sustainability

MDPI

Article

Sustainability Indicators Past and Present: What Next?

Simon Bell [1] and Stephen Morse [2,*]

[1] Bayswater Institute and the Science, Technology, Engineering and Mathematics Faculty, Open University, Milton Keynes MK7 6AA, UK; S.G.Bell@open.ac.uk
[2] Centre for Environment and Sustainability, University of Surrey, Guildford GU2 7XH, UK
* Correspondence: s.morse@surrey.ac.uk; Tel.: +44-(0)1483-686079; Fax: +44-(0)1483-686671

Received: 27 March 2018; Accepted: 16 April 2018; Published: 20 April 2018

Abstract: This paper discusses the current state of thought amongst the Sustainability Indicator (SI) community, what has been achieved and where we are succeeding and failing. Recent years have witnessed the rise of "alternative facts" and "fake news" and this paper discusses how SIs fit into this maelstrom, especially as they are themselves designed to encapsulate complexity into condensed signals and it has long been known that SIs can be selectively used to support polarized sides of a debate. This paper draws from chapters in a new edited volume, the "Routledge Handbook of Sustainability Indicators and Indices", edited by the authors. The book has 34 chapters written by a total of 59 SI experts from a wide range of backgrounds, and attempts to provide a picture of the past and present, strengths and weaknesses of SI development today. This paper is an "analysis of those analyses"—a mindful reflection on reflection, and an assessment of the malign and benign forces at work in 2018 within the SI arena. Finally, we seek to identify where SIs may be going over the coming, unpredictable years.

Keywords: sustainability indicators; gross domestic product; GDP; fake news; tweets

1. Introduction

> "The moment we begin to fear the opinions of others and hesitate to tell the truth that is in us, and from motives of policy are silent when we should speak, the divine floods of light and life no longer flow into our souls".
>
> Elizabeth Cady Stanton

We argue in this paper, without trying to be alarmist, that a truly existential issue faces all of us in the sustainable development community and, in this crisis of truth, Sustainability Indicators (SIs) are at the epicentre, especially as given the breadth of concerns within sustainable development the variety of what can be an SI is understandably immense. Here, we use the term "Sustainability Indicator" to encompass indices (amalgams of indicators). We have also taken a liberal view of what could be considered to be an "SI" given that sustainability spans the three pillars of social, economic and environmental dimensions. Similarly, there is "no one SI to rule them all" (although some agencies have arguably exhibited a Mordor-esqe attitude to SIs on occasion) but a wide diversity of approaches and indicators, each emerging in their own time and space and designed to meet a defined set of objectives. Thus, we have seen indices such as the Human Development Index (HDI), Ecological Footprint (EF) and Environmental Performance Index (EPI) becoming popular and, at the time of writing, we have the emergence of the targets and indicators linked to the Planetary Boundaries concept [1] as well as the Sustainable Development Goals (SDGs). Indices (aggregations of indicators) such as the HDI and EPI have evolved over time in response to feedback from researchers and practitioners, and the

ever-increasing availability of data (albeit of varying qualities and arguably still not enough) also acts as a spur to change. However, at their heart, we all know that indicators and indices are simplifying tools designed to capture complexity and help convey information to specialists and non-specialists alike. This is, of course, well known and there are many published examples spanning decades as to how this process of simplification results in trade-offs; decisions to exclude and include; and to manipulate data (for an early review, please see [2]). These are human decisions and, while they are rationalized by their "owners", they are nonetheless inherently subjective. It is acknowledged that not all will agree with those decisions and the reader need look no further than the numerous debates that have resonated over the years regarding the HDI let alone the EPI and its precursor called the Environmental Sustainability Index (ESI). Morse [2] provided a summary of the debates surrounding indices such as the HDI and EPI/ESI. We must accept that SIs are not "laws of nature" but human constructs that reflect the biases, failings, intentions and worldview of their creators. In that sense, because of the inherent subjectivity all indicators and indices can be labelled as "fake" by at least someone and they can provide "evidence" (based on different biases, intentions, assumptions and worldviews) to back it up. Needless to say, this "home truth" may be uncomfortable reading for those of us in the indicator business.

The SI landscape is certainly a constantly shifting one, and, while much of what we have said in the previous paragraph is well known, there are still many questions that need answers. Amongst them are:

- What is the current state of thought amongst the SI community?
- What has been achieved and where were we succeeding and failing?
- What challenges and threats face the informing agency at the heart of the SI process?
- Most seriously and existentially for the indicator oeuvre, is there evidence of a fight on-going for what we might call "the soul of facts"?

These were questions we had been asking ourselves, especially with the recent rise of "alternative facts" and "fake news" [3], which take highly selective stances on what are "facts" and the Twitter phenomenon where complexity is condensed into tweets of just a few hundred characters. "Fake news" can be believed as "truth" by many people; it can indeed become "realer than real" [4]. At one level, the rise of the fake news phenomenon in the 2000s is but a recent manifestation of the hoaxes portrayed by writers such as Edgar Allan Poe in the 19th century. For example, Poe published a short story (called the "Balloon Hoax") in the form of a newspaper article that purported to describe the first crossing of the Atlantic by a manned balloon. The story was very detailed and had a ring of plausibility about it, hence it was believed by many who first read it in the Sun newspaper published in New York. It was only later revealed to be a hoax. While Poe certainly did not invent hoaxes, he was one of the first writers of science fiction and clearly had a fertile mind, even if some have since suggested that the balloon hoax was derived from other written and contemporary sources [5]. What is different about the fake news of today compared to the 19th century is its rapid spread and indeed democratization via social media such as Facebook and Twitter [6]. Anyone with a Twitter account can now make up their own news and the system facilitates its rapid spread via "re-tweeting". Re-tweeting has a cascade, even domino effect which means that a news item can literally be spread to millions of Twitter users in seconds. How do SIs fit into all of this, especially as they are themselves designed to encapsulate complexity into condensed signals and it has long been known that SIs can be selectively used to support polarized sides of a debate? Indeed, are SIs the sustainability equivalent of "tweets", fulfilling an innate human thirst for rapid information that simplifies complexity? In addition, do SIs under certain circumstances play into a desire amongst some for "alternative facts" which can be in some way customized, even weaponized, to create "formations of terror" in receiving communities [7]? Are we in a fight about the nature of facts without even knowing it? This post-truth debate has been going on for a while now. In 2006, Steven Poole [8] and Anthony O'Hear [9] anticipated the rise of trivialization and the demise of "truth" in public discourse in their respective books. The debates contained in these

books could now be said to have matured. An apparent "easy" answer to these questions rests with motivation. Those of us in the "indicator business" think of ourselves as having a good motive; we want to help bring about a positive change. Hence, the indicators we develop and encourage others to use are there with the very best of intentions. Poe knew he was writing a hoax and while the offices of the Sun were besieged with people looking to get the "news" about the balloon crossing, Poe would no doubt argue that he did not set out to hurt anyone. However, are the modern purveyors of fake news purposely setting out to cause damage? Some may well, but it might surprise us how genuine the motives are of those who create and spread such news. It should be noted here that this apparent similarity between SIs and Twitter/Facebook domain of "quick" and "fake" news is not a similarity the authors see as a fact, but that it is a fact that (biased) consumers in their echo chambers, and thus significant parts of the public, may be unable to recognize the difference.

In 2014, a major publisher—Routledge—approached us and asked if we would be interested in editing a book on SIs. With a combined experience of over 35 thirty years of effort and learning from responses to our previous books and papers, we felt that this may well be an ideal opportunity to reflect the history and theory of sustainability measurement, approaches and methods used, agencies involved and critiques of where we are today and their intended use for "measuring the immeasurable", especially the awkward question as to whether SIs play into a desire for "alternative facts". We begin this paper with our analysis of the book and in particular the major points which emerged regarding the future of SIs, and what the authors felt was needed going forward from here. Following that, we discuss some of the thoughts regarding the point we make above about the future of SIs in this new era of "fake news" and "tweets". These thoughts were informed by various points made throughout the book as well as numerous email communications we have had with contributors since 2014, especially by some authors who were clearly frustrated with what they regarded as the current state-of-play regarding "non-use" or arguably "misuse" of SIs. As we have noted above, this raises some uncomfortable (perhaps) issues for those of us in the SI community. Without wishing to be overly-provocative, are we also playing the same game as those who readily use the term "fake news" at every opportunity that suits them and use "tweets" to get their messages out? Are we not in a glass box and perhaps should we stop throwing stones?

2. The Book: An Analysis

2.1. A Brief Tour

In the book, 59 distinguished authors, many of them with decades of experience working on the "coal face" of SI development, have contributed to map out their past experiences of SIs and reflect on the future. To provide a summary of the topics covered in the book is never really an adequate exposition of the richness of the original, and here we can only really set out some brief outlines of the material and messages. We divided the book into four sections and 34 chapters, as shown in Figure 1. The topics spanned the theory and history of SIs through to methods, agency experiences and critical reflections. As editors we sought to avoid a book which simply acted as a shop window for many "favourite" SIs, but wished to include a more nuanced perspective regarding the many years of experience the indicator community has amassed with their use. Hence, there are two sections in the book on experience and reflection.

We should emphasize here that our intention in this paper is not to offer a kind of book editorial or summary, but instead we have utilized the material in the book as a source of information to address the questions we set out regarding the future of SIs. In effect, this paper is an "analysis of analyses", and, given the material in the book is contemporary and reflective, it does provide a unique resource on SIs.

Authors in the collection made various and wide-ranging suggestions regarding future work on SIs, and we have focused on those points that stood out from the various conclusions reached by the contributors. The points span the following:

1. More case studies on the development/use of SIs
2. Alternatives to Gross Domestic Product (GDP)
3. The growing confusion around data provision
4. The essential need for a more systemic perspective
5. Top-down versus bottom-up
6. Issues around the aggregation of indicators

All of these cover long-established debates in the SI arena, of course, even if some have arguably received more attention than others. Indeed, it should perhaps not be surprising that they emerged again as strong points of discussion within the book. However, it was also clear from the chapters that the debates had moved on and it is useful to set out some of the conclusions that were reached and what we as editors can conclude from those conclusions.

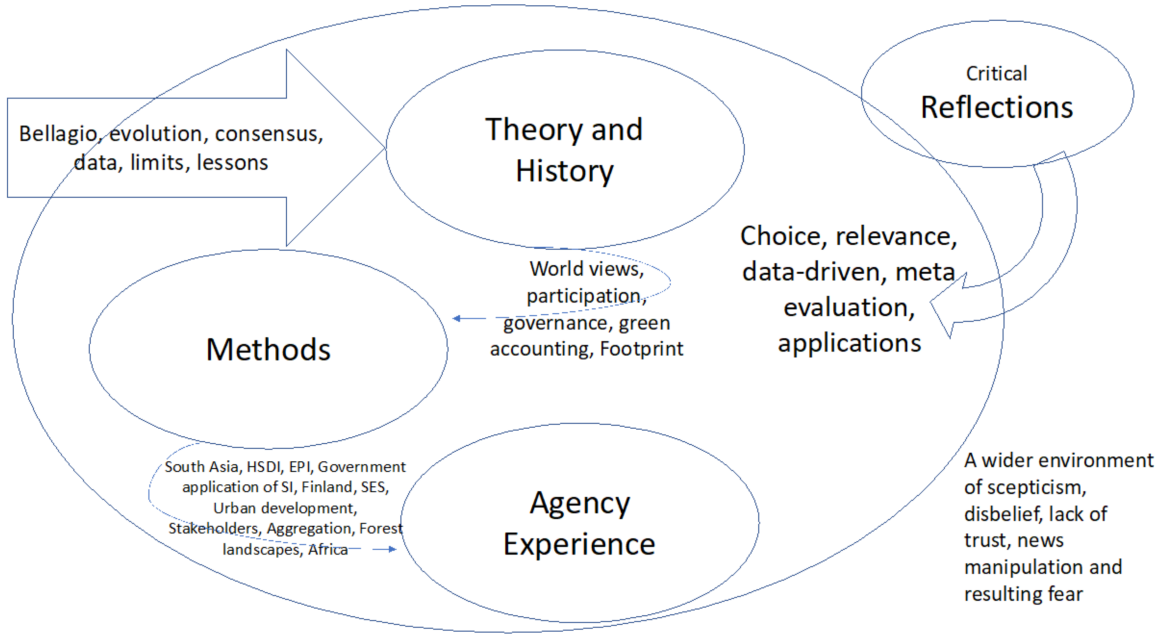

Figure 1. The structure of our book set in its environment.

2.2. More Case Studies on the Development/Use of Sustainability Indicators

Pintér et al. called for a "*richer selection of case studies*" to help create "*practical and more useful guidance*" regarding Sustainability Assessment and Measurement Principles (STAMP) [10] and the book had several "case study" chapters which discussed the development and application of SIs; examples are chapters on experiences with the EPI in Malta [11] and SIs in Finland [12]. There is certainly a need for more research of this type to allow for the identification of potential generic patterns as to what works best, or not. However, case study-based research certainly has its critics and challenges, as those of us who have tried to publish case study-based research findings have repeatedly found. The dilemma, and one that is so often espoused by paper reviewers and journal editors, is that case study findings are often not readily generalizable. Hence, they can be dismissed as being "context specific", and linked to a specific place and time. How can we derive more universal "truths" from such work, especially in a world of publication metrics where impact factor (at the level of the journal) and H-Index (at the level of the individual researcher) increasingly seem to dominate? Competition for space in the best journals is increasingly intense and journal editors are looking for those papers that will amplify the journal itself (often by promoting those who are already successful and therefore less risky) and boost ratings? Given this competition for space, it is easy to appreciate how negative comments from some reviewers can readily be seized upon and used to reject case study-based work.

This is not the case for all case-study based papers, of course, and some reviewers and editors are more amenable and supportive than are others, but we do nonetheless wonder how much is missed.

However, case studies have a place, and in the case of Sis, they allow us to understand much more about that critical interface with SI users albeit, we accept, in what can be quite context-specific spaces. Case studies can provide early examples of experiences which may become general trends, weird results which provoke curiosity, even contradictions to the established opus of "truth". Hence, we agree with Pintér et al that a case-study based body of knowledge regarding SIs can allow for new patterns to emerge (and old ones to be questioned) and that is why we were keen to include case study experiences in the book [10]. What we perhaps need is a meta-analysis of SI use experiences, but, to do this, we need the case studies to be peer reviewed and placed in the public domain. This is very challenging work, as we note later in this paper, but also very valuable. The dilemma, of course, is how to get such case study-based material on SIs reviewed and published. Maybe there is a need for a new journal devoted to case studies in sustainability.

2.3. Alternatives to Gross Domestic Product

Dahl, in his chapter on the Contributions to the "Evolving Theory and Practice of Indicators of Sustainability" [13], reiterated the need for alternative indicators to GDP and suggests material flow analysis as an integrating approach in sustainability assessment. There are echoes here with an intriguing call for a "*New Bretton Woods*" to help achieve a broad consensus regarding alternative indicators to allow us to move beyond GDP and achieve "*measures of what we really want and to achieve these goals*" [14]. However, while the "*New Bretton Woods*" idea is tantalizing, these calls to explore alternatives to GDP have been with us for some years with little obvious success to date. Indeed, one of the rationales for the HDI was as a counter-weight to the economic-based indicators that were perceived by the United Nations Development Programme (UNDP) to be so dominant in assessing development. Nonetheless, economic-based indicators still dominate in a world desperate to see the return of economic growth and prosperity. We flag this issue to contribute to the amassing weight of evidence that GDP does not provide the necessary or sufficient resilience for twenty first century needs. However, the question is arguably not whether other indicators are needed but what they should be and how to get them accepted in the light of experience to date.

2.4. Confusions in Data Provision

Some contributors to the book note the potential of indicators to help support environmental decision-making but point to continuing problems of data limitation, even if there has been much improvement and data are no longer as scarce as they once were [15–17]. We very much agree, as without an adequate availability of good quality indicators there is a likelihood that indicators may be deeply flawed and hence readily dismissed. Ulla Rosenström made the interesting observation about how digitization has done little to improve the timeliness of data provision or it "created new opportunities to measure sustainable development. Too much of the data is still presented on an annual basis when more real-time databases could be created" [12].

The question, of course, is what it would take to achieve this. Collecting necessary data of the required quality is likely to be resource-demanding and/or imagination challenging. At one level, we have a profusion of data being collected of a good quality on a daily basis on mobile phones. However, how do we lever this for SI purposes? It may be that what we have witnessed so far with digitization is but a reflection of the limited capability of machines on the one hand and the creative imaginations of researchers on the other, and as machines become more sophisticated, machine learning begins to expand and researchers become more aware of the wealth of data incidentally collected second by second by millions of people, then we may pass into a new age of automation, with machine and human, digital and analogue combining to revolutionize the concept of the data needed for SIs. Jean et al. provided an example of using machine learning to help predict poverty, using another tool

(satellite imagery) which may well grow in importance for populating SIs especially in places where resources to collect good quality data in the field may be lacking [18].

2.5. A systems Perspective

Walter Vermeulen suggested that "we need to build indicators and index systems based on a clear guiding vision and key elements" [19] and, in a related vein, Rotz and Fraser called for a greater acknowledgement that "conceptual and instrumental challenges" of sustainability and resilience are deeply linked and that "indicators need to be nested in a broader analysis that helps to make sense of context specific dynamics" [20]. Gilberto Gallopin also called for a more integrated approach that considers linkages, synergies and antagonisms between goals and targets (and their associated SIs of course) rather than simple listings under themes as we see with the Sustainable Development Goals (SDGs) [21]. It is hard to disagree with that or indeed his sombre conclusion that "given that linear thinking is still dominant in most institutions (including governments), the outlook is rather pessimistic, at least in the short and medium term". Herein rests a significant challenge that has been with us for some time. It has been relatively easy for us to "talk the talk" of such systems approaches to SIs, and we have also added out voices to this over the years, but linear thinking and desires to strict accountability over relatively short time periods can work against "walking the talk". Clearly, the issues involved here are proving to be far more intractable than we would have thought over 20 years ago when we first began working on SIs. Breaking out of the "linear thinking" cultural mindset arguably dominant since the advent of the first industrial revolution and prevalent as a knee-jerk against risky ideas in most institutions clearly requires much more analysis as to why such thinking has become so dominant in the first place. Some of it is no doubt driven by a legacy of innate distrust of the individual in the world of work to "deliver" and a commensurate push for an apparent accountability that makes sure "delivery" can be assessed. In this sense, SIs could be seen to be part of a more general drive to crudely equate measurement with outcomes relating to inputs (no matter how spurious the measurement method applied); as if any single input were ever responsible for one single output. This delusion propagated by the management classes to spuriously link outcomes to expenditure has been exemplified in the past by planning frameworks such as the "logical framework" approach [22–26]. The "square peg" mindset of the "log frame" as developed in the 1980s and 1990s might be said to have found a refined form in the SIs of recent times.

2.6. Top-Down vs. Bottom-Up

A further point linked to the systems perspective is the role of SIs in helping to facilitate the development of an appreciation of what sustainability and resilience are in any particular context. Hence, it is not solely a case of SIs being created as an operational output after an understanding of sustainability and resilience has been arrived at, but SIs as a catalytic precursor to help facilitate such an understanding. SIs can help ground such discussions and provide tangible representations of what is seen as relevant and important. We have often advocated such a dialectic and others in the book have also made the point. For example, Dwi Amalia Sari and colleagues in their chapter on SIs in complex, multi-functional forest landscapes suggested that "the role of criteria and indicator processes in these complex and contested situations is perhaps more to allow a structuring of the debate than to provide a set of boxes to be ticked" [27].

However, one of the dilemma's here is what to do with the SIs that emerge out of such a dialectic. Once the SIs have allowed an "arrival" at an understanding and have no doubt passed through a process of discussion, sieving and modification, then it is possible that they may not necessarily match the SIs that have been set in a more "top-down and one-way" process by government or other experts. This is certainly not to say that "top-down and one-way" SIs are bad or irrelevant; they may well have a strong antecedence of their own and offer advantages such as cross-country and timeline comparison. Simon Joss and Yvonne Rydin addressed this "bottom-up and dialectic"–"top-down and one-way" space in the context of urban sustainability and come to understandable conclusion

that: "What constitutes an appropriate balance between the standard aspects of urban sustainability frameworks and the local variation of particular applications remains an open discussion in need of ongoing conceptual and practical exploration" [28].

We very much agree with this sentiment and would postulate that, while much progress has been made with participatory methodologies and their acceptance within interventions, there does indeed still seem to be something of an unexplored boundary between SIs developed via such approaches and those derived "top down" by experts. The dualism implicit in this may be false and, in the "space" between experts and "people", emerge many of the intriguing problems which provide the wider environment for the SI discourse and project. This is surely a space in deep need of mindful exploration. Either by intent or accident, experts can be perceived (perhaps even presented) as callous and unworldly, indicators as symptoms of authority and even demagoguery, and the entire SI project as an example of an educated and liberal elites conspiracy to enforce an agenda at variance with common sense and social/economic needs. This remains a contaminating issue for the field but maybe one which could be most richly mined in future research. Where there is contention, there should research cluster.

2.7. Aggregation of Indicators

One of the fascinating aspects that emerges from the book chapters is the varied views on aggregation of indicators into indices. Many of the chapters include examples where this has been done, for example with the EPI [15] and a derivative of the HDI called the Human Sustainable Development Index (HSDI) [29], but there are some stark warnings as well. As Jesinghaus passionately put it, "Aggregation is evil when it gives mediatic power to numbers that do not deserve it" [30]. However, and perhaps surprising to us, we do not detect a clear consensus amongst the authors that more integration is required, and Dahl when summarizing the outcomes of a UN Commission on Sustainable Development (CSD) led process to identify SIs reflects this by noting that "despite repeated requests from governments, reviews of progress, and the best efforts of the scientific community, no consensus emerged on highly aggregated indices" [31]. This raises an interesting dilemma. On the one hand, one of the "givens" often assumed in the indicator world is that aggregated indices are useful tools as they help present complexity in simple ways. On the other hand, we all seem to know the risks involved as aggregation can "hide" key decisions over what to aggregate and how that can, in turn, significantly influence the result and any conclusions that emerge from it. Indeed, the creators of the HDI say that they have resisted major changes to the index for that very reason and go to great lengths to present "standardized" (in methodological terms) versions of the HDI to allow for time-series comparisons [2]. However, it seems that the experts have yet to arrive at a clear consensus, although this is not for the want of trying. We would argue that the work of Dahl regarding what "consumers" of SIs want needs to be more fully developed: is there demand for aggregated indices and are there patterns which exist in this demand between types of SI consumer?

However, the issue of aggregation takes us to the equally contentious issue of what is a fact? How is an "aggregation of facts" contrived to be meaningful and how does meaning result in an action/response which is in some way commensurate to the "fact" outlined in the aggregation? What is real and what is fake in the SI world? This is a question that drives at the very heart of our interests in SIs, and we provide some thoughts in the next section.

3. Fake Indicators?

Given that SIs occupy that nexus between developers and users, it seems almost inevitable that there could be an element of selection-bias by the latter [32]. No matter the motives of the SI developers, some people may indeed want to make selective use of them to convey a message. However, this is a complex landscape. For example, in one of the first published studies of the use of SIs by government, Herzi suggested that there are five categories of use [33]:

- Instrumental: Indicators inform decisions that have impacts

- Conceptual: Catalyse learning and understanding
- Tactical: Substitute for action and deflect criticism
- Symbolic: Ritualistic assurance
- Political: Support a pre-determined position

The first two in the list are arguably the most "positive" uses in the sense that the SIs seemed to be linked to a desire for genuine improvement, while the other three are arguably more "negative" in the sense that they seem to be about deflection, false assurance and support of entrenched positions that may not necessarily be to the benefit of society as a whole. However, while the categories may seem to be neat, the boundaries between them are blurred, and what one user may genuinely regard as "instrumental" use of an SI another may vigorously regard as "political". Thus, in any one context, and with a suite of SIs available, it is not hard to imagine that different users would select different SIs to address any of these uses. For the researcher, this may be something of an intriguing and bewildering minefield, and an attempt to categorize the use of an SI cherished by one group as "political", while others may see it as "instrumental" or "conceptual", can leave him/her open to the claim of spreading "fake news". Even if the process of categorization was opened-up to a kind of democratic decision-making where the majority view rules, it is not guaranteed that those in the minority would accept it and it is highly likely that at least some of them would not. Even so, we may argue that it is the majority view which counts and a minority, even if vociferous, is still a minority. After all, science may not be based on fiat but, in the world of Sis, fiat is arguably the only game in town. However, here is another symptom of the complexity masked by indicators. Indicator intention and application relates to psychological choices and these are deep waters worthy and in need of exploration. For a topical example, the reader need look no further that the June 2016 "Brexit" referendum and heated debate in the UK associated with it that continues to the time of writing. One of the most oft-quoted phrases by those on the "leave" campaign (those in favour of Brexit) was that the UK was the "5th largest economy" in the world and thus, by extrapolation, well-able to flourish outside of the EU. The phrase was often repeated and is still a key element of the Brexiteers (those who support Brexit) lexicon. The phrase is claimed to be based on a metric and statistics but is it true?

Well, of course, much depends on the measures one uses to represent the size of the "economy". Economies can be measured in various ways and the World Bank has been collating such information for many years with data readily available at https://data.worldbank.org/. Several indicators could be employed but here we have focused on just four. In each case, the indicator is founded upon the Gross Domestic Product (GDP) where, using the World Banks definition:

> GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. [34]

In effect, GDP calculated on the basis of expenditure is given by:

$$\text{GDP (expenditure)} = C + G + I + (EX - IM) \quad (1)$$

where C is the consumers' expenditure on goods and services; G is the government expenditure on goods and services; I is investment; EX is exports; and IM is imports.

The balance of these components will vary across economies [2]. In essence, the assumption here is that the higher the level of GDP then the greater the "size" of the economy, with an additional implied assumption that, the bigger the GDP, the better. Jesinghaus certainly made a good case for treating GDP with care when it comes to sustainable development and care does need to be taken in assuming that GDP growth is always a good thing, at least for most of a population, as much depends on distribution [30]. As Peter Bartelmus has noted, the GDP has often been "accused of being a misleading measure of well-being" [35]. Clearly, it is not such a measure and was never intended

to be; unfortunately, it has become the key barometer of national economic performance and, in the minds of many, this is very much associated with well-being. However, is GDP an SI? It does, of course, sit within the economic domain often included in sustainable development. However, it needs to be noted here that, while GDP may not be unanimously regarded as an SI, it has certainly found its way into indices often considered to be part of the SI stable, such as the HDI (where GDP/capita is regarded as a measure of "income") and even within components of the Environmental Sustainability Index (ESI), the precursor of the EPI. In addition, GDP is often used as an independent variable for exploring environmental performance, as with the Environmental Kuznet Curve models [2]. It needs to be stressed that GDP is not itself a "bad" indicator, and, as Bartelmus noted, we do need to be careful not to discard the GDP: "There is indeed no other place where standardized measures of economic activities can be found and presented to policy makers in a meaningful "nutshell". Individuals, corporations, and trade unions can compare information on their economic situation and prospects with those of their own country and other nations" [35].

One can indeed use the GDP for international comparisons by converting local currencies to the U.S.$ using exchange rates (GDP current U.S.$). However, a complication, of course, is that the size of a country's GDP expressed as U.S.$ could fluctuate over time as the exchange rate fluctuates. To allow for fluctuations in relative currency value over time, caused by inflation for example, GDP could be based on a single reference point and the World Bank provide an estimate of GDP using exchange rates for 2010. A further refinement is to adjust the GDP to allow for changes in the "purchasing power" of currencies, which is referred to as Purchasing Power Parity (PPP). Purchasing Power Parity is much more than a simple adjustment for exchange rate and is based on the knowledge that one US$ will buy different quantities of goods and services across the globe. As the World Bank define it: "Purchasing Power Parity GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States."

Purchasing Power Parity adjusted GDP could also be based on current exchange rates and an exchange rate fixed to one particular year (as above). Table 1 provides a summary of the four indicators. Using these four indicators of economy "size", the ranking of the UK amongst the countries of the globe is shown in Figure 2. The numbers of newspaper articles published each year that mention the phrases "5th largest economy" and "fifth largest economy" in relation to the UK are also shown. These data have come from the Nexis database of global media publications (https://www.lexisnexis.com/en-us/products/nexis.page) but specifically searching newspapers where these phrases appears in English referring to the UK. The Nexis database has been applied in several published studies designed to explore reporting of indicators in the media [36–39]. Unsurprisingly, the number of "mentions" of the phrase surged in 2016, and is also higher than the 2010–2014 norm in 2015 when speculation over the referendum was rife and in 2017 as the UK started negotiating the terms of its exit from the EU. Prior to the 2015–2017 period, the terms appeared in the press, but the incidence was less than 100 articles per annum. Immediately after the referendum result in 2016, the value of the Pound Sterling fell by 10% against the U.S.$; indeed, it hit a 31 year low, and this would have affected the value of the GDP calculation expressed in US$ and the country's ranking in the "size of the economy" league tables.

However, does the use of the "5th largest economy" term match the reality? Well, with GDP (expressed as current U.S.$) and GDP (expressed as constant 2010 US$), the answer seems to be "no" The UK tends to fluctuate between 6th and 7th between 2010 and 2016, although it did hit a peak of 5th in 2015 for the GDP (current U.S.$) indicator. Nonetheless the "5th largest economy" claim that was so loudly proclaimed in 2016 is hardly convincing. However, let us provide some benefit of the doubt here, as such calculations are complex and say that the GDP (current U.S.$) and GDP (constant 2010 U.S.$) are at least in the right ballpark and the ranking based on GDP (current U.S.$) is close to being true. Nonetheless, "fifth" does obviously sound better than claims of "sixth" or "seventh".

Table 1. Summary of four indicators of economic "size". Purchasing Power Parity (PPP) [40] .

Indicator Name	Notes (as Provided by the World Bank for Each Indicator)
GDP (constant 2010 U.S.$)	Data are in constant 2010 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2010 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.
GDP (current U.S.$)	Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.
GDP, PPP (constant 2011 international $)	Data are in constant 2011 international dollars.
GDP, PPP (current international $)	Data are in current international dollars. For most economies PPP figures are extrapolated from the 2011 International Comparison Program (ICP) benchmark estimates or imputed using a statistical model based on the 2011 ICP. For 47 high- and upper middle-income economies, conversion factors are provided by Eurostat and the Organisation for Economic Co-operation and Development (OECD).

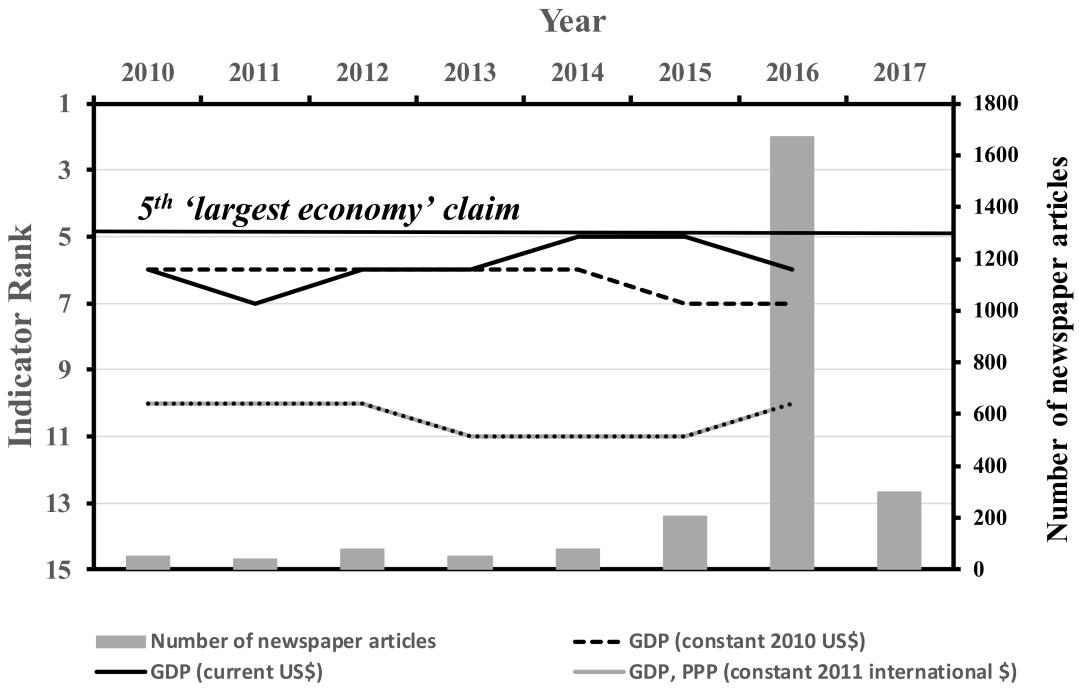

Figure 2. Four indicators of measuring the size of the UK economy and the rank of the UK in the global "league table" using those measures [40].

However, the same cannot be said of the two GDP indicators adjusted for purchasing power, a commonly applied technique for adjusting GDP over many years [41]. With these PPP-adjusted measures, the UK typically ranks between 9th and 10th—some considerable distance away from the "5th largest economy" claim. However, in fairness, it should be noted that PPP has attracted criticism from some economists [42], although there is logic in the notion that PPP adjustments allow for differing purchasing power across economies, and hence reduce any distortions that might arise. However, there is little, if any, evidence to suggest that the PPP adjustment GDPs were employed by those advocating for Brexit. Similarly, while Figure 2 does not include the figures if the GDP

and GDP PPP are calculated on a per capita basis, the UK ranks even lower in those "league table". Per capita adjustments allow for the fact that the value of the GDP may be linked to population size: the more people there are then the greater the flow of money in the system. This is not always the case, of course, and can distort the rankings as countries with small populations and low corporate tax regimes can rank very high purely because companies introduce processes to ensure that a lot of their taxable income flows through them, but it is a widely used adjustment of GDP nonetheless. The HDI, for example, uses the GDP PPP adjusted on a per capita basis and has long argued in favour of that as an indicator of income even if the HDI engineers have sought to cap high values of GDP PPP/capita in various ways to prevent a distorting effect on the index [37]. However, all of these adjustments were ignored by the Brexit supporters and instead the focus was on the most "favourable" measure for their case—the GDP based on current US$. They would regard this as an "instrumental" use of the indicator as it was being used by them to help inform an important decision. Others, based upon the evidence presented above, may see it as more of a symbolic or ritual use.

We as SI developers and practitioners should not be surprised by any of this, and indeed it does have to be stressed that, while we have used the Brexit "hot house" period of intense debate to illustrate the selective used of indicators, this is by no means an issue solely linked to that time and place. It goes with the "indicator territory" and we must accept, whether we like it or not, that the indicators we develop or promote may be "used" in ways that we did not intend or that users may be highly selective in their choices [32]. Indicators do not have any special privileges in the complex, "messy" real world of decision making where those who take the decisions are being influenced by implicit and explicit concerns and pressures, and it would naïve to think that an SI, no matter how well-crafted or presented, would be a sole, pure source of influence. Even efforts to develop neat looking typologies of SI use have to contend with a multitude of interactions and forces as well as multiple perspectives on what our apparently "well defined" categories mean. In a sense, we are part of that mess and are playing the same game as everyone else; maybe we just do not reflect on it as much as we should. As Rotz and Fraser noted: "we must remain focused on understanding the conditions within which sustainability and resilience get manipulated in the interests of political-economic and social empowerment and capital accumulation. How are these concepts deployed by different groups, and for what possible ends?" [20].

If we wish to produce an SI that will somehow be above all of this, then maybe we would be chasing the end of a rainbow—we would be seeking to "know" in a manner which is culturally and ethically "neutral". As social and psychological actors in the world with innumerable stakes in outcomes of diverse kinds this can never be possible. In the same vein, if we are in the business of producing indicators to help make a difference by influencing those with power then we must expect that power to also have an impact on the uses it puts to those indicators. We cannot have it both ways. Decision-making is a complex process and decision-makers will be subject to many influences and motives. However, does this mean that we have to stop trying and accept that we will always be producing and promoting "fake" indicators, at least in the eyes of some? Well no—not at all. We live in a world where many (rapidly becoming "most") people get their news from social media outlets such as WhatsApp, LinkedIn, Twitter and Facebook. This context demands that complex events be reduced to "Tweets" of just a few hundred characters. Such simplifications are pernicious and viral. They can influence the thinking of many people. At the time of writing, Twitter has over 300 million "active" users across most countries of the globe, and the President of the USA (perhaps the most influential global citizen) is using it to get highly subjective points over directly to the public—presenting as truth—and it seems will readily re-tweet "news" without necessarily checking its veracity.

There is an appetite for communication tools that seek to present complexity in ways that busy people can interact with but with simplification come consequences. To some extent SIs are trying to do the same thing and there is also an appetite for them, but as with Twitter there are profound dangers to the consumers of such simplification. This brings us neatly into what we think the messages in the book tell us about the future of SIs.

4. Discussion and Tentative Conclusions

What conclusions can we come to regarding the future of SIs based upon material provided by contributors to the new book on SIs? Do we see any resonance between SIs and the world of "fake news" and "tweets"? Do SIs play into a desire amongst some for "alternative facts"? Are we in the SI community living in a glass box and should we stop throwing stones? Indeed, what is the future of SIs? Well, it would appear we are in something of a fight on a number of fronts, spanning familiar battlefields such as aggregation, stakeholder participation and the need for good quality data to less-well trodden territory such as the need for more published case studies on the use of SIs so insights can be drawn. There is no other way of putting it. However, perhaps the front that is of greatest concern to us is a fight of an existential nature in terms of *reasonably* objective and verifiable facts as counters to the "fake news" agenda. We recognize the reality that interest groups will always make selective and distorted use of indicators. That is the price we pay for being human beings involved in the objective/ subjective indicator business. Thus, we would like to see a greater emphasis in research on the space between production and use. Specifically, the uses to which SIs are put and how that information can feed back into the development and presentation of SIs. As Giangiacomo Bravo succinctly put it: "Any index inevitably is the product of a number of more or less arbitrary choices (not only scientific ones, since politics often plays a major role)" [29].

From what we have seen before, clearly, there is no magic bullet or one-size-fits-all here; no SI can ever be made immune to all manner of intended and accidental distortion and we need to be aware of our own biases. This is a point echoed by Joachim H. Spangenberg:

> Indicator users should be aware of the limitations each indicator, index or indicator system has, partly from the method of calculation, but also from the often-hidden assumptions inherent to the world views from which they have been derived. Practitioners should choose and combine the indicators they use carefully, being fully aware of these biases and their impacts on both the measurement and the messages derived from it, implicitly or explicitly [43].

SIs are, after all, human constructs and their development and use can be subject to the same biases that drive the "echo chambers" we see in Twitter and Facebook. However, that human fallibility must not dissuade us for further development of SIs and seeking new ways for presenting them to a defined group (or groups) of consumer(s). We just need to be more reflective in our assumptions, smarter in our use and have a better sense who our consumers are, what they are looking for and how we can best help. To date, SI development has been almost entirely "creator-led" with little, if any, input from consumers of those SIs—those we intend to use them. That balance needs to shift so that we as creators move towards a model of co-creation with the voices of SI consumers being part of the process. This is not a new call, of course, and we amongst many others have been saying it for years, including Almassy and Pinter [44], but we still feel that much more progress is required and for us this is a key element in the future of SIs. As Ulla Rosenström has noted: "good indicators are of little influence and importance if they are not used in any way. Although use does not guarantee the desired influence, aiming at use is well argued for. Hence efforts to create opportunities for use and disseminating information remain crucial" [12].

The "Indicator Policy Fact Sheets" proposed by Janoušková et.al are one tangible suggestion to "help SI users (most often decision- and policy-makers) choose and use the most appropriate indicators for assessing particular sustainability issues" [45]. However, maybe there is a deeper issue at the heart of this issue. Maybe the indicator community (along with many other areas of rationalism) were labouring under a misapprehension that we are, as Steven Pinker suggested in his opus—"The Better Angels of our Natures" [46]—living in a more rational world. A world where instinctive and knee jerk reactions are beginning to fade out in the on-rush of rational and objective decision making. Of course, this has been a dream for time out of mind. Since Plato's "Philosopher Kings" through to Saint Simon and Auguste Comte's concepts of a new social doctrine based on science and today's

algorithmic governance by global data corps such as Facebook, humankind has sought what we may consider to be an illusion of a rational world. A world governed by clear data, un-contestable facts and wise administration. To some extent the whole SI debate might be seen as a sub-set of this project—a rationalizing project to save human beings from their instinctive and irrational selves.

Sadly, this does not seem to be working terribly well. Plato's Republic remains a paper dream only, Saint Simon and Comte's technocracy could not dispel the terror of the French Revolution and the power of global algorithms raise as much "1984" and "Brave New World" angst as they do hopes for a better world. Indeed, the total transparency which Facebook might be argued and provoking, mimicked and played to horrific levels in David Egers book "The Circle" appears only as a nightmare of algorithm-led social engineering. Knee-jerk reactions, the denial of "evidence-based facts" with disdain, the assumption of subjective "truth" and the trust in instinct seems to be prevalent and has been argued to lead to more terror and even an amplification of terror based on compounding cycles of unreasonable social fear [7].

The experiences of the authors of this book with the complexity of the indicator/indices fields, the short comings of any statistical means to address complex truths, the uneven and evolving nature of the field and the issues of objectivity and subjectivity remain as on-going strategic and tactical issues, logistic complexities set against a much more troubling background—the human proclivity to the irrational and the dupes of the sellers of snake oil. While the challenges arising from the (necessary and intentional) simplification, and the questions of manipulation and instrumentalisation associated with SIs are not new, they have arguably gained new urgency far beyond the statistical and policy advisory professions in the context of the age of "fake news".

The arguments we set out in this paper bear witness to the long, hard and arduous task of understanding—understanding how human beings interact with social, technical and environmental issues, and how the psychology of the human attempts to measure the immeasurable and make sense of the world so that in the future there will be a world to make sense of. It is a testimony to the noble attempt at the measurement of the immeasurable. They are a step towards sustainability, resilience and what we have called elsewhere "*the saving of the human project*" [47]. On the road so far, great progress has been made. Hosts of indicators and indices have been constructed to try and influence people with power (including the public) to do wiser things. There remains important second order work to engage with. This can be framed in terms of continuing reflection on the formulation of indicators by experts and communities, the strategic, tactical and operational value and targeting of indicators and the development of forms of assessment. All of these have been mulled over but the mulling is in its infancy and has not as yet taken into account the fearsome push-back of those hostile to the sense of the SI project. We must not forget, we are in an existential fight.

We are not at the end of the SI process, but we may be at the end of the beginning. Battle lines are still being drawn up.

Acknowledgments: The authors would like to thank the anonymous reviewers for their suggestions regarding the improvement of this paper. They would also like to thank the editor of the Special Edition—Joachim Spangenberg—for his kind invitation to write this paper and for the advice he provided to us.

Author Contributions: S.B. and S.M. made equal contributions to the development and writing of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Steffen, W.; Richardson, K.; Rockström, J.; Cornell, S.E.; Fetzer, I.; Bennett, E.M.; Biggs, R.; Carpenter, S.R.; de Vries, W.; de Wit, C.A.; et al. Planetary boundaries: Guiding human development on a changing planet. *Science* **2015**, *347*, 1259855. [CrossRef] [PubMed]
2. Morse, S. *Indices and Indicators in Development: An Unhealthy Obsession with Numbers*; Earthscan: London, UK, 2004.
3. Mitchell Waldrop, M. News Feature: The genuine problem of fake news. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, 12631–12634. [CrossRef] [PubMed]

4. Berkowitz, D.; Asa Schwartz, D. Miley, CNN and the Onion. *J. Pract.* **2016**, *10*, 1–17.
5. Wilkinson, R.S. Poe's "Balloon-Hoax" Once More. *Am. Lit.* **1960**, *32*, 313–317.
6. Carruthers, K.; Ballsun-Stanton, B. #c3t An Agreeable Swarm: Twitter, the Democratization of Media & Non-localized Proximity. In Proceedings of the 5th International Conference on Computer Sciences and Convergence Information Technology, Seoul, Korea, 30 November–2 December 2010; pp. 166–169.
7. Bell, S. *Formations of Terror*; Cambridge Scholars Publishing: London, UK, 2017.
8. Poole, S. *Unspeak*; Little, Brown: London, UK, 2006.
9. O'Hear, A. *Plato's Children: The State We Are in*; Gibson Square: London, UK, 2006.
10. Pinter, L.; Hardi, P.; Martinuzzi, A.; Hall, J. Bellagio STAMP: Principles for Sustainability Assessment and Measurement. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 21–41.
11. Conrad, E.; Cassar, L.F. The Environmental Performance Index: Does this reflect reality. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 294–307.
12. Rosenstrom, U. Sustainable development indicators. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 321–328.
13. Dahl, A.L. Contributions to the Evolving Theory and Practice of Indicators of Sustainability. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 42–58.
14. Costanza, R.; Hart, M.; Kubiszewski, I.; Posner, S.; Talberth, J. Lessons from the History of GDP in the Effort to Create Better Indicators of Prosperity, Well-being, and Happiness. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 117–123.
15. Esty, D.C.; Emerson, J.W. From Crises and Gurus to Science and Metrics: Yales Environmental Performance Index and the Rise of Data-Driven Policymaking. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 93–102.
16. Esty, D.C. Toward Data-Driven Environmental Policy-making. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 494–506.
17. Hsu, A. Governing by Numbers: China, Viet Nam, and Malaysia's Adaptation of the Environmental Performance Index. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 167–283.
18. Jean, N.; Burke, M.; Xie, M.; Davis, W.M.; Lobell, D.B.; Ermon, S. Combining satellite imagery and machine learning to predict poverty. *Science* **2016**, *353*, 790–794. [CrossRef] [PubMed]
19. Vermeulen, W.J.V. Substantiating the rough consensus on concept of sustainable development. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 59–92.
20. Rotz, S.; Fraser, E. The Limits of Sustainability and Resilience Frameworks: Lessons from agri-food systems research. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 103–116.
21. Gallopin, G.C. The socio-ecological system (SES) approach to sustainable development Indicators. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 329–346.
22. Coleman, G. Logical Framework Approach to the Monitoring and Evaluation of Agricultural and Rural Development projects. *Proj. Apprais.* **1987**, *2*, 251–259. [CrossRef]
23. Cordingley, D. Integrating the Logical Framework into the Management of Technical Co-operation Projects. *Proj. Apprais.* **1995**, *10*, 103–112. [CrossRef]
24. Girma, M.; Sartorius, R.; Silansky, C.; Thompson, R.M. *The Project Cycle Management Resource Guide: A Logical Framework Approach*; Team Technologies Inc.: Chantilly, France, 1996.
25. Baccarini, D. The Logical Framework Method for Defining Project Success. *Proj. Manag. J.* **1999**, *30*, 25–32.
26. Bell, S. Logical frameworks, Aristotle and soft systems: A note on the origins, values and uses of logical frameworks, in reply to Gasper. *Public Adm. Dev.* **2000**, *20*, 29–31. [CrossRef]
27. Sari, D.A.; Margules, C.; Boedhiharton, A.K.; Sayer, J. Criteria and indicators to audit the performance of complex, multi-functional forest landscapes. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 407–426.
28. Joss, S.; Rydin, Y. Prospects for Standardising Sustainable Urban Development. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 364–378.

29. Bravo, G. The Human Sustainable Development Index. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 284–293.
30. Jesinghaus, J. How Evil is Aggregation? Lessons from the Dashboard of Sustainability. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 392–406.
31. Dahl, A.L. UNEP and the CSD Process for Sustainable Development Indicators. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 347–363.
32. Frederiksen, F.; Gudmundsson, H. Policy use and influence of indicators. *Ecol. Indic.* **2013**, *35*, 1–2. [CrossRef]
33. Herzi, A.A. Sustainability indicators system and policy process in Malaysia: A framework for utilisation and learning. *J. Environ. Manag.* **2004**, *73*, 357–371.
34. Coyle, D. *GDP: A Brief but Affectionate History*; Princeton University Press: Princeton, NJ, USA; Oxford, UK, 2014.
35. Bartelmus, P. Green accounting: Balancing environment and economy. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 236–244.
36. Morse, S. Out of sight, out of mind. Reporting of three indices in the UK national press between 1990 and 2009. *Sustain. Dev.* **2013**, *21*, 242–259. [CrossRef]
37. Morse, S. Stirring the pot. Influence of changes in methodology of the Human Development Index on reporting by the press. *Ecol. Indic.* **2014**, *45*, 245–254. [CrossRef]
38. Morse, S. Measuring the success of sustainable development indices in terms of reporting by the global press. *Soc. Indic. Res.* **2016**, *125*, 359–375. [CrossRef]
39. Morse, S. Focusing on the extremes of good and bad: Media reporting of countries ranked via index-based league tables. *Soc. Indic. Res.* **2017**. [CrossRef]
40. Bell, S.; Morse, S. What next? In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 543-555
41. Officer, L. The purchasing power parity theory of exchange rates: A review article. *Int. Monet. Fund Staff Pap.* **1976**, *23*, 1–60. [CrossRef]
42. Hyrina, Y.; Serletis, A. Purchasing power parity over a century. *J. Econ. Stud.* **2010**, *37*, 117–144. [CrossRef]
43. Spangenberg, J.H. World views, interests and indicator choices. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 143–155.
44. Almassy, D.; Pinter, L. Environmental governance indicators and indices in support of policy-making. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 204–223.
45. Janoušková, S.; Hák, T.; Moldan, B. Relevance—A neglected feature of sustainability indicators. In *Routledge Handbook of Sustainability Indicators*; Bell, S., Morse, S., Eds.; Routledge: London, UK, 2018; pp. 477–493.
46. Pinker, S. *The Better Angels of Our Nature: A History of Violence and Humanity*; Penguin: London, UK, 2011.
47. Bell, S.; Morse, S. *Resilient Participation: Saving the Human Project?* Earthscan: London, UK, 2012.