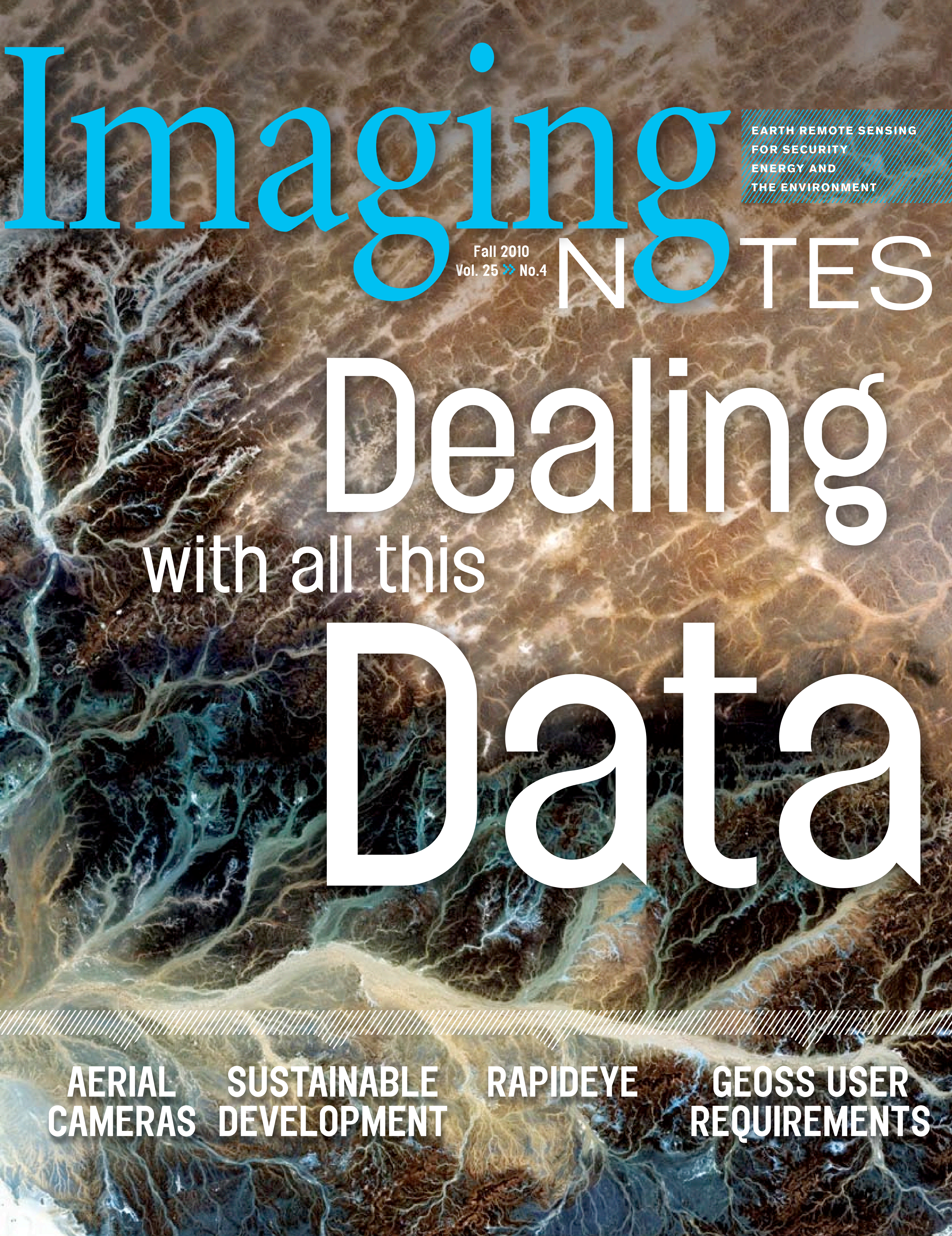


Imaging NOTES

EARTH REMOTE SENSING
FOR SECURITY
ENERGY AND
THE ENVIRONMENT

Fall 2010
Vol. 25 >> No.4

Dealing with all this Data

AERIAL CAMERAS

SUSTAINABLE DEVELOPMENT

RAPIDEYE

GEOSS USER REQUIREMENTS

The GEOSS User Requirement Registry

SUPPORTING A USER-DRIVEN GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS

THE WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT HELD IN 2002 IN Johannesburg, South Africa re-emphasized the need to know the state and the trends of the Earth system in order to support decision making that would lead to a sustainable course of the environment and our societies. At their annual meeting in 2003 in Évian-les-Bains, the Group of Eight (G8) took up the challenge in the G8 Action Plan "Science and Technology for Sustainable Development" and agreed to "Strengthen international cooperation on global observation." Increasing interoperability of existing infrastructure and closing gaps in the observations systems were seen as key steps towards more coordination.

Then in June 2003, representatives of 33 governments participated in the first Earth Observation Summit (EOS) in Washington, D.C. and established the ad hoc Group on Earth Observations (ad hoc GEO) with the mandate to develop a ten-year implementation plan for a Global Earth Observing System of Systems (GEOSS). Guided by the urgency of improving our knowledge about the Earth system and the global change challenging sustainable development, they gave the ad hoc GEO only 18 months to prepare this plan. The second EOS held in 2004 in Tokyo identified nine societal Benefit Areas (SBAs, see ***Box 1*** on page 33) of Earth observations and asked the ad hoc GEO to ensure that the implementation plan would address the needs of these nine SBAs as well as the cross-cutting needs. By the time the third EOS in February 2005 came together in Brussels to endorsed the 10-Year Implementation Plan (10YIP), which had been iterated in six international plenary meetings and numerous meetings of working groups, the ad hoc GEO had grown to more than 50 Member Countries and nearly 50 Participating Organizations.

EDITOR'S NOTE: See related story on page 24 about ways that EO is used for Sustainable Development.

BY HANS-PETER PLAG, PhD
Research Professor
Nevada Bureau of Mines and Geology and Seismological Laboratory
Reno, Nev.
http://geodesy.unr.edu

GARY FOLEY, PhD
Earth Observations Systems Executive
Environmental Protection Agency
Washington, D.C.
www.epa.gov/osa

GREG ONDICH, PhD
Senior Environmental Engineer

JUSTIN KAUFMAN
Web/Database Developer
The Scientific Consulting Group, Inc.
Gaithersburg, Md.
www.scgcorp.com

For the Benefit of Humankind

The 10YIP states that "The vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information." Bridging the gap between science and technology on the one side and end users in many societal areas on the other side is crucial for progress towards this vision. The 10YIP requests that GEOSS is implemented as a user-driven system responding as far as possible to the needs of end users and decision makers. GEO is asked to establish mechanisms to collect user needs, and to use this information as a driver for the development of GEOSS.

A Truly Global Effort

At the 2005 Brussels EOS, the ministers decided to establish the GEO with the mandate to implement GEOSS. Since then, GEO has grown continuously and has today more than 80 Member Countries, and more than 55 Participating Organizations. During the last five years, four Committees, more than 70 Work Plan Task teams, and a number of Communities of Practice have worked intensely to build the infrastructure that would help to realize the full benefits of Earth observations in the nine SBAs. Annual plenary meetings bringing together high-level representatives of the governments of the Member Countries and the Participating Organizations give guidance and direction to the work of these components of GEO.

The "Capetown Declaration" adopted by the Ministerial Summit on Earth

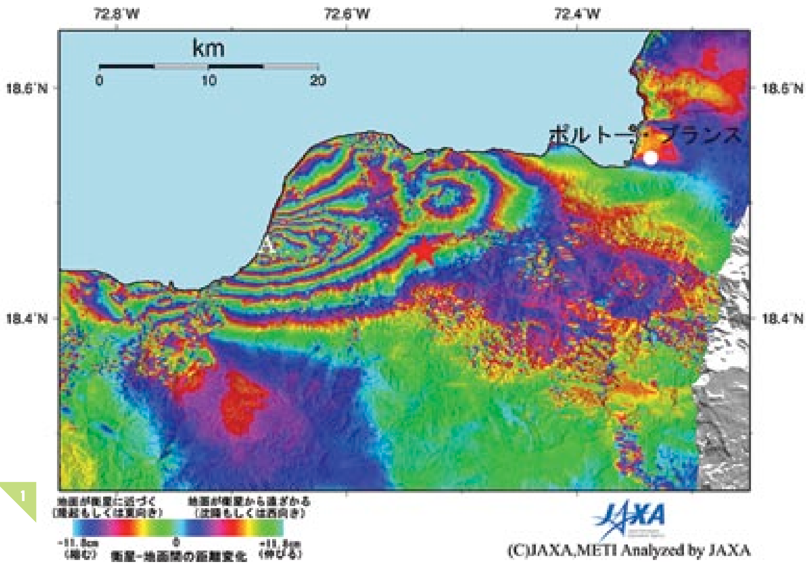
Observations in 2007 in Capetown, South Africa, recognizes the importance of Earth observations for sustainable development and confirms the view of the Member Countries that sustained Earth observations are crucial for sustainable development. Currently, GEO is preparing for the mid-term review of GEOSS by the next EOS, which will take place in November 2010, in Beijing, China.

Meeting the many challenges to sustainable development requires more comprehensive, timely, and accessible Earth observations. The challenges to sustainable development in the nine SBAs are many, and for most of them, coping with the challenges depends heavily on environmental information. For example, land use planning aiming to reduce the degradation or loss of ecosystems and to halt the rapid extinction of species and reduction in biodiversity requires information on the distribution of ecosystems, habitats of species, and changes over time in these, and it depends on detailed information on land use. Likewise, land use planning for sustainable agriculture and reduction of food shortages needs environmental information, including climate and weather conditions. For the planning of adaptation to climate change and the reduction of climate change impacts such as sea level rise, accurate information about current trends and reliable estimates of future trajectories have to be provided to decision makers.

Risk management and disaster reduction for geohazards such as earthquakes, volcano eruptions, landslides, and tsunamis depend on the understanding and monitoring of the hazards, for which, for example, accurate observations of the deformations of the solid earth are mandatory (***Figure 1***). Mounting water scarcity, particularly of potable water, in many parts of the world necessitates improved water management, which depends on information about water quantity, usage, and quality. Extreme weather events such as hurricanes, tornados, floods, and droughts pose a severe and growing threat to society and early warnings are crucial for impact mitigation and loss reduction.

Reducing the impacts of many infectious or chronic diseases, such as malaria, meningitis, cholera, dengue, asthma, and rhinitis depends on understanding the relationship between environmental parameters and the occurrence of these diseases, and monitoring of outbreaks and early warnings are crucial steps for meeting these challenges. Mapping the availability of renewable energy sources such as geothermal, wind, wave, and solar energy is a crucial input for the development of reliable and sustainable supplies of energy. Changes in our environment, such as chemicals, dust, and other contaminants in our water and air, also have negative impacts on humans that can be understood and reduced only if these changes are sufficiently monitored and assessed.

GEO is comprehensively considering all these challenges and with GEOSS aims to provide Earth observation data



▲ ***FIGURE 1.*** *Interferogram showing the surface displacement during the devastating January 12, 2010, earthquake in Haiti. The image is available on the Supersite Web Page of GEO with links to the Haiti web page maintained by JAXA.*

▲ ***FIGURE 2.*** *GEOSS is addressing the information needs in nine SBAs.*

and decision-support tools to a wide variety of users, particularly in the nine SBAs (***Figure 2***). The GEO Portal provides a unique entrance point to a global network of services, data sets and products (***Figure 3***).

The Core of GEOSS

At the core of GEOSS is the GEOSS Common Infrastructure (GCI), which informs users in the nine SBAs about available Earth observations, data sets, models, and products (see ***Figure 4***). The GCI includes four registries that enable users of Earth observations to search, discover, access, and use the data, information, tools, and services available through GEOSS (see ***Figure 5***). Three of these four registries, the GEOSS Components and Services Registry, the GEOSS Standards and Interoperability Registry, and the Best Practices Wiki, collect information related to the available services and products, as well as information needed to ensure interoperability among all the different services contributing to GEOSS.

The Components and Services Registry, which was developed and is maintained by U.S. Geological Survey (USGS), provides essential details about the components and services contributed to GEOSS by governments and organizations. The Standards and Interoperability Registry is a reference database of interoperability arrangements that enables contributors to GEOSS to configure their systems so that they can share information with other systems. The GEOSS Best Practices Wiki was created for the aggregation and community review of best practices in all fields of Earth observation, and it is provided by the IEEE Committee on Earth Observation. These first three registries focus primarily on the contributors to GEOSS.

The fourth registry, the User Requirements Registry (URR) is the newest addition to the GEOSS registries and it is a unique place for users to publish their needs in terms of Earth observations and derived information. The URR also makes available tools for the analysis of value chains and networks from Earth observations to end users and thus informs both the providers and end users about the connections between observations, applications, and societal benefits.

Bridging the gap between science and technology on the one side and end users in many societal areas on the other side is crucial.

User Needs and GEOSS

The 10YIP emphasizes the intention for GEOSS to be user-driven in order to serve the needs of users in a wide range of SBAs. To build GEOSS as a truly user-driven system, the development must be guided by a set of explicitly known user needs in the nine SBAs, as well as by the observation requirements corresponding to these needs. Therefore, a versatile infrastructure that could answer questions about what users need from GEOSS is a key element of the GCI. This versatile infrastructure is the URR, which connects users to GEOSS.

The URR contains information on user types, applications, requirements, and the links among these entities (***Figure 6***). It links to the Components and Services Registry providing information about the available products. A fully populated URR and GEOSS Components and Services Registry will allow the identification of gaps between user requirements and available products and thus provides a basis for the prioritizing of user needs.

A Versatile Component of GEOSS

The URR provides tools for the collection, sharing, and analysis of user needs and Earth observation requirements. At the core of the URR is a comprehensive database describing the User Types in the nine SBAs; the Applications that depend on Earth observations and products or information derived from Earth observations; and the qualitative and quantitative Requirements in terms of Earth observa-

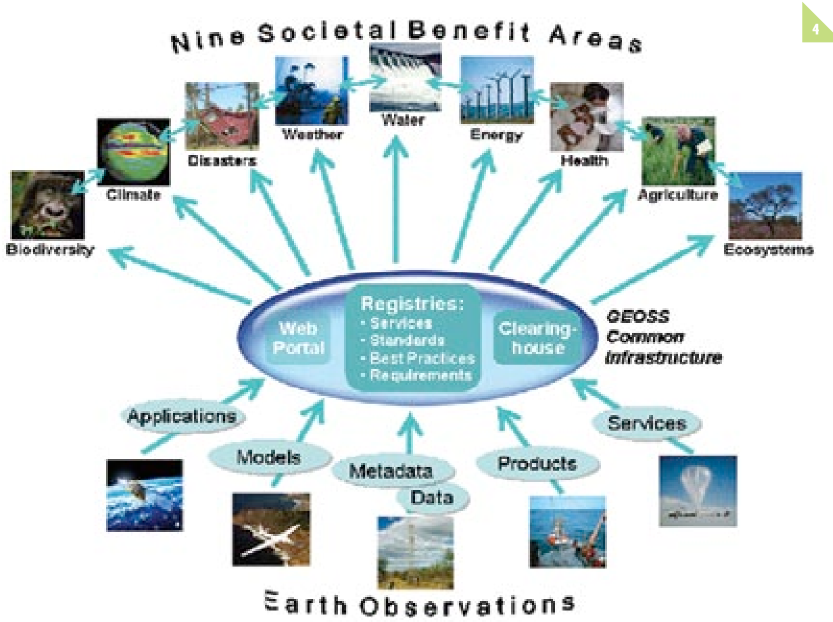
tions and derived information. The database includes an extendable Lexicon with the vocabulary used and Reference to literature with more background information. A new addition also allows the publishing of Research Needs, and the addition of a form for Technology Needs is under consideration.

The novel concept, which distinguishes the URR from many, if not all, other registries of user requirements is the information captured in the Links form. Here, links between any pairs of individual entries for User Types, Applications, Requirements, Research Needs, and Lexicon can be published. Besides the source and target entries, information on the societal benefits associated with the link and the implementation status can be provided. As the URR evolves, the powerful nature of this concept is slowly becoming more obvious as it allows users to answer many questions, such as:

- **"Who is using my data?"**
- **"On what applications do I directly or indirectly depend?"**
- **"What requirements need to be met in order to make these applications work?"**

For a practical illustration of how the URR links user types, applications, and Earth observation requirements, we consider the example of a public health official (i.e., the user type), who may be interested in numerical weather prediction (i.e., the application) to provide wind forecasts every three hours (i.e., the requirement) to help prevent or reduce airborne diseases (***Figure 7***). In this example, the GEO meningitis vaccination and control effort in Africa (the Meningitis Environmental Risk Information Technologies Project) is helping African health officials link forecasts of drought and dry spells (i.e., a link between an application and requirements) in the Sahel zone with disease outbreaks in central Africa.

GEO is facilitating efforts to combine Earth observations with public health data and information systems to improve strategies for the prevention and control of meningitis epidemics in Africa. The GEO data are helping to map the population at risk for meningitis, provide earlier and timelier warning of the occurrence of epidemics, monitor the efficacy of the vaccines, and predict changes in the distribution that may result from environmental or climate changes.



◀ ***FIGURE 3.*** *The GEO Portal giving access to metadata for a global network of services, datasets, and products.*

▲ ***FIGURE 4.*** *Conceptual operational view diagram of the GEOSS Common Infrastructure (GCI) and its relationship to observations and observation-based products and end users in the nine SBAs.*

An Open System Inviting Peer Contributions

The URR is designed to be populated by peer contributions. Users in the GEO community and beyond have to contribute in order to make the URR a utility truly representing the Earth observation needs of society.

Initially, the URR is being populated using information collected in SBA-specific reports prepared by a GEO Work Plan Task (US-09-01a) based on published literature discussing user needs. During the development phase, the URR was populated with the information extracted from reports for the two SBAs of Disasters (specifically landslides, earthquakes, and floods) and Health (specifically air quality and health, aeroallergens, and infectious diseases). After this initial population was completed, the URR was launched for testing by a broader audience.

Feedback from users revealed the necessity of extensive tutorials in support of those who want to publish their needs, applications and requirements. These tutorials are designed to walk users through the various workflows and to explain the underlying concepts. User feedback confirmed considerable interest in a fully populated URR, and indicated a wide range of questions users would like to ask the URR.

Many Benefits of the URR

As mentioned before, the key innovative element of the URR is the ability to link user types to applications, applications to requirements, requirements to products, products to observations, and all of these to system components. By introducing this simple but very flexible data model of "knots" and "links," the construction and analysis of value chains, networks of value chains, dependency networks, and so on, are possible. The URR helps connect the processes, individuals, and dependencies that support decision making through Earth observations.

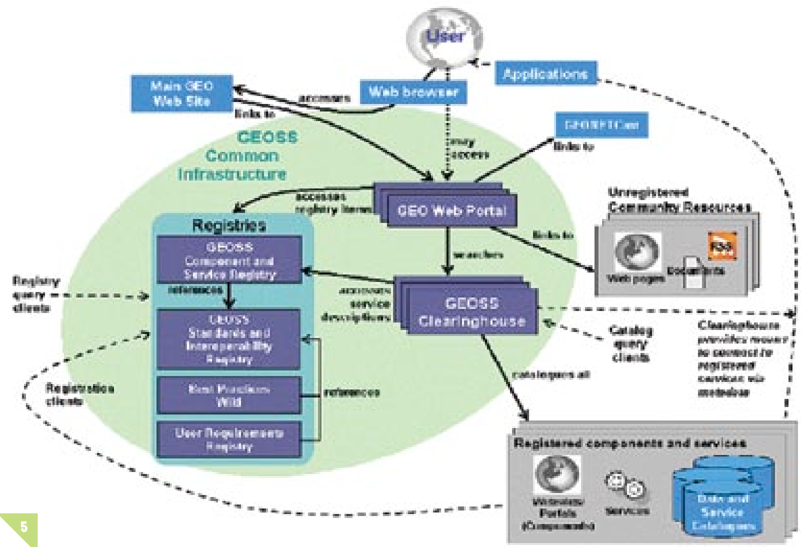
The system performance specifications allow the matching of the user- and system-related components against each other to facilitate a gap analysis. In the next stage of URR development, algorithms for gap analysis will be added to the registry, and the output of these algorithms can provide a basis for informing decisions on GEOSS development priorities.

Linking GEOSS to the Users

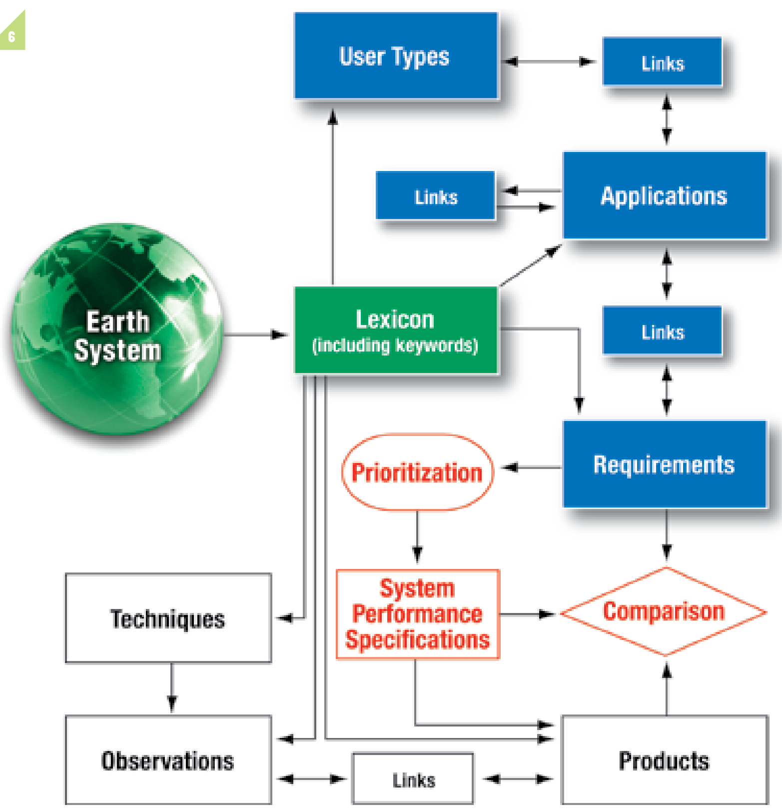
As a user-driven system, GEOSS needs to engage users. The URR is designed to be one of the key entry points for user engagement. GEO is discussing a registration system for users of GEOSS. Most likely, the registration will be global and scalable, so that any user can register in any of the GEOSS components and is then known globally in GEOSS. Combining this registration system with the URR will open many new opportunities for social and expert networking, which will further increase the versatility of the URR.

The best way to test the URR is by entering information. Thus, users can assist in the further development of the URR in two ways: (1) by publishing information in the various URR forms; and (2) by providing comments on the overall URR design and logic flow. A comments field is available on each URR form to provide feedback on individual entries and a questionnaire is available online to provide more overall comments.

The potential of GEOSS is significant for supporting sustainability and resilience, managing increasingly scarce resources, and saving lives and property. For example, GEOSS helps to improve



▲ **FIGURE 5.** *An object-interaction diagram depicting the major relationships between the GCI component services and selected external resources (modified from GEO Secretariat "Portal Process Document," Feb. 2008).*



▲ **FIGURE 6.** *The URR provides forms to publish user-related information (blue boxes) and vocabulary (green). System-related information is in the GEOSS Component and Services registry (schematically indicated with the black boxes). In combination, the GEOSS registries include comparisons of system performance to specifications, identification of gaps, and prioritization of requirements (red boxes).*

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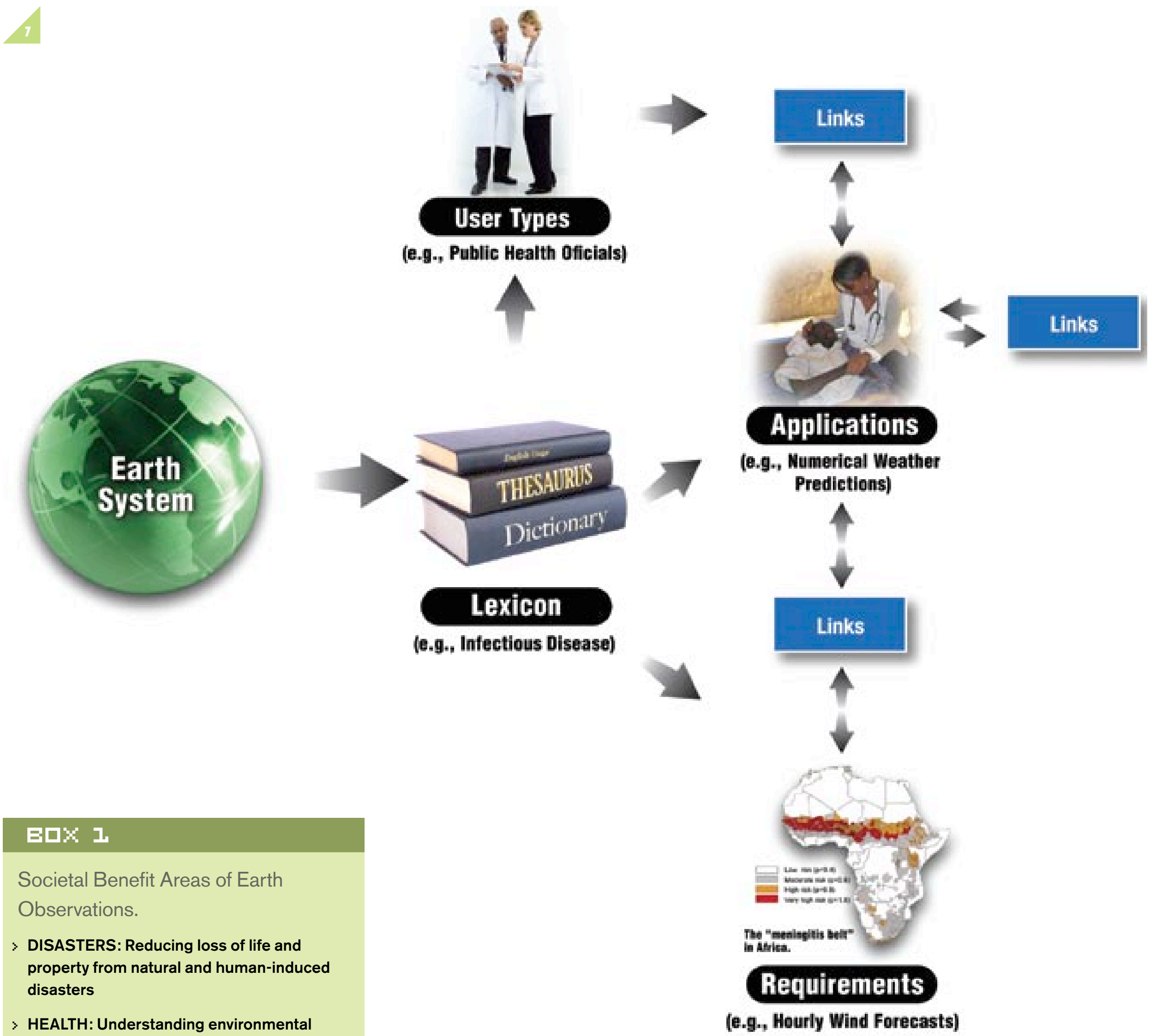

▲ ***FIGURE 7.*** *Links between user types, applications, and requirements for the example of infectious diseases.*

BOX 1

Societal Benefit Areas of Earth Observations.

- **DISASTERS: Reducing loss of life and property from natural and human-induced disasters**
- **HEALTH: Understanding environmental factors affecting human health and well being**
- **ENERGY: Improving management of energy resources**
- **CLIMATE: Understanding, assessing, predicting, mitigating, and adapting to climate variability and change**
- **WATER: Improving water resource management through better understanding of the water cycle**
- **WEATHER: Improving weather information, forecasting, and warning**
- **ECOSYSTEMS: Improving the management and protection of terrestrial, coastal, and marine ecosystems**
- **AGRICULTURE: Supporting sustainable agriculture and combating desertification**
- **BIODIVERSITY: Understanding, monitoring, and conserving biodiversity**

water management and reduce the number of people without access to clean and sufficient drinking water; enables early warning for diseases such as malaria, Rift Valley fever, and meningitis; improves forecasts for aeroallergens; supports the exploitation of renewable energy sources; and informs risk management to reduce disasters due to natural hazards. However, in its effort to build a GEOSS that utilizes the full societal benefits of Earth observations, GEO depends on the input from users in all areas of society including you.

GEO needs your input and involvement not least as a user of Earth observations or derived information who knows best what type of products would enable or support you in whatever you do. Therefore, we reach out to individuals and communities and ask them to visit the URR at www.scgcorp.com/urr and publish relevant information they may have. Eventually, broad participation will turn the URR into a very powerful piece in the dialog between society and GEO. «