Project objectives

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"

Provide contribution to the definition and implementation of **WIS 2.0**, as a collaborative system of systems using web-architecture and open standards to provide simple, timely and seamless sharing of trusted weather, water and climate data

- Support NMHSs in **publication** of hydrological data on the Internet via web services

- Advance Discovery and Access Broker (DAB) technology for **hydrological metadata, data and web services harmonization** using standardized web services and data formats, such as those stemming from the WMO, ISO and OGC

- Facilitate **discovery**, **access** and **use** of real-time and historical hydrological data that are freely and openly published by heterogeneous data providers

- Promote the reuse of shared data

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Project team

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Vice-president of the WMO Infrastructure Commission

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National Water Institute

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Federal Service for Hydrometeorology and Environmental Monitoring

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WHOS implementation in the Arctic basin

Arctic-HYCOS Project Steering Committee Members

Canada	Dr. Alain Pietroniro
Finland	Dr. Johanna Korhonen
Iceland	Dr. Jórunn Harðardóttir
Norway	Dr. Hege Hisdal
Russian Federation	Prof. Valery Vuglinsky
Sweden	Dr. David Gustafsson
United States of America	Mr. Jeff Conaway

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WHOS implementation in the La Plata basin

Regional WHOS Broker Administration
(GISC, INMET)

Mr José Mauro de Rezende

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Brazil   Mr. Vinícius Roman   Ms. Juliana Maria Duarte Mol

Paraguay   Lic. Alejandro Pasten   Lic. Eduardo Mingo

Uruguay   MSc. Ing. Silvana Alcoz   Mr. Nestor Santayana

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Project plan

Timeline	Projects	Normative	Communication	Training
2021 Cg-2021 EC-73	• Continued WHOS pilot projects • Launch national WHOS projects • Launch WHOS community page and portals	• WHOS Phase II operational plan	• Engagement with RA • Survey available data sources and brokering needs • WHOS Webinar	• Workshop for SC-IMT • Training plans for RA
2022 INFCOM EC-74	• Continued WHOS pilot projects (e.g., CREWS Cambodia and Laos)	• WHOS Phase II draft architecture	• Communication plan for WHOS Phase II implementation published to Members	• WHOS Phase II training in RA
2023 Cg-19 EC-75	• Pilot projects final report	• WHOS Phase II recommendations compliant with WIS 2.0 guidelines	• WHOS Phase II recommendations and guidelines published to Members	• Continued training in RA

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WIS 2 Principles in the project

Principle 1: WIS 2.0 adopts Web technologies and leverages industry best practices and open standards

- WHOS supports various service interfaces and Application Programming Interfaces (APIs) that various data providers and user application builders can already leverage (e.g., OGC SOS, OGC CSW, OGC WMS, ESRI Feature Service, CUAHSI WaterOneFlow, DAB API, USGS RDB, OAI-PMH/WIGOS, THREDDS)

- New API and service protocols are continuously added to support new data providers web services and user applications with the aim of improving its interoperability. This is due to the WHOS-Broker being a modular and flexible framework designed considering the change/evolution of standards through time

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WIS 2 Principles in the project

Principle 2: WIS 2.0 uses Uniform Resource Locators (URL) to identify resources

- WHOS makes use of URLs to identify resources such as datasets, sites, concepts from ontologies, through several of its published service interfaces

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WIS 2 Principles in the project

Principle 3: WIS 2.0 prioritizes use of public telecommunications networks (i.e., Internet) when publishing digital resources

- WHOS supports publishing of metadata and data on Internet through various web services available for machine-to-machine access

- WHOS supports harvesting of digital data and metadata resources from various data providers that publish their resources on Internet through web services

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WIS 2 Principles in the project

Principle 4: WIS 2.0 requires provision of Web service(s) to access or interact with digital resources (e.g., data, information, products) published using WIS

- WHOS-broker provides various standard web service interfaces and APIs (e.g., OGC SOS, OGC CSW, OGC WMS, ESRI Feature Service, CUAHSI WaterOneFlow, DAB API, USGS RDB, OAI-PMH/WIGOS, THREDDS)
- New APIs and service protocols are continuously added to support new applications

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WIS 2 Principles in the project

Principle 5: WIS 2.0 encourages NCs and DCPCs to provide 'data reduction' services via WIS that process 'big data' to create results or products that are small enough to be conveniently downloaded and used by those with minimal technical infrastructure

- WHOS publishes data access interfaces supporting (1) subset functionality to retrieve only the data subsets that are of interest to the users (e.g., subset by temporal and spatial extent) and (2) down-sampling functionality to reduce the data size

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WIS 2 Principles in the project

Principle 6: WIS 2.0 will add open standard messaging protocols that use the publish-subscribe message pattern to the list of data exchange mechanisms approved for use within WIS and GTS

- WHOS already supports publication of web services implementing publish-subscribe message pattern such as OGC Publish/Subscribe interface standard

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WIS 2 Principles in the project

Principle 7: WIS 2.0 will require all services that provide real-time distribution of messages to cache/store the messages for a minimum of 24-hours, and allow users to request cached messages for download

- WHOS supports such requirements through its Data Cube component that acts as cache/store mechanism (component planned to be released by 2022)

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WIS 2 Principles in the project

Principle 8: WIS 2.0 will adopt direct data exchange between provider and consumer

– WHOS-Broker works as a mediator between provider's service and consumer's application, suitably transforming the data on-the-fly and without storing any data (except for caching purposes)

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WIS 2 Principles in the project

Principle 9: WIS 2.0 will phase out the use of routing tables and bulletin headers

- WHOS can support publication of web services implementing different message patterns (including Publish/Subscribe) and be configured to achieve desired information flow

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WIS 2 Principles in the project

Principle 10: WIS 2.0 will provide a Catalogue containing metadata that describes both data and the service(s) provided to access that data

- WHOS already publishes different customized catalogue web service interfaces (e.g., OAI-PMH/WIGOS, OGC-CSW, CUAHSI HIS Central) that can be queried to obtain metadata records describing datasets and the services to access them

- WHOS will also publish discovery metadata in the Global Information System Centers (GISCs) allowing WMO users to access a range of services on WHOS. By publishing in GISCs, the discovery metadata will also be available to the GEOSS community through the GEO Data Portal that includes all WMO discovery metadata

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WIS 2 Principles in the project

Principle 11: WIS 2.0 encourages data providers to publish metadata describing their data [EF1] and Web services in a way that can be indexed by commercial search engines

- WHOS-Broker also publishes an OpenSearch 1.1 service which is supported by the main commercial web browsers (other indexes can be easily implemented as needed)

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Project data standards

The following data standards are **consumed** (e.g., downloaded and decoded from data access services) and/or **produced** (e.g., published to user clients):

- WMO-OGC WaterML 2.0
- CUAHSI WaterML 1.0
- NetCDF
- USGS RDB

(in addition to other community standards based on JSON, XML and CSV)

Moreover, WHOS broker uses NetCDF as its **internal data model**.

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Project metadata standards

The following metadata standards are **consumed** (e.g., harvested from metadata catalogs and inventories) and/or **produced** (e.g., published for discovery):

- WIGOS
- ISO 19139
- Dublin Core
- GEO RSS
- CUAHSI WaterML 1.0
- WMO-OGC WaterML 2.0
- NetCDF
- OGC O&M

(in addition to other community standards based on JSON, XML and CSV)

Moreover, WHOS broker uses ISO 19115 + extensions as its **internal metadata model**.

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Data discovery

WHOS implements a data discovery function through the **publication of multiple standard data discovery service interfaces**, such as:

- OAI-PMH
- OGC CSW
- OpenSearch
- CUAHSI WOF HIS Central Catalog
- DAB API

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Data exchange

WHOS implements data access function through the **publication of multiple standard data access service interfaces**, such as:

- CUAHSI WOF HydroServer
- OGC SOS
- USGS Water Services
- ESRI Feature Server
- DAB API

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Input to WIS2

- The brokering architecture can be suitable for other domains other than hydrology that also have a diversity of data sharing solutions

- It can be suitable for cross-domain data sharing that works as an interface between diverse systems and WIS2

- The development is not restricted to metadata and data interoperability, WHOS also supports interoperability of tools for operational needs of NMHSs and other users

- Existing mechanisms of user authentication should be used to strenghten the roadmap for free and unrestricted data sharing according to the new WMO Data Policy

- The WHOS Broker is based on code provided free of charge for education, research and non-commercial usage. The code will be released as open-source with a CC-BY-NC kind of license to support local deployment and personalization (Community Edition)

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