WMO needs and plans for GroundWaterML2 standard

Silvano Pecora, Vice-President of the WMO Infrastructure Commission

WORLD METEOROLOGICAL ORGANIZATION

WMO HydroHub

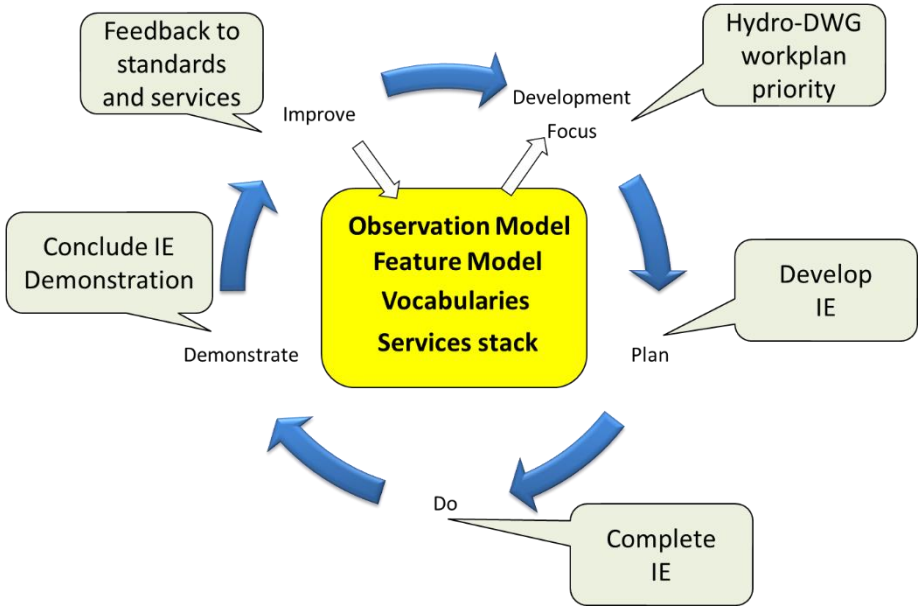
Open Geospatial Consortium

International Standardization for Water Data

- OGC-WMO Hydrology Domain Working Group
  - standards for water data: **WaterML 2.0 suite**
  - organizing Interoperability Experiments (IEs) focused on different sub-domains of water

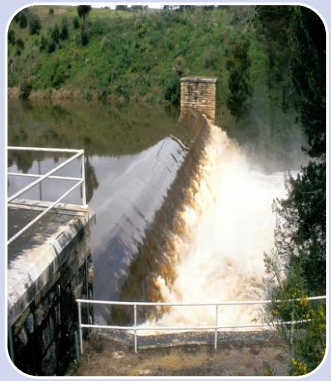
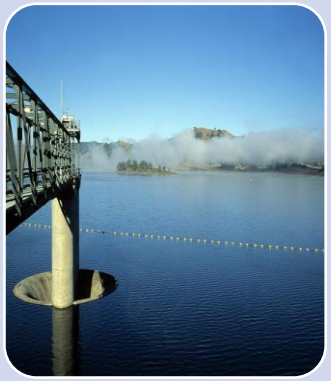
- Chairs:
  - Tony Boston (Australia)
  - Silvano Pecora (Italy)
  - David Blodgett (USA)

Iterative Development



http://external.opengis.org/twiki_public/bin/view/HydrologyDWG/WebHome

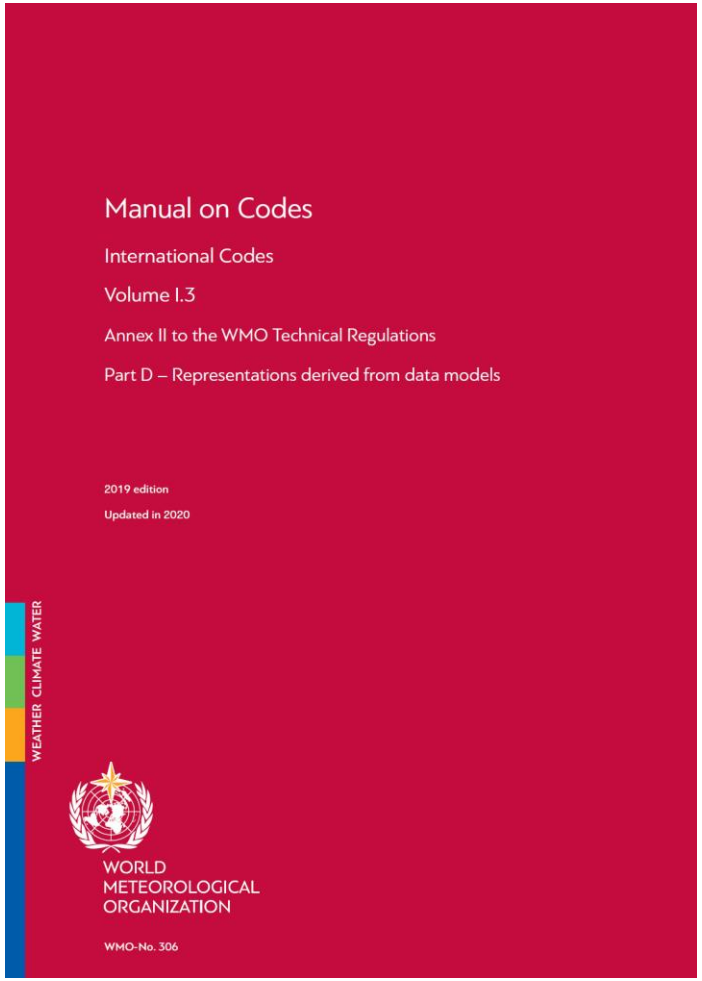
WaterML2.0 standards

Part 1 - Timeseries	Part 2 – Ratings, Gaugings and Sections	Part 3 – Surface water features	Part 4 – Groundwater	Part 5 – Water quality

ADOPTIONS by OGC and WMO

- **OGC** adopted WaterML2 Part1 – Timeseries in February 2014, WaterML2 Part2 - Ratings, Gaugings and Sections in February 2016, the conceptual model WaterML2 Part3 - Surface Hydrology Features in January 2018, WaterML2 Part 4 - GroundWaterML2 in March 2017
- **WMO** formally adopted WaterML2 Part 1, 2 & 4 standards



https://library.wmo.int/?lvl=notice_display&id=19508#.YAakp-hKjSI

FM 231: WMLTS

FM 231-16 WMLTS-XML WATERML2 TIME SERIES OBSERVATIONS

231-16.1 Scope

WMLTS-XML shall be used for the exchange in XML of time series of hydrological information conforming to the "WaterML2.0: Part 1 – Timeseries" conceptual model. WMLTS-XML may be used directly to represent time series information or incorporated as components within other XML encodings.

Notes:

1. WaterML2.0: Part 1 – Timeseries was developed jointly by WMO and the Open Geospatial Consortium.
2. The WMLTS-XML application schema and XML encoding are both described in the document OGC/IS 10-126r4 WaterML 2.0: Part 1 – Timeseries. A copy of that document is available at http://wis.wmo.int/WMLTS and the reference version of the associated schema is available at http://schemas.opengis.net/waterml/2.0 (WMO retains a copy of the schema at http://schemas.wmo.int/waterml/2.0).
3. Further information on handling application schema and data modelling can be found in the *Guidelines on Data Modelling for WMO Codes* (available in English only from http://wis.wmo.int/metce-uml).
4. Representation of non-hydrological information in time series should use FM-221 TSML.

FM 232: WATERML2

FM 232-16 WMLRGS-XML WATERML2 RATINGS, GAUGINGS AND SECTIONS

232-16.1 Scope

WMLRGS-XML shall be used for the exchange in XML of hydrological information conforming to the "WaterML2.0: Part 2 – Ratings, Gaugings and Sections" conceptual model. WMLRGS-XML may be used directly to encode ratings, gaugings and sections information or incorporated as components within other XML encodings.

Notes:

1. WaterML2.0: Part 2 – Ratings, Gaugings and Sections was developed jointly by WMO and the Open Geospatial Consortium.
2. The WMLRGS-XML application schema and XML encoding are both described in the document 15-018r2 OGC WaterML2.0: Part 2 – Ratings, Gaugings and Sections (Version 1.0). A copy of that document is available at http://wis.wmo.int/WMLRGS and the reference version of the associated schema is available at http://schemas.opengis.net/waterml/part2/1.0 (WMO retains a copy of the schema at http://schemas.wmo.int/waterml/part2/1.0).
3. Further information on handling application schema and data modelling can be found in the *Guidelines on Data Modelling for WMO Codes* (available in English only from http://wis.wmo.int/metce-uml).

FM 232-2020 WMLGW-XML WATERML2 GROUNDWATER

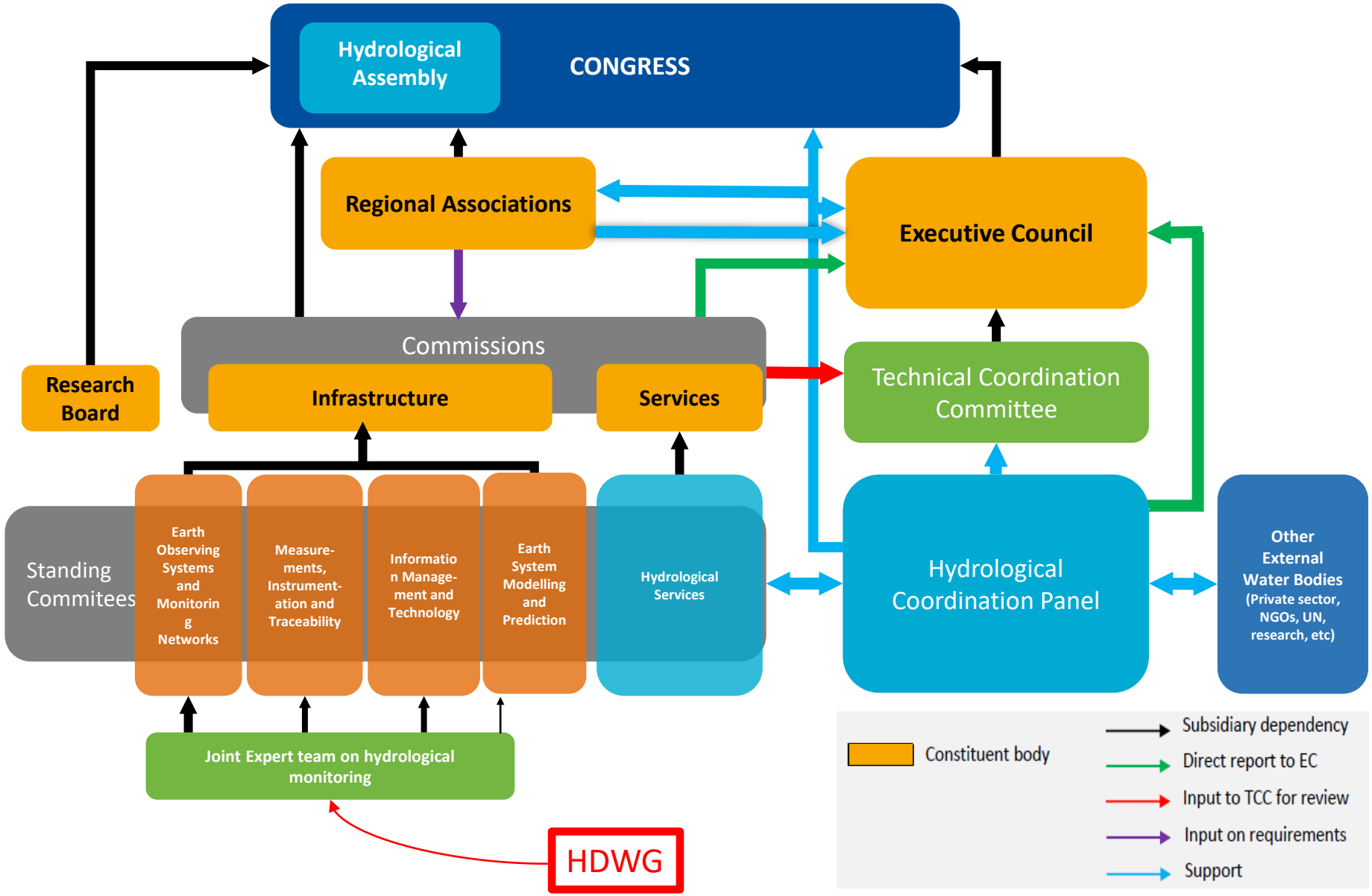
232-2020.1 Scope

WMLGW-XML shall be used for the exchange of hydrogeological information in XML in accordance with the "WaterML 2: Part 4 – GroundWaterML 2 (GWML2)" schemas. WMLGW-XML may be used directly to encode information about key hydrogeological entities, such as aquifers and water wells, as well as related measurements and groundwater flows.

Notes:

1. WaterML2: Part 4 – GroundWaterML2 was developed jointly by WMO and the Open Geospatial Consortium.
2. The GWML2 conceptual, logical and physical schemas and related XML encoding guidelines are all described in the document 16-032r2 OGC WaterML2.0: Part 4 – GroundWaterML2. This document is available at https://www.opengeospatial.org/standards/gwml2, and the reference version of the associated XML (physical) schema is available at http://schemas.opengis.net/gwml/.
3. Further information on handling application schema and data modelling can be found in the *Guidelines on Data Modelling for WMO Codes* (available in English only from http://wis.wmo.int/metce-uml).
4. Further articles on GWML2 can be found at:
   https://link.springer.com/article/10.1007/s10040-018-1747-9
   https://link.springer.com/article/10.1186%2Fs40965-018-0058-3

Mapping of Hydrology in WMO



JET-HYDMON SPECIFIC TERMS OF REFERENCE

Note: This INFCOM SC-ON, SC-MINT and SC-IMT Joint Expert Team is governed and coordinated by SC-ON, in collaboration with both others and SC-ESMP.

Purpose:

The Joint Expert Team on hydrological monitoring (JET-HYDMON) shall ensure the coherence of the INFCOM hydrology experts' contribution to the relevant activities of the Infrastructure Commission and its subsidiary bodies in an **integrated manner in the spirit of the Earth System approach**, preserving the hydrological value chain, and contribute the necessary infrastructure support to the relevant activities of SERCOM, in particular of SC-HYD.

Expected outputs:

Under the governance of SC-ON and the joint guidance of SC-ON, SC-MINT and SC-IMT, JET-HYDMON ensures:

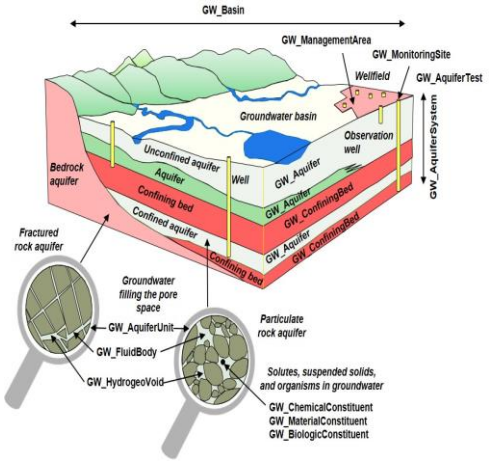
- development of tools, guidelines, training material, and other documents and desired outputs of purely hydrological activities and tasks (e.g., measurement of river flow, sediment, groundwater, water quality, etc.),

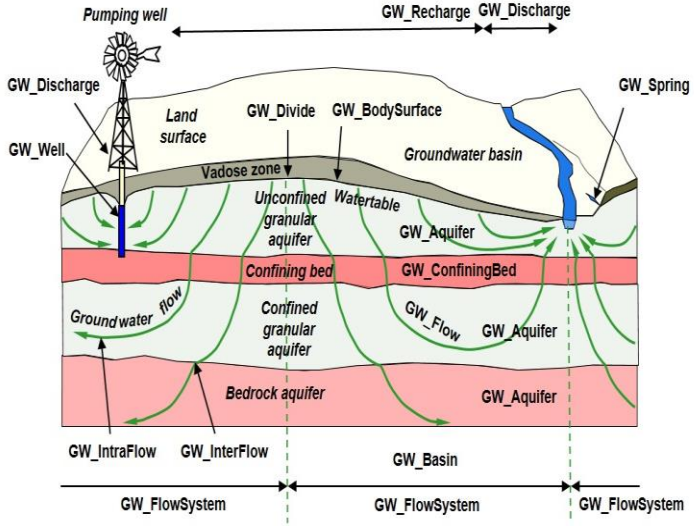
- support others JETs (e.g., JET-OWR) that may have interest for hydrology expertise e.g. for the short term flash flood forecasting

- support to ETs of various SC, where subject is cross cutting across disciplines and demand for ad-hoc inputs from hydrological experts.

All this in accordance with the SC-ON, SC-MINT and SC-IMT Terms of Reference.

WIGOS, WHOS, WIS and GW



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    [... snip ...]
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    <gwml2:gwUnitWaterBudget xsi:nil="true"/>
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          Hydraulic regional conductivity The decreasing trend of transmissivity with depth in the
          rock is observed in all contexts. The average hydraulic conductivity is 10^-3 0.9 m/s near
          the top of bedrock (z = 1 m) which gradually loses an order of magnitude at a depth of 10
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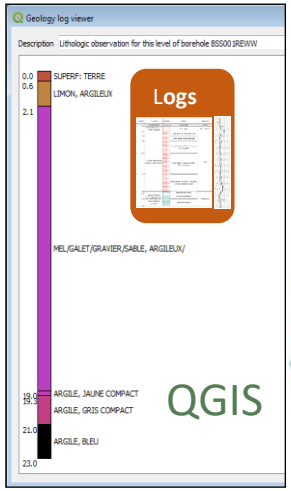
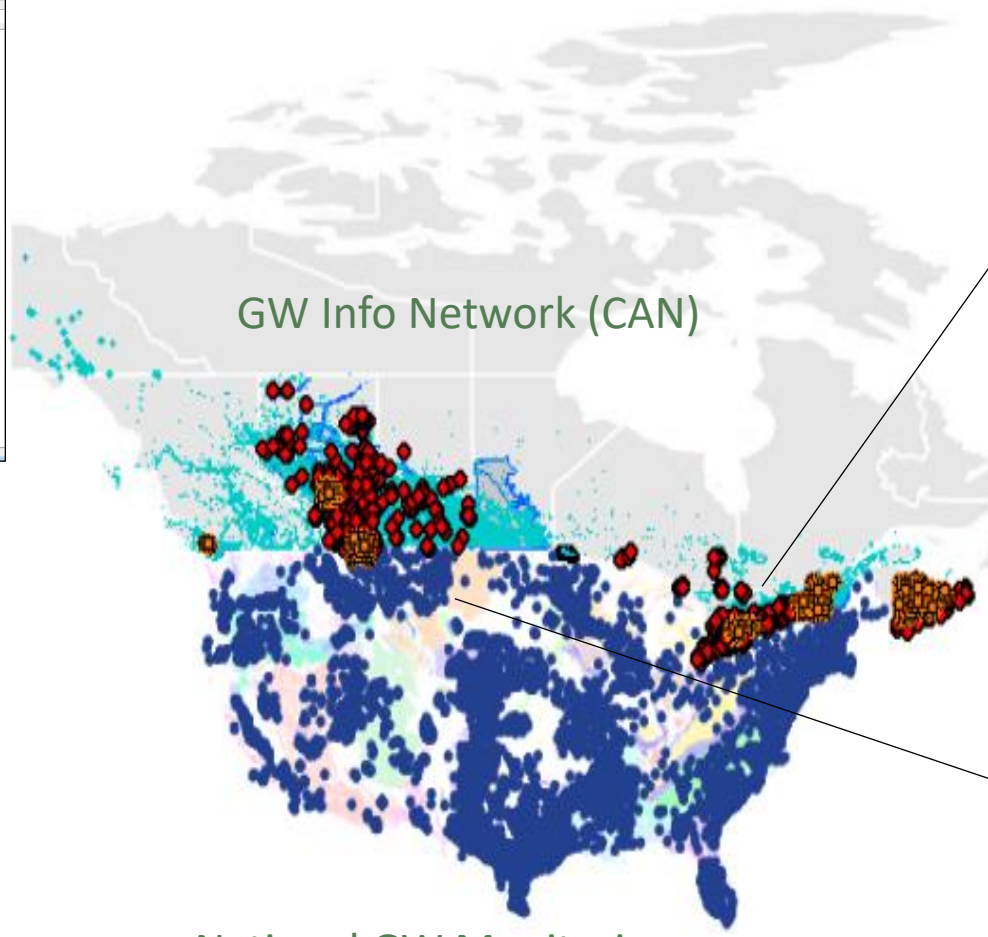
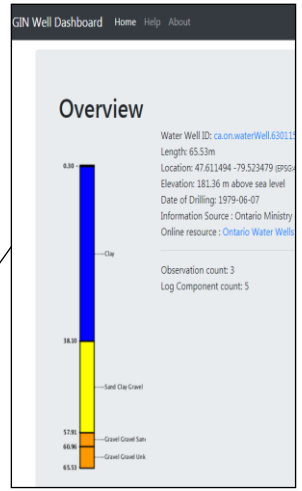
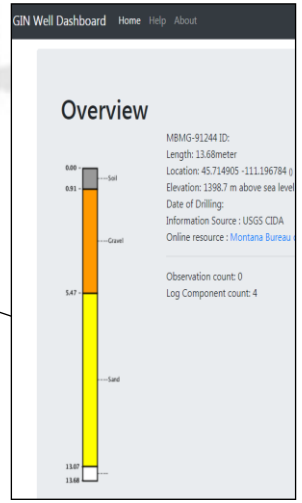
GW MONITORING

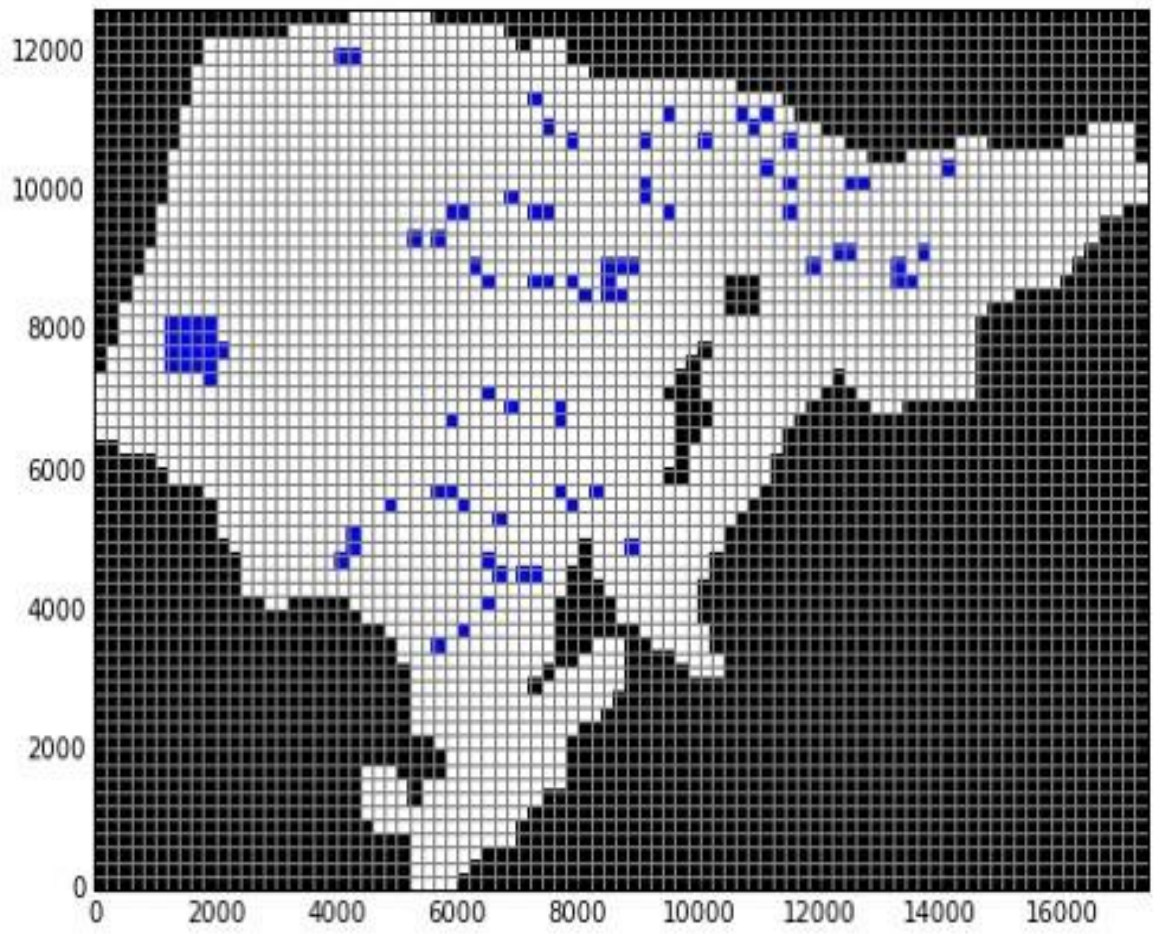






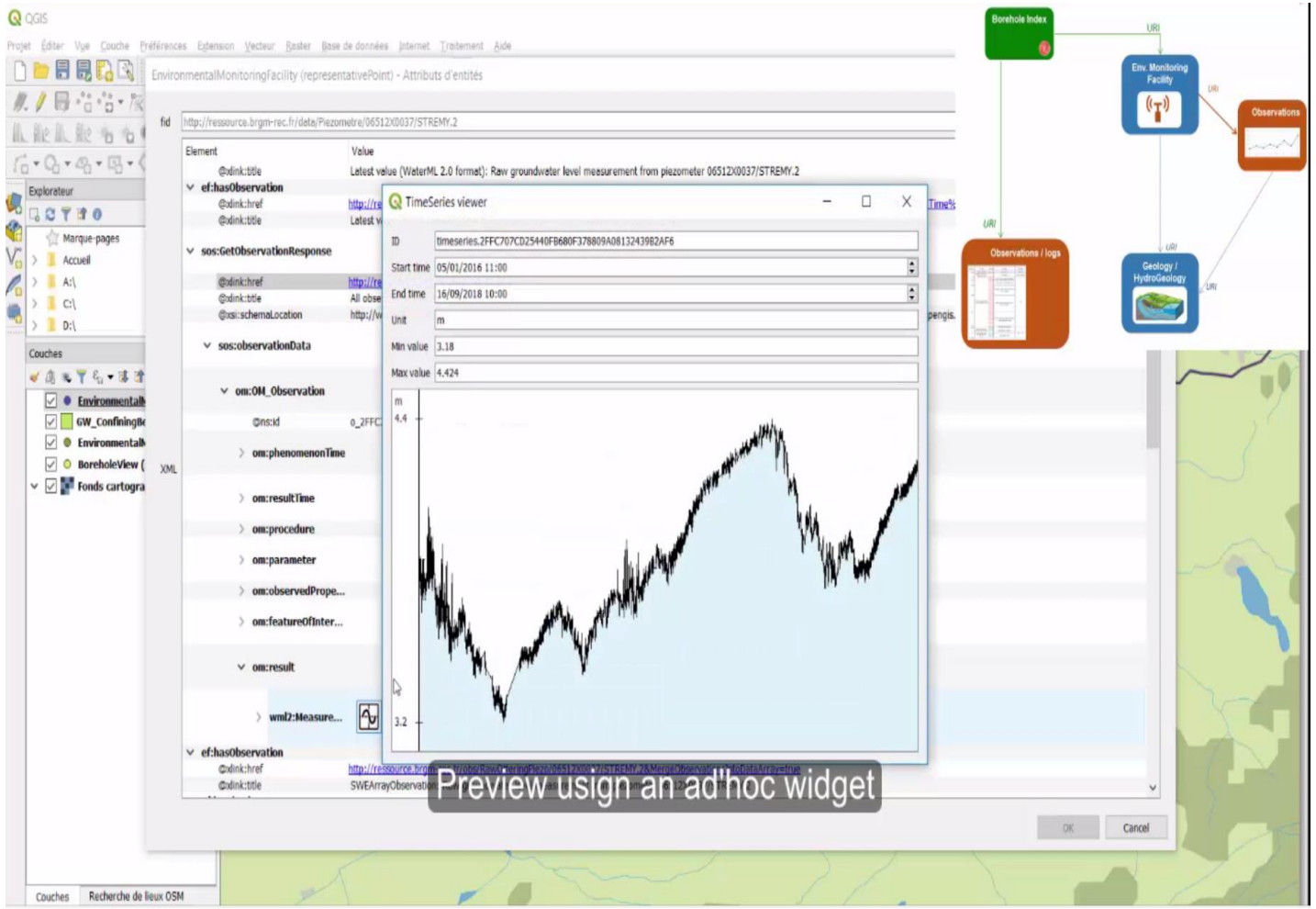


GW MODELING



MODFLOW model from GWML2 inputs (Horowhenua, NZ)

GW TOOLS



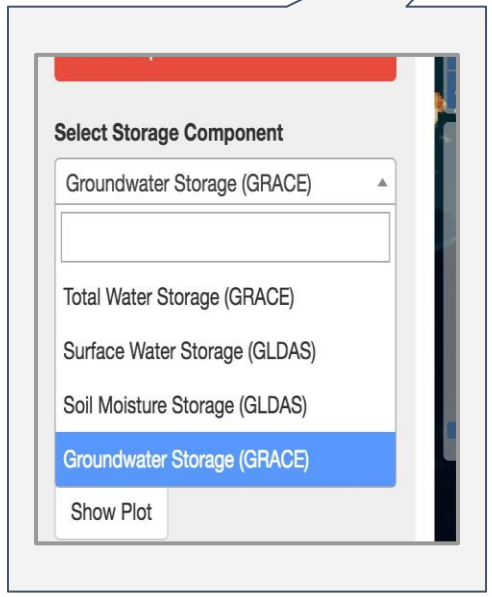
Screenshot QGIS GMLAS toolbox interaction with French Groundwater Information Network : linking stations to groundwater level observations services

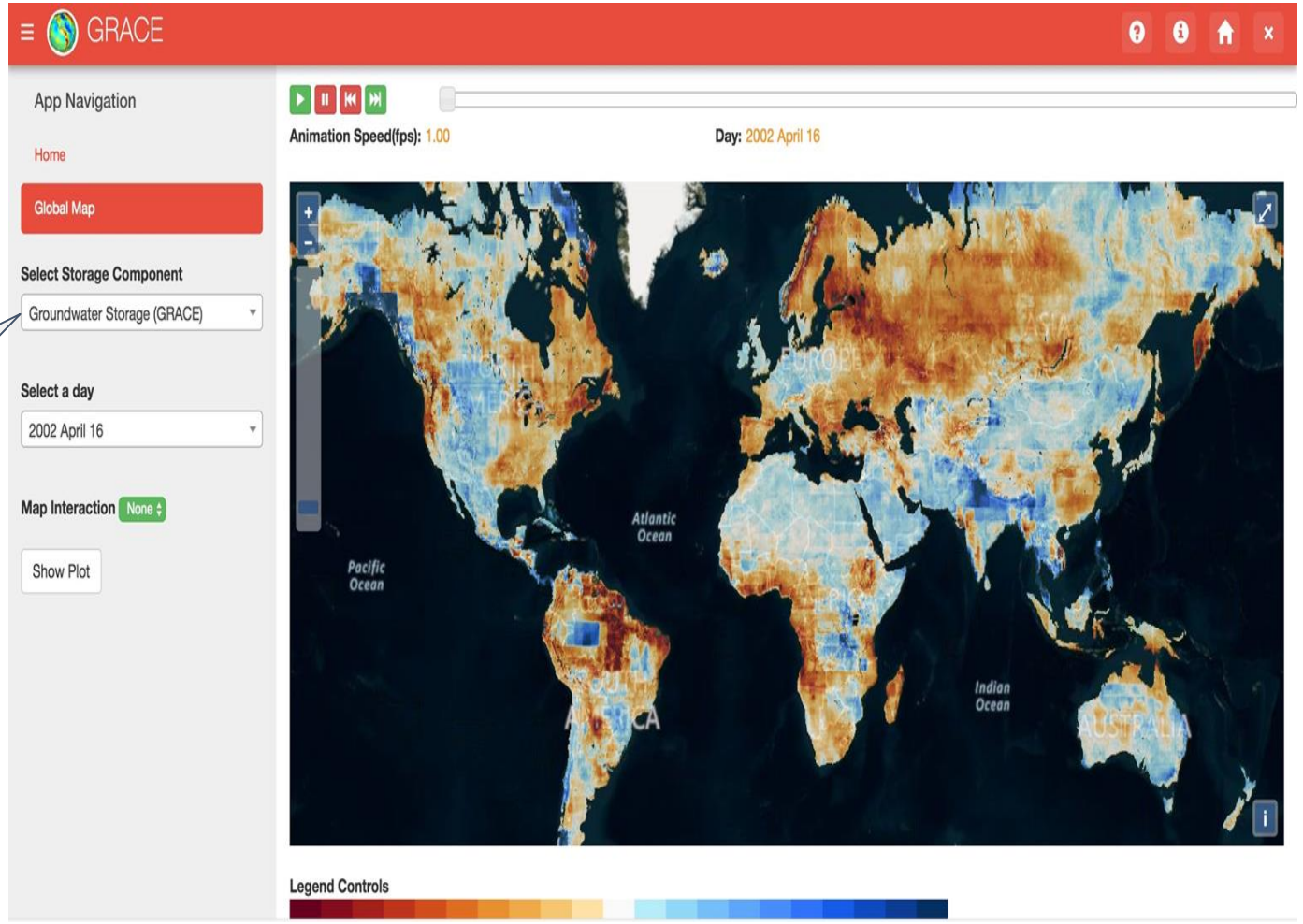
ADVANCED GW APPLICATIONS

- GRACE Data

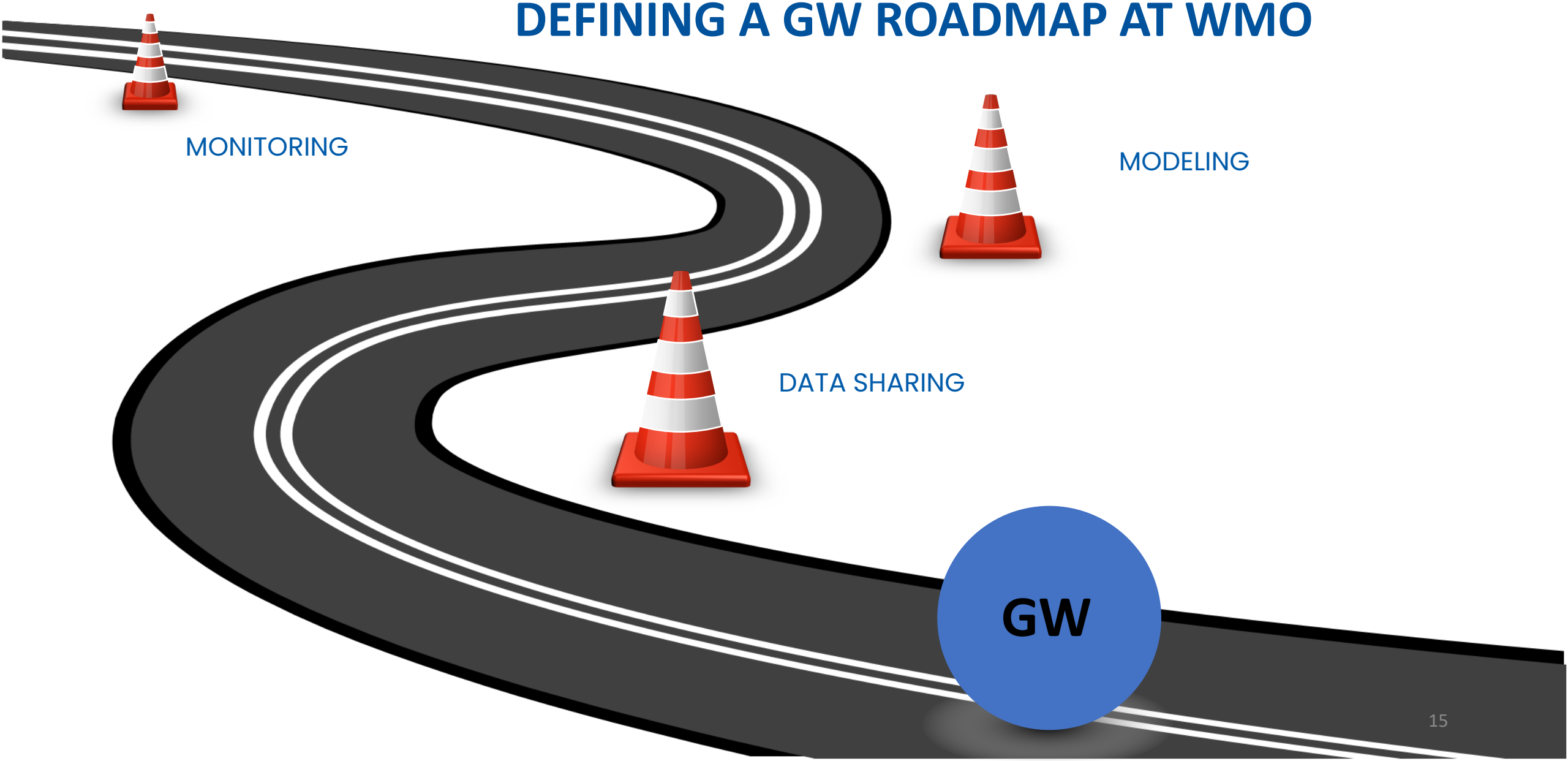
- GLDAS Data

- Calculated Groundwater Data





DEFINING A GW ROADMAP AT WMO



Thank you!

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