THE GEOSS USER REQUIREMENT REGISTRY: LINKING USERS OF GEOSS ACROSS DISCIPLINES AND SOCIETAL AREAS

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1. INTRODUCTION

The Global Earth Observation System of Systems (GEOSS) implemented by the Group on Earth Observations (GEO) is user-driven and responds to the needs of users in nine interdependent Societal Benefit Areas (SBAs) of Earth observations (EOs). GEOSS requires an interdisciplinary scientific approach integrating observations, research, and knowledge in these SBAs in order to enable the scientific interpretation of the collected observations and the extraction of actionable information. Using EOs to actually produce these societal benefits means getting the data to users, i.e., decision-makers, thus needing to know what they need and how they would use it. A key infrastructure element linking users and GEOSS is the User Requirements Registry (URR), which is developed as a facility that enables a wide range of users to express their needs in terms of EOs and to understand the benefits of GEOSS for their fields. Of particular interest are users in science and technology communities, which need to be involved in both the development and the use of GEOSS. The URR is designed to capture not only the needs of these communities in terms of data and products, but also the research, infrastructure, technology, and capacity building needs that would enable new applications.

The importance of GEOSS being developed as a user-driven system of systems is emphasized in the 10-Year Implementation Plan for GEOSS [1]. In 2006, the GEO User Interface Committee (UIC) started the development of the URR with a discussion of the design, data model, and functionality of this component of the GEOSS Common Infrastructure (GCI). A prototype became available in 2010 [2]. In 2011, further progress was made in the development of the data model and the implementation of the URR [3]. The Concept of Operation (CoO) for the URR as part of the GCI was developed in 2011 [4] and finalization of the operational URR is expected at the end of 2012. By then, the URR will have menus for searching, viewing and exporting entries in the URR (View); publishing data (Publish); and analyzing networks and gaps (Analyze). A graphical interface will allow users to explore graphically the interdependencies between entries. Users will be able to customize the URR, including the specification of a sub-domain of the URR as the work basis.

Experience with the population of URR was gained in 2010 and 2011. The UIC carried out a review of user requirements in the nine SBAs, and this activity produced SBA-specific summary reports of observational requirements. In 2010, the reports in the Health and Disasters SBAs (available at http://sbageotask.larc.nasa.gov/) were used by experts to translate the requirements into the URR data model. In 2011, the use cases of risk-based management and Integrated Coastal Zone Management (ICZM) provided two examples of cross-cutting areas. In response to demands from users of the URR, on-line tutorials were developed explaining comprehensively the concepts of the URR and guiding users through publishing, viewing, and analyzing the URR contents.

2. THE URR: A COMPONENT OF THE GEOSS COMMON INFRASTRUCTURE (GCI)

The GCI of GEOSS includes registries enabling users to discover, access, and use EOs and derived products and services available through GEOSS [2, 3]. The registries are the GEOSS Components and Services Registry, the GEOSS Standards and Interoperability Registry, and the Best Practices Wiki. These registries primarily focus on the providers and collect information related to the available services and products, as well as information needed to ensure interoperability between the services contributing to GEOSS.

Complementing these system-related registries, the URR is a user-related registry that allows for the collection, sharing, and analysis of user needs and EO requirements. With this, the URR enables an efficient dialog between users and providers. It is a comprehensive community-based facility to publish, view, and analyze information on societal activities depending on EOs and derived products, on the user types associated with these applications, and on a range of needs and requirements. A novel concept of the URR uses links between any pairs of entries in the URR forms to capture the interdependency between these entries.

3. THE URR DATA MODEL

The core of the data model of the URR consists of seven relations that describe the users, applications, requirements, and various needs related to decision making and support through EOs (Fig. 1). The basic relations of the URR are:

- **Applications:** processes and activities that use Earth observations or derived information to produce new information, arrive at decisions, or execute decisions.
- **User Types:** generic users who are involved in applications, benefit from these, or contribute to them.
- **Requirements:** specifications of observations or derived products.
- **Research Needs:** research tasks to be performed in order to enable applications that are currently not possible due to a lack of knowledge.
- **Technology Needs:** description of preferably observational requirements that cannot be met because the necessary technology to carry out the observations is not available and a description of what this technology would be.
- **Infrastructure Needs:** description of requirements that cannot be met or applications that can not take place because of the lack of infrastructure and a description of the infrastructure necessary to enable the applications.
- **Capacity Building Needs:** description of problems that in parts or globally cannot be solved today because of a lack of capacity in terms of organizational or human resources and a description of the necessary capacity building that would enable applications addressing these problems.

A link relation is used to capture the interconnectivity between entries in each of these relations. The entries in the **Links** table connect a source entry and a target entry in two different relations or in the same relation. This concept is a novel and rather powerful way of capturing interconnectivity. Information on the societal relevance and the implementation status of a link enable the analysis of value chains from EOs to end applications.

Two auxiliary registries represent a lexicon of all terms used and the references to documents that provide additional informations on the entries in the main forms. The **Lexicon** collects all terms used in the URR; allows for the definition of acronyms and abbreviations; and specifies units of EOs or other quantities. Entries can be linked to keywords. These keywords are defined in the Lexicon. Requirements can be specified for EO parameters, which first need to be entered in the Lexicon and there specified as EO parameters. In some cases, it is not the parameter itself but rather a derived quantity that is needed (e.g., the concentration). Thus, derived quantities are denoted as attributes and specified in the Lexicon. Similarly, some observations are only needed in a specific medium (e.g., soil moisture in soil); available mediums are also specified in the Lexicon. The **References** table collects all references to documents (publications, reports, web pages, etc.) that are used to link entries to more detailed background information.
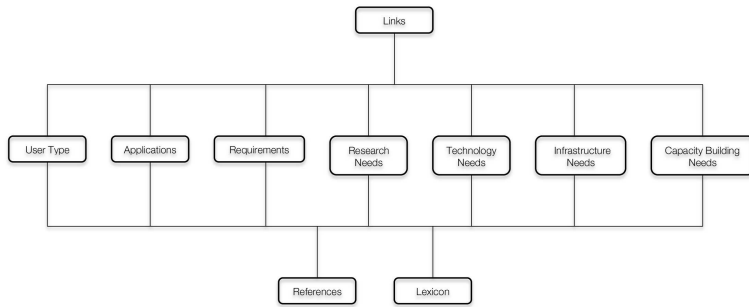
Fig. 1. Data model of the URR. The data model can be separated into three parts: (1) seven forms to capture information on user needs and applications (middle); (2) the Links form to capture connectivity (top); (3) a number of auxiliary forms to capture relevant information used in the other parts (bottom).

4. METHODS FOR POPULATING THE URR

Populating the URR has two separate aspects, one being the analysis of user needs and applications in a societal area, and the other being the collection of information to be published in the URR. There are several ways of approaching the analysis of the various needs and requirements that can be published in the URR. The approaches separate into two main classes, which we denote as global and local approaches (Fig 2). The first one is more top-down and the second one more bottom up.
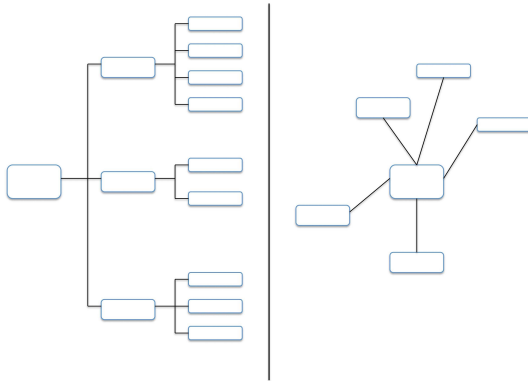

Fig. 2. Two principle approaches to the analysis of needs in a societal area. Left: the global, top-down approach resulting in a comprehensive structure for the area; right: the local, bottom-up approach starting from a local environment. The local approach can be used by any expert in a narrowly defined area of decision making. A global approach requires a broad expert knowledge of a comprehensive field.

In an global approach (left sketch), we take a starting point at a high level and rather general entry. This could be an application, user type, requirement, etc. The tutorials use the examples of ICZM and risk-based planning to illustrate this approach (Fig. 3). A user type providing a good starting point could be 'national government', and an example for a high-level requirement would be 'atmospheric methane contents.' Starting from the selected entry, we can identify all those activities and needs that related to this entry and then progress for each of them to the next level. In this approach, it makes sense to analyze first the dependencies within one group, e.g., for all applications.

In a local approach (right sketch), we can take any possible entry as the starting point and analyze the local environment of this entry. As an example for this approach, the tutorials use the application Early Warning.

While a local approach lends itself to a more ad hoc start and an immediate publishing, a global approach requires considerable analysis prior to the publication of any entries in the URR. The local approach requires some effort to ensure that the local environment is linked appropriately to the existing contents in the URR and does not duplicate already existing entries. In the global approach it is also important to use as many as possible of the existing entries and to link the determined structure with the rest of the URR at all appropriate levels.

Concerning the collection of information, we have identified four different methods: (1) Experts in a societal area analyze the area using the global approach and publish the results; (2) in an open crowd-sourcing approach, people publish the information relevant to their immediate environment using the local approach; (3) information published in other user requirement registries of other relevant registries is harvested and integrated into the URR; and (4) a moderator collects information in interviews with users asking a set of agreed-upon questions. To date, methods (1) and (2) have been primarily employed in populating the

Fig. 3. Examples of graphical representation of the interconnectivity captured in the URR. Left: center of graphics is on the application ICZM; right: center is on the application hazard assessment, which feeds into risk assessment and risk-based planning.

URR. Method (3) will be pursued in 2012 and method (4) is being investigated separately, through the application of the URR infrastructure to a domestic (e.g., United States) environmental issue.

5. DISCUSSION, CONCLUSIONS AND PERSPECTIVE

Already at the currently available stage, the URR is providing a viable tool for the publishing and viewing of user-related information, and the analyzing of the links between Earth observations, applications, and users. The data model of the URR appears to be comprehensive and flexible enough to capture all user-related aspects such that they can be compared to the system-related information in the GCI.

The URR experience concerning publishing shows that the entries in the URR display a wide range of quality, and in many cases, editing is required. The use of experts is not always a guarantee for the published information being consistent with the URR data model and of high quality. The value of the URR depends on the information published in the URR. In order to reach many potential users, the URR needs to offer an ensemble of methods for the collection of information; perhaps beyond the four described above. The URR offers a versatile model for compiling and analyzing data, as well as a tool for problem solving. The inclusion of research, infrastructure, technology and capacity building needs in the data model opens the URR for emerging uses such as the assessment of the societal relevance of a research need. By publishing and viewing problem-specific data in the URR and graphically displaying options, users may have the opportunity to exhibit and differentiate among problem-solving approaches that may not be possible without this dynamic analytical tool.

6. REFERENCES

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