# Open Geospatial Consortium

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# OGC **CHISP-1 Summary Engineering Report**



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## Preface

The CHISP-1 initiative was conducted as a Pilot initiative, which is a collaborative effort that applies technology elements from the OGC Technical Baseline and other (non-OGC) technologies to address Sponsor requirements and scenarios.

OGC Pilot initiatives are part of OGC's Interoperability Program, a global, hands-on and collaborative prototyping program designed to rapidly develop, test and deliver proven candidate standards into OGC's Standards Program, where they are formalized for public release. In OGC's Interoperability Initiatives, international teams of technology providers work together to solve specific geo-processing interoperability problems posed by the Initiative's sponsoring organizations. OGC Interoperability Initiatives include test beds, pilot projects, interoperability experiments and interoperability support services - all designed to encourage rapid development, testing, validation and adoption of OGC standards.

This report summarizes the results of OGC's Climatology-Hydrology Information Sharing Pilot, Phase 1 (CHISP-1). The objective of this initiative was to develop an inter-disciplinary, inter-agency and international virtual observatory system for water resources information from observations in the U.S. and Canada, building on current networks and capabilities.

The CHISP-1 Initiative was designed to support these Use Case functions:

- Hydrologic modeling for historical and current stream flow and groundwater conditions
- Modeling and assessment of nutrient load into the Great Lakes

Suggested additions, changes, and comments on this report are welcome and encouraged. Such suggestions may be submitted by email message to the editor or by making suggested changes in an edited copy of this document (keep Revision Tracking enabled).

 

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# OGC® CHISP-1 Summary Engineering Report

# Summary of OGC Climatology-Hydrology Information Sharing Pilot, Phase 1 (CHISP-1)

## 1 Overview

The Climatology-Hydrology Information Sharing Pilot, Phase 1 (CHISP-1) was an initiative of OGC's Interoperability Program. The Pilot was a collaborative effort that applied technology elements from the OGC Technical Baseline and other (non-OGC) technologies to Sponsor scenarios. The Pilot was conducted to "stress test" a set of OGC standards based on real-world application and experience. The majority of work for CHISP-1 was conducted from November 2012 through April 2013, with the following outcomes:

- **18** Components were developed or deployed for the Pilot to demonstrate system functions and interoperability by participants and sponsor organizations
- An Engineering Report (ER) was prepared to capture the technical architecture, description of the system functions developed to address Sponsor provided Use Cases, and Lessons-learned along with recommendations for Next Steps.
- A live presentation and demonstration was conducted in the form of a public webinar, hosted and broadcast by Directions Media, on 16 April 2013. Recording of the webinar is available for review by the public here: http://www.directionsmag.com/webinars/view/ogc-update-results-of-the-climate-hydrologic-information-sharing-pilot/318678
- **10** organizations were involved in the CHISP-1 initiative consisting of 3 participants and 7 sponsor organizations. Additionally, a number of other organizations were observers on the project.
- **7** sponsoring organizations defined requirements for CHISP-1. The sponsors' requirements were recorded in a set of RFQ/CFP documents that were released by OGC seeking organizations that wished to participate in the project.

### 1.1 Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

| Name | Organization |
|---|---|
| Lew Leinenweber | Open Geospatial Consortium |
| Peter Vretanos | CubeWerx |
| | |

### 1.2 Revision history

| Date | Release | Editor | Primary clauses modified | Description |
|---|---|---|---|---|
| 2013-07-15 | r2 | Lew Leinenweber | 1.1, 1.2, update section headers | □ Added contact points and revision history tables<br>□ Corrected OGC doc number in page headers<br>□ Editorial updates in a number of sections. |
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## 2 Organizations in CHISP-1

### 2.1 Sponsoring Organizations

CHISP-1 was sponsored by the following organizations:

- □ Environment Canada
- □ Natural Resources Canada (NRCan)
- □ GeoConnections
- □ NRCan Groundwater Science Program
- □ US Geological Service (USGS)
- □ Environmental Protection Agency (EPA)

### 2.2 List of Participating Organizations

The following OGC member organizations were participants in this project.

- □ Explorus Data Solutions

 

- RPS ASA (Applied Science Associates)
- GIS Research Center, Feng Chia University (GIS.FCU)

Additionally, there were 7 other organizations that were observers for the CHISP-1 project.

### 2.3 CHISP-1 IP Team

The IP Team is an engineering and management team to oversee and coordinate an OGC Interoperability Initiatives. The IP Team facilitates architectural discussions, synopsizes technology threads, and supports the specification editorial process. The IP Team is comprised of OGC staff and representatives from member organizations. The CHISP-1 IP Team was as follows:

- Interoperability Program Chief Engineer: George Percivall, OGC
- Interoperability Program Executive Director: Nadine Alameh, OGC
- Initiative Director: Lewis Leinenweber, OGC
- Thread Architect: Panagiotis (Peter) A. Vretanos, CubeWerx

## 3 Milestone Schedule

The CHISP-1 Pilot project was planned and conducted as shown in the following table of milestones.

**Table 1, CHISP-1 Milestone Schedule**

| Milestone | Date |
|---|---|
| Sponsor Meetings | January – June 2012 |
| RFQ Development | July 2012 |
| RFQ/CFP Released | 31 July 2012 |
| Bidders Conference | 15 August 2012 |
| Clarifications Posted and final questions due | 20 August 2012 |
| RFQ Responses Due | 14 September 2012 |
| Pilot Kickoff, Toronto Canada | 13-14 November 2012 |
| Preliminary Design Milestone | 18 January 2013 |
| Demonstration and Presentation | 16 April 2013 |
| Completion of Pilot Activities | 26 April 2013 |

# 4 Development Objective and Results

The objective of this initiative was to develop an inter-disciplinary, inter-agency and international virtual observatory system for water resources information from observations in the U.S. and Canada, building on current networks and capabilities.

The CHISP-1 Initiative was designed to support these Use Case functions:

- Hydrologic modeling for historical and current stream flow and groundwater conditions. Integrate trans-boundary stream flow and groundwater well data, as well as national river networks (US NHD and Canada NHN) from multiple agencies with emphasis on time series data encoded as WaterML2 and real-time flood monitoring.

- Modeling and assessment of nutrient load into the Great Lakes. Access water-quality data from multiple agencies and integrate with stream flow information for calculating nutrient loads. Emphasis was on discrete sampled water quality observations, linking those to specific NHD stream reaches and catchments, and additional metadata for sampled data.

## 4.1 CHISP-1 Engineering Report

The detailed technical results for the CHISP-1 initiative are documented in the following Engineering Report

- OGC 13-053, CHISP-1 Engineering Report

## 4.2 CHISP-1 Scenarios Use Cases

The following paragraphs describe in more detail the Use Cases developed in the CHISP-1 pilot.

### 4.2.1 Hydrologic modeling for historical and current stream flow and groundwater conditions

This scenario focuses on accessing river gage and groundwater well information associated with a river network that in turn is associated with a set of basins (watersheds). Millions of stream gages and well monitors have been installed throughout the U.S. and Canada, reporting continuous values of depth, flow rate and/or other parameters, as time series. The purpose of this use case is to provide seamless access and interoperability of this data across the U.S.-Canada border.

Several water catchment basins cross this border. The Pilot region considered two basins with portions in both the U.S. and Canada. The Milk River basin includes parts of Alberta, Saskatchewan, and Montana (**Figure 1**) and the Souris River basin includes parts of Manitoba, North Dakota, and Saskatchewan (**Figure 2**)

 

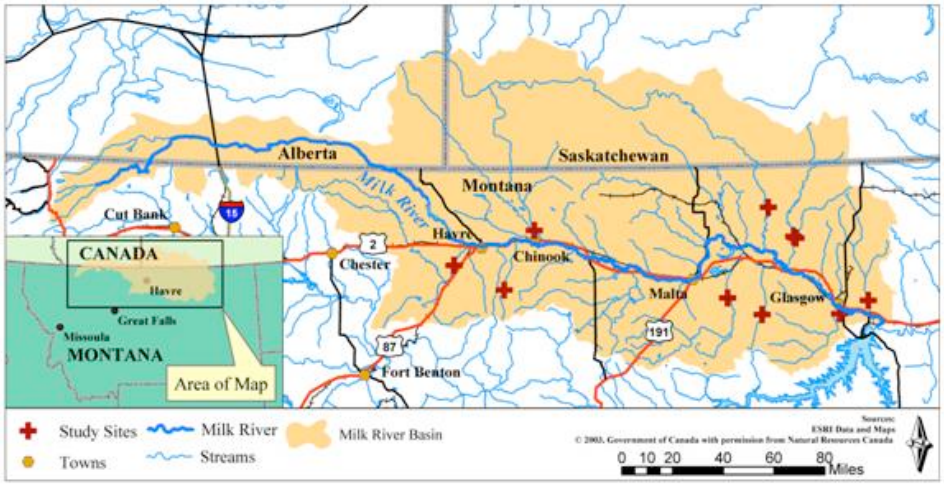


**Figure 1, Scenario 1 – Milk River Basin**

Source: http://www.umt.edu/watershedclinic/images/clip_image002.jpg

The Souris River flows into the Assiniboine River, then into the Red River and Lake Winnipeg, which is part of the Hudson Bay. The Souris River basin shows the locations of stream gauges as green circles (source: http://nd.water.usgs.gov/floodinfo/souris.html).

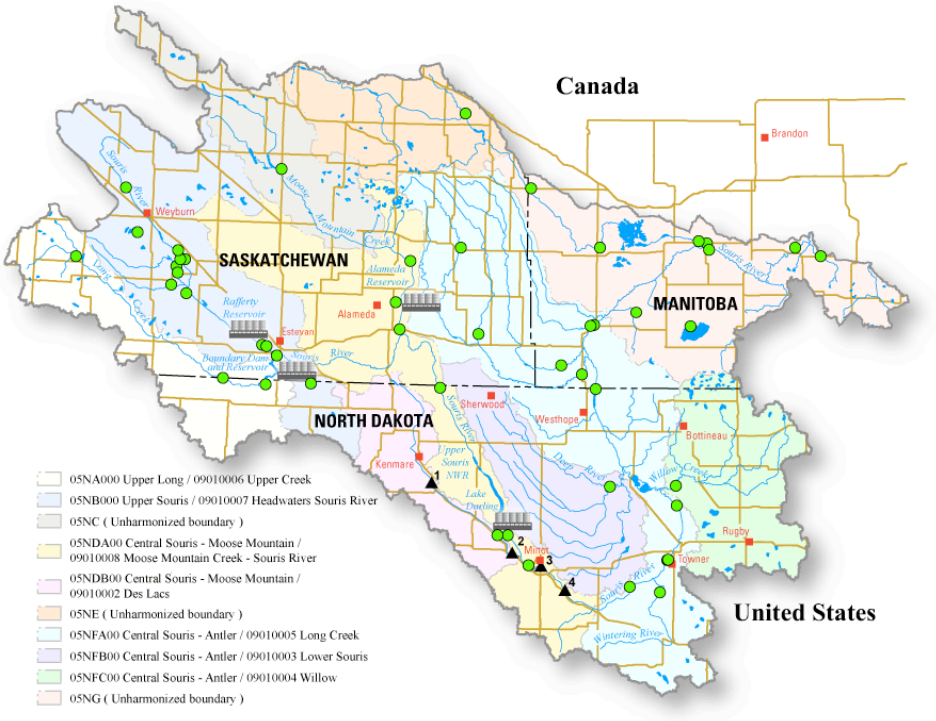


**Figure 2, Scenario 1 – Souris-Red River Basins**

Source: http://en.wikipedia.org/wiki/File:Sourisrivermap.png

The CHISP-1 Pilot initiative selected the Milk River as the area of interest to focus on services and data to support the Use Case scenario. More specifically, this Use Case focused on exchanging cross-border hydrologic data (stream flow and groundwater levels) with a unified alert service. Stream/river gauge and groundwater well locations associated with a river network and in turn associated with a set of basins (watersheds). For any well or stream gauge location, a web service was developed to provide access to the gauge and well information on all upstream stream segments or in all contributing basins. An event service was developed to provide subscribers with a notification if any upstream streamflow or well water level reaches or exceeds a user-defined threshold. The selected Milk River basin crosses the U.S./Canada border. Data providers were identified and selected from include provincial and federal agencies. Based on sensor events, a flood is determined to be imminent and alert is generated for distribution to authorities in the affected areas.

### 4.2.2 Architecture – Upstream Monitoring and Event Notification Scenario

The CHISP-1 system architecture for this Use Case is represented in the following diagram.

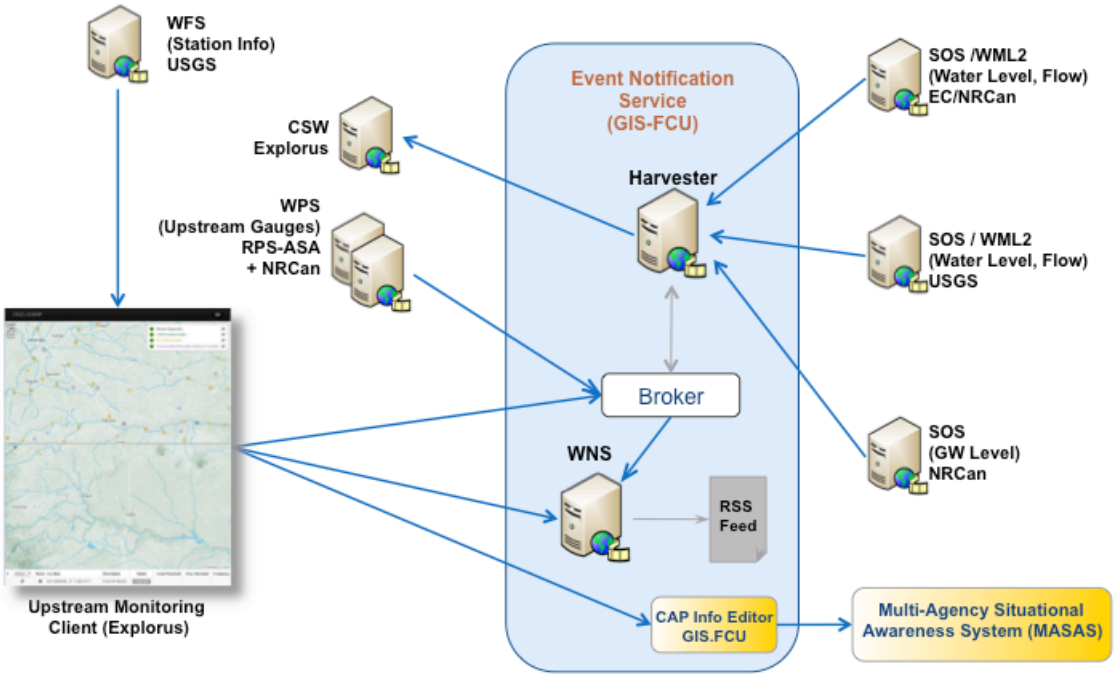


**Figure 3, Scenario 1 - Upstream Monitoring and Event Notification Architecture**

### 4.2.3 Modeling and assessment of nutrient load into the Great Lakes

This scenario focuses on calculating nutrient loads (particularly Nitrogen and Phosphorus) flowing into the Great Lakes from tributaries (e.g., via hydrologic pathways), using web-accessible inputs of water quality observations and flow rates. The system produces web-accessible outputs of known nutrient loads that includes metadata to document the model output and processing steps. The project focused on the Lake Ontario basins as shown in the following diagram.


**Figure 4, Scenario 2 – Lake Erie Basin and Lake Ontario Basin**

http://www.glfc.org/lakecom/lec/spatial_inventory/images/LakeErie.jpg

### 4.2.4 Architecture – Great Lakes Nutrient Load Calculation Scenario

The CHISP-1 architecture implemented for this Nutrient Load Calculation Use Case is represented in the following diagram.

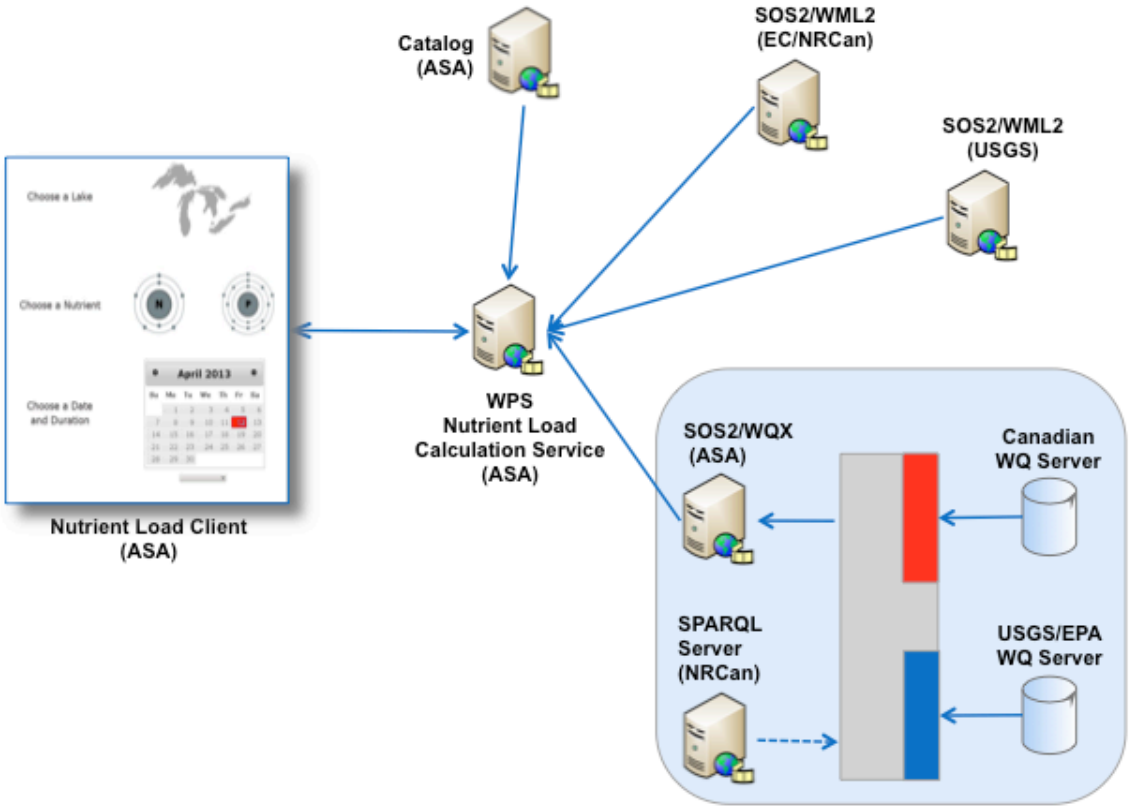


**Figure 5, Scenario 2 – Great Lakes Nutrient Load Calculation Service Architecture**

### 4.3 CHISP-1 Client and Service Components

Pre-existing System and Service components shown in Table 2 were deployed and used in the CHISP-1 initiative.

**Table 2, Pre-existing components used in CHISP-1**

| Component | Provider | Standard | Output | Use Case | |
|---|---|---|---|---|---|
| | | | | Flood Monitoring | Nutrient Load |
| Sensor Observation Service (Water Level, Water Flow, historic & live) | Environment Canada (via NRCan) | SOS 2.0 | WaterML 2.0 | ● | ● |
| Sensor Observation Service (Groundwater Level) | NRCan | SOS 2.0 | WaterML 2.0 | ● | |
| Sensor Observation Service (Water Level, Water Flow) | USGS | SOS 2.0 | WaterML 2.0 | ● | ● |
| Web Feature Service (Station info) | USGS | WFS 1.1.0 | WaterML 2.0 | ● | |
| Web Processing Service (Upstream geometry NHD/NHN) | NRCan | WPS 1.0 | WPS 1.0 | ● | |
| Web Map Service (Stream segments) | NRCan | WMS 1.3.0 | Map image (png, gif, jpg, wbmp, svg) | ● | |
| Multi-Agency Situational Awareness System (MASAS Cap alert system) | Government of Canada | Ad-hoc | Common Alert Protocol (CAP) messages | ● | |

Components shown in Table 3 were developed and deployed by Participants during the CHISP-1 initiative.

**Table 3, Components developed and deployed during CHISP-1 project**

| Component | Provider | Standard | Output | Use Case | |
|---|---|---|---|---|---|
| | | | | Flood Monitoring | Nutrient Load |
| Web-based Subscription Client | Explorus | N/A | N/A | ● | |
| Catalogue (Service metadata, Station metadata) | Explorus (hosted pycsw instance) | CSW 2.0.2, APSIO 1.0.0 | ISO 19115, ISO 19119, OGC Core (csw:Record) | ● | |
| Event Notification Service (Monitor stations, flood event notification) | GIS-FCU | N/A | N/A | ● | |
| Web Notification Service (notifications to subscribers) | GIS-FCU | WNS 0.0.9 | email | ● | |
| Web Processing Service (Upstream stations/gauges) | ASA | WPS 1.0 | WPS 1.0 | ● | |
| Nutrient Load Calculation Web Client | ASA | N/A | N/A | | ● |
| Web Processing Service (Nutrient load calculation) | ASA | WPS 1.0 | WPS 1.0 | | ● |
| Sensor Observation Service (Integrates US and CAN Water Quality servers) | ASA | SOS 2.0 | IOOS SWE XML | | ● |
| Local catalogue (Tributaries, stream & WQ gauges) | ASA | Django Database Abstraction API | N/A | | ● |
| SPARQL server (Analyte equivalents US, Can) | NRCan | SPARQL | RDF | | ● |

## 5 Achievements

Highlights of significant results achieved for this CHISP-1 initiative included:

- ✧ For the first time, provided a capability for an EM Analyst (or anyone) to view trans-boundary upstream hydrometric (and groundwater) data via the web in near real-time.
- ✧ Developed a capability to monitor all available upstream stations independent of location or jurisdiction to generate an alert in case of flood and/or drought.

 

- ✧ Developed and demonstrated use of the GetDataAvailability (GDA) operation for SOS v2 for retrieval of time-series WaterML2 encoded stream flow data.

- ✧ Demonstrated interoperability through integration of SOS, WPS, WNS, and CSW services along with the OASIS CAP standard to provide near real-time threshold monitoring and notification to support alert mechanisms across international boundary and jurisdictions.

- ✧ Implemented a single SOS service to monitor cross-border international water quality sample data.

- ✧ Demonstrated integration and interoperability of international data services using the SOS and WaterML2 for stream flow and water quality data in order to execute a web-based nutrient load model.

- ✧ Implemented a system to identify upstream water level and flow gauges regardless of relation to US/CAN border.

- ✧ Implemented a Harvester capability to automatically retrieve and store time-series WaterML2 data for streamflow and water level; and to identify if an identified threshold value had been reached on a near real-time basis.

# 6 Future work.

Outcomes and achievements in this CHISP-1 initiative suggested several potential future work areas, which are described in the following sections.

## 6.1 Catalogue

This project used the ISO profile of the OGC Catalogue specification. Such a catalogue is specifically designed to maintain metadata about services, data and their relationship. During the CHISP-1 project however, it was clear that other objects and relationships needed to be catalogued. For example, metadata about gauge stations and their relationship to the hydrographic network needed to be maintained and accessed and this was not easily handled using an ISO based catalogue. A future work item would thus be to investigate using the CSW-ebRIM catalogue, which includes a rich set of structures for cataloguing objects of all kinds, classifying those objects according to any classification scheme and maintaining arbitrary associations between those objects.

## 6.2 Big Data Handling

During this project an SOS profile was developed which, among other things, was designed to compensate for shortcomings in the SOS standard related to handling large networks of sensors. For example, in situations where large networks of sensors are made accessible via SOS, managing the capabilities document of these services becomes cumbersome because the content section can become quite large. A future work item

 

would be to enhance the SOS standard to handle large networks of sensors. This would include work in enhancing the GetCapabilities operation to allows large content sections to be accessed more efficiently – perhaps employing paging or some simple query capability to limit the number of items appearing in the response.

### 6.3 Semantic Mediation

The nutrient load calculation use case illustrated a need that commonly arises in cross-border projects and this is the need for semantic mediation of information. An example of this was the need to mediate analyte names. During the CHISP-1 project a SPARQL server was deployed to investigate its use in this mediation role. However, the server was never populated and so a future work item would be to complete the integration of the SPARQL server into the system.

### 6.4 Service Performance

The CHISP-1 project deployed a large number of services that interacted with each other. Some of these services were not stable resulting in frequent service outages and connection problems with required robust exception handling. This was particularly true for components that operated on a periodic basis such as the Harvester module. A future work item would be to (a) determine why the underlying services were having performance and stability issues and (b) consider more fault tolerant system designs.

### 6.5 Subscription Client Improvements

The following enhancements could be considered for the web-based subscription client:

- Include a search box to allow geo-search by name (e.g. user enters “Milk River” and map zooms to Milk river area)

- The current set of data sources presented on the map is fixed and displayed in a legend in the upper right. Allow sources to be dynamically discovered and added to the map and make the legend dynamic to reflect which sources are currently being displayed.

- Suggestion capability – when creating a subscription it would be useful if the web-based subscription client could access historical information to suggest values for the various input parameters.

### 6.6 Event Notification Service (ENS) Enhancements

The CHISP-1 project has only considered subscription and notification via a web-based browser client and email. However, there are many other standards that might be useful in real world situations. Some examples include GeoSMS (see OGC 11-030r1), that can send notification via SMS and can include all the spatial information that a subscriber needs to know; GeoPackage (see OGC 12-128r1), a draft standard that allows mobile applications to describe and store spatial information locally in a user’s mobile devices;

 

Geosync. (see OGC 10-069r1), that allows users to sync in-situ information back to emergency management centers for further integration.

### 6.7 Nutrient Load Calculation Model

Because of issues with data availability and sparseness on the Canadian side, a simple and ultimately non-scientifically correct model was used in the CHISP-1 project to compute nutrient load. This approach – while yielding invalid results -- allowed us to show that OGC services could be used to (a) provide the data to drive the model and (b) make the model available as a service via WPS. A future work item would be to enhance the model to account for the sparseness of observation and thus generate scientifically valid results.