SDG13 and SDG14, the EPI scoring and ranking results for Japan are analogous. However, the scoring and ranking results for SDG15 under SDG Index (which is low) and for biodiversity and habitat under EPI (which is high) are controversial.

Figure 3 Framework of the EPI

Source: Yale University (2016).

First, SDG15 covers the issues of biodiversity, forests and terrestrial protection, while biodiversity and habitat under the EPI covers issues of terrestrial and marine protection and biodiversity. Second, for the same issues of biodiversity and terrestrial protection that are covered by both indexing systems, the indicators selected are different. In particular, for measuring biodiversity protection, the Red List Index (RLI) is used for the SDG Index while different indicators, i.e. species protection at both national and global levels are used for the EPI. Based on different indicators, Japan ranked 122th among 149 countries measured by the RLI but ranked 20th and 33th among 180 countries when using the indicators of species protection at national and global levels. To measure the same issue of biodiversity protection, the scoring and ranking results from the two indexing schemes diverge.

Table 4 Japan's EPI and ranking

EPI				Issue Category				Indicator			
Definition	Score	Global rank	OECD rank	Definition	Score	Global rank	OECD rank	Definition	Score	Global rank	OECD rank
EPI	80.59	39	29	Health Impacts	82.13	57	24	Environmental Risk Exposure	82.13	57	24
				Air Quality	77.63	104	23	Household Air Quality	97.5	1	1
								Air Pollution - Average Exposure to PM2.5	81.26	95	22
								Air Pollution - PM2.5 Exceedance	71.73	133	21
								Air Pollution - Average Exposure to NO_2	24.87	172	29
				Water and Sanitation	100	1	1	Unsafe Sanitation	100	1	1
								Drinking Water Quality	100	1	1
				Water Resources	87.01	35	28	Wastewater Treatment	87.01	35	28
				Agriculture	51.74	138	33	Nitrogen Use Efficiency	68.99	121	33
								Nitrogen Balance	0	141	33
				Forests	82.44	20	3/32	Change in Forest Cover	82.44	20	3/32
				Fisheries	25.91	125	25/28	Fish Stocks	25.91	125	25/28
				Biodiversity and Habitat	93.25	38	20	Terrestrial Protected Areas (National Biome Weights)	100	1	1
								Terrestrial Protected Areas (Global Biome Weights)	100	1	1
								Marine Protected Areas	71.33	83	13/17
								Species Protection (National)	97.91	20	17
								Species Protection (Global)	97	33	20
				Climate and Energy	59.22	88	31	Trend in Carbon Intensity	67.58	83	32
								Trend in CO_2 Emissions per KWh	49.31	169	33

Source: Compiled by the authors based on the data provided by the EPI website (http://epi.yale.edu/country/japan).

In fact, RLI used for SDG Index is measured by the number of species in each Red List Category multiplied by the Category weight, which ranges from 0 for Least Concern, 1 for Near Threatened, 2 for Vulnerable, 3 for Endangered, 4 for Critically Endangered and 5 for Extinct in the Wild and Extinct (IUCN, 2009). Therefore, RLI measures the state of biodiversity indicated by both the number of species endangered and the levels of seriousness. On the other hand, species protection indicators used for EPI report on countries' efforts to protect species (for mammals, birds, and amphibians by taxonomic classes) in their actual ranges (Yale University, 2016). Therefore, these two indicators measure a country's efforts or policy response. For addressing the issue of biodiversity protection, different indicators depict different facets of the issue. Particularly for Japan, we understand that the state of endangered species is serious (indicated by the RLI); however, the country has made significant efforts to protect biodiversity (measured by the species protection indicators). The differences in selecting indicators are well explained by the DPSIR, i.e. Drivers, Pressures, State, Impact and Responses, an indicator framework (see Figure 4) provided by the European Environment Agency (EEA, 1999).

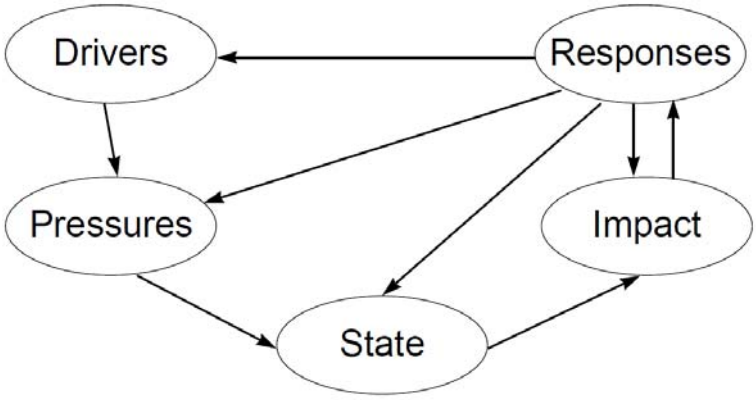

Figure 4 DPSIR framework

Source: EEA, 1999.

As a summary on the compatibility issue, the index scores and the ranking results are solely bound with the specific set of indicators selected under individual schemes. Readers or users of the SDSN's SDG index or similar indexing schemes should fully understand this fundamental assumption. However, in many cases the ranking results tend to overshadow the assumptions upon which they are based.

4. Practical issues related to the SDG indicators and influences on global ranking

Similar to other indexing schemes and global ranking systems, SDG indicators, the SDG Index, Dashboards and global ranking can help measure the state of sustainability, shed light on the

progress made for achieving the SDGs, identify the gaps remaining and communicate with relevant stakeholders on the required actions to be taken. However, despite noble intents, several practical issues related to the indicators and their usage may lead to distorted results and flawed views that can cause additional problems. Some of the issues that users therefore need to be cognizant of include *inter alia* i) the definition on what should be measured (such as the definition of the 17 SDGs and the 169 targets); ii) identification of proper indicators (such as the IAEG-SDGs indicators and the SDSN-SDG indicators, etc.); iii) collection of trackable data; and iv) reporting on the measuring results (such as the SDG Index, Dashboards and global ranking). We will discuss issues related to the identification of proper indicators, data availability and the influences on effective reporting.

Big data gap and in particular environmental data gap

Through intensive discussions and extensive consultations for IAEG-SDGs Indicators, a comprehensive proposal of 230 SDG indicators was agreed as a global indicator framework for the SDGs and Targets on 29 February 2016 (United Nations, 2016). The 230 indicators provide at least one indicator and, in many cases, two or more indicators corresponding to each of the targets. However, against this complete list, the **lack of trackable data becomes a critical barrier which undermines the effectiveness of using the SDG indicators as practical tools for measuring the progress.**

The Global SDG Indicators Database, provided by the United Nations Statistical Division (UNSD, 2016c), serves as the official data source for tracking the 230 SDG indicators. However, only 123 indicators with trackable data, about half of the total 230 indicators, are provided currently by the global Database. In addition, data for the 123 indicators covers different countries and timeframes. Within the defined data coverage for each of the 123 indicators, in most of the cases, data is not equally available for all countries and years (sometimes only one data point available). For example, data for Indicator 2.1.1, prevalence of undernourishment, covers 238 countries/regions and a time series from 2001 to 2016. However, within this coverage, 54 countries do not have any data. Conversely, data for Indicator 3.1.1, maternal mortality ratio, covers 195 countries/regions and a time series from 1990 to 2015. Within this coverage, data is available for 183 countries for the whole time period 1990-2015 and for every five years on 2000, 2005, 2010 and 2015 for the aggregate level in different regions.

Table 5 provides a summary on data availability against the proposed 230 SDG indicators. Not surprisingly, there is a paucity of data for environment-related SDGs, including SDG11 *Sustainable Cities* (5 indicators with trackable data against 15 UN proposed indicators for 10 targets), SDG12 *Sustainable Consumption and Production* (3 indicators with trackable data against 13 UN proposed indicators for 11 targets), SDG13 *Climate Action* (2 indicators with trackable data against 7 UN proposed indicators for 5 targets), SDG14 *Life below Water* (2 indicators with trackable data against 10 indicators for 10 targets) and SDG15 *Life on Land* (6

indicators with trackable data against 12 UN proposed indicators for 12 targets).

Using a part of the whole list of the indicators due to data constraints will provide an incomplete picture of status of many of the SDGs; the potential for an incomplete understanding is particularly high for environmental SDGs.

The SDSN's SDG Index uses a different set of indicators than the UN official proposal of 230 SDG indicators. SDSN's SDG Index and Dashboards report suggests that the indicators selection prioritised using official indicators whenever possible; alternative variables based on data availability were then used to fill up the gaps. Also, a different database than the Global SDG Indicators Database was used albeit with some overlaps. Overall 79 indicators with trackable data were used for the SDG Indexing and global ranking (Bertelsmann Stiftung and SDSN, 2016), which are fewer than those provided by the Global SDG Indicators Database. Similar to the problems on data availability discussed for the Global SDG Indicators Database, within the 79 indicators, country coverage and timeframes for the data are different depending on the indicators. Also for the same indicator, data is not evenly available for all countries. For example, covering 149 countries in total, some indicators, such as daily smokers as a percentage of the population aged older than 15, are only available for 34 OECD countries. Also, data for the indicator of poverty headcount ratio at USD 1.9 per day at 2011 PPP (% of population) is not available for 10 out of 149 countries.

Table 6 is a summary of the indicators and data used for the SDG indexing. With only 79 indicators in total, there are many targets which do not have any indicator(s). In particular for SDG1 *No poverty* (2 indicators against 7 targets and 12 UN proposed indicators), SDG6 *Clean Water and Sanitation* (3 indicators against 8 targets and 11 UN proposed indicators), SDG10 *Reduced Inequality* (3 indicators against 10 targets and 11 UN proposed indicators), SDG11 *Sustainable Cities* (3 indicators against 10 targets and 15 UN proposed indicators), SDG12 *Sustainable Consumption and Production* (3 indicators against 11 targets and 13 UN proposed indicators), SDG13 *Climate Action* (2 indicators against 5 targets and 7 UN proposed indicators), SDG15 *Life on Land* (3 indicators against 12 targets and 14 UN proposed indicators) and SDG17 *Partnership for Action* (3 indicators against 19 targets and 25 UN proposed indicators), the ratio of the number of indicators to the number of UN proposed indicators is less than 0.3.

Of the 79 indicators, some indicators are newly introduced, e.g. Subjective Wellbeing for SDG3 (Good Health and Well-being), which are not included in the proposed 230 indicators. Therefore, only 48 indicators are either the same as or similar to the corresponding ones in the 230 indicators. As a result, for SDG10, SDG12 and SDG13, there is no single indicator which is either the same as or analogous to those in the UN proposed list. In addition, of the 48 indicators, some are similar but not the same as those that are defined in the 230 indicators. For example, Access to Non-Solid Fuels (% of population) used for the SDG Index can be

considered as a proxy, but not the same indicator of Renewable Energy Share in the Total Final Energy Consumption defined under the UN indicators framework. Therefore, only 30 indicators out of 48 are the same as those defined in the 230 indicators. Furthermore, some indicators are only used for 34 OECD countries but not for the full set of 149 countries. For example, Poverty Rate after Taxes and Transfers, Poverty Line 50% (% of population) were only used for the OECD countries. As a result, only 25 indicators out of 30 are used for the indexing and global ranking of 149 countries (with breakdowns indicated in brackets in the last column of Table 6). Using such limited number of indicators which are trackable with data (however not always available for all countries for most of the indicators) for the indexing and global ranking, the results may reflect only a limited part of the whole picture. This is particularly problematic given the SDGs commitment to providing a basis for a more holistic approach to development.

Table 5 Data availability for the proposed SDG indicators

SDGs	No. of targets	No. of proposed indicators	No. of indicators with trackable data
1	7	12	6
2	8	14	9
3	13	26	20
4	10	11	10
5	9	14	5
6	8	11	6
7	5	6	4
8	12	17	9
9	8	12	9
10	10	11	6
11	10	15	5
12	11	13	3
13	5	7	2
14	10	10	2
15	12	14	6
16	12	23	9
17	19	25	12
Total	**169**	**241**	**123**

Source: Summarised by the authors based on UN documents (United Nations, 2016) and the Global SDG Indicators Database (United Nations Statistical Division, 2016c).

Table 6 Summary on UN-proposed indicators and the indicators used for the SDG Index

SDGs	No. of SDG targets	No. of UN-proposed indicators	No. of indicators used for the SDG Index	Of which no. of similar or same indicators of UN-proposed ones	Of which no. of same indicators as UN-proposed ones*
1	7	12	2	2	2 (1)
2	8	14	6	4	3 (3)
3	13	26	11	9	8 (7)
4	10	11	6	2	2 (2)
5	9	14	5	2	2 (2)
6	8	11	3	3	0 (0)
7	5	6	4	3	2 (1)
8	12	17	6	5	4 (3)
9	8	12	7	3	1 (1)
10	10	11	3	0	0 (0)
11	10	15	3	1	1 (1)
12	11	13	3	0	0 (0)
13	5	7	2	0	0 (0)
14	10	10	5	4	1 (1)
15	12	14	3	4	1 (1)
16	12	23	7	4	1 (1)
17	19	25	3	2	2 (1)
Total	**169**	**241****	**79**	**48**	**30 (25)**

Source: Summarised by the authors based on UN documents (United Nations, 2016) and the Global SDG Indicators Database (UNSD, 2016c).

Note: * Numbers in bracket indicates numbers of indicators that cover the full set of 149 countries. This is because some indicators are only used for 34 OECD countries and do not cover non-OECD countries.

** Some of the same indicators are used for different SDGs and targets making the total number of indicators greater than 230.

Robustness of the results

The second issue is the robustness of the indexing and global ranking results and the consistency among similar indexing and global ranking systems. As discussed in the previous section on the case of Japan, using different indicators or similar indicators but different data, e.g. the SDG Index used the Red List Index as the indicator and the EPI used protection of species as the indicators, to measure the same issue of biodiversity protection, the scoring and global ranking results can be diverged. For the current SDG indexing and global ranking, if we use different SDG indicators and data set (such as the 230 official SDG indicators and the Global SDG Indicators Database), the scoring and ranking results are likely to be different. In addition, when use different indexing and weighting methods, the results can also be different. In most of the cases, subjective rather than more robust scientifically grounded methods are used for establishing the indexing and weighting methods.

Problems of the indexing method

The third issue is related to the problems of the indexing method. Through the indexing process used by the SDG Index, scores of individual indicators are aggregated using their arithmetic mean value by which the indicator scores (normalised to range from 0 to 100) are added up and then divided by the total number of indicators. This method implies that the weights given to the indicators are the same, i.e. equal to one. On the one hand, this method sounds good from the viewpoint that all the SDGs and targets are equally important to achieving sustainable development, effectively leaving no area behind. On the other hand, the SDG indexing results will be the same by adding the same point scores from different areas. In another words, the achievements made in one SDG area is equivalent to the same level of achievements made in another SDG area. This implies that achievements made in different SDG areas are fully substitutable with one another. This may or may not be the case for two reasons. First, the SDGs and their Targets are different things. Second, they are not equivalent to each other by the same proportionate interlinkage. Their interlinkages can be reinforcing, dependent, conflicting and compromising. The current indexing method ignores these two points and therefore is premised on a rather faulty assumption.

The above point can be further illustrated by an example. The SDG indexing results will be the same by adding three point scores in the area of economic growth measured by the indicator of adjusted growth (%)[8] under SDG8 on decent work and economic growth, and at the same time subtracting three point scores in the area of energy consumption and associated emissions measured by the indicator of energy-related CO_2 emissions per capita (tCO_2/capita)[9] under SDG13 on climate action. This infers that better achievements made in GDP growth can fully compensate for the regress in combating climate change, assuming the overall SDG performance the same level. This lies in direct contrast to the well-received wisdom that high GDP growth cannot compensate for the negative impacts from climate change; rather they conflict with one another in many cases.

In another example, the SDG indexing results by adding three point scores in the area of quality infrastructure measured by the indicator of the quality of overall infrastructure (1 = extremely underdeveloped; 7 = extensive and efficient by international standards)[10] under SDG9 on industry, innovation and infrastructure will be the same by adding three point scores in the area of halting biodiversity loss measured by the indicator of Red List Index of species

[8] Indicator of Adjusted Growth (%) is normalized to fall in the range of 0-100 with top level set as 3.7% (equal to 100) and bottom level set as -7.3% (equal to 0).

[9] Indicator of energy-related CO_2 emissions per capita (tCO_2/capita) is normalized to fall in the range of 0-100 with top level set as 0 (equal to 100) and bottom level set as 20.9 (set as 0).

[10] Indicator of the quality of overall infrastructure (1 = extremely underdeveloped; 7 = extensive and efficient by international standards) is normalized to fall in the range of 0-100 with top level set as 7 (equal to 100) and bottom level set as 2.4 (equal to 0).

under SDG 15 on life on land. This indicates that well-built infrastructure, as physical capital, can fully substitute natural capital. This again is inconsistent with generally accepted claims that the protection of natural capital is important to maintaining fundamental life-supporting systems and cannot be fully substituted by man-made capital.

Challenge in packaging and delivering the messages

The fourth practical issue is related to how to properly package the monitoring results and convey the correct messages to target stakeholders. The SDG Index and the global ranking system which was developed based on a limited number of indicators and data compared with the official SDG indicators is pioneering but far from a matured product. Releasing this work to the public should be done very cautiously with explicit references to technical limitations in terms of both the methodology and data and associated impacts on the scoring and ranking results. However, these important explanations and caveats are not in our view given due attention in the report and related products.

One message that can be derived from the current global ranking results is that top ten countries, which are all from OECD, perform better than other countries and can be considered as global models for the SDG practitioners. It is true that OECD countries have made great achievements in many social and economic areas; however, their environmental performance, particularly in the area of sustainable consumption and production and other areas related to global change, including climate change, loss in biodiversity, depletion of natural resources and the deterioration of the ecological system, should not be viewed as exemplary. In fact, in several of these areas the lack of sound environmental indicators and consistent data at the global level and an inappropriate indexing system serve to disguise their environmental performance in the global ranking.

5. Conclusions and recommendations

The world celebrated the proposal of 230 SDG indicators in March, 2016. This was indeed a milestone for how we conceive and assess development at the global level.

By reviewing the SDG scoring and indexing system using the SDG global ranking results of Japan as an example, we discussed four practical issues which may hinder the effective use of the SDG Index as a practical tool for measuring the state of the progress in the SDGs across countries.

The first and most critical issue is the big data gap, particularly the environmental data gap, which cautions against using the SDG indicators as a practical tool for measuring progress. Moreover, using only part of the whole list of indicators will offer incomplete picture of many of development areas; the risk of getting only a partial picture are particularly great for environmental issues.

The big data gap, in particular related to the environment, may be limited to the global level due to lack of consistent indicators or available data across all the countries; or may happen in some developing and least developed countries due to lack of resources, limited statistical capacity or perceived unimportance of environmental monitoring. Many countries, including developed countries and developing countries, however, have developed domestic environmental indicators with regular updates to reflect the latest knowledge, the evolution of the problems and the results of the implementation of environmental countermeasures, etc. In addition, countries have collected and published statistics related to environmental indicators.

For example, the OECD has constantly developed and refined environmental indicators since the 1990s, and have used the indicators and relevant data for conducting various analysis and publishing environmental outlooks. Japan developed a comprehensive indicator system for the implementation of the Fourth National Environment Plan, among others. Also, the Ministry of the Environment of Japan (MOEJ) has published annual reports on the country's environment since 2003; these have been extended to include the statistics on the sound material-cycle society in 2007-2010 and then to cover biodiversity since 2009. Moreover, the Chinese Government publishes China Environmental Yearbook which includes environmental indicators and statistics on the state of the environment, the level of pollution and the status of pollution abatement in various areas, as well as the implementation of environmental countermeasures.

It nonetheless merits underlining that environmental indicators and constant statistical data available at the national level in many countries are collected mainly for addressing domestic priorities. For example, the indicators and statistics used in Japan reflects the national priority on achieving the sound material-cycle society and contributions to solving global environmental issues such as climate change. In China, the priorities in using environmental indicators and collecting statistics are again concentrated on domestic environmental issues, such as air pollution, water pollution and solid wastes, etc. The national differences in setting the environmental indicators and data collection makes consistent global comparison difficult.

In addition, the existing indicators, data and associated statistical capacity have been built over time in response to previous development agendas at the national and global levels, such as the MDGs. SDGs and its monitoring with the official 230 indicators at the global level are new tasks for UN organisations, international and regional organisations and national governments. Many of these organisations have not yet established the required capacity and integrated the SDGs into their existing statistical frameworks.

Therefore, differences in the selection of indicators and data availability in countries make the international comparison of countries' progress in achieving the SDGs challenging. This

suggests that, at least initially, international comparison of the progress in achieving the SDGs will be limited. However, this does not necessarily prevent monitoring progress over time with due consideration of national circumstances and available resources.

The second issue is the robustness of the indexing and global ranking results and the consistency among similar indexing and global ranking systems. The current SDG indexing and ranking results cannot be considered robust as they are subject to change depending on the selection of SDG indicators, data availability and the indexing and weighting methods.

The third issue is with the indexing method which aggregates the scores of individual indicators by their arithmetic mean value. Here again two caveats should be borne in mind. First, the SDGs and their targets are different things. Second, they are not equivalent to each other by the same proportionate interlinkage. Their interlinkages can be reinforcing, dependent, conflicting and compromising. The current indexing method ignores these two points and therefore arrives at sometimes problematic results. A proper nesting structure for the SDGs, such as grouping the SDGs into the economic, social and environmental dimensions--which are the three major pillars of sustainable development--together with the weighting schemes which are developed based on scientific evidence offer an alternative way forward. The OECD Handbook on Constructing Composite Indicators provided potentially useful guidance and good practices for producing composite indices and index (OECD, 2008).

The fourth practical issue is related to how to properly package the monitoring results and convey accurate messages to the target stakeholders. A lack of environmental indicators and trackable data and an inappropriate indexing system serve to disguise the environmental performance in the current global ranking. Without making these technical limitations and caveats explicit in terms of both the methodology and data and associated impacts on the scoring and ranking results, the messages that the audience learned from the indexing and global ranking results can be misleading.

To transform the UN-proposed SDG indicators from a nice conceptual framework to a practical tool for measuring the progress in achieving the SDGs and their targets, the next step is to provide reliable and consistent data, work on proper methodologies for analysing the data, and build good practices for reporting and packing the results. This in turn requires deepening and broadening collaborations among the UN organisations, the academia and national governments.

Among these challenges, one priority for effective SDG monitoring should be increasing investment and capacity building in data collection related to the SDG indicators. This should be done both for conventional statistical channels in all countries and by using new

technologies, including remote sensing techniques, big data and social media information and analysis, etc. It is also important to strengthen the roles of the UN organisations and other international and regional organisations in the coordination of the consistency of the indicators and data used for progress measurement at both the national and global levels.

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