GROUP ON EARTH OBSERVATIONS

Progress Report on GEO Inland and Near-Coastal Water Quality Remote Sensing Working Group

January 2011

Pre-amble:

This is a progress report of the Inland and Near-Coastal Water Quality Remote Sensing Working Group. This working group was created to carry out the activities of the GEO Subtask WA-08-01g *Global Water Quality Monitoring,* which is a component of WA-08-01 Overarching Task *Integrated Products for Water Resource Management and Research.(* See http://www.grouponearthobservations.org/cdb/geoss_imp.php). This report lists and briefly describes six activities that the newly formed working group has been involved in over the past three years. Two of the activities, the further development of *terms of reference* for the working group and the 2009 algorithm workshop outcomes, are described in greater detail in Annex 1 and 2 respectively. This report was written and compiled by members of the working group who met at ESA-ESRIN in Frascati, Italy on 16 November 2010, along with numerous intercessional ad hoc and telecom discussions.

Overview and History:

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 hosted by the GEO Secretariat and Co-chaired by representatives from GEO and the Integrated Global Observing Strategy Partnership (IGOS-P) Integrated Global Water Cycle Observation (IGWCO). The workshop 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 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. The ability to construct an inland and coastal water quality GEOSS have not reached the maturity of other hydrologic parameters covered under WA-08-01 (e.g. precipitation) 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/20070327_29_water_quality_workshop_report.pdf

Current GEO WA-08-01g activities:

Following the Geneva workshop recommendations, selected activities were identified for future actions under the auspices of WA-08-01g. At present, these 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 six activities.

1.) Development of the working group's terms of reference. A consensus of the participants of the Geneva workshop was the need for a inland and near-coastal water quality remote sensing working group . The overarching objective of the group is to provide an effective link between the research and development communities engaged in developing the use of remote sensing based techniques for coastal and inland water quality assessment and the different user groups that require such information for research, operational monitoring or commercial service provision. Areas the group potentially will address include research, advocacy, consultation, applications, and education and capacity building. The group has approximately 80 members, with global representation. Further information of the group's terms of reference can be found in **Annex 1**.

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.) 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. Additional details regarding workshop outcomes can be found below in **Annex 2.**

5.) 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).

6.) 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.

7.) 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.

Challenges and Opportunities:

Key challenges are resource allocation in the form of both time and money. For example, although required activities from the Algorithm workshop in Washington DC. are clear, it is less evident how to execute these activities. At this stage all activities are performed on a best-effort basis (leading to slow, intermittent and ad-hoc progress). Even as we look towards the 2012-15 GEO work planning process, there are still questions of how do we enable or support people to execute the proposed plans?

Proposed options are

a.) **Continue volunteer support** that presently exists, One suggestion to assist our volunteer efforts has been for this working group to initially focus on finding support from a space agency and/or research institutions to support the programmatic efforts. This relatively small investment would help catalyze our efforts and bring some continuity to the activities.

b.) **Weave our GEO proposed actions into existing programs and research efforts**. As far as joining with existing programs, there are a number of programs that currently exist within the realm of ocean and coastal remote sensing that may provide a basis for more rapid progress. These include ESA CoastColour, ChloroGIN and FP7 projects. Working with these existing programs to expand their scope into inland waters may have advantage of institutional support and experience. Another suggestion, specific to advancing the algorithm outcomes forward is to propose a new working group within IOCCG. This approach would potentially bring some support, in terms of meeting expenses, and provide a framework for this effort.

c.) **Members of the working group develop independent GEO water quality remote sensing R &D proposals**. If the working group felt our objectives didn't align with existing programs (option b), members of the working group might collaboratively develop a proposal more directly focused on our needs. Opportunities may exist (and should be exploited fully):

- FP7 (COST, SPACE, Environment, Marie-Curie, Global Carbon Task) ;
- Other EU funding sources (e.g. LIFE+, EU External Action funding etc);
- ESA development and exploitation programmes (DUE, VAE, STSE) ;
- GEF ;
- World Bank and other development banks (e.g. African Development Bank, Asian Development Bank);
- National funding agencies.

Report recommendations:

General recommendations include:

- Pro-actively engage space agencies, user consituencies, GEO member nations and participating organizations etc to promote and advance our goals.
- Engage existing formal communities of practice (water, coastal, carbon, et al.).
- Assess relevance millennium development goals (MDG's)-specifically inland waters.
- Create a dedicated website.
- Ensure the outcomes and plans of this working group are publicly available and more visible in suitable fora.

Recommendations specificto the Algorithm workshop include:

- Evaluate opportunity to generate special issue of peer reviewed journal.
- Prioritise activities defined in the Washington DC algorithm Workshop.
- Identify Task Leaders for activities defined in the Washington DC Algorithm Workshop, as well as acquire resources to execute these tasks.

Contributions received:

Contributions were received from the following persons:

- Mark Dowell (JRC);
- Ru Morrisson (UNH);
- Jami Montgomery (US EPA);
- Emilio Mayorga (APL);
- Steve Greb (WDNR);
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- Gordon Campbell (ESA);
- Carsten Brockmann (BC);
- Tiit Kutser (EMI);
- Hans van der Woerd (IVM);
- Paul DiGiacomo (NOAA)
- Samantha Lavender (ARGANS);
- Arnold Dekker (CSIRO).

Annex 1:

Working Group Terms of Reference

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 optimisation 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.

Scope of the Working Group

The group shall represent the interests of all professionals working in inland and near-coastal water quality remote sensing. This shall include research institutions, collaborative research programmes, government agencies (local, national and international), private sector commercial operators, NGOs and consultants.

It shall encompass all measurement technologies (including satellite remote sensing, airborne data, modelling and in-situ measurements), be recognisably distinct from coastal zone management, open ocean remote sensing and climate change assessment but will closely link to those and be complementary.

It shall consider all aspects of integrated water management and the water cycle including applications of coastal and inland water quality remote sensing that include pollution, contamination, eutrophication, sediment transport, habitat changes, local and regional ecosystem responses, coastal and riverine engineering impacts, human health related issues and coastal planning.

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 Millenium 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.

Implementation approaches

The group should set specific targets for achievements, in the coastal and inland remote sensing sector, to have been realised by 2020. This should include consideration of the following elements:

- Continuity of key data streams & requirements for new data sources (satellite, airborne & in-situ).
- Improved algorithms and processing chains.
- Enhanced validation approaches and application of quality assurance standards.
- Preservation and reprocessing of key time series measurements.

- Ensuring effective data access and exchange for all coastal and inland water quality datasets.
- Elaboration of new opportunities for application development.
- Identification of emerging issues (e.g. policies, commercial activities, technology developments) and defining the opportunities for responses including remote sensing technologies.
- Establishment of new partnerships for capacity building and extended user uptake.

On the basis of these overall targets, specific shorter term objectives should be elaborated and a high level plan of activities for their realisation should be developed. These should be clearly identified with respect to the commitments and responsibilities of the various:

- Space agencies for completion of identified activities.
- Research establishments to undertake identified basic science.
- International organisations to foster international collaboration between coastal and inland water remote sensing practitioners, to support capacity building in developing countries and to promote the international collaborative activities.

The group shall assess progress against stated objectives on an annual basis.

Annex 2:

Water Quality Algorithm Workshop, Washington DC, May 2009

Workshop rationale

Although the need is recognized for implementation of Earth Observation (EO) based water quality information systems, numerous science and technology gaps exist in this field that need addressing first (See Geneva Workshop Report 2007). These gaps/areas of improvement were categorized into:

1. Lack of appropriate/dedicated satellite sensors for nearshore coastal and inland water quality applications.
2. Requirement to determine practical (and sufficiently reliable) algorithms for atmospheric correction/air-water interface correction; in water-(both optically deep and optically shallow water ecosystems)
3. Calibration and validation requirements for satellite measurements and products.
4. Data acquisition and distribution (ease of access).
5. Data pre-processing and final water quality product development.
6. Developing countries needs in earth observation and in situ monitoring and management of inland and near coastal water quality.

Of the issues identified in the Geneva Workshop (2007), the initial more tractable priority was considered to be practical and sufficiently reliable algorithms for atmospheric correction/air-water interface correction and water quality determination. The rationale was that, prior to implementation, consensus is needed on suitable globally applicable well-documented algorithms. Along these lines, the May 2009 Washington Workshop was organised to address these and related issues as follows.

Algorithms provide the important linkage between raw data and derived products. The needs of inland and coastal water (case II and eutrophic waters) users are generally not addressed by global (primarily open-ocean) algorithms and datasets. Numerous researchers have used a variety of algorithms to provide the linkage between image brightness/reflectance and usable information for end users. These algorithms span a spectrum from relatively simple empirical (or statistic/ regression) methods to semi-analytical to fully analytical methods, where inherent and apparent optical properties of the water are utilized to model the reflectance as a function of the color-producing constituents.

Presently, there is no concerted coordination of research and development efforts on inland and coastal water quality algorithm use and application. What is critically lacking is a focal point for exchange of information with respect to the numerous facets surrounding algorithm development, and the synergy that follows such a collaborative effort. In past, with research focused predominantly on oceanic waters, there was greater impetus for international cooperation through sharing of data and inter-comparison activities because of joint interest in a common water body (e.g. the Atlantic Ocean), or the need for long-term globally cohesive data sets. Inland and near-coastal investigators generally have a narrower focus on their particular *local* water bodies and water quality issues.

The focus on water quality rather than biogeochemistry also creates a shift in rationale; with a greater emphasis on the immediate use of earth observation data for sustainable resource management rather than longer term research-driven goals. This is particularly true in the developing world – with poorer infrastructure for *in situ* monitoring of water quality, particularly in highly utilised freshwater systems, the immediate societal benefits of EO based water quality products are far more tangible. The optical complexity and sometimes extreme nature of these waters calls for new atmospheric and bio-optical scientific capabilities; whilst the shift in scientific drivers (particularly within a GEO context) calls for new and more applied product types such as eutrophication indices. Therefore, the time is ideal for creating consensus on inland and near-coastal water quality remote sensing algorithms suitable for global applications. Towards this goal, the second Inland and Near-Coastal Water Quality Remote Sensing workshop was held in Washington in May 2009.

Objectives
To develop a strategic framework and action plan to advance the algorithm development and implementation needed to provide management-relevant water quality information for inland and coastal waters using global and/or regional algorithms. Both shorter term, readily implementable actions, and longer term plans more focused on research and new scientific capability were identified at the workshop. Shorter term actions, typically best-effort based, focused on testing and value demonstration of simple products, e.g. water clarity and eutrophication indices; and making such products available to users in the near-future through ChloroGIN-style dissemination networks (www.chlorogin.org). Longer term plans focused on strategic development and value demonstration of best knowledge, algorithm development data sets under new protocols, atmospheric correction and in water algorithms. These will require sustained research efforts with dedicated funding, and will demonstrate more sophisticated and potentially better characterised products using advanced algorithm types.

In this context, water quality algorithm development was considered from two perspectives. Firstly, to evaluate *currently available* water quality algorithms for challenging coastal and inland conditions with the use of available synthetic, field and satellite data with high spatial and spectral resolution. Secondly, to develop and validate new algorithms better suited to complex and extreme water types, with concomitant efforts on developing and obtaining the new synthetic and *in situ* data sets required.

1. Algorithm Development and Validation: Data Set Development
Coastal and inland waters are optically complex and can be extreme relative to the majority of data currently used for algorithm development and validation e.g. NOMAD 2 (Werdell & Bailey 2005). Phytoplankton biomass can exceed 1000 mg m^{-3} Chl *a* in red tide or cyanobacterial bloom scenarios; concentrations of total suspended matter (TSM) can range up to 3000 g m^{-3} in high run-off areas; CDOM absorption values may become as high as 100 m^{-1} at blue wavelengths in humic lakes. Atmospheric correction will be made complex by high atmospheric variability, the presence of absorbing aerosols, potentially high and variable water leaving signal in the NIR, and land adjacency effects. Algorithm development and validation is dependent upon the availability of well characterised and standardised bio-optical data sets, whether synthetic or measured: producing the necessary data sets for coastal and inland waters through observation and modelling is one of the key challenges to the community.

Synthetic In-Water Data Sets
Synthetic data sets, produced by forward radiative transfer modelling with ranges of constituent-related inherent optical property (IOP) data as input, play an extremely important role in algorithm development and validation (e.g. IOCCG 2006). They offer highly constrained suites of bio-optical data across a systematically varied and broad range of water types. However, they are highly dependent upon the veracity of the IOP data used as model input, specifically the absorbing and angular scattering properties of the primary particulate and dissolved constituents. Actions include:

- In-water data: In the short term development of Hydrolight derived data-sets for optically deep water based mostly on IOCCG (2006) data-set assumptions with conditions expanded to coastal and moderate inland water conditions with regard to Chl a, TSM and CDOM. Longer term strategic research is needed to provide valid IOP data for more extreme water types (most notably spectrally variant phase functions), followed by appropriate radiative transfer modeling across the necessarily wide IOP and biogeochemical data ranges.
- Top-of-atmosphere data: Development of top-of-atmosphere synthetic data sets with conditions typical of inland and coastal conditions, following from above

Observation Based In-Water Data Sets

Collation of a in-situ bio-optical and remote sensing data set (including metadata) for representative inland and coastal waters over highly variable water conditions. Provision of data set on (protected) website for community evaluation and the various algorithm evaluation and validation activities outlined below.

2. Atmospheric Correction Algorithm Validation and Evaluation
The synthetic and observed data sets described above will be used to evaluate a range of in water algorithms outlined in Section 3 below. For core data sets with both remote sensing and in-situ data, several atmospheric correction algorithms will be applied to TOA data, to generate a suite of Level 2 equivalent normalised water leaving radiance/reflectance data, each associated with a different atmospheric correction scheme.

3. In Water Algorithm Validation & Evaluation
Evaluation of IOP and Biogeochemical Algorithms for current sensors
Focusing on current sensors i.e. MODIS, MERIS and OCM-2, extended evaluation of currently available (SEADAS/BEAM) algorithms using synthetic and observational data from Section 1 for: IOPs, Chl *a*, Total Suspended Matter, and CDOM. Results to be posted on website for community evaluation.

Evaluation of Optical Water Type & Screening Algorithms
Evaluation of classification and/or screening algorithms (phytoplankton, CDOM or TSM dominated waters) for coastal and inland waters using data from Section 1. Assess available options by means of high spatial resolution sensor data. Alternative evaluation of optical water type reflectance classification; post preliminary results on website, publish or make available in SeaDAS for community evaluation.

Evaluation of Water Clarity Algorithms
Evaluate algorithms for water clarity (vertical attenuation of light/euphotic depth, Secchi depth) on synthetic and in-situ data, depending on available atmospheric corrections and data from Section 1 . Comparisons with established data sets e.g. CalCOFI and other (Baltic, Lake Erie, Chesapeake Bay etc.) as reference data-sets. Post on website for community evaluation.

Evaluation of All Algorithms with Emerging & Experimental Sensors
Evaluation of algorithms as above with available data from high spatial and spectral resolution sensors such as the new generation multi to hyper spectral high spatial resolution satellite sensors.

Evaluation of Emerging & Experimental Algorithms
Evaluate other emerging and non-standard published algorithms with data sets from Section 1, using equivalent evaluation criteria according to IOCCG evaluation standards.

Analysis of Sensor and Product Suitability for Application Ranges
Assessment of suitability of low/high spatial/spectral/temporal resolution sensors for specific tasks, taking into account sensor-specific algorithms and the applicability of atmospheric correction methods.

4. Preliminary Implementation and Operational Impact
Pre-operational Pilot Study with Near Real-Time Processing & Dissemination
Implement products from algorithms/sensor data identified in Section 3 in chosen pilot regions; evaluate ChloroGIN as regional processing/delivery mechanism and explore ChloroGIN-Lakes possibilities; explore potential to add lakes to CoastColor, or build an independent LakesColour. Also explore potential to publish results in a journal special edition, or within a special session of an ocean color conference.

5. Development of In Situ Protocols & Validation Data Sets

The building of data sets for algorithm development and validation is critically dependent upon standardised measurement protocols suitable for coastal and inland waters – these protocols are likely to differ from those used for oceanic and shelf waters e.g. Mueller et al 2003, particularly for extreme water types. Ongoing development in this area should address the following primary issues:

- Summary of the existing capabilities and practices of operation.
- Plans and resources for new/improved facilities (super sites).
- Inter-comparison of practices and data produced with practical recommendations for joint use of data facilities.
- Generation of global in situ test data-set of highest accuracy for algorithm development, calibration and validation.

Scientific Data-set Generation Activity in the Medium Term

Focusing on research vessels, research groups with field measurement equipment, automated stations, and dedicated laboratories.

- Summary of the existing capabilities and practices of operation.
- Plans and resources for new/improved facilities.
- Inter-comparison of practices and data produced with practical recommendations for joint use of data.
- Generation of global in situ test data-set of highest accuracy for algorithm development, calibration and validation.

Minimal data-set generation

Focusing on other scientific disciplines, stationary administrative environmental monitoring, and developing country activities

- Interfacing with limnological / biological scientific community & general pub/outreach.
- Acquisition of suitable data-set, such as Secchi disc & other water quality parameters for validation e.g GEMStat (CalCoFI on web).
- Design and definition of “minimal equipment package”.
- Capacity building and training.
- Establishment of measurement teams and/or network for gathering validation data.

Networks of the stakeholders

- Measurement and data gathering protocols.
- Data sharing policy definition (no publication/use without Intellectual Property consult, initial restriction to data set).
- Practical application of measurement protocols – summary and establishment of community. Data providers to give protocol requirements.
- Protocols development for better in situ data consistency from different sources.

Pre-existing observational networks and organizations

- Establishment of contact person network.
- Feedback and user requests for algorithm development.

Capacity building and practical organization of algorithm work

1. Establishment of project / work context for in situ data with necessary financing.
2. Practical meeting & group participation for developing countries.

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