

GEO GLOBAL WATER QUALITY MONITORING ACTIVITIES

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ABSTRACT: In 2005, the Group on Earth Observations (GEO) was formed to ensure future comprehensive and sustained Earth observations. The GEO effort towards building a “system of systems” adds value to existing Earth observation systems by coordinating their efforts, addressing critical gaps, supporting their interoperability, sharing information, reaching a common understanding of user requirements and improving delivery of information to users. Remote sensing technology is an emerging capability that can greatly bolster traditional water quality *in situ* methods. Even though the field is relatively new, especially in addressing optically complex waters, satellite remote sensing offers a promising alternative for scientists and managers to use for assessment of a large number of water bodies in an economical and timely fashion. Future GEO water quality activities will focus on continuity of existing satellites, development of new and improved sensor/platform technology, algorithm development and calibration/validation activities, improvements in data accessibility, education, and capacity building through new demonstration project initiatives, and the formation of a scientific group dedicated to inland and coastal water quality remote sensing. Given the great number of global issues directly or indirectly linked to water resources, or more specifically here, water quality, GEO will continue to list water quality as a priority societal benefit need and continue to pursue advances in earth observation capabilities.

Keywords: Water quality, remote sensing GEO, lakes, algorithms

1. INTRODUCTION

Having and maintaining suitable water quality is critical to sustain life on our planet. Monitoring of water quality using remote sensing, in conjunction with strategic *in situ* sampling can play a crucial role in determining the current status of water quality conditions and helps anticipate, mitigate and even avoid future water catastrophes. Today, many water quality monitoring programs are deficient, a prevalent problem common to many other environmental monitoring programs. The first GEO Inland and Nearshore Coastal Water Quality Remote Sensing Workshop was held in Geneva, Switzerland, on 27-29 March 2007. This seminal gathering of experts from around the world was endorsed by GEO as a part of their activities on water resources and water quality initiated in 2006. The workshop was attended by 55 participants representing a diversity of backgrounds, expertise and regions of the world, with a total of 26 countries

being represented. A major outcome of the workshop was a series of recommendations, addressing a number of far-ranging facets of this emerging remote sensing application. Keeping in mind the goal of GEO is to build a global earth observation system of systems (GEOSS), key recommendations focused on:

- continuity of existing satellites
- development of new and improved sensor/platform technology
- algorithm development
- calibration/validation activities
- improvements in data accessibility
- education and capacity building through new demonstration project initiatives

The ability to construct an inland and coastal water quality GEOSS have not reached the maturity of other hydrologic parameters and current water quality earth observation activities focus on continued research and development of new methodologies. The workshop report is available at the following website:

http://www.earthobservations.org/meetings/200703_27_29_water_quality_workshop_report.pdf. In

order to advance the key recommendations highlighted above, a scientific group dedicated to inland and coastal water quality remote sensing was formed.

2. The GEO INLAND and NEAR-COASTAL WATER QUALITY REMOTE SENSING WORKING GROUP

A terms of reference has been drafted to define the working group and identify areas where inland and near-coastal water quality remote sensing may play a significant role. These include:

- The group should address both coastal and inland waters because of their social and economic importance.
- The application of remote sensing and related *in situ* data will be considered in an end to end context (i.e., addressing needs for sensors, algorithms, processing, validation, utilisation et al.).
- Satellite observing system capabilities will be evaluated relative to inland and near-coastal water quality observation requirements, with gaps in current and proposed sensor/platform capabilities identified. These gaps will be considered in the context of both user needs (product and information requirements) as well as technological push/research and development activities.
- The group must consider issues associated with both satellite and *in situ* data. Regarding the latter, this should take into account the use of *in situ* data in support of remote sensing (e.g.,

cal/val data), fusion of remote sensing and in-situ data for enhanced monitoring (including optimization of in-situ networks and acquisition campaigns), and the combined assimilation into local and regional models (e.g., for climate change impact assessment, propagation vectors for disease/parasites and monitoring of sensitive habitats). Further, issues associated with airborne remote sensing should be considered, in particular for inland water remote sensing.

- Capacity building is identified as important in terms of: 1) capacity building for user groups to better understand the scope for integrating remote sensing derived information, and, 2) for building operational monitoring and assessment capacity in developing countries.
- The integration of water quality remotely sensed data within aquatic ecological models (also known as model-data fusion or assimilation) is necessary and seen as contributing to improved knowledge and understanding as well as hindcasting, nowcasting and forecasting. Issues associated with advancing these capabilities will be addressed.
- Strengthening the interactions between scientists, data & information providers and end users.

2.1 The Objectives of the Working Group

The overarching objective is to provide an effective link between the research and development communities engaged in developing the use of remote sensing based techniques for inland and near-coastal water quality assessment and the different user groups that require such information for research, operational monitoring or commercial service provision. To achieve this it is necessary to work with both user communities and the remote sensing research and development community:

- With respect to the different user communities, the principal objective is to expand the level of awareness, understanding and acceptance of the practical utility resulting from the exploitation of remote sensing techniques for the investigation, monitoring, characterisation and assessment of coastal and inland water status. This shall include consideration of the resulting operational and socio-economic benefits resulting from wider exploitation of remote sensing techniques
- With respect to the different observing communities (space, airborne and in-situ), the objective is to identify and agree upon suitable implementation approaches within key development areas which can result in an improved capability of remote sensing applications to respond to user requirements in the area of inland and near-coastal water monitoring, analysis and management.

With respect to the various inland and near-coastal water user communities (operational, commercial, research etc), the group shall work to promote increased capability to utilise remote sensing techniques in areas where operational data gathering systems are already in place. A key role plays here to foster the development of better quality

processing algorithms following internationally accepted standards.

In developing countries, the group shall work to promote appropriate access to global EO data sets and supporting tools, and develop local know-how and processing/analysis capabilities to effectively utilise remote sensing data streams as a coastal and inland water management support tool. Capacity building in support of collecting cal/val data for regional algorithm development shall be supported.

The group shall also work to develop enhanced exchange and cooperation between all professionals active in coastal and inland water quality remote sensing with the intention of ensuring:

- The possibility of aggregating individual data collection, monitoring and forecasting components into larger scale systems to support wider area integrated water management and assessment.
- Open access to key databases to support cal/val activities and the assembling of dedicated quality controlled time series datasets.
- Benchmarking different approaches for the development and delivery of new water quality information products.
- Stimulate the application of quality assurance standards (e.g. QA4EO) for EO derived products.

The group shall foster partnerships with appropriate complementary developments in both the private (e.g. Google Oceans) public (e.g. EMODNet for EU member states) sectors in relation to the collection, management and access to data.

The group shall foster partnerships with appropriate international initiatives and development programmes. This should include developments in sectors such as aquaculture and fisheries (e.g. FAO), international development (e.g. UNEP and UNDP activities in relation to the Millennium Development Goals, the GEMS initiative and the International Water Decade, the RAMSAR secretariat for wetlands protection, IUCN), regional development initiatives under the auspices of international development banks (e.g. World Bank, African Development Bank) and regional organisations responsible for management of coastal and river systems (e.g. international river commissions).

The group shall represent the reference position with respect to the Integrated Water Management Community on requirements for new satellite and in-situ sensor technologies and developments. It will interact with the International Ocean Colour Coordinating Group (IOCCG) amongst other community working groups.

2.2 CURRENT WORKING GROUP ACTIVITIES

At present, working group activities are “best effort” actions conducted by individuals who donate their time and resources to advance this work. The following is a brief update of these activities

1.) Algorithm Workshop. A GEO Inland and Nearshore Coastal Water Quality Remote Sensing Algorithm Workshop was held in Washington DC, USA, on 19-21, May 2009. This workshop was sponsored by NASA and endorsed by GEO as a part of task WA-08-01g. This workshop intended to develop an action plan to advance algorithm development and implementation in providing synoptic management relevant water quality information of inland and coastal waters using global and/or regional algorithms. The workshop was attended by 41 participants representing a diversity of backgrounds, expertise and regions of the world, with a total of 17 countries being represented.

2.) Demonstration projects. Three GEO Water quality demonstration projects have been proposed. These have focused on water resources in Bangladesh, Brazil and Nicaragua. Recently, the Nicaragua project was tentatively funded by IEEE. The objective of this one-year project is to develop and implement a MERIS-based water quality monitoring system for the Central American Lake Nicaragua and train local staff in the use of these tools.

3.) Capacity Building Over the past three years, the WA-08-01 task has led three capacity building workshops, located Buenos Aires (Argentina), Bangkok (Thailand) and Lima (Peru). At all three of these workshops, water quality/remote sensing presentations were given on the current state of the science. These were given by members of the working group and provided federal and local agency staff with a fundamental understanding of EO science, and current capabilities of water quality remote sensing. The purpose of these activities is to expand awareness and knowledge of these tools.

4) Linkages to the GEO Health societal benefit area (SBA). Water quality has relevance to both the health and water SBA's. Recent discussions with members of the health tasks have focused on proposing a GEO water quality/health joint workshop focusing on current and future capabilities of inland and coastal water quality remote sensing in support of human health (e.g. harmful algal blooms, cholera etc).

5.) Linkages to GEO Agriculture and Ecosystems SBA. In 2009, GEO released a call for proposals for

decision support systems. A proposal lead by POGO and combining activities of SAFARI (Societal Applications in Fisheries and Aquaculture using Remotely-sensed Imagery, AG-06-02) and ChloroGIN (The Chlorophyll Global Integrated Network, EC-06-07) projects was approved by GEO. The proposal, in part written by members of the working group, includes expanding the ChloroGIN network on lakes as well as near coastal remote sensing activities related to the present working group.

6.) Support and participate in internal/external activities. Over the course of the past three years, WA-08-01g co-chairs have participating in a number of GEO associated activities including attending GEO Work Plan Symposium, Science and Technology committee meetings, User Interface committee meetings, GEO summits and the overarching WA-08-01 coordination meetings. Working group members have also contributed to GEO educational materials and publications. Examples of these printed materials include http://www.earthobservations.org/documents/the_full_picture.pdf and http://watercycleforum.com/pdf/igwco_brochure_2010.pdf. In addition, the task leads have participated in proposal development and written letters of support for projects that address the GEO tenets and improve our ability to monitor water quality through EO.

3. FUTURE PLANS

Recommendations for the future include proactively engage space agencies, user constituencies, GEO member nations and participating organizations etc to promote and advance our goals, engage existing formal communities of practice (water, coastal, carbon, et al.), assessing the relevance millennium development goals (MDG's)-specifically inland waters. In addition we are creating a dedicated website that will ensure the outcomes and plans of this working group are publicly available and more visible. In the immediate future, we will be rewriting and restructuring the GEO 2012-2015 work plan with a "deliverable-oriented" task for a new GEO Work Plan. One approach might be titled, "Global Inland and near- Coastal Water Quality Information System."