

GEO and Science – Identifying research priorities for the near future

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A challenging vision

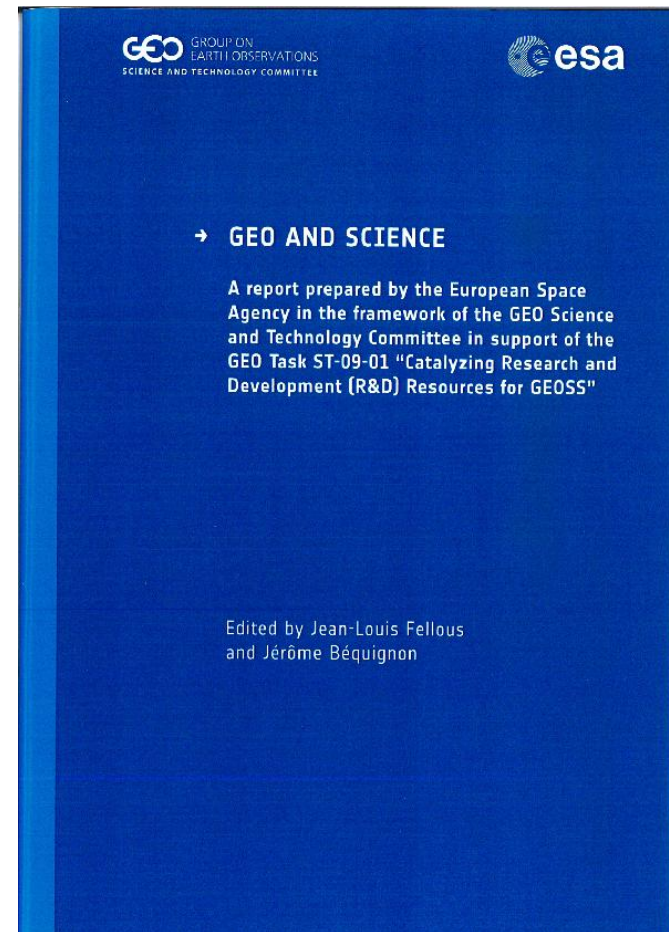
- *“The vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information.”*
 - A number of challenges are still to overcome before this vision, set forth in 2005 by the Group on Earth Observation, is realised.
 - In particular, a number of **scientific research challenges** need special efforts for GEOSS to develop and deliver its benefits to society.

The “GEO and Science” Report

- The “GEO and Science” report has been prepared by a group of renowned experts and scientists, through an initiative of the European Space Agency, as a voluntary contribution to the GEO Task ST-09-01 under the responsibility of the Science and Technology Committee.
- The report was aimed at
 - identifying research priorities and “catalyse R&D resources for GEOSS”
 - drawing the attention of the research community to the specific benefits for science and research that will stem from a fully-fledged GEOSS
- It has been subject to careful review by a broader community of users and scientists.

Download the pdf!

- The report (50 pages) is available at http://www.earthobservations.org/documents/committees/stc/20100923_geo_and_science.pdf



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Report Structure

- The overall structure of the report is essentially aligned, but a few exceptions, with GEO SBAs
- Each Report section includes a short account of the state-of-the art in the area and addresses the scientific research needs that are considered critical for reaching GEO objectives.
 - Gaps in research and potential shortcomings are identified.
 - Similarly critical infrastructure needs (space-based and non-space-based observing systems, computing facilities, etc.) are outlined.
 - Whenever applicable, the integration of the former “IGOS Themes” into GEO is assessed.

Research Priority Example 1: Disasters

- Report main findings are summarized as follows:
 - A first category of research needs is linked with the characterization of hazards, vulnerability and risk, and the identification and assessment of risks from natural hazards on global, regional and local scales.
 - A second category of research needs is related to the modelling of physical phenomena such as fire ignition and propagation, flood, landslide, detailed volcano eruption, rainfall/runoff relationship, etc.
 - A third category of research needs relates to the development, improvement and sustainability of early warning systems, in particular as regards the scientific and technical infrastructures, systems and capabilities for research, observation, detection, forecasting and warning of geophysical, weather-, water- or climate-related hazards.

Research Priority Example 2: Health

- Forthcoming research projects [should] integrate multidisciplinary aspects and follow a three-step approach:
 - Understanding mechanisms at stake: Monitoring and assembling multidisciplinary in situ data sets to extract and identify the physical and biological mechanisms at stake;
 - Pertinent use of remote sensors: Remote-sensing monitoring of environment, linking epidemics with ‘confounding factors’ such as rainfall, vegetation, hydrology and population dynamics;
 - Contribution to early-warning systems (EWS): Use of bio-mathematical models for epidemic dynamics integrating remote sensing inputs, vector aggressiveness and associated risks in order to contribute to EWS.
- *In situ* measurement campaigns of entomological, epidemiological, environmental, climate, microbiological data for GEO should be encouraged and funded. And data funded in support of GEO should be delivered to the GEO community on the GEO Portal.
- Downscaling and upscaling between various tailored remote-sensing products made for end users in such end-to-end projects for health remain a research issue. Projects aiming at merging very high resolution with high and low resolution satellite imagery should be encouraged.

Research Priority Example 3: Ice

- With the transition of the IGOS themes to the GEO/GEOSS framework, it was hoped that many of the IGOS Cryosphere Theme recommendations would be incorporated into the GEO Work Plan. However, the observational needs detailed in the IGOS Cryosphere Theme and SWIPA reports are not being addressed comprehensively by GEOSS.
- A few of the critical needs from the IGOS Cryosphere Theme that do not appear to be part of the Work Plan are:
 - Basin-scale sea ice thickness measurements need to be further developed. Snow depth on ice is a major uncertainty in deriving ice thickness.
 - Aircraft and satellite implementations of advanced ice sheet sounding synthetic aperture radars should be explored. The time series of space-borne gravity observations for monitoring changes in ice sheet mass and the contribution of ice sheet mass loss to sea level rise must be continued.
 - Although snow water equivalent (SWE) is critically important, SWE observations are very sparse and are totally absent in many regions. Priority should be given to research and development of algorithms and new sensors to measure SWE.

Research Priority Example 3: Ice (cont'd)

- The glacier topography database is fragmentary and/or of poor quality. Space-based data are needed to improve it.
 - An international network should be created to monitor seasonally frozen ground in non-permafrost regions. Soil temperature and frost depth measurements should be recommended as standard parameters to all WMO (World Meteorological Organization) and national cold regions meteorological stations.
 - Precipitation gauge networks in the cold regions need to be sustained and enhanced. A bias analysis of historical precipitation gauge data at regional to global scale .needs to be undertaken. The use of wind shields and the direct measurement of winds at emerging auto gauge sites/networks need to be expanded.
 - Surface-based observations were once the most important source of information for lake- and river-ice conditions. The declining state of the surface-based networks since the mid 1980s has led to serious geographical and temporal gaps for several lake and river ice parameters. Existing lake and river ice sites need to be reactivated and new observation sites added.
- GEOSS could also be a mechanism to aid in the development of the WMO's Global Cryosphere Watch.

Expected Scientific Benefits associated with GEOSS

- Each Report section includes a short account of the expected benefits for science and research that would stem from a fully-developed GEOSS in the corresponding area.
- To the extent possible emphasis is placed on the benefits that would evolve from the integrated use of a “system of systems”, including a combination of diverse observing components, as opposed to the direct use of application-tailored, dedicated observing systems.

Expected Benefits Example: Land Biodiversity

- Pattern and change detection
 - Some biodiversity changes are rapid and obvious, but most are slow and not recognised until too late. The acquisition of biodiversity-relevant information (i.e. on both biodiversity and the drivers of change, which largely come from other SBAs) on these “slow variables” is essential to the detection and understanding of a changing planet. Doing so requires a “sustained” and “harmonised” observing system, like GEOSS.
- Ecological dynamics
 - We are in general still a long way from a predictive theory of ecosystem dynamics, and one of the main impediments is reliable, long-term, spatially comprehensive data regarding changes in the structure, function and composition of ecosystems. Only a globally-coordinated, long term observation programme can alleviate this constraint.
- Etc.

Report Summary and Conclusions

- Science has multiple roles to play with respect to GEO:
 - Science is the foundation upon which are based the initial set of applications delivering the societal benefits expected from GEOSS;
 - Science provides the indispensable test bench against which GEOSS observations must be verified and validated;
 - Science also provides the tools necessary to assess and control the quality of application products based on GEOSS;
 - Science is needed to improve the applications in response to GEOSS user assessment of their value; and,
 - Science has the potential to develop new applications in response to GEOSS users' evolving needs and requirements.
- Conversely observations gathered through GEOSS will nurture Earth science, contribute to elucidating processes at work, resolve environmental issues, and more generally help advance our overall understanding of the Earth system.

Report Outcome and Uses

- The “GEO and Science” Report has been presented as an STC achievement at the GEO-VI Pleanry and Ministerial Summit in Beijing, November 2010.
- It has been offered for consideration by the national agencies involved in funding research for GEO and GEOSS, particularly through the International Group of Funding Agencies for global environmental change research (IGFA).
- It should also be distributed to research communities, with a view to encourage their increased involvement into GEO.
 - There is still a lot to be done to convince the scientific community at large to invest into GEO and devote more directed efforts towards its accomplishment in the desired timeframe.