



World Meteorological Organization

Weather • Climate • Water

Standardization of hydrologic data sharing in RAIII

Silvano Pecora, ARPA, Italy

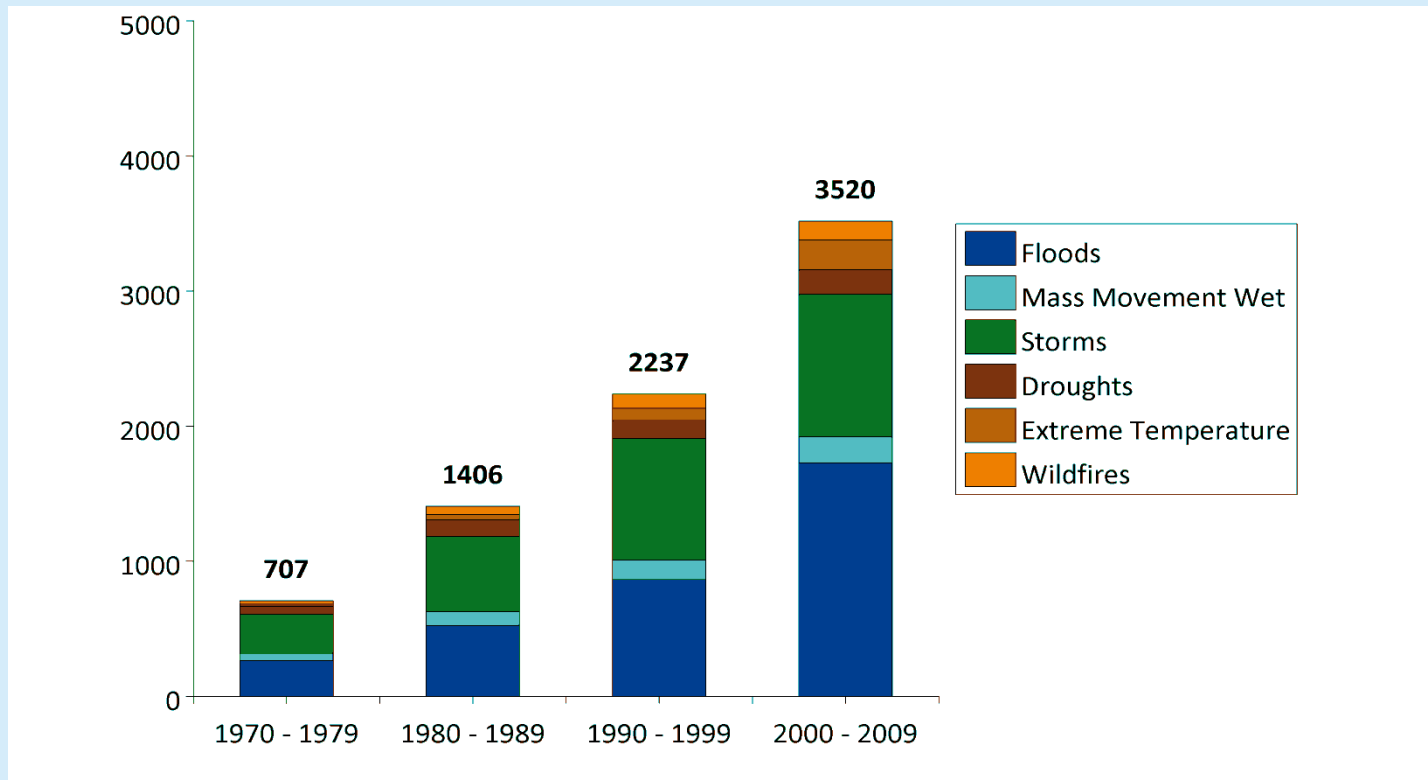
Meeting of the Working Group on Hydrology and Water Resources
in Regional Association III

Asuncion, Paraguay, 5-9 September 2015

VALUABLE INFORMATION FROM WATER DATA

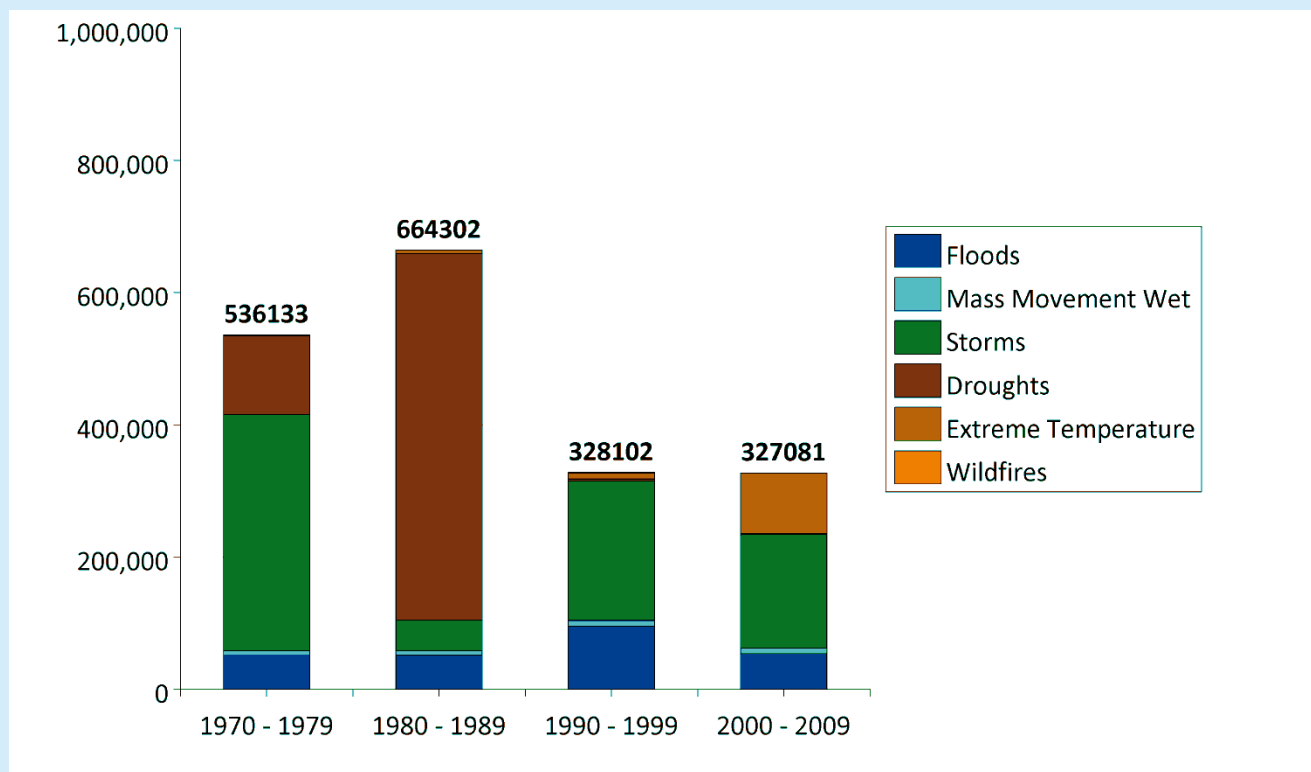


Statistics of disasters associated with weather-, water- and climate-related hazards for the period 1970 to 2009



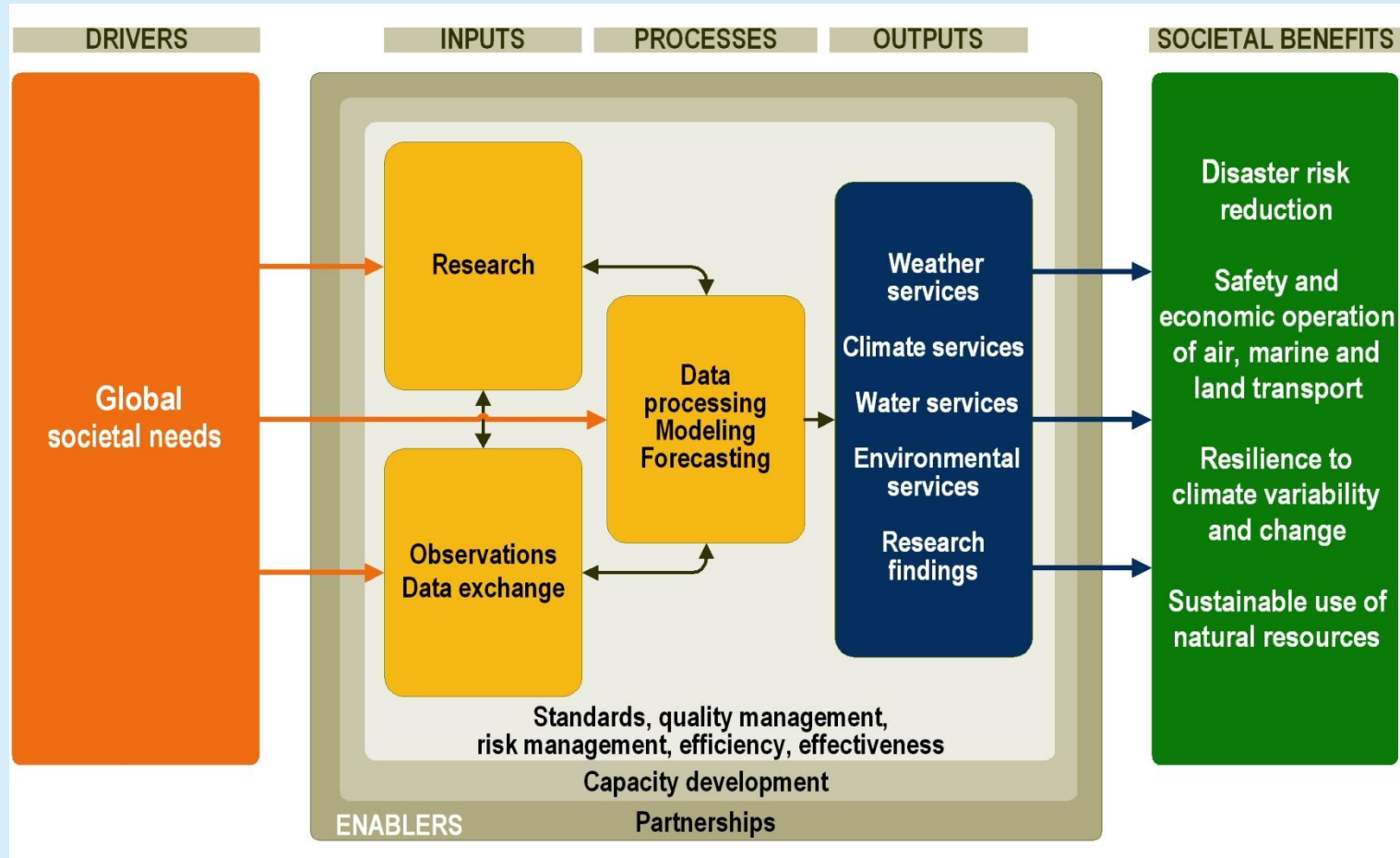
The global total number of disasters by decade and hazard type: significant increase

Statistics of disasters associated with weather-, water- and climate-related hazards for the period 1970 to 2009



The global total number of deaths by decade and hazard type: significant decrease

Schematic representation of the WMO Strategic Plan



Processes to achieve expected results and realize the intended societal benefits

from the WMO STRATEGIC PLAN 2016-2019

WMO COMMISSION FOR HYDROLOGY





CONGRESS

The supreme body, on which all Members are represented; meets every four years

REGIONAL ASSOCIATIONS

- Regional Association I (Africa)
- Regional Association II (Asia)
- Regional Association III (South America)
- Regional Association IV (North America, Central America and the Caribbean)
- Regional Association V (South-West Pacific)
- Regional Association VI (Europe)

Working groups and rapporteurs of regional associations

Regional hydrological advisers

EXECUTIVE COUNCIL

Consists of 37 members, including the President, three Vice-Presidents and the six presidents of the regional associations, who are *ex officio* members; meets annually

Working groups, committees and panels of experts of the Executive Council

TECHNICAL COMMISSIONS

- Commission for Basic Systems (CBS)
- Commission for Instruments and Methods of Observation (CI MO)
- Commission for Hydrology (CHy)
- Commission for Atmospheric Sciences (CAS)
- Commission for Aeronautical Meteorology (CAeM)
- Commission for Agricultural Meteorology (CAgM)
- Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)
- Commission for Climatology (CCI)

Advisory working groups, working groups and rapporteurs of technical commissions

Other bodies which are affiliated with WMO, e.g. JSC for WCRP, IPCC, JSTC for GCOS

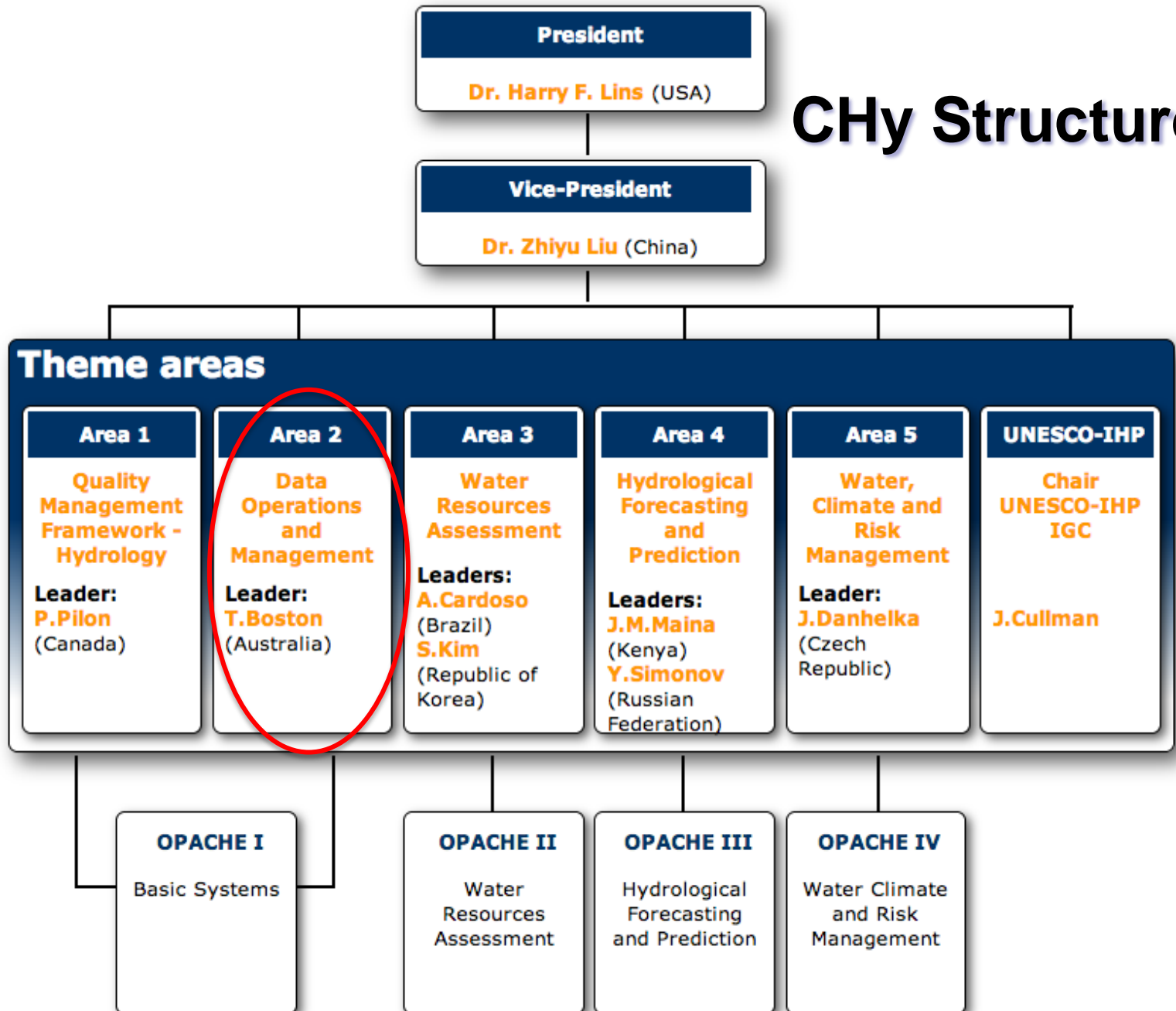
SECRETARY-GENERAL SECRETARIAT

The Secretariat, headed by the Secretary-General, provides support to the above constituent bodies and groups





CHy Structure





Commission for Hydrology (CHy)

Data Operations and Management

- Guide the implementation of CHy-14 Resolution 7/1 that began “a process, including testing, that could see the potential adoption of the WaterML 2.0 as a WMO standard for information exchange managed by WMO (supported by the WMO/OGC MOU) and to register this standard as a joint WMO/ISO standard”;
- Monitor and report on new developments dealing with data management issues, such as observations, data exchange and protocols, data transfer formats, and WIS and WIGOS;
- Review progress with respect to the exchange of hydrological data and products, and propose additional guidance on data that should be exchanged, including harmonization of exchange practices.





International resolutions

WMO Res. 40 (Cg-XII) - WMO policy and practice for the exchange of meteorological and related data and products.

Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well being of all the nations...

WMO Res 25 (Cg-XIII) - Exchange of hydrological data and products.

Members shall provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services in support of the protection of life and property and the well being of all the nations...

WMO Congress of 2012 noted the considerable work being undertaken internationally with respect to the development and agreement on standards for the transfer of hydrologic data between data servers (databases) and users.

WaterML 2.0 was proposed for adoption as a WMO standard for information exchange.



WMO Hydrological Observing System (WHOS)

The background of the slide is a blue gradient. The bottom portion of the image features a realistic, wavy surface of water, with white foam and bubbles visible, suggesting a dynamic aquatic environment. The text is centered in the upper half of the image.

WMO Hydrological Observing System (WHOS)

Background:

No analogue to World Weather Watch within hydrology.

No portal to real-time hydrological data of NHSs, or direct online access to NHS historical data.

WHYCOS is capacity building, not data delivery.

Given increasing number of NHSs with real-time and historical data available online, as well as systems that facilitate data exchange and interoperability (e.g., WaterML 2.0), improved accessibility is achievable goal.

WMO Hydrological Observing System (WHOS)

Proposal:

CHy Advisory Working Group has proposed the **WMO Hydrological Observing System (WHOS)** as the means to provide the most comprehensive hydrological component in fulfillment of the WIGOS objective of “an integrated, comprehensive, and coordinated system which is comprised of the present WMO global observing systems.”

WMO Hydrological Observing System (WHOS)

Design:

WHOS is conceived as a portal to facilitate access to already available on-line real-time and historical data, drawing from the water information systems of countries around the world that make their data freely and openly available, including HYCOS projects.

WMO Hydrological Observing System (WHOS)

Implementation:

Phase 1:

Map interface with links to those NHSs that make their real-time and historical stage and discharge data available online. Initial implementation July 2015.

Phase 2:

A fully WIS/WIGOS compliant services-oriented framework linking hydrologic data providers and users through a hydrologic information system enabling data registration, data discovery, and data access.

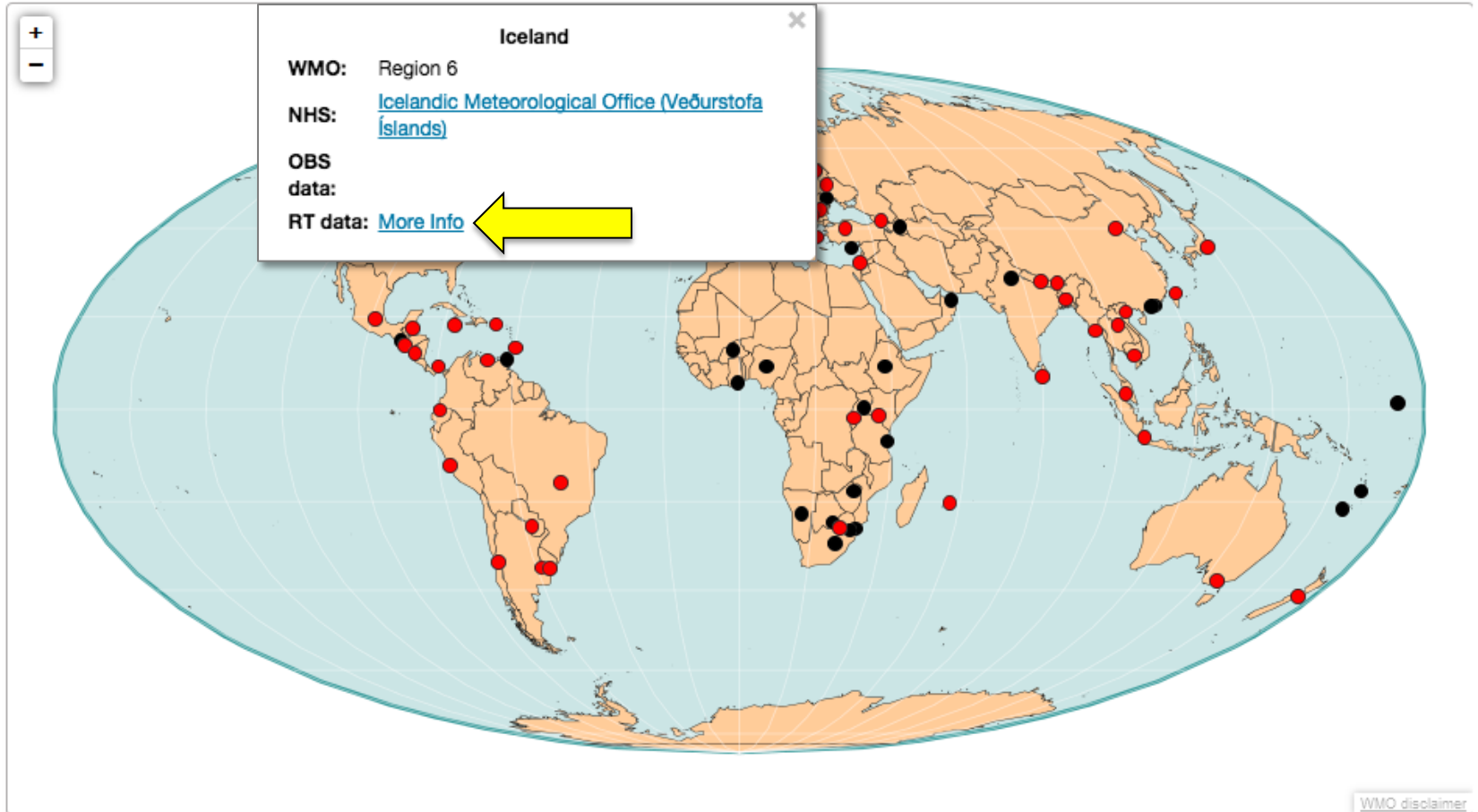
Beta version for CHy-15 review and endorsement (Dec 2016)
Initial implementation for EC approval (June 2018)

WHOS WMO Hydrological Observing System

WHOS is a portal to the online holdings of National Hydrological Services (NHS) around the world that publish their data without restrictions or cost. It represents the hydrological component of the WMO Integrated Global Observing System (WIGOS).

Access to the data comprising WHOS can be obtained via map-based links on the following map. Red dots appear in countries where the National Hydrological Service makes data available from its website. Black dots appear in countries where the National Hydrological Service has a website, but where hydrological data are not available.

Please note that NHS websites appear in the native language of the country, although some NHSs translate parts or all of their websites into English or other languages.



Weather forecast

Weather observations

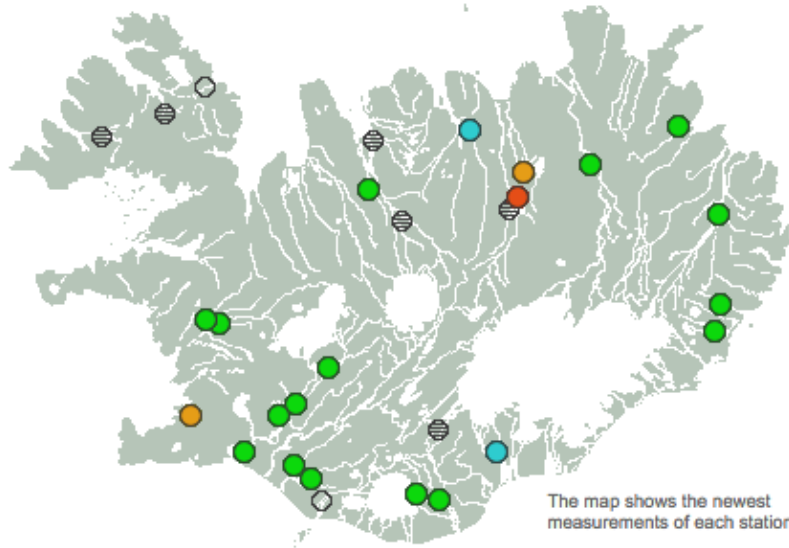
Earthquakes

Hydrology

Avalanches

Stream flow ratio

Preliminary results



The map shows the newest measurements of each station

Explanation of stream flow ratio



Average flow and temperature last 24 hours

River	Place	Flow	Water temperature
Norðurá	Stekkur		
Austari Jökulsá	Skatastaðir		
Jökulsá á Fjöllum	Grímsstaðir	214.0 m ³ /s	5.1 °C
Eldvatn	Eystri-Ásar	58.7 m ³ /s	
Ölfusá	Selfoss		6.3 °C

More hydrological information

Choose a river

Open

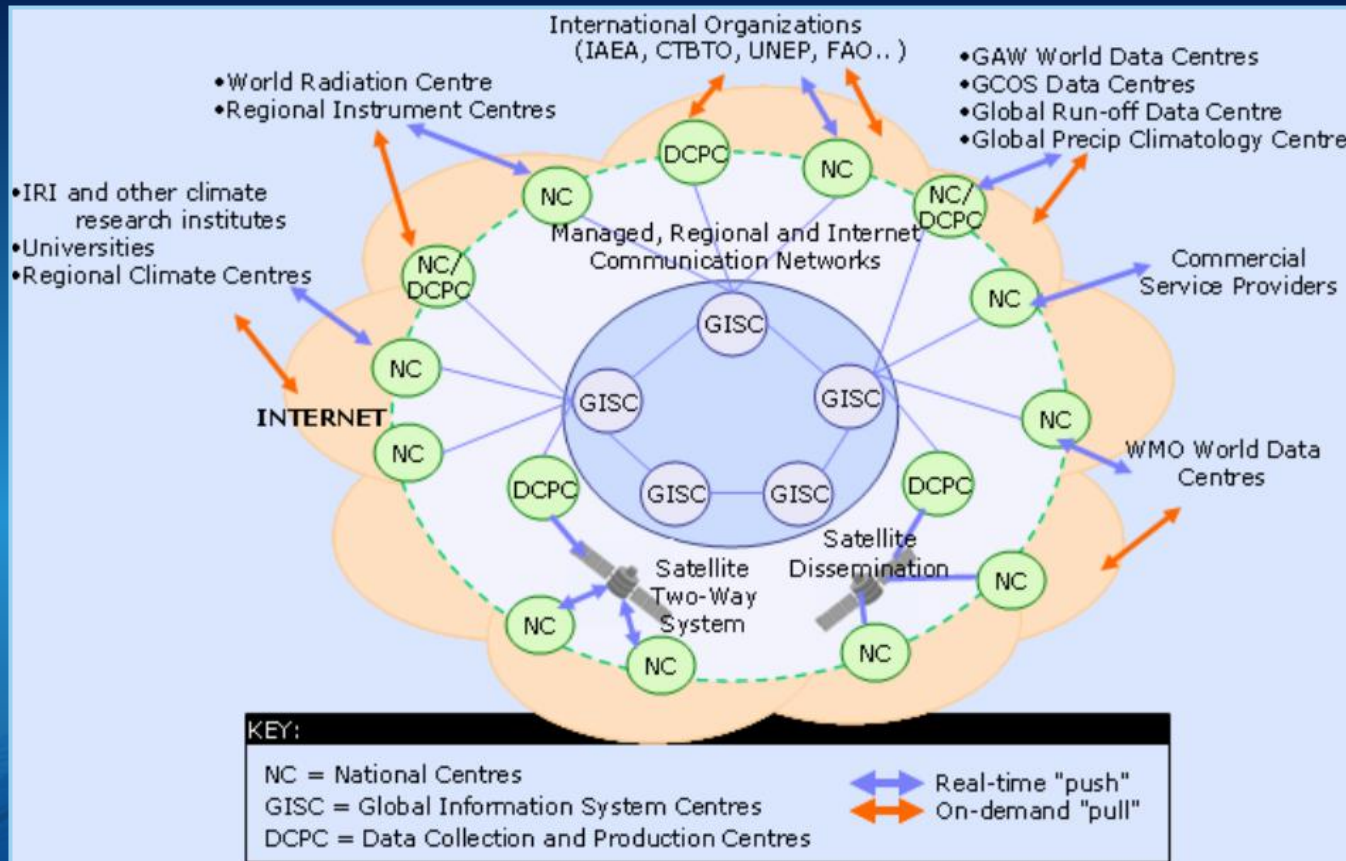
▶ Icelandic Nature Geoportal

▶ Measurement map

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)



WIS – WMO Information System



Ingests data from National Centers . . .

. . . synthesized globally through communication networks



ISPRA

Istituto Superiore per la Protezione
e la Ricerca Ambientale

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ISPRA HIS Sistema informativo idrologico servizio registri Web

Il monitoraggio idrologico italiano viene effettuato mediante una rete federata composta da 19 regioni amministrative e 2 province autonome, insieme con ISPRA, che è l'organo tecnico governativo istituito dal Ministero dell'Ambiente italiano.

Il portale fornisce l'accesso alle osservazioni idrologiche in Italia, comunemente pubblicate come Annali idrologici. In particolare, per le osservazioni in situ, fornisce ulteriori capacità operative, quali un registro nazionale di servizio dati, catalogati utilizzando le norme e le procedure della Geospatial Consortium e l'Organizzazione meteorologica mondiale.

Le interfacce pubblicate sul portale permettono di recuperare i dati idrologici regionali direttamente dai fornitori tramite abilitazione e download.



WEB SERVICE CATALOG SYSTEM

- Brokered services: 19
- Brokered sites: 6088
- Brokered variables: 6
- Brokered values: 73491569
- Geographic extent: [6.704337, 18.48, 35.5017, 47.03659]

The background of the slide is a vibrant blue gradient. At the bottom, there is a detailed, high-resolution image of water splashing, showing droplets and ripples. The text is centered in the upper half of the image.

WATER DATA DISSEMINATION

the old style

THE HYDROLOGICAL YEARBOOKS

Part I Yearbooks published from 1913 to 2014

Part II Yearbooks published from 1913 to 2014

Arpa Servizio IdroMeteo - Windows Internet Explorer

http://www.arpa.emr.it/documenti.asp?anno=0&annof=0&parolachave=sim_annal&cerca=s&idlivello=64&pag=1

Arpa Servizio IdroMeteo

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ADGB
AIAM

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- 2005, Servizio Idrometeorologico - Area Idrologia - Meteo e clima - **Annali idrologici 2005** sim_annali
- 2004, Servizio Idrometeorologico - Area Idrologia - Meteo e clima - **Annali idrologici 2004** sim_annali
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- 1998, Servizio Idrometeorologico - Area Idrologia - Meteo e clima - **Annali idrologici 1998** sim_annali
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1 2 successiva >

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- 1994, Servizio Idrometeorologico - Area Idrologia - Meteo e clima - **Annali idrologici 1994** sim_annali
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- 1991, Servizio Idrometeorologico - Area Idrologia - Meteo e clima - **Annali idrologici 1991** sim_annali
- 1990, Servizio Idrometeorologico - Area Idrologia - Meteo e clima - **Annali idrologici 1990** sim_annali

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<precedente 1 2

a cura di: Servizio IdroMeteorologico - ultimo aggiornamento: 29/10/2007
Arpa Emilia-Romagna - P.IVA 04290860370 Credits - Disclaimer - Privacy WSC 2011/11 WSC VAE-A MGA 1.0

WEB APPLICATIONS

The screenshot shows a web browser window titled "Main Applet - Microsoft Internet Explorer" with the address bar displaying "http://snoopy.metarpa:8080/WebModule1/Servlet1". The application interface includes several tabs: "Stazioni Ad Alta Frequenza", "Dati Riassuntivi Giornalieri", and "Circuito Internazionale". A central "Intervallo Temporale" section is set to "Dal 12:00AM 01 marzo 1984 Al 12:00AM 01 febbraio 2005".

The main content area is titled "Emilia Romagna" and features a map on the left with a zoom control. A central panel displays a "SOMMARIO DELLA RICHIESTA" for the period "Dal 04 marzo 2013 00:00 Al 11 marzo 2013 12:14". This panel includes the following data:

- Numero Stazioni: 2
- Numero Variabili: 1
- Numero Misurazioni ~: 362

Below the summary, there are two lists:

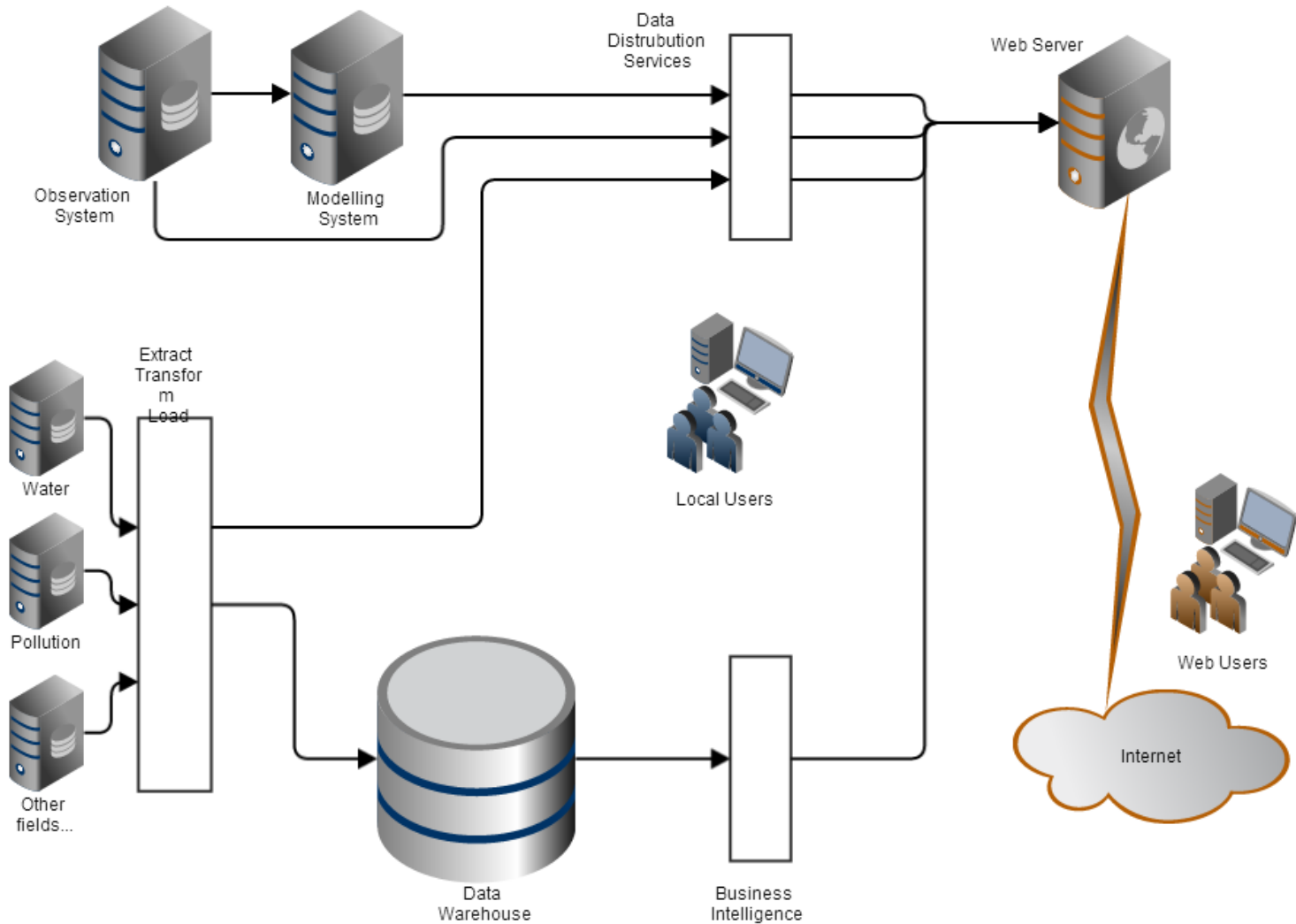
- Stazioni:** San Pietro Capofiume, San Pietro Capofiume
- Variabili Richieste per San...:** Contenuto Idrico Del Suolo L

To the right of the summary is a configuration panel titled "Seleziona il formato di presentazione ed il media". It includes a "Formato" section with radio buttons for Excel, **Html** (selected), Testo separato da virgola, Pdf, VM, and Grafico. A "Media" section has radio buttons for File, **Video** (selected), Ftp, and E-mail. A button "Mostra le opzioni avanzate per Html" is located below the format options.

At the bottom of the configuration panel are "Indietro" and "Avanti" buttons. To the right of the main configuration area is a "Mappe" sidebar with buttons for "Emilia Romagna" and "Europa". At the bottom right, there are input fields for "12" and "13" with an "Ok" button.

A status bar at the bottom of the application window displays the message: "Procedi Alla Selezione Delle Variabili Per Le Stazioni Selezionate In Stazioni Ad Alta Frequenza". The system tray at the bottom of the browser window shows "Applet MainApplet started" and "Internet".

Common actual architecture



WATER DATA DISSEMINATION
the new style



Making data available...

The concept of open data is not new, but a formalized definition is relatively new.

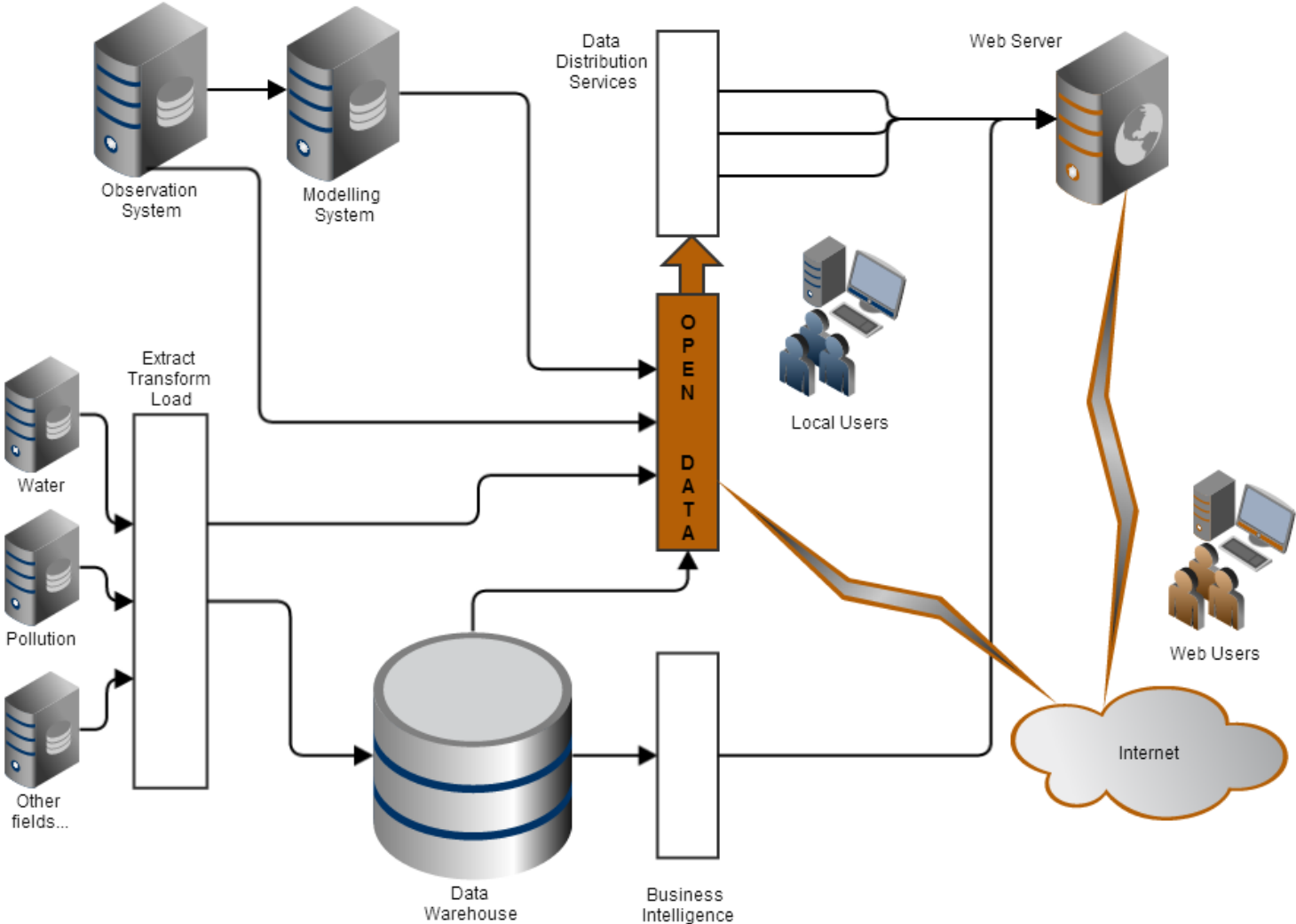
A typical depiction of the need for open data:

Numerous scientists have pointed out the irony that right at the historical moment when we have the technologies to permit worldwide availability and distributed process of scientific data, broadening collaboration and accelerating the pace and depth of discovery.....we are busy locking up that data and preventing the use of correspondingly advanced technologies on knowledge.



John Wilbanks, VP Science, Creative Commons

Open data architecture (towards level 5)



The 5 star deployment scheme



Available on the web (whatever format) *but with an open licence, to be Open Data*



Available as machine-readable structured data (e.g. excel instead of image scan of a table)



as (2) plus non-proprietary format (e.g. CSV instead of excel)



All the above, plus use open standards from W3C (RDF and SPARQL) to identify things, so that people can point at your stuff



All the above, plus link your data to other people's data to provide context

EVOLUTION IN WATER DATA SHARING



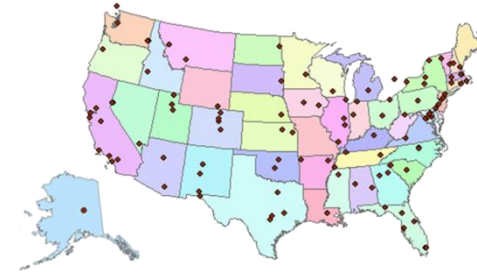


CUAHSI
universities allied for water research

Consortium of Universities for the
Advancement of Hydrologic Science, Inc.
www.cuahsi.org

CUAHSI

A consortium representing 125 US universities

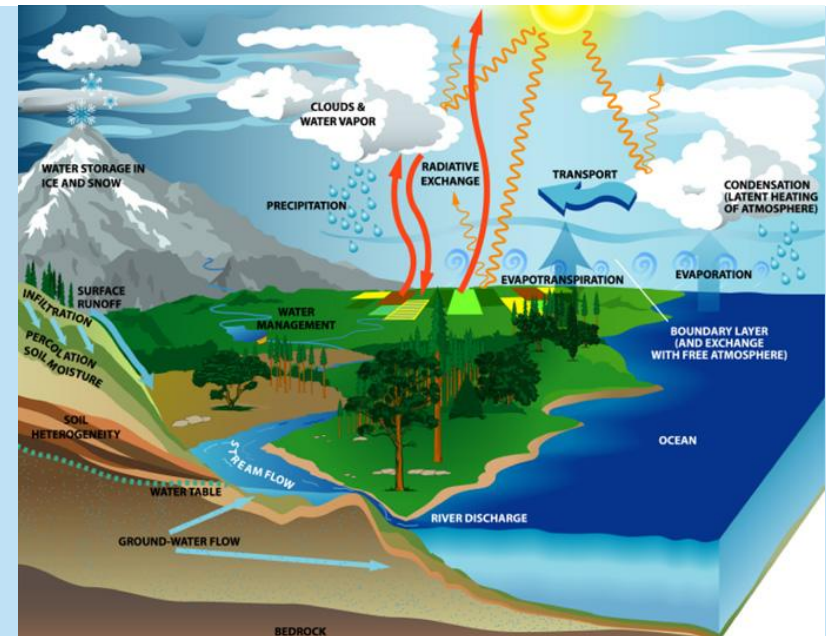


Supported by the **National Science Foundation** Earth Science Division

Advances **hydrologic science** in nation's universities

Includes a **Hydrologic Information System** project

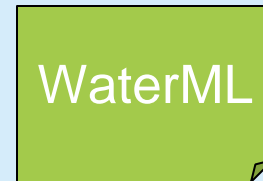
Invented **WaterML** language for water resources time series



Building an academic prototype system

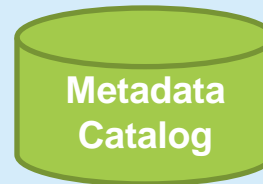
The Result

WaterML language for describing water data



Standards

National catalog of water data sources



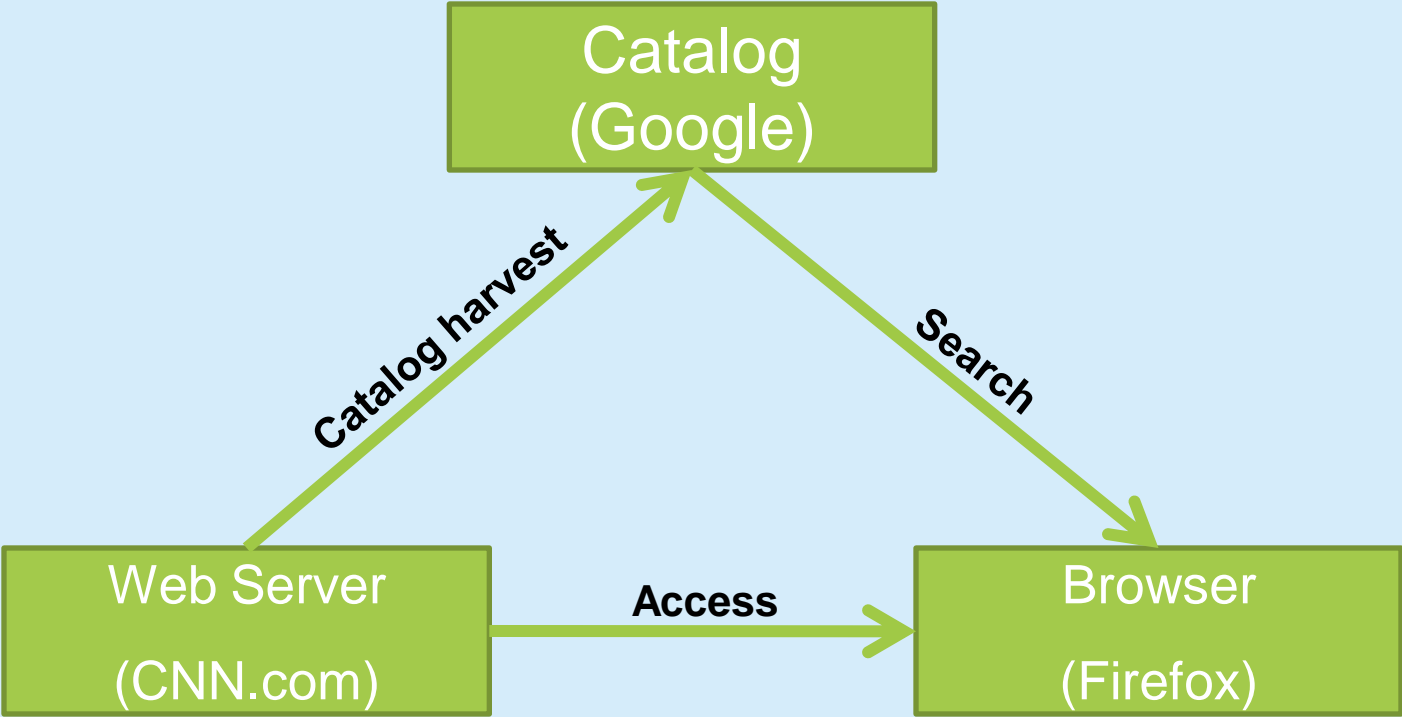
Services

Free software for data access

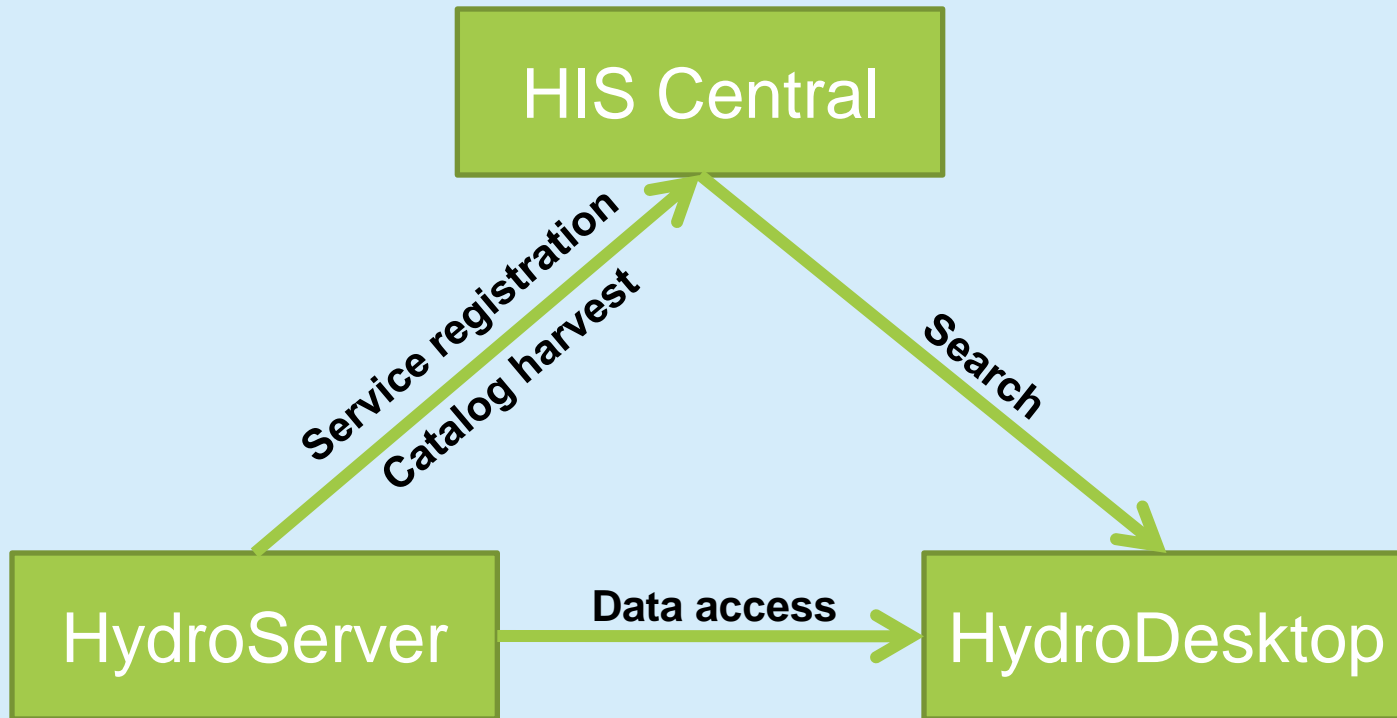


Software

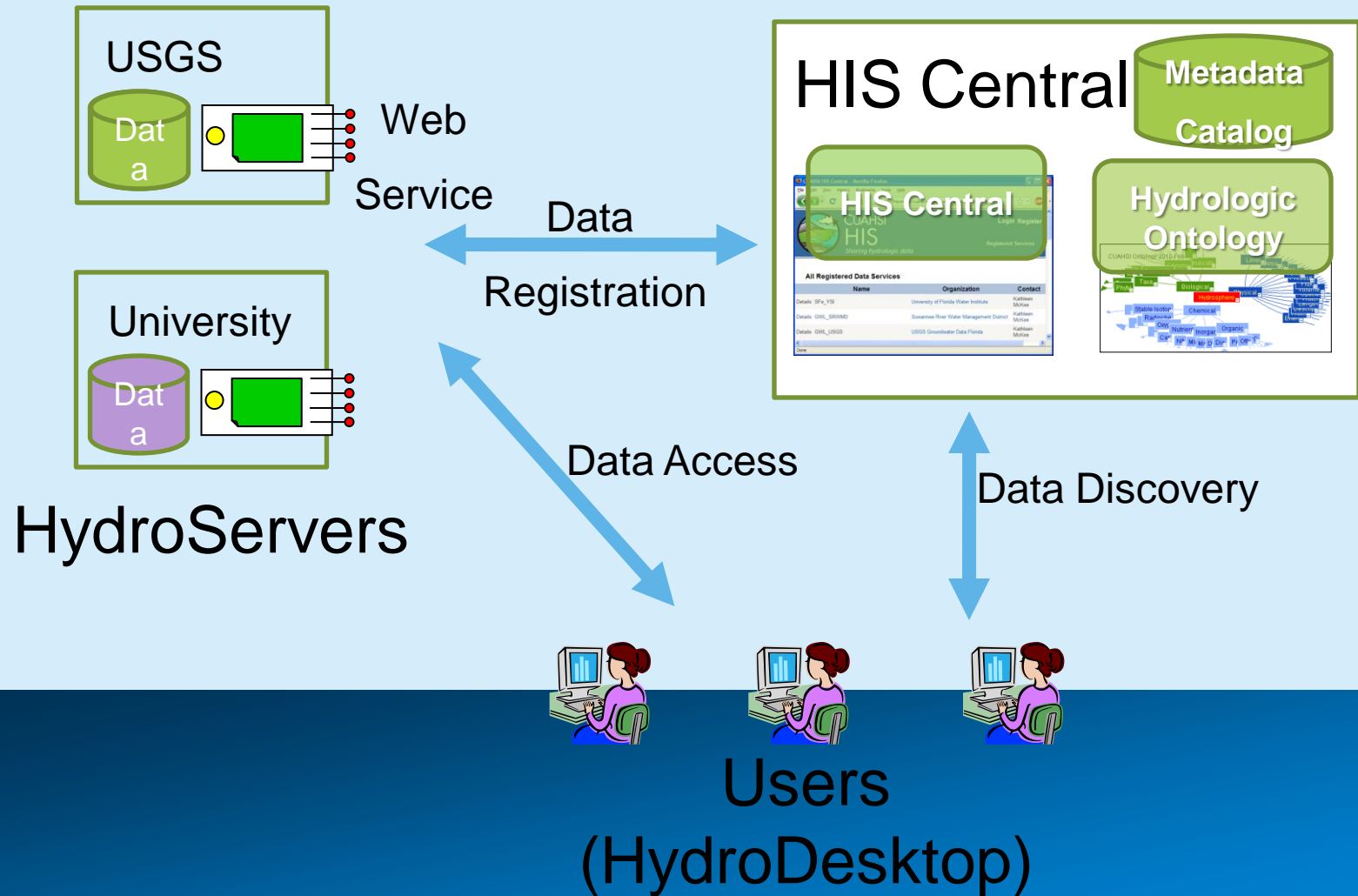
Web Paradigm



Services-Oriented Architecture for Water Data



HIS System Overview



XML – A Primer

The Extensible Markup Language (**XML**) is a W3C-recommended general-purpose markup language that supports a wide variety of applications. – *Wikipedia*

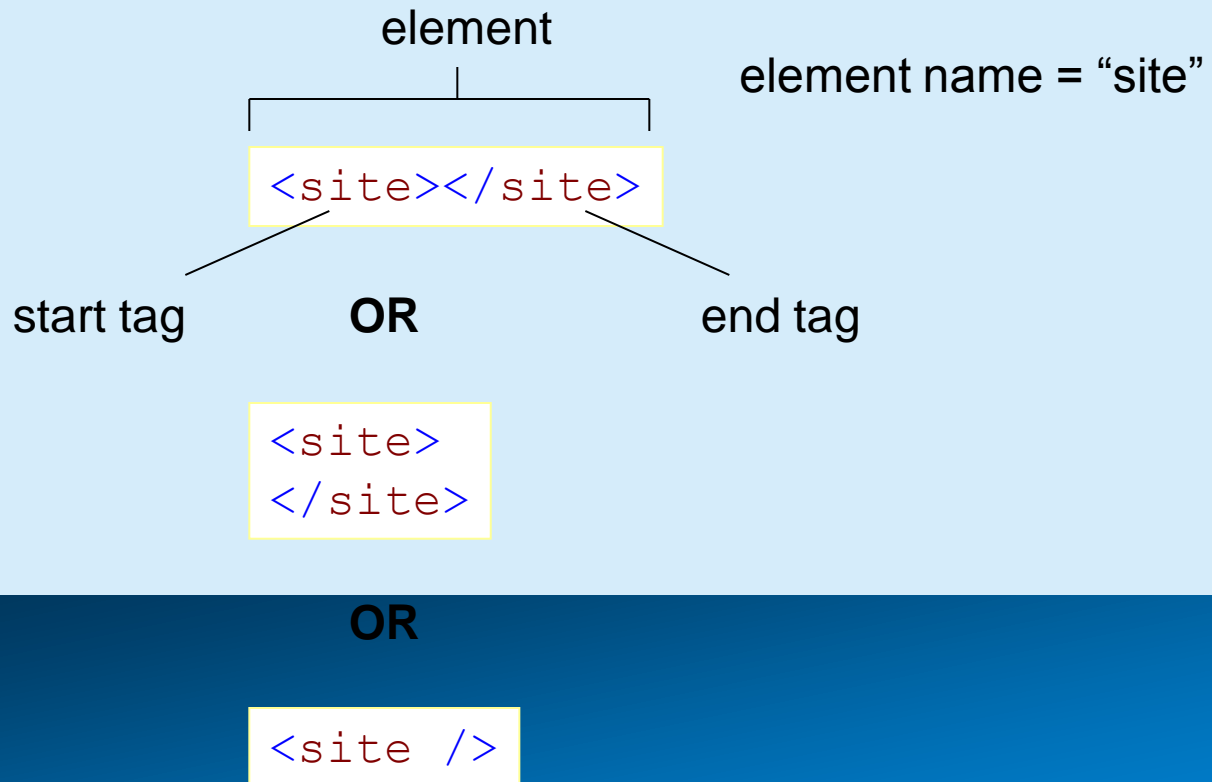
XML represents **data**

XML is both **human** and **machine** readable

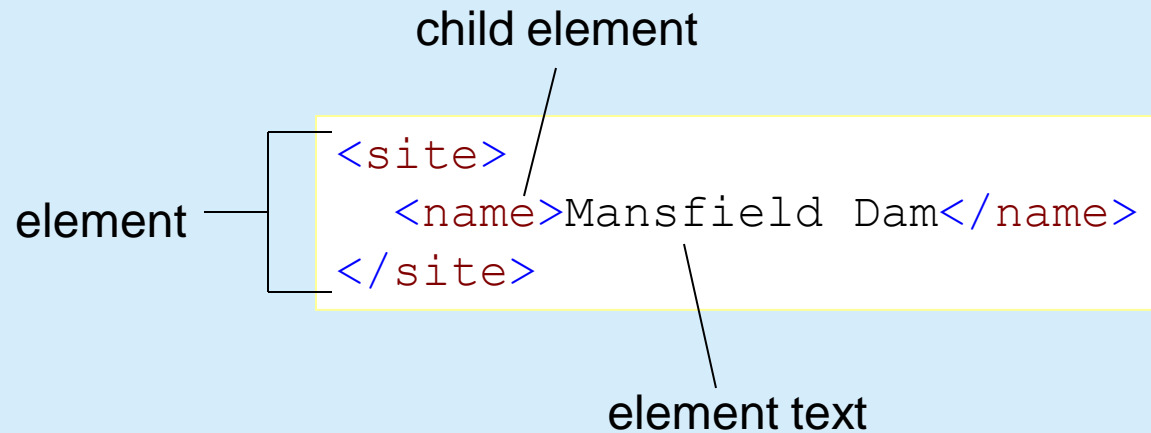
```
<site>  
  <name>Mansfield Dam</name>  
</site>
```

XML Structure

Example – Let's describe a streamflow site



Elements can have Children



Elements can have **Attributes**

```
<site>  
  <name>Mansfield Dam</name>  
  <siteCode network="NWIS">08154510</siteCode>  
</site>
```

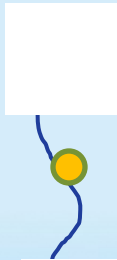
attribute name

attribute value

XML Nesting

```
<site>
  <name>Mansfield Dam</name>
  <siteCode network="NWIS">08154510</siteCode>
  <location>
    <latitude>30.39</latitude>
    <longitude>97.91</longitude>
  </location>
</site>
```

WaterML includes sites, variables and timeseries

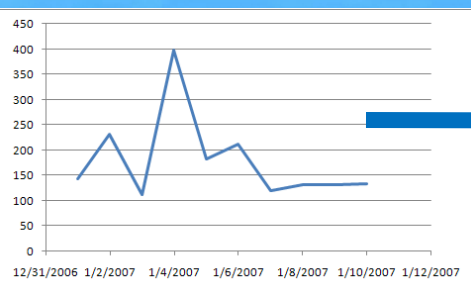


```
<timeSeriesResponse xmlns:gml="http://www.opengis.net/gml" xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:wtr="http://www.cuahsi.org/waterML/"
  xmlns="http://www.cuahsi.org/waterML/1.0/">
  <queryInfo>...
  <timeSeries>
    <sourceInfo xsi:type="SiteInfoType">
      <siteName>Colorado Rv at Austin, TX</siteName>
      <siteCode siteID="1389">08158000</siteCode>
      <timeZoneInfo>...
      <geoLocation>...
      <note>Agency:USGS</note>
    </sourceInfo>
    <variable>
      <variableCode vocabulary="USGS">00060</variableCode>
      <variableName>Discharge</variableName>
      <dataType>Average</dataType>
      <units>cfs</units>
      <options>...
    </variable>
    <values>
      <value qualifiers="A" dateTime="2007-01-01T00:00:00">143</value>
      <value qualifiers="A" dateTime="2007-01-02T00:00:00">231</value>
      <value qualifiers="A" dateTime="2007-01-03T00:00:00">112</value>
      <value qualifiers="A" dateTime="2007-01-04T00:00:00">398</value>
      <value qualifiers="A" dateTime="2007-01-05T00:00:00">182</value>
      <value qualifiers="A" dateTime="2007-01-06T00:00:00">212</value>
      <value qualifiers="A" dateTime="2007-01-07T00:00:00">120</value>
      <value qualifiers="A" dateTime="2007-01-08T00:00:00">131</value>
      <value qualifiers="A" dateTime="2007-01-09T00:00:00">132</value>
      <value qualifiers="A" dateTime="2007-01-10T00:00:00">133</value>
      <qualifier qualifierCode="A" network="USGS" vocabulary="dv_rm_k_cd">
        Approved for publication -- Processing and review completed.</qualifier>
    </values>
  </timeSeries>
</timeSeriesResponse>
```

location

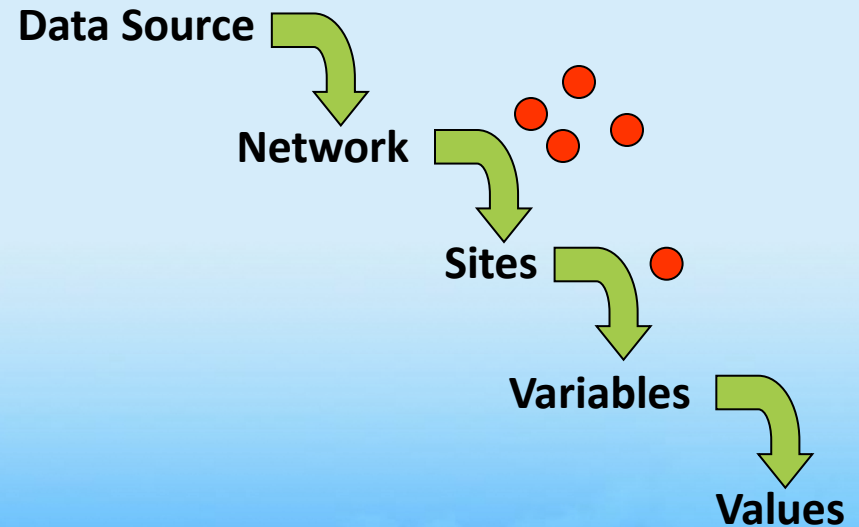
variable

time series

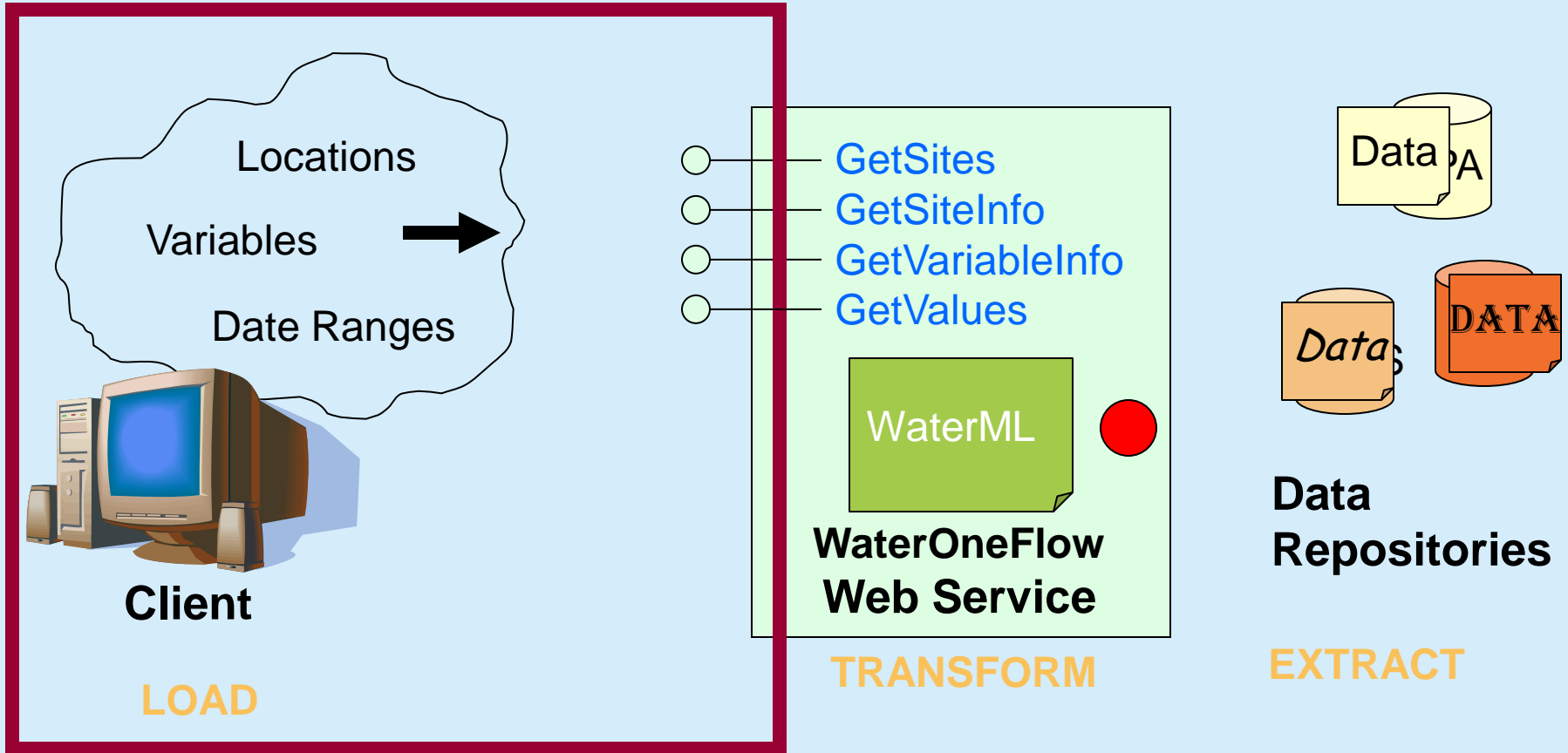


WaterOneFlow web service

- Set of **query** functions
 - Get Sites
 - Get Site Info
 - Get Variable Info
 - Get Values
- returns data in **WaterML**

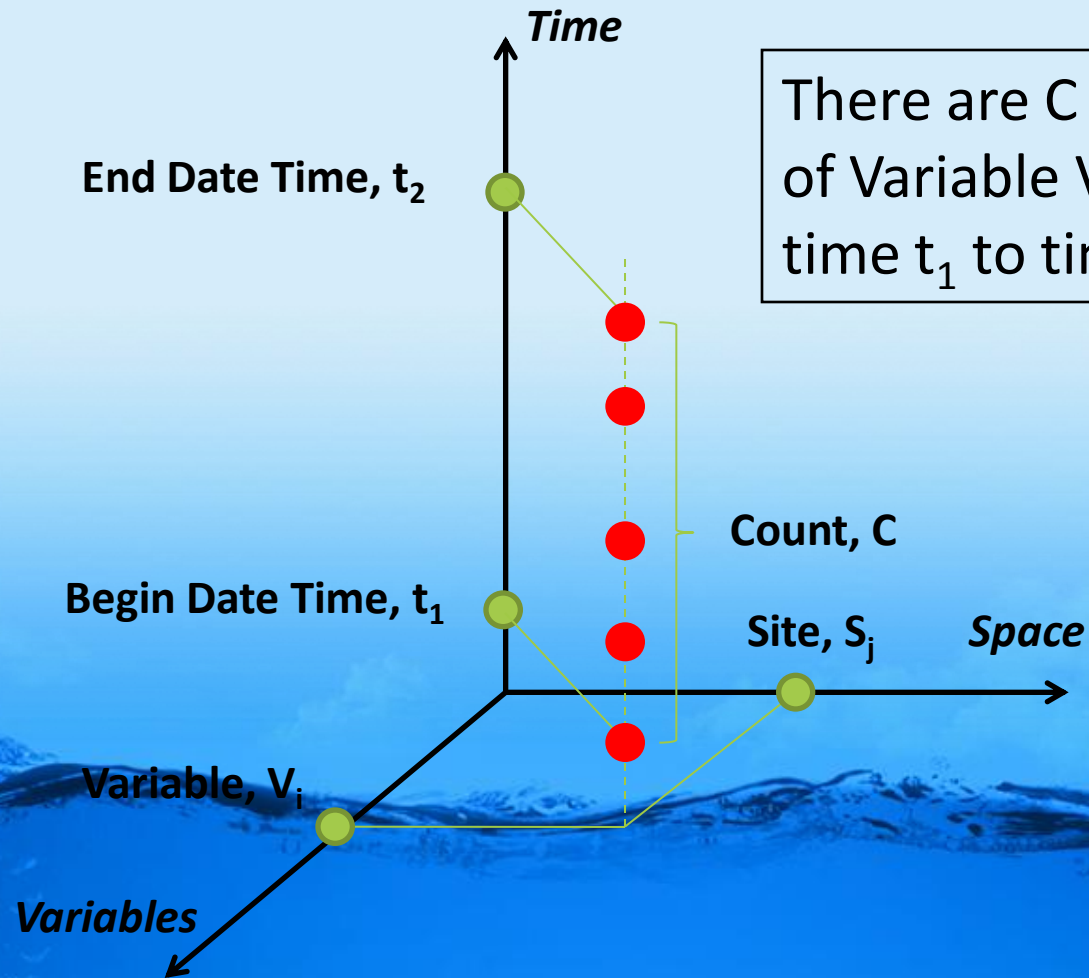


WaterML and WaterOneFlow



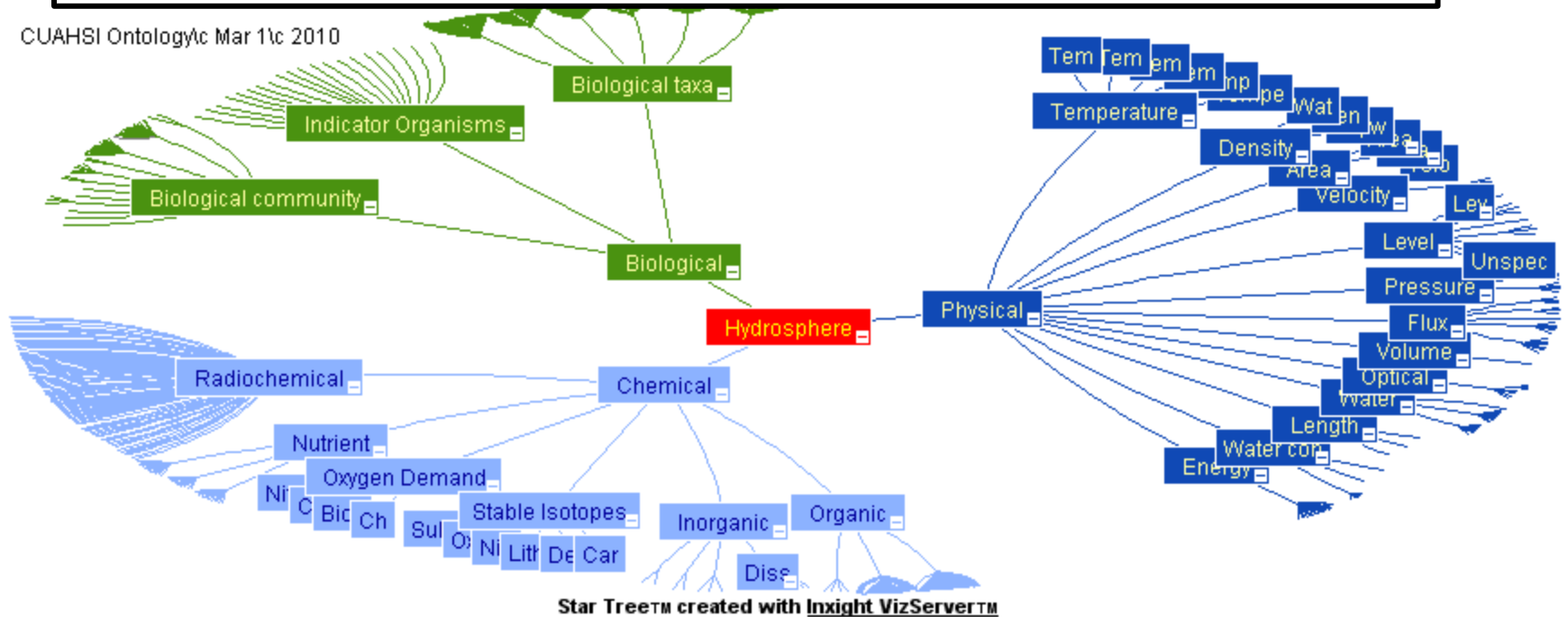
WaterOneFlow is how you ask for data
WaterML is the format of what comes back

Data Series – Metadata description



HydroTagger

CUAHSI Ontology Mar 1st 2010



Block

Variable Name	Code	Medium	
sampling depth, feet	nwisuv:00003	unknown	select
sample accounting number	nwisuv:00008	unknown	select
location in cross sectio...	nwisuv:00009	unknown	select
temperature, water, degr...	nwisuv:00010	unknown	select
temperature, water, degr...	nwisuv:00011	unknown	select
1 2 3 4 5 6 7 8 9 10 ...			

Variable:	Variable	Keyword	
Temperature, Water, Degr...	gage height, feet	water depth, stream	delete
Mapping: Temperature, water	discharge, cubic feet per second	discharge, stream	delete
Map!	barometric pressure, not corrected to sea level, millibars	atmospheric pressure	delete
	acoustic signal strength, units specified in data descriptor	atmospheric pressure	delete

Each **Variable** in your data is connected to a corresponding **Concept**

HIS Central *Web Service*

- Programmatic methods to query the national metadata catalog
- Search by:
 - Location
 - Variable
 - Date Range
 - Data source

hiscentral

The following operations are supported. For a formal definition, please review the [Service Description](#).

- [GetMappedVariables](#)
- [GetMappedVariables2](#)
- [GetSearchableConcepts](#)
- [GetSeriesCatalogForBox](#)
- [GetSeriesCatalogForBox2](#)
- [GetServicesInBox](#)
- [GetServicesInBox2](#)
- [GetSitesInBox](#)
- [GetSitesInBox2](#)
- [GetWaterOneFlowServiceInfo](#)
- [GetWordList](#)
- [getOntologyTree](#)
- [getSearchablePaths](#)
- [getSeriesCatalogInBoxPaged](#)

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Open Geospatial Consortium

More than 400 companies and agencies globally

The screenshot shows the OGC website homepage. At the top left is the OGC logo with the tagline "Making location count." To the right are links for "Have an Idea?", "INSPIRE", and a YouTube video "What is the OGC?". Below the logo is a navigation menu with items: Home, Standards, Programs, Participate, News & Events, About OGC, and Member Login. A search bar is on the right. The main content area features a list of sectors on the left and a central diagram of standards.

Geospatial and location standards for:

- Aviation
- Built Environment & 3D
- Business Intelligence
- Defense & Intelligence
- Emergency Response & Disaster Management
- Geosciences & Environment
- Government & Spatial Data Infrastructure
- Mobile Internet & Location Services
- Sensor Webs
- University & Research

Standards Diagram:

- Open** (Where): Analysis, Earth Observation, Navigation, BIM, Proximity, Open Source, GIS, Points of Interest, Global, Place, Linked Data, Geoweb, Geosemantics, Sensor Web, Shared Understanding, SDI, Indoor/Outdoor, Metadata, GPS, Real Time, Visualization, Alerts, Situational Awareness, Data Quality, Weather, Climate, Planning, Time, Open Data, Information Integration, Geosynchronization, Map, Monitoring, Location, Crowdsourcing, CAD, Spatial Policy, Interoperability, Share.

... internet data standards for maps and observational data

OGC/WMO Hydrology Domain Working Group

4-Year International Effort – WaterML2

A time series for one variable at one location

WaterML2

Hydrology Domain Working Group formed

OGC observer at CHy-13

November 2009

*MEMORANDUM OF UNDERSTANDING
BETWEEN
THE WORLD METEOROLOGICAL
ORGANIZATION
AND
THE OPEN GEOSPATIAL CONSORTIUM, INC.*

Technical Meetings Each 3 Months
Four Interoperability Experiments
(Surface water, groundwater, forecasting)

Annual week-long workshops

Involvement by many countries

Acknowledgements: OGC, GRDC, CUAHSI,
BoM/CSIRO, USGS, GSC, Kisters,

2008

2009

2010

2011

2012

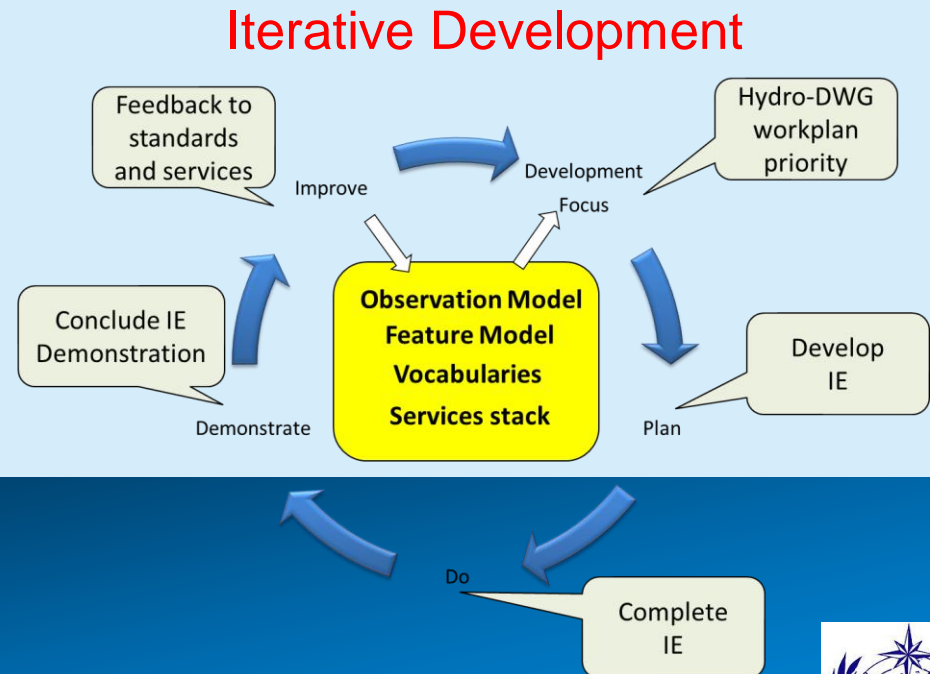
International Standardization of WaterML

Hydrology Domain Working Group (HDWG)

- standards for water data: **WaterML 2.0 suite**
- organizing Interoperability Experiments (IEs) focused on different sub-domains of water

Chairs:

- Ilya Zaslavsky (USA)
- Tony Boston (Australia)
- Silvano Pecora (Italy)



GML - Geography Markup Language

GML is a standard of the Open Geospatial Consortium (OGC).

It offers a data model as well as an XML encoding for geographic features (abstractions of real world phenomena).

GML has been developed to enable the standardised and interoperable exchange of geospatial objects (features) together with their attributes, their relationships to other objects as well as their geometries.

GML is relevant because of two reasons: on the one hand, the Observations and Measurements standard (which is again the foundation for WaterML 2.0) has been defined as an application profile of GML; on the other hand, GML is the standard for modelling and encoding geometries such as the features of interest, to which hydrological observations are related.

O&M - Observations and Measurements

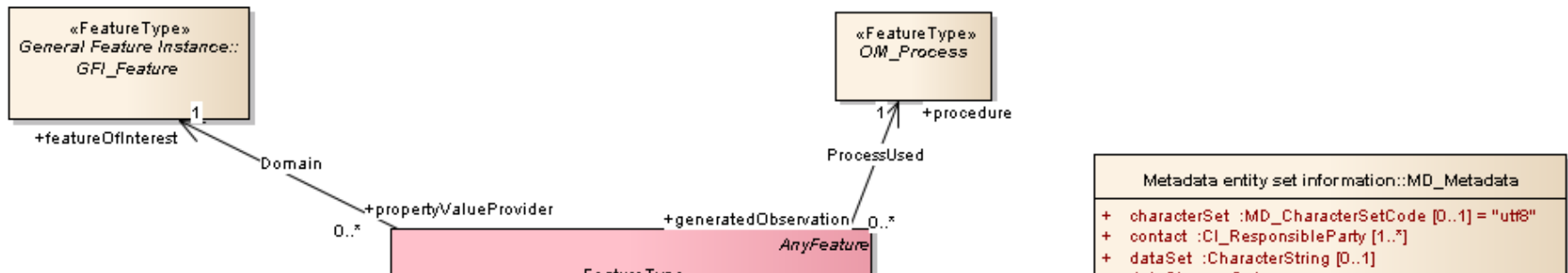
O&M belongs to the framework of Sensor Web Enablement (SWE) standards of the OGC. It defines a data model as well as an encoding for observation data (e.g. sensor data).

Generally an observation contains a set of time stamps: `phenomenonTime` , `resultTime` and `validTime`.

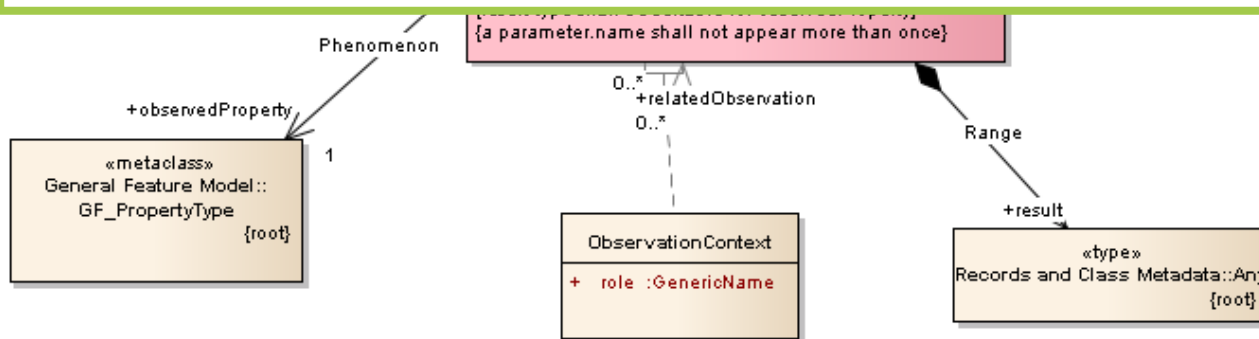
Furthermore, every observation contains a description of the observed property (the phenomenon that was observed), the geometric feature to which the observation belongs (feature of interest) and information about the process/sensor (procedure) which has been used for obtaining the result.

Finally, an observation may contain optional information about its quality as well as parameters of the measurement process.

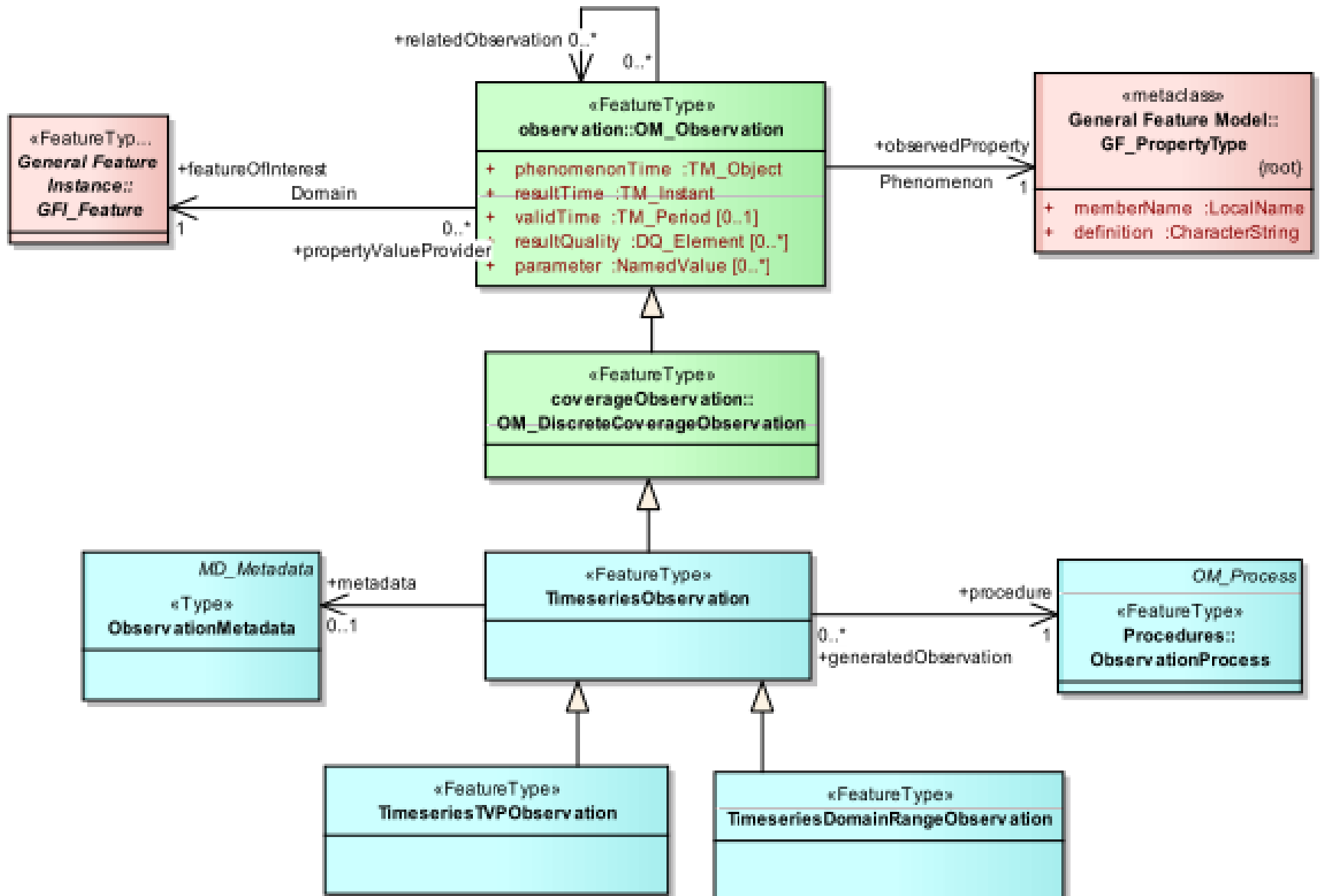
Observations Information Model



Observations & Measurements Model:
A Feature of Interest has a **Property** that is measured by a **Process** that produces a **Result**



WaterML2

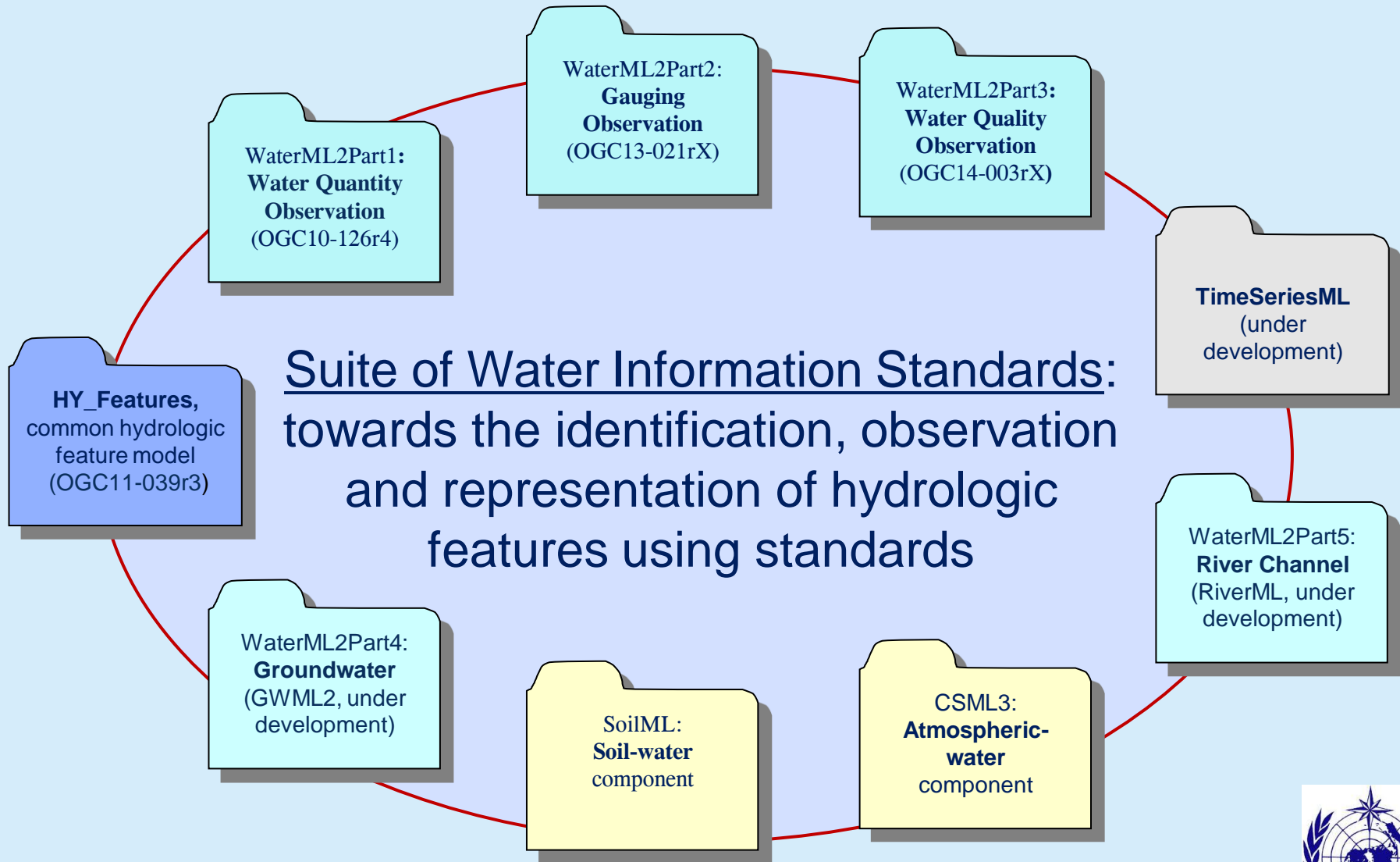


WaterML2 – a Profile of O&M

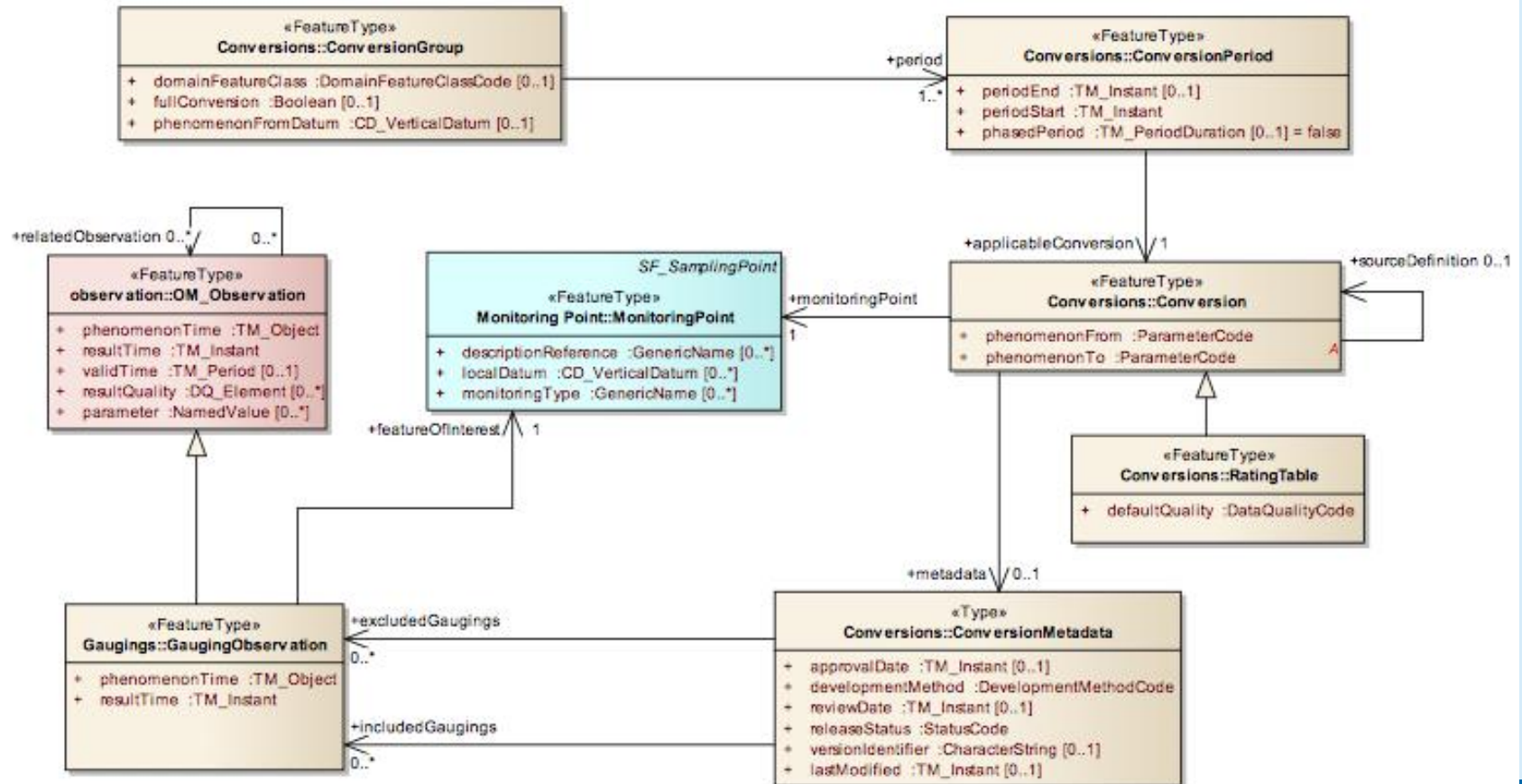
```
- <wml2:Collection gml:id="KI.Col.1" xsi:schemaLocation="http://www.opengis.net/waterml/2.0 http://schemas.opengis.net/waterml/2.0/waterml2.xsd" >
- <gml:description>
  KISTERS WaterML2.0 demonstration based on GRDC data
</gml:description>
+ <wml2:metadata></wml2:metadata>
- <wml2:observationMember>
  - <om:OM_Observation gml:id="Ki.Obs.1">
    + <om:phenomenonTime></om:phenomenonTime>
    + <om:resultTime></om:resultTime>
    + <om:procedure></om:procedure>
    <om:observedProperty>
  - <om:featureOfInterest>
    + <wml2:MeasurementTimeseries gml:id="Ki.Ts.1">
      + <wml2:metadata></wml2:metadata>
      + <wml2:defaultPointMetadata></wml2:defaultPointMetadata>
      - <wml2:point>
        - <wml2:MeasurementTVP>
          <wml2:time>2000-01-01T00:00:00.000Z</wml2:time>
          <wml2:value>266</wml2:value>
        </wml2:MeasurementTVP>
      </wml2:point>
      - <wml2:point>
        - <wml2:MeasurementTVP>
          <wml2:time>2000-01-02T00:00:00.000Z</wml2:time>
          <wml2:value>266</wml2:value>
        </wml2:MeasurementTVP>
      </wml2:point>
    </om:featureOfInterest>
  </om:observedProperty>
  </om:OM_Observation>
</wml2:observationMember>
</wml2:Collection>
```

Time Series as a set of Time-Value Pairs

WMO/OGC Hydrology Domain Working Group Suite of Water Information Standards



WaterML2.0 part 2



As of August 2015, the OGC TC & PC votes for adoption have been completed, and WaterML 2.0 Part 2 - RGS is now an OGC international standard.

Test web client



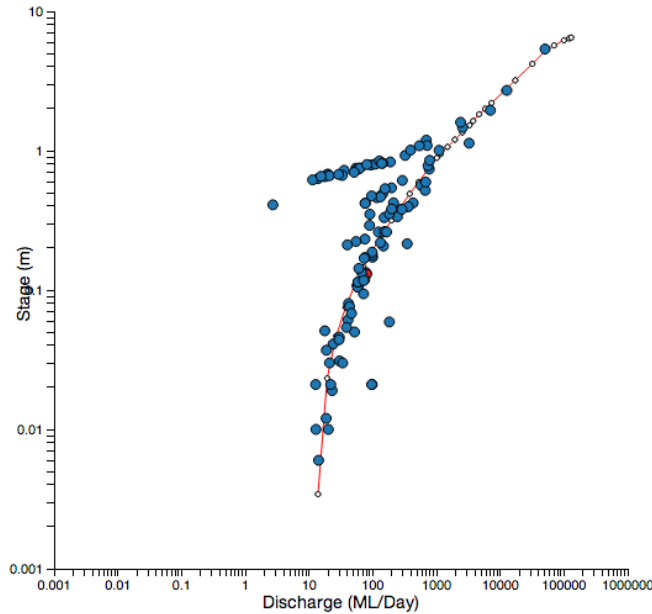
WaterML2.0 part 2 - demonstration client

Peel River At Somerton

Geofabric Rating Tables Deviation Plots

Stage vs. Discharge

Stream Water Level vs. Stream Discharge



Settings

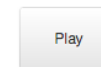
Rating Table Settings

Quality:

- 0-26
- 26-51
- 51-77
- 77-102
- 102-128
- 128-153
- 153-179
- 179-204
- 204-230
- 230-255

- Show vertical lines
- Show horizontal lines
- Show error bars
- Show 95% confidence lines

Timeline Settings



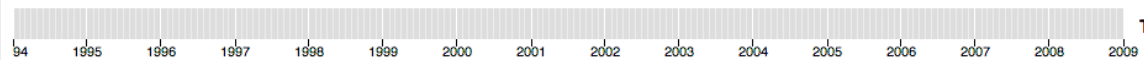
Speed (10-1)



Snap to:

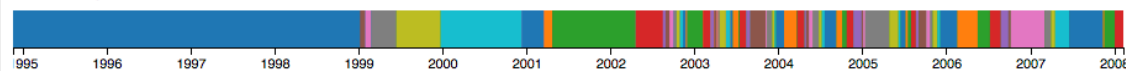
- Months
- Years

Nov 1994 to Nov 1994



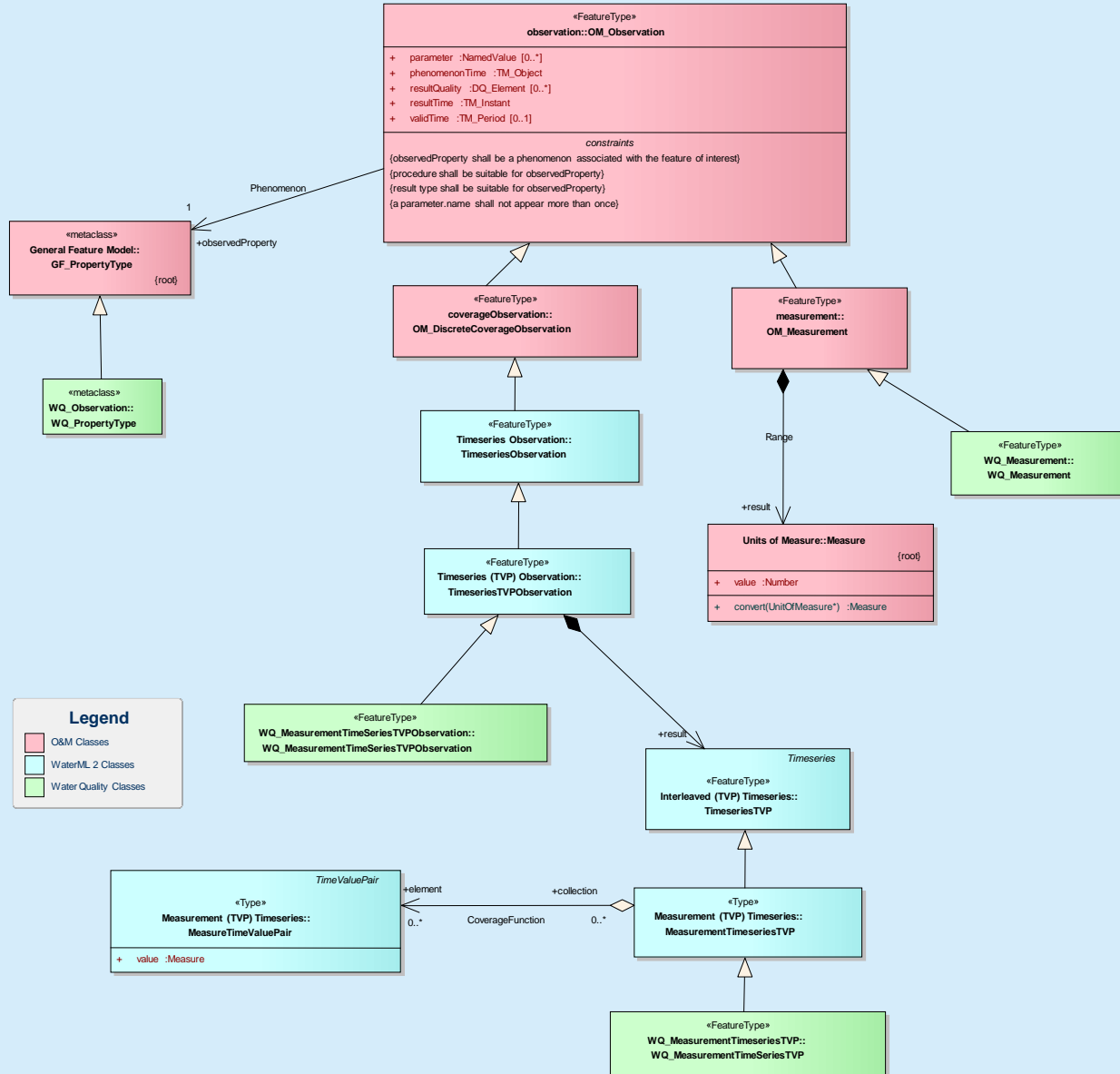
Timeline

Conversion period: 1971-08-10 to 1971-09-24

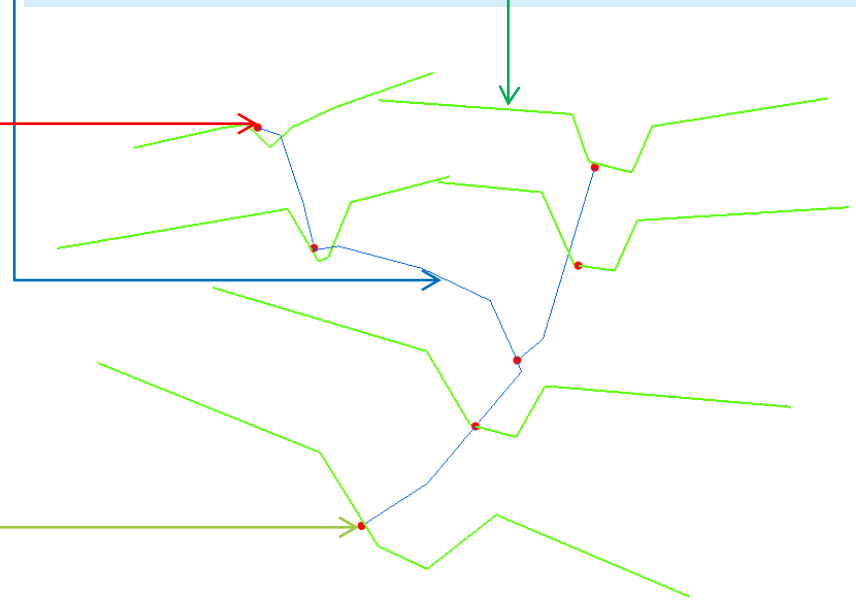
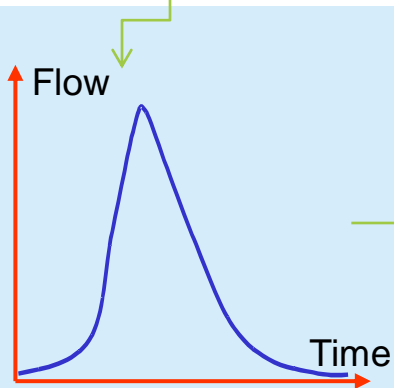
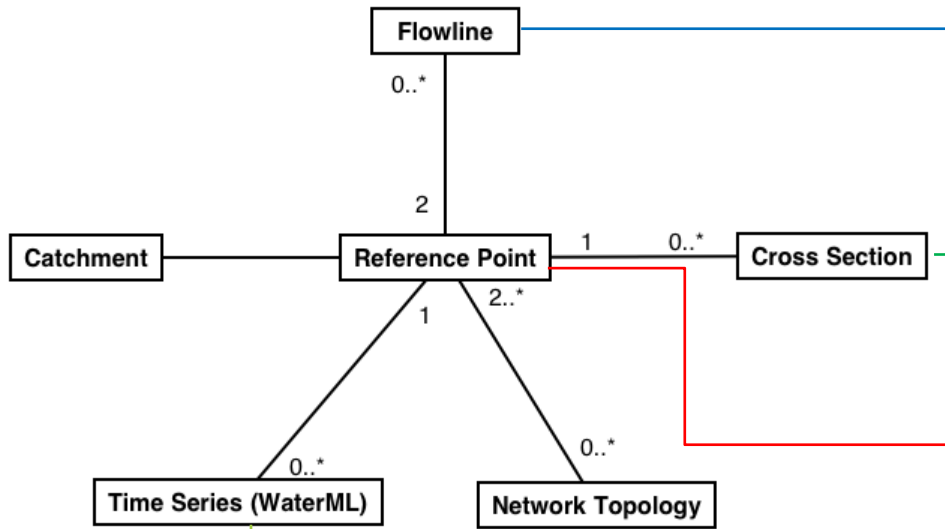


Rating Periods

WQ classes as sub-types of O&M and WaterML 2



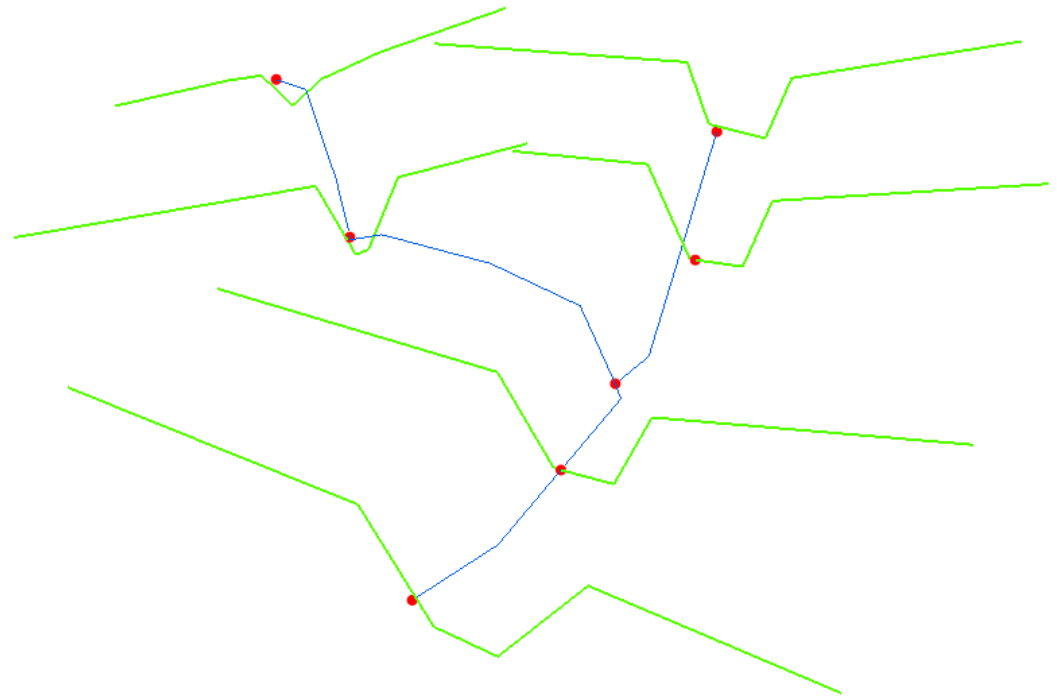
RiverML: Modular River Data Format



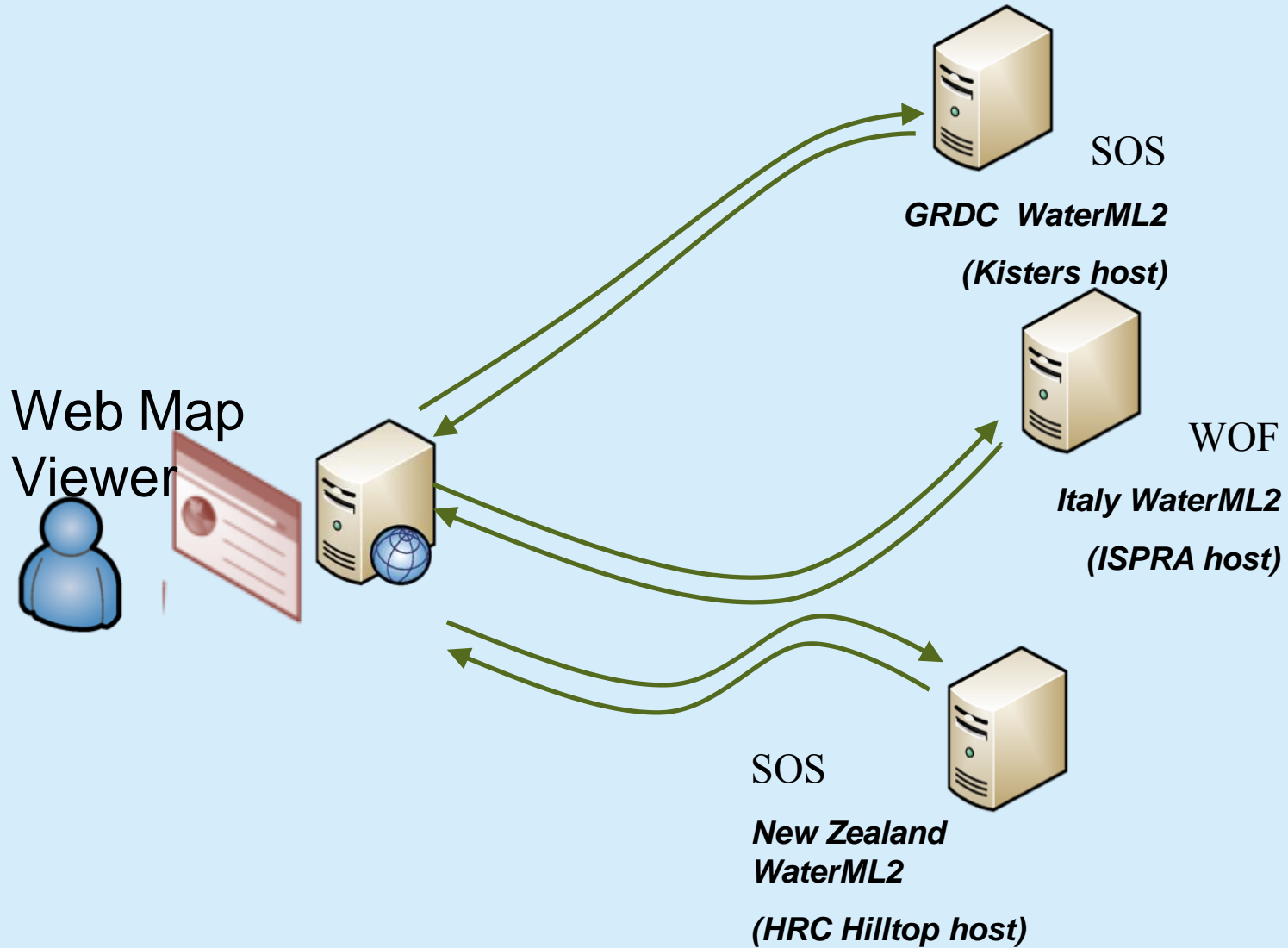
Relationships organized by a system of Reference Points

RiverML: Modular River Data Format

```
17 > <rml:metadata xlink:type="simple" xlink:href="http://www.oxygenxml.com/" xlink:role="http://www.oxygenxml.com/" x|
44 > <rml:scenario> [13 lines]
58 > <rml:scenario> [13 lines]
72 > <rml:terrain> [10 lines]
83 > <rml:terrain> [9 lines]
93 > <rml:referencePoint> [18 lines]
112 > <rml:referencePoint> [18 lines]
131 > <rml:referencePoint> [8 lines]
140 > <rml:referencePoint> [8 lines]
149 > <rml:referencePoint> [8 lines]
158 > <rml:referencePoint> [8 lines]
167 > <rml:referencePoint> [8 lines]
176 > <rml:reach> [7 lines]
184 > <rml:reach> [7 lines]
192 > <rml:reach> [7 lines]
200 > <rml:crossSectionObservation> [17 lines]
218 > <rml:crossSectionObservation> [17 lines]
236 > <rml:crossSectionObservation> [17 lines]
254 > <rml:crossSectionObservation> [17 lines]
272 > <rml:crossSectionObservation> [17 lines]
290 > <rml:crossSectionObservation> [17 lines]
308 > <rml:crossSectionObservation> [17 lines]
326 > <rml:flowlineObservation> [18 lines]
345 > <rml:flowlineObservation> [18 lines]
364 > <rml:flowlineObservation> [18 lines]
383 > <rml:timeseriesObservation> [40 lines]
424 </rml:RiverCollection>
425
```



OGC SOS 2 as the web data service for WaterML 2



SOS 2.0: development and objectives

- Originated from the requirement of technically and semantically interoperable web services for hydrological data
- Create a fully interoperable SOS 2.0 for hydrological data
- Specifies WaterML2.0 as the language for timeseries data
- Guide developers to ONE specific way of implementation (instead of supporting multiple variants)

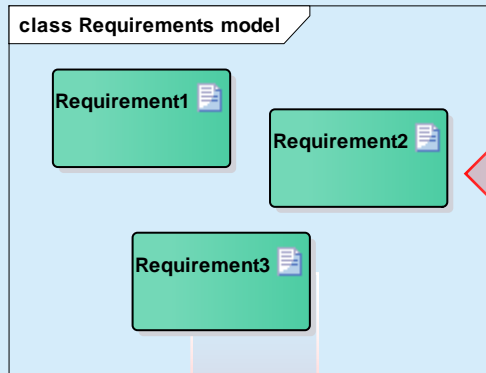


WMO STANDARDS IN HYDROLOGY

data formats and service types

Specification to data encoding

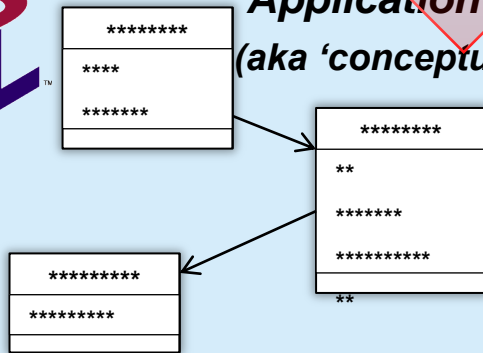
Requirements model



WMO regulation and other specifications



Application Schema
(aka 'conceptual model')



Technology independent description of content and structure of information to be exchanged for a given application

XML Schema 1.0
Schematron



« derived from »

Validation schema and rules

« conforms to »

XML instance documents



Validatable data products

Two standards: Conceptual & Implementation

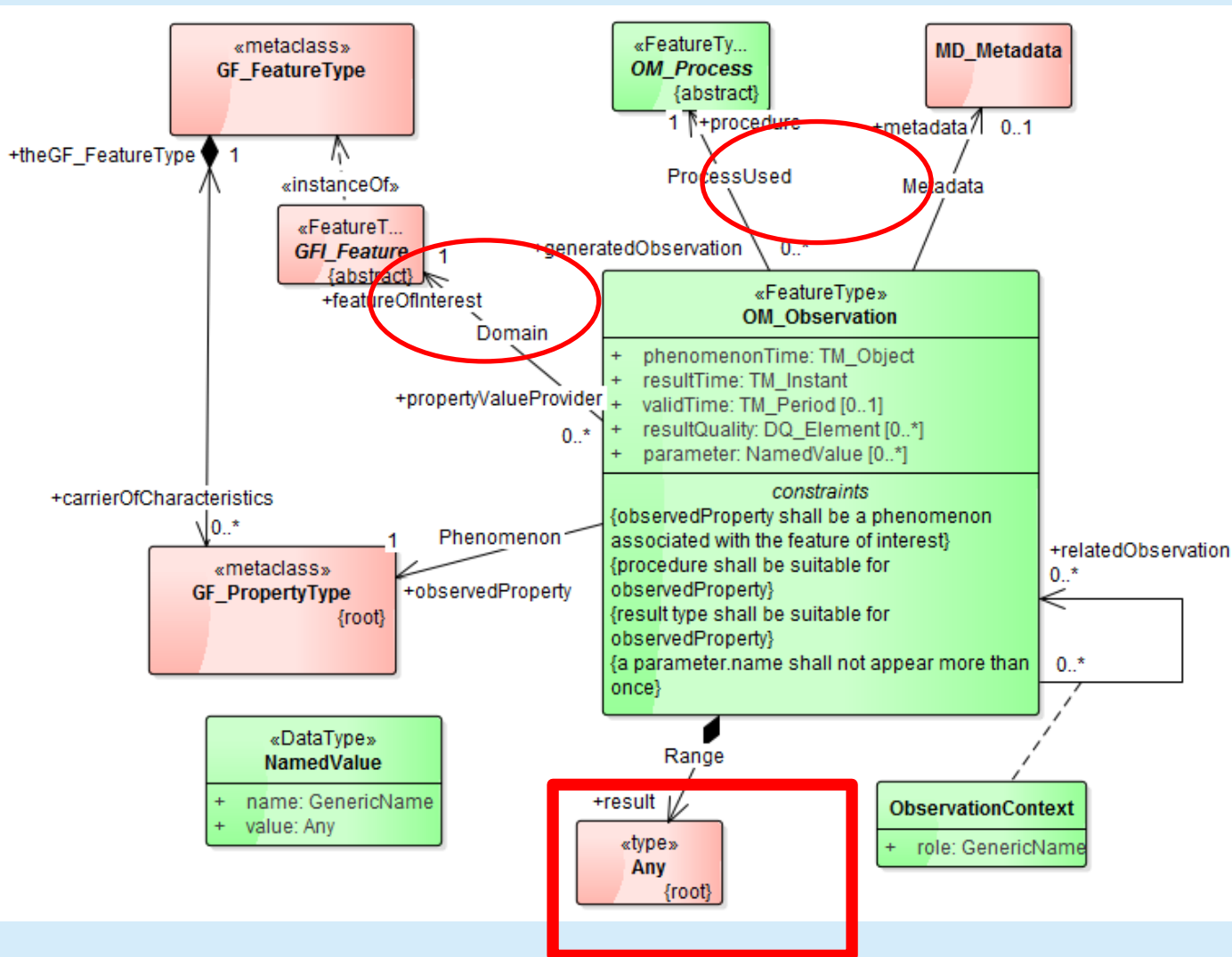
Timeseries Profile

- Timeseries Profile of Observations and Measurements

TimeseriesML 1.0

- XML Encoding of the Timeseries Profile of Observations and Measurements

Conceptual Model - based on O&M



Timeseries is the 'result' of an Observation

Implementation Model - Mapping to Concepts

Table 3 - Mapping of Timeseries Profile of Observations and Measurements to TimeseriesML 1.0 XML Schema types.

Timeseries Profile of Observations and Measurements	TimeseriesML 1.0 XML
Collection	tsml:Collection
DocumentMetadata	tsml:DocumentMetadata
CategoricalTimeseriesTVPObservation	om:OM_Observation*
MeasurementTimeseriesTVPObservation	
CategoricalTimeseriesDomainRangeObservation	
MeasurementTimeseriesDomainRangeObservation	
TimeseriesTVP	tsml:TimeseriesTVP
MeasurementTimeseriesTVP	
CategoricalTimeseriesTVP	
TimeseriesDomainRange	tsml:TimeseriesDomainRange
MeasurementTimeseriesDomainRange	
CategoricalTimeseriesDomainRange	
PointMetadata	tsml:PointMetadata
MeasurementPointMetadata	
CategoricalPointMetadata	
TimeValuePair	tsml:TimeValuePair (abstract)
MeasureTimeValuePair	tsml:MeasurementTVP
CategoricalTimeValuePair	tsml:CategoricalTVP
ObservationProcess	tsml:ObservationProcess
MonitoringFeature	tsml:MonitoringFeature
* The specialisation of OM_Observation is provided through Schematron rather than a specialised XML type.	

Collection/Metadata

OM Observation

Time Value Pair Encoding

Domain Range Encoding

Point Metadata

Specialised data types

Process

Monitoring feature

Metadata – a much abused concept please qualify your use

- **Observations Metadata**

- Time-series data that describe how, when and where meteorological observations were made and the conditions they were made under

- **Discovery Metadata**

- Information intended to facilitate the discovery and assessment of a dataset to determine if it is fit for reuse for a purpose that may be at odds with the reason for which it was originally created

- **Data Provenance Metadata**

- Information relevant to climate data that allows end-users, including data managers, scientists and the general public, to develop trust in the integrity of the climate data

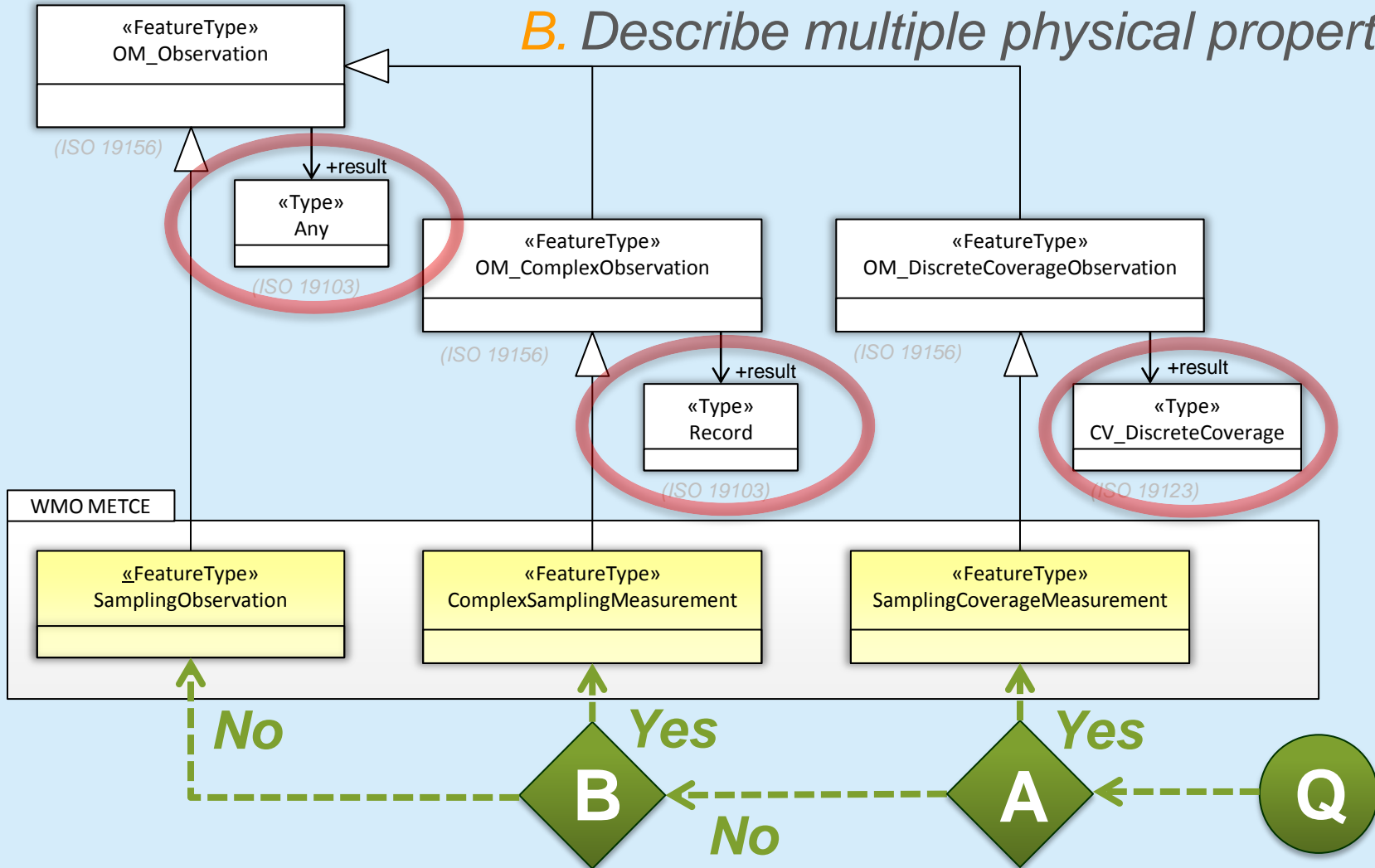
- **Data Intellectual Property Metadata**

METCE: a *profile* of Observations and Measurements

Does the data collected (e.g. the 'result') from the Observation event:

A. Vary in space and or time?

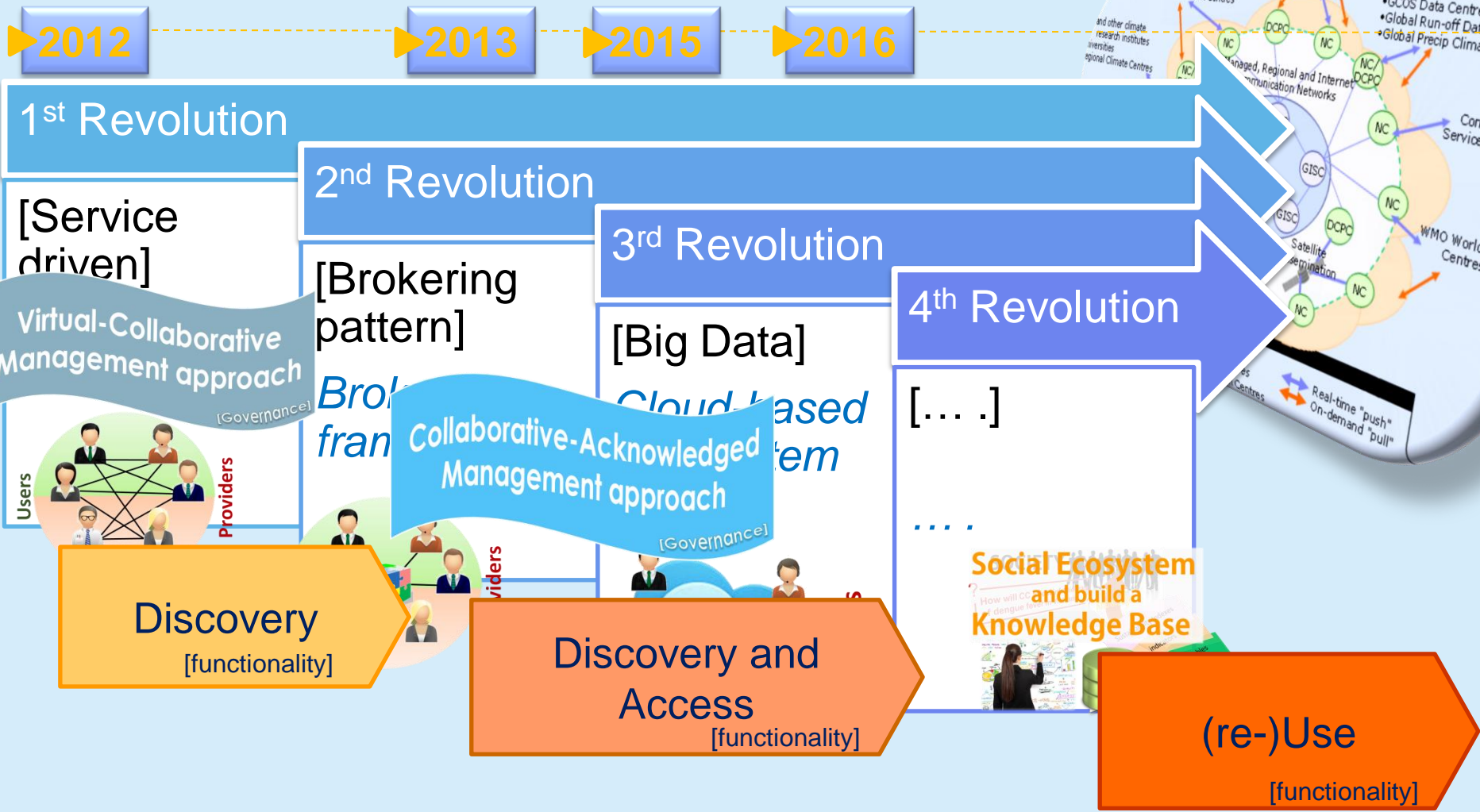
B. Describe multiple physical properties?



DEFINITION OF A STRATEGIC ROADMAP

The background of the slide is a light blue gradient. At the bottom, there is a horizontal line representing the surface of water, with a wavy, rippling effect. Below this line, the water is depicted in a darker blue, with some bubbles and ripples visible, suggesting movement and depth.

Hydrologic data exchange revolutions



Virtual Community Approach

Applications



**Virtual-Collaborative
Management approach**

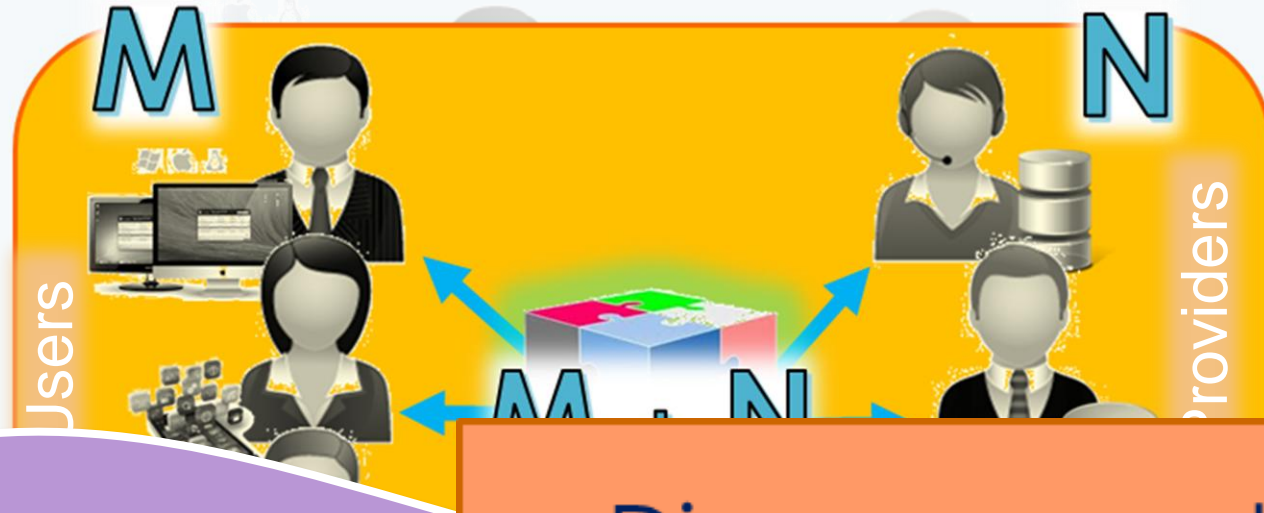
[Governance]

Discovery
[functionality]

Data Infrastructure

Broker Approach

Applications



Data Infrastructures

Collaborative-AM
Management approach

Discovery and
Access

[functionality]

[Governance]



Welcome

This site provides public access to real-time hydrometric data collected at over 1800 locations and access to historical data collected at over 7600 stations (active and discontinued) in Canada. These data are collected under a national program jointly administered under federal-provincial and federal-territorial cost-sharing agreements. It is through partnerships that the Water Survey of Canada program has built a standardized and credible environmental information base for Canada.

Search for Real-Time Data by:

Station Name

OR

Station Number

OR

Province or Territory

OR





Drainage Basin

[More Search Options](#)[Map Search](#)

Notice

Environment Canada (EC) is pleased to announce that the real time hydrometric data are now available on EC's data mart site:
<http://dd.weather.gc.ca/hydrometric/>

Partners

 [Alberta](#) [British Columbia](#) [Manitoba](#) [New Brunswick](#) [Newfoundland and Labrador](#) [Northwest Territories](#) [Nova Scotia](#) [Nunavut](#) [Ontario](#) [Prince Edward Island](#)

GI-conf web tool

[Logout](#)

- Profilers & Sources
- Settings
- Configurations

Profilers

[+ Add](#)

HIS Profiler
[Endpoint](#)
[Remove](#)

SOS Profiler
[Endpoint](#)
[Remove](#)

Sources

[+ Add](#)

ARPA EMR ODEmiliaRomagna

- Source type: HYDROSERVER-DB version 1.0
- Scheduled harvesting not set

[Settings](#)
[Harvest this source](#)
[Harvesting status](#)
[Remove](#)

EC

- Source type: ECANADA version 1.0
- Scheduled harvesting not set


[Settings](#)
[Harvest this source](#)
[Harvesting status](#)

- Phase: PROCESSING
- Progress: 20.0
- Populating temporary repository

[Remove](#)

Views

[+ Add](#)



The diagram shows a central 'GI AXE' logo with a globe on top, connected by lines to the 'Profilers' and 'Sources' sections. The 'Profilers' section contains 'HIS Profiler' and 'SOS Profiler'. The 'Sources' section contains 'ARPA EMR ODEmiliaRomagna' and 'EC'. The 'Views' section is currently empty.

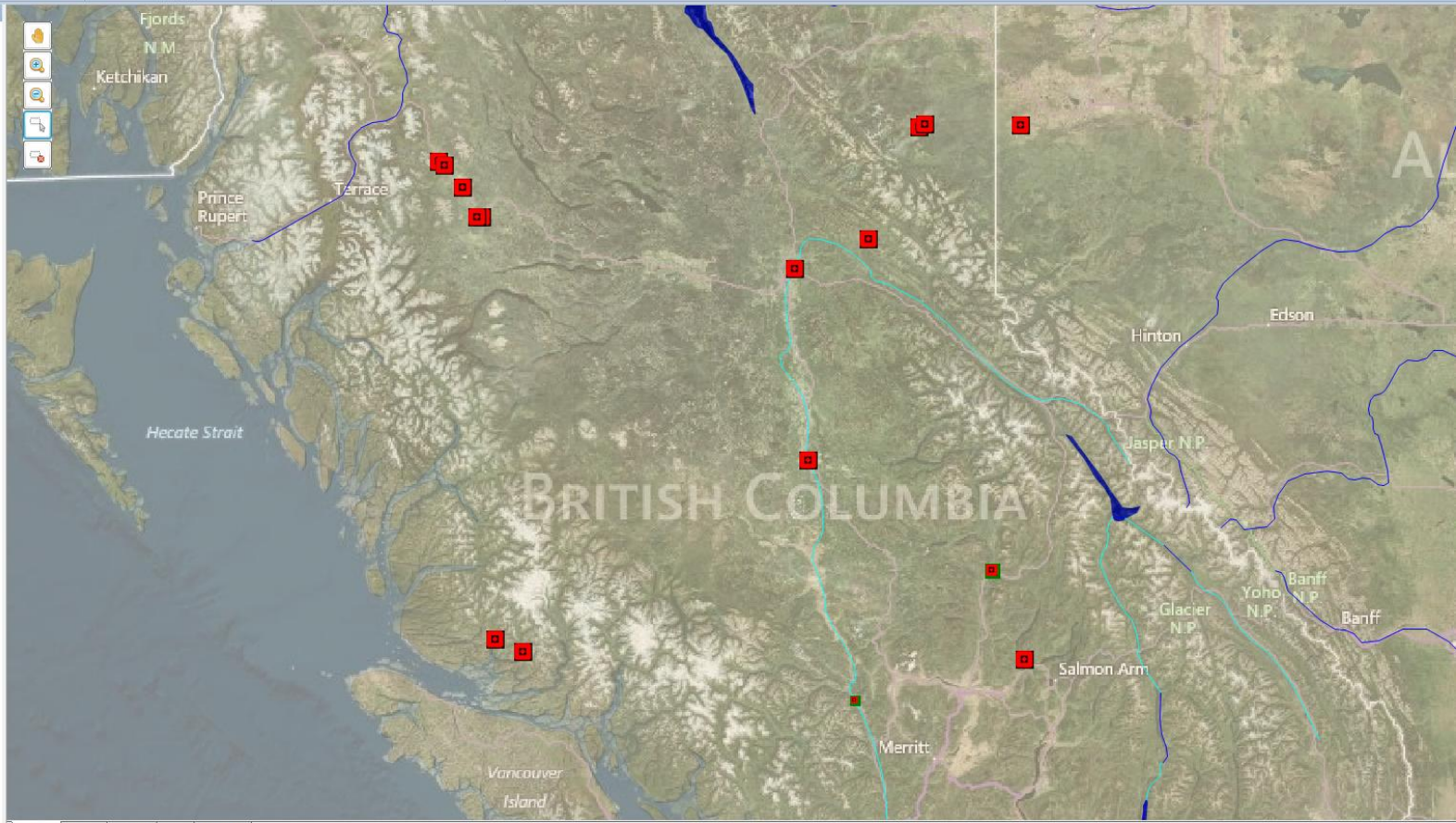
File Map Search Table Graph Edit HydroR Help

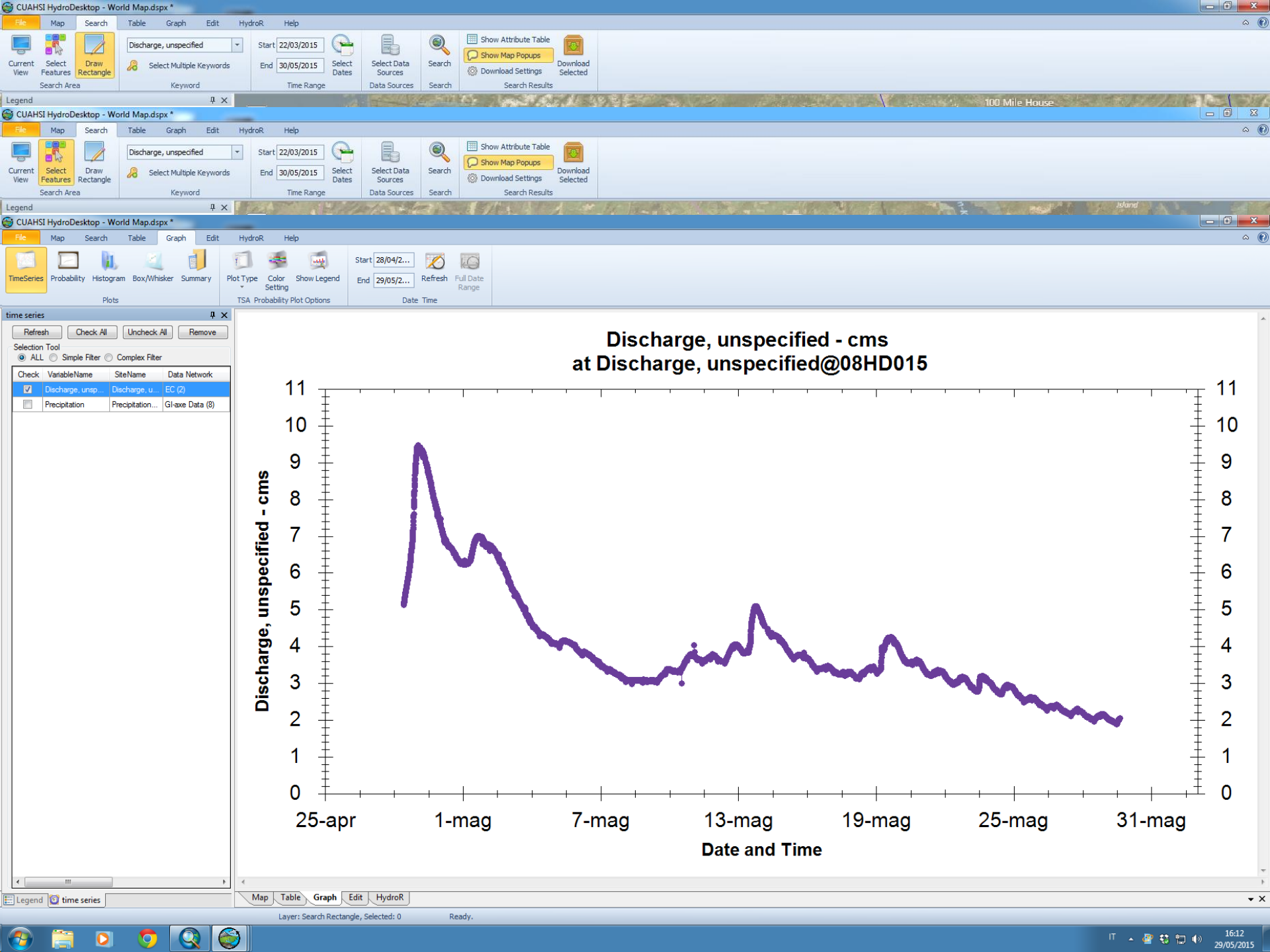
Add Layer... Remove Layer Full Extent Previous Next Zoom To Layer Zoom To Coordinates Identify Select by Attribute View Attribute Table

Bing Aerial Map Opacity: 50 Delineate Watershed

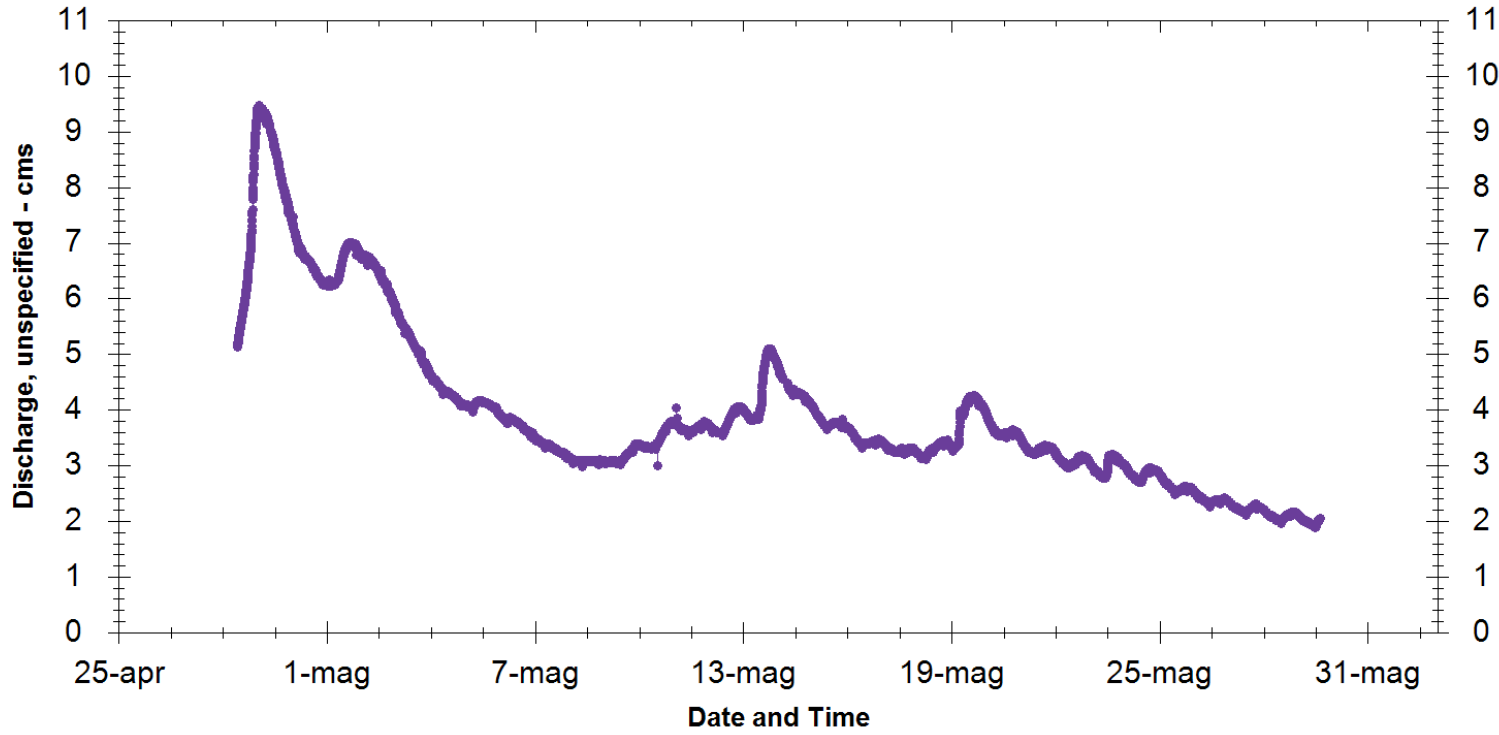
Legend

- Map Layers
 - Data Sites
 - EC
 - Number of Observations
 - Rivers
 - Online Basemap
 - Lakes
 - Countries





Discharge, unspecified - cms at Discharge, unspecified@08HD015



time series

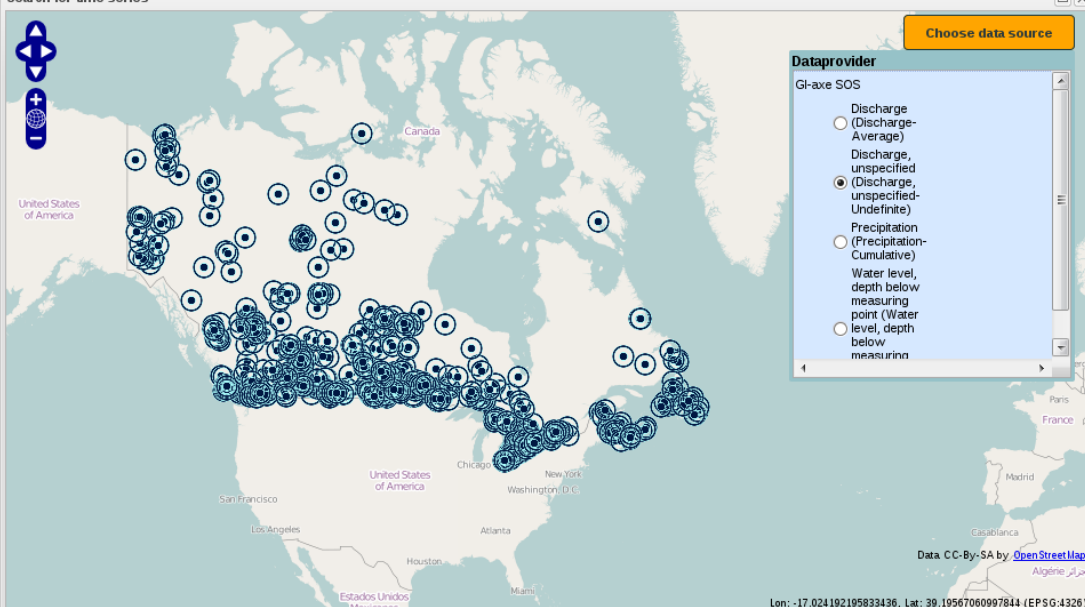
Refresh Check All Uncheck All Remove

Selection Tool

ALL Simple Filter Complex Filter

Check	VariableName	SiteName	Data Network
<input checked="" type="checkbox"/>	Discharge, unsp.	Discharge, u...	EC (2)
<input type="checkbox"/>	Precipitation...	Precipitation...	GI-axe Data (8)

Search for time series



Choose data source

Dataprovider

GI-axe SOS

- Discharge (Discharge-Average)
- Discharge, unspecified
- (Discharge, unspecified-Undefinite)
- Precipitation (Precipitation-Cumulative)
- Water level, depth below measuring point (Water level, depth below measuring point)

Data CC-BY-SA by [OpenStreetMap](#)

Lon: -17.024192195833436, Lat: 39.19567060997844 (EPSG:4326)



Data CC-BY-SA by [OpenStreetMap](#)

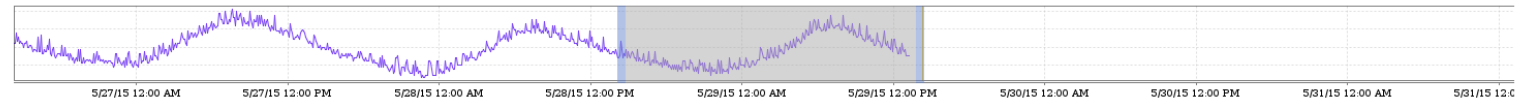
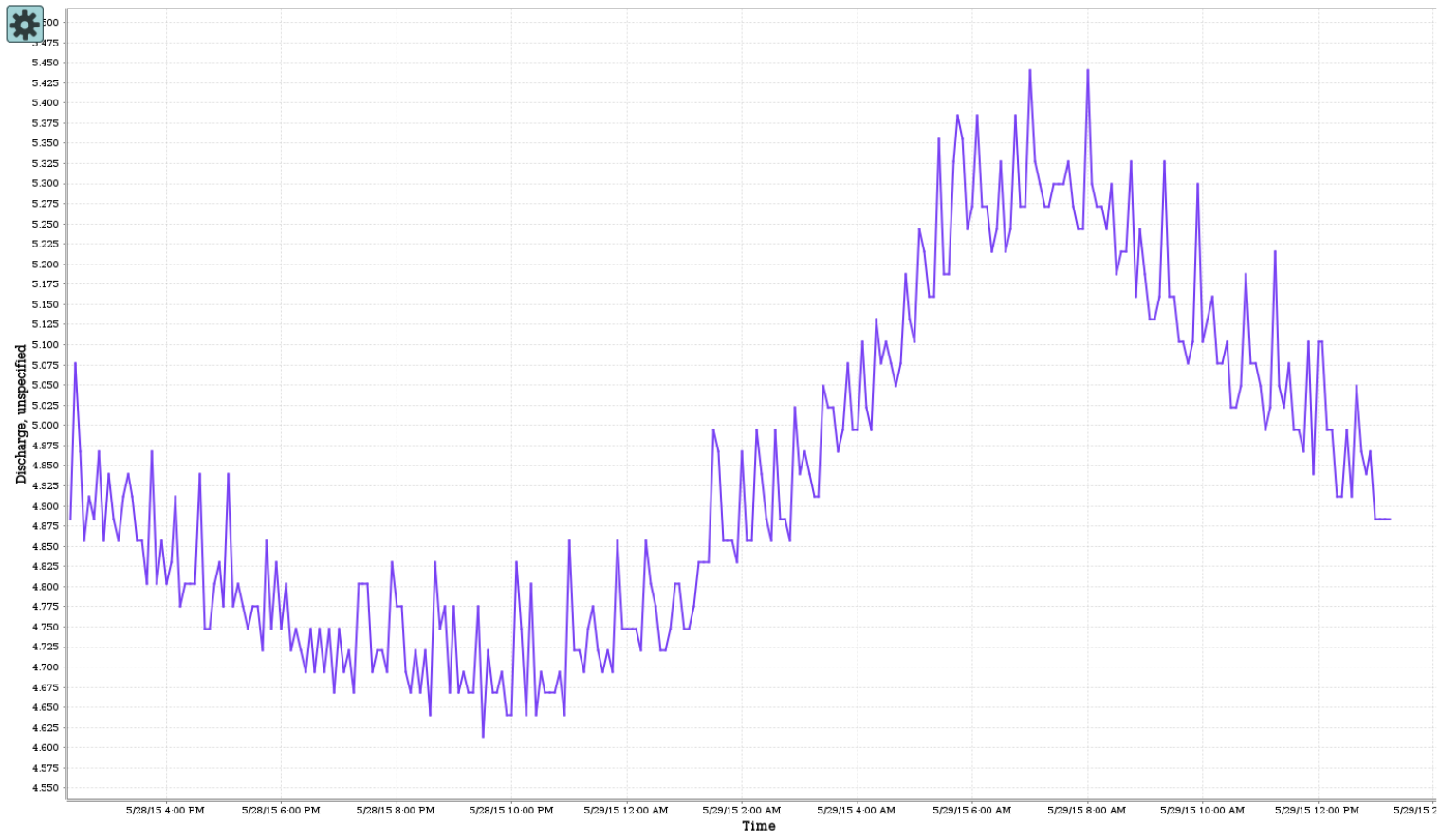
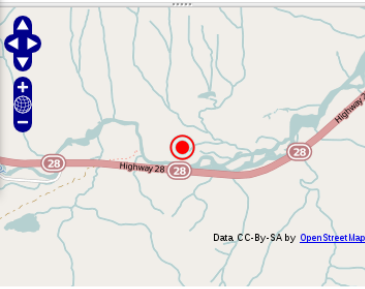
Search for time series

Dataprovider: GI-axe SOS

- Discharge (Discharge-Average)
- Discharge, unspecified

Discharge, unspecified@EC:08HD018

Parameter: Discharge, unspecified
Station: EC:08HD018
28.04.2015 10:00 (7.432) to 29.05.2015 12:15 (5.077)



Views

GI-conf web tool

Profilers

[+ Add](#)

OPENSEARCH Profiler

- [Endpoint](#)
- [Description document](#)
- [Remove](#)

OAI-PMH Profiler

- [Endpoint](#)
- [Identify](#)
- [Remove](#)

CSW/ISO-GEO Profiler

- [Endpoint](#)
- [Capabilities](#)
- [Remove](#)

CSW/ISO Profiler

- [Endpoint](#)
- [Capabilities](#)
- [Remove](#)

OPENSEARCH-SEMANTIC-ENHANCED Profiler

- [Endpoint](#)
- [Description document](#)
- [Remove](#)



Views

[+ Add](#)

VIEW1

- Endpoint:
 - [OAI-PMH](#)
 - [OPENSEARCH](#)
- Sources:
 - Geo Commons Core
 - IRIS EVENT
 - NASA GES DISC WCS v1.0.0 for L...
 - NASA SVS Image Server
- Keywords:
 - keyword1
 - keyword2
- Protocols:
 - OGC Web Map Service 1.3.0 Prot...
 - OGC Web Coverage Service 2.0 P...
- Only GDC: true
- BBOX:
 - west: -4.22
 - south: 31.82
 - east: 28.48
 - north: 52.38
- Time range:
 - start: 2015-05-01
 - end:

[Settings](#)

[Delete](#)

Sources

[+ Add](#)

Geo Commons Core

- Source type: OPENSEARCH version 1.1
- [Settings](#)
- [Remove](#)

IRIS EVENT

- Source type: IRIS_EVENT version 1.0
- [Settings](#)
- [Remove](#)

NASA GES DISC WCS v1.0.0 for Level 3 AIRS Products

- Source type: WCS version 1.0.0
- Scheduled harvesting not set
- [Settings](#)
- [Harvest this source](#)
- [Harvesting status](#)
- [Remove](#)

NASA SVS Image Server

- Source type: WMS version 1.3.0
- Scheduled harvesting not set
- [Settings](#)
- [Harvest this source](#)
- [Harvesting status](#)
- [Remove](#)

GI-conf web tool

Configurations

Profilers

[+ Add](#)

OPENSEARCH Profiler

[Endpoint](#)
[Description document](#)
[Remove](#)

OAI-PMH Profiler

[Endpoint](#)
[Identify](#)
[Remove](#)

CSW/ISO-GEO Profiler

[Endpoint](#)
[Capabilities](#)
[Remove](#)

CSW/ISO Profiler

[Endpoint](#)
[Capabilities](#)
[Remove](#)

OPENSEARCH-SEMANTIC-ENHANCED Profiler

[Endpoint](#)
[Description document](#)
[Remove](#)

Sources

Geo

OPENSEARCH version 1.1

S_EVENT version 1.0

WCS v1.0.0 for Level 3 AIRS Products

CS version 1.0.0
Testing not set

[Harvest this source](#)

[Harvesting status](#)

[Remove](#)

NASA SVS Image Server

- Source type: WMS version 1.3.0
- Scheduled harvesting not set

[Settings](#)

[Harvest this source](#)

[Harvesting status](#)

[Remove](#)

Add a view



Label:

Admit only GeossDataCore records

[▶ Edit profilers](#)

[▼ Edit sources](#)

Geo Commons Core

IRIS EVENT

NASA GES DISC WCS v1.0.0 for Level 3 AIRS Products

NASA SVS Image Server

[▶ Edit keywords](#)

[▶ Edit transfer protocols](#)

[▶ Edit bounding box](#)

[▶ Edit temporal subset](#)

GI-conf web tool

ations

Profilers

+ Add

OPENSEARCH Profiler

Endpoint

Description document

Remove

OAI-PMH Profiler

Endpoint

Identify

Remove

CSW/ISO-GEO Profiler

Endpoint

Capabilities

Remove

CSW/ISO Profiler

Endpoint

Capabilities

Remove

OPENSEARCH-SEMANTIC-ENHANCED P

Endpoint

Description document

Remove

Sources

Core

OPENSEARCH version 1.1

S_EVENT version 1.0

WCS v1.0.0 for Level 3 AIRS Products

CS version 1.0.0

Testing not set

source

status

Server

MS version 1.3.0

Testing not set

Settings

Harvest this source

Harvesting status

Remove

Add a view



Label:

Admit only GeossDataCore records

▶ Edit profilers

▶ Edit sources

▶ Edit keywords

▶ Edit transfer protocols

▼ Edit bounding box



i Hold shift and drag to select an area

West, south, east, north

Clear map

▶ Edit temporal subset

Submit

Profilers

Add

OPENSEARCH Profiler

[Endpoint](#)
 [Description document](#)
 Remove

OAI-PMH Profiler

[Endpoint](#)
 [Identify](#)
 Remove

CSW/ISO-GEO Profiler

[Endpoint](#)
 [Capabilities](#)
 Remove

CSW/ISO Profiler

[Endpoint](#)
 [Capabilities](#)
 Remove

OPENSEARCH-SEMANTIC-ENHANCED Profiler

[Endpoint](#)
 [Description document](#)
 Remove

Sources

Core
OPENSEARCH version 1.1

S_EVENT version 1.0

WCS v1.0.0 for Level 3 AIRS Products

CS version 1.0.0
Harvesting not set

[Settings](#)
 [Harvest this source](#)
 [Harvesting status](#)
 Remove

NASA SVS Image Server
• Source type: WMS version 1.3.0
• Scheduled harvesting not set

[Settings](#)
 [Harvest this source](#)
 [Harvesting status](#)
 Remove

Add a view



Label:

Admit only GeossDataCore records

[▶ Edit profilers](#)

[▶ Edit sources](#)

[▶ Edit keywords](#)

[▶ Edit transfer protocols](#)

[▶ Edit bounding box](#)

[▼ Edit temporal subset](#)

May 2015

Su Mo Tu We Th Fr Sa

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

This XML file does not appear to have any style information associated with it. The document tree is shown below.

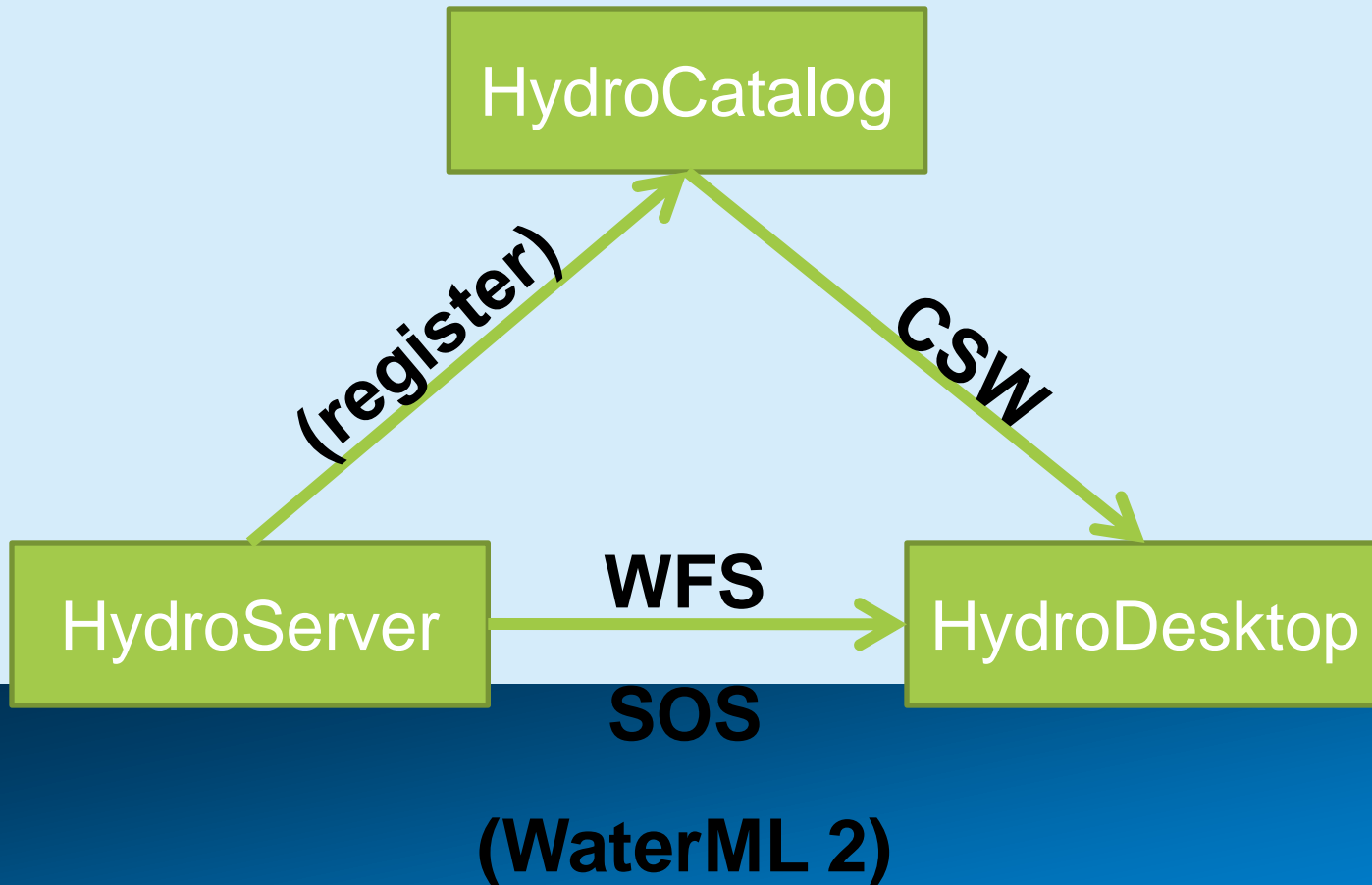
```
<?xml version="1.0" encoding="UTF-8" ?>
<OAI-PMH xmlns="http://www.openarchives.org/OAI/2.0/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/oai-2.0.xsd http://www.openarchives.org/OAI/2.0/oai-2.0.xsd">
  <responseDate>2015-05-29T09:16:09Z</responseDate>
  <request verb="Identify">http://localhost:8085/gi-cat/services/oaipmh/v0</request>
  <Identify>
    <repositoryName>DAB OAI-PMH 2.0 interface</repositoryName>
    <baseUrl>http://localhost:8085/gi-cat/services/oaipmh/v0</baseUrl>
    <protocolVersion>2.0</protocolVersion>
    <adminEmail>e.boldrini@iia.cnr.it</adminEmail>
    <earliestDatestamp>2015-05-29T09:16:09Z</earliestDatestamp>
    <deletedRecord>transient</deletedRecord>
    <granularity>YYYY-MM-DDThh:mm:ssZ</granularity>
  </Identify>
</OAI-PMH>
```

DEMONSTRATIONS ON HYDROLOGIC DATA EXCHANGE



The Road Further Ahead

Using OGC Standards



HIS in the SAVA River Basin



SAVA Hydrologic Information System Central Web Service Registry

The Sava hydrologic monitoring is a federated network composed by 5 States (Bosnia and Herzegovina, Croatia, Montenegro, Serbia and Slovenia), including 2 Entities (Federation of Bosnia and Herzegovina - Bosnia and Herzegovina, Republika Srpska), together with the [International Sava River Basin Commission](#), an international organization established by the Framework Agreement on the Sava River Basin (FASRB), which is the unique international agreement integrating all aspects of the water resources management.

The portal provides access to the hydrological observations in the International Sava River Basin, commonly published as Hydrological Yearbooks. In particular, it provides additional operational capability, for in situ water observations, as a national registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

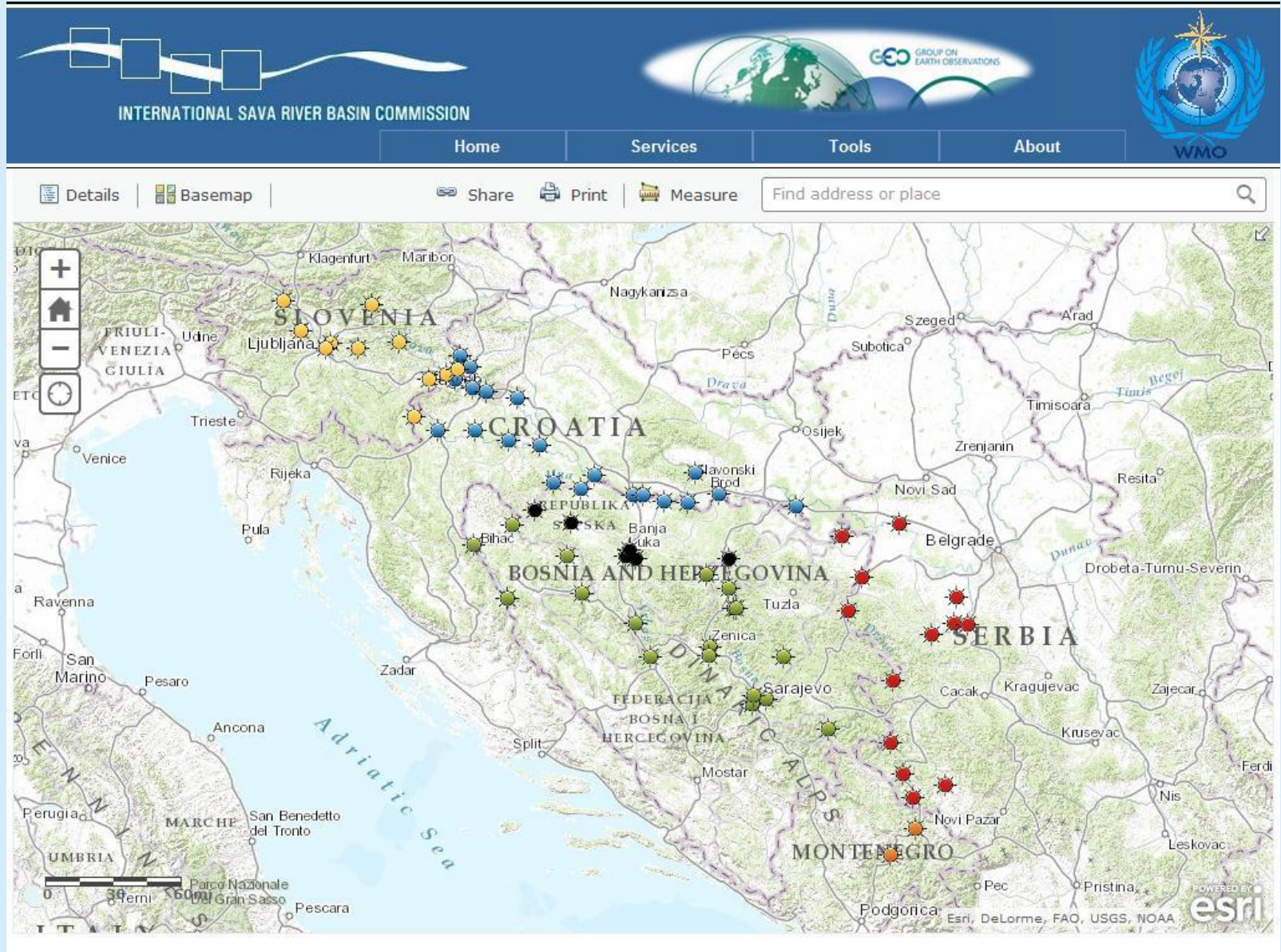
The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 6
- Brokered sites: 110
- Brokered variables: 5
- Brokered values: 58724
- Geographic extent: [14.1653, 20.4547, 42.8622, 46.34]

HIS in the SAVA River Basin



CHINA Hydrologic Information System Central Web Service Registry

The China hydrologic monitoring is a federated network composed by 22 Provinces, 4 Municipalities, 5 Autonomous Regions, 2 Special Administrative Regions and the Taiwan Province, together with the Ministry of Water Resources (MWR), the Chinese Government Department responsible for water administration.

The portal provides access to the hydrological observations in China, commonly published as Hydrological Yearbooks. In particular, the portal provides additional operational capability, for in situ water observations, as an international registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 34
- Brokered sites: 5576
- Brokered variables: 1
- Brokered values: 67668
- Geographic extent: [73.56471, 135.0822, 4.1877, 53.56073]



HIS in Niger River Basin



Home

Services

Tools

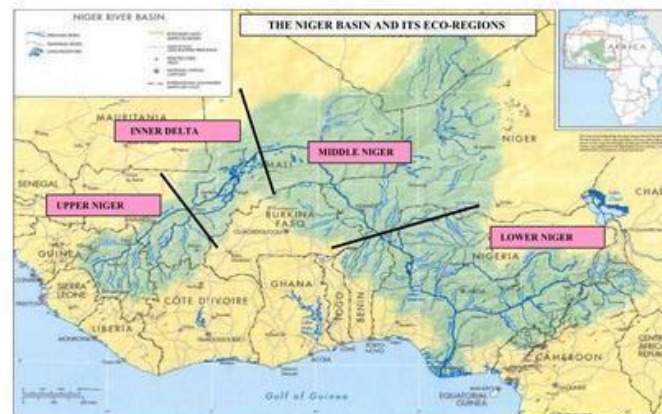
About

NIGER Hydrologic Information System Central Web Service Registry

The Niger river basin hydrological observing system, designated **Niger-HYCOS**, is a federated network composed by 9 States (Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Guinea, Mali, Niger, Nigeria and Chad), together with the Niger Basin Authority (NBA), an inter-governmental organization responsible for promoting cooperation amongst Member States and contributing to improve the living conditions of the basin populations through sustainable management of water resources and associated ecosystems.

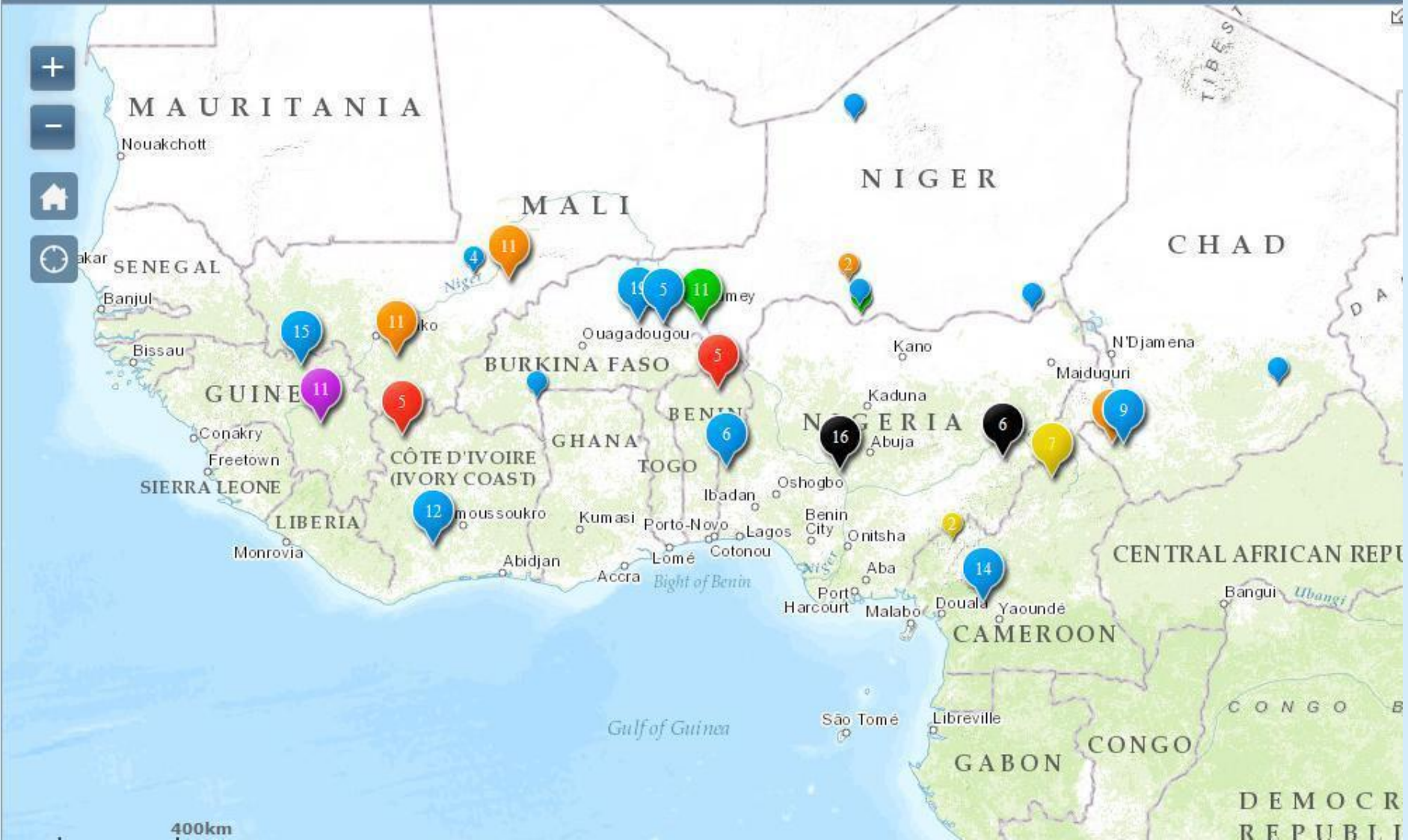
The portal provides access to the hydrological observations in the Niger river basin, commonly published as Hydrological Bulletins. In particular, the portal provides additional operational capability, for in situ water observations, as an international registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 9
- Brokered sites: 191
- Brokered variables: 1
- Brokered values: 29272
- Geographic extent: [-13.2, 146.11, -7.81, 19]



NEW ZEALAND Hydrologic Information System Central Web Service Registry

The New Zealand hydrologic monitoring is a federated network composed by 16 Regional Councils, together with National Institute of Water and Atmospheric Research (NIWA), a Crown Research Institute established in 1992, which conducts leading environmental science to enable the sustainable management of natural resources for New Zealand and the planet.

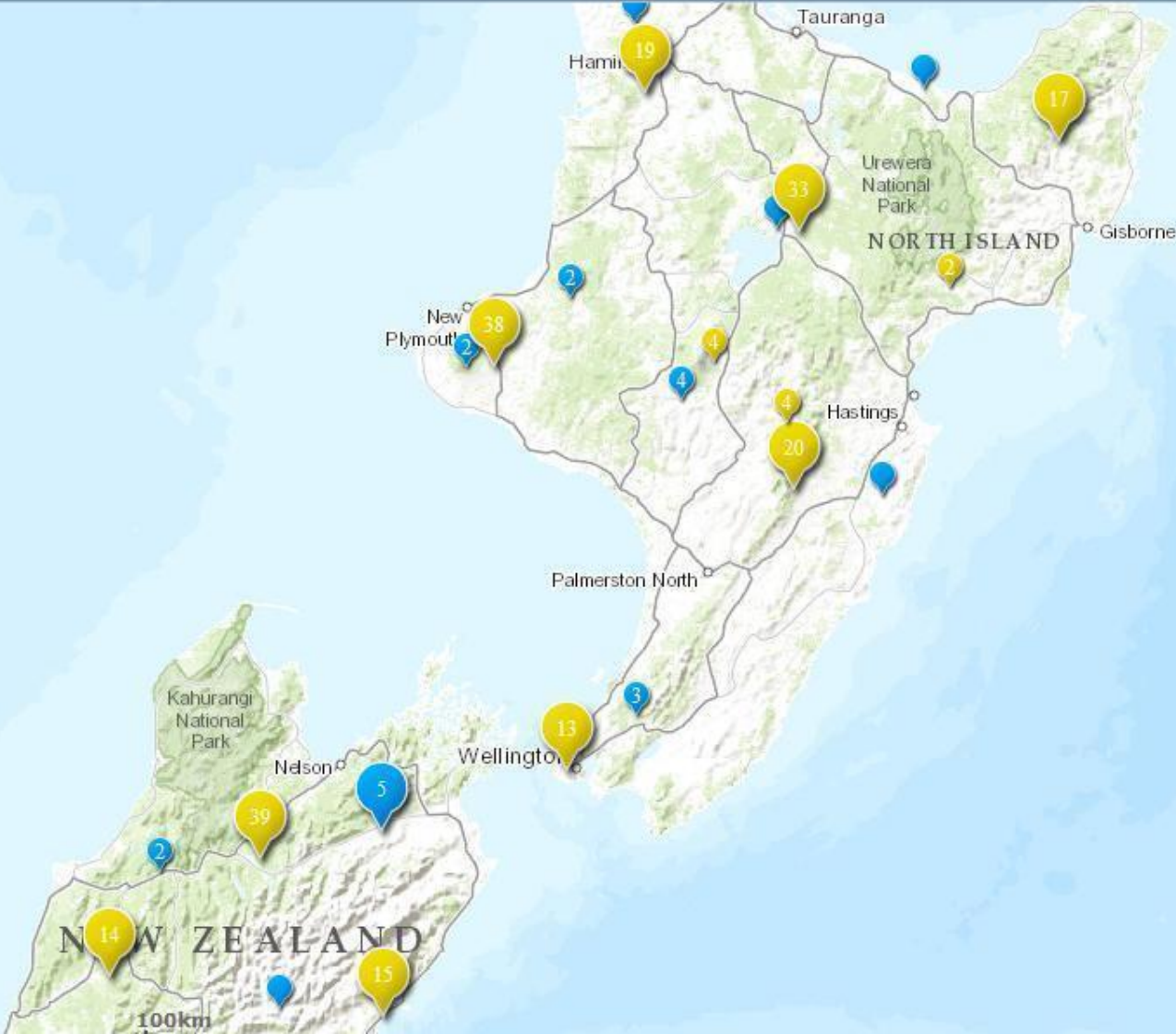
The portal provides access to the hydrological observations in New Zealand, commonly published as Hydrological Yearbooks. In particular, the portal provides additional operational capability, for in situ water observations, as an international registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 16
- Brokered sites: 568
- Brokered variables: 1
- Brokered values: 13872
- Geographic extent: [167.5113, 178.2036, -46.23, -34.91962]



SADC Hydrologic Information System Central Web Service Registry

The SADC-HYCOS program is a regional component of the World Hydrological Cycle Observing System ([WHYCOS](#)). The main goal of the SADC-HYCOS program is to ensure that participating countries, individually and collectively, attain the technical capability, effective management and equitable use of the freshwater resources of the sub-region and to establish a Water Resources Information System as an effective decision making tool.

The portal provides access to the hydrological observations in the Southern African monitoring network, composed of stations located in Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Madagascar, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. In particular, the portal provides additional operational capability, for in situ water observations, as an international registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 14
- Brokered sites: 176
- Brokered variables: 444
- Brokered values: 17125
- Geographic extent: [11.96, 57.76, -33.24, 4.22]



HIS in the WMO RAIV



Home

Services

Tools

About

WMO RAIV Hydrologic Information System Central Web Service Registry

The main goal of the WMO RAIV program is to improve monitoring, data accuracy, availability and dissemination of information in North America, Central America and the Caribbean (WMO Members of Regional Association IV).

This region stretches from the far north of Canada all the way to the equator. Also, it includes the rich economies of the USA and Canada, as well as the developing countries in the Caribbean, such as Haiti. The main issues from weather and climate impacts are hurricanes, drought and flooding. The agricultural sector as well as transport and tourism are greatly impacted by severe weather and climate events.

The portal provides access to the hydrological observations in North America, Central America and the Caribbean monitoring network composed of stations located in Antigua and Barbuda, Bahamas, Barbados, Belize, British Caribbean Territories, Canada, Colombia, Costa Rica, Cuba, Curacao and Sint Maarten, Dominica, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Saint Lucia, Trinidad and Tobago, United States of America, Venezuel.

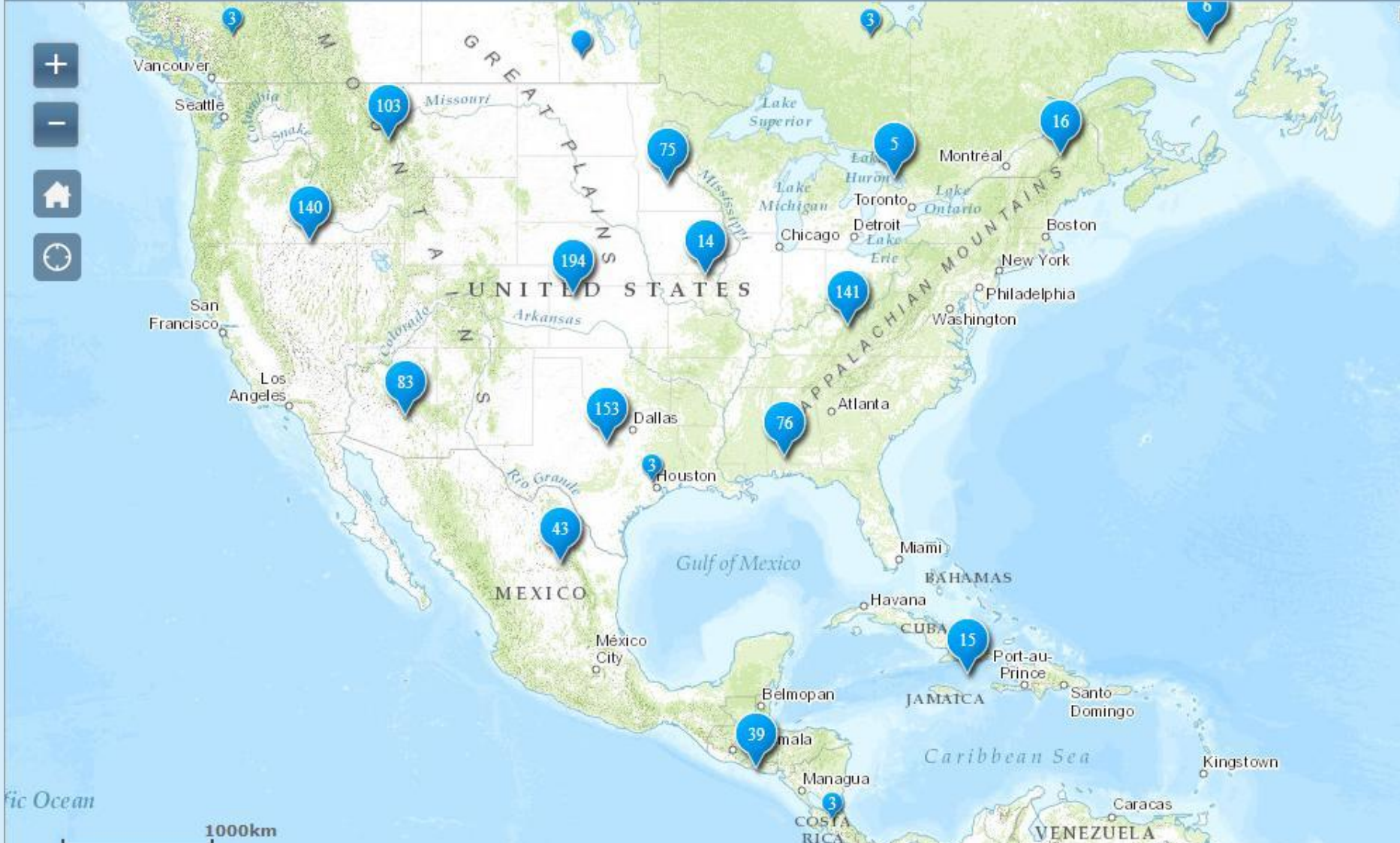


The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.

WEB SERVICE STATISTICS

- Brokered services: 12

- Registered users: 1000



HIS in WMO Arctic-HYCOS



[Home](#)

[Services](#)

[Tools](#)

[About](#)

ARCTIC Hydrologic Information System Central Web Service Registry

The Arctic-HYCOS program is being promoted through the World Hydrological Cycle Observing System (WHYCOS). The main goal of the Arctic-HYCOS program is to improve monitoring, data accuracy, availability and dissemination of information in the pan-arctic drainage basin. This project is science-driven and is aimed at monitoring freshwater fluxes and pollutants into the Arctic Ocean with the objective of improving climate predictions in the Northern Hemisphere and assessing the pollution of the Arctic coastal areas and the open Arctic Ocean.

The portal provides access to the hydrological observations in the Arctic monitoring network, composed of stations located in Canada, Denmark, Finland, Iceland, Kazakhstan, Mongolia, Norway, Russian Federation and United States of America. In particular, the portal provides additional operational capability, for in situ water observations, as an international registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 12
- Brokered sites: 5191
- Brokered variables: 1
- Brokered values: 697073
- Geographic extent: [-178.67, 179.24, 45.82, 80.6]

ARCTIC Hydrologic Information System Web Service Registry

Brokered OBS data

Brokered GIS data

Brokered MOD data

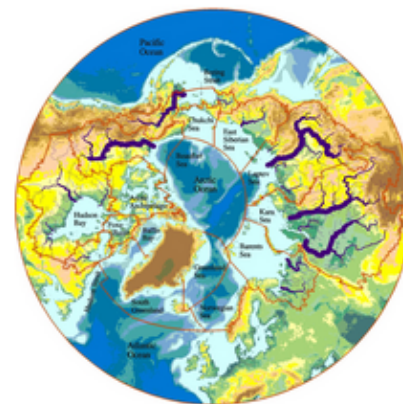
Catalog interfaces

Server status

The Arctic-HYCOS program is being promoted through the Hydrological Cycle Observing System (WHYCOS). The main goal of the Arctic-HYCOS program is to improve monitoring, data accuracy, availability and dissemination of information in the pan-arctic drainage basin. This project is science-driven and is aimed at monitoring freshwater fluxes and pollutants into the Arctic Ocean with the objective of improving climate predictions in the Northern Hemisphere and assessing the pollution of the Arctic coastal areas and the open Arctic Ocean.

The portal provides access to the hydrological observations in the Arctic monitoring network, composed of stations located in Canada, Denmark, Finland, Iceland, Kazakhstan, Mongolia, Norway, Russian Federation and United States of America. In particular, the portal provides additional operational capability, for in situ water observations, as an international registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



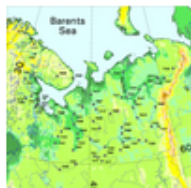
WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 12
- Brokered sites: 5191
- Brokered variables: 1
- Brokered values: 697073
- Geographic extent: [-178.67, 179.24, 45.82, 80.6]

Brokered observational services

Data Service Title	Observation Network Name	WSDL	Created Date	Organization	Earliest Start Date	Latest End Date
Anadyr and Kolyma Basins	Anadyr	WSDL	2014.09.02		1927.01.01	2000.12.01
Barents Sea	Barents	WSDL	2014.09.02		1877.06.01	1999.12.01
Lena Basin with Laptev Sea and parts of the East Siberian Sea	Lena	WSDL	2014.09.02		1912.06.01	2000.12.01
Mackenzie	Mackenzie	WSDL	2014.08.25		1913.08.01	2002.12.01
Nelson	Nelson	WSDL	2014.08.25		1892.10.01	2000.12.01
Ob Basin and Western Kara Sea	Ob	WSDL	2014.09.02		1891.08.01	2000.12.01
Scandinavia	Scandinavia	WSDL	2014.09.02		1907.10.01	2000.12.01
South and East Hudson Bay	SEHB	WSDL	2014.08.25		1914.10.01	2000.12.01
Souris and Red Rivers Basins	Souris	WSDL	2014.09.02		1901.06.01	2003.09.01
NorthWest Hudson Bay	WNHB	WSDL	2014.08.25		1928.10.01	2002.12.01
Yenisei Basin	Yenisei	WSDL	2014.09.02		1902.09.01	1999.12.01
Yukon	Yukon	WSDL	2014.08.25		1909.11.01	2003.09.01

Scandinavia



Scandinavia

[WaterML Service](#)

[WFS Service](#)

Contact:

Service Statistics:

Sites:	17	Geographic Extent:	70.11	
Variables:	1		-21.02	28.08
Values:	9646		63.93	

Last Harvested on 1/30/2015 2:41:38 PM
(assumed static)

Abstract

Understanding of the Arctic Ocean's freshwater budget variability requires analysis of hydrological processes across the entire river runoff formation zone covering both the Arctic Ocean watershed and the adjacent territories from which the runoff contributes to the ocean freshwater budget. The entire Pan-Arctic hydrological domain covers a region of approximately 24 million km² (including Greenland) and represents a significant part of the global land surface in the north. The region is characterized and defined hydrologically by the north flowing rivers entering the Arctic Ocean, Hudson Bay, James Bay, the Canadian Arctic Archipelago, the far north Atlantic Ocean, and Bering Strait including much of Alaska. Although the Hudson Bay, James Bay, and Bering Strait are located outside of the Arctic Ocean drainage basin, the rivers draining into these water bodies supply a large amount of freshwater discharge to the Arctic Ocean via the north-flowing oceanic currents.



Citation

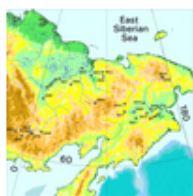
Data are collected from hydrological stations in R-ArcticNET, a regional hydrometeorological data network for the pan-Arctic region.



Brokered GIS services

Gis Service Title	Map Server Name	WSDL	CreatedDate	Organization	Reference Date
Anadyr and Kolyma Basins	Anadyr	WSDL	2014.12.16		2014.12.01
Nelson	Nelson	WSDL	2014.12.16		2014.11.18
Ob Basin and Western Kara Sea	OB	WSDL	2014.12.16		2014.12.01
Scandinavia	Scandinavia	WSDL	2014.12.16		2014.12.01

Anadyr and Kolyma Basins



Anadyr
[WMS Service](#)
[WFS Service](#)

Contact:

Service Statistics:

Service Statistics:	Geographic Extent:	
Reference Date 12/16/2014 1:41:33 PM	-13.3	-24.7
	67	63.1

Abstract

Understanding of the Arctic Ocean’s freshwater budget variability requires analysis of hydrological processes across the entire river runoff formation zone covering both the Arctic Ocean watershed and the adjacent territories from which the runoff contributes to the ocean freshwater budget. The entire Pan-Arctic hydrological domain covers a region of approximately 24 million km² (including Greenland) and represents a significant part of the global land surface in the north. The region is characterized and defined hydrologically by the north flowing rivers entering the Arctic Ocean, Hudson Bay, James Bay, the Canadian Arctic Archipelago, the far north Atlantic Ocean, and Bering Strait including much of Alaska. Although the Hudson Bay, James Bay, and Bering Strait are located outside of the Arctic Ocean drainage basin, the rivers draining into these water bodies supply a large amount of freshwater discharge to the Arctic Ocean via the north-flowing oceanic currents.



Citation

GIS layers published as online resources.

Brokered MOD services

Mod Service Title	Mod Server Name	WSDL	CreatedDate	Organization	Reference Date
CANADA	canada	WSDL		Environment Canada	2014.12.01
NOAA	noaa	WSDL		National Oceanic and Atmospheric Administration	2014.12.01

NOAA



National Oceanic and Atmospheric Administration

noaa
 WMS Service
 WFS Service

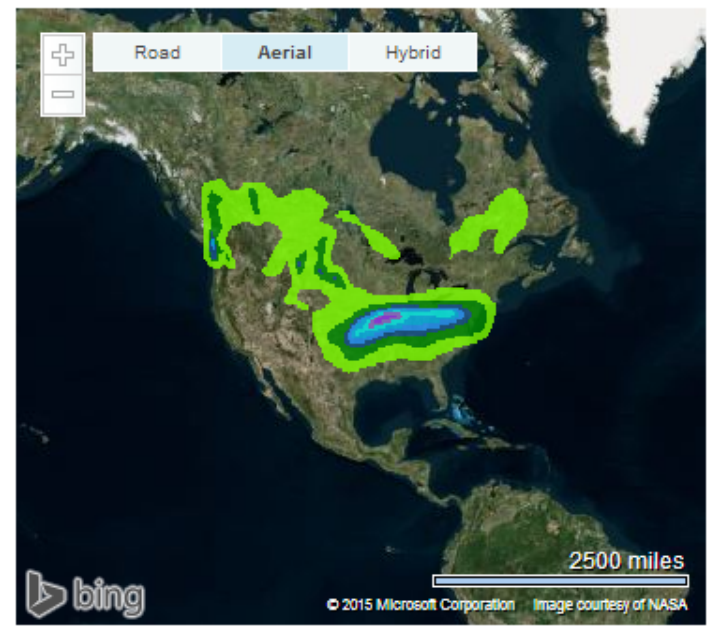
Contact:

Service Statistics:

Reference Date 12/1/2014 12:00:00 AM	Geographic Extent:	60	-60
		-133	19

Abstract

NOAA is an agency that enriches life through science. Our reach goes from the surface of the sun to the depths of the ocean floor as we work to keep citizens informed of the changing environment around them. From daily weather forecasts, severe storm warnings and climate monitoring to fisheries management, coastal restoration and supporting marine commerce, NOAA's products and services support economic vitality and affect more than one-third of America's gross domestic product. NOAA's dedicated scientists use cutting-edge research and high-tech instrumentation to provide citizens, planners, emergency managers and other decision makers with reliable information they need when they need it.



Citation

GIS layers published as online resources.

24 Hour Precipitation Forecast

Details Legend

Print

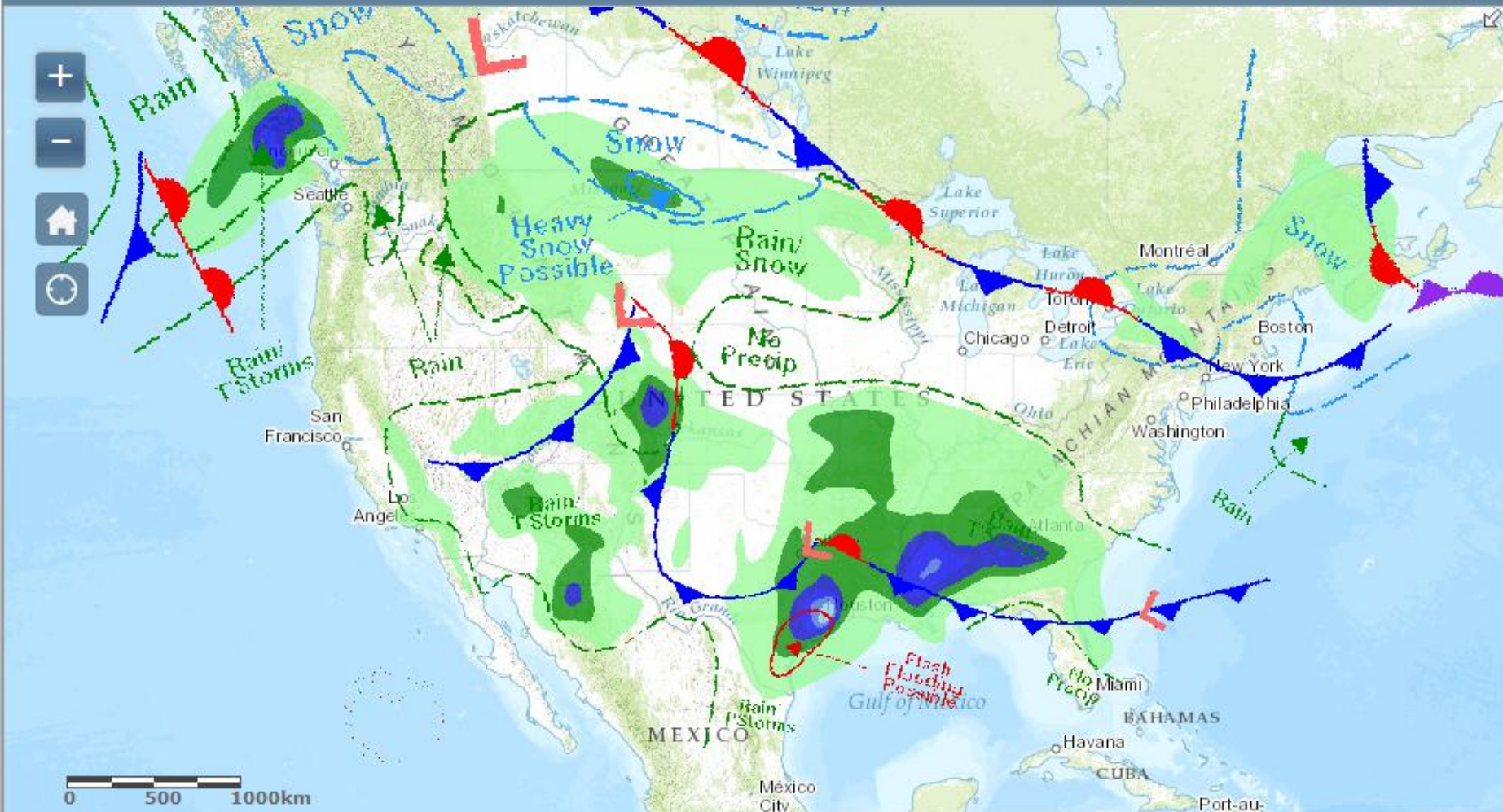
Layers

Basemap

Measure

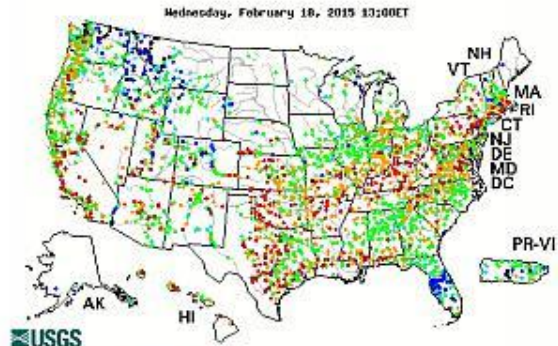
Share

Find address or place

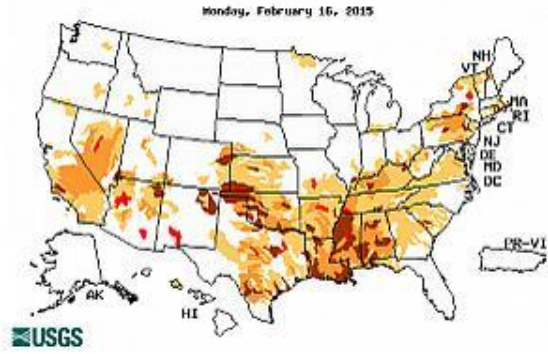


USGS WaterWatch

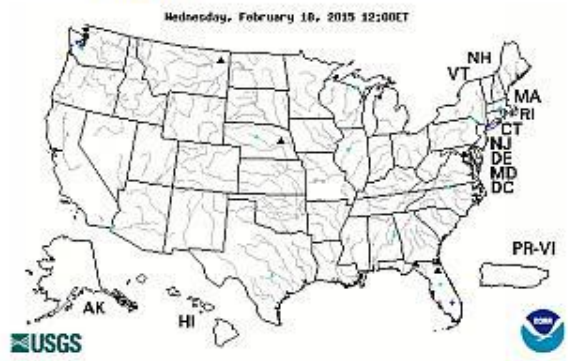
Current Streamflow



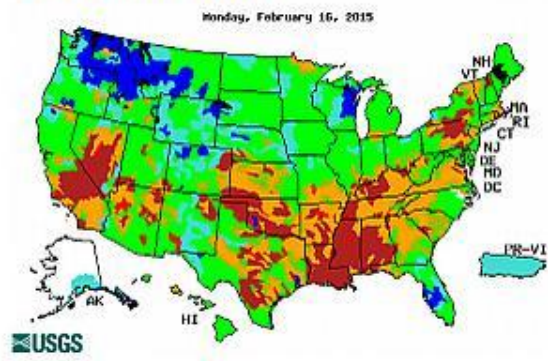
Drought



Flood

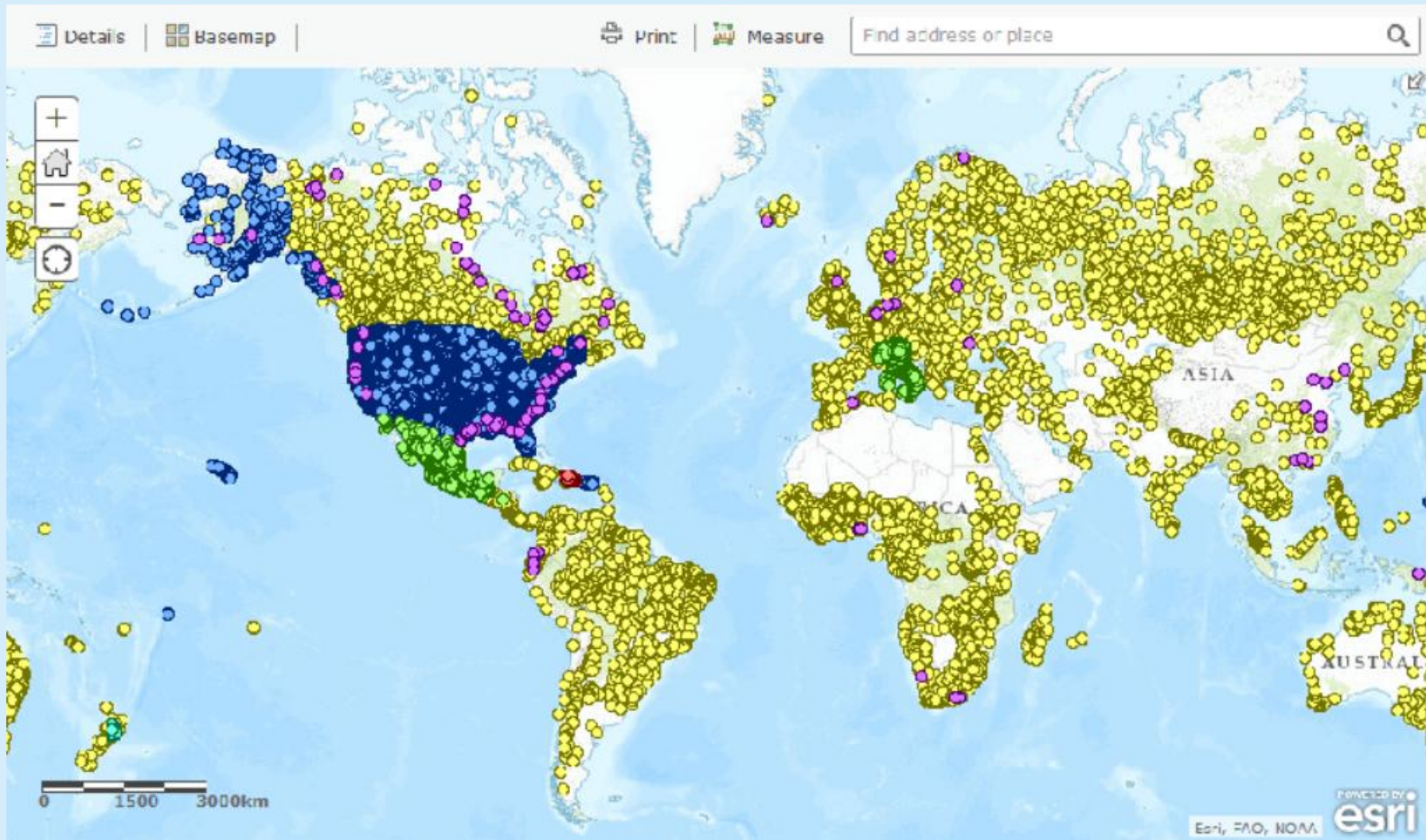


Past Flow/Runoff



World Water OnLine

Home > map



APPLICATIONS





Data Viewer

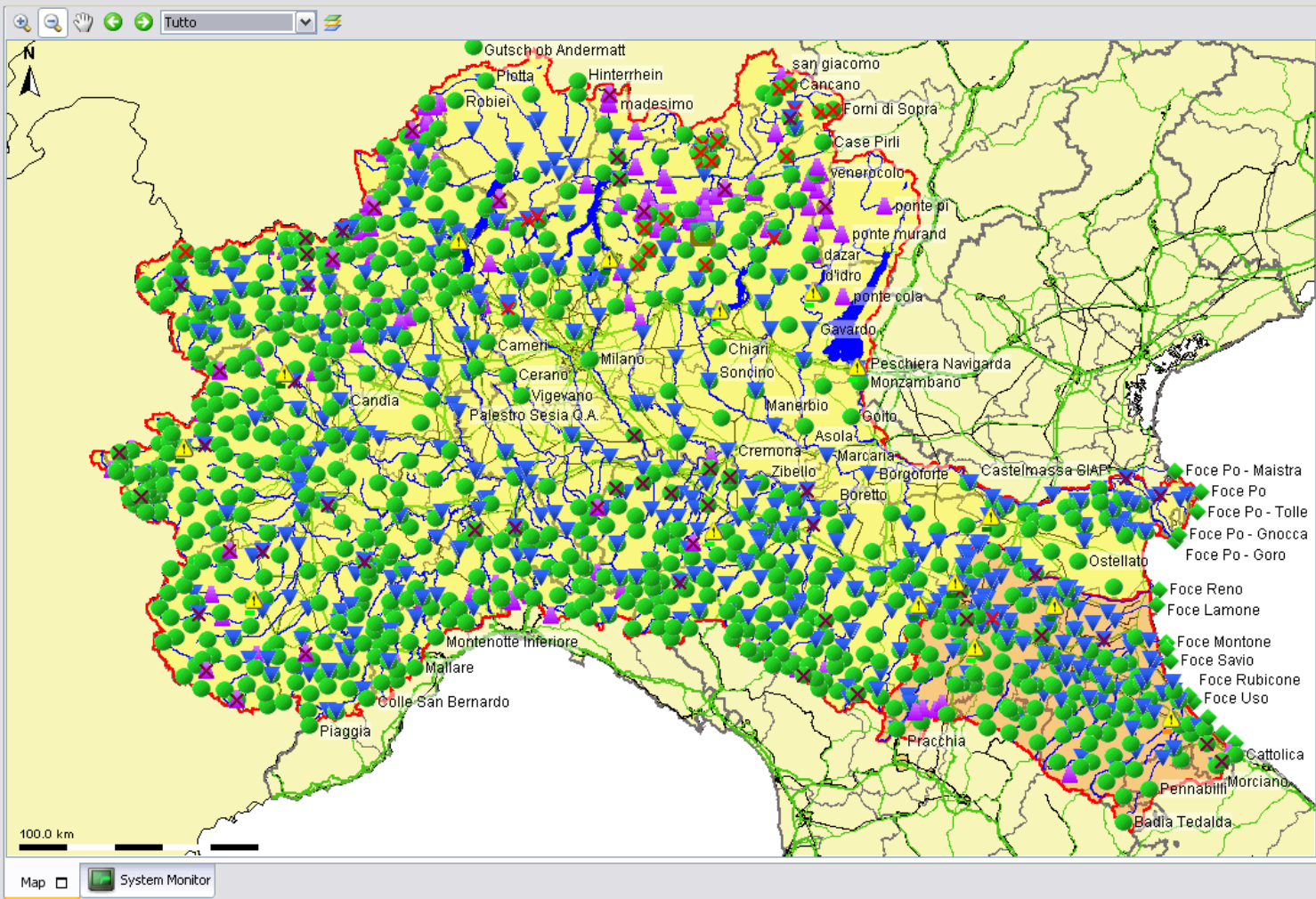
- Gauges
- Stochastic Models
- External Forecast Points
- LAMI Forecast Points
- COSMO Forecast Points
- Hydrol. Model subbasins
- Sobek Delta Low Flow
- Ribasim
- Performance Indicators
- Romagna

5 : Data Viewer

- Trivero
- Unchio Trobaso
- Upega
- Vaccera
- Val Clarea
- Valbondione
- Valcanale ERICSSON

Calculated Discharge
Observed Water Levels
Observed Salinity
Observed Precipitation
Observed Drybulb Temperature
Observed Volume

Map System Monitor



Logs

10-06-2010 11:41:46 INFO - LocalDataStore.Finished: Compact cache files finished
10-06-2010 11:41:41 INFO - DataStore.Info: Compact time series cache files
10-06-2010 11:41:41 INFO - LocalDataStore.Start: Compact cache files started

6 : Logs

Import data from a WaterML2 webservice

WaterML2 Server import

Here is an example import module configuration file that imports data from a WaterML2 webservice:

```
<?xml version="1.0" encoding="UTF-8"?>
<timeSeriesImportRun xmlns="http://www.wldelft.nl/fews"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.wldelft.nl/fews http://fews.wldelft.nl/schemas/version1.0/timeSeriesImportRun.xsd">
  <!-- This is an example import configuration file for importing WaterML data from a WaterML server -->
  <import>
    <general>
      <!-- Class name of WaterML server parser -->
      <parserClassName>nl.wldelft.waterml.timeseriesparsers.WaterMLServerParser</parserClassName>

      <!-- Path to directory containing libraries -->
      <binDir>%REGION_HOME%/Modules/waterml-bin</binDir>

      <!-- Directory from which CSV files are to be imported -->
      <serverUrl>http://nwisvaws02.er.usgs.gov/ogc-swie/wml2/uv/sos</serverUrl>
      <idMapId>IdImportWaterML2_usgs</idMapId>
      <importTimeZone>
        <timeZoneOffset>-06:00</timeZoneOffset>
      </importTimeZone>
    </general>
    <timeSeriesSet>
      <moduleInstanceId>ImportWaterML2_usgs</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MyPar</parameterId>
      <locationSetId>MyLocSet</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="nonequidistant"/>
      <readWriteMode>add originals</readWriteMode>
      <synchLevel>1</synchLevel>
    </timeSeriesSet>
  </import>
</timeSeriesImportRun>
```

Import WaterML2 data from a directory

WaterML2 file import

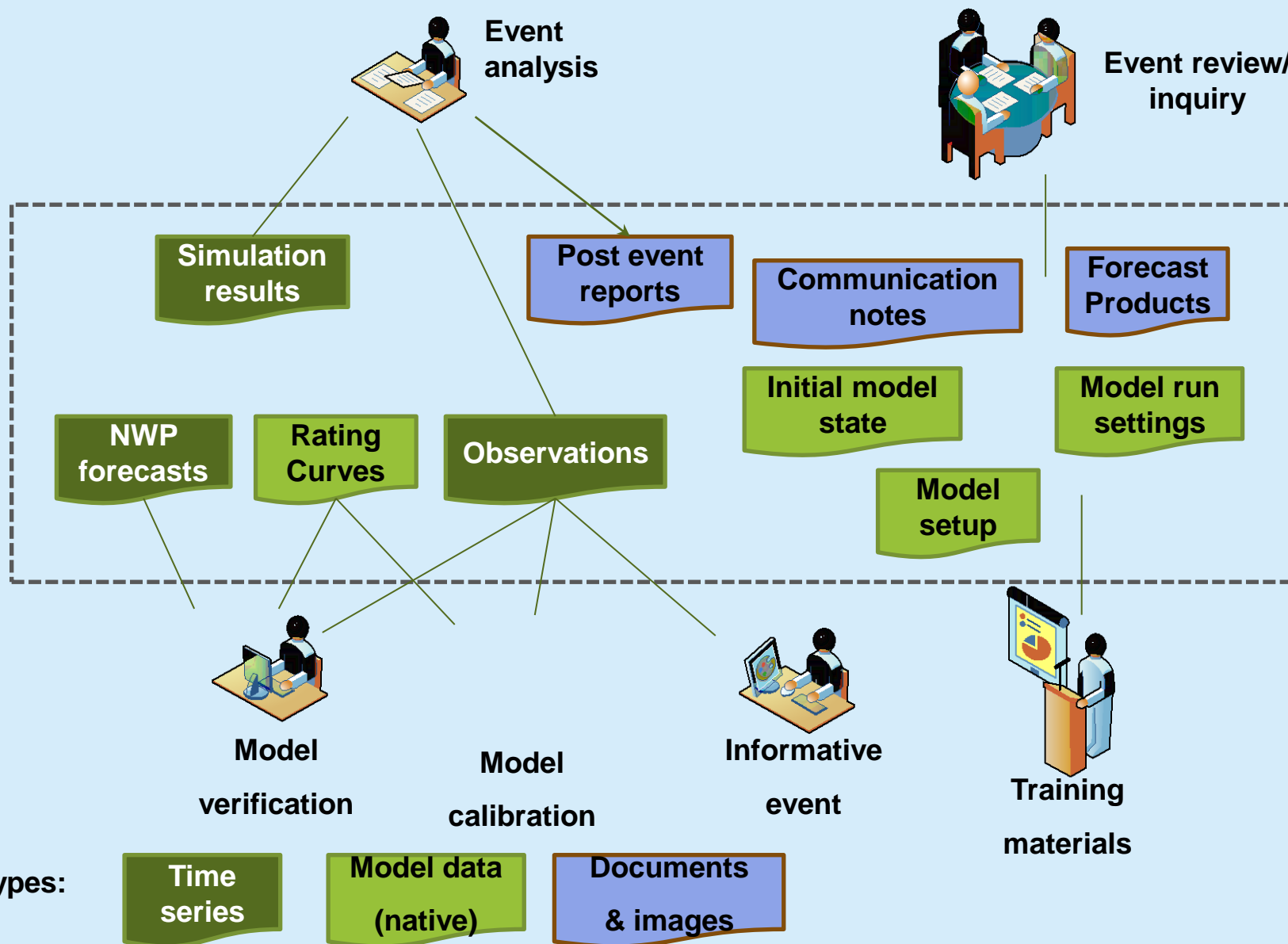
Here is an example import module configuration file that imports data from a directory

```
<?xml version="1.0" encoding="UTF-8"?>
<timeSeriesImportRun xmlns="http://www.wldelft.nl/fews"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.wldelft.nl/fews http://fews.wldelft.nl/schemas/version1.0/timeSeriesImportRun.xsd">
  <!-- This is an example import configuration file for importing WaterML data from a WaterML server -->
  <import>
    <general>
      <!-- Class name of WaterML server parser -->
      <parserClassName>nl.wldelft.waterml.timeseriesparsers.WaterMLTimeSeriesParser</parserClassName>

      <!-- Path to directory containing libraries -->
      <binDir>%REGION_HOME%/Modules/waterml-bin</binDir>

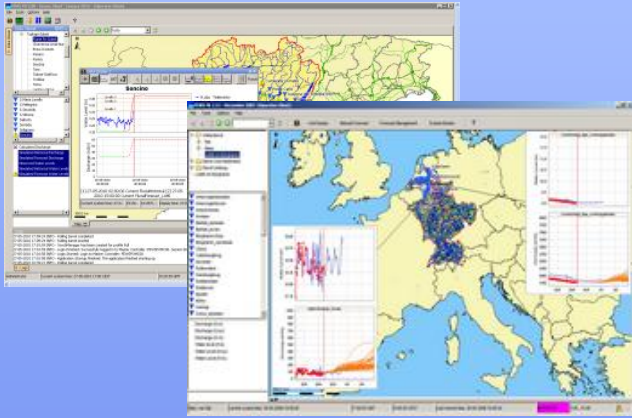
      <!-- Directory from which CSV files are to be imported -->
      <folder>$IMPORT_FOLDER_WATERML$</folder>
      <idMapId>IdImportWaterML2_usgs</idMapId>
      <importTimeZone>
        <timeZoneOffset>-06:00</timeZoneOffset>
      </importTimeZone>
    </general>
    <timeSeriesSet>
      <moduleInstanceId>ImportWaterML2_usgs</moduleInstanceId>
      <valueType>scalar</valueType>
      <parameterId>MyPar</parameterId>
      <locationSetId>MyLocSet</locationSetId>
      <timeSeriesType>external historical</timeSeriesType>
      <timeStep unit="nonequidistant"/>
      <readWriteMode>add originals</readWriteMode>
      <synchLevel>1</synchLevel>
    </timeSeriesSet>
  </import>
</timeSeriesImportRun>
```

Archive use case analysis



Requirements

Delft-FEWS



Deltares Open Archive

Observations

Simulations

Configuration

Rating curves

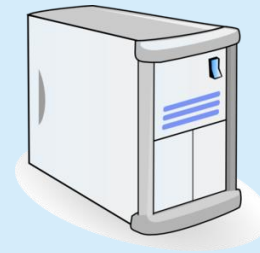
Reports

Messages



- Open archive (accessible and usable by wide variety of tools and systems)
- Based on standards
- Support for different data access protocols
- Scalable
- Data is easy to find

Overview of the Deltares Open Archive



Data Importer



Data storage



harvester



Catalogue



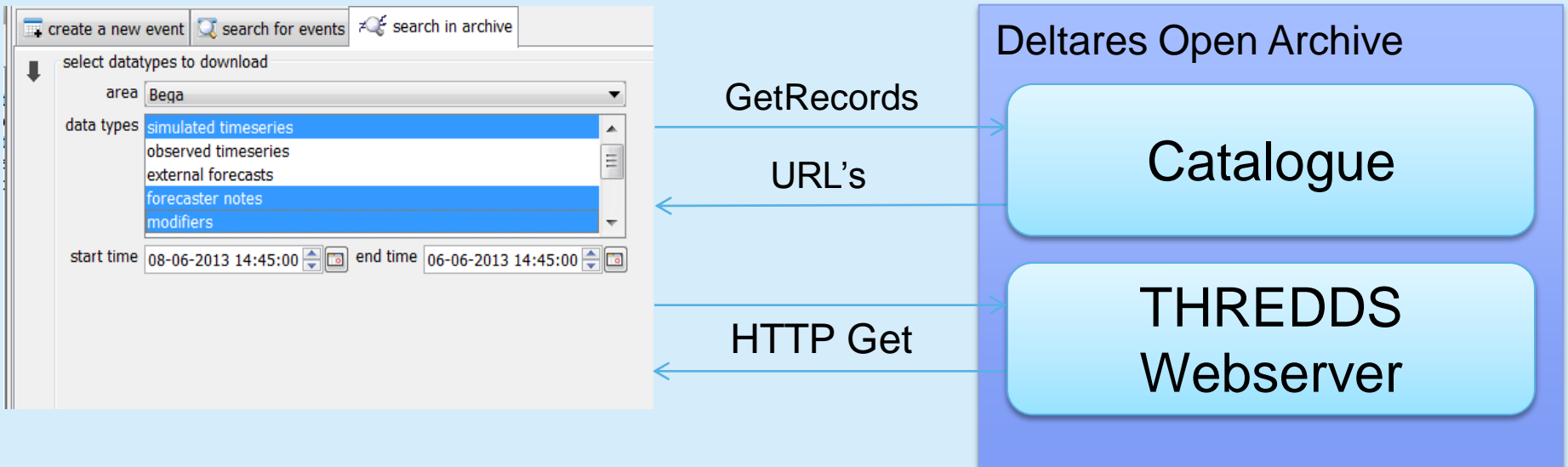
Retrieve data



Search for data

Finding and retrieving data from the archive (1)

Method 1: Retrieving data by location, data type and area



Retrieving data from the archive for analysis

- Request is send to the catalogue (area, period of time, data type),
- Catalogue responds with a list of URL's to download,
- Delft-FEWS downloads the data from the THREDDS webserver,
- Data can be imported in the stand alone version by running a workflow

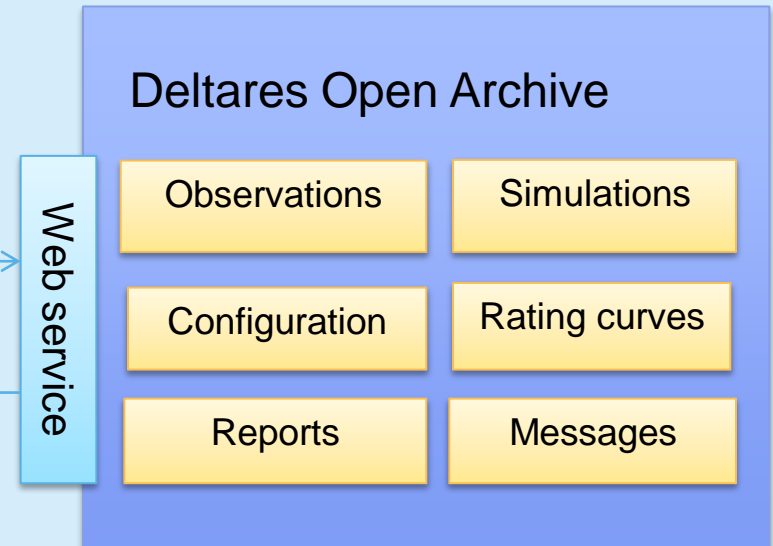
Finding and retrieving data from the archive (2)

Method 2: Retrieving data by event

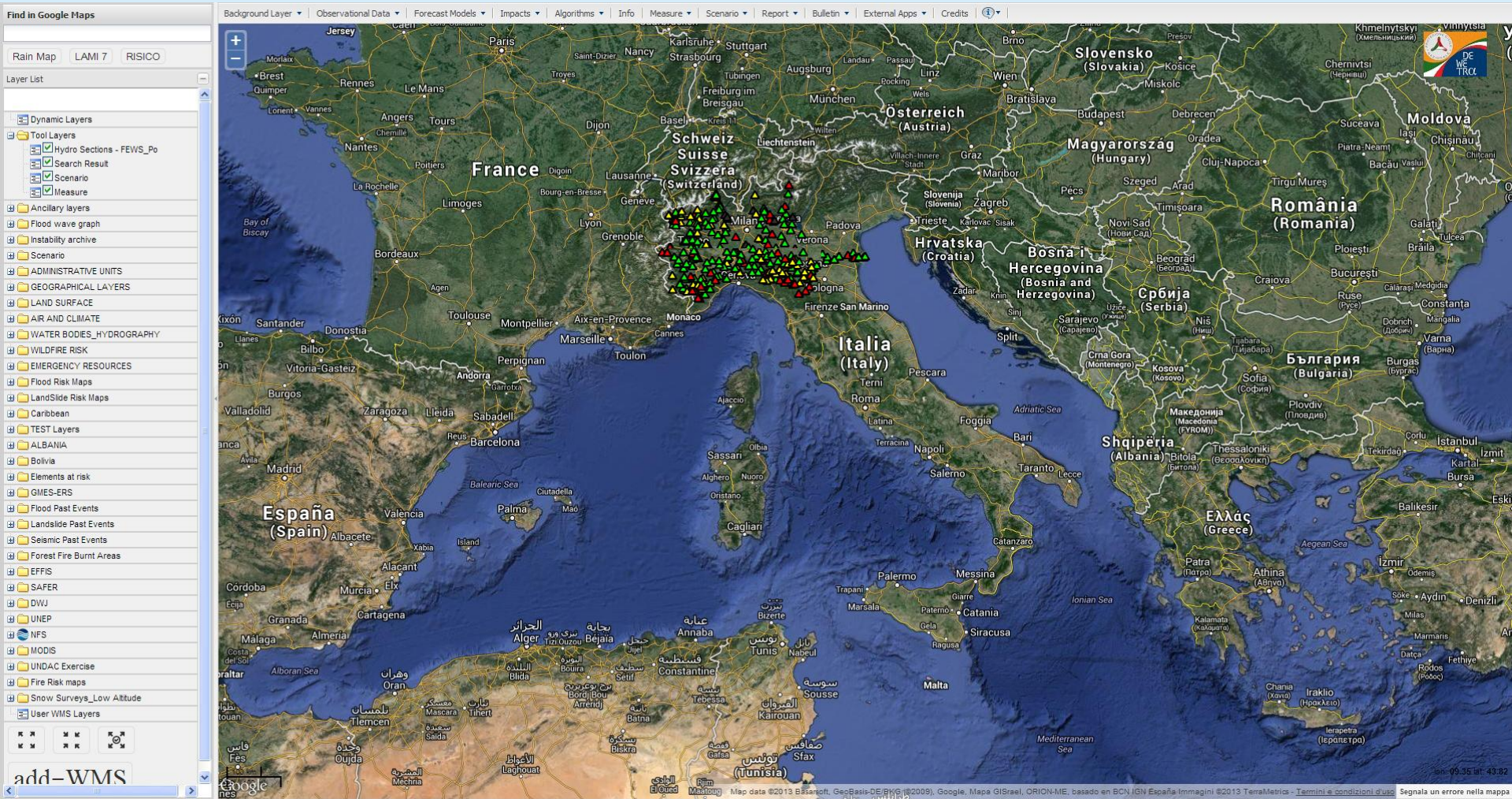
Events, a special kind of tagging mechanism

- Events occur in an area over a certain period of time
- Forecaster can define an event as a post-event activity
- Users can search by event to retrieve all associated data
- Data related to an event is kept longer in the archive.

name	description	creation time	start time	end time	area	event type
Huon May 2014 event	Test for Archive calibration reports	13-06-2014 1...	10-05-2014 0...	25-05-2014 00...	TAS Huon	calibration event
Review Event	Review event for performance	12-06-2014 0...	18-05-2014 0...	25-05-2014 00...	TAS Huon	Review event



DEWETRA and the Po river basin

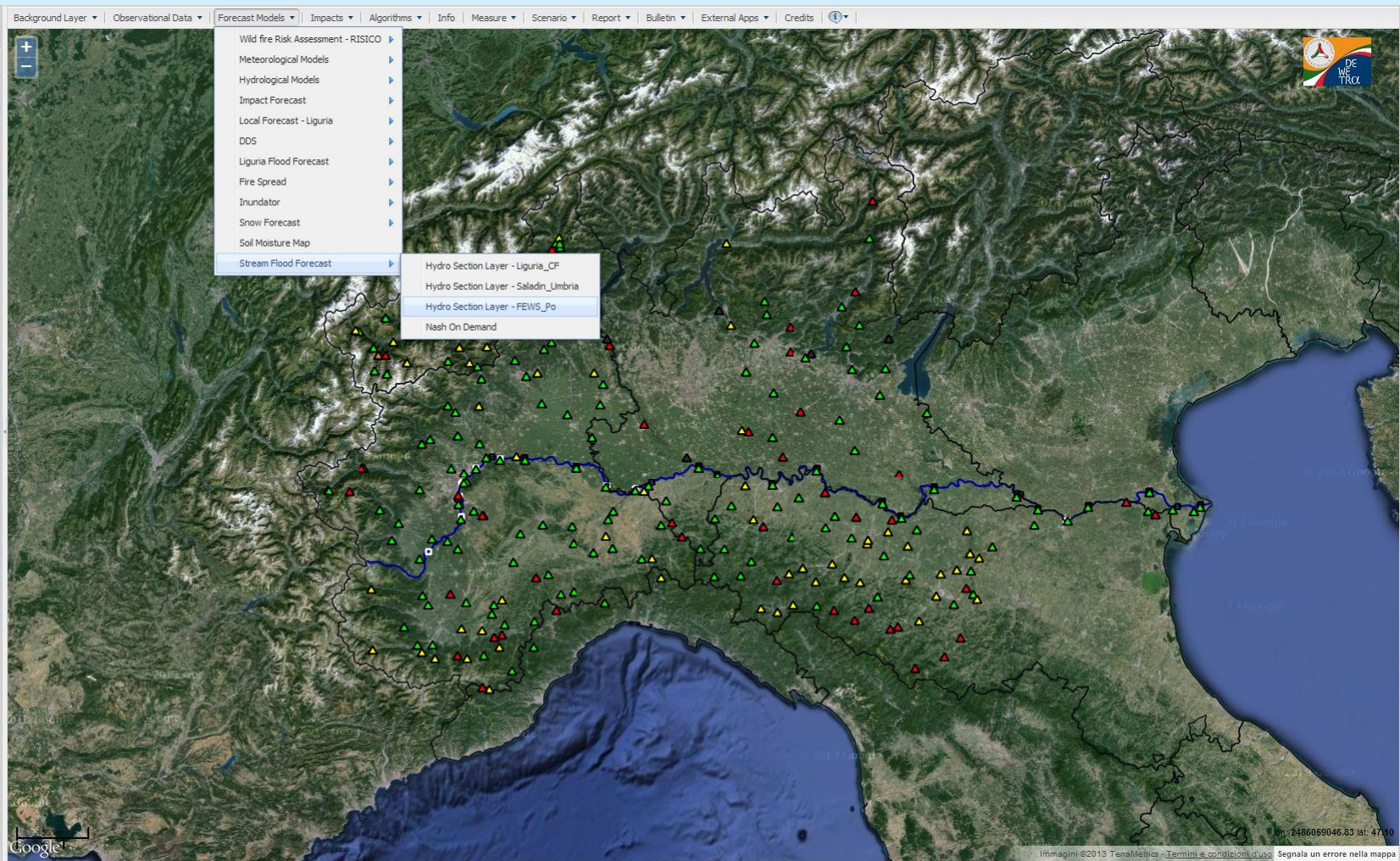


Find in Google Maps

Rain Map LAMI 7 RISICO

Layer List

- Sele [CIMA]
- Scrivia [CIMA]
- Sarno [CIMA]
- Reno [CIMA]
- Potenza [CIMA]
- Po [CIMA]
- Piave [CIMA]
- Pellice [CIMA]
- Parma [CIMA]
- Ombrone [CIMA]
- Oglio [CIMA]
- Ofanto [CIMA]
- Nure [CIMA]
- Musone [CIMA]
- Misa [CIMA]
- Mincio [CIMA]
- Metauro [CIMA]
- Marecchia [CIMA]
- Maira [CIMA]
- Magra [CIMA]
- Lemene [CIMA]
- Lamone [CIMA]
- Lambro [CIMA]
- Garigliano [CIMA]
- Foglia [CIMA]
- Fiumi_Uniti [CIMA]
- Esino [CIMA]
- Enza [CIMA]
- DoraBatea [CIMA]
- Crostolo [CIMA]
- Crati [CIMA]
- Cornia [CIMA]
- Cormor [CIMA]
- Chienti [CIMA]
- Cesano [CIMA]
- Cedrino [CIMA]
- Cecina [CIMA]
- Candelaro [CIMA]
- CanaleBianco [CIMA]
- Brenta [CIMA]
- Bradano [CIMA]
- Biferno [CIMA]
- Basento [CIMA]
- Aterno_Pescara [CIMA]
- Aso [CIMA]
- Arno [CIMA]
- Adige [CIMA]
- Adda [CIMA]
- Instability archive



Find in Google Maps

Rain Map LAMI 7 RISICO

Layer List

Dynamic Layers

Tool Layers

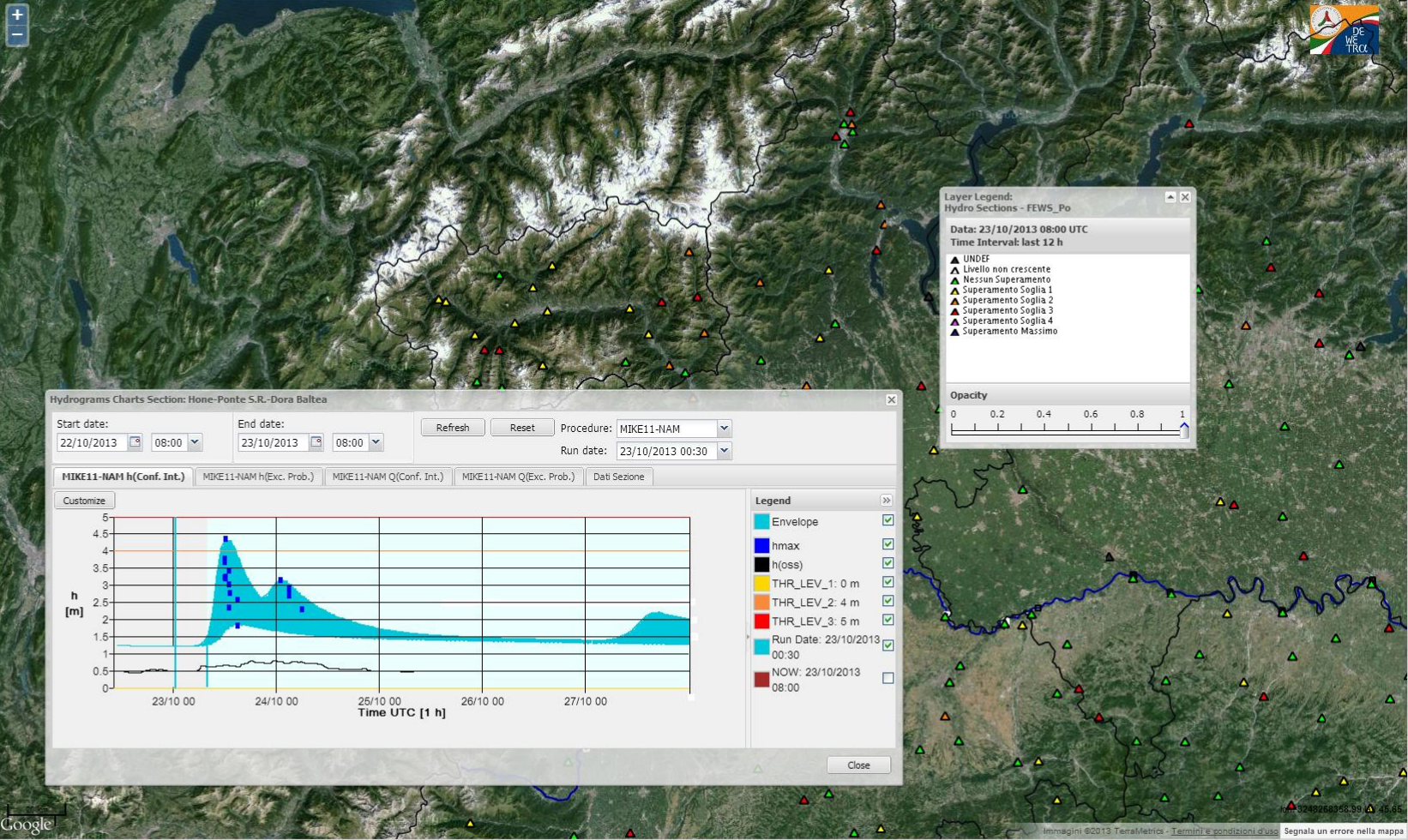
- Hydro Sections - FEWS_Po
- Search Result
- Scenario
- Measure

Ancillary layers

- Wild fire
- Warning Areas [DPC]
- Trento
- Seismic Structures Observatory [DPC]
- Rivers [DBPrior10k]
- River_Instrumented [CIMA]
- Regions 2010 [ISTAT]
- Radar [DPC]
- RISICO fuel map
- Provinces 2010 [ISTAT]
- Municipalities 2010 [ISTAT]
- Meteo-Vigilance Areas [DPC]
- Ligurian Small Catchments
- Lakes[DPC]
- Italian Basin Authorities [GN]
- Dams[DPC]
- Dams ICON
- Corine Land Cover 2006 [EEA]
- Contour_levels_step 100 m [CIMA]
- Catchments_Liguria
- Catchments_Italy
- Catchments [ISPRA]

Flood wave graph

- Volturno [CIMA]
- Tronto [CIMA]
- Trebbia [CIMA]
- Tirso [CIMA]
- Ticino [CIMA]
- Tevere [CIMA]
- Tenna [CIMA]
- Tanaro [CIMA]
- Tagliamento [CIMA]
- Stura_di_Lanzo [CIMA]
- Stella [CIMA]
- Sesia [CIMA]
- Serchio [CIMA]
- Sele [CIMA]
- Scrivia [CIMA]
- Sarno [CIMA]
- Reno [CIMA]



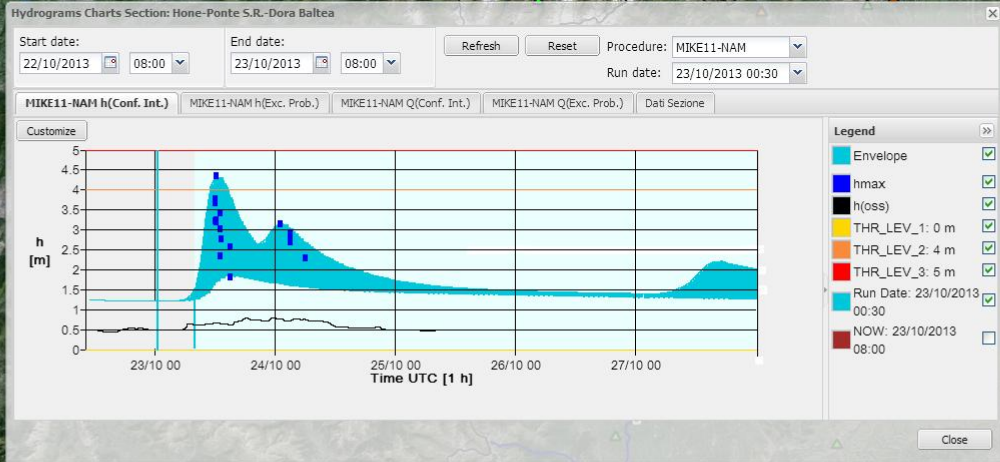
Layer Legend: Hydro Sections - FEWS_Po

Data: 23/10/2013 08:00 UTC
Time Interval: last 12 h

- ▲ UNDEF
- ▲ Livello non crescente
- ▲ Nessun Superamento
- ▲ Superamento Soglia 1
- ▲ Superamento Soglia 2
- ▲ Superamento Soglia 3
- ▲ Superamento Soglia 4
- ▲ Superamento Massimo

Opacity

0 0.2 0.4 0.6 0.8 1



WATER DATA SHARING IN RAIII



HIS in the Ibero-American Countries



Ibero-American Hydrologic Information System Central Web Service Registry

The Ibero-American hydrologic monitoring is a federated network composed by the Ibero-American National Meteorological and Hydrological Services (NMHSs), including the [Conferencia de Directores de los Servicios Meteorológicos e Hidrológicos Iberoamericanos](#), an international conference focusing efforts on institutional development, training of human resources and consolidation of operational management in meteorology, hydrology and climatology.

The portal provides access to the hydrological observations in the Ibero-American countries, commonly published as Hydrological Yearbooks. In particular, it provides additional operational capability, for in situ water observations, as a national registry of water data services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization.

The published interfaces of the portal retrieve data from distributed national water data providers, enabling plots and download.



WEB SERVICE REGISTRATION SYSTEM

- Brokered services: 1
- Brokered sites: 201
- Brokered variables: 1
- Brokered values: 701638
- Geographic extent: [-105.97, -54.16667, -34.85, 31.32]

HIS in the Ibero-American Countries

The screenshot displays the website for the Ibero-American National Meteorological and Hydrological Services. The header includes the organization's name and the WMO logo. The main content area features a map of the Americas with several weather station icons. A popup window is open over a station in Bolivia, displaying the following data:

(1 of 2)	
Country	BOLIVIA
DataProvider	MCH
DataSource	MCH
StationCode	BOSANTACRUZ
StationName	SANTA CRUZ
VariableName	Precipitation
VariableUnit	millimeter
DataType	Cumulative
StartDate	January 1, 2013
EndDate	December 31, 2013
Latitude	-17.80
Longitude	-63.20
WaterML_1.0	More info
WaterML_1.1	More info
WaterML_2.0	More info
Zoom to	

The map interface includes navigation controls (zoom in, home, zoom out, refresh), a search bar, and a scale bar (0 to 1000 miles). The Esri logo and 'POWERED BY esri' are visible in the bottom right corner.



Details

Basemap

Share

Print

Measure

Find address or place

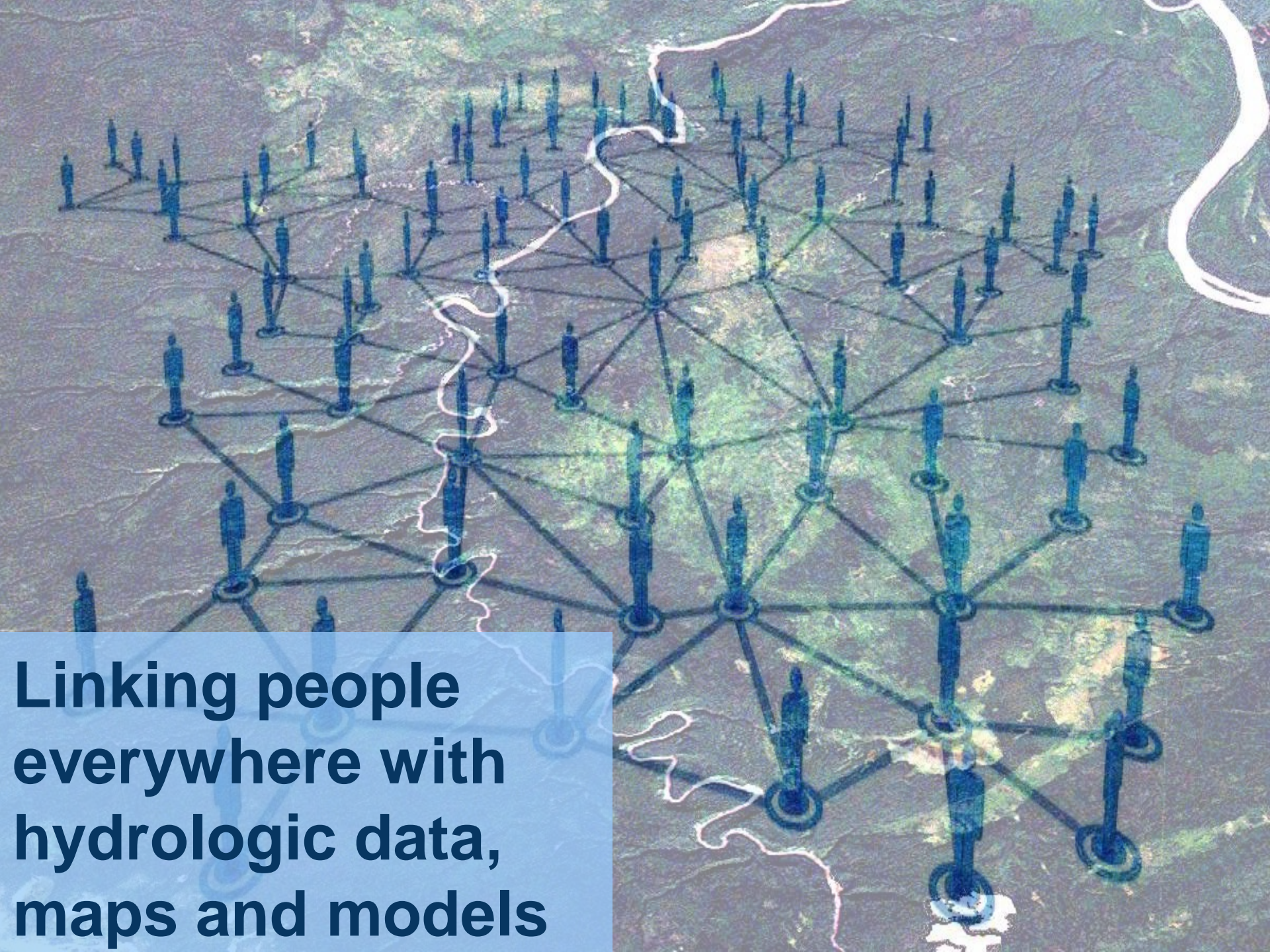


CONCLUSIONS



Recommendations

- Water data sharing is essential for improved water resources management
- Water data availability/accessibility is fundamental to the transparent management of the resource
- Tools and techniques have to be made available for the optimization of hydrological data collection and related networks of National Meteorological and Hydrological Services
- Internationally agreed standards, formats and protocols have to be adopted for the transfer of hydrological data and information
- Exchange of hydrological and related data have to be increased at national, regional and international levels
- Dependency on the availability of the data should be increased as value added products and services

An aerial photograph of a landscape with a network of blue figures and lines overlaid. The figures are stylized human icons, and the lines connect them in a grid-like pattern, representing a network. The background is a textured, brownish-green map. A white, wavy line is drawn across the map, possibly representing a river or a boundary. The overall image conveys the concept of linking people and data in a geographic context.

**Linking people
everywhere with
hydrologic data,
maps and models**



**World
Meteorological
Organization**

Weather • Climate • Water

Thank you for your attention