PHILOSOPHY OF OPENNESS AND ITS RELEVANCE IN MOVING TOWARD SUSTAINABLE DEVELOPMENT

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ABSTRACT
There is a close match between the principles of the philosophy of Openness and the principles and practices necessary to move toward sustainable development (SD). On one hand, the achievement of SD requires development of local capacity, self-reliance, adaptability, reduction of risks and vulnerabilities, resilience, stability, democracy, transparency, equal access, strengthening of social networks, cooperation, increased learning capacity, and enablement of local capacity to fix and develop. On the other, the application of the principles of Openness (collaboration, inclusiveness, access, participatory development, and decision making) lead to science and technologies that are not exclusionary, have less barriers to be adapted to specific needs and contexts, encourage communication and cooperation strengthening social networks, foster learning and development of local capacities, and by being interoperable and reusable, reduce waste of time and efforts while increasing creativity and productivity. This paper defines what Openness and SD are and provides examples of the previously mentioned match and of the significant contributions of Openness to the achievement of SD. The examples provided are in the context of geospatial science and technology.
Keywords: Openness; sustainable development; Open Specifications; Open Source Software; Open Data; geospatial.

1 INTRODUCTION

Openness is a philosophy that promotes transparency and no-cost unrestricted access to data, information, knowledge, or technologies with emphasis on collaborative development, management, and decision-making [1], [2]. Sustainable development (SD) has been defined in different ways, however, it is agreed that it requires the development and implementation of several features and practices: development of local capacity, self-reliance, adaptability, reduction of risks and vulnerabilities, resilience, stability, democracy, transparency, equal access, strengthening of social networks, cooperation, increased learning capacity, and enablement of local capacity to fix and develop data, information, infrastructures, and technologies.

The purpose of this paper is to present and illustrate in the context of geospatial science and technology the contributions of the application of the philosophy of Openness to support and promote values, attitudes, behaviours, and motivations, as well as science and technologies that align with the features and practices required to move toward SD. Section 2 goes deeper into defining Openness and how its application creates Open resources, processes, and effects. Section 3 defines SD and presents the challenges and complexity that we face in our attempts to move towards it. Section 4 illustrates in the context of geospatial science and technology the match that exists between the result of applying the philosophy of Openness and what is required to move toward SD locally and globally. Finally, Section 5 presents some concluding remarks.

2 DEFINING OPENNESS

Again, Openness is a philosophy that promotes transparency and no-cost unrestricted access to data, information, knowledge, or technologies with emphasis on collaborative development, management, and decision-making [1], [2]. The application of this philosophy

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in diverse socio-political, scientific, and technological areas is denoted by the use of the term "Open", such as Open Source Software, Open Data, Open Science, Open Publishing, Open Hardware, Open Government, Open Innovation, and Open Education among others.

The principles of Openness are applied in many fields in diverse forms for different purposes. Schlagwein et al. [3] present a framework to assist in conceptualizing and understanding the term Openness and how it is applied in different contexts for diverse purposes. The framework proposed by these authors separates the application of the overarching principles of Openness (i.e. collaboration, inclusiveness, access, participatory development and decision making) into **resources** (e.g. accessible resources such as Open Data, Open Source Software), **processes** (e.g. participation, collaboration, and inclusiveness such as Crowdsourcing and Open Innovation), and **effects** (e.g. democratization, facilitation of access, transparency, and equality such as Open Government, Open Education) (see Fig. 1). This framework assists in understanding the connections and synergies between the different dimensions and applications of the principles of Openness. Coetzee et al. [4] point to the synergies that occur when applying concurrently the principles of Openness to resources (Open Data, Open Hardware, Open Source Software, Open Standards), processes (Open Source Software development), and effects (Open Science, Open Education) in the area of geospatial science and technology. These authors pay particular attention to the process involved in the creation and development of geospatial Open Source Software.

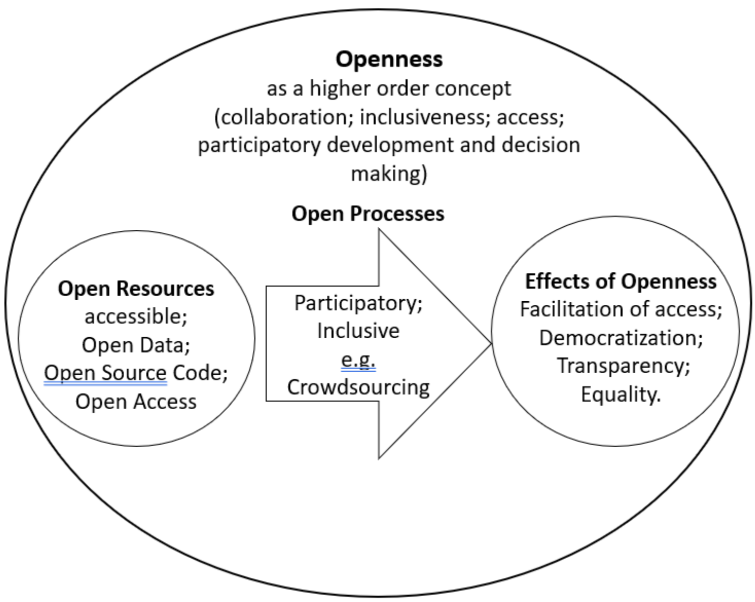

Figure 1: Framework for conceptualizing the philosophy of Openness and its applications [3].

The benefits of Openness are numerous and diverse depending on the area in which it is applied and on the level of the integrated use of Open resources, processes, and effects in a given context. For example, Open Data and Open Source Software used together with Open participatory development and Open Science, culminating in the distribution of the

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knowledge generated through Open Access and Open Education practices. Maxwell [5], Hernandez-Vivanco et al. [6], Roper et al. [7], Murray et al. [8], Wiley and Green [9] and Weibezahn and Kendziorski [10] illustrate the benefits of Openness in different applications and contexts (e.g. education, innovation, energy management systems). There are also concerns (most unfounded) regarding the use of Open principles and technologies. For example, the following have been mentioned regarding the use of Open Source Software: how good could it be if you don't have to pay for it, it is not ready for mission-critical applications, it has no customer support or learning resources, it is only for experts and it is difficult to use. Wheatley [11] lists the most common myths and concern around Open Source Software and dispels them by providing examples of sophisticated large-scale mission-critical successful applications.

3 CHALLENGES TO MOVE TOWARDS SUSTAINABLE DEVELOPMENT

The most well-known definition of sustainable development (SD) is contained in the Brundtland report [12]: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition has the appeal that everyone can subscribe to it, but it has been criticized by being vague and using terms that are not fully defined (e.g. "needs"). More specifically, SD requires the identification and application of values, attitudes, motivations, and behaviours, as well as technologies that improve the quality of life of humans while being socially acceptable, economically feasible, and environmentally viable.

Our current SD social, economic, and environmental challenges must be conceptualized, studied, and addressed using multi-disciplinary and multi-scale systems-thinking approaches. Multi-disciplinary approaches help us uncover and understand the interactions and repercussions of socio-cultural values and economic decisions on societies and on the environment. Today the effects of our decisions and behaviours extend over larger geographic areas, longer time spans, and multiple socio-cultural, political, economic, and jurisdictional scales. Our most pressing socio-economic-environmental challenges emerge, interact, and must be addressed at these different scales. Intra-scale effects (e.g. cumulative effects at different geographic scales) and cross-scale interactions (e.g. national/institutional areas of control interacting with spatial and temporal scales of ecological process in the management of natural resources) must be identified and dealt with full consideration of the existence of these intra and cross-scale effects and interactions (see [13]).

The complexity that emerges from our attempts to carry out multi-disciplinary multi-scale studies for the development of effective SD practices is further compounded by the need to include diverse stakeholders (individuals, organizations, governments). These stakeholders are located over large geographic areas, have diverse socio-cultural/economic/technological backgrounds, and usually have conflicting priorities, interests, and agendas. Equality, democracy, transparency, inclusiveness, and access to data, information, and knowledge, as well as to decision-making processes must be facilitated for these stakeholders in order to move toward SD at different spatial/temporal/jurisdictional scales. The provision of these features is essential for the identification and implementation of effective SD behaviours, practices, and systems. In this endeavour, we need to make use not only of the best science, but also to facilitate the use of diverse systems and technologies (i.e. proprietary/closed as well as Open) that allow us to better address the needs for data, information, and decision-making support demanded by these stakeholders around the world [14].

4 THE RELEVANCE OF OPENNESS TO MOVE TOWARD SUSTAINABLE DEVELOPMENT

In the past humanity has relied heavily on technological solutions to push through environmental limits to obtain the goods and services that satisfy our growing needs and wants. In coming decades, exclusive reliance on technological solutions will not help us move toward SD. Technological and economic approaches by themselves will only buy us time to make the necessary adjustments in the ultimate drivers of our societies and economies. We must urgently consider and carry out revolutionary changes in the values, attitudes, behaviours, motivations, and choices that drive our societies and economies [15]. To assist in the transition, we must promote the use and development of data, information, science, and technologies that foster the practice of values, attitudes, behaviours, motivations, and choices that align with the achievement of SD. There is a close match between the principles and practices that characterize Openness and the requirements to move toward SD.

The multi-scale multi-dimensional challenges to achieve SD require governments, companies, scientists, policy makers, and citizens willing to work together in a transparent, collaborative, inclusive, and democratic way facilitating access and distribution of data, information, knowledge, and technologies. These characteristics are core to the definition of Openness and guide the development, distribution, and application of Open resources, processes, and effects [14]. To illustrate the match that exists between the requirements to move toward SD and the features that characterize the applications of the philosophy of Openness, next the case of Open Standards, Open Data, and Open Source Software in the area of geospatial science and technology is presented.

4.1 Geospatial Open Standards, Open Data, and Open Source Software

The Open Geospatial Consortium (OGC) is an international consortium of more than 500 businesses, government agencies, research organizations, and universities driven to make geospatial information and services **FAIR** – *Findable, Accessible, Interoperable, and Reusable* [16]. One of the main activities of the OGC is to coordinate the creation, development, and distribution of Open standards that enable the creation of FAIR resources (e.g. Open Source Software, Open Data, and Open Web Services; see [17]).

OGC standards are used by software developers distributed around the world to build Open interfaces and encodings into their products and services [18], this use enables these products and services to be FAIR. Interfaces allow different pieces of software to work together seamlessly (i.e. to be interoperable) and to be reused in different projects. The use of OGC encodings enables geospatial data to be interoperable and Open as explained in Open Geospatial Consortium [19]. Using OGC Open standards not only makes geospatial data and software FAIR, but also fosters collaboration, cooperation, inclusiveness, transparency, access, and democratization of data and software for developers and users that are distributed across socio-political/ institutional borders and that are located in diverse socio-cultural/economic/technological contexts. The features fostered by following the principles of Openness enhance developers' creativity, productivity, and impact in providing access to geospatial data, information, knowledge, and technologies as well as improving decision-making processes [20].

OGC maintains a public Standards Roadmap [21] for every standard currently under development. Each Open standard document provides detailed guidelines on how to comply and implement it for data, software, applications, or systems. The OGC repository of White Papers [22] provides multiple documents that discuss the benefits of complying with OGC standards. The OGC White Paper [23] provides a brief overview of the benefits of Openness and FAIR geospatial data, software, and technologies. FAIR data and technologies address fundamental users' needs (note that these needs align with what is required to deal with the complexity of moving toward SD). Overall, users want to maintain and maximize the value of past and future investments in geospatial data and systems. More specifically users around the world need to (a) share and reuse data produced by different entities located in diverse geographic locations (from local to global) and institutional settings in order to generate better information and be able to better support decision-making processes; (b) choose and customize the best tool for the job at hand while reducing the risk and vulnerability of being locked in to one software, vendor, or technological solution; and (c) provide more people with less training access to geospatial data, information, knowledge, and technologies.

More resources for understanding the OGC, their work and its importance are provided by Reichardt and Robida [20] who present an overview and discussion of what are the OGC standards, their importance, and their role in bring the power of geospatial data and technologies to decision makers around the world. Coetzee et al. [4] explain the use of Open standards in the development of geospatial Open Source Software and the synergies that occur when it is use in conjunction with Open Hardware, Open Data, Open Science, and Open Education. These authors also present a detailed explanation of the distributed-collaborative process that is followed in the development of geospatial Open Source Software. Moreno-Sanchez [24] presents a brief overview of the history, importance in different contexts, and growing interest in geospatial Open Source Software.

It is clear that there is a close match between the characteristics of geospatial Open Source Software and Open Data (and more generally, the multiple areas and technologies where Openness is applied) and some of the fundamental requirements to move toward SD in diverse socio-cultural, economic, and technological contexts around the world. On one hand some of the fundamental requirements for SD are development of local capacity, self-reliance, adaptability, reduction of risks and vulnerabilities, resilience, stability, democracy, transparency, equal access, strengthening of social networks, cooperation, increased learning capacity, and enablement of local capacity to fix and develop. On the other hand, for example, the use of OGC Open Standards enables the transparent, inclusive, democratic, collaborative, and distributed development of data, software and systems. By the way Open Source Software and Open Data are created, developed, distributed, and used, they are FAIR. This software and data are not exclusionary, have less barriers to be adapted to specific needs and contexts, encourage communication and cooperation strengthening social networks, foster learning and development of local capacities, and by being interoperable and reusable reduce waste of time and efforts while increasing creativity and productivity [20], [23].

5 CONCLUDING REMARKS

Understanding the current state, interactions, and future trends of our societies, economies, and environment at different geographical, temporal, and jurisdictional scales is becoming fundamental to our subsistence and development. This understanding must be made accessible to diverse stakeholders (citizens, scientists, policy makers, and governments) located in different socio-cultural, economic, and technological contexts. The complexity in achieving this goal requires the use of the best science, technologies, and philosophies. Openness principles and Open resources, processes, and effects offer features that support and promote values, attitudes, and behaviours that are conducive to move towards SD.

The transition to SD behaviours and practices locally and around the world will demand a drastic change in the dominant values, motivations, and attitudes in our societies and economies, from the individual to societies, from the short-term to the long-term, and from the local to the global level. We must now more than ever remember and apply principles and practices that help us move toward SD societies and economies: Openness, communication, collaboration, equality, access, empowerment of stakeholders, strengthening of social networks, resilience, increased learning capacity, adaptability, democracy, and altruism.

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