GEO Capacity Building Strategy

As Accepted at GEO-III

1 Introduction

The intergovernmental Group on Earth Observations (GEO) foresees a world where a spectrum of global citizens – scientists, decision makers, individuals – have the ability to access and use Earth observations to make decisions for the benefit of humankind. The GEO-sponsored effort to build a Global Earth Observation System of Systems (GEOSS) over the next ten years calls for the development of a Capacity Building Strategy[1] based on existing efforts and best practices. This five-year strategy should advance the implementation of GEOSS capacity building targets as established in the 10-year implementation plan. It should serve as a roadmap for the GEO community of nations and participating organizations to guide, enhance and coordinate existing and future Earth observation capacity building activities in support of GEO's goals. This strategy should also inform non-GEO M ember nations and Participating Organizations about GEO's capacity building approach and activities, and encourage their participation.

2 Background for GEO Capacity Building

2.1 Definitions

GEO's use of the term "capacity building"[2] is based on the definition established at the 1992 United Nations Conference on Environment and Development (UNCED) which encompasses human, scientific, technological, organizational and institutional resources and capabilities. UNCED recognized that a fundamental goal of capacity building is to enhance the abilities of stakeholders to evaluate and address crucial questions related to policy choices and different options for development. The GEO definition of capacity building embraces UNCED's aspirations and focuses

[1] 10-year target in reference document.

[2] Some institutions in the GEO community have chosen to use the term "capacity development" rather than capacity building in their initiatives given the importance of recognizing existing knowledge when engaging in sustainable development activities. GEO acknowledges the differences in terms, but has chosen to continue the use of the term "capacity building" which is consistent with the terminology used in the Declaration of the First Earth Observation Summit and in the GEOSS 10-Year Implementation Plan.

on three elements of clearest relevance to Earth observations: human, institutional and infrastructure capacity.

- **Human capacity building** refers to the education and training of individuals to be aware of, access, use and develop Earth observation data and products.
- **Institutional capacity building** is focused on developing and fostering an environment for the use of Earth observations to enhance decision making. This includes building policies, programs and organizational structures in governments and organizations aimed at enhancing the understanding of the value of Earth observation data and products.
- **Infrastructure capacity building** is related to the hardware, software and other technology required to access, use and develop Earth observation data and products for decision making.

2.2 Current Status of Earth Observation Capacity Building Initiatives

The GEOSS 10-Year Implementation Plan noted that the current availability of Earth observation data and products, especially in developing countries, is not sufficient to support environmental decision making. Gaps in satellite, aerial and *in situ* observations[3] are being addressed through existing capacity building efforts being pursued by member and non-member GEO institutions.

Using a preliminary survey and analyses of existing documentation related to Earth observation capacity building needs, GEO's findings[4] indicate there are many opportunities to build Earth observation capacity, especially in developing countries. For example, initial research revealed the following issues:

- Limited access to capacity building resources;
- Lack of e-science infrastructure for Earth observation education and training;
- Need for criteria and standards for Earth observation capacity building;
- Gaps between Earth observation research and operational application;
- Connectivity inefficiency between providers and users of Earth observation systems;
- Need for cooperation within and between developed and developing countries and regions;
- Lack of awareness about the value of Earth observations among decision makers; and
- Duplication of Earth observation capacity building efforts.

[3] When referring to Earth observations, the GEO Capacity Building Strategy encompasses space-based, airborne and *in situ* observations, consistent with the definitions agreed to in the GEOSS 10-Year Implementation Plan.

[4] For a detailed explanation, see Annex 1

3 The GEO Approach to Capacity Building

Rather than creating new Earth observation capacity building efforts, GEO seeks to coordinate and build upon existing efforts worldwide to increase the efficient use of limited resources. Such coordination can bring additional institutions into the GEO community and can help fill gaps in current Earth observation capacity.

3.1 Vision for GEO Capacity Building

GEO envisions a future where Earth observation capacity building efforts are coordinated, and the access to and availability of capacity building programs to users in all of GEO's societal benefit areas are enhanced. This coordination should increase access to Earth observation data and products and seeks to encourage decision makers worldwide to use these tools to guide their decisions in sustainable development planning and policymaking.

3.2 Guiding Principles for GEO Capacity Building

The guiding principles listed below are rooted in the capacity building elements of documents and fora developed by GEO as well as GEO Members and Participating Organizations that have existing Earth observation capacity building initiatives.[5] These guiding principles confirm GEO's commitment to sustainable actions in responding to user needs.[6]

- Build on existing efforts and best practices;
- Focus on user needs;
- Foster collaboration and partnership, especially with and between developing countries, at the local, national, regional and global level, and within and between GEO societal benefit and transverse areas;
- Concentrate on end-to-end Earth observation needs in each of GEO's societal benefit areas, including user requirements; data access, collection, archiving and analysis; and product development and exchange;
- Enhance the sustainability of existing and future Earth observation capacity building efforts by building awareness amongst decision makers in developing countries; and
- Facilitate the development of comprehensive, sustainable capacity building efforts that address infrastructure capacity needs, education and training, and building local institutional capacity.

3.3 Objectives for GEO Capacity Building

The objectives of GEO's capacity building efforts during the next five years are framed to reflect the nature and character of GEO as a "best efforts" endeavour. GEO Member Governments and Participating Organisations are responsible for implementing and resourcing the activities presented

[5] Capacity building documentation consulted includes those developed by IOC, UNEP, CEOS, UNDP, and APN.

[6] Key GEO document components for this chapter include section 5.6 of the GEOSS 10-Year Implementation Plan and sections 7.3 and 7.4 of the Implementation Plan Reference Document. The GEO Capacity Building Workshop, held 29-31 May 2006 in Brazil, also impacted the content of these principles.

within GEO's work plans. The objectives of this strategy draw on this context and seek to guide the implementation of priority actions and should serve as milestones in pursuing the vision of this strategy.

The objectives of the strategy are:

3.3.1 Identify, coordinate and build synergies between existing and future efforts.

3.3.2 Encourage and enable developing countries to identify and address their capacity building needs to access, use and produce Earth observation data and products on a sustainable basis.

3.3.3 Enhance access to data and information, especially on a real-time and near real-time basis and encourage information and infrastructure sharing.

3.3.4 Prioritize the inclusion of capacity building as a component of all GEO societal benefit and transverse areas.

3.3.5 Facilitate coordination among GEO Members and Participating Organizations as they seek further resources for identified capacity building priorities.

To achieve enhanced coordination, GEO's capacity building mission should identify the diverse requirements for building capacity within each of GEO's nine societal benefit areas. This identification process, which began with the assessment detailed in Section 2, is crucial to achieving the vision for GEO capacity building. Some key areas of possible implementation developed through this initial requirements identification are presented in Section 4. It is by building on lessons learned and established good practices, together with coordination within and across societal benefit areas, that GEO can achieve its vision for capacity building.

4 Priority Actions

The priority actions identified below seek to build on and enhance existing activities within the GEOSS implementation process. The successful implementation of these priority actions requires sustained efforts and investment by GEO partners over the next five years. Specific tasks for future GEO work plans will be developed from the priority actions discussed below.

A diagram mapping of objectives to priority actions follows in section 4.7

4.1 Enabling capacity building through the GEO Web Portal

Developing a capacity building component for the GEO Web Portal[7] should be an important tool for focusing the capacity building efforts of the GEO community to areas where capacity is needed most in each societal benefit area. It provides a mechanism to facilitate human, institutional and infrastructure development by:

- Fostering information exchange and knowledge development;
- Promoting coordination and synergy;
- Providing access to resources for capacity building;

[7] The GEO Web Portal is an internet based mechanism to allow access to GEOSS components and services

- Promoting networking; and
- Conducting outreach.

To avoid duplication, such a portal must be built on existing Earth observation capacity building portals and online resources, and focus on users, recognizing their priorities for information.

In order to play this role, the portal's functionality should include access to registries of experts and practitioners, good practice examples and identified capacity building user needs across all societal benefit areas. The portal should enable access to downloadable capacity building data (including near real-time datasets), products and tools. Open courseware and e-learning material, open source Earth observation software as well as capacity building outreach material should be made available through the portal. The portal should provide links to other sources of capacity building information and provide a mechanism for dissemination of information to foster donor engagement. Specifically, it should encourage donors towards well established institutional development needs and priorities in the Earth observation community.

Capacity building registries available on the GEO Web Portal should be updated through biennial surveys which gather evolving information on capacity building activities from the Earth observation community. Identification and analysis of gaps to populate appropriate registries should be enabled through the involvement of international user groups.

In concert with the GEO outreach plan, outreach elements for capacity building that address needs at global and regional levels should be developed. These should include, but should not be limited to, raising awareness about best practices. Specific outreach material reflecting best practices in each societal benefit area should be developed. In partnership with existing networks and their publications, a periodic GEO e-newsletter related to capacity building coordination should be developed to raise awareness and highlight successes. In addition, the level of use of the various elements of the portal should be assessed on an ongoing basis to determine what information on the site is in greatest demand by the user community to ensure that future development is targeted in areas of greatest need and use.

Through the consolidation of these functions, the GEO portal should serve as a mechanism for matching capacity building needs with the expertise to meet and address these needs, and then linking them to the resources required for implementation.

4.2 Enabling sustainable infrastructure capacity building efforts, particularly through GEONETCast.

GEONETCast is a near real-time data and product dissemination system under development within GEOSS by which environmental observations, products and services are transmitted to users through communication satellites.[8] It is intended to serve all GEO societal benefit areas and link data providers and users through reception technology that is less expensive than many traditional ground stations. GEONETCast has significant potential to enhance access to a wide range of Earth observation data in all societal benefit areas to users who may not have previously had access to such resources, especially developing country users with limited access to high speed Internet.

[8] While GEONETCast is the focus of this section as it is a major component of GEOSS implementation, the concepts may also be relevant to other Earth observation systems that may require technology transfer efforts for the system to provide benefits, particularly in developing countries.

For this and other infrastructure capacity building efforts to be sustainable over time, it must be built on the lessons learned from past technology transfer efforts.[9] Therefore, the GEO Capacity Building Strategy has identified the following critical elements that should be considered in the implementation of infrastructure capacity building efforts:

4.2.1 Sustainable Technology Transfer and Training

For Earth observation infrastructure capacity building efforts to be successful for the largest amount of users, the technology on which the system is based must be accessible by cost effective and user-friendly terminal stations. To ensure sustainability, ongoing comprehensive training must be provided to users, particularly related to using and developing new Earth observation products. This must be accompanied by educational outreach to decision makers, which reinforces the value of such a system as an environmental decision support tool. Significant initial investments with multiple stakeholders are required to ensure that these resources should be available on an ongoing basis.

4.2.2 Access to Data Sets That Fulfill Specific User Requirements

The data and products available through GEONETCast and other similar systems should reflect the needs of users, particularly the needs for near-real time data that have been identified by many user groups across GEO's societal benefit areas. GEO's capacity building and user interface efforts must be coordinated to identify developing country data needs, especially for satellite data sets which are often subject to access restrictions due to diverse data policies within the GEO community, and build on existing pilot efforts to enable access to such data sets at least cost.

4.2.3 Fill in situ data gaps

Training and mobilization in target countries related to infrastructure capacity building efforts should focus on data and product utilization. Building on efforts to recruit additional developing country data users, next steps should enable and train those users to become data providers, therefore helping to fill gaps in *in situ* data records.

4.3 Strengthening Earth observation capacity building networks

GEO should help coordinate, strengthen and sustain existing networks within Earth observation communities as well as facilitate the construction of new networks in order to enhance capacity building. Networking is a cost-effective means of coordination for existing capacity building efforts, particularly related to:

- Facilitating the exchange of ideas and best practices;
- Promoting in-person and virtual collaborative opportunities;
- Encouraging personnel exchange for training purposes;
- Maintaining rosters of experts in particular areas of Earth observation;
- Facilitating the sharing of human and technical resources;

[9] An example that has recently been documented in literature was the transfer of satellite ground systems to Central America following Hurricane Mitch in 1998.

- Enabling standardisation of methods; and
- Promoting the sharing of data, information, reports and articles.

Where needed, networks of networks should be established to cross-fertilise disciplines, and promote integration where appropriate.

The development of a "Virtual University," a network of education and training institutes, should be explored to coordinate existing efforts and stimulate the creation of new ones to provide a global base of technical expertise for GEOSS. The Virtual University would coordinate programs within existing training centres and enable the development of education and training standards, recognised and agreed by all GEO Members. As part of this effort, GEO should encourage the development of open content course material (open courseware) and e-learning based on on these standards. A crucial component of the development of such open courseware should be the provision of education and training material in multiple languages

4.4 Promoting the development and use of open source software.

Open source software is an important tool that lowers barriers to entry in developing value-added Earth observation software applications that respond to local, national and regional information needs. Building on existing efforts and drawing on networks of open source developers, GEO should encourage the development and use of open source software across the complete life cycle of development, use and archiving of Earth observation data and products. Identifying existing and related open source activities and developing collaborative open source projects to address identified gaps should foster the development of technical skills and leverage local knowledge. Barriers to entry for institutions to contribute to the development of end-user applications can be lowered through the provision of toolkits, libraries and application development environments tailored to specific needs and contexts. Necessary human resource development can be facilitated through the provision of institutional support and education and training.

4.5 Facilitating the development of national and regional capacity

Governments and international institutions are aware, to varying degrees, of the socio-economic benefits of operational Earth observations for sustainable development. Also, they invest, to varying degrees, in research and operations, and with different balances of activities. Where awareness is already high, it is not always matched by investments in sustainable end-to-end Earth observation efforts and the organisational capacity to leverage derived information into routine decision-making processes.

Value can added by building on existing national and regional mechanisms, especially in developing countries, to leverage human, technical and institutional capacity to access, use and share data, information, infrastructure and services. While this area of priority action is not as developed as some others identified, actions such as "twinning" of institutions and the creation of regional institutional networks should be explored.

4.6 Engaging donors on Earth observation capacity building priorities

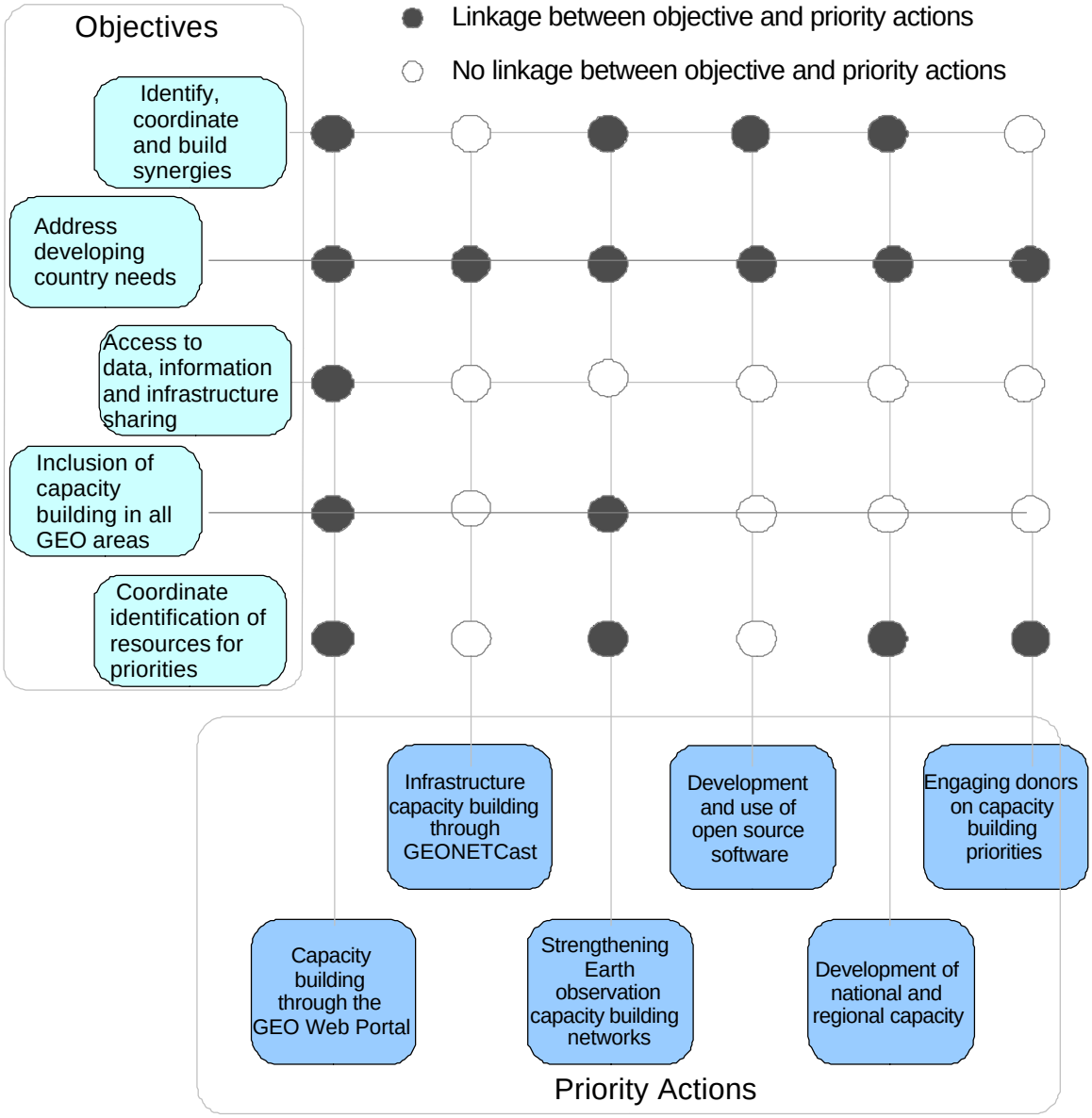
By coordinating existing and planned capacity building efforts and collectively identifying priorities, the GEO community should be better positioned to attract resources to address human, institutional and infrastructural gaps in Earth observation capacity building. Further, a coordinated approach would facilitate engagement with the donor community and thereby position Earth

observation capacity building to align with donor priorities. Donor engagement and coordination should be facilitated by GEO by:

- Matching identified development needs and gaps with donor priorities;
- Connecting end-to-end activities by bridging infrastructure and tool development to education and training and to institutional enhancements;
- Building new capacity building activities that address identified needs and derived socio-economic benefits more comprehensively;
- Developing a network of donors in Earth observation capacity building for exchange of information on current and future funding efforts; and
- Harmonizing and standardizing performance indicators.

The first opportunity to engage donors on Earth observation priorities should be at the GEO Capacity Building Symposium, planned for the first half of 2007. The symposium should be focused on building linkages with existing and potential future donors with its outcomes intended to guide the implementation of this action through 2011.

4.7 Diagram mapping of objectives to priority actions



5 Developing performance indicators to measure progress

Indicators to measure progress in capacity building for Earth observations should be defined by integrating elements of new and existing international and global capacity development indicator concepts and frameworks[10], tailored to the purpose of GEO. A comprehensive capacity assessment scheme, including a three-tier structure of capacity appraisal in line with the GEO definition of capacity building (human, institution and infrastructure) should be developed.

[10] UNDP/GEF, 2003; OECD, 2004

Some examples of capacity development indicators for GEO, which should be further elaborated during implementation, include:

- Number of user interactions with the capacity building portal and its specific links to products and tools for capacity building;
- Number of downloads of open source software to both end-users and resource developers in;
- Number of e-learning courses made available with reported outcomes by providers and users;
- New products made available as a result of ongoing or completed GEO tasks;
- Membership in networks dedicated to specific components of GEO Capacity building;
- Effectiveness of the use of GEONETCast as a tool for Earth observation data and product dissemination (For example, number of users in developing countries, number of reception systems in operation, and number of agencies in each country using data/products.); and
- Funding leveraged for GEO capacity building activities.

6 Conclusion

Just as GEOSS is being developed to add value to Earth observation systems and activities through coordination, the GEO Capacity Building Strategy seeks to add value to existing and future Earth observation capacity building activities in the same way. Capacity building is central to the successful implementation of GEOSS for all global stakeholders. While this strategy is intended to guide the next five years of GEO implementation, it also seeks to embrace the changing GEO landscape during that time. In particular, it recognises the need for a concerted engagement with industry on their role in GEO capacity building, guided by a broader GEO engagement with industry. By investing in the implementation of this strategy, the GEO community should see enhanced coordination of capacity building efforts, which should lead to a more efficient and sustainable system of systems.

Annex 1
Current Status of Earth Observation Capacity Building Initiatives

This Annex reviews the existing situation and the needs for further analysis of capacity building activities in Earth observations (EO), in support of the GEO vision, principles and strategic objectives.

Using a preliminary survey instrument and analysing existing documentation of Earth observation educational infrastructures[11], GEO has generated initial information on the current state of Earth observation capacity building efforts. The initial research indicated there are many current obstacles to Earth observation capacity building. In analyzing the initial survey results, particular attention was given to the relationships and differences between developed and developing countries.

Initial findings included the following issues:

Limited access to capacity building resources

A major hindrance to the use of Earth observations is the lack of capacity building resources and knowledge transfer for EO applications. While the area of greatest concern is a lack of trained scientists and educators, there is also a need for further educational resources and technology, including in-situ data collection systems and infrastructures. The initial survey indicated several hundreds of EO capacity building initiatives worldwide focused on human resources, ranging from short workshops to continuous internationally recognised higher education programmes. Total numbers of trainees on a global scale however are still limited, when considering the substantial need for trained EO scientists and practitioners to be able to translate satellite oriented data and products into relevant end-user geo-information. Lack of funding is the most cited cause for the lack of resources to expand human resources through capacity building.

Lack of E-science infrastructure for EO education and training

Earth observation infrastructure means to put in place systems to deliver reliable, cost-effective and sustainable satellite, ground based observations and *in situ* infrastructures that make best use of existing tools, help to define and take advantage of emerging technologies and meet the observational needs.

Although a limited number of initiatives in distance and Internet-based learning were detected by the survey, a gap was identified in EO capacity building related to e-learning, particularly when

[11] GEO Tasks CB-06-01 and CB-06-02

compared to other sciences and education programmes. More benefits could be derived from the current global communications infrastructure, leading to an e-science network in EO capacity building. However, an operational e-science capacity building network will depend largely on proper functioning of a Spatial Data Infrastructure (SDI). The analysis indicated that in many developing countries still exists a lack in institutional capacity to develop an appropriate and operational SDI.

Need for criteria and standards for EO capacity building

For capacity building initiatives to be effective, continuous efforts should be made to improve the quality status of education and training, including the related educational infrastructure and institutional settings. The analysis indicated that in certain cases, obsolete education curricula and facilities exist in institutions of higher education. Also, inappropriate staffing and inadequate material infrastructure characterise the public institutions dealing with EO as compared to the private sector especially in less developed countries. Typical shortcomings such as a lack of up-to-date equipment, limited possibility for combined use of in-situ, satellite and ground-based observational data, poor access to cost effective bandwith , intra-national networks and the limited number of databases enabling free data access and exchange were observed in certain developing countries.

Gap between EO science research and operational application

While many satellite application facilities exist or are under development in both the weather and climate sectors, few examples of real operational use and dissemination of EO data on a routine basis were inventoried in the other societal benefit areas. A gap can be observed between the state of research and the state of operational application, in relation to the use of EO data in the water, health, energy, ecosystem and agricultural sectors. The current status of existing Earth observation infrastructure indicates a need for a more comprehensive gap analysis between research and operational needs in each of the nine societal benefit areas Gap analysis will be a future major action of within GEO capacity building strategy.

Inefficiency of connectivity among providers and users of EO systems

Initial results indicated an important number of global, international EO system deployments (as noted in Annex 1 of the GEO 10-Year Implementation Plan), as well as several globally oriented educational efforts, bilateral and multilateral education initiatives, many geared towards developing countries. A more horizontal type of networking is commonly observed among EO system developers and scientists, education centres and specific EO user groups. However, interaction and operational link building between typical EO data providers (like space agencies, global EO system science groups and educators, scientists) and representatives of end-user communities (essential for defining data requirements and information needs) is barely observed, or only in some unique cases or on a demonstration basis).

Need for cooperation between developed and developing countries and regions.

The initial research indicated that countries have a range of capacities to conduct scientific research and technological development. Amongst the factors that contribute to scientific capacity are the national infrastructure, pool of scientists, laboratories, other research facilities and academic institutions. Besides current technological and capacity development in developing countries, there is a need for close collaboration between countries to strengthen institutions and infrastructures.

The existing but limited current international collaboration happening on EO capacity building is having a positive impact as it is raising awareness to the needs of developing countries.

Lack of awareness

One main issue is the insufficient awareness of decision-makers and public surrounding the value of Earth observations as timely and cost-effective information sources. Beyond the weather, climate and disasters societal benefit areas, decision makers are quite unaware of EO and their potential use for sustainable development, particularly related to health and energy. Not enough promotion, outreach and education activities are seen in these areas. The issue of institutional capacity play a major role for the promotion of these activities. Moreover, “brain drain” is pervasive in many developing countries where the best EO practitioners tend to leave in search of better professional options.