GROUP ON EARTH OBSERVATIONS

Group on Earth Observation (GEO) Water Quality Summit

World Meteorological Organization
Geneva, Switzerland 20-22, April, 2015

Summit Goal

Define specific requirements of the water quality system components and develop a plan to implement an integrated end-to-end water quality monitoring and forecasting service

Summit Deliverables

- ⇨ Develop a.) Strategic implementation and b.) a *phased* action plan including baseline (goal, ample funding) and threshold (funding constrained) service build-outs, with both a short-term (0-5 year) build-out plan for pilot/prototype regional service(s) and a long-term (6-10 year) plan for a global-scale water quality monitoring and forecasting service.
- ⇨ Formation of a GEO Water Quality (GEO-WaQ) Community of Practice bringing together relevant data providers and users who will work collaboratively to implement, utilize, maintain and enhance the regional (initially) and (ultimately) global water quality monitoring and forecasting service.

GEO Water Quality Summit Organizing Committee

Member	**Affiliation**
Stewart Bernard	CSIR
Vittorio Brando	CSIRO/CNR
Maycira Costa	University of Victoria
Douglas Cripe	GEO
Arnold Dekker	CSIRO
Paul DiGiacomo	NOAA
Mark Dowell	JRC
Steven Greb	Wisconsin DNR
Steve Groom	PML
Erin Hestir	North Carolina State University
Rifat Hossain	WHO
Tiit Kutser	University of Tartu
Bunkei Matsushita	University of Tsukuba
Daniel Odermatt	Brockmann Assoc.
Adrian Strauch	University of Bonn
Bernhard Wehrli	EAWAG
Dominique D. Bérod	GEO Sec

Group on Earth Observation (GEO) Water Quality Summit

Agenda (April 10, 2015)

Sunday, April 19, 2015	
7:00-8:00 pm	Steering Committee meeting (meet at Mr. Pickwick)

Monday, April 20, 2015	
8:00-8:30	Registration
8:30-8:45	Welcome and context by GEO Sec. - *Barbara Ryan/ Dominique D. Bérod /GEO*
8:45-9:00	GEO Water Quality Task and framework- *Steven Greb/Wisconsin DNR*
9:00-9:20	Summit Charge, vision for WQ service, requirements, et al- *Paul DiGiacomo/NOAA*
9:20-10:00	**Keynotes 1 & 2** Perspectives on end-user needs *Rifat Hossain, WHO & Blake Schaeffer, US EPA*
10:00-10:30	Coffee Break
10:30-11:00	GEO WQ Partnerships GEO Initiatives (GEOBON, GEO Health, Blue Planet, Coastal CoP) *Dominique D. Bérod /GEO Sec* Partner programs (World Bank, WHO, UNEP, CEOS, etc.) *Arnold Dekker/CSIRO*
11:00-11:30	**Keynote 3** Inland monitoring programs/systems *Laurence Carvalho/ NERC*
11:30-12:00	**Keynote 4** Coastal monitoring programs/systems *Britta Schaffelke/AIMS (given by Vittorio Brando)*
12:00-1:00	Lunch
1:00-1:15	Introduction to Service Requirements. Charge to breakout groups- *Paul DiGiacomo*
1:15-3:00	Inland and Coastal Service Requirements Breakout Sessions The participants will be divided into four groups, two inland and two coastal) Inland Waters (group A) Facilitated by - *Laurence Carvalho* Inland Waters (group B) Facilitated by –*Steef Peters* Coastal Waters (group C) Facilitated by - *Paul DiGiacomo* Coastal Waters (group D) Facilitated by – *Erin Hestir*
3:00-3:30	Coffee Break
3:30- 4:15	Inland Waters group A & B breakout report and discussion (15 min each)

4:15-5:00	Coastal Waters group C & D breakout report and discussion (15 min each)
5:00-5:30	Group Discussion and Day 1 Wrap-up
5:30	Conclude. Dinner on own

Tuesday, April 21, 2015	
8:30-9:00	Synthesis and review of service requirements, Introduction to system components *Led by Blake Schaeffer/Steve Greb*
9:00-9:30	**Keynote 5** Data *In-situ- Philipp Saile/GEMS and remote sensed- Mark Matthews/ University of Cape Town*
9:30-10:00	**Keynote 6** Products and Indicators *Carsten Brockmann/Brockmann Consult*
10:00-10:30	**Keynote 7** Information *Vittorio Brando/CNR-IREA, Nicki Villars/DELTARES*
10:30-11:00	Coffee
11:00-11:30	**Keynote 8** Knowledge *Hartwig Kremer/ UNEP*
11:30-12:30	Component Breakout Session A *During these sessions, participants will be asked to attend one of four breakout groups, Each of the four breakouts will focus on one of the four major components and participants should attend the group that aligns with their interest and expertise. After lunch, participants will be asked to rotate and provide input into a second component* . Component 1 Data- Facilitated by *Mark Matthews* Component 2 Products and Indicators- Facilitated by *Steve Groom* Component 3 Information- Facilitated by *Vittorio Brando* Component 4 Knowledge- Facilitated by *Hartwig Kremer*
12:30-1:30	Lunch
1:30-2:30	Component Breakout Session B. Component 1 Data -Facilitated by *Philipp Saile* Component 2 Products and Indicators -Facilitated by *Daniel Odermatt* Component 3 Information- Facilitated by *Nicki Villars* Component 4 Knowledge- Facilitated by *Chris Mannaerts*
2:30-3:15	C1A and C1B reports and group discussion (Data)
3:15-3:45	Coffee
3:45-4:30	C2A and C2B reports and group discussion (Products)
4:30-5:15	C3A and C3B reports and group discussion (Information)
5:15-7:00	Social Mixer (Sponsored by EAWAG and GEO

Wednesday, April 22, 2015

8:30-9:15	C4A and C4B reports and group discussion (Knowledge)
9:15-10:00	Group Synthesis Discussion
10:00-10:30	Coffee
10:30-12:00	Strategic Implementation plan, and resource, discussion (minimum and highly funded WQ system/ services) Facilitator- *Ru Morrison/Mark Dowell*
12:00-1:00	Lunch
1:00-2:30	Phased Action Plan, Pilot project, discussion Facilitator- *Carsten Brockmann*
2:30-3:00	Coffee
3:00-4:15	Future Plan Coordination-Actions, Project Synergies, and Schedule. Facilitator-*Arnold Dekker*
4:00-4:30	GEO Programmatic activities, GEO-Water Quality Community of Practice, organization and governance *Steve Greb/Paul DiGiacomo*
4:30-4:45	Final comments, concluding remarks

Abbreviated supporting information

A. GEO Tasks

1.) WA-01-C4: Global Water Quality Products and Services (From the GEO website) http://www.earthobservations.org/ and GEO Water Quality report http://www.igcp565.org/library/reports/GEO%20Water%20Quality%20report.pdf

The deterioration of surface water quality through the effects of contaminants, nutrients, excess heat, and other factors is arguably the greatest threat to future water availability. Health studies show that water-related illnesses are a major global problem. Clearly, having and maintaining suitable water quality is critical to sustaining life on our planet. The UN Millennium 2015 Goals highlight the importance of accessible freshwater and sanitation for human health. Clean water is critical not only to human health, but overall ecosystem health. Monitoring is critical for the protection of biodiversity in natural areas (e.g. Natura 2000). Remotely-sensed water quality monitoring systems used to measure global-scale freshwater quality are non-existent. Operational observation systems need to be developed and the resulting information systems made compatible and interoperable as part of the GEO system of systems. Monitoring water quality using remote sensing, in conjunction with strategic in-situ sampling, is needed to determine the current status of water quality conditions and to help anticipate, mitigate, and even avoid future water catastrophes.

It is feasible to implement a fully operational, spatially comprehensive water quality information system globally relying on systematic observations from past, present and future satellite sensor systems. The spatial and temporal information from remote sensing can validate and update detailed models that relate to transport and fate of chemical substances and their effect on drinking water quality and ecosystems. Thematically, only optically active constituents in the water column and water surface temperature can be mapped directly from satellites. However, this suite of variables can be combined to produce indices of water quality. Reliable quantitative (temporal and spatial) measures of: phytoplankton contents (and blooms) and composition; suspended sediments composition and concentration; dissolved organic matter concentrations and source material identification and light availability assessments for photosynthesis (including derived water quality variables such as secchi disk transparency and turbidity) can be provided.

By combining information from multiple water quality variables mainly based on Earth observation, water quality indices such as eutrophication, primary productivity and carbon contents may be calculated. Through assimilating data from Earth observation with other sources of data such as water quantity, hydrodynamics, biogeochemical modelling it becomes possible to generate hindcast, nowcast and forecast higher level information products such as trends and anomalies in nutrient, carbon or primary productivity. Additional "value-added" products such as fluxes and flows (source, transport and fate) of pollutants can also be estimated.

Space agencies, research agencies and universities have invested significant effort into operationalising Earth observation for terrestrial and marine applications. Inland water quality was not part of these investments as it falls outside of most coastal to ocean programs and is insufficiently funded for either complex coastal or inland water quality activities. Systematic investments in an inland and near-coastal water quality information system are required.

The GEO Inland and Near-Coastal Water Quality Working Group aims to develop international operational water quality information systems based on Earth observation with a focus on the developing world. GEO is looking to developed countries to play a lead role. The aims of this international GEO Working Group are aligned with the developing world's requirements because the extensive nature of many surface water resources and the lack of suitable measurement or access infrastructure inhibit intensive in situ water quality sampling networks.

Water quality monitoring is a large multi-faceted field with many areas that need to be addressed. The GEO working group has chosen to focus on only two topics (subcomponents) within this water quality theme. Both have the common goal of producing information systems but take differing approaches, one focused on space-based measurements, the other being a ground-based or in situ measurements and subsequent products.

The two subcomponents are:

Remotely-sensed water quality, including current sensor, algorithm, and data processing and distribution systems and subsequent water quality information systems for inland and coastal waters and secondly, In-situ water quality data, with the development of new information systems including water-quality data assimilation systems focused on sediment and nutrient fluxes and budgets.

Because the space-based approach is a relatively new science (no standardization of approaches/ data products exist) relative to ground-based measurements, a broader and more comprehensive set of activities are listed for the space-based activities. In contrast, the activities based on accepted historical ground-based data will pursue advanced integrative tools.

Expected Achievements by 2015 (expected outcomes by 2015 including main characteristics, and if possible quantification)

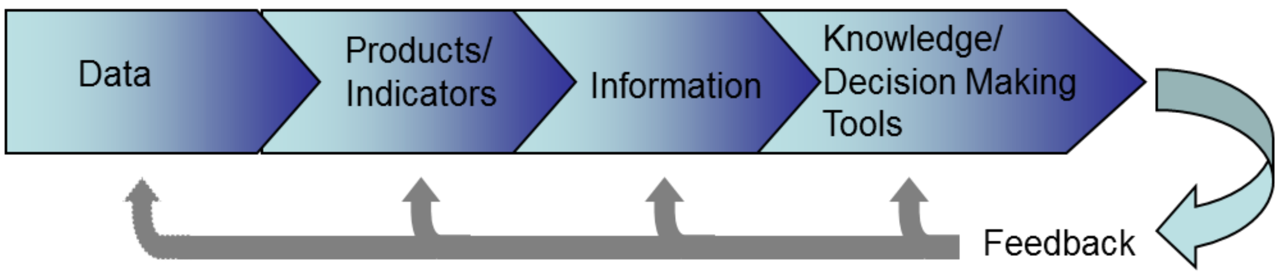
- Increase availability and use of data and information of quality of inland and near-coastal waters to support an operational water quality decision making system.
- Generate routine, reliable human and ecosystem health indicators from satellite and in-situ data, and data assimilation capabilities.

The working group recognizes that a number of areas related to this task still require major research and development efforts to strengthen the science's foundation. At the same time, recent successes with limited water quality remote sensing information systems provides a way forward to demonstrate potential capabilities. Therefore, this task will take two approaches in addressing the stated goals. The first approach will look at four interrelated components, namely 1.) data, 2.) products, 3.) information and 4.) knowledge/decision making. A number of activities, each critical to the overall goal will be proposed under each of these components. The second approach taken under this task is a fast track end-to-end application, using current tools and available infrastructure. This subtask will build on the existing marine-focused Chlorophyll Global Integrated Project (ChloroGIN) program, extending it into large inland lakes and reservoirs. The final task is the considerable coordination and oversight efforts of all these activities.

Overall GEO WQ Task Goal: Develop, implement and maintain a global inland and coastal water quality monitoring and forecasting service. This task will be facilitated by a newly implemented GEO Water Quality (GEO-WaQ) Community of Practice.

WQ Service Mission Statement: Deliver, on a routine and sustained basis, timely, consistent, accurate and fit-for -purpose water quality data products and information to support water resource management and decision making in coastal and inland waters.

Conceptual system vision: components, flow and integration



2.) **SB-01 Oceans and Society: Blue Planet**:
Provide sustained ocean observations and information to underpin the development, and assess the efficacy, of global-change adaptation measures (such as those related to vulnerability of coastal zones, sea-level rise, and ocean acidification). Improve the global coverage and data accuracy of coastal and open-ocean observing systems (remote-sensing and in-situ). Coordinate and promote the gathering, processing, and analysis of ocean observations. Develop a global operational ocean forecasting network. Establish a global ocean information system by making observations and information, generated on a routine basis, available through the GEOSS Common Infrastructure. Provide advanced training in ocean observations, especially for developing countries. Raise awareness of biodiversity issues in the ocean.

3.) **SB-01-C4: Services for the Coastal Zone**
Activity 5: Assess user needs and observational requirements for coastal water quality (using the GEOSS User Requirements Registry); identify indicators and best practices for coastal water quality, and implement a monitoring service pilot for coastal water quality (with WA-01 and HE-01); disseminate information particularly to under-served communities (with IN-04)
Activity 5.1: Use the proposed Socio-Economic and Environmental Information Needs Knowledge Base (SEE IN KB) to capture water quality goals, targets, indicators and essential variables in deliberations with the relevant user communities.

The main outcome of this activity will be a set of Essential Water Quality Variables (EWQVs) and observation specification for these variables with particular focus on the information needs in the coastal zone.
Activity 5.2: Develop a demonstrator for a coastal water quality service based on observations of the EWQVs with the specific goal to make the information available to underrepresented communities.
The demonstrator will allow to assess data gaps and it will help to assess to what extent the information is of value to societal users, including underrepresented groups.

B. Committee on Earth Observation Satellites (CEOS) 2014-2016 Work Plan
http://ceos.org/wp-content/uploads/2014/11/CEOS-2014-2016-Work-Plan-FINAL-6.03.14.pdf

Action VC-10: Recommend the creation of a GEO Water Quality Community of Practice (Q2 2015)

An emerging thrust for the Ocean Color Radiometry- Virtual Constellation (OCR-VC) is in the area of remote sensing of coastal and inland water quality. A related International Ocean Colour Coordinating Group (IOCCG) Working Group (Earth Observations in Support of Global Water Quality Monitoring) has recently been established. The OCR-VC recommends the creation of a GEO Water Quality Community of Practice, which would significantly expand upon the IOCCG working group and bring together data providers and users to significantly advance the utilization of satellite observations in support of water quality monitoring in both developed and developing nations.

C. IOCCG Working Group: Earth Observations in Support of Global Water Quality Monitoring http://www.ioccg.org/groups/water_quality.html

Scientific and Programmatic Background and Rationale

Water quality is a measure of the chemical, physical and biological condition of water relative to human and ecosystem requirements. Available freshwater resources are emerging as a limiting factor not only in quantity but also in quality for human development and ecological stability. Nutrient over-enrichment (eutrophication) is a rapidly growing environmental crisis in freshwater and coastal ecosystems.

Globally, water quality monitoring is receiving inadequate attention particularly in developing countries and in countries in transition where existing water quality monitoring networks, expertise on water quality management and laboratories for water quality assessments are all deficient. The measurement of water quality variables via radiometric measurements of the water's optical properties has rapidly grown over recent years. Improvements in algorithms and product development, sensor technology and maturity, and data accessibility and provision have led to demonstrated confidence in remotely sensed data with potential applications to water resources management. However, to date, management agencies have been slow to embrace satellite derived measurements even though important parameters such as chlorophyll, suspended solids, light attenuation, and colored dissolved organic matter have been quantified with required accuracies.

A recent internal US Environmental Protection Agency survey (Schaeffer et al, 2013) queried potential users' perceptions and found concerns centered on cost, product accuracy, data continuity and programmatic support. Their recommendation was initiating open and effective discussions between scientists, stakeholders, policy makes and environmental managers. This working group seeks to build a stronger linkage between the water resources management end users and data providers to fully realize current and future Earth Observation (EO) products.

Goal and Vision

To provide a strategic plan for incorporation of current and future EO information into national and international near-coastal and inland water quality monitoring efforts. Promote best practices, coordination of efforts and partnerships, and propose specific new linkages between data providers and data end users. Ultimately the intent is to work toward implementation of a global water quality monitoring service under the auspices of GEO. See also the website of the related Group on Earth Observations (GEO) Inland and Coastal Water Quality working group at: http://www.geo-water-quality.org/home.

Terms of Reference

1. Assess current knowledge regarding coastal and inland water quality and associated use of remote sensing data.
2. Identify user needs and requirements, including future mission requirements.
3. Assess existing, and identify new, space-based and in situ observing capabilities.
4. Identify supporting research and development activities.
5. Identify best practices, and new and improved data streams and products.
6. User engagement and outreach: Develop a strategy to strengthen linkages between data providers and end users, and coordinate with GEO and its Blue Planet Task to advance development of a global coastal and inland water monitoring service.