**Geneva Presentation**

**Science Lecture to the 14th Congress of the WMO Commission for Hydrology (CHy)**

**Title: Towards a Global Water Information System**

**Goal:** To show the participants in the WMO Commission for Hydrology Congress that open standards for sharing water data have been developed, and that existing infrastructure is adequate to use them to build regional, national and global water information systems.

**Story Line:** There are three parts to the story

* **Prologue** – where have we come from?
* **Present** – what can we do now?
* **Sequel** – where can we go in the future?

**(1)** **Prologue – where have we come from?**

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| **Slide** | **Concept** | **Graphic** |
|  | **(1.1) WMO has existing efforts** |  |
| **1** | * **Global Runoff Data Center** <http://grdc.bafg.de> * Collects runoff data from national hydrology surveys. * Also **Global Precipitation Climatology Center** <http://gpcc.dwd.de> | World GRDC data map produced by ESRI Map service at UT Austin (Fernando has a map of the yellow dots)  Graphic of GRDC logo  Graphic of GPCC logo (map of gridded precip?) |
| **2** | * **World Hydrological Cycle Observing System (WHYCOS)**   WHYCOS is developed for promoting a bottom up approach, from the country level through the basin to global scale.   * It’s mainly focused on regional or basin scale projects at present. Not really a global system as yet | Graphic of world map at <http://www.whycos.org> The World Hydrological Cycle Observing System (WHYCOS) is a WMO programme aiming at improving the basic observation activities, strengthening the international cooperation and promoting free exchange of data in the field of hydrology. |
| **3** | * **Guide to Hydrological Practices**   + Volume I is entitled: “Hydrology – from Measurement to Hydrological Information”     - Chapter 10 is entitled “Data Storage, Access and Dissemination”   + The data sharing standards build on this foundation | Image of Front Page of the Guide, some quotes from contents  (slide sent already) |
|  | **(1.2) CUAHSI Hydrologic Information System** |  |
| 4 | **CUAHSI as an organization**   * NSF supports a consortium of universities to advance hydrologic science * This has a hydrologic Information System component focusing on Observational data | Map of the US showing CUAHSI institutions |
| 5 | **Point Observations Data**   * Measurement at point locations and produce a time series at each | Picture of observation site and graph of data measured there. |
| 6 | **Services-Oriented Architecture for Water Data**   * How the internet works for regular html and for water data * Centrality of WaterML as the language that underlies this services architecture | Two “golden triangles”, one for regular internet, one for water observations data  Map of water observations catalog at SDSC |
|  | **(1.3) Adoption and Internationalization of WaterML** |  |
| 7 | **Adoption of WaterML by USGS**   * Adopted as a prototype first, then hardened into a 24/7/365 system * First for real-time observations later for daily time series data * Water.usgs.gov vs Waterservices.usgs.gov | Picture of observation sites with USGS WaterML web services with output XML from one service |
| 8 | **Open Geospatial Consortium (OGC)**   * 400 companies and agencies worldwide that develop standards for map and observations data exchange on the internet * Proposal to OGC to form Hydrology Domain Working Group in Sept 2008 * OGC representative attends WMO CHy-13 in Nov 2008 * Agreement in 2009 between Sec Gen of WMO and Pres OGC to jointly develop internet data exchange standards for hydrology, meteorology, oceanography and climatology | Screen shot of OGC stuff – map services and observation services |
| 9 | **OGC/WMO Hydrology Domain Working Group**   * Very active work program with meetings each three months, week-long workshop each year, four international interoperability experiments in surface water, groundwater, hydrologic forecasting * OGC voted to adopt a revised version, WaterML2, as a water resources time series standard in June 2012 * WaterML2 is being considered by this CHy-14 for endorsement | Screenshot of work program of HDWG <http://external.opengis.org/twiki_public/HydrologyDWG/WebHome>  WaterML2 is the first public standard for the exchange of water resources time series through the internet.  (in other words the statement in the WMO Guide to Hydrological Practices about there being no standards for water data exchange may now be modified) |

**(2)** **Present – what can we do now?**

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| **Slide** | **Concept** | **Graphic** |
|  | **(2.1) Standards-Based Services Architecture** |  |
| **10** | **Water Data Services Stack**   * **Time series service** to convey observations data * **Map service** to convey site location and metadata * **Catalog registration** to enable integration across organizations | Vertical cylinder with catalog, space and time arranged vertically, symbols showing a catalog, a map of dots and a time series graph |
| **11** | **Thematic layers**   * Separate layers for precipitation, streamflow, water levels, … * Observations integrated across organizations that provide these data * Observations integrated across regions spatially | A labeled GIS layer stack associated with a particular regional polygon outline |
| **12** | **GEOSS and WIS**   * Background about **GEO and GEOSS** * Background about **WIS** * Idea that **OGC/WMO for HWDG** corresponds to **GEOSS/WIS for implementation** * Mapping science and hydrologic science | Logos and illustrative graphics about GEOSS [www.earthobservations.org](http://www.earthobservations.org) and WIS <http://www.wmo.int/pages/prog/www/WIS/index_en.html> |
|  | **(2.2) Examples of Application** |  |
| 12 | **Global Map of all streamflow services**   * Some have time series data behind them, others not yet * Role of GRDC | Fernando’s big map |
| 13 | **Dominican Republic**   * BYU does conversion to WaterML using CUAHSI data services * UT Austin does map services * Registration in GEOSS and link to WIS | How the services stack looks for the DR and how it was produced. Map of observations sites for DR with one chart of results. DR has to agree to ingest data before information can be harvested into WIS |
| 14 | **United States**   * Metadata provide by USGS and mapped at UT Austin * WaterML service provided by USGS * Separate services for real-time and historical information | Map of US with real-time stations and an example graphic for time series |

**(3)** **Sequel – where are we going?**

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| **Slide** | **Concept** | **Graphic** |
|  | **(3.1) Regional Integration** |  |
| **15** | **New Zealand**   * Data collected by **regional authorities and by NIWA** * Mix of **commercial and open source software** systems, modern and legacy systems * Effort being undertaken by NIWA to adopt OGC standards (WFS and SOS) and use these to bridge differences across regions * Federate regional and national data | Map of New Zealand showing the regional authority territories, overlaid by observation sitesSlogan “An open information system includes both commercial and open source software linked by open standards” |
| **16** | **Geospatial Integration**   * **Generic problem** is how to integrate integration across a region given multiple data providers * **Any spatial scale –** local, regional, national, global * **Solving the problem within a country uses the same architecture as solving the problem for the world or for a local region.** | Conceptual figure about a region and multiple providers with multiple types of data they provide. Icons from NZ example |
| **17** | **Central Texas Hub**   * Thematic mapping of streamflow, precip and water levels across three data providers * Updated continually (each 15 mins) * All observations charts are cached and available instantaneously * Can be adapted to the cloud * “Need to invest in the integration layer” | Picture of the Hub  <http://centraltexashub.org>  Idea that it’s a web portal and also a point of original for WaterML web services (ie both a web portal and a web services point of access, not just a web portal alone. |
|  | **(3.2) World Water Online** |  |
| 18 | **Integration of Mapping, Time Series and Modeling**   * Leveraging standardized services to produce usable information products * Collaboration of ESRI and Kisters | Four panel diagram |
| 19 | **World Hydro Overlay Reference Map**   * Multiscale standardized maps introduced by Google Earth * Adoption by ESRI for cartographic base maps of different themes * Publicly accessible at no cost | Global map, US, Texas, my house |
| 20 | **Global Watershed Delineation Services**   * Derived from SRTM or best available topography * Delineate a watershed from any point on earth just by clicking on a web map or using the service | Examples of delineated watersheds in various parts of the world |
|  | **(3.2) Landscape Scale Modeling and Data** |  |
| 21 | **Land-Atmosphere Modeling**   * Vertical water balance | Three panel diagram in Ahmad’s proposal defence |
| 22 | **RAPID flow modeling in rivers**   * Horizontal water balance * Continuous flow modeling in rivers | Examples of RAPID maps for various regions with one animation. |
| 23 | **GRACE**   * **Gravity measurements** of water balance from satellites | Global animation and gravity anomaly for Texas, comparison with reservoir levels. |
|  | **(3.3) What can WMO CHy Do?** |  |
| 24 | **Systematization of Metadata Standards**   * Technology is there to convey information but agreement is needed as to what information to convey * Especially the case for describing observation sites | Graphic of the descriptive characteristics of an observation site |
| 25 | **Engagement of National Hydrological Surveys**   * Pilot studies, testing infrastructure, OGC AIP-6 | Graphic of CHy work program and the “Data Operations and Management Theme” |
| 26 | **Hydrologic Feature Model**   * Good agreement about how to describe “sampling features” (observation sites) but less about the “sampled feature” (the river, lake, watershed, aquifer, bay that is being measured | Graphic about Hydrologic Feature Model |

**(4)** **Conclusion**

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| 27 | * WMO CHy has been involved in water data for many years * New technology and standards have emerged * Existing infrastructure is good – we just need to build on it * Not expensive or resource intensive | Inspirational quotation and picture |