A Critical Analysis of the Sustainable Development Goals

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Abstract

The ambitious UN-adopted sustainable development goals (SDGs) have been criticized for being inconsistent, difficult to quantify, implement and monitor. Disparaging analysis suggests that there exists a potential inconsistency in the SDGs, particularly between the socio-economic development and the environmental sustainability goals. Critiques also raise questions on the measurability and monitoring of the broadly framed SDGs. The goals are non-binding, with each country being expected to create their own national or regional plans. Moreover, the source(s) and the extent of the financial resources and investments for the SDGs are ambiguous. This chapter quantifies and examines the inconsistencies of the SDGs. It further inspects which of the underlying social, economic or environmental pillars are that most effective for achieving sustainable development. Analyses of the data reveal that the developed countries need to remain focused on their social and environmental policies. The developing countries, on the other hand, are better off being focused on their economics and social policies in the short run, even though environmental policies remain significant for sustainable development.

Keywords

Sustainable development goals · Sustainable development incompatibility · Structural equation modelling · Factor analysis · UN data revolution

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1 Introduction

Referred to as comprehensive, far-reaching, people-centred and universal, the sustainable development goals (SDGs) have also been described as the 'transformative agenda' (UN 2014). The SDGs aim to eradicate poverty, establish socio-economic inclusion and protect the environment. Disparaging analysis suggests that there exists a potential inconsistency in the SDGs, particularly between the socio-economic development and the environmental sustainability goals (Spaiser et al. 2016; ICSU and ISSC 2015). Critiques also raise questions on if and whether the SDGs can be measured and monitored. The SDGs are non-binding with each country being expected to create their own national or regional plans. Moreover, the source(s) and the extent of the financial resources and investments for the SDGs are ambiguous. Addressing these questions, this paper investigates and presents the evidence quantifying the inconsistencies within the SDGs. It further examines alternative measures of SDGs and investigates which of the underlying pillars of SDGs (economic, social or environment) are the most effective in achieving sustainable development.

The new global SDGs are not neoteric. About 56 years ago, the OECD Convention (Article 1) targeted sustainable development to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability and contributing to the development of the world economy. By the early 1970s, OECD began to focus on all three pillars: economic, social and environmental. It was about two decades later that the Brundtland Commission Report (WCED 1987) defined sustainable development as the *ability* of the present generations to meet their own needs without compromising the ability of the future generations to meet their own needs.

It was during the Rio + 20 summit in 2012 that an Open Working Group (OWG) with representatives from UN member countries was mandated to create a draft set of goals. The goals were to replace the Millennium Development Goals (MDGs), while providing continuity to them and motivate policymaking on both the national and local scale towards sustainability. Unlike the MDGs that had been criticized for being set in an ad hoc, insulated manner, the SDGs are a result of the largest consultation process, resulting in 17 main goals and 169 sub-targets (Ranganathan et al. 2017; UN SDSN 2015). The UN unanimously approved its new global SDGs or Agenda 2030 in New York in September 2015.

The universal SDGs have been heavily criticized. They envelop a broad range of ambitious sustainable development agenda that covers poverty to urban development to marine life. While defenders of SDGs claim that the goals reflect the complexity of development, detractors argue that the breadth is at odds with the need to prioritize (The Economist 2015). The Economist describes the SDGs as so broad and sprawling as to ' …amount to a betrayal of the world's poorest people'.

There has also been concern that the targets included in the SDGs are not the right ones. For example, the Copenhagen Consensus Centre has led an initiative to conduct cost–benefit analysis on the SDG targets, highlighting that efforts to achieve some of the targets would be 'poor value for money' and suggesting that either they should be changed or dropped entirely (Lomborg 2014). Others have been less worried about the targets per se, on the assumption that these will be further negotiated at the country level. Another issue raised has been the wording with claims that a number of targets could be constructed more clearly (UN SDSN 2015; ICSU and ISSC 2015). Some of the goals and targets use ambiguous language. The Center for Global Development (CGD) dedicated an entire blog series on how many of the targets could be improved if small changes were made to the language (Kenny 2015). Despite these issues, the SDGs stand as new global development goals agreed to by world leaders.

The IPCC (2007, 2014) has recommended that our planet's temperature should be limited to less than 2 degrees by the end of this century. This requires large-scale changes in energy systems and land use, by cutting emissions by 40–70% of the 2010 levels, by 2050 and emissions levels at zero by 2100. This necessitates immediate improvements in efficient and renewable energy by a factor of 3–4 times as compared to the current levels. It also demands greater afforestation and a reduction in deforestation. A major additional challenge is to ensure adequate investments and financial assistance for the developing countries (Campaginolo et al. 2015; OECD 2014; UN SDSN 2015). While some believe that the SDGs are financially unviable, others estimate that this would require about $2 trillion–3 trillion a year of public and private money over the next 15 years. This is roughly equivalent to 15% of the annual global savings, or 4% of the world GDP (The Economist 2015). At the moment, the Western governments promise to provide 0.7% of GDP in aid, but only a third of that materializes.

Easterly (2015) is overtly critical of the SDGs describing them as, '… beauty pageant contestants' calls for World Peace'. He argues that the whole point of the SDGs is to answer 'what should we do?', which suffers from at least three major fallacies: First, that the answers do not lead to actions; second, it is unclear that who are the ones responsible for undertaking the actions; and third, that action recommendations are the only way to induce progress. The SDGs are non-binding with the signatories committed to 'respecting national policies and priorities' with 'each Government setting its own national targets'. The shared responsibility for SDGs outcomes is collective, extending to all the leaders, UN agencies, multilateral and bilateral aid agencies, and numerous other private sector, nongovernmental and civil society actors. And the action plans are the only way to progress. Easterly (2015) forcefully reasons that the SDGs illustrate that action plans do not necessarily lead to action, collective responsibility may not necessarily be the right way to act, and there exist alternative paths to progress than the action plans.

2 Inconsistencies in SDGs and Other Challenges

By its very nature, economic growth leads to a depletion of natural resources and deterioration of environmental service (Repetto et al. 1989; Pearce and Atkinson 1993; Hamilton and Clemens 1999). In the quest for growing economic growth and higher standards of living, nature is under-prioritized (Managi and Kaneko 2009; Jorgenson 2010; Pao and Tsai 2010; Redclift 2010; Rich 2013). The very concept of sustainable development reflects the inherent conflict between the human and natural systems (Redclift 2005; Dasgupta 2013). While reviewing the SDGs, the International Council for Science (ICSU) critically pointed towards the internal inconsistency between the ecological sustainability and the socio-economic progression (ICSU and ISSC 2015). However, there is limited evidence about the nature and extent of this repeatedly claimed incompatibility of sustainability and development (ICSU and ISSC 2015; Stern et al. 1996; Redclift 2005).

Spaiser, Ranganathan, Bali Swain and Sumpter (2016) is one of the few, if not the only, study that quantifies and models these potential inconsistencies in the SDGs. Their analysis is based on an extensive dataset of 1423 economic, social, environmental and political indicators for 217 countries, covering the period 1980–2014 (including data from the World Bank, Polity IV, CIRI Human Rights Data Project, Freedom House and the Heritage Foundation/The Wall Street Journal). Spaiser et al. (2016) first employ confirmatory factor analysis (CFA) to test the consistency of an abstract unobservable construct like sustainable development. Choosing one indicator for each of the three SDG pillars a latent variable for sustainable development is estimated. These selected indicators: Child Mortality, Education and CO_2 emissions, have the highest factor loadings for sustainable development. Figure 1 (source: Spaiser et al. 2016) reveals the stark incompatibility within the SDGs framework as the CO_2 emissions load in the opposite direction on the first-factor dimension (with a proportion of explained variance of 73.5%) than economic and social pillar indicators.

Spaiser et al. (2016) further model these inconsistencies by employing the Feature Selection Algorithm (Variable Elimination Algorithm[1]). A large number of potential indicators are inspected to find the most relevant predictors of latent sustainable development data and the three selected indicators of SDG pillars. These most relevant variables are then used to fit a dynamical system model. The best model is identified according to the Bayes Factor. Based on their results, they argue that the GDP per capita has an overall positive effect on reducing poverty and increasing socio-economic, but a mainly negative impact on CO_2 emissions. Thus given the business-as-usual scenario, growth and consumption lead to incompatibility between the SDGs. However, the models also suggest some common factors that contribute to beneficial effects on one SDG dimension without having simultaneously adverse effects on other dimensions, such as, extensive health programmes for reducing child mortality, government spending on education and

[1]Variable Elimination Algorithm is a supervised feature selection machine learning method based on partial least square regression.

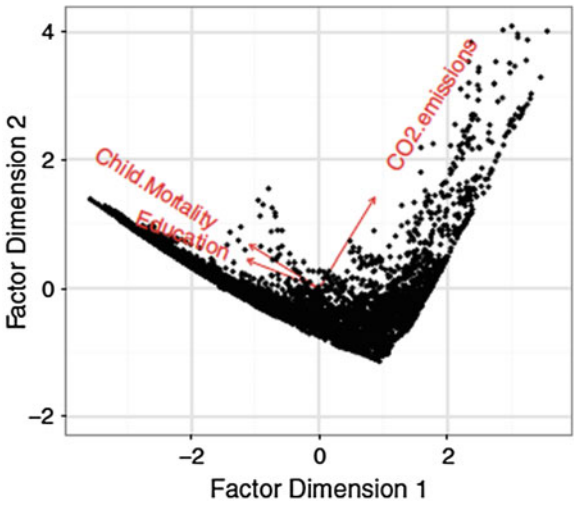

Fig. 1 EFA-Biplot of sustainable development (latent factor), comprising of the three underlying SDG pillar indicators, child mortality, Education and CO_2 emissions. *Source*: Figure 3, Spaiser et al. (2016)

environmentally friendly technologies. Thus, they conclude that future policy and efforts should shift the focus from a consumption-based economic growth to investment in human well-being (health, education) and environment-friendly technologies.

3 Challenges in Quantifying SDGs

The MDGs were appealing because they were precise and measurable (Easterly 2015). It is pointless to define goals that cannot be quantified, measured and monitored. Quantifying a multidimensional concept like sustainable development, however, is fraught with challenges. In the 1970s, Agenda 21 formulated the need for sustainable development indicators. Agenda 21 was adopted by 183 governments at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (United Nations 1992). It was later reaffirmed at the World Summit on sustainable development held in Johannesburg, South Africa in 2002, and 2012 Rio de Janeiro conference. On sustainable development indicators, Agenda 21 (paragraph 40.4) states that: 'Indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems'.

Focusing on an integrated economic, environmental and social framework, OECD (2004) developed indicators that could be used for sustainability. Eurostat also established a task force of national experts in 2001 in support of the European Union sustainable development strategy and the first set of indicators were adopted in 2005 and reviewed in 2007 (OECD 2008).

Initially, sustainable development was about ensuring optimal consumption that could be maintained in the long run without depleting the generated capital (where the optimal rate of consumption was equal to growth rate of population plus growth rate of technical progress). Sustainability was thus a dynamic optimization problem of intergenerational equity (Pierantoni 2004). According to Pierantoni (2004), *ability* may include a wider definition of capital that goes beyond economic capital to include human capital, environmental capital (natural renewable and non-renewable resources), and social capital. Sen's theory of development as freedom and capabilities approach also provides a wider interpretation of social capital and human capital. Sustainable development is a thus a complex, multi-domain issue that combines efficiency, equity and intergenerational equity across economic, social and environmental pillars. Sustainable development may be measured by well-being, which may be defined as the discounted present value of future utility. For it to be measured in terms of well-being, the concept of consumption needs to be broadened (OECD 2008). Dasgupta (2001) argues that well-being includes welfare and the additional benefits derived from intangibles other than consumption; for instance, presence of fundamental human rights, forest products, beautiful sunsets, etc. To a certain degree, sustainable development also remains anthropocentric as a concept.

A recent body of literature defines sustainable development in terms of Inclusive Wealth or intergenerational well-being (Arrow et al. 2012). Inclusive Wealth measures a society' s stock of all its capital assets (reproducible/productive capital, human capital and natural capital) and their changes over time accounting for population growth and technological change. Empirical evidence shows that unlike GDP per capita and Human Development Index (HDI), Inclusive Wealth Index is better able to capture sustainable development through changes in intergenerational well-being (Dasgupta, 2013). However, this measure is severely limited by cross-country, time series data availability (Arrow et al. 2012; Dasgupta 2013).

Several researchers suggest that physical capital, social capital and natural capital are the three underlying assets of sustainable development (Hamilton et al. 2004). A path is sustainable if the future per capita value of these assets is not less than the current well-being. Pearce et al. (1989) define this as weak sustainability. Determining values of these assets is difficult as for some markets may not exist. Furthermore, it is also difficult to determine the threshold beyond which an irreversible change takes place. To circumvent some of these difficulties, Pearce et al. suggest strong sustainability, which demands that some critical amount of the non-substitutable natural capital be preserved, independent of any increases in value of other social or physical assets. For instance, substitutes do not exist for global natural assets like the ozone layer. Thus, sustainability measures should include both concepts of sustainability, measuring weak sustainability in monetary units and strong sustainability in biophysical ones (tones, hectares or joules). Hamilton (2004) argues that measurement of sustainability is required for extending national accounting systems. Nordhaus and Kokkelenberg (1999) motivate sustainability measurement because for several developing countries the combination of low

saving effort, high resource depletion, high population growth, and ineffective public investments, particularly in education is critical.

Besides operationalization of SDGs, their implementation includes monitoring and measuring sustainable development indicators. Three notable publications in the emerging literature are: the GGKP Report on 'Measuring Inclusive Green Growth at the Country Level' (2016); the SDG Index and Dashboards—Global Report prepared by the UNSDSN and the Bertelsmann Stiftung (Sachs et al. 2016); and the Overseas Development Institute Report (Nicolai et al. 2015).

The GGKP Report on Measuring Inclusive Green Growth[2] (IGG) at the country level focuses on the main reliable sources and constraints for data collection at the country level. The report, however, is not limited to the SDGs but to the Inclusive Green Growth (WB 2012). Instead of the social, environmental, economic dimension, the IGG context with 'inclusive, green, growth', emphasizes their interaction in a dynamic perspective.

The Overseas Development Institute's report (Nicolai et al. 2015) develops a grading system for each of the SDGs, classifying them broadly into three levels in terms of their chance of reaching the targets by 2030. The report classifies them into reform, revolution, and reversal. SDGs that are classified at reform levels are more than halfway to achievement by 2030. These include ending extreme poverty, strengthening economic growth in least-developed countries and halting deforestation (SDGs 1, 8, 15). Goals that require progress by multiples of current rates were categorized as revolution. Nine targets belong to this group: ending hunger, reducing maternal mortality, secondary school completion, ending child marriage, access to sanitation, access to energy (electricity), industrialization in LDCs, reducing deaths and domestic resource mobilization (SDGs 2–7, 9, 16, 17). Targets classified under reversals are moving in the opposite direction and require a reversal of current trends. They include inequality, slum populations, climate change, waste management and marine (reef) conservation. (SDGs 10–14). Nicolai and others are optimistic that the least-developed countries are halfway towards their 2030 targets of ending extreme poverty, economic growth in least-developed countries and halting deforestation. In terms of regional projections, sub-Saharan Africa requires special efforts in SDG implementation.

Spaiser et al. (2016) employ a data-driven approach to measure and monitor sustainable development. They construct two separate measures of SDGs. The first model assumes a true latent variable (for sustainable development) with the three components of child mortality, education and CO_2 emissions (representing the three underlying pillars of SDGs—economic, social and environmental) as observable indicators for this latent phenomenon, which ultimately goes beyond those three indicators. Thus, the first model seeks to predict changes in this latent sustainable development variable primarily and not changes in its components. The second model primarily predicts changes in the three components and to a lesser extent changes in the true latent sustainable development variable. Spaiser et al. (2016)

[2]The GGKP report identifies five broad characteristics of IGG: Natural Assets; Resource Efficiency and Decoupling; Resilience and Risks; Economic Opportunities and Efforts; and Inclusiveness.

compare the performance of these two SDG indices with GDP per capita and HDI, in terms of the how well these indices predict changes in the three components (Child Mortality, Education and CO_2 emissions). They find that both their SDG indices perform better than the common indices for used development and economic growth, namely, HDI and GDP per capita.

Easterly (2015) argues that SDGs are encyclopedic where everything is top priority, which means nothing is a priority. He importantly points out that it is unclear how the U.N. is going to proceed in achieving the unactionable, unquantifiable targets for the SDGs, as also the unattainable ones like 'ending poverty in all its forms and dimensions', 'universal health coverage', 'ending all … preventable deaths [related to newborn, child, and maternal mortality] before 2030', '[end] all forms of discrimination against all women and girls everywhere' and 'achieve full and productive employment and decent work for all women and men'. Even staunch supporters of the SDGs will acknowledge that there is substance to Easterly and other critics. Spaiser et al. (2016), quantify the incompatibility and inconsistency in the SDGs. Most studies are sector-specific and typically ignore the synergies and trade-offs identified in multisector assessments (ICSU and ISSC 2015; van Vuuren 2015). Policy makers cannot assume that policies targeting SDGs would lead to zero-sum trade-offs (Nilsson et al. 2012).

Obersteiner et al. (2016) argue that trade-offs within the global SDG agenda will manifest as obstacles to progress at regional and national levels. For instance, in the Congo Basin satellite, data has identified that agricultural expansion and fuel wood and timber extraction are the leading drivers of deforestation and habitat degradation (Celine et al. 2013). Similarly, in Sumatra, the rising agricultural commodity prices are detrimental to tropical forests and their biodiversity (Gaveau et al. 2009).

In an attempt to address some of these criticisms, Bali Swain and Wallentin (2017) construct a latent sustainable development variable to investigate which ones of the underlying pillars: economic, social and environment have the largest causal impact on improving sustainable development. Evidence on this is critical for the path that developing and developed countries and regions might take to attain SDGs. For instance, given the limited available resources, should developing countries focus on all three pillars to achieve SDGs, or are they most successful by emphasizing development and growth in the economic and social pillar?

Bali Swain and Wallentin (2017) further compare their SDG construct with SDG indices from Sachs et al. (2016) and the Human Development Index (HDI) to investigate if these different measures suggest conflicting policy inferences to the developing and developed countries in terms of achieving SDGs. Employing Structural Equation Models (SEM) to the Sachs et al. (2016) data set, the model described by the path diagram in Fig. 2 is estimated. The ellipses in the figure (with the arrows) represent the structural model. The three underlying pillars of sustainable development are represented by the latent variables: economic, social and environment. The causal impact of these three latent variables on the latent sustainable development variable (right-hand side ellipse) is estimated in the structural model. The measurement of the three pillars of SDGs (in ellipses) is in estimated in two steps. Using the UN SDSN (2015) data, in Step 1, the Principle Component

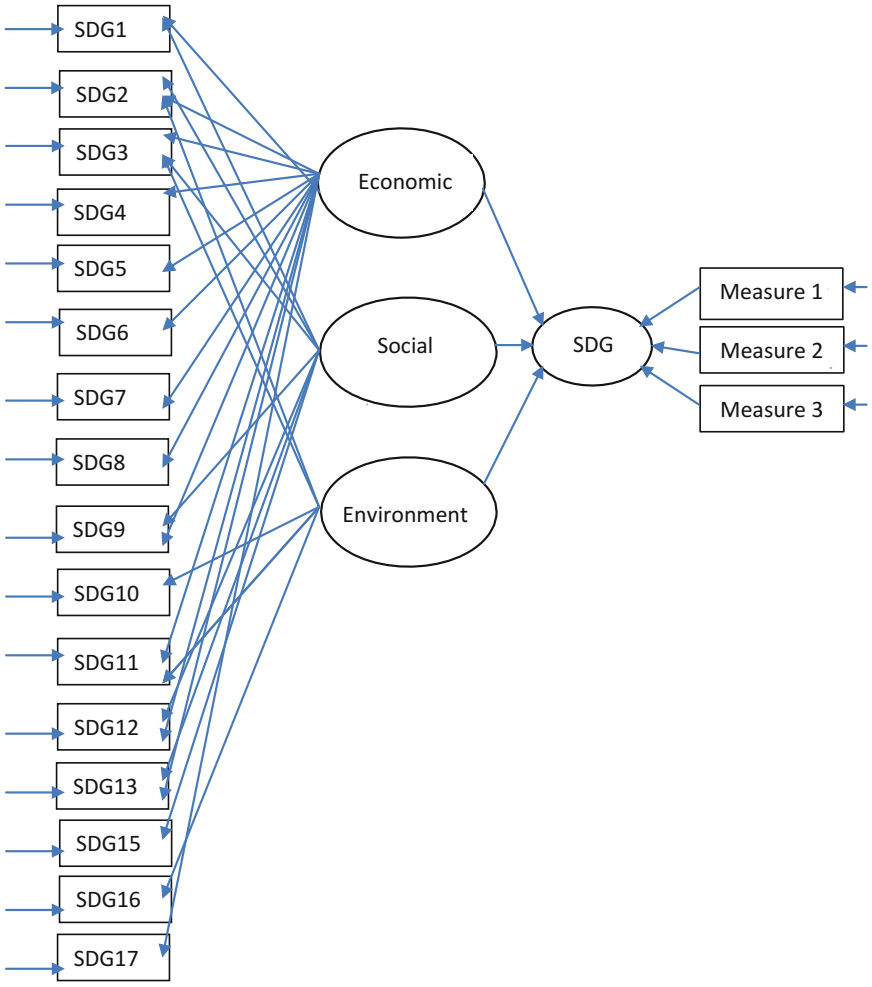

Fig. 2 Path diagram for SEM of sustainable development. *Source*: Adapted from Bali Swain and Wallentin (2017)

Analysis (PCA) is employed. The Principle Component Scores are calculated for each of the SDGs using the set of observed indicators for that specific goal. In Step 2, Exploratory Factor Analysis (EFA) is conducted to determine the SDGs (in rectangles) that measure the latent factors or sustainable development pillars (in ellipses). The other measurement model (on right-hand side) of the path diagram determines the latent sustainable development (in ellipses) using indicators (measures in rectangles).

Preliminary evidence suggests that while all the three latent factors have a significant and positive impact on sustainable development, their magnitude of impact varies (Bali Swain and Wallentin 2017). For both, the developing and the

developed countries, the social pillar remains an important feature of any policy that successfully wants to achieve SDGs. Though the environmental factor is significant for the developing countries, their impact is small as compared to the social and economic factors. Developing countries will thus attain the largest impact on sustainable development by focusing on policies that lead to economic and social development. In the short run, they may be able to decrease their emphasis on the environmental side. The developed countries cannot grow sustainably unless they focus on both their social and environmental policies. Results obtained by Bali Swain and Wallentin (2017) are in line with the literature that visualizes SDGs as an interlinked set of policies with trade-offs and synergies.

4 Big Data and Sustainable Development

Quantifying SDGs requires data and data in the developing countries is often remarkably poor. In fact, there is not a single 5-year period since 1990 where countries have enough data to report on more than 70 percent of MDG progress (UN Independent Expert Advisory Group 2014). More worryingly, about half of this data is based on firm country-level surveys; the rest are comprised of estimates, modelling and global monitoring.

Missing data is a major problem in developing countries. For instance, even for well reported variables like child mortality, 136 of the 161 countries track data on this goal (Rodriguez-Takeuchi 2014). About two-thirds of the 75 countries accounting for more than 95% of all maternal, newborn and child deaths do not have records of births and deaths, whereas twenty-six countries have no data on child mortality since 2009 (Stuart et al. 2015).

Data on ethnic minorities, regional groups and indigenous populations and slum dwellers are often left unrecorded in data sets. For example, data is rarely collected from women 50 and over; and little is available on the division of money and labour within households (UNICEF 2013). Governments and national statistics offices need better funding and training, and data collection should be more frequent, rigorous and universal.

Data challenges have implored researchers to test if big data may be used to monitor the SDGs. Big data produces large volumes of massive data generated from satellite images, social media, online commercial transactions, bank transactions data and cell phone record, etc. As Alex 'Sandy' Pentland, of the MIT Media Lab explains 'the power of Big Data Community Big Data is that it is information about people's behavior instead of information about their beliefs' (Letouze 2015). For instance, monitoring poverty or food security may be done by using cell phone activity, Call Detail Records (CDRs) analytics or satellite data (Steele et al. 2017; Elvidge et al. 2009; Smith-Clarke et al. 2014; Eagle et al. 2010; UN Global Pulse 2015). Most big data is currently owned by banks, mobile phone internet providers, social media providers, etc. To exploit its full potential, it, therefore, needs to be standardized and accessible so that the users may be able to effectively use it for

monitoring, evaluating and analysing its impact on sustainable development policies (UN 2015). Letouze (2015) points to the perils of the use of big data as there exists a potential risk to individual and group rights, privacy, identity and security. In addition to this, the legality and legitimacy of this is also questionable. Even when the data is anonymized it is possible to deanonymize it, making it very hard for any given individual to hide digitally in the data. Another problem of employing big data analyses is the risk that the focus moves towards correlation and prediction and away from the diagnostics or causal inference. Without causal analysis and the factors that affect policy impact, framing policy becomes difficult. Finally, there are fears that a 'new digital divide' might arise as a result of analytical capacities and access to data that only a limited number of institutions, corporations and individuals have. Paradoxically this would result in disadvantage for the countries and individuals that it intends to help in the first place.

5 Conclusion

The path to quantifying and monitoring SDGs is fraught with challenges. It requires a profound understanding of sustainable development, comprehension about how to operationalize and implement the SDGs, access to all forms of data and the expertise to analyse and interpret the results. This critical analysis of SDGs quantifies and examines the inconsistencies of the SDGs. The pursuit of economic growth and consumption underlies the inconsistencies between the economic and social development and the environmental goals. However, there are common denominators like health programmes and ecological sustainability that can lead to achieving SDGs without initiating the inconsistencies. Further investigating, which of the underlying social, economic or environmental pillars are the most effective for achieving sustainable development, reveals that the policy focus of the developing and the developed countries should be different. The developed countries are better off focusing on their social and environmental policies. The developing countries, on the other hand, should focus on their economic and social policies in the short run, even though the environmental policies remain significant for sustainable development.

Lack of limited availability of the data is a major constraint for quantifying and monitoring SDGs. The studies mentioned here are limited due to a data-driven approach. While data on economic indicators is widely available for most countries, data on environmental and social indicators is incomplete and of poor quality. Furthermore, studies using data-driven approaches usually lack an underlying theoretical foundation. SDGs are no exception and have often been criticized for a lack of underlying comprehensive theoretical framework. Finally, SDGs are long-term development agenda and have the potential to be exposed to unforeseen positive and negative shocks. The inferences derived from the data are based on the business-as-usual scenario using historical data. These may change in the future

while responding to positive changes by providing, for instance, incentives or adopting technological innovations.

While being a transformative agenda that is universal, people-centric and comprehensive, SDGs are also constrained by these characteristics. A situation that is made more acute by the lack of appropriate data. While future studies may explore alternative approaches to quantify and monitoring SDGs, additional challenges require emphasis on raising required resources to finance Agenda 2030 and exploring alternative Action plans at the national and regional level and ways of implementing the agenda even though it remains non-binding on countries.

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References

Arrow, K. J., Dasgupta, P., Goulder, L. H., Mumford, K. J., & Oleson, K. (2012). Sustainability and the measurement of wealth. *Environmental Development Economics, 17,* 317–353.

Bali Swain, R., & Wallentin, F. Y. (2017). The Sustainable development quagmire: Quantifying the sustainable development goals. Unpublished draft, Södertörn University & Stockholm School of Economics.

Campaginolo, L., Carraro, C., Eboli, F., & Farnia, L. (2015). Assessing SDGs: A new methodology to measure sustainability. FEEM Nota di Lavoro, 89.

Céline, E., Philippe, M., Astrid, V., Catherine, B., Musampa, C., & Pierre, D. (2013). National forest cover change in Congo Basin: Deforestation, reforestation, degradation and regeneration for the years 1990, 2000 and 2005. *Global Change Biology, 19,* 1173–1187.

Development in OECD. (2004). *Measuring sustainable development: Integrated economic, environmental and social frameworks*. Paris: OECD.

Dasgupta, P. (2001). *Human well-being and the natural environment* (2nd ed.). Oxford, UK: Oxford University Press.

Dasgupta, P. (2013). *The nature of economic development and the economic development of nature. Cambridge Working Papers in Economics. CWPE 1349*. Cambridge: University of Cambridge.

Eagle, N., Macy, M., & Claxton, R. (2010). Network diversity and economic development. *Science, 328,* 5981.

Easterly, W. (2015). The trouble with the sustainable development goals. *Current History,* November 2015, p. 322–325.

Elvidge, C., et al. (2009). A global poverty map derived from satellite data. *Computers & Geosciences, 35*(8), 1652–1660.

Gaveau, D. L. A., Linkie, M., Suyadi, Levang, P., & Leader-Williams, N. (2009). Three decades of deforestation in southwest Sumatra: Effects of coffee prices, law enforcement and rural poverty. *Biological Conservation, 142,* 597–605.

Giovannini, E. (Ed.). (1995). *Social statistics, national accounts and economic analysis*, Proceedings of the international conference in memory of Sir Richard Stone, Annali di Statistica, Serie X (Vol. 6) Roma, Italy: Istituto Nazionale di Statistica.

Green Growth Knowledge Platform (GGKP). (2016). Measuring inclusive green growth at the country level—Taking stock of measurement approaches and indicators. GGKP Research Committee on Measurement & Indicators.

Hamilton, K., Loh, J., Sayre, J., Thouvenot, T., & Wackernagel, M. (2004). Accounting for sustainable development: Complementary monetary and biophysical approaches. In *OECD,*

measuring sustainable development: Integrated economic, environmental and social frameworks, Paris.

Hamilton, K., & Clemens, M. (1999). Genuine savings rates in developing countries. *World Bank Economic Review, 13*(2), 33–56.

ICSU and ISSC. (2015). In A. S. Stevance, J. Mengel, D. Young, G. Glaser, C. Symon (Eds.), *Review of the sustainable development goals: The science perspective*. Paris: International Council for Science (ICSU).

IPCC. (2007). In R. K. Pachauri, A. Reisinger (Eds.), *Climate change 2007*. Synthesis report. Contribution of working groups I, II and III to the fourth assessment report of the intergovernmental panel on climate change core writing team, IPCC, Geneva, Switzerland. pp 104.

IPCC. (2014). Climate change 2014: Synthesis report topic 3: Future pathways for adaption, mitigation and sustainable development.

Jorgenson, A. K. (2010). World-economic integration, supply depots, and environmental degradation: A study of ecologically unequal exchange, foreign investment dependence, and deforestation in less developed countries. *Critical Sociology, 36,* 453–477.

Kenny, C. (2015). 'SDG targets: Here's how to make them stronger. http://www.cgdev.org/blog/sdg-targets-heres-how-make-them-stronger. March 23, 2015.

Kroll, C. (2015). *Sustainable development goals: Are the rich countries ready?* Germany: Bertelsmann Stiftung.

Letouze, E. (2015). Big data and development: An overview data, Pop Alliance Data—Pop Alliance Primer Series, 2015.

Lomborg, B. (2014). The United Nations needs a shorter, stronger game plan for humanity. *The Washington Post*, 21 November, https://www.washingtonpost.com/opinions/the-united-nations-needs-a-shorter-strongergame-plan-for-humanity/2014/11/21/a65e14d4-6f7611e4-ad12-3734c461eab6_story.html.

Lutz, E. (Ed.). (1993). *Toward improved accounting for the environment*. Washington: The World Bank.

Managi, S., & Kaneko, S. (2009). *Chinese economic development and the environment*. Cheltham: Edward Elgar.

Nicolai, S., Hoy, C., Berliner, T., & Aedy, T. (2015). *Projecting progress: Reaching the SDGs by 2030*. London: Overseas Development Institute.

Nilsson, M., & Persson, Å. (2012). Can earth system interactions be governed? Governance functions for linking climate change mitigation with land use, freshwater and biodiversity protection. *Ecological Economics, 75,* 61–71.

Nordhaus, W., & Kokkelenberg, E. (Eds.). (1999). *Nature's numbers: Expanding the national economic accounts to include the environment*. Washington: National Academy Press.

Obersteiner, M., Walsh, B., Frank, S., Havlík, P., Cantele, M., Liu, J., et al. (2016). Assessing the land resource–food price nexus of the sustainable development goals. *Science Advances, 2*(9), e1501499.

OECD. (2004). *Measuring sustainable development: Integrated economic, environmental and social frameworks*. Paris: OECD.

OECD. (2008). OECD environmental outlook to 2030. Paris: OECD.

OECD. (2014). *Development cooperation report 2014: Mobilising resources for sustainable development*. Paris: OECD.

Pao, H. T., & Tsai, C. M. (2010). CO_2 emissions, energy consumption and economic growth in BRIC countries. *Energy Policy, 38,* 7850–7860.

Pearce, D., Markandya, A., & Barbier, E. (1989). *Blueprint for a green economy*. London: Earthscan Publications.

Pearce, D. W., & Atkinson, G. (1993). Capital theory and the measurement of sustainable development: An indicator of weak sustainability. *Ecological Economics, 8,* 103–108.

Pierantoni, I. (2004). A few remarks on methodological aspects related to sustainable development in OECD 2004. *Measuring sustainable development: Integrated economic, environmental and social frameworks*. Paris: OECD.

Ranganathan, S., Bali Swain, R., & Sumpter, D. (2015). The demographic transition and economic growth: implications for development policy. *Palgrave Communications, 1*(15033), 2015.

Ranganathan, S., Nicolis, S. C., Bali Swain, R., & Sumpter, D. (2017). Setting development goals using stochastic dynamical system models. *PLOS One* (forthcoming).

Redclift, M. (2005). Sustainable development (1987–2005): An oxymoron comes of age. *Sustainable Development, 13*(4), 212–227.

Redclift, M. (2010). *Development and the environmental crisis: Red or green alternatives*. London: Routledge.

Repetto, R., Magrath, W., Wells, M., Beer, C., & Rossini, F. (1989). *Wasting assets: Natural resources in the national income accounts*. Washington, DC: World Resources Institute.

Rich, B. (2013). *Mortgaging the earth: The World Bank, environmental impoverishment, and the crisis of development*. Washington, DC: Island Press.

Rodriguez-Takeuchi, L. (2014). The 'X-File' and the Need for Civil Registration and Vital Statistics Systems Post-2015. London: ODI.

Rodríguez-Pose, R., & Samuels, F. (2015). *Rwanda's progress in health: Leadership, performance and health insurance*. London: ODI.

Sachs, J., Schmidt-Traub, G., Kroll, C., Durand-Delacre, D., & Teksoz, K. (2016). *An SDG index and dashboards—Global report*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Spaiser, V., Ranganathan, S., Bali Swain, R., & Sumpter, D. (2016). The sustainable development oxymoron: Quantifying and modelling the incompatibility of sustainable development goals. *International Journal of Sustainable Development & World Ecology*. online September 2016.

Smith-Clarke, C., Mashhadi, A., & Capra, L. (2014). Poverty on the cheap: Estimating poverty maps using aggregated mobile communication networks. In *Proceedings of the ACM conference on Human Factors in Computing Systems*.

Steele, J., Sundsøy, P. R., Pezzulo, C., Alegana, V. A., Bird, T. J., Blumenstock, J., et al. (2017). Mapping poverty using mobile phone and satellite data. *Journal of the Royal Society, Interface, 14*(127), 20160690.

Stern, D. I., Common, M. S., & Barbier, E. B. (1996). Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development. *World Development, 24,* 1151–1160.

Stuart, E., Samman, E., Avis, W. and Berliner, T. (2015). *The data revolution: Finding the missing millions*. London: ODI.

The Economist. (2015). The 169 commandments. http://www.economist.com/news/leaders/21647286proposed-sustainable-development-goals-would-beworse-useless-169-commandments. March 28.

UNICEF. (2013). *Every child's birth right: Inequities and trends in birth registration*. New York: UNICEF.

United Nations. (1992). Agenda 21.

United Nations. (2014). *A world that counts mobilising the data revolution for sustainable development*, Independent Expert Advisory Group on a Data Revolution for Sustainable Development, 2014.

United Nations. (2015). *Global sustainable development report*, 2015 edition. New York: United Nations.

UN Global Pulse. (2015). Using mobile phone data and airtime credit purchases to estimate food security. New York: UN World Food Programme (WFP), Université Catholique de Louvain, Real Impact Analytics, Pulse Lab New York.

UN SDSN. (2015). *Data for development. A needs assessment for SDG monitoring and statistical capacity development*. New York: UN SDSN.

van Vuuren, D. P., Kok, M., Lucas, P. L., Prins, A. G., Alkemade, R., van den Berg, M., et al. (2015). Pathways to achieve a set of ambitious global sustainability objectives by 2050: Explorations using the IMAGE integrated assessment model. *Technology Forecasting Social Change, 98,* 303–323.

World Bank (WB). (2012). Inclusive green growth: The pathway to sustainable development. New York. Home Boards About Subscribe Journal GP Events Themes Comment & Opinion Media Contribute Terms and Conditions and Privacy.

World Commission on Environment and Development (WCED). (1987). *Our common future*. Brundtland Report. New York: United Nations.

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