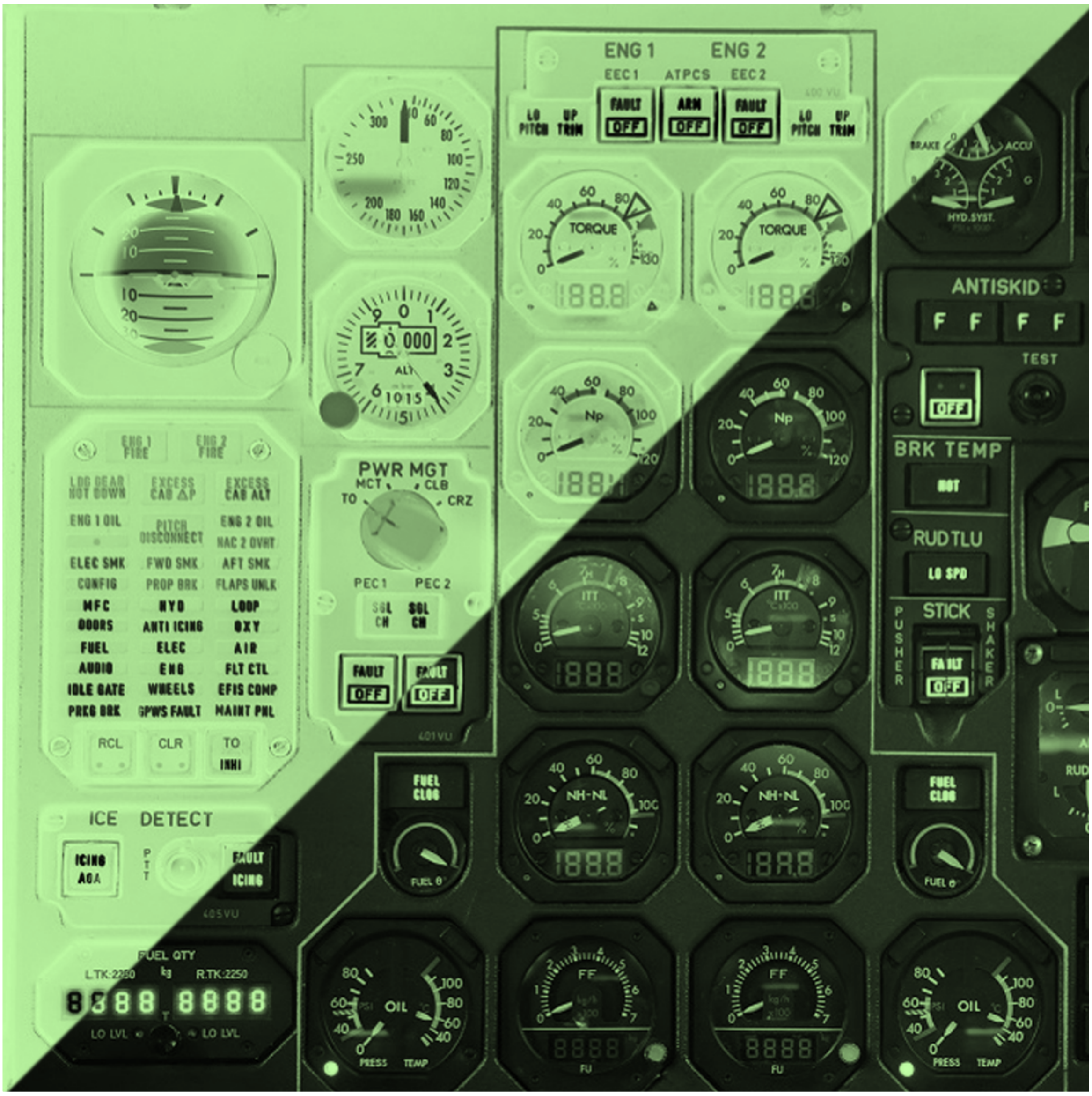
DEVELOPING SUSTAINABILITY INDICATORS–THE NEED FOR RADICAL TRANSPARENCY



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Abstract

There is a strong impetus to adopt sustainability targets and measures across primary industries. Measuring sustainability demands the development of indicators. Conventional approaches to the development of sustainability indicators (SI) are technocratic, which thwarts the open and critical development of SI. Specifically, the technocratic approach: precludes debate concerning the implicit values that guide indicator development and selection; fails to recognise areas where SI cannot be developed for measuring crucial socioecological functions; and reduces complexity and embellishes certainty. To address these shortcomings, we argue that radical transparency is required. This would involve the following actions: making explicit the values and moral imperatives used to determine what is to be sustained and for whom; opening for critical examination the processes and tools used to weigh and prioritize indicators against each other and create aggregate scores; providing information about the types of expertise involved in the development and the limitations of this expertise; and making candid the 'gaps' where it is necessary, but difficult, or even impossible, to develop quantitative SIs; removing bias against, and accepting the use of qualitative approaches where appropriate. Examples of these forms of transparency are provided from the development of an indigenous sustainability indicator suite, though radical transparency is viewed as a universal solution to the problems of the technocratic approach.

Keywords: sustainability indicators; technocracy; mechanistic worldview; radical transparency.

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1. Introduction

The impetus for this paper emerged while working in a cross-cultural and multidisciplinary team to develop a sustainability dashboard for a group of primary industries in New Zealand. This program involved academics from economics, social science, ecology, cultural studies, engineering and agribusiness disciplines as well as industry representatives and primary producers (see Whitehead et al. 2019 for final synthesis report of the program).[1] The authors worked with a large farming business owned by Ngāi Tahu (a Māori tribe) to develop a culturally-aligned online sustainability assessment and reporting system which also interfaced with 'Western' sustainability audit systems. The process of developing an indigenous sustainability indicator suite appears at first sight to be a technical exercise whereby different disciplines select or formulate sustainability indicators (SIs) pertinent to their field and to the type of farming activity. Building a dashboard is then presumably a straightforward process of graphically representing these indicators to demonstrate the performance of a farm, or a cohort of farms that represent the performance of an industry. However, building a sustainability dashboard is not this straight-forward. The decisions concerning what indicators to select or develop are based upon value-judgements of what is to be sustained and for whom – a political process. There is significant uncertainty concerning fidelity of various indicators and measures, and areas where important properties of socioecological systems cannot be measured. Furthermore, there are no agreed, or standardized methods by which the scores of different indicators may be added together to arrive at aggregate scores that provide an overall picture of a farm, or industry's, sustainability status.

Despite these limitations a plethora of sustainability assessment systems have emerged generated by governments, industries, and non-governmental organisations, that aim to provide certainty and assurance to either consumers, or the public, that particular farming activities are sustainable. This attempt to measure and communicate sustainability attributes is undoubtedly positive given that it has generated improved awareness of environmental and social issues while facilitating the development of sustainable practices across agrifood organisations and businesses. However, there are currently many uncertainties and difficulties in sustainability assessment that need to be made open and explicit if there is to be an open, honest, and critical approach to the development of sustainability assessment systems.

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[1] The Māori primary production dashboard can be found at https://kohuratia.nz

The central importance of values to sustainability measurement and decision-making was magnified by the cross-cultural nature of the program. The need to make these values explicit, as well as their underlying worldviews and the decision-making processes that prioritized certain values and measures over others, became obvious during the early phases of research. Much regarding the identified issues, underlying thought processes and solutions developed and refined in these phases can be found in Reid and Rout (2018), which explores the Western mechanist and Māori animist worldviews and proposes a number of ways in which sustainability auditing can be indigenized. However, as well as providing a way of 'indigenizing' sustainability auditing, the research and debate that emerged as part of the project also spurred a wider discussion about the lack of transparency in indicator development, particularly the role of the mechanist worldview, and the potential solutions to this issue. This piece is based on both the critiques within the field of indicator development (see Bell and Morse 2008) and also the experiences of developing a set of indicators for indigenous stakeholders, bringing together theoretical and practical insights.

In this paper we outline how the subconsciously-held mechanistic worldview, which supports and informs the technocratic paradigm, plays a significant role in circumventing critical thinking in conventional approaches to SI development. Initially we provide a general overview of both the technocratic paradigm and the mechanistic worldview before detailing four key ways in which the latter, in particular, restricts SIs development. Firstly, the mechanistic worldview frames the concept of an 'indicator' with excessive certainty, ignoring the underlying 'fuzzy' complexity of socioecological systems. Secondly, essential functions of socioecological systems that have intangible properties that are difficult to understand from a mechanistic position are either disregarded or inadequately dealt with. Thirdly, bias toward measuring properties of socioecological systems that can be understood mechanistically (e.g. physical properties) reduces complexity and in turn skews sustainability assessments. Fourthly, the conventional processes by which measures are aggregated into indicator scores to indicate the 'sustainability' of social and ecological systems, are based on simple mechanical models, which reduce complexity and embellish certainty. Each of the above interconnected problems are explored and discussed in this paper to arrive at a series of recommendations for improving the processes used in the development of SIs and sustainability assessment systems. Ultimately, we argue for a more open, transparent, and critical approach to the development of SIs across a series of criteria, both as a way of improving the process and of better communicating its flaws. To be clear, despite its origins in indigenous sustainability, this paper and the solutions it proposes are not specific to indigenous context, but offer insights into sustainability assessment in general.

2. **Theory**

2.1 The technocratic paradigm

Contemporary sustainability auditing is dominated by the technocratic paradigm, which emphasizes hard data and its capacity to provide overarching control over humans, institutions, and systems (Reid and Rout 2018). Oft defined as 'rule by experts', Burris (1989) sees technocracy as an 'organizational control structure'. Drengson (1995, 81-82) outlines it as the "systematic application of technology to all levels of human activity" where the "aim becomes the control of life by means of management techniques… to reduce all phenomena to those features which can be quantified, controlled, and observed directly with the instruments produced by technology". This impetus for control may be observed in auditing's spread from sectors that deal with financial and physical processes that have an affinity with hard data, like accounting and manufacturing, through to those involving social and ecological processes, like healthcare and farming, which more often involve categorical, ordinal, and qualitative data (Powers 1997). Technocracy is now the main approach towards sustainable development, it has become paradigmatic; this dominance is derived from an overriding belief in technocracy's powers of universal 'quantification, observation, and control' and its ability to manage the planetary socio-ecological system as a "controlled artifact" (Drengson 1995, 82). Technocracy's own internal logic that leads it to monopolize sustainability is built on a particular view of socio-ecological systems, to which we turn now.

2.2 The mechanistic worldview

The belief that human activity and its impact can be measured and controlled comes from the mechanistic worldview, which sees 'nature as a machine' (Abram 1991; Drengson 1995; Riskin 2015). Descartes (quoted in Funkowitz and Pereira 2015, 1) declared that total knowledge of the physical world would render humanity "the masters and possessors of Nature". Ravetz (quoted in Funkowitz and Pereira 2015, 1) notes that in Descartes' statement "we have the modern scientific-technical, or should I say, technocratic paradigm, stated clearly for all to see". Technocracy emerges from and is sustained by the mechanistic worldview. Understood through deductive logic that fundamentally breaks the whole into its components, the mechanistic worldview has "a deterministic conception of Nature and Society, such that the consequences of any action are held in principle to be predictable, given sufficient information concerning initial conditions" (Stirling 1997, 189). Understanding the world as a machine suggests complete predictability and, consequently, the capacity for comprehensive measurement and control (Bell 2013). This reductive cognitive orientation has proved so successful over the past centuries that it has become widely viewed as fact (Davies and Gribbin 1992). Rather than understood as an imperfect but useful model, the mechanistic worldview is often believed to be the literal description of nature – that is the physical and biological, individual and systemic. As Nicol (quoted in Selby 2007, 165 – emphasis in original) states, "*we have no metaphysical assumptions*" because we assume "we are more or less seeing reality 'as it is'".

The belief that reality is composed of machinelike parts has impacted the development of sustainability initiatives, particularly the focus on indicators as the means of measuring and controlling sustainability (Drengson 1995; Gasparatos et al. 2008). The reason for this is that if reality is machinelike then all that is needed to measure and regulate socioecological systems is a "classic reductionist set of tools" (Bell and Morse 2008, 42) as they can deliver the requisite data that provides exact measurement and facilitates control the same way gauges and levers work for machines. The mechanistic worldview generates a perception that SIs are in effect gauges able to deliver accurate measures concerning the operational health of social and ecological machines and the impacts of industrial and agricultural activity (Reid and Rout 2018). In the following sections we will show how the mechanistic worldview causes a number of problems during the development process, from the very concept of what SIs are, to the ways in which they are measured and aggregated and, finally, the values that guide them.

3. Analysis

3.1 Machinelike dials – Indicator concept

The term 'indicator' does not refer to a singularly defined and highly precise concept. As Gallopín (1996, 102), notes, there are "ambiguities and contradictions regarding the fundamental meaning of the concept of indicator in general". Jollands (2006, 329) complains that there are "contradicting and obtuse interpretations of what indicators are" in the literature, where an 'indicator' may be defined as a parameter, a measure, a model, a metric, a value, a fraction or a sign. This vagueness is problematic. Indicators are generally framed as accurate portrayals. However, rather than having a direct fidelity with reality they are representations that have varying degrees of accuracy (Moldan and Dahl 2012). To be clear, some indicators are highly accurate but, critically, not all indicators are equally accurate and the degree to which they vary in their accuracy is variable though this variability is rarely expressed or communicated. An indicator is, fundamentally, a sign (Jollands 2006). Rather than being the 'thing' itself an indicator is a representation of that 'thing', it is a sign, which requires interpretation. Revealingly, 'indicator' comes from the Latin term *indicare* which means ‘to point out’ or ‘one who points out’, originally referring to the human action of using a finger/arm to ‘indicate’ something (Jolland 2006). Long used in English, in the mid-nineteenth century it began to be used to describe machine instrumentation. Consequently, the representative capacity of the term has been degraded because it has become ‘mechanized’, it is no longer a finger pointing but a dial. And because of the accuracy with which a dial can represent a part of a mechanical system, the signifying nature of the term ‘indicator’ has been reduced. While a finger points vaguely, a dial points ‘accurately’. In the final *coup de grâce* the etymological trajectory of the term has seen it applied to socioecological systems but with the original biological vagueness removed.

Bell and Morse (2008, 41) question the capacity of SIs “to encapsulate complex and diverse processes in a relatively few simple measures”. Further, they go on to say “[s]implifying system complexity into single values that allow for easy comparison has a definite appeal”, but these values are not always accurate, often providing a false exactitude rather than a precise indication (Bell and Morse 2008, 41). Stirling (1999, 112 – emphasis in original) reiterates this, lamenting: “[u]nfortunately, the assertive self-confidence and heroic precision with which the results of so much environmental and economic appraisal are typically expressed do not seem to be borne out in their practical *accuracy*”. To have reliability, “[a]ny measuring instrument must be able to interact with the measured attributes and must convert the interaction into some form which directly represents states of the corresponding variable” (Gallopín 1996, 103). However, ‘sustainability’ initiatives are beset by manifold uncertainties – given that the “appraisal of ‘sustainability' implies the consideration of enormously complex causal chains” – meaning there are many aspects socioecological systems that are unknowable and, consequently, unmeasurable (Stirling 1999, 121). These uncertainties spring from many areas, including “incomplete knowledge, contradictory information, conceptual imprecision, divergent frames of reference and the intrinsic complexity or indeterminacy of many natural and social processes” and any representations of certainty “display what Hayek once called the ‘pretence at knowledge’” (Stirling 1999, 124, 125). The consistency and fidelity of SIs may be considered a false projection.

Typically SIs are presented numerically. As Gallopín (1996, 104) explains, “[p]ractically all definitions of environmental or sustainable development indicators rule out the possibility of qualitative indicators, by restricting the concept to numerical variables, either explicitly or implicitly”. Likewise, Moldan et al. (2012, 7) state that “the most attractive idea remains having a numeric value for sustainability”. However, often the “numerical data used for inputs… may simply be guesses collected from experts… Even when there is empirical data for policy problems, it is not really amenable to treatment by traditional statistical techniques" (Funtowicz and Ravetz 1993, 743). There is an 'aura around numbers' that gives them a false exactitude, impeding rather than improving insight because they misrepresent their degree of accuracy (Strathern 2000). Use of solely numerical indicators compounds the above accuracy issue because it conflates a range of different types and kinds of indicators such that, conceptually, SIs project a false fidelity.

3.2 Machinelike parts – Indicator measurement

The next, related, issue is that it is difficult to identify or know all of the 'parts' – where 'part' refers to the individual human and natural components of a specified socioecological system – in a socioecological system, yet analogizing them as machines logically demands that each 'part' not only be identified, but the function of each discerned and, in turn, the interactions between each part completely understood and accurately measured. Measuring the functions of individual parts demands a degree of insight into how they work together, otherwise each part cannot be fully understood. However, the near limitless number of 'parts' within socioecological systems, their manifold interactions in complex causal chains, and their emergent properties means that there are many aspects that are simply unknowable and, consequently, unmeasurable (Stirling 1999). McCool and Stankey (2004, 297) explain that "[h]uman–environmental systems tend to be loosely coupled, characterized by temporal and spatial delays, nonlinear dynamics, and cause–effect relationships dominated by stochastic processes". Separating the system into components that indicators measure means that SIs will not be able to capture the relationships between these components. This is problematic as the "primacy of the whole suggests that relationships are, in a genuine sense, more fundamental than things, and the wholes are primordial to parts. We do not have to create interrelatedness. The world is already interrelated" (Senget al quoted in Bell and Morse 2008, 111). Measuring every 'part' is likely impossible, yet it is a prerequisite that SIs can perform this task and understand how every part interacts.

Not only is it likely impossible to measure all the components or their interactions but, as Gallopín (1996, 109) notes, "sometimes those interactions dominate the total behavior of the system, above and beyond the behavior of the component elements". This emergent nature of socioecological systems means they do not function according to predetermined goals and yet the ability to know where the system will 'be' at any point in time is critical to accurate measurement. Gasparatos et al. (2009, 248) explain that "emergent complex systems… cannot in most cases be fully explained mechanistically and functionally as ordinarily complex systems because at least some of their elements possess individuality, a degree of intentionality, consciousness and morality amongst others". However, the 'measurement' of these systems is generally portrayed in a manner that obscures these issues, breaking the complex, interrelated whole into components that are able to be measured while ignoring those that cannot be measured and not taking into account the way these components effect each other, or the emergent aspects of the system (Stirling 1999).

3.3 Machinelike construction – Indicator aggregation

This brings us to the third issue exposed by the development of SIs, the problems with aggregation. As SIs are developed, the socioecological 'system' being measured is observed so that the relevant 'pieces' of information can be gathered (Bell and Morse 2008). These are then converted into indicators, and then these indicators are frequently aggregated before they are presented to the relevant stakeholders (Bell and Morse 2008). This process follows the 'information pyramid' model developed by Hammond et al. (referenced in Gasparatos et al. 2008), which sees 'raw data' become 'analysed data' which is then turned into 'indicators' and finally composite 'indices', with aggregation occurring at each stage, from what pieces of information are collected to how these are analysed to which are turned into SIs to how these are interpreted and used. These numerical variables are then aggregated using statistics, which "themselves are essentially symbolic manipulations" (Funtowicz and Ravetz 1993, 743). The existence of the interactions and emergent properties, as outlined above, "highlights the limitations of the usual procedures (often as simple as summation or averaging) for aggregating indicators" (Gallopín 1996, 109). The "use of a linear aggregation procedure implies that among the different ecosystem aspects there are not phenomena of synergy or conflict", as Munda (2005, 124) notes before going on to conclude that this "appears to be quite an unrealistic assumption". Ultimately, this means that significant information is lost during the aggregation process (Gasparatos et al. 2008, 303). Not only are SIs constructed using single indicators that are conceptually-vague and imperfectly measured, but the aggregation process sees further loss of information. A loss that is rarely exposed or expressed.

3.4 Machinelike objectivity – Indicator values

Finally, there is a significant underlying problem with the development process of SIs as a whole. Throughout the technical process the very purpose of sustainability may become obscured – it risks becoming a valueless or value-hidden project. Often SIs are developed by specialists who understand the process as a technical challenge without reflection on taken-for-granted assumptions on what sustainability means by society at large. For example, as Dahl (2012, 15) argues the "prominence today of economic indicators reflects the dominance of materialistic and self-centred values" of the economic specialists developing indicators. Sustainability has become beholden to econometric concerns rather than, for example, ecocentric ones (Davison 2001). Often the "choice of the evaluation tool (and of certain methodological steps within tools), and hence the worldview through which the evaluation is performed is in most cases made by the analyst(s) and is rarely, if ever, influenced by the stakeholders' views, needs and values" (Gasparatos 2010, 1618). The use of scientifically-oriented indicators makes it appear as if "the problem of achieving sustainability is being dealt with as a 'purely' technical one" (Scerri and James 2010, 42). Furthermore, it also delineates the types of people who should be involved in this process: experts. There is a "technocratic conception of expertise" which is generally limited to very specific forms of scientific knowledge (Funtowitz and Ravetz 1993; Rametsteiner et al. 2011, 62). In choosing to use indicators, value judgements have been made and these particular value judgements inherently limit the capacity for non-experts to engage in the development process or, even more crucially, exclude the values underpinning the indicators to be explicitly discussed.

There are "inherent value judgements within reductionist tools", tool selection is itself a value judgement as the "ethical implication lies in the fact that by choosing a certain tool to evaluate a project, the analyst 'subscribes to' and in effect "enforces" a specific worldview as the correct or most appropriate yardstick to measure the performance" (Gasparatos 2010, 1617). As McCool and Stankey (2004, 295 – emphasis in original) explain, "selection of indicators might precede, or even preempt, the needed public debate about what should be sustained, meaning that the search for indicators is guided more by *what can be measured* (a technical issue) than by *what should be measured* (a normative issue)". The aggregation process further obscures the values and objectives of sustainability. Rowley et al. (2012, 24) state that "[i]t is important to recognise that the very choice of an aggregation method introduces subjectivity into our analyses". Stirling (1999, 119) makes the case that the "aggregation of performance measured under any one criterion with that under any other criterion will require (either implicitly or explicitly) the imposition of subjective value judgements concerning the relative importance of the different aspects of sustainability". There is a "problem with the selection of indicators to be aggregated, which can intentionally or unintentionally introduce arbitrary weightings or other distortions" (Moldan and Dahl 2012, 12). Linear aggregation methods sees "assigned weights end up gaining a trade-off status that implies complete compensability and substitutability between the components", such that a higher performance in one indicator is able to 'balance' out a lower performance in another, obscuring value through erroneous assumptions of equivalence and false divisions of the whole into parts, in turn leading to counterproductive outcomes where, for example, economic gain is traded off for environmental degradation (Gasparatos et al. 2008, 306). Quite simply, "[a]ll aggregation methods have biases which can influence the final result" (Mayer 2008, 287). By turning sustainability into a technical exercise, SIs may disenfranchise stakeholders in favour technocrats, who in turn tend to frame and present the outcomes as 'valueless'.

Consequently, 'sustainability' is portrayed and promoted "as if it were an objectively determinate quantity… converting the fuzzy and controversial socio-political *problems* of sustainability into precisely defined and relatively tractable analytical *puzzles*" (Stirling 1999, 112 – emphasis in original). As Funtowicz and Ravetz (1993, 741) explain, "[t]here has been a universal assumption (however superficial and laced with cynicism) that scientific expertise is the crucial component of decision making, whether concerning Nature or society". Furthermore, as Drengson (1995, 82) explains, "sciences so stressed are thought to be value-free". The implication of this is that SIs and systems of aggregation have been developed by technical experts, without critical and explicit exposure regarding the underlying value-drivers underpinning their prioritisation processes, nor has it been informed by public debate enabling prioritisation. An appearance of objectivity and neutrality masks them.

4. Alternatives

4.1 Values-oriented – Indicator development

However, there are alternative methods that do seek to select SIs and construct sustainability assessment approaches through making values explicit. These 'participatory' approaches are aimed at creating stakeholder-guided assessment systems, in which participants identify their values and goals, and identify quantitative and qualitative indicators for determining change against these parameters. Several issues limit this approach, however. Firstly, the technocratic and participatory processes are often portrayed as "mutually excluding forms of sustainability assessment"; that is, the indicator data gained from one is not substitutable to that from the other (Alrøe and Noe 2016). This is because the technocratic approach seeks standardisation and universal application, which is generally framed as a scientifically desirable approach. Conversely, participatory approaches are contextual and generate fuzzy, qualitative data, which cannot be codified or standardised (Bell and Morse 2008; Davison 2001; Drengson 1995). Critically, these two are not seen as equal, but rather qualitative information is generally "tolerated as a stopgap until it can be replaced with or converted into quantified knowledge" (Reid and Rout 2018, 287). This bias towards codified data is part of the technocratic mindset, with its emphasis "upon method and technique, upon reductionism, upon explaining all natural phenomenon in mechanistic terms, [and] the quantification of as much of the natural world as possible" (Drengson 1995, 83).

Second is that it is impossible to both democratically and consistently rank values in a plural society, "there can be no uniquely 'rational' way to resolve contradictory perspectives or conflicts of interest over incommensurable issues in a plural society" (Stirling 1999, 120). This is known as Arrow's impossibility theorem, which Sen (2004, 69) describes as "a result of breathtaking elegance and power", explaining that in any plural grouping any ranking of values would "have to be, it seemed, inevitably arbitrary or unremediably despotic". In other words, while participatory approaches are able to extrapolate a set of values that can guide sustainability initiatives any attempt to rank these values by a plural group is not just difficult in practice but impossible in principle (Stirling 1999). The plurality of the group means that there will always be either compromise or despotism.

Finally, as Reed (2008, 2422-2423) has noted in his wide-ranging critique of participatory approaches; generally these approaches only involve stakeholders in the "implementation phase of the project cycle, and not in earlier project identification and preparation phases", effectively canalizing and corralling the participatory input. Bringing stakeholders in at this point when the agenda has been set means they have little ability to fundamentality impact the scope. Another point Reed makes (2008, 2423) is that they often presume "that stakeholders are self-evident and self-construed". This further limits the capacity for a true values-oriented approach as the stakeholders are essentially pre-selected from the existing group, a judgement that has implicit values itself. As Scerri and James (2010, 42) argue, most indicator development processes privilege "technique over reflexively engaging in the world… [they] often seem to perpetuate a particular set of epistemological and ontological assumptions concerning human situatedness in the world".

To be clear, this is not to dismiss participatory approaches but rather to indicate that they alone are not able to overcome, mitigate, or communicate the issues with SIs outlined above. There is also a need for 'radical transparency' throughout the development of SIs to complement these approaches, as it is believed that this will provide a range of fixes for these issues.

5. Solution

5.1 Radical transparency

It is proposed that indicator development needs to be conducted with 'radical transparency'. "Simply put," as Rawlins (2009, 73) writes, "transparency is the opposite of secrecy", with secrecy involving 'hiding something by action, practice or policy'. While this implies a deliberateness, 'opacity' does not need to be intentional. As the above analysis shows, the opaque nature of SIs comes largely from the implicit assumptions of the mechanistic worldview rather than an attempt to misinform. Still, the outcome is that SIs 'hide', they are not transparent. Generally three types of 'transparency' are identified in the literature: participatory transparency – providing stakeholders with information that suits their needs by involving them; information transparency – providing stakeholders with information that is accurate, useful, and substantial; and, accountability transparency – providing stakeholders with information that is neutral, objective, and balanced (Potts et al. 2010; Rawlins 2009). These serve as a useful guide for now, but will be dealt with more directly once we have outlined our four, relatively proximate measures that we believe will increase SIs transparency: make transparent the purpose, focus, and locus sustainability, make transparent the processes that underpin the development and aggregation of indicators, make transparent the experts and expertise involved in the development and aggregation of indicators, and make transparent the failings of indicators. Each of these will be illustrated with an example from the process used during the development of Kohuratia – the sustainability assessment and reporting system developed with Ngāi Tahu Farming. However, given our thinking regarding radical transparency was formed and refined during the development of the Kohuratia indicator suite the examples should be viewed as preliminary sketches rather than prescribed solutions.

5.2 Four forms of transparency

Values-oriented transparency: The dominance of the technocratic approach means that the vital sustainability questions of 'why', 'how', and 'what' are often ignored or obscured in favour of the technical focus. However, rather than being implicit, and, consequently, often ignored, the purpose, focus, and locus of 'sustainability' must be made concrete at the outset so that it can guide the development process. We would argue that value judgements are impossible to avoid during the development of SIs, so the best aim is to make those that are made public amongst stakeholders and actively discussed and debated. This *values-oriented* transparency ensures the moral impetus underpinning specific value judgements can be conscientized, enabling reflexivity, refinement, discussion, debate, selection, and synthesis amongst stakeholders.

Gaining values-oriented transparency was relatively straight-forward. Ngāi Tahu, like other Māori tribes, has the legislated right and responsibility to engage in resource management issues in New

Zealand and have, consequently, developed numerous management plans. Within these plans Ngāi Tahu have made their cultural values concerning sustainable land use explicit. In the first stage of developing the Kohuratia indicator suite content analysis of all Ngāi Tahu resource management documentation was undertaken to identify key values, their definitions, and frequency of use. Following this process kaumatua (elders) and kaihautu (tribal leaders) were interviewed and surveyed to validate the importance of each value (see Reid et al. 2013 for some of this work). The process allowed the identified values to be rapidly validated in terms of their prominence and importance. The final suite of values included:

- Tino rangatiratanga – the value of independence and self-governance;
- Manaakitanga – the value of supporting and caring for others to maintain personal and group dignity;
- Kaitiakitanga – the value and obligation of maintaining the health and wellbeing of non-human communities;
- Whai rawa – the value of building inter-generational wealth.

Genuinely informative transparency: The desire to measure a diverse set of socioecological phenomena and the demand for simple sets of numerical sustainability indices to streamline technocratic decision-making (or rather the justification of those decisions to the non-expert stakeholders) results in the use of various processes and statistical methods for selecting, measuring, and then statistically aggregating SIs. Such varied means of measurement and the simplified aggregated indices are inevitably unable to accurately and consistently represent either the diverse phenomena measured or the complexity of the systems as a whole. Instead, they reflect the weightings, value-judgements and worldview of those designing the SIs, as well as the more pragmatic reality of using existing tools rather than developing new ones. To ensure the limitations and weaknesses that underpin SIs development and aggregation are exposed the selection, measuring, and weighting processes and methods also need to be made explicit and open for critical examination, ensuring *genuinely informative* transparency.

To ensure the dashboard was built on genuinely informative transparency involved several key components. First, the team identified indicators that would allow the performance of Ngāi Tahu Farms to be measured against the values identified through the process described above. A review of different national and international farm sustainability assessment schemes and indigenous resource management approaches was conducted to identify sets of indicators that could be used to measure farm performance against the values: psychosocial, governance, and manawhahaere (indigenous governance) indicators were found for measuring the capacity for, and realization of, self-governance; social wellbeing and hauora (indigenous wellbeing) indicators were identified for establishing performance against manaakitanga; ecological, mahinga kai (indigenous wild food), and farm practice indicators were identified to measure performance against kaitiakitanga; and agronomic and tau utuutu (indigenous economic reciprocity) indicators were found to ascertain performance against whai rawa.

Indicators were then subjected to a three-step review process to increase transparency. First, tribal kaumatua (elders) and governors (kaihautu) were surveyed to ascertain how important and relevant they considered identified indicators to be in terms of measuring against each value. Second, farm managers were surveyed to rank the indicators in terms of their practicality (how easy it was to gather data against the indicator) and relevance. Both kaumatua and kaihautu were then asked if they considered any indicators were missing or should be added. Third, indicators were reviewed in terms of their scientific validity. This involved ascertaining whether the indicator had been validated, or invalidated, as efficacious in a peer-reviewed journal. Indicators considered important to tribal leadership, practical to farm managers, relevant, and that had not been invalidated scientifically were included in the final indicator suite.

The online tool, Kohuratia, was then built that allowed data to be gathered against indicators. The tool uses a simple scoring system where indicators are given a score out of 5, with a score of 5 indicating an 'excellent state' and 1 being a 'very poor state'. Currently pyramid aggregation is being used to add-up scores to report against specific values. As outlined previously, this method, although common, is weak given that not all indicators will be of equal importance in determining the functioning of the system. This weakness is acknowledged, and to compensate Kohuratia presents all indicator scores under aggregate scores to encourage learning, discussion, and debate – rather than fixation on a number or representation. However, Kohuratia does allow indicators scores across farms to be compared, which is permitting certain functions to be identified that are more impactful than others. For example, preliminary findings show that the level of trust in a farming business tends to strongly influence a range of ecological and economic indicators. Consequently, a trust indicator may need to be weighted more heavily than other indicators. Over time, we consider that weighting among indicators will emerge based on the power of the indicator for representing system health – removing the need for presenting results through aggregation.

Knowledge domain transparency: While there are risks that come with expert-led SIs development it is also critical to have expert involvement. However, this needs to be a more comprehensive set of expertise than the 'technocratic conception of expertise' which is generally limited to very specific forms of scientific knowledge. Furthermore, often 'expertise' lacks transparency in terms of what type of expertise they have (Forsyth 2011). This is partly due to this technocratic conception, in a form of circular logic the holders of the relevant scientific, technical knowledge are implicitly accepted as experts in a technocracy because of their affinity with the mechanistic worldview. However, as Forsyth (2011, 321-322) explains, "the role of expertise is both contested and highly changing… [e]xpertise is fluid in content, membership, and in terms of public legitimacy… [therefore m]aking the content, membership and legitimacy of expertise more transparent… is the way ahead". Thus, a third form of transparency is for the types of expertise engaged in development to be made public, as well as the limitations of those types of expertise, delivering *knowledge domain* transparency.

As outlined above the process used in developing Kohuratia involved three types of experts: kaumatua, or cultural experts, kaihautu, or organizational leadership experts, and the research team - which was responsible for the identification of appropriate indicators. Each of these experts fed into the indicator selection process to arrive at an expert-identified set. Furthermore, there was another step, the review by farm managers to ensure that indicators were practicable and affordable., which provided 'ground-truthing'.

Relatively objective transparency: There are many properties of socioecological systems that are unknown, too complicated, or intangible (e.g. agency, consciousness, and intentionality) and as such cannot be measured. As a consequence, there are assessment 'gaps' where the properties of socioecological systems cannot be measured. Rather than admit such gaps, the technocratic need for control and measurement leads to the development of pseudoscientific indicators. A critical approach to the development of SIs requires that the existence of these 'gaps' be made explicit, as well as differentiating these pseudoscientific indicators from the SIs which can be empirically measured. Transparency around the differing veracity of SIs would increase the legitimacy of those that can be empirically measured. It may also reinforce the utility of qualitative indicators, representing embodied and local knowledge of place, that are best placed to capture properties that cannot be captured empirically. These indicators are currently either rejected or considered of low value within the technocratic paradigm (Reid and Rout 2018). Making the limitations and 'gaps' explicit will help reinforce the necessity of qualitative indicators. Using a mixture of quantitative and qualitative indicators would provide *relatively objective* transparency.

Relatively objective transparency was achieved during the Kohuratia development process by first identifying and removing any indicators that were demonstrably shown to be scientifically invalid, or implausible to any of the stakeholders involved in the development process. This left room for the existence of indicators that cannot be scientifically invalidated yet are important for capturing intangible, qualitative elements and processes important in indigenous contexts. For example, Kohuratia has indicators that allow the amount of wahi tapu (sacred site) protection to be ascertained, or the level of whānaungatanga (warmth and social connection in human relationships) to verified. Furthermore, many of the identified 'gaps' in the indicator suite have been published in Reid and Rout (2018).

6. Discussion

Certainly, these four measures increase 'transparency' but what makes this transparency 'radical'? This is where we need to refer back to those three commonly referred to forms of transparency. As would be apparent from our examination of SIs development, there are many issues that we would take with these standard types of transparency. Concerning participatory transparency, we already outlined the problems regarding participatory methods, and while we are not arguing against using these, we believe that portraying participation as a means of enhancing transparency is problematic on its own. That is why we believe that making the values that shaped SIs development explicit is a useful and relatively simple means of increasing transparency. It provides the necessary information for stakeholders to engage with the SIs critically. Likewise, information transparency demands accurate information yet as we have explored 'accuracy' is a highly variable concept and rather than falsely portraying all the information as having the same high degree of accuracy it would be better to be transparent about the varying degrees of accuracy, explaining how the SIs were measured and aggregated as well as providing transparency regarding the knowledge domains used in the development process. Finally, accounting accuracy requires the information be 'objective'; however, as we have outlined this is not always possible when measuring socioecological systems. Instead, we believe that it is better to aim to be transparent about where there are gaps that cannot be filled with quantitative data and require more subjective measures.

Radical transparency questions the very nature of 'transparency' in the contemporary era. As noted in the introduction, transparency is one of the goals frequently associated with sustainability auditing – one that not always achieved. We would argue that one of the core reasons for this ongoing failure is that genuine and comprehensive 'transparency' is essentially antithetical to the technocratic approach. Burris (1989, 19) warns that there is "the potential for technocratic systems to promote and legitimate a technologically based authoritarianism". We believe that this potential is very high when it comes to indicator development, with one of the results being a lack of real transparency. The very notion of 'rule by expert' creates a binary situation where the non-expert is deemed not to have sufficient expertise to be involved in decision-making (Burris 1989). In turn, this implies that the non-expert is not capable of understanding the inputted information that underpins that decision-making. Therefore, there is little need for genuine and comprehensive transparency but rather just enough 'transparency' to quell popular debate. If there is to be legitimate transparency in SI, then it needs to be values-oriented, genuinely informative in how it was developed and what knowledge domains were involved, and relatively objective so that the very flaws of SI and of 'transparency' are exposed and the 'non-experts' can gain a degree of expertise in the fuzzy, inaccurate, and subjective nature of nature and the means by which it can be measured and controlled.

We also believe that radical transparency will help promote positive reflexivity amongst stakeholders, which will help overcome the 'tyranny of the majority' that often compromises the integrity of participatory processes. Making the entire development process radically transparent is not just a means of 'opening the lid' on how the indicators were devised but is also a way of making people engage and think about what matters to them and to the other stakeholders, it forces them to not only ask the big questions but also to think about how and why they might answer those big questions. Too often participatory processes became moribund, contentious or simply deny participation to the minority because participants have preconceived outcomes in mind. Radical transparency will help make stakeholder confront these preconceptions and, hopefully, rethink them.

7. Conclusion

The mechanistic worldview that dominates SIs development lacks reflexive awareness of its failings, and in service to the technocratic paradigm it is framed and projected as a precise, objective and value-free means of measuring and communicating 'sustainability'. This leads to number distortions during indicator development, distortions we believe are counter-productive to the ultimate aim of these indicators. There is a real danger, we believe, in presenting and representing the world mechanistically both in the way this delineates the environmental problems the world faces and, consequently, the way it proscribes the types of possible solutions, and those who should be in charge of them. The problems are technical and scientific rather than moral and political, meaning the solutions – as guided by SIs – are limited to technical and scientific solutions, often either 'tweaks' that seek to reverse negatively trending indicators in a minimalist manner that isolates single critical measures or technological 'fixes' that seek to overcome problems through greater attempts at control of socioecological systems. This obscures the intractable, chaotic complexity of socioecological systems, the underlying values of human society that are driving these systems to collapse and therefore the full range of needed solutions to these problems.

To address these issues we have argued that those involved in the development of SIs need to adopt radical transparency to complement values-oriented participatory processes. While the four forms of radical transparency outlined above do not provide a solution to all the issues outlined in this paper, what they do deliver is greater honesty about the flaws of indicators, which we believe will also help emphasize the benefits that SI deliver and ultimately, help broaden the scope of potential solutions. While it is unlikely, or even impossible, that SIs and associated sustainability and assessment schemes will be able to measure and model the sustainability status of socioecological systems empirically, SIs do have an influential role in making society aware of critical environmental, social, and economic issues, including the health status of our water, land, air, non-human, and human communities. Put simply, SIs do have a utility in their capacity to provide easy to interpret and understand snapshots of 'sustainability' to stakeholders and done so in a radically transparent way they can also help communicate the complexity of the issues faced as well as the need for a change in the way humanity values the environment and therefore solutions that go beyond 'tweaks' and 'fixes' to address the way humans think about, interact with and make use of the natural world. For as well as exposing the flaws in SIs, the mechanistic worldview and the technocratic paradigm, radical transparency can help to expose the flaws in humanity's relationship with nature.

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