WMO Hydrological Observing System (WHOS)
World Meteorological Organization (WMO)

• Set up on 23 March 1950

• Successor to International Meteorological Organization (IMO, created in 1873)

• Specialized agency of the United Nations for meteorology, operational hydrology and related geophysical sciences

• UN system’s authoritative voice on the state and behavior of the Earth’s atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources
Role of WMO in the field of Hydrology and Water Resources

WMO Convention

Art: 2(e): "to promote activities in operational hydrology and close co-operation between Meteorological and Hydrological Services."

WMO Hydrology and Water Resources Programme
Standards and Quality Management (QM)

- **Quality is essential!**

- **Four benefits of QM:**
  - Better management and a more effective organization
  - Employee satisfaction and commitment to the organization
  - Improving the quality of products and services.
  - Improving customer satisfaction and NHS image
WMO regulatory framework

- Technical Regulation
- Manual
- Guides
Meteorological, Climatological and Hydrological data base management system (MCH)

For whom?

➢ NMHSs looking for a simple, customizable and license free solution to store, analyze and generate reports and maps on large amount of data.
Advantages of MCH

• **OPEN SOURCE** based (no license fees)

• **A configurable system** (you define your variables and stations etc.), and allows you to connect external modules

• Manages **hydrological, climatological** and **meteorological data** under a unique platform

• **Multilingual**, using an external text file, currently available in Spanish, English and French

• **Minimum system requirement**
Data exchange and use

Exchanged data should be used to:

❖ planning, designing, operating and maintaining **water management systems**;

❖ preparation and distribution of **flood forecasts** and **warnings**;

❖ design of **spillways, highways, bridges and culverts**;

❖ **flood plain** mapping;

❖ determining and monitoring **environmental or ecological flows**;

❖ managing **water rights** and **transboundary water issues**;

❖ **education and research**;

❖ protecting **water quality** and regulating **pollutant discharges**.
Challenges of data exchange: data formats

WMO Guide to Hydrological Practices (updated in 2008) states:

“There are currently no standards for data exchange formats for hydrological data”

Through joint activities of WMO and Open Geospatial Consortium (OGC), WaterML 2.0 standard had been developed and its following parts have been approved by OGS:

• Part 1 - Time Series;
• Part 2 - Ratings, Gaugings and Sections.

Parts under development:

• Part 3 - Surface Hydrology Features;
• Part 4 - Groundwater Features.
Challenges of data exchange and use

MULTIPLE DATA PROVIDERS

NO DATA STORED

TOOLS

USER NEEDS

- USER NEEDS
  - SEARCH
  - FIND
  - ACCESS
  - FILTER
  - DOWNLOAD
  - VISUALIZE
  - ANALYZE
  - MODEL

- MULTIPLE DATA PROVIDERS
  - WHoS
    - Implement interoperability with exchange protocols
    - Metadata mapping
    - Data format conversion

- NO DATA STORED
  - BASIC functionalities

- TOOLS
  - A
  - B
  - C
  - D
  - ...

10
WHOS PLATA: Current status

PROVIDED DATA

- Hydrological data
- Meteorological data*
- Hydrological data (in the near future)
- Meteorological data*
- Hydrological data
- Meteorological data*

NO DATA STORED

- Implement interoperability with exchange protocols
- Metadata mapping
- Data format conversion

SUPPORTED TOOLS

- HydroDesktop
- Helgoland
- Jupyter
- R WaterML
- Node.js WaterML
- GI-portal

* through the Global Information System Centre (GISC) - Brasilia
Arctic-HYCOS Pilot: Current status

**Provided Data**
- Historical data:
  - Canada: 200
  - Norway: 3
  - Russia: 3
  - USA: 1
  - Total: 200 + 3 + 3 + 1 = 205
- Real-time data:
  - Canada: 1176
  - Norway: 19
  - Russia: 1
  - Total: 1176 + 19 + 1 = 1196
  - USA: 4248
  - Total: 4248
  - Total real-time data: 1196 + 4248 = 5444

**No Data Stored**
- Different exchange protocols and data formats
  - Implement interoperability with exchange protocols
  - Metadata mapping
  - Data format conversion

**Supported Tools**
- HydroDesktop
- Helgoland
- Jupyter
- R WaterML
- ArcGIS Online
- GI-portal

- NMHSs
- Universities
- Research institutes
- International Organizations
- Private sector

*Data source: GRDC*
As a pre-condition, data provider need to **publish their data** through local or global platforms (e.g. internet website, FTP, API, GRDC) or **provide direct access** to their online databases.

As a data provider, you need to **describe your data formats and services used** and how the data are published (public or private access), providing access details (e.g. specific IP or login details), if needed.

If data providers want that their data are converted into specific format, they need to **describe the desired output format**.

All this information should be **communicated to WMO Secretariat** *(automatic submission of information on the WHOS Portal will be available soon)*.

Data providers can also request to **create customized data sets (views)**.

Every created data set (view) generates the **new web-links (end-points)** which can be used to discover and access the data included in this view.
WHOS Portal and webpage for data users

**WHOS Portal**

provides web-links needed to configure the tools for use of data available through a particular view

**WHOS Webpage**

provides short technical guides and tutorials to use the supported tools

---

**find the page of “a particular view” by means of filters**

**the web-link needed to connect the view’s data to a particular tool**

**a step-by-step guide to use the data in the tool**
Future WHOS Portal (in process)

- **Map representation** of data providers
- **Multi-filter functionality** to find data
- **Information needed** to configure supported tools
- **Direct links** to supported tools and their manuals
- **Online submission** of request to connect new data to WHOS
- **User guide** for WHOS Portal
How to use web-links?

➢ use the web-links generated by WHOS to configure supported tools and applications you would like to use

That’s all, now you can discover, access and use shared data!!!

Example

If your organization would like to use HydroDesktop tool (currently does not use it):

➢ connect your data to WHOS
➢ WHOS will automatically convert your data to the format and exchange protocol required by HydroDesktop
➢ the converted data can now be directly connected to HydroDesktop and easily used
Arctic-HYCOS: Current status

**PROVIDED DATA**

- **Historical data**
  - Canada: 200
  - Norway: 3
  - Russia: 5
  - USA: 36

- **Real-time data**
  - Canada: 1176
  - Norway: 19
  - Russia: 1
  - USA: 4248

**NO DATA STORED**

- WHoS: Different exchange protocols and data formats
  - Implement interoperability with exchange protocols
  - Metadata mapping
  - Data format conversion

**SUPPORTED TOOLS**

- HydroDesktop
- Helgoland
- Jupyter
- R WaterML
- ArcGIS Online
- GI-portal

**Exchange protocols and data formats requested by tools**

- NMHSs
- Universities
- Research institutes
- International Organizations
- Private sector

**Different exchange protocols and data formats**

- Historical data: 200, 3, 5, 36
- Real-time data: 1176, 19, 4248, 1
TOOL: HydroDesktop

Access | Filter | Visualize | Download

Río de la Plata basin view
TOOL: Jupyter notebooks

ACCESS  FILTER  VISUALIZE  DOWNLOAD  ANALYZE

Plot values for selected station, series and time interval

Selected station

Selected time interval

Frequency of exceedance of the parameters

Arctic-HYCOS view
TOOL: **Jupyter notebooks**

Graph with the analyzed data

<table>
<thead>
<tr>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.809</td>
<td>134</td>
<td>72</td>
</tr>
</tbody>
</table>

- **Maximum value**
- **Mean value**
- **Minimum value**

You can select a threshold

<table>
<thead>
<tr>
<th>time</th>
<th>DataValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2018-06-27</td>
<td>133</td>
</tr>
<tr>
<td>2 2018-05-28</td>
<td>131</td>
</tr>
<tr>
<td>3 2018-06-29</td>
<td>134</td>
</tr>
<tr>
<td>4 2018-06-30</td>
<td>133</td>
</tr>
<tr>
<td>5 2018-07-01</td>
<td>139</td>
</tr>
<tr>
<td>6 2018-07-02</td>
<td>131</td>
</tr>
<tr>
<td>7 2018-07-03</td>
<td>130</td>
</tr>
<tr>
<td>8 2018-07-04</td>
<td>130</td>
</tr>
<tr>
<td>9 2018-07-05</td>
<td>130</td>
</tr>
<tr>
<td>10 2018-07-06</td>
<td>130</td>
</tr>
</tbody>
</table>

Only the data that have a higher value are visualized!
Benefits of using WHOS?

✔ NMHSs can share their hydrological data and information customizing views and access (any data format and service are supported)

✔ Shared data and information can automatically be converted by WHOS into standardized and non-standardized formats requested by end-users

✔ Automatic conversion of data speeds the use of hydrological applications

✔ Make use of tools and applications through the WHOS without any additional local development

✔ The data and information are not duplicated due to direct connection to data providers

✔ Possibility to test models using data from other countries with same hydrological conditions

✔ During the emergency situations, WHOS facilitates international cooperation (including transboundary basins and islands)
Learning about WHOS

How to learn more about WHOS?

Distance Learning Course and tutorials are being prepared together with COMET Program (UCAR - University Corporation for Atmospheric Research, USA).

Learning objectives:

1. Describe the WHOS architecture
2. Explain the needs for hydrologic data sharing that are driving the need for WHOS
3. Explain the seven components of WHOS: Data, Format, Services, Mediator, Broker, Ontology, Client
4. Demonstrate how to share data and information via WHOS
5. Demonstrate how to use shared data in different applications