2.4.6 Water- Water Quality Scenario

Clean water is essential for human and ecological health. Surface water quality in particular, whether in lakes, rivers, beaches, or coastal marine areas, has a range of effects on the way people live and work. Water connects to everything, but everything also connects to water. This means that a wide range of observational, framework, and model data are required to evaluate, predict, and make decisions about water quality. Coastal river-ocean systems are particularly challenging because so many different water quality effects are possible, and because they are often located in complex urban areas.

The objective of the Water Quality scenario is to assist decision-making in the Water Societal Benefit Area (and other SBA's). The focus of the scenario will be on leveraging the GEOSS Common Infrastructure to address the fundamental challenge of water quality management–that observation, interpretation, and reporting cycles usually occur much more slowly than effective decision-making requires. A GEOSS Water Quality scenario should be able to support several avenues of decision-making improvement:

- Discovery of a wide variety of information relevant to water quality decisions,

- Live integration of inputs from a range of organizations and institutions at many levels, many of which (such as community groups) have limited means themselves to host and publish data.

- Rapid publication of preliminary observation data to support necessary decision making, with service-based updates as further analysis and interpretation are performed.

- Development and validation of model indicators such as precipitation for beach closures and other urgent management decisions

There are a tremendous number of both mandatory and voluntary in situ observations of water quality, biogeochemical, and physical characteristics of waterways, water bodies, and drainage / discharge facilities. While many hydrologic features relevant to water quality management are too small to effectively apply many satellite remote sensing techniques, there is increasing application of remote sensing to water quality and related processes such as drainage, development, weather, etc. Of particular interest to the Internet enablement represented by GEOSS are the many sources and types of community involvement in data provision, from volunteer water sampling and biological inventories to reports of anomalous discharges and spills. Water quality scenarios are a good opportunity for involving a wide range of actors in GEOSS both as providers and consumers.

2.4.6.1 Targeted or Supported Community

The community involved in a water quality scenario includes all of those who support, make, and are affected by water quality decisions in urban coastal watersheds. While water scientists and engineers are a key user group for GEOSS, the scenario will target particularly the community of managers and decision makers who must oversee and

communicate beach closures, health alerts, compliance reporting, and other water quality related public policy measures.

2.4.6.2 Context and pre-conditions

2.4.6.2.1 Actors

- Data collectors and providers
    - Federal, state, and local agency water professionals
    - Watershed, waterway, and coastal zone assocations
    - Community volunteers
- Managers and decision makers
    - National (e.g. USGS and EPA in USA) regional administrators
    - State health and natural resources authorities
    - Local public safety and health authorities
- Agencies, businesses and industries whose activities affect water quality.
    - Sanitary, effluent, and stormwater dischargers
    - Non-point-source and and aerial pollutant emitters
- End users and citizens affected by water quality decisions
    - Beach and waterway users
    - Fishermen
    - Homeowners and residents

2.4.6.2.2 Information Assumed to be Available

A wide array of water quality information is assumed to be available in terms of collection and processing, although a major challenge of this scenario will be to publish this information in the form of services and make it available through the GCI. In particular, much critical information is only presently published in lengthy reports long after the actual observations have been made. Information in this form is not readily accessible either for online modelling of significant indicators, or for critical decision making based on those indicators. Another challenge is that relevant information is generated or compiled by a variety of organizations at various governmental levels and sampling scales.

- Framework data: typical basemap layers are important for placing processes affecting water quality in context. Aspects of the landscape specifically important for water quality include hydrography, topography, land use land cover, infrastructure, and coastal bathymetry.
- Water quality data: in situ measurements of water quality include both time series information for model development, and rapid-response parameters such as e coli count for decision support.

- Hydrology data: stage, current, temperature, clarity and other physical measurements. Also important are data on effluent discharges, water usage for irrigation, and other non-point-source contributions to constituent loading.

- Biological data: observations of vegetation type and extent, occurrence of bottom sludge, benthic ecology, plankton ecology and distribution, fishery sampling.

- Remote sensing / synoptic data: remote sensing applications for water quality are more developed for coastal ocean characteristics such as chlorophyll-a, but

2.4.6.2.3 Processing and Collaboration Functionality Needed

Both process-oriented and statistical models are routinely used for evaluating and predicting water quality effects at local and regional scales. The ability to update the calibration and validation of models as new or reconsidered inputs are available is particularly important.

Nutrient transport algorithms are now also being included in some global water transport models (such as WBM/WTM), which have daily time steps.   At the same time, nutrient models are being coupled with carbon models within land surface models (although such land surface models do not carry out water routing, except in specialized cases of post-processing). These techniques identify source strength for such nutrient concentrations, which are then added to river networks. These modeling techniques need to be integrated with space-born Earth Observations.

Collaboration between data providers and consumers will be critical to a water quality scenario as decision-making priorities interact with the cycle of data collection and interpretation. This includes access to data provenance and status, as well as the ability to propagate data needs and availability from one group to the other.

2.4.6.3 Scenario Description

Below are four possible scenarios that can be exercised during AIP-3. The final scenario(s) and their associated steps will be determined based on the CFP responses.

Possible Scenario 1

This scenario is focused on a single large water body (as in the case of a large lake system or coastal bay) and its surrounding watershed up to the water divide (mountain chain separating drainage basins). A policy maker within a state or national environmental protection organization is charged with responsibility for preparing annual reports certifying progress towards targeted restoration of a coastal bay or large lake, including
- Water Quality (Dissolved Oxygen, Mid-channel water clarity, Chlorophyl-a, Chemical contaminants, etc)
- Habitat and Lower Trophic-Benthic Community (Benthic index of Biotic Integrity, Phytoplankton, Submerged Aquatic Vegetation abundance, sediment health, etc)
- Total Maximum Daily Load (TMDL) for the water body and constituents
- Changes in land use within the upstream watershed upon these coastal bay or large lake indicators

Landsat and MODIS satellite data (SeaWiFS, AVHRR, etc) can be blended with in situ observations of water clarity and chlorophyll-a content, while Landsat and MODIS time series can be used to track changes in land use and linked to predictive values in numerical models used to simulate water quality and water nutrient loads. Surface water buoys deployed as a sensor net can also provide in situ data streams that are inputs to a visualization of total water body health. The combination of multiple sources of information—including visualized information accessible through portal tools—decreases the labor required to prepare the progress report on progress made towards restoration of the coastal bay (or other water body). Interim visualizations and other interpretive products can be more easily and rapidly updated during the course of the year, allowing state government officials and the public to participate in restoration policy and other activities over shorter time scales than the yearly one over which formal reports on progress towards reaching restoration goals are published.

Possible Scenario 2

An water manager or an official in a public health agency (a decision maker) has the responsibility of issuing alerts warning the public, as during significant precipitation events, when the storm drain infrastructure capacity of a city is exceeded, resulting in CSO's (Combined Sewer Overflows). CSO consequences include beach, waterway, and fishing closures, as well as compromised drinking water and even air quality near contaminated surface water. In extreme cases, it may be necessary to detect and mitigate surface drainage of raw sewage in urban areas. This type of scenario is relevant around the world wherever the urban water infrastructure is aging, inadequate, or underdeveloped.

Possible Scenario 3

A policy maker manages a decision support system that sends alerts to the academic marine science community to dispatch university marine scientists to investigate possibl conditions of coral reef bleaching. This system is automated, and is based upon processing input data, such as high-resolution sea surface temperature (SST), wind from buoys, downwelling solar radiation from satellite and buoys, and Photosynthetic Active Radiation (PAR) from satellite (and buoy), combined with decision rules that define the threshold for triggering email alerts. Pylons and buoys can be linked together as a sensor network, combined with satellite-based Earth Observations. For example, the US National Oceanic and Atmospheric Administration (NOAA) Integrated Coral Observing Network (ICON) is such a system.

Possible Scenario 4

In addition to anthropogenic water uses (such as agriculture and power generation), water is also required to maintain the normal functioning of ecosystem services, maintaining high biodiversity. For example, water will be withdrawn by root systems of riparian vegetation or wetland vegetation. Minimum water levels and quality required to sustain fish migration as well as to provide habitat and water quality (e.g. dissolved oxygen levels, effluent dilution, temperature) during low flow and flood conditions. This "allocated use" of the environment constitutes "environmental flow requirement."
This scenario focuses on a decision maker who is allocating scarce water flows between multiple ecological and human water needs.

2.4.6.3.1 Scenario Events

The specific scenario events to be implemented will be determined after selection of specific scenarios to focus on during AIP-3, based on the CFP responses. A notional sequence of events is presented below:

1. Water quality data providers at national, state, and local levels publish live water quality measurements from one or more coastal river-ocean watersheds to GCI

2. Water quality scientists discover new sources of data and build water quality predictive model applications for supporting management decisions

3. Water quality managers discover model applications and utilize them to determine indicator thresholds such as rainfall rate and overflow occurrence.

4. Community members provide additional observations of significant indicators via a Web application.

5. Indicator observations trigger alerts in decision support applications for a management action such as beach closure.

6. Water quality managers communicate a closure or other mitigation decision to the public.

7. Additional sampling and observations update the model application visualization of water quality effects.

8. The public is able to make water use and water impact decisions based on visualization updates.

2.4.6.4 Enterprise Model

The Water Quality Scenario enterprise model will be further developed upon selection of one or more scenarios to focus on during AIP-3, based on the CFP responses.
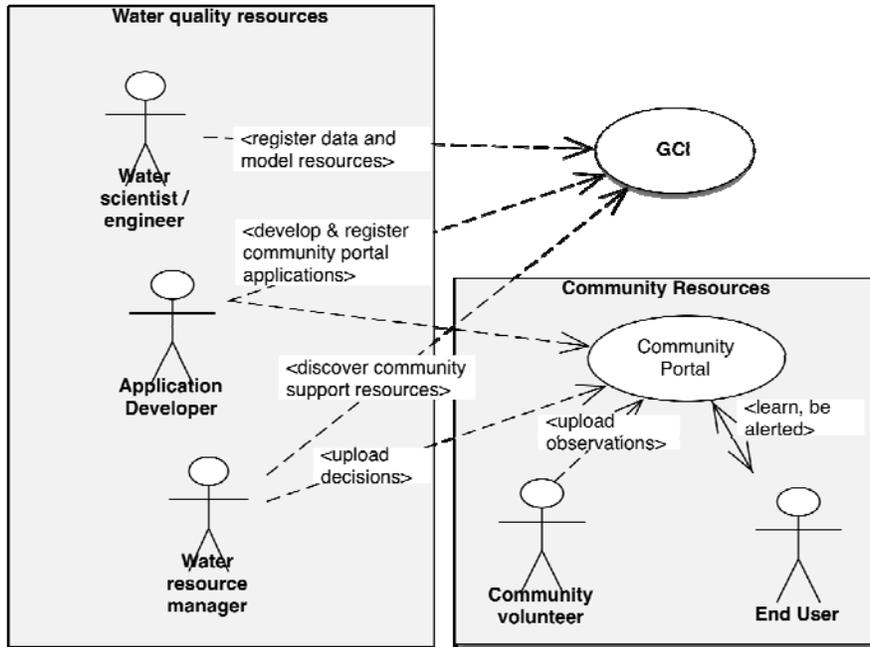
Figure 1 – Water Quality decision support enterprise model

2.4.6.5 References

IGWCO- Water Quality http://www.earthobservations.org/wa_igwco_th_wq.shtml

GEO Task 09-01-a Water Societal Benefit Area
http://sbageotask.larc.nasa.gov/water.html