



## Benefits and challenges of voluntary contribution to GEOSS

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### ABSTRACT

The vision of the Global Earth Observation System of Systems (GEOSS) is the achievement of societal benefits through voluntary contribution and sharing of data, metadata and products at no or minimum cost. Such undertakings, where contribution provides positive externalities, benefiting contributors and non-contributors alike, are often described as ‘social dilemmas’, usually resulting in small levels of voluntary contribution. We investigate the benefits and challenges of voluntary contribution to GEOSS, surveying economic and game theoretic literature and examining how the concepts of social dilemmas apply to the provision of GEOSS. We conduct an exploratory survey among individuals involved in the Group on Earth Observation (GEO) to understand their perception of voluntarily contribution. Even though contribution to GEOSS was perceived as rather low, e.g. because of a perceived lack of funds, commitment or organization, survey respondents also perceived many (exclusive) benefits of contribution, e.g. networking, visibility for their work or collaborating with motivated individuals. To increase participation, respondents suggested increasing financial support and raising awareness of GEOSS. We conclude that communicating the efficacy of individuals’ contributions, the personal benefits of contribution and strengthening of group identity and knowledge about fellow participants’ work can constitute incentives for future voluntary contribution. This could be facilitated by an externally established institution providing a framework for cooperation, or by institutions, agreements or frameworks agreed upon by contributors themselves.

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### 1. Introduction

In 2003 the first political summit on Earth Observation was convened in Washington DC, and the need to strengthen “cooperation and coordination among global observing systems and research programs for integrated global observation” [1] was highlighted, to ensure cost-efficiency, to reduce gaps and avoid data redundancies. Thus, in 2005 the Group on Earth Observation (GEO) was formed and adopted a 10-year Implementation Plan (2005–2015) to set up the Global Earth Observation System of Systems (GEOSS) [2]. GEOSS is a network coordinating Earth observing and information systems, contributed to on a voluntary basis. GEOSS facilitates access to data resources, information and computer technologies, existing and future observation systems and forecasting models, to add value to Earth observation activities through

coordination. The products and services are to be made accessible for free or at very low cost, benefiting contributors and non-contributors alike. The vision for GEOSS, is thus “to realize a future wherein decisions and actions for the benefit of humankind are informed via coordinated, comprehensive and sustained Earth observations and information” [2].

Even though the 2003 summit increased political awareness of collaborative efforts, voluntary cooperation remains challenging. With regards to GEOSS we distinguish two types of voluntary contribution. The first is contribution by continuous or one-time provision of data, services or infrastructures. Generally, data sharing can be complicated by technical and functional aspects, such as data harmonization, sensor selection and deployment, technical incompatibility of systems or standards [3], or differences between data access and delivery infrastructure [4]. Earth observation has a history of restriction by matters of national prestige, security and sovereignty. Many countries lack consistent political and fiscal support to engage in cooperative projects, or incompatible data access-, sharing- or pricing policies. Additionally, different languages and cultures can add to the difficulty of cooperation [3,5].

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The second form of voluntary contribution to GEOSS is the allocation of time, labor and effort. Both forms of contribution are crucial and not mutually exclusive, even though the latter represents a stronger commitment.

In economic and game theoretical literature the voluntary provision of a good meant to benefit contributors and non-contributors alike is often referred to as a ‘social dilemma’ [6]. Social dilemmas characterize situations where it is in the collective interest that everyone contributes, but individual interest suggests free-riding on the contributions of others. Individual interest is assumed to dominate, leading to an under-supply of the respective good and to a situation where everyone is worse off. Social dilemmas are often described by the voluntary provision of a public good or Hardin’s Tragedy of the Commons [6,7]. Theoretical and experimental approaches in economics and game theory have investigated social dilemmas and provided suggestions how to overcome them (see Section 5).

Our analysis aims to provide an understanding of the benefits and challenges of voluntary contribution to GEOSS from a theoretical as well as an empirical perspective. We discuss the extent to which the concept of social dilemma applies to the provision of GEOSS. We then provide the results of an exploratory survey among individuals involved in/contributing to GEOSS and/or GEO about their perceptions of the benefits and challenges of voluntary contribution. This is followed by discussion of these results based on findings from theoretical and experimental approaches, postulating how to overcome social dilemmas in the implementation of GEOSS. Concluding, we aim to provide insights about future strategies to sustain or increase contribution to GEOSS.

## 2. The construct of GEOSS

GEOSS is a ‘system of systems’ that builds on existing and future observing and processing systems, which continue to operate within their own mandates. GEOSS aims to support common standards and practices to ensure that the shared observations and products are accessible, comparable and understandable, and to address users’ needs [2,8,9]. The 10-year Implementation Plan is non-binding, but addresses important steps to achieve international collaboration and outlines the vision, purpose and expected benefits of GEOSS within nine Societal Benefits Areas (SBAs): weather, climate, energy, water, biodiversity, ecosystems, health, agriculture and disasters.

As of September 2011 GEO’s members include 87 countries and the European Commission and 64 intergovernmental, international, and regional participating organizations [10]. GEO consists of a Plenary, its primary decision-making body, and Committees and Working Groups to further GEOSS’ implementation. Currently there are four Committees, related to the cross-cutting areas user interface, architecture and data, science and technology, and capacity building, as well as the Monitoring and Evaluation Working Group [11,12]. GEO activities are supported by in-kind contributions from member states or voluntary contributions to a Trust Fund [11,13]. Based on the levels of the past four years, annual cash contributions of CHF 3.3 million are typical [14].

The Work Plan is central to GEOSS’s implementation [11]. It establishes the GEOSS Tasks, which pursue a mix of activities (producing, applying and analyzing data, or addressing barriers to using the data) supporting strategic targets for GEOSS implementation. Within Work Plan 2009–2011, the Tasks are divided into: 1) 20 Transverse Tasks aimed at “Building an integrated GEOSS” in the areas architecture, data and management, user interface, capacity building, and science and technology; and 2) 24

Tasks related to the nine SBAs [15]. The GEO 2012–2015 Work Plan follows this general approach [10].

Data sharing is a declared aim of GEOSS [2], and is based on three main principles: “(i) Full and open exchange of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation. (ii) All shared data, metadata and products will be available within minimum time delay and at minimum cost. (iii) All shared data, metadata and products being free of charge or no more cost than cost of reproduction will be encouraged for research and education” [4]. To implement the data sharing principles, a White Paper was drafted as well as Implementation Guidelines for the GEOSS Data Sharing Principles and the GEOSS Data Sharing Action Plan.<sup>1</sup> In addition, an architectural framework to search and access data, products and a metadata catalog, the GEOSS Common Infrastructure (GCI), was developed [10].<sup>2</sup>

## 3. GEOSS, a social dilemma?

A social dilemma characterizes a situation where individual rationality leads to collective irrationality and individually reasonable behavior leads to situation in which everyone is worse off. Social dilemmas are often described by the provision of a public good or the Tragedy of the Commons [6]. The provision of a public good exhibits positive externalities, i.e. the behavior of one agent has an unintended impact on other agents’ utility [16], providing incentives to free-ride. A brief classification of goods should help identify GEOSS as a social dilemma.

Two relevant characteristics of goods are: rivalry – an agent’s consumption happens at the expense of another agent’s consumption – and excludability – an agent’s consumption excludes other agents’ consumption. Pure private goods are characterized as rivalrous and exclusive [16], and are produced and optimally distributed by the free market [17]. Pure public goods exhibit neither rivalry nor excludability [16]. Samuelson describes them as goods “which all enjoy in common in the sense that each individual’s consumption of such a good leads to no subtraction from any other individual’s consumption of that good” [18], p 387]. Pure public and private goods are polar cases and several intermediate cases exist. The most frequently used intermediate cases are open-access resources and congestible resources. Open-access resources exhibit rivalry but not excludability [16]. An example is Hardin’s Tragedy of the Commons [7], or ocean fishery. In the latter case, no fishing boat can be excluded from catching the fish; but fishing is rivalrous, as one boat’s catch decreases the potential catch of the other fishing boats. Congestible resources or club goods [19] are excludable but, up to a point where congestion sets in, non-rivalrous. An example is a National park, where individuals are

<sup>1</sup> The White paper provides an overview of international data sharing laws, principles, and policies. It recommends implementation guidelines, and was established by the GEOSS Task DA-06-01 under the leadership of the Committee on Data for Science and Technology (CODATA) of the International Council for Science. The Task team drafted a set of implementation guidelines, which were later refined by the GEOSS Data Sharing Task Force. The GEO-VI Plenary in 2009 accepted the Implementation Guidelines for the GEOSS Data Sharing Principles, and in 2010 a “GEOSS Data Sharing Action Plan” was accepted. It is incorporated into the “Beijing Declaration”, which calls for the creation of GEOSS Data Collection of Open Resources for Everyone (GEOSS Data-CORE), a pool of documented datasets [10].

<sup>2</sup> The components of the GCI include registries for components, services, interoperability arrangements, best practices, and user requirements, a Clearinghouse (common search facility), and GEO Web Portal solutions. These components have to be coordinated and maintained to provide GEOSS functionality. The components are defined and coordinated by the Architecture Tasks AR-09-01 “GEOSS Common Infrastructure (GCI)” and the Sub Task AR-09-01a “Enabling Deployment of a GEOSS Architecture” [10].

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