International Journal of *Geo-Information*

MDPI

Editorial

Global Ambitions, Local Contexts: Alternative Ways of Knowing the World

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Received: 1 November 2019; Accepted: 4 November 2019; Published: 15 November 2019

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Abstract: In this Special Issue, we bring together contributions from authors in the scientific discipline *Geo-Information Science* who engaged with the question: How does Geo-Information Science contribute to the development of Sustainable Development Goals (SDG) indicators? The editorial to the Special Issue situates the individual contributions in a broader social science debate, which critically examines the quantification of global policy goals and its effects on how we know and govern the world. We put forward concepts of 'measuring the world' and a brief history of the Geo-Information Science discipline, including its dominant positivist paradigm as well as scholarly debates that reflected on and shifted that paradigm. Given the global policy focus of the SDGs, we also briefly discuss policy science paradigms. We analyze the individual articles with regard to their contribution to the SDG indicator development trajectory. We also show how alternative ways of knowing and governing the world complement the dominant positivist paradigm.

Keywords: sustainable development goals; indicators; geo-information science; ontology; policy making

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> *'Abraham falls victim to the following illusion: he cannot stand the uniformity of the world. Now the world is known, however, to be uncommonly various, which can be verified at any time by taking a handful of world and looking at it closely. Thus this complaint at the uniformity of the world is really a complaint at not having been mixed profoundly enough with the diversity of the world.'*
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> —Kafka, Parables and Paradoxes

1. Prologue

Most contributors to this Special Issue (SI), including the editors, are 'students'—a word of Latin origin meaning 'applying oneself seriously'—of the scientific discipline *Geo-Information Science*. The question informing the contributions to this issue is: How does Geo-Information Science contribute to the development of Sustainable Development Goals (SDG) indicators? In this editorial, we situate the individual contributions within a broader social science debate, shaped by legal anthropologist Sally Engle Merry, political economist Sakiko Fukuda-Parr and their collaborators. This body of work critically examines the quantification of global policy goals and its effects on how we know and govern the world. For simplicity, we refer to the theoretical underpinning of this debate as *'measuring the world.'*

We start with an account of '*measuring the world*' concepts, followed by a brief history of our scientific discipline, its dominant positivist paradigm and the ensuing scholarly debates that substantially increased reflexivity and shifted the dominant paradigm over time. Because of our focus on global policy goals, we also briefly examine the parallel trajectory of policy science paradigms. We then proceed to the heart of this editorial—a detailed analysis of the papers' contributions to the development trajectories of selected SDG indicators. In conclusion, we exemplify the knowledge and governance (policy) effects of the 'water for all' goal by 'taking a handful from the global South and looking at it closely'. The first example shows how knowledge practices (re)produce the SDG6 goal 'water for all' within a specific cultural context. The second shows how formal governance practices frame the 'water for all' goal, why, and with what deleterious effects, while at the same time revealing alternative paths to achieve the elusive goal.

2. 'Measuring the World'

Global institutions, such as the United Nations, set ambitious global policy goals, e.g., 'end poverty in all its forms everywhere' [1]. The intention is to elicit policy change on the part of national governments and other societal actors. The SDGs and their precursors, the Millennium Development Goals (MDGs), are well-known examples. The qualitative norms expressed in these global goals are translated into quantitative, time-bound targets using numerical indicators. SDG 1 'End poverty in all its forms everywhere' is translated into the time-bound target 1.1 'By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day,' and the numerical indicator 1.1.1 'Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural).' In the past decade, the legal anthropologist Sally Engle Merry [2,3], the political economist Sakiko Fukuda-Parr [4–6] and their collaborators theorized the development trajectory of global governance and MDG/SDG indicators. Their framework, dubbed here 'measuring the world,' assumes that indicators are both a form of knowledge and a technology of governance. The emergence of this framework as a distinctive form of inquiry requires a deeper analysis than we can give here, but a simple account runs as follows.

Translating a qualitative goal to a quantitative indicator has momentous consequences. The numerical indicator shapes how the qualitative goal is defined and used in narratives about goal implementation. This is because quantification not only describes but also reconfigures the social and natural world. As James C. Scott [7] points out in his magisterial *Seeing Like a State*, quantification radically simplifies the social and natural world and, in the process, remakes the world in order to make true its simplified description. Numerical indicators are powerful for several reasons [2]. They engender people's trust because they are scientifically derived; they abstract local context and culture to become universally applicable; they create a single standard that can be applied to multiple, comparative cases and furnish a means for assessing improvement or deterioration. Finally, yet importantly, indicators have knowledge and governance effects on global, national and local agendas. For instance, knowing citizens as earners of less than $1.25 a day (knowledge effect) implies treating them as eligible for government subsidies (governance effect), or as the Dutch historian Rutger Bregman [8] argues, giving them a guaranteed basic income, an admittedly more radical solution than government handouts.

'Measuring the world' submits that indicator development involves five phases—conceptualization, production, use, impact, and contestation. *Conceptualization* of the indicator entails smuggling a micro-theory into a number—a link between a dependent and an independent variable. For instance, an indicator measuring access to an improved water source (dependent variable) is linked to a distance of 400 meters from a water source (independent variable). The link may be calculable, but the micro-theory—a maximum distance of 400 meters secures access to water—may be wrong. Distance is a non-issue for citizens buying water from street vendors in sprawling urban regions. The *production* phase aligns the indicator to available or created data as well as established methodologies and curates their presentation, packaging and dissemination to imagined prospective users. In the *use* phase, the indicator, if highly authoritative and stable over time, may provide a basis for decision and action (e.g., university rankings in academia). In contrast, an unstable indicator over time may be used not as a basis for decision and action, but as an object of manipulation. For instance, if the definition of a functional water source changes three times within a few years, any hope of monitoring access to water over time is doomed [9].

Some indicators allow *impact* to be readily observed. For example, if the participation rate of youths and adults in organized learning in any given country increases from one year to another, a positive change in the country is likely to have occurred. However, attributing the change to the discursive power of the indicator itself is problematic because the change may be due to other factors. Finally, different indicators (based on divergent micro-theories) compete with those promoted in the same social field by powerful actors and institutions, flaunting authoritative expertise and commanding significant resources. *Contestation* is mostly evident at the level of conceptualization, as people fight about the best measure, as well as at the level of production as people choose what (not) to measure. In the analysis of the contributions, we use only conceptualization, production and contestation, since most contributions do not study the use or impact of indicators or goals on the ground.

3. Discourses in Geographic Information Science (GIScience) and Policy Science

Measuring and representing geographical phenomena has always been at the core of a geographic information system (GIS)—an organized activity by which people measure and represent geographic phenomena, and transform these representations into other forms. In an attempt to reconcile feuding human and physical geographers during the nineties, Chrisman ([10], p. 175) added a crucial clause (here in bold) to this definition of a GIS: *"an organized activity by which people measure and represent geographic phenomena, then transform these representations into other forms,* ***while interacting with social structures."*** During that period, human geographers were becoming increasingly concerned that GIS served large corporations and governments while eschewing the disenfranchised, emphasized systems engineering rather than people, contributed to surveillance and societal control and was generally inaccessible to those lacking high levels of technical skill [11,12].

These critiques stimulated reflection on the role of geo-information technologists and their social accountability. At the same time, influential geographers were claiming that the 'S' in GIS should stand for 'Science' not for 'System' [13,14]. Shifting the focus to 'Science', they argued, would eliminate the isolation between the traditional geospatial disciplines (geography, cartography, surveying and geodesy) and geography and computer science. Eventually, participants from a broad range of traditional disciplines convened in 1999 at a historic workshop held at the USA National Science Foundation and defined Geographic Information Science (GIScience) as *"the basic research field that seeks to redefine geographic concepts and their use in the context of GIS. GIScience also examines the impacts of GIS on individuals and society, and the influences of society on GIS. GIScience re-examines some of the most fundamental themes in traditional spatially oriented fields such as geography, cartography, and geodesy, while incorporating more recent developments in cognitive and information science"* ([15], p. 48). Participants identified an urgent need for a focused investment in GIScience, and the National Science Foundation as the most appropriate U.S.A. institution to support the newly born discipline.

Scientific disciplines are the result of the institutionalization of scientific inquiry and historical contingencies, while interdisciplinary domains, e.g., sustainability science, emerge continuously. GIScience inherited the positivist paradigm of the traditional disciplines at its roots. But the nineties debates injected considerable reflexivity and alternative paradigms into the scientific community through the insightful critiques by John Pickles [16], among others. In her historiographic examination *Trouble in the heartland: GIS and its critics in the 1990s*, Schuurman concludes that the debates contributed to the prosperity of the discipline and its continuing practical relevance. Despite the early hostility, critiques evolved into co-operative ventures between social scientists and scientists within geography to ensure responsible GIS use at the application and algorithmic levels [12]. Eventually, the potential for GIS and GIScience to contribute to public policy on crucial national issues, such as climate change, immigration, health, civil rights and racism, transportation, energy, electoral redistricting, natural resources, social justice, the environment, and many others, was recognized (American Association of Geographers 2014).

The discipline of policy science had a similar turbulent trajectory during the same period. Policy scholars challenged the dominant view, captured in the phrase '*speaking truth to power,*' that policy analysts provide impartial, disinterested evidence to policy makers—an approach known as evidence-based policy making. Instead, they argued for the full incorporation of policy actors in policy analysis and knowledge (co)production. The diverse contributions came to be known collectively as post-positivist—and included both interpretive and critical analysis—under various labels, e.g., argumentative policy analysis [17], critical policy analysis [18], political decision making [19], deliberative policy analysis [20], problem structuring [21] and problematization [22]. For post-positivist policy scholars, politics is not an obstacle that messes up clear-headed, scientific policy analysis, but a valuable creative process. Policy analysts reveal and clarify disputes over policy beliefs, examine policy actors' diverse ways of portraying disparities between policy goals and the current state of affairs, and view policy instruments as constantly contested moves and countermoves of policy actors [19]. Policy actors struggle over ideas and beliefs, which involve getting others to see a problem as a policy problem.

In their scholarly work, GI scientists and public policy scientists make assumptions regarding ontology (what is the world like), epistemology (what can we know about the world), methodology (how can we know the world) and axiology (what should we do in the world). In other words, they implicitly or explicitly embrace a paradigm. Paradigms do not match with disciplines; different scholars within a discipline follow different paradigms. There is no single paradigm for correct scholarship; multiple paradigms co-exist. Paradigmatic tenets and disciplinary context influence what kind of questions can be asked and what materials and methods can be used to answer them.

For instance, positivist GI scientists *represent* the world (e.g., 'water for all,' 'housing for all', among others) implied in the SDGs with an ever increasing accuracy and resolution; they attempt to refine/redefine an SDG indicator and/or harness alternative data sources to more truthfully represent this objective world. Interpretive GI scientists attempt to *understand* how humans (re)produce this world from the participants' perspective by asking how people achieve an indicator. Critical GI scientists attempt to *reveal* how we are governed by SDGs and what are the alternatively organized worlds of access to water or to housing. Table 1 summarizes the ontological assumptions of GI and policy scientists, with examples of policy making approaches for each paradigm.

Table 1. Ontology and examples of policy making approaches for each paradigm.

Paradigm	**Positivist**	**Interpretive**	**Critical**
Keyword	*Represent*	*Understand*	*Reveal*
Ontology (general)	Objects, processes and structures in the real world can be truthfully represented.	The social world is produced and reinforced by human agents through their (inter)action.	Subjects and objects are not essences, but always contingent and subject to change.
Ontology (specifically for policy making)	A policy problem can be readily identified "out there" and can be "addressed" by finding a "solution".	Policy actors actively "create" their world, mobilize "values", and "frame" problems.	Policies "produce" problems, hide assumptions behind taken-for-granted practices, and reveal how we are ruled and what we can become.
Examples of approaches to policy making	Evidence-based policy making	Problem structuring	What-the-Problem-is-Represented-to-be (WPR)

Evidence-based policy making, an example of a positivist policy making approach, is suitable for tame policy problems or moderately structured ones, with consensus on values (see [21,23]). *Policy problem structuring*, an example of an interpretive policy making approach, is eminently suited for moderately structured policy problems with no consensus on values, and for wicked policy problems (ibid.). Finally, Bacchi's [22] *What-the-Problem-is-Represented-to-be (WPR)* approach reveals how we are governed by policy problem representations, how we are produced as subjects within governing practices, and with what ethical implications. WPR entails six interlinked questions that foster an enhanced critical engagement with any policy or proposal for change. WPR highlights that specific proposals (or ways of talking about a 'problem') impose particular interpretations upon an issue. In this sense, *"governments create 'problems', rather than reacting to them, meaning that they create particular impressions of what the 'problem' is"* (p. 2). These impressions translate into real and meaningful effects for those affected. Effects take various forms. Discursive effects result from what is (not) discussed in the policy. Subjectification effects emerge from how people are thought about in the policy and how they actually think about themselves. Lived effects refer to the policy's impact on life and death.

4. Measuring Global Policy Goals: Alternatives and Insights

We invited authors of this SI to engage with the question: How does Geo-Information Science contribute to the development of SDG indicators? We received 15 contributions, of which the majority (eight) focused on indicators related to the urban goal (SDG 11), and a few on water (three; SDG6), health (one; SDG 3), education (one; SDG 4) and forest areas (one; SDG 15). One contribution [24] did not specifically select a particular indicator or goal, but provided a meta-level contribution on mapping. (See Table A1 in Appendix A for the full list of indicators analyzed in this SI). In this section, we analyze the individual contributions using *'Measuring the world'* as our conceptual lens, focusing on conceptualization and production, with contestation as a cross-cutting theme (Section 2).

Conceptualization

The conceptualization of the 232 SDG indicators is the result of an iterative and open negotiation process between multiple stakeholders and shaped by dominant development agendas [4]. Several contributions to this SI [25–30] critically examine the framing of specific indicators or the content of goals within their domain. They propose alternative framings or suggestions for inclusions, which they feel provide a more meaningful, scientifically sound and context-specific reference for monitoring and addressing the policy problem.

One contribution on conceptualizations unpacked the first urban indicator on providing adequate housing and services (SDG 11.1.1), framed as 'Proportion of urban population living in slums, informal settlements or inadequate housing'. Kuffer et al. [27] discuss the ambiguities of the different terms 'slums', 'informal settlements' and 'inadequate housing', as the definition of those terms varies across the globe. Even within one country such as India, the definition of the term slum, usually used in policy debates, differs across cities and states [31]. Furthermore, many more terms refer to precarious settlements with sub-standard living conditions [32], which are not captured in the framing of the indicators. Moreover, the multiple terms used to label precarious settlements neglect varying degrees of precariousness. In order to adopt a consistent framing across the globe, Kuffer et al. [27] propose identifying deprived areas morphologically, based on physical characteristics that can be identified in earth observation (EO) imagery by means of advanced remote sensing and machine learning algorithms. They also underscore the importance of local contexts and seeing deprivation not as a binary, but as a continuous range of phenomena in support of meaningful planning interventions. The authors recognize the necessity of calibrating categories using ground-based knowledge of local situations and acknowledge the limitations and ethical dilemmas of seeing urban deprivations through EO data and machine learning algorithms.

A second contribution conceptualizing indicators is related to urban transport, a dominant topic in sustainable urban development agendas. Many transport policies start from the assumption that providing additional or more advanced transport infrastructure will solve the problem of unequal access to transport, as framed in target 11.2. This aims to 'provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons'. Target 11.2 is measured by indicator 11.2.1. 'Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities'. However, Brussel et al. [26] claim that the access problem is not only a transport supply problem. Supply needs to be connected to people's activities and land use demand, namely the locations offering jobs, facilities (e.g., hospitals, schools, public institutions) and amenities (e.g., shops, attractions). Moreover, they highlight the importance of people's travel patterns and local context, particularly in cities in the global South, which experience a high degree of urban informality, including informal transport providers (minibuses) catering to the socio-economically weaker groups. In their contribution, they demonstrate the shortcomings of the supply-driven framing of UN indicator 11.2.1, which neglects activity locations and context-specific issues. Drawing on contemporary knowledge in transport studies, Brussel et al. [26] propose two alternative access indicators, i.e., the potential accessibility indicator and actual travel indicator, to complement the UN indicator. Both are showcased for the city of Bogotá in Colombia, a highly unequal city in terms of transport supply, spatial pattern of different socio-economic groups and activity locations [33]. There, most activity locations are in the central business districts while socio-economically weaker groups are largely located in the periphery of Bogotá. They argue that an accessibility framing, stratified by socio-economic groups, is more meaningful for capturing differences in access and future planning interventions.

Similar to Brussel et al.'s [26] critique on the lack of capacity of the access indicator to capture transport inequalities, Ulbrich et al. [30] question the sensitivity of selected urban goal targets and indicators to reveal intra-urban inequalities. They systematically analyze the framing of several targets and associated indicators (11.1.1, 11.2.1, 11.5.1, 11.6.1, 11.7.1 and 11.7.2; see Table A1 in Appendix A), point to the absence of intra-urban inequalities in their framing, and redress it by distinguishing between vertical (income-based), horizontal (social differences) and spatial inequality. For example, the perception of convenient access of the transport indicator (11.2.1), measured by a distance of 500 metres, will differ across specified groups as they have different demands and capabilities. Despite the obvious potential to account for social and spatial differences, the indicator on people affected by disasters (11.5.1) and the environmental exposure (waste and air pollution) indicator (11.6.1) do not consider these differences, while certain groups have fewer means to deal with disaster risks or live in environmentally disadvantaged areas. Moreover, with the exception of the indicator on improved living conditions (11.1.1), none of the indicators they examined considers intra-urban spatial differentiations, despite the spatial nature of the measured phenomenon such as environmental exposure or transport access. Ulbrich et al. [30] suggest that a more explicit focus on intra-urban socio-spatial inequalities in Goal 11 is needed.

Making inequalities or group underrepresentation visible is also taken up by Prieto et al. [28] for the access to education target (4.5) and by Rood et al. [29] for the health target on ending epidemics, among which is tuberculosis (3.3). Both develop a different way of measuring. Prieto et al. [28] draw their inspiration from the Human Opportunity Index [34], which considers the distribution of opportunities in space and across social groups in the equity measurement. More specifically, they measure education opportunities along two dimensions, attainment and admission, and control for the quality of the school by employing a statistical model and utilizing school district data on enrolment and admission. The application of their human opportunity-based education access indicator to the case of school districts in Florida in the United States demonstrates that their approach enables researchers to both identify and analyze potential inequalities in access to primary education across different social (vulnerable) groups, unlike the Parity Index proposed by the SDG metadata document [35], which only looks at gender.

Rood et al. [29] critique the lack of attention to spatial variation in the conceptualization of the tuberculosis indicator 3.3.2, which measures tuberculosis incidence per 100,000 population at the country level. They argue that the non-spatial rate leads to potential underreporting of certain areas. In order to obtain insights on the spatial clustering and heterogeneity of tuberculosis case notifications in support of dedicated interventions, specifically *"to identify areas where tuberculosis underreporting is likely to occur"* (p. 9), they propose an analytical framework called Mapping and Analysis for Tailored disease Control, and Health (MATCH). This framework combines register data, survey data, health data and spatial data within a geo-statistical approach for the case of Bangladesh to identify and locate target areas where tuberculosis under-detection, diagnosis and reporting are expected to occur. According to Rood et al. [29], the contextualization to the geography of case notifications, when verified in follow-up supervision missions, can help to more effectively allocate resources to those underreported areas.

The importance of spatial scale and geographic context was also addressed by Blatchford et al. [25] for the water efficiency and sustainable water use target. The indicator methodology, as developed within the SDG framework, does not account for differing local geographic context, specifically regarding the availability of land and water resources. Therefore, Blatchford et al. [25] develop a crop water productivity (CWP) framework consisting of water productive scores on different spatial scales (global, local), which consider different geographical conditions at the water basin level, e.g., whether the area faces constraints in water resources, land resources or both. In order to demonstrate the conceptual refinements, the EO data based methodological contribution utilizes Landsat 8 images, a digital elevation model (DEM) and meteorological data to illustrate potential implications of different CWP sub-indicators and their interdependencies in practice, such as the possibility of increasing crop production while minimizing water use. Their contribution exemplifies the importance of context and responsible use of water resources.

Context matters also for Koch et al. [36], who engage with the suitability of the conceptualization and measurement of SDG indicators for a national context. They extensively discuss the translation of the SDG 11 indicator framework to the German situation by analyzing three Goal 11 initiatives of three different actor groups (government, academia, civil society). They find that several of the original targets and indicators for SDG 11 are not used in the German context and that the framing of defined indicators differs across the three initiatives. Their analysis of the three initiatives illustrates the difficulty of developing universal indicators fitting local national contexts and understood in the same way. They also emphasize that such a global framework needs to consider the possible disaggregation of data, availability of comparable data at local and national levels, the definition of adequate indicators, and a certain degree of flexibility to allow for national and local adaptations, while recognizing the limited comparability of these adaptations.

Production

To measure progress with indicators, we need to align relevant data and present them in a comprehensible manner. In the meta-documents of SDG indicators, several are seen to lack the necessary data for measuring them in a globally consistent manner. Further, for several indicators the production of data is not yet clear. A number of SI contributions [30,37–42] engage with the production phase, in particular with sourcing or creating data that can support the measurement and monitoring of conceptually clear indicators, albeit allowing for additional refinements.

Chew at al. [37], for instance, focus on indicators requiring household listings for their production, for instance to determine progress on adequate housing (SDG indicator 11.1.1). Such data are usually derived from household questionnaires such as those collected by a census or other type of survey. However, especially in low- and middle-income countries, only areas recognized by the government are surveyed, while households in ‘invisible’ areas are excluded from such data collection campaigns. In order to ensure complete coverage and generate support for targeted and inclusive household sampling, Chew et al. [37] develop an object detection model based on EO data (Bing maps) to detect housing structures in Kaduna state in Nigeria. To do so, they employ machine learning, specifically deep learning, a promising method to directly enumerate housing structures in EO data for compiling household lists as input for household sampling [27]. While Chew et al. [37] rely on EO data to account for the unaccounted, Ulbrich et al. [30], in this issue, advocate participatory geo-spatial methodologies and citizen-generated data practices to collect data on multi-dimensional urban issues of marginalized urban communities and complement national statistics.

Taking a more global perspective, three contributions [27,40,41] focus on producing data for (globally) consistent measurement of various indicators (11.1.1, 11.3.1,15.1.1), taking advantage of EO imagery. Kuffer et al. [27] propose utilizing EO data to consistently capture urban deprivations across the globe, independent of terminologies, assuming that the degree of deprivation can be adequately derived from morphological properties. While they discuss the potentials and limitations of different EO-based approaches, they also warn of ethical dilemmas and potential societal consequences of these approaches, such as the displacement of entire settlements to peripheral areas.

Another global data production contribution with an urban focus is by Melchiorri et al. [41], specifically on the SDG target 11.3. of sustainable urbanization. They elaborate the potential of the global human settlement layer (GHSL) to consistently and globally measure and monitor land use efficiency (LUE). The GHSL, an open, packaged, globally consistent gridded database on built-up areas, developed by researchers from the European Commission (i.e., Joint Research Centre in Ispra), is generated from multiple EO data sources of different resolutions using advanced EO and machine learning algorithms. Besides elaborating the principles of the GHSL such as the conceptualization of built-up area and associated data and tools used (including volunteer geographic information for validation purposes), the authors propose a refinement of the UN methodology by measuring LUE instead of the ratio between the land consumption rate and population growth rate. Moreover, aligning their global dataset on LUE with indicator 11.3.1., the authors suggest raising indicator 11.3.1. from Tier 2 to Tier 1. The computation and analysis of LUE is also demonstrated by Nicolau et al. [42] for the national case of Portugal. They adopt the conceptual refinement proposed by Melchiorri et al. [41] as it seems to better capture urban dynamics and is easier to interpret than the UN methodology. Their contribution differs from Melchiorri et al. [41] in terms of data used. They use readily available spatial data such as the Portuguese land cover/land use reference map (COS) and the European corine land cover (CLC) map in combination with dasymetric mapping, the latter to only focus on built-up areas for population figures, comparable to Melchiorri et al. [41]. Applying their methodology to Portugal, they mainly find negative land use efficiencies, suggesting an increase in urban land use, but a decrease in population numbers.

A third sustainable urbanization contribution concerns the 'greening' of urban space. Giezen et al. [38] explore the tension between Amsterdam's ambitions to increase green space while undergoing a process of densification within its existing boundaries. Using very high resolution EO data, they align data on green urban space (public and private) with the sustainable urbanization target to explore the progress on increasing urban green space in the city of Amsterdam. They argue that municipal policies are inadequate for maintaining and increasing urban green space within its compact city strategy as no 'visible' progress is seen through EO data. The authors underscore the potential of EO data for policy evaluation, but also highlight the shortcomings, for instance the lack of differentiation between private and public space.

In contrast to green space in the city, Honeck et al. [40] focus on the conservation, restoration and sustainable use of forests at a national level. The authors critique the clarity of the data requirements for computing the forest indicator 15.1.1 as outlined in its metadata document and put forward a methodology to produce consistent time-series data on forests, in particular on forest area as a percentage of the total area, applied to the Swiss context. This also includes data packing, specifically an infrastructure (Swiss Data Cube) to utilize and disseminate ready-to-analyze EO data (i.e., Landsat). Their Data Cube approach has a global scope. It adequately represents detailed forest trends, harmonizes the measurement of SDG indicator 15.1.1, overcomes inconsistencies across countries and reduces the reporting effort for member states.

While most contributions on *production* rely on EO or readily available GIS data, Homberg and Susha [39] propose taking advantage of the variety of (publicly) accessible data sources—structured and unstructured, small and big data—to complement official statistics. Focusing on the access to safe drinking water services indicator (6.1.1.), currently a Tier 2 indicator—meaning that data are not yet readily available—they develop a framework to map the (open) data ecosystem and apply it to Malawi. The conceptual mapping process, based on two workshops, a survey and key informant interviews, identifies relevant actors in the data ecosystem, in order to match data demand with data supply and address the data infrastructure as well as data governance. The authors highlight the transferability of the generic framework for other indicators or geographic contexts to support more comprehensive sourcing and aligning of relevant data to measure actual progress of an SDG target across social groups and geographic areas.

Complementing the other SI contributions on production, Kraak et al. [24] engaged with the question of how to responsibly 'represent' indicator measures through maps, seeing them as means to reduce complexity. Drawing on well-established debates in critical cartography, on how mapping decisions such as the choice of a particular spatial unit, boundary, data classification or map projection affect mapping outcomes with possible detrimental societal consequences, they outline a comprehensive cartographic workflow and elaborate associated considerations for (spatially) visualizing the UN SDG indicators. Since these indicators vary in nature and are measured in different ways (rates, proportions, absolute values, etc.), they require carefully designed transformations for mapping. Through national and regional examples, they sketch potential pitfalls and suggestions on how to overcome them, demonstrated for visualizing infant mortality (SDG 3.2.1) and carbon dioxide emissions (SDG 9.4.1).

Finally, Katomero and Georgiadou [43] invert the 'measuring the world' framework. Instead of exploring the governance and knowledge effects of SDG 6.1.1 'Proportion of population using safely managed drinking water services', they reveal the 'indicator effects' of (in)formal governance and knowledge practices in the Kilimanjaro region. Following an interpretative paradigm grounded on organization and institutional theory and qualitative data, they show that when informal governance and knowledge practices complement their formal counterparts, the chances of achieving 6.1.1 are dramatically increased. However, the pervasive informality in the water sector, as well as in other policy domains (e.g., transportation), is notoriously difficult to represent in terms of indicators. Even formal governance and knowledge practices are hard to quantify [3]. This contribution points to a paradox of governance by (numerical) indicators: globally legitimate SDG indicators may reconfigure the world locally (for better or for worse) while locally legitimate governance and knowledge practices appear to 'produce' the SDG goal itself, without the mediation of (numerical) indicators.

Insights and refinements

The SI contributions collected here reveal several interesting insights. First, they identify weaknesses in the framing and conceptualization of a number of indicators, reflect on social inequalities or informal ways of accessing resources as well as incorporate overlooked areas and social groups and the issue of how measuring access can be improved. Furthermore, they show that local context matters; global policy goals need to be flexible enough to accommodate contextual differences, varying needs and different scales. They also address possible implications of particular scale levels of measurement for making policy choices. In addition, several contributions demonstrate the potential of data sources and data collection methods other than conventional national statistics. These include EO data for (globally) consistent measurements over time and policy evaluation as well as participatory methodologies and statistical research approaches to comprehensively measure a policy problem and leave no one behind in the measurement. Finally, the contributions also highlight the necessity of spatializing the UN SDG indicators and measuring progress along them across the board, in order to find and interpret spatial patterns and inequalities and allow for policy priorities that can be more effective in targeting areas and social groups.

Most SI contributions follow a positivist-oriented research paradigm. They view geo-technologies (i.e., EO data classifications, machine learning algorithms, geographic information analysis, statistical models, geodata or geo-spatial methodologies) as suitable means to capture and represent a particular phenomenon, including (precarious) human settlements, green space, forest area, water productivity, land use, population, access to basic services such as water, transportation or education, and underrepresented groups/areas (see Table 2). However, contributions also critically reflect on potential (societal) effects, implications or ethical dilemmas, discuss the uncertainties involved, emphasize the importance of the local context, or see the offered positivist-oriented research approach as complementary to other ways of producing policy-relevant knowledge and not as the only reality (Table 2). In contrast to the many GI-oriented approaches, Katomero and Georgiadou [43] show that there are also other ways of knowing (and governing), often not formally measured or measurable. In

Table 2, we summarize the different contributions, their link to policy making as well as the critical insights offered, where applicable.

Table 2. Overview of assumptions, policy focus and insights.

Ontologies of Special Issue (SI) Contributions	Ontology for Policy Making Signaling (the Extent of) a Problem, Spatial Information to Inform Policy:	Critical Insights/Conceptual Refinements
EO data-based classification can adequately capture a particular phenomenon (green space, presence of forest, water productivity, urban built-up area, building structures, deprived areas)	Green space is lost due to densification, while the aim is to increase green space [38]	Seeing the methodology as complementary/supportive [37,38,40]
	Spatial knowledge of informal housing (location, degree of deprivation) to inform pro-poor development strategies [27]	Considering the importance of local differences/goals [25,27,36] Emphasizing potential societal effects [27]; ethical implications, possibility of multiple understandings/framings [27]
	Identification of underrepresented groups to leave no one behind [37]	Considering shortcomings of conventional population statistics [37]
	Monitoring forest cover trends in support of forest conservation [40]	Warning of 'uncertainty in values' [27,40]
	Consistent information on urban built-up area to inform land-use efficient urban development strategies [41,42]	Addressing shortcomings of administrative boundaries [41,42]
Geographic information analysis and maps (if suitable spatial data are available) can adequately capture urban reality (land use, population distribution, accessibility, etc.)	Equal accessibility for all:identifying inequalities in transport accessibility for targeted policy interventions [26]	Revealing an effect (inequality) [26,30]
	Spatial analysis to inform land-use efficient urban development strategies [42]	Easy interpretation [42]
	Mapping to reduce complexities [24]	Warning of potential pitfalls due to subjective choices made [24]
Statistical methodologies can adequately identify spatial differences and clustering	Identifying underrepresented groups to leave no one behind [29] Equal access for all: identifying inequalities in education [28]	Identifying underreported groups which may be at risk [29,30] Identifying inequality [28]
Participatory geo-spatial methodologies can produce reliable information from marginalized groups	Certain inequalities are not sufficiently captured by the SDGs: alternative approaches to leave no one behind [30]	Revealing effects, i.e., inequality [30]
Combining multiple data streams will adequately measure the real world (data ecosystem)	Access to water for all [39,43]	Triangulation of different data sources [39,43] Acknowledging informal practices [43]

5. Taking a '*Handful of World*' and Looking at It Closely

In this final section, we take a '*handful of world*' and look at it closely from an interpretive and critical research perspective. We look at Tanzania, a country struggling with chronic rural water woes since the sixties, despite substantial top-down policy reforms and funding by donors and lenders. Tanzania was unable to meet the MDG for water by 2015. The latest figures from the Joint Monitoring Programme show no increase in overall improved water coverage access, with deficits in rural areas almost twice those in urban areas. About 52% of the population living in rural areas—21.1 million people—still lacks access to improved water [9].

Understanding 'water for all'—an interpretive perspective

We are more likely to understand why an astounding 92% of the population in Tanzania's Kilimanjaro region has access to improved water sources by viewing formality and informality in the world of water access not as analytically distinct ("either formality or informality") but as mutually constitutive ("both formality and informality") and impossible to disentangle from each other. In

Kilimanjaro, SDG target 6.1 *'By 2030, achieve universal and equitable access to safe and affordable drinking water for all'* will be reached. This is because formal water policies are securely grafted in informal knowledge and governance practices—sanctions and rewards—that go back centuries before the first colonizers marveled at the skill with which the Chagga tribe irrigated Kilimanjaro's terraced hillsides as well as at the subtle Chagga hierarchy of sanctions for water mismanagement. Christianity and Islam and other socially embedded institutions, although never mentioned in water policies and regulations, further reinforce informality in Kilimanjaro and provide the fertile soil on which formal government programs build. The practices that (re)produce the SDG6 goal 'water for all' in the Kilimanjaro region harness informality embedded in shared tribal and religious norms and practices, blend them with government programs and sustain superior rural water access.

Another theoretical lens from the same interpretive tradition would explain the success in Kilimanjaro by focusing on how water actors graft thin onto thick accountability [44]. Thick accountability is a justificatory account of my actions that I give to people whose opinion of me I value and whose esteem I seek as a water user, as a community leader, or as a district water official. Thin accountability is that small part of my accountability, which includes a few objective facts regarding my actions and communicates them to my hierarchical superior upon demand. The more thick and thin accountability diverge, the more fictional are the 'facts' that I communicate upwards regarding water access [45]; the more thick and thin accountability converge, the higher are the chances of achieving SDG target 6.1. When thin, simplified, formal orders and accountabilities replace thick, complex, informal social orders and accountabilities, they fail even for the limited purposes for which they are designed. *"Thin simplifications, if they survive at all, do so by virtue of their unacknowledged dependence on improvised "order" outside the scheme."* ([46], p. 273). In sum, an interpretive GI scientist would view formality and informality, thin and thick accountability, facts and values as intertwined and hard to disentangle. S/he would expect a numerical indicator intended to reflect the goal 'water for all' to effectively redefine this goal and how progress towards achieving it can be governed—i.e., monitored, and rewarded or penalized. Alternatively, s/he would endeavor to standardize the causal mechanism (and related independent variables) responsible for actually achieving the goal on the ground.

Revealing alternative 'water for all' worlds—a critical perspective

We are more likely to reveal hidden assumptions of and alternatives to top-down central government policies to achieve the elusive goal of "water for all" in Tanzania if we take a critical perspective. To give a flavor of the workings of a critical approach, we apply Bacchi's [47] *What-the-Problem-is-Represented-to-be (WPR)* approach to the rural water policy of the United Republic of Tanzania (URT) [48]. The WPR approach consists of six interlinked questions.

- What is the problem represented to be in the rural water policy of the URT (2010)?

In 2010, the Ministry of Water (MoW) decided to create a baseline of all rural water points (labelling them functional, non-functional, or needing repair) that could be used for monitoring progress towards "water for all." *"The intention is that the baseline data will be updated by village representatives using their mobile phones [. . .]. Government and other stakeholders (if authorized to do so) would then in real time be able to monitor and analyze functionality and other aspects of all water points, via a web based interface. [. . .] The GIS web based user interface under the new WPM contract will be user-friendly and accessible."* ([48], p. 72). So, the rural water policy [48] represents the problem as a lack of a reliable baseline of water points and a lack of an updating mechanism.

- What deep-seated presuppositions underlie this representation of the problem?

The meaning that had to be in place for this policy to be intelligible in 2010 was that GIS, web-based interfaces and mobile apps will solve the wicked policy problem of dismal rural water services in Tanzania. Back in 2010, belief in solutionism—meaning all difficult problems have benign solutions, often technical in nature—was dominant around the world. We may 'read off' the policy text the hidden assumption that individual villagers will behave as '*entrepreneurs of themselves*', as self-governing neoliberal subjects, while district water engineers will behave as Weberian bureaucrats.

- How has this representation of the 'problem' come about?

The dominance of this problem representation can be explained by the pervasive logic of donor- and lender-financed water projects in the global South [49]. Foreign experts, hired by donors and lenders to execute water projects, can only be held accountable to their paymasters for predictable consequences of a development project, i.e., for the appropriate execution of adequate procedures. The procedures and means experts use to implement the project must be linked to certain (often technical) ways of doing things and must have certain goals attached to them before they are transferred to the beneficiary country. Consequently, the self-determination of local beneficiaries as well as genuine collaboration between beneficiaries and experts to arrive at a consensus on the means and goals of the project are impossible. The paradox is that to achieve the maximum predictability of the project, nobody can be held accountable for unpredicted consequences (incl. complete failure) of the project as long as the procedures have been followed by the experts in charge. The ideal form of de-paradoxification is the technical game, which essentially turns the wicked problem of access to water into a tame technical problem of establishing a baseline and an updating mechanism, with GIS and mobile apps, while bracketing any social and cultural frames of reference.

- What is left unproblematic in this problem representation? Where are the silences?

The ubiquitous informality within the Tanzanian water sector is silenced. While the water sector is formally decentralized, informally it is centralized. Informal African institutions, such as churches and mosques, as well as grassroots organizations and tribal solidarities are silenced. Rural Tanzanians do not see themselves primarily as individuals. In concentric circles of weakening moral obligation, they think of themselves as members of limited extended families, wider extended families, tribes, ethnic groups, and only then as citizens [50]. Rural Tanzanians' *"politics of getting by"* are silenced [51]. Citizens regularly circumvent the state in order to achieve their aims, but make an effort to keep the state intact and at a manageable distance. Thus, citizens can rest assured that they may get by on a day-to-day basis without state interference.

- What effects are produced by this representation of the problem?

Discursive effects: the policy's focus is on what (resourceless) district water engineers and citizens have to do to improve water services, limiting consideration of the pervasive informality in the water sector.

Subjectification effects: district water engineers are seen as hierarchically thinly accountable Weberian bureaucrats, while they consider themselves as thickly accountable social beings. Citizens are seen as having a reporting obligation to a state, while they think of themselves as distanced from the state.

Lived effects: the chronically "broken" baseline of water points and failed water GIS systems impose significant constraints on the possibility of improving water services.

- How/where is this representation of the 'problem' produced, disseminated and defended? How could it be questioned, disrupted and replaced?

Access to water 'managed' at the village level works for the state as a means of offloading responsibility for public service provision to the most disempowered strata of the water bureaucracy—district officers and village representatives. Community management endures because it enables the state and donors to abdicate long-term responsibility for service provision [52]. Externally nominated problems, or "solutions" in which deviation from a best practice has been defined as the "problem," dominate the rural waterscape. A possible replacement for the dominant problem representation is suggested by Africanist policy scientists. For instance, Tim Kelsall argues that we should "*study systematically the characteristics of institutions that appear to be comparatively successful in [. . .] providing public goods in Africa. Are these institutions based around, or do they at least try to accommodate, African extended families, either structurally or ideologically? Do they have a religious component broadly conceived? In other words do they refer to some other-worldly dimension of accountability? [. . .] Are they held together by ethnic sentiment and (neo-)tradition? [. . .] In short, do successful institutions in Africa work with the grain of traditional society, or against it? Is the answer different for different countries, or in different sectors?*" ([50], p. 649). In sum, a critical GI scientist would view the social order of access to water as always contingent and subject to change and would explore alternative policy paths to achieve an SDG goal. S/he might ask: How do alternative ways of knowing and governing fit in the (global) policy context? How to redirect sustainable development efforts so that they stop working against, and start building upon extant notions of informality, moral obligation and interpersonal accountability? [50] These could be constructive avenues for future research.

6. Epilogue

In this SI, we have brought together scholars who provided alternative ways to conceptualize and measure indicators, create (globally) consistent data to monitor indicator progress, and responsibly visualize indicator measures through maps. Applying the conceptual lens of research and policy making paradigms reveals positivism as the dominant paradigm to 'improve' the global measurement framework of the SDGs, albeit with multiple relevant 'refinements' and insights (Table 2). Situating the SI contributions in broader social science debates helped us to draw critical insights from the SI contributions as well as elicit what other paradigms can add to the discussion on measuring development progress through indicators. While we should not prioritize a particular paradigm, we should rather seek their complementarities, as each paradigm has its merits (e.g., view from above vs. view from below, formal vs. informal, etc.) for the characterization of the nature of a certain policy problem and measuring progress.

A GI scientist of positivist inclination could view facts as (distinct from values and) purely scientific; s/he would appreciate the power of numerical indicators to make the world knowable (i.e., truthfully representable) and governable without the detailed particulars of context and history. An interpretive scientist would view facts and values as intertwined and hard to disentangle; s/he would expect an indicator intended to reflect a goal, e.g., 'water for all', to effectively redefine this goal and how progress towards achieving it can be governed—i.e., monitored, and rewarded or penalized. A critical GI scientist would view the social order as always contingent and subject to change and would explore alternative policy paths to achieve SDG policy goals. In the future, we may feel more encouraged to complement approaches *representing* the SDG world with an ever increasing accuracy and resolution, to *understand* how this world is (re)produced by humans through their action and interaction, and finally to *reveal* the assumptions underpinning taken-for-granted governance and knowledge practices as well as alternative possible worlds.

Author Contributions: The authors jointly conceptualized the editorial and wrote the paper.

Funding: This publication received no external funding.

Acknowledgments: The SI guest editors thank the contributing authors for the carefully designed contributions, the reviewers for devoting their valuable time, Isa Baud for providing comments on a draft version of the editorial, and the ISPRS IJGI managing editor for the smooth publication process.

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

Appendix A

Table A1. Overview of goals, targets and indicators elaborated in this SI.

Goal 3: Ensure healthy lives and promote well-being for all at all ages	
3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births	3.2.1 Under-five mortality rate
3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	3.3.2 Tuberculosis incidence per 100,000 population
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
4.5. By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations	4.5.1 Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated
Goal 5. Achieve gender equality and empower all women and girls (several indicators)	
Goal 6: Ensure availability and sustainable management of water and sanitation for all	
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1 Proportion of population using safely managed drinking water services
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	
9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	9.4.1 CO_2 emission per unit of value added
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	
11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	11.1.1 Proportion of urban population living in slums, informal settlements or inadequate housing
11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	11.2.1 Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities
11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	11.3.1 Ratio of land consumption rate to population growth rate

Table A1. *Cont.*

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	
11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	11.5.1 Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	11.6.1 Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated by cities 11.6.2 Annual mean levels of fine particulate matter (e.g., PM2.5 and PM10) in cities (population weighted)
11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	11.7.1 Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities 11.7.2 Proportion of persons victim of physical or sexual harassment, by sex, age, disability status and place of occurrence, in the previous 12 months
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss	
15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.1 Forest area as a proportion of total land area

References

1. UN Statistics Compilation of 2020 Comprehensive Review Proposals Received. Available online: https://unstats.un.org/sdgs/files/2020ComprehensiveReviewProposals_web.pdf (accessed on 28 October 2019).
2. Merry, S.E.; Davis, K.E.; Kingsbury, B. *The Quiet Power of Indicators: Measuring Governance, Corruption, and the Rule of Law (Cambridge Studies in Law and Society)*; Merry, S.E., Davis, K.E., Kingsbury, B., Eds.; Cambridge University Press: Cambridge, CA, USA, 2015.
3. Merry, S.E. Measuring the world: Indicators, human rights, and global governance: With CA comment by John, M. Conley. *Curr. Anthropol.* **2011**, *52*, S83–S95. [CrossRef]
4. Fukuda-Parr, S.; McNeill, D. Knowledge and politics in setting and measuring the SDGs: Introduction to special issue. *Glob. Policy* **2019**, *10*, 5–15. [CrossRef]
5. Fukuda-Parr, S. Global Goals as a policy tool: Intended and unintended consequences. *J. Hum. Dev. Capab.* **2014**, *15*, 118–131. [CrossRef]
6. Fukuda-Parr, S.; Yamin, A.E.; Greenstein, J. The power of numbers: A critical review of millennium development goal targets for human development and human rights. *J. Hum. Dev. Capab.* **2014**, *15*, 105–117. [CrossRef]
7. Scott, J.C. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*; Yale University Press: New Haven, CT, USA; London, UK, 1998.
8. Bregman, R. *Utopia for Realists: And How We Can Get There*; Bloomsbury Publishing: London, UK, 2017.
9. Katomero, J.; Georgiadou, Y.; Lungo, J.; Hoppe, R. Tensions in rural water governance: The elusive functioning of rural water points in Tanzania. *ISPRS Int. J. Geo Inf.* **2017**, *6*, 266. [CrossRef]
10. Chrisman, N.R. What Does 'GIS' Mean? *Trans. GIS* **1999**, *3*, 175–186. [CrossRef]
11. Schuurman, N. Critical GIScience in Canada in the new millennium. *Can. Geogr. Le Géographe. Can.* **2009**, *53*, 139–144. [CrossRef]
12. Schuurman, N. Trouble in the heartland: GIS and its critics in the 1990s. *Prog. Hum. Geogr.* **2000**, *24*, 569–590. [CrossRef]
13. Goodchild, M.F. Geographical information science. *Int. J. Geogr. Inf. Syst.* **1992**, *6*, 31–45. [CrossRef]
14. Goodchild, M.F. Geographic information systems and geographic research. In *Ground Truth*; Pickles, J., Ed.; Guilford: New York, NY, USA, 1995; pp. 31–50.

15. Mark, D.M. Geographic information science: Critical issues in an emerging cross-disciplinary research domain. *J. Urban Reg. Inf. Syst. Assoc.* **2000**, *12*, 45–54.
16. Pickles, J. *A History of Spaces: Cartographic Reason, Mapping and the Geo-Coded World*; Routledge: London, UK, 2003.
17. Fischer, F.; Forester, J. *The Argumentative Turn in Policy Analysis and Planning*; Duke University Press: Durham, NC, USA, 1993.
18. Dryzek, J.S. Policy Sciences of Democracy. *Polity* **1989**, *22*, 97–118. [CrossRef]
19. Stone, D. *Policy Paradox: The Art of Political Decision Making*, Revised ed.; Norton and Company: New York, NY, USA; London, UK, 2002.
20. Hajer, M.; Wagenaar, H. *Deliberative Policy Analysis*; Cambridge University Press: Cambridge, CA, USA, 2003.
21. Hoppe, R. *The Governance of Problems*; Policy Press: Bristol, UK, 2010.
22. Bacchi, C. Why Study Problematizations? Making Politics Visible. *Open J. Polit. Sci.* **2012**, *2*, 1–8. [CrossRef]
23. Georgiadou, Y.; Reckien, D. Geo-information tools, governance, and wicked policy problems. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 21. [CrossRef]
24. Kraak, M.J.; Ricker, B.; Engelhardt, Y. Challenges of mapping sustainable development goals indicators data. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 482. [CrossRef]
25. Blatchford, M.L.; Karimi, P.; Bastiaanssen, W.G.M.; Nouri, H. From global goals to local gains—A framework for crop water productivity. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 414. [CrossRef]
26. Brussel, M.; Zuidgeest, M.; Pfeffer, K.; van Maarseveen, M. Access or accessibility? A critique of the urban transport SDG indicator. *ISPRS Int. J. Geo Inf.* **2019**, *8*, 67. [CrossRef]
27. Kuffer, M.; Wang, J.; Nagenborg, M.; Pfeffer, K.; Kohli, D.; Sliuzas, R.; Persello, C. The scope of earth-observation to improve the consistency of the SDG slum indicator. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 428. [CrossRef]
28. Prieto, L.M.; Flacke, J.; Aguero-Valverde, J.; Van Maarseveen, M. Measuring inequality of opportunity in access to quality basic education: A case study in Florida, US. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 465. [CrossRef]
29. Rood, E.; Khan, A.H.; Modak, P.K.; Mergenthaler, C.; Van Gurp, M.; Blok, L.; Bakker, M. A spatial analysis framework to monitor and accelerate progress towards SDG 3 to end TB in Bangladesh. *ISPRS Int. J. Geo Inf.* **2019**, *8*, 14. [CrossRef]
30. Ulbrich, P.; de Albuquerque, J.; Coaffee, J. The impact of urban inequalities on monitoring progress towards the sustainable development goals: Methodological considerations. *ISPRS Int. J. Geo Inf.* **2019**, *8*, 6. [CrossRef]
31. Nolan, L.B. Slum definitions in urban India: Implications for the measurement of health inequalities. *Popul. Dev. Rev.* **2015**, *41*, 59–84. [CrossRef]
32. Kuffer, M.; Pfeffer, K.; Sliuzas, R. Slums from space-15 years of slum mapping using remote sensing. *Remote Sens.* **2016**, *8*, 455. [CrossRef]
33. Bocarejo, J.P.; Portilla, I.; Meléndez, D. Social fragmentation as a consequence of implementing a bus rapid transit system in the city of Bogotá. *Urban Stud.* **2016**, *53*, 1617–1634. [CrossRef]
34. Paes de Barros, R.P.; Vega, J.R.M.; Saavedra, J. *Measuring Inequality of Opportunities for Children*; BMC Health Services Research: Washington, DC, USA, 2008.
35. *UNESCO Education for People and Planet: Creating Sustainable Futures for all*, Global Education Monitoring Report, 2nd ed.; UNESCO Publishing: Paris, France, 2016.
36. Koch, F.; Krellenberg, K. How to contextualize SDG 11? Looking at indicators for sustainable urban development in Germany. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 464. [CrossRef]
37. Chew, R.; Jones, K.; Unangst, J.; Cajka, J.; Allpress, J.; Amer, S.; Krotki, K. Toward model-generated household listing in low-and middle-income countries using deep learning. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 448. [CrossRef]
38. Giezen, M.; Balikci, S.; Arundel, R. Using remote sensing to analyse Net land-use change from conflicting sustainability policies: The case of Amsterdam. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 381. [CrossRef]
39. Den Homberg, M.; Susha, I. characterizing data ecosystems to support official statistics with open mapping data for reporting on sustainable development goals. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 456. [CrossRef]
40. Honeck, E.; Castello, R.; Chatenoux, B.; Richard, J.P.; Lehmann, A.; Giuliani, G. From a vegetation index to a sustainable development goal indicator: Forest trend monitoring using three decades of earth observations across Switzerland. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 455. [CrossRef]

41. Melchiorri, M.; Pesaresi, M.; Florczyk, A.J.; Corbane, C.; Kemper, T. Principles and applications of the global human settlement layer as baseline for the land use efficiency indicator—SDG 11.3.1. *ISPRS Int. J. Geo Inf.* **2019**, *8*, 96. [CrossRef]
42. Nicolau, R.; David, J.; Caetano, M.; Pereira, J.M.C. Ratio of land consumption rate to population growth rate—Analysis of different formulations applied to Mainland Portugal. *ISPRS Int. J. Geo Inf.* **2019**, *8*, 10. [CrossRef]
43. Katomero, J.; Georgiadou, Y. The elephant in the room: Informality in Tanzania's rural waterscape. *ISPRS Int. J. Geo Inf.* **2018**, *7*, 437. [CrossRef]
44. Dubnick, M. *Accountability through Thick and Thin: Preliminary Explorations*; Institute of Governance Public Policy and Social Research, Queen's University: Belfast, UK, 2003.
45. Pritchett, L. *Folk and the Formula: Fact and Fiction in Development*; UNU World Institute for Development Economics Research (UNU-WIDER): Helsinki, Finland, 2013; Available online: https://www.wider.unu.edu/sites/default/files/News/Documents/Folk-and-formula-fact-and-fiction-Lant-Pritchett-5766.pdf (accessed on 15 November 2019).
46. Scott, J.C. *Geographies of trust, geographies of hierarchy. Democracy and Trust*; Warren, M.E., Ed.; Cambridge University Press: Cambridge, CA, USA, 1999; pp. 273–289.
47. Bacchi, C. *Foucault, Policy and Rule: Challenging the Problem-Solving Paradigm*; Institute of History, International Studies and Social Relations, Aalborg University: Aalborg, Denmark, 2010; T. 74.
48. United Republic of Tanzania (URT)—Ministry of Water and Irrigation. Water Sector Status Report. Available online: http://www.tzdpg.or.tz/fileadmin/documents/dpg_internal/dpg_working_groups_clusters/cluster_2/water/WSDP/Reviews/2010_Water_Sector_Status_Report.pdf (accessed on 15 November 2019).
49. Rottenburg, R. *Far-Fetched Facts. A Parable of Development Aid*; The MIT Press: Cambridge, MA, USA; London, UK, 2009.
50. Kelsall, T. Going with the grain in African development? *Dev. Policy Rev.* **2011**, *29*, s223–s251. [CrossRef]
51. Mulqueen, T. *The Politics of Getting By: Understanding Political Stability in Tanzania*. 2009. Available online: http://www.brooklyn.cuny.edu/pub/departments/bcurj/pdf/mulqueen.pdf (accessed on 15 November 2019).
52. Chowns, E. Is Community management an efficient and effective model of public service delivery? Lessons from the rural water supply sector in Malawi. *Public Adm. Dev.* **2015**, *35*, 263–276. [CrossRef]