Comments on the Draft Outline for the GEO Work Plan 2007-2009 provide by the Executive Committee of the Global Geodetic Observing System

The International Association of Geodesy (IAG) has asked the Global Geodetic Observing System (GGOS) to coordinate the representation of IAG in and the input of IAG to GEO. The Steering Committee of the GGOS has been asked to comment on the draft *Outline for the GEO Work Plan 2007 - 2009*. The following suggestions are based on the comments from Steering Committee members received by the GGOS Executive Committee.

GGOS supports the current process to establish a three year Work Plan with the goal to identify priorities as well as to reach the two year goals and to initiate the six year goals. The task-based approach is helpful to advance the implementation, but this approach needs to be embedded in a framework of well-defined priorities.

GGOS agrees with the general set of priorities as defined in the outline. In particular, the cross disciplinary objectives are well defined. However, GGOS proposes to add a new cross disciplinary objective, which, alternatively, could be considered as a transverse activity. This objective would be the global geodetic reference frames.

With the global geodetic reference frames, the *International Terrestrial Reference Frame* (ITRF) and the *International Celestial Reference Frame* (ICRF), GGOS provides the metrological basis for all Earth observations independent of the targeted benefit areas. These reference frames depend on considerable global infrastructure comprising not only the global *in situ* networks of several space-geodetic techniques (GNSS, VLBI, SLR, DORIS) with up to 400 stations, and gravimetric techniques, but also the GNSS satellites and, increasingly, dedicated satellite missions. In total, an estimated 500 to 1000 person years/year are provided on a best effort and voluntary commitment basis by national operational and research institutes to maintain the networks, data centers, analysis centers and user interfaces, that are required to determine and maintain the reference frames as well as to make them accessible for a wide range of applications.

Maintaining a terrestrial reference frame at the level that allows, for example, the determination of global sea level changes at the sub-millimeter per year level, pre- co- and post-seismic displacement fields associated with large earthquakes at the sub-centimeter level, timely early warnings for earthquakes, tsunamis, landslides, and volcanic eruptions, as well as the monitoring of mass transport in the Earth system at the few Gigatons level requires an Earth system approach, crossing all Earth sciences. Among others, this has recently been acknowledged by IGOS-P, for which a proposal for an Earth System Dynamics Theme is in preparation.

The IAG and in particular GGOS is aware of the enormous challenge implied in the demand to improve the accuracy from an average level of close to 10^{-9} to an instantaneous level of 10^{-10}, which is required in order to meet emerging user requirements. Therefore, GGOS is

currently preparing a document that reviews the wide range of scientific and societal applications of geodetic observations and products. This document will provide the scientific basis for an implementation of the geodetic observing system that meets the requirements of the society at large and GEO and IGOS-P in particular. Identifying the reference frame as a cross disciplinary objective of GEO would provide the frame to develop and discuss this document in close cooperation with GEO members and participating organisations.

Currently, GGOS is facing an increasing demand from science, the Earth observation community, and the society at large for improved services, observations and products. On the other hand, funding for the global geodetic infrastructure depends on the national decisions and priorities in many countries and this implies considerable fluctuations, sometimes threatening the proper maintenance of the reference frames and Services. Here, too, we expect that a formal acknowledgment by GEO of the importance of the geodetic observations and products, not least the reference frames, would raise the awareness in the member countries and thus reduce the fluctuations in support.

As a minimum solution, we propose an additional bullet in Section 2:

- Ensuring a consistent, high-accuracy, and long-term stable global geodetic reference frame for Earth observation.

However, considering the importance of the geodetic reference frames, we consider it more appropriate to add a Section 1.12 'Global Geodetic Reference Frames' before the present Section 1.12 'Data Management'.

In this Section, we would suggest the following new items to be considered for task developments:

- Advocate the continuous support of the global geodetic infrastructure required for the maintenance and development of the global geodetic reference frames at an appropriate level;
- Together with the Architecture activity, facilitate an assessment of the current status and future requirements for the geodetic reference frames and geodetic observations;
- Together with the Data Management activities, improve the accessibility and applicability of the geodetic reference frames for all GEOSS components;
- Promote the establishment of sufficient geodetic infrastructure in regions currently lacking such infrastructure, particularly in Africa and parts of Asia and Latin America.

We are aware of the fact that the identification of new transverse activities requires careful considerations and should not be done in an ad hoc fashion. Taking into account that the geodetic observations and products are relevant at least for the benefit areas of water, disasters, energy, weather, climate, and agriculture, and that the GGOS is a major component in

the architecture of GEOSS, we consider a dialog between GEO and GGOS with the goal to assess the mutual advantages of such a transverse activity as being very timely.

Concerning individual tasks, we propose to extend the title of Task DI-06-02 to include explicitly the GNSS Networks. Recent studies have shown that real-time processing of GPS observations can provide realistic estimates of the magnitude of large and great earthquakes within 15 minutes after the onset of an earthquake, thus mitigating a major deficiency of estimates based on seismic body and surface waves. The latter saturate at a magnitude around 8, thus significantly underestimating the tsunamigenic potential of a large earthquake in the critical first one to two hours after an earthquake. Consequently, improvements of real-time GNSS networks should be considered together with the seismic networks. In the discussion of the WP 2006, the GNSS networks were introduced in the task description, but are not reflected in the task title.

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