GEO AquaWatch Initiative

2017 – 2019 Implementation Plan
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Executive Summary

Water quality is essential for human, ecosystem and economic health. Degradation of water quality can result in human exposure to disease and harmful chemicals, reduction in productivity and diversity of ecosystems and damage to aquaculture, agriculture and other water-related industries. Water quality monitoring is a large multi-faceted field that is directly related to a number of the Group on Earth Observation’s societal benefit areas as well a variety of policy and sustainable development goals.

The overall goal of the AquaWatch Initiative is to develop and build the global capacity and utility of Earth Observation-derived water quality data, products and information to support effective monitoring, management and decision making. The objectives to achieve this goal are:

**Objective 1:** Facilitate effective partnerships between the producers, providers and users of water quality data, products and information.

**Objective 2:** Improve analysis and integration of in situ and remote sensing water quality data.

**Objective 3:** Develop and deliver fit-for-purpose water quality products and information services.

**Objective 4:** Support technology transfer and access to water quality data products and information.

**Objective 5:** Advocate for increased education and capacity for the use of water quality information for decision making.

As a GEO Initiative, AquaWatch will support the need for global water quality data, products and information. AquaWatch is currently working on a project to develop a global water quality monitoring service. This project, as well as other activities aligned with the AquaWatch objectives, will be implemented by five working groups: 1) outreach and user engagement, 2) observations and data, 3) products and information, 4) distribution access and visualization, and 5) education and capacity building. It is expected that the work of the AquaWatch Initiative will improve decision making, support sustainable development and protect ecosystems. AquaWatch will add value by improving access to data and information, providing a venue for the sharing of best practices and advocating for the importance of sustained and routine water quality monitoring at the global scale. AquaWatch will also link communities with common interests in the freshwater and support global water quality information needs.

AquaWatch is working towards building a single network that integrates existing water quality monitoring efforts for the benefit of the global community. AquaWatch participants currently include representatives from various organizations including state, federal, and international
governmental agencies, private consulting companies, nonprofit organizations, nongovernmental organizations and academic institutions. Over the coming year, AquaWatch will work to expand its focus on inclusion of representatives from the in situ and user communities and identify and develop working group activities. Over the next three years, AquaWatch will also work to supporting related Group on Earth Observations activities and will continue work on a long-term project to develop a global water quality information service.

1 Synopsis of Objectives and Benefits

Water quality is essential for human, ecosystem and economic health. Degradation of water quality can result in human exposure to disease and harmful chemicals, reduction in productivity and diversity of ecosystems and damage to aquaculture, agriculture and other water-related industries. The monitoring of water quality allows countries to identify and track water quality degradation and the associated impacts on ecosystems and human health.

1.1 Importance of Water Quality Monitoring to the Group on Earth Observations

Water quality monitoring is a large multi-faceted field that is directly related to a number of the societal benefit areas identified in the Group on Earth Observations (GEO) 2016-2025 Strategic Plan:

- Disaster Resilience,
- Food Security and Sustainable Agriculture,
- Water Resources Management,
- Energy and Mineral Resources Management,
- Public Health Surveillance,
- Biodiversity and Ecosystem Sustainability, and
- Sustainable Urban Development [1].

Water quality monitoring is also required for the successful implementation of policy and sustainable development goals that GEO seeks to support including the United Nations (UN) 2030 Agenda’s Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction [2, 3]. Water quality monitoring is particularly relevant to tracking progress towards SDG targets 6.3, 6.6 and 14.1:

6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.
14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution [2].

For disaster risk reduction, water quality monitoring and forecasting is critical for the development and assessment of safe water and sanitation systems required for successful implementation of the Sendai Framework [3, 4].

1.2 Necessity for the Initiative and Expected Outcomes

Water quality monitoring can be grouped into two approaches: 1) remotely-sensed water quality data from satellite, airborne or ground-based sensors and 2) 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. These approaches, sometimes in concert, can address water quality at local, regional and global scales. However, many traditional ground-based water quality monitoring programs are deficient. For example, many countries lack the required technical, institutional and financial capacities to develop and maintain water quality monitoring programs necessary to conduct proper water quality assessments on a long-term basis.

As outlined in the GEOSS Water Strategy Report, operational water quality monitoring systems need to be enhanced and expanded and the resulting data and information made openly available as part of the Global Earth Observation System of Systems [5]. Monitoring water quality using remote sensing, in conjunction with strategic in-situ analysis, is needed to monitor and assess water quality conditions to anticipate, mitigate, and even avoid future water quality challenges.

It is feasible to implement a fully operational, spatially comprehensive water quality information system globally relying on systematic observations from past, present and future water quality data. By combining information from multiple water quality variables based on Earth observation, water quality indices such as eutrophication, primary productivity and carbon contents may be calculated. Through fusing 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 trends and anomalies in nutrient, carbon or primary productivity.

As a GEO Initiative, AquaWatch will support the need for global water quality data, products and information. AquaWatch will add value to by improving access to data and information, providing a venue for the sharing of best practices and advocating for the importance of sustained and routine water quality monitoring at the global scale. AquaWatch will also link communities with common interests in the freshwater and support global water quality information needs.

The Global Environment Monitoring System for Water (GEMS/Water) Programme of the United Nations Environment Programme (UN Environment) is one international programme that will benefit from the AquaWatch Initiative. GEMS/Water is maintaining a global water quality
monitoring network that is based on governmental and research monitoring programs to enhance the global water quality database and information system GEMStat. GEMStat relies on voluntary data submissions from UN member states and collaborating partners and lacks comprehensive global spatial and temporal coverage due to capacity constraints of its partners as well as missing data exchange standards. AquaWatch will support the development of water quality data products and data fusion techniques to improve GEMStat’s data coverage. AquaWatch will also work with GEMS/Water and other water-related UN programmes to develop and showcase case studies and products that can be leveraged and implemented by UN stakeholders and support capacity building efforts by informing the community on how new technologies (remote sensing, automated sampling systems, etc.) can be used to improve water quality monitoring.

AquaWatch will benefit other GEO Initiatives, Flagships, Community Activities and Foundational Tasks by supporting their water quality data and information needs. This will reduce duplication of efforts within the GEO community and increase collaboration within GEO.

1.3 Mission

The mission of the AquaWatch Initiative is to improve the coordination, delivery and utilization of water quality information for the benefit of society.

1.4 Goal and Objectives

The goal of the AquaWatch Initiative is to develop and build the global capacity and utility of Earth Observation-derived water quality data, products and information to support effective monitoring, management and decision making.

The objectives to achieve this goal are:

**Objective 1:** Facilitate effective partnerships between the producers, providers and users of water quality data, products and information.

**Objective 2:** Improve analysis and integration of in situ and remote sensing water quality data.

**Objective 3:** Develop and deliver fit-for-purpose water quality products and information services.

**Objective 4:** Support technology transfer and access to water quality data products and information.

**Objective 5:** Advocate for increased education and capacity for the use of water quality information for decision making.
2 Previous Developments and Results

AquaWatch (previously referred to as the GEO Water Quality Community of Practice or the GEO Inland and Near-Coastal Water Quality Working Group) was formed in response to the need for an international operational (i.e., routine and sustained) water quality information system. The group stemmed from a GEO Inland and Nearshore Coastal Water Quality Remote Sensing Workshop that was held in Geneva, Switzerland, on 27-29 March 2007. This 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. Follow up workshops included a Water Quality Algorithm Workshop in Washington D.C. in 2009 and most recently, a Water Quality summit in Geneva in 2015.

During the 2015 summit, the group produced a draft 10-year strategic plan for developing water quality assessment products to be used globally. The summit participants also advocated implementing a GEO Water Quality Community of Practice that would complement other GEO activities [6]. In early 2016, the community established a Secretariat and was rebranded as “AquaWatch”. In June of 2016, AquaWatch hosted a meeting at the German Federal Institute of Hydrology where priority projects for 2016 – 2017 were identified. Other activities in 2016 included the initial development of a water quality monitoring project inventory, the initiation of global turbidity and Secchi disk depth product, and AquaWatch support of the Meridian Institute and Pisces Foundation in preparations for a workshop in Wisconsin – Using Remote Sensing to Empower the Public to Address Water Pollution. AquaWatch also worked with the Meridian Institute to set up SharePoint site to support future collaboration between Wisconsin workshop attendees titled “Using Remote Sensing to Address Water Pollution Collaboration Hub”.

Activities in 2017 have focused on the production of an informational booklet on the monitoring of Earth Observation of water quality, the production of a new website (www.geoaquawatch.org) and updates to the governance structure and direction of AquaWatch.

3 Participants and Contributors

To date, AquaWatch has had participants from various organizations including state, federal, and international governmental agencies, private consulting companies, nonprofit organizations, nongovernmental organizations and academic institutions. These participants are part of the AquaWatch network and contribute to AquaWatch in a variety of ways depending on their interests and availability.
**AquaWatch leadership:** The primary leadership point of contact for AquaWatch is Steven Greb - Wisconsin Department of Natural Resources. The co-leads are Paul DiGiacomo - National Oceanic and Atmospheric Administration (NOAA) and Arnold Dekker - SatDek Pty Ltd. Over the next year, AquaWatch will be building a Steering Community to expand and diversify the leadership.

**Working Groups:** Currently AquaWatch Working Group representation is presented in Annex E. Over the coming years, AquaWatch will be working to expand participation in the Working Groups.

**Secretariat:** The Secretariat duties are conducted by Emily Smail (University of Maryland/NOAA).

### 4 Activities

AquaWatch activities will be conducted on a global scale with prototype projects being focused at the local and regional scale. Management and coordination activities will be conducted initially by the AquaWatch leads and the Secretariat. Starting in the 4th quarter of 2017, these tasks will be the responsibility of the Steering Committee and Working Groups outlined in section 9.

AquaWatch activities will support and be coordinated with many other GEO Work Programme activities. Existing ties with other GEO Work Programme activities include:

**GEO GLOWS:** One of the co-leads of AquaWatch (Paul DiGiacomo) is on GEO GLOWS Steering Committee. The AquaWatch Secretariat, Emily Smail, attended a recent GEO GLOWS meeting where collaboration between AquaWatch and GEO GLOWS was discussed including AquaWatch support of information required for the GEO GLOWS effort to define essential water variables.

**GEO Wetlands:** Adrian Strauch of the GEO Wetlands Initiative attended the AquaWatch meeting in Koblenz Germany in 2016. GEO Wetlands and AquaWatch are currently developing a collaboration on activities to support SDG 6.6.1.

**Oceans and Society – Blue Planet:** The AquaWatch Secretariat, Emily Smail, and Paul DiGiacomo, AquaWatch co-lead, are actively involved in Blue Planet. Blue Planet is developing a workshop in the Caribbean on SDG implementation and AquaWatch experts will be invited and encouraged to attend.

Moving forward, AquaWatch will continue to build collaborative relationships and projects within the GEO community with assistance from the GEO Secretariat. Collaborations will focus, where possible, on efforts that support the GEO engagement priorities of the SDGs and the Sendai Framework. Potential collaborators for the SDGs and Sendai Framework are outlined below.
SDG 6

- AfriGEOSS: Reinforcing Regional African Engagement
- AmeriGEOSS
- Asia-Oceania GEOSS (AOGEOSS)
- Earth Observations for Health (EO4HEALTH)
- Earth Observations in Service of the 2030 Agenda for Sustainable Development (EO4SDGs)
- GEO Global Water Sustainability (GEOGLOWS)
- GEO Wetlands
- In-situ Observations and Practices for the Water Cycle
- Integrated Global Water Cycle Observation (IGWCO)

SDG 14

- AfriGEOSS
- AmeriGEOSS
- AOGEOSS
- EO4SDGs
- Oceans and Society: Blue Planet

Sendai Framework

- AfriGEOSS: Reinforcing Regional African Engagement
- AmeriGEOSS
- AOGEOSS
- Data Access for Risk Management (GEO-DARMA)

4.1 Working Group Activities

Activities to achieve the Initiative’s objectives will be conducted by five working groups of experts that will focus on transforming water quality data to information and decision-support tools based on user needs (Figure 1). The activities of the working groups directly support the objectives of AquaWatch.
Figure 1: AquaWatch working groups. The five working groups work in a collaborative manner to achieve AquaWatch’s objectives.

The Working Groups are standing bodies of experts that will conduct the activities outlined below on an ongoing basis.

**Working Group 1 – Outreach and User Engagement:** Working Group 1 will be responsible for facilitating effective partnerships between the producers, providers and users of water quality data, products and information. Activities of this working group will include the generation of a communication strategy for AquaWatch and information from other GEO water quality-related activities as well as the development of the AquaWatch website (www.geoaquawatch.org) into a knowledge hub for water-quality related activities (within and outside of GEO). This group will also work to identify current and potential users and create partnerships with providers and users.

**Working Group 2 – Observations and Data:** Working Group 2 will be responsible for improving analysis and integration of in situ and remote sensing water quality data. Activities of this group will include identifying and linking key data sets from remote sensing and in situ data sources and identifying data and observation gaps.

**Working Group 3 – Products and Information:** Working Group 3 will be responsible for developing and delivering fit-for-purpose water quality products and information services. The group will be tasked with generating and evaluating products derived from complementary remote sensing and in situ data sets, as well as supporting modeling and data assimilation activities for regional and global water quality nowcasts, forecasts and predictions.

**Working Group 4 – Distribution, Access, and Visualization:** Working Group 4 will be responsible for supporting technology transfer and access to water quality data products and information. The group will be tasked with distributing scientific, technical and other outputs to applicable end users and facilitating access to making products and derived information.

**Working Group 5 – Education and Capacity Building:** Working Group 5 will be responsible for advocating increased capacity and use of water quality information for decision making. The group will be tasked with generating educational content for policy makers, decision makers, and the environmental managers. This group will also support, identify and lead capacity building efforts in
developed and developing nations to expand the effective and timely utilization of Earth observations for societal benefits.

4.2 Projects

AquaWatch working groups will also work in a coordinated manner on collaborative projects that support the initiative’s objectives. The project currently being pursued by AquaWatch is the development and uptake of a global water quality information service. This effort will enable users open access to readily available water quality data through data sharing and capacity building, particularly in developing countries.

5 Involvement of Users

There are many types of users of water quality monitoring and including the science community, industry, UN groups, environmental managers, regulators, policy makers, non-governmental organizations, non-profit organizations and recreational users.

While AquaWatch has begun to identify and engage the user community, an increase in this effort will take place over the coming year. Moving forward, AquaWatch will seek involve end-users in the Steering Committee and Working Groups. Users will be directly involved in the identification and development of AquaWatch services to ensure that services are functional and tailored to their needs.

6 Planning and Implementation

Working Groups will identify and organize the implementation of activities related to their area of expertise on an ongoing basis. Working groups may form temporary task teams to address specific interests. Working Group leaders are responsible for coordinating activities within their activity and with the Secretariat and Steering Committee. Planning and implementation will be conducted largely through electronic means to reduce resource requirements.

6.1 Projects

AquaWatch projects that require work across working groups will be reviewed by the Steering Committee. Upon approval of a project by the Steering Committee, the workflow will begin with work package selection by the leadership committees and flow through the working groups to completion (Figure 2).

1. Project selection: The Steering Committee will review any proposed projects and select projects for AquaWatch to pursue based on interest, user need and resources.

2. Work package selection: The Steering Committee discusses work packages options and selects project work packages.
3. **Work package leader selection**: Steering Committee and Management Committee discuss the work packages and identify a work package leader.

4. **Tasks identified and assigned to working groups**: The work package leader and Management Committee determine the tasks and sub-tasks required to complete the work package and assign duties to the different working groups as applicable.

5. **Task completion**: Working groups complete assigned work package tasks and sub-tasks.

*Figure 2: AquaWatch Project Implementation*
6.1.2 Water Quality Information Service Project

Implementation of the water quality information service is organized into seven work packages (Figure 3). In the future, additional work packages may be added. Work necessary to complete the work packages will be carried out by specialists from the working groups as outlined above.

Figure 3: The work packages of the AquaWatch water quality information service project.

6.2 Milestones and Deliverables

Milestones and deliverables for July 2017 – December 2019 are outlined in the Gantt chart on page 13 and summarized below.

Governance transition date: During 2017, AquaWatch will work to transition to the new governance structure outlined in section 9.

Working group expansion and activities: During 2017, AquaWatch will work to expand and identify initial activities. Working group expansion will be focused on inclusion of representatives
from the in situ and user communities. During 2018 – 2019, working groups will work to undertake and expand activities. Topical task teams may be formed by working groups based on interest and need. Working groups will also contribute to water quality information service activities as needed.

Communication and community building activities: During 2017-2019, AquaWatch will work to further develop the website and produce other outreach materials including brochures, stock presentations and posters.

Water quality information service activities: During 2017-2019, AquaWatch will undertake work to move the development of the water quality and information service forward as outlined below.

- **Water quality information service work packages 1 & 2:** Work package 1 (the initiation of the water quality information service activity) has been completed and a first version of work package 2 (the project inventory) has been produced. The inventory is a living document that will be continually updated throughout 2017-2019.

- **Water quality information service work package 3:** In the remaining months of 2017, AquaWatch will work to developing an initial product suite that will include a Nephelometric Turbidity Unit (NTU) turbidity product, a Secchi disk depth product, a diffuse attenuation coefficient product, and a surface reflectance product. Absorption and scattering information will also be included where appropriate for added value and product comparability. The product will be done at three resolutions – 1 km, 300 m and 100 m. The product will be coherent globally at the 1 km level, continent or country level at 300m and regional “zoom-in” at the ≤100 m level. The further development of this product suite as well as the production of additional products will be pursued in 2018 and 2019 depending on the availability of funds and resources.

- **Water quality information service work package 4:** The AquaWatch community is currently producing a booklet highlighting the functionality of prototype projects that include in situ data, remote sensing data and modelling titled “Advanced techniques for monitoring water quality using earth observation”. The booklet will be used to educate potential end users about available functionality in water quality monitoring and forecasting and spur interest and funding for the development of new AquaWatch prototype projects. The booklet will be completed in the summer of 2017 with the remainder of 2017 focused on acquiring funding for future projects. Depending on available funds and resources, new prototype projects will be identified and started in 2018 and 2019.

- **Water quality information service work package 5:** In 2019, AquaWatch will initiate the development of the initial demonstration water quality monitoring service.
## 6.3 Evaluation and Reporting

Evaluation in 2017 will be conducted by the AquaWatch leads, Secretariat and Working Group co-chairs. During the 2018 – 2019 time period, Evaluation will be conducted by the Steering Committee. The Committee will regularly track implementation, milestones, deliverables and resource needs.

The AquaWatch Secretariat will report progress to the community of practice and GEO Secretariat on a quarterly basis. The AquaWatch Secretariat will also report progress to country level GEO groups as requested.

## 7 Data Management and Data Policy

AquaWatch will primarily leverage existing data, systems and services. The Initiative will work to encourage other data providers to comply with GEOSS data sharing and data management principles. Data and metadata will be managed and delivered by leveraging existing information platforms which are hosted by supporting agencies. Services developed for AquaWatch will aim
to present data and information in a format that is useful to target users and beneficial to data providers. Data products and services developed by AquaWatch will be linked to the GEOSS Common Infrastructure.

AquaWatch will comply with and promote all of the GEOSS Data Sharing and Data Management Principles [7]. A key focus of data management will be to increase data accessibility and user awareness of available data and the benefits of concepts of open data, data services and data interoperability. AquaWatch will engage with many other GEO initiatives and other national, regional or global activities to help develop identify data needs and tools related to water quality monitoring and forecasting.

8 AquaWatch Initiative Program Risk

The task that lies ahead of AquaWatch is ambitious. Collaboration and coordination is in itself a challenge, to which are added the dimensions of international, cross-cultural and cross-disciplinary work. AquaWatch seeks to integrate the work of scientists, regulators, industry and governments, and many international and regional observing programmes. AquaWatch focuses not only on observations, but also capacity building, communication, outreach and user engagement. A primary challenge to the success of AquaWatch is the volunteer, best-effort nature. As a result, resources (financial and human) may hinder its progress. The identification of resources will be crucial to the successful implementation of AquaWatch. The Steering Committee will be responsible for managing and identifying current and future risks. Regular reporting and coordination with the GEO Secretariat will be used as a mechanism to manage risk. The deliverables of the next three years will be accomplished by leveraging and coordinating disparate activities. Development of further deliverables will be dependent on the acquisition of additional resources.

9 Management and Governance

The organization of AquaWatch is reflected in the Figure 3. The structural elements include:

Steering Committee: This committee will be composed of AquaWatch stakeholders and shareholders as well as working group representatives. The former will include advisory organizations such as United Nations programmes and organizations that provide perspective on user needs, international mandates, et al.; the latter will consist of patrons and other representatives from organizations contributing funds to AquaWatch.

Secretariat: The Secretariat will provide scientific and technical coordination as well as programmatic support for the overall community of practice.

Management Committee: This committee will be composed of the AquaWatch Secretariat, Steering committee co-Steering chairs and leads (and co-leads where applicable) of the five working groups as below. The board will be responsible for the management and implementation
of projects and coordination between working groups. The Management Committee will be supported in day-to-day activities and functions by the AquaWatch Secretariat.

**Working Groups:** AquaWatch will have five Working Groups (WGs). The function of the WGs is to support timely and successful project implementation and task execution, and provide necessary scientific, technical and other support as required for projects, tasks and activities.

*Figure 3:* The governance structure of AquaWatch.
10 Summary of Committed Resources

AquaWatch is supported part time by a NOAA-funded Secretariat based in College Park, MD. Other support includes the support of the web page by the Commonwealth Scientific Research Organisation of Australia (previously supported by Swiss Federal Institute of Aquatic Science and Technology), hosting of an AquaWatch SharePoint site by the United States Environmental Protection Agency, and funding of the production and printing of AquaWatch informational booklet by the International Centre for Water Resources and Global Change (ICWRGC) a UNESCO Category 2 Centre in Koblenz, Germany.

AquaWatch will seek additional resources to support activities during the 2017-2019 time period.
Annex A – Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>GEMS/Water</td>
<td>Global Environment Monitoring System for Water (GEMS/Water)</td>
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<tr>
<td>GEO</td>
<td>Group on Earth Observations</td>
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<tr>
<td>GEOSS</td>
<td>Global Earth Observation System of Systems</td>
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<tr>
<td>GCI</td>
<td>Global Earth Observation System of Systems Common Infrastructure</td>
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<tr>
<td>ICWRGC</td>
<td>International Centre for Water Resources and Global Change</td>
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<tr>
<td>IGOS-P</td>
<td>Integrated Global Observing Strategy Partnership</td>
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<tr>
<td>IGWCO</td>
<td>Integrated Global Water Cycle Observation</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric</td>
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<td>NTU</td>
<td>Nephelometric Turbidity Unit</td>
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<td>SDGs</td>
<td>Sustainable Development Goals</td>
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<td>UN</td>
<td>United Nations</td>
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<td>UN Environment</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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</table>
Annex B – List of References


Annex C – CV of Project Leader

Steven R. Greb

Wisconsin Dept. of Natural Resources-Research Center
2801 Progress Rd.
Madison, WI 52716
608.221.6362  fax 608-221.6353
Steven.greb@wisconsin.gov

Education
M.S.  Forest Hydrology  1986  Utah State University
B.S.  Chemistry  1978  University of Wisconsin-Stevens Point
B.S.  Water Res. Mangt.  1978  University of Wisconsin-Stevens Point

Employment
2017-present  Honorary Fellow- University of Wisconsin Aquatic Sciences Center
1992-present  Research Hydrologist/Limnologist- Wisconsin Department of Natural Resources
2006  Sabbatical appointment to UNESCO International Hydrologic Programme
1986-1992  Water Resources Project Position- Wisconsin Department of Natural Resources
1984-1986  Teaching Assistant- Utah State University
1978-1984  Head Chemist- State of Wyoming Water Quality Laboratory

Research and Professional Interests
Satellite remote sensing applications for inland and coastal water quality, optical properties of inland lakes, ecosystem management, riparian nutrient loss, thermal pollution in the urban environment, effects of forestry best management practices on stream water quality, impact of climate change on hydrologic regimes and lake carbon dynamics, and interactions between hydrologic regimes and water quality.

Professional Memberships
American Water Resources Association
International Water Association
International Association of Great Lakes Research
Remote Sensing and Photogrammetry Society
North American Lake Management Society

Past and Current Synergistic Activities
Integrated Global Observing Strategy (IGOS) (member of the scientific steering committee)
International Ocean Color Coordinating Group (IOCCG) committee member
Group on Earth Observations (GEO) chair of water quality working group
Integrated Global Water Cycle Observation (IGWCO) Science Advisory Committee
NASA Energy and Water Cycle Study Program Review
Wisconsin Climate Change Initiative (hydrologic working group)
National Water Quality Monitoring Council Committee Member
GloboLakes Project, led by University of Stirling, UK - Advisory panel
Lake Michigan Monitoring Coordinating Council, current co-chair

Recent talks and poster presentations

Greb, S. April 24, 2014 Water Quality of Lake Nicaragua. Wisconsin Lakes Partnership Conference. Stevens Point, WI
Greb, S. Dec 16, 2013 Remote Sensing of Lakes. GEO Webinar (remote presentation)
Recent Research Grant Activities

Project manager and principal investigator (unless noted otherwise) for the following research studies:

- Remote Sensing of Wisconsin Lakes
  Cooperators-UW-Madison Duration- 4 years Total project funds –$85,000/year
- Lake Michigan Nearshore Water Quality Dynamics
  Cooperators UWM Water Institute. Duration-ongoing Total project funds $35,000/year
- NASA Inland and Coastal Water Quality Workshop Coordination
  Cooperators UW-Madison 2012. Duration one year Total project funds $30,000
- Water Quality in Lake Michigan Areas of Concern (AOCs)
  Cooperators USEPA, local governments Duration -1 year 2014. Total project funds- $15,500
- Potential Thermal Pollution from Runoff Water in Urban Areas
  Cooperators- USGS. Duration- two years, Total project fund- $160,000 (US EPA, Washington DC and USGS partial match).
- Relationship of Ecological Landscapes and Land Use to Small Stream Nutrient Loads
  Cooperators- University of Wisconsin-Madison. Duration- 2 years. Total project funds-$160,000 (US EPA Region V).
- Occurrence of Pathogens in Urban Streams
  Cooperators- USGS, Great Lakes Institute. Duration- 2 years. Total project funds- Approx. $300,000
- New Methodologies for Low-Impact Urban Development (P.I. only)
  Cooperators- University of Wisconsin-Madison, USGS. Duration- 2 years. Total project funds-$860,000 (US EPA, Washington D.C.)

Relevant reports and publications


**Community Involvement**
Town of Dunn Town Board 2000-present
Volunteer Firefighter/EMT, Oregon Area Fire/EMS District
Annex D – Addresses of Project Leadership and Secretariat Staff

**Project Leadership Point of Contact:** Steven Greb  
Email: [Steven.Greb@wisconsin.gov](mailto:Steven.Greb@wisconsin.gov)  
Mailing address:  
Wisconsin Department of Natural Resources  
2801 Progress Rd.  
Madison, WI 53716  
USA

**AquaWatch Secretariat – Scientific Coordinator:** Emily Smail  
Email: [emily.smail@noaa.gov](mailto:emily.smail@noaa.gov)  
Mailing address:  
National Oceanic and Atmospheric Administration  
NESDIS STAR/SOCD  
NCWCP (E/RA3)  
5830 University Research Ct.  
Office #3200  
College Park, MD 20740-3818  
USA
Annex E – Working Group Membership

**Working Group 1**
- Co-chairs
  - Carsten Brockmann, Brockmann Consult GmbH
  - Emily Smail, University of Maryland/National Oceanic and Atmospheric Administration
- Members
  - Michael Natschke, Kisters AG
  - Adrian Strauch, University of Bonn

**Working Group 2**
- Co-chairs
  - Maycira Costa, University of Victoria
  - Philipp Saile, Federal Institute of Hydrology (BfG) and United Nations Environment Programme-GEMS/ Water
- Members
  - Laurence Carvalho, Centre for Ecology & Hydrology
  - Miroslaw Darecki, Institute of Oceanology Polish Academy of Sciences
  - Gerardo Toro-Farmer, University of South Florida
  - Hans Peter Grossart, Leibniz-Institute of Freshwater Ecology and Inland Fisheries
  - Bilqis Hoque, Environment and Population Research Centre
  - Peter Hunter, University of Stirling
  - Cedric Jamet, Laboratoire d'Océanologie et de Géosciences
  - Anders Jensen Knudby, University of Ottowa
  - Harald Krawczyk, German Aerospace Center, Remote Sensing Technology Institute
  - Tiit Kutser, University of Tartu
  - Zhong Ping Lee, University of Massachusetts, Boston
  - George Leshkevich, National Oceanic and Atmospheric Administration
  - Soo Chin Liew, National University of Singapore
  - Mark Matthews, CyanoLakes
  - Wes J. Moses, United States Naval Research Laboratory
  - Michael Natschke, KISTERs AG
  - Nima Pahlevan, National Aeronautics and Space Administration
  - Suhyb Salama, University of Twente
  - John F. Schalles, Creighton University
  - Frank Schlaeger, KISTERs AG
  - Evangelos Spyrakos, University of Stirling
  - Andrew Tyler, University of Stirling
  - Maria Tzotziou, City College of New York
Working Group 3

- Co-chairs
  - Blake Schaeffer, United States Environmental Protection Agency
  - Ghada El Serafy, Deltas

- Members
  - Damien Bouffard, École Polytechnique Fédérale de Lausanne
  - Laurence Carvalho, Centre for Ecology and Hydrology
  - Maycira Costa, University of Victoria
  - Miroslaw Darecki, Institute of Oceanology Polish Academy of Sciences
  - Deltas
  - Gerardo Toro-Farmer, University of South Florida
  - Steve Groom, Plymouth Marine Lab
  - Angelica Gutierrez, National Oceanic and Atmospheric Administration
  - Paul Hanson, University of Wisconsin-Madison
  - Thomas Heege, EOMAP GmbH & Co.
  - Peter Hunter, University of Stirling
  - Cedric Jamet, Laboratoire d'Océanologie et de Géosciences
  - Klaus Joehnk, Commonwealth Scientific and Industrial Research Organisation
  - Philip Klinger, EOMAP GmbH & Co.
  - Els Knaeps, VITO
  - Anders Jensen Knudby, Univesrity of Ottowa
  - Tiit Kutser, University of Tartu
  - Zhong Ping Lee, University of Massachusetts-Boston
  - George Leshkevich, National Oceanic and Atmospheric Administration
  - Soo Chin Liew, National University of Singapore
  - Stephen C. Maberly, Center for Hydrology and Ecology
  - Mark Matthews, CyanoLakes
  - Emilio Mayorga, University of Washington
  - Michael Natschke, KISTERS AG
  - Daniel Odermatt, Odermatt & Brockmann GmbH
  - Emily Read, United States Geological Survey
  - IIs Reusen, VITO
  - Kevin Rose, Rensselaer Polytechnic Institute, Troy
  - Philipp Saile, Federal Institute of Hydrology (BfG) and United Nations Environment Programme-GEMS/ Water
  - John F. Schalles, Creighton University
  - Frank Schlaeger, KISTERS, AG
  - Richard "Dick" Smith, United States Geological Survey
  - Anthony Vodacek, Rochester Institute of Technology
  - Kathleen Weathers, Cary Institute of Ecosystem Studies
Working Group 4

- Co-chair
  - Steve Groom, Plymouth Marine Lab
- Members
  - Deltarcs
  - Paul Hanson, University of Wisconsin-Madison
  - Thomas Heege, EOMAP GmbH & Co.
  - Philip Klinger, EOMAP GmbH & Co.
  - Els Knaeps VITO
  - George Leshkevich, National Oceanic and Atmospheric Administration
  - Michael Natschke
  - Ills Reusen, KISTERS AG
  - Philipp Saile, Federal Institute of Hydrology (BfG) and United Nations Environment Programme-GEMS/ Water
  - Blake Schaeffer, United States Environmental Protection Agency
  - John F. Schalles, Creighton University
  - Frank Schlaeger, KISTERS AG
  - Kathleen Weathers, Cary Institute of Ecosystem Studies

Working Group 5

- Co-chairs
  - Bilqis Hoque, Environment and Population Research Centre
  - Andrew Tyler, University of Stirling
- Members
  - Laurence Carvalho, Centre for Ecology & Hydrology
  - Paul Hanson, University of Wisconsin-Madison
  - Erin Hester, North Carolina State University
  - Peter Hunter, University of Stirling
  - Kevin Rose, Rensselaer Polytechnic Institute, Troy
  - Suhuy Salama, University of Twente
  - Blake Schaeffer, United States Environmental Protection Agency
  - Anthony Vodacek, Rochester Institute of Technology
  - Kathleen Weathers, Cary Institute of Ecosystem Studies