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REVIEW AND UPDATE OF STATEMENTS OF GUIDANCE

SOGs FOR HYDROLOGY AND WATER RESOURCES

(Submitted by the Secretariat)

Summary and Purpose of Document

The purpose of the document is to inform the Expert Team of the revised Statement of Guidance for Hydrology and Water Resources

ACTION PROPOSED

The meeting is invited to use this information when preparing updates to the Statements of Guidance.

STATEMENT OF GUIDANCE FROM HYDROLOGY AND WATER RESOURCES

The collection of hydrological data is crucial to improve our understanding of the hydrological cycle for weather and climate-related scientific and application issues as well as for water resources management through improved assessment methods and the reduction of disasters following observations of hydrological extremes. For most of the presently available observations, the adequacy of observational networks varies largely from region to region and observations for some of the variables described below are inadequate in terms of spatial and temporal coverage.

As a methodological approach it has become evident, that observations of hydrological variables on global and regional scale in a continued and consistent manner will require integrated observation systems making use of both terrestrial as well as satellite observations and the generation of products on the basis of data assimilation products generated from these integrated networks and multi-platform observations.

The Terrestrial Observation Panel on Climate (TOPC) has identified 11 hydrometerological variables with a high observation priority (GCOS, 1997). An expert meeting on the Establishment of a Global Terrestrial Network – Hydrology (GTN-H) confirmed these 11 variables (GCOS, 2000) recognizing that several of these variables have both an in-situ as well as a satellite observation component. These variables and their current state of observation are briefly discussed in the paragraphs below. All variables are also discussed in detail in the IGOS Water Cycle Theme Report 2004.

It needs to be cautioned however, that observational requirements over the oceans are not reflected in the SOGs from Hydrology and Water Resources. In this regard, a critical field where global observations are required is the early detection of storm surges, in particular in combination with riverine floods in low-lying coastal zones. Storm surge detection is possible using satellite-based altimetry. At present, global observations are not undertaken on a routine basis.

1. DESCRIPTION OF VARIABLES

1.1 Surface water - Discharge

Discharge is typically calculated at a particular location in a river from measured water levels by means of a transformation or rating curve developed for the particular channel cross-section at which the water level is measured. Flow in a channel can be influenced by factors such as changes in land use, withdrawal for water use, or contributions from artificial water storage reservoirs, and thus discharge does not necessarily represent a response to climatic conditions. On a global scale, terrestrial hydrological observations are marginally adequate and generally inadequate in remote and mountain areas. Access to hydrological data is frequently impeded due to a number of factors including fragmentation of data holdings and access restrictions. Satellite water-level observations based on altimetry methods are available for large rivers but are presently not used in an operational mode. Several satellite-based methods are available on demand to map the extent of flooding in floodplains or large riverine systems as well as the duration of flooding, including visual, IR and radar sensors.

1.2 Surface water storage fluxes

This variable is directly related to the retention of surface fluxes in lakes, reservoirs and wetlands. There is also the issue of water storage in river channels, flood plains and large estuaries. While terrestrial observations are being made for lakes and reservoirs (levels of lakes and reservoirs, volumetric observations), space-based observations are also desirable and can be made using state-of-the art altimetry and/or gravimetric methods. Generally, observations are not yet available for wetlands, large floodplains and estuaries. To justify the necessity for observations of surface water storage fluxes it needs to be mentioned that at present, most climate circulation models do not realistically model lateral water fluxes, in part because of inadequate information on flow times; flow retention in dams, reservoirs, lakes and wetlands; and the evaporative loss of water from storage surfaces.

1.3 Ground water fluxes

Groundwater fluxes have a major influence on the dynamics of the global hydrological cycle. Because groundwater tends to respond more slowly to short term climatic variations than do surface water resources, this variable is often not considered to be of first-order importance from a climate perspective. Terrestrial observations are being made but overall global access to groundwater data (rates of recharge and abstraction in particular) is highly limited. Gravimetric observations techniques for very large groundwater bodies are available on satellite platforms in an experimental mode. The use of permanent scatters in use with ERS SARs enables derivation of groundwater depletion processes through the detection of ground subsidence.

1.4 Precipitation (liquid/solid)

Various meteorological variables including precipitation depth and type are routinely observed on an hourly to daily basis at synoptic weather stations. In general, global coverage from in-situ observations is adequate however with large regional differences. Exchange of data is achieved in real-time and near real-time mode and subsets of the precipitation measurements made are accessible through global networks and data centres. Increasingly, spatial and temporal coverage of rainfall observations is improved using ground radar techniques. Satellite observations on the basis of on-board radars as well as microwave imagers and sounders are also available from where precipitation information can be derived on a global scale. Merged data products using direct terrestrial observations and satellite observations are routinely available on a global scale. However, quantitative precipitation observations from satellite measurements at present do not meet accuracy requirements without extensive validation but provide precipitation estimates when combined with terrestrial observations.

1.5 Isotope signatures

Isotope data using environmental isotopes in precipitation are required for a number of hydrological investigations to improve understanding of the hydrological cycle. Isotope signatures in precipitation also constitute an essential tool for calibration and validation of atmospheric circulation models. At present, only a small global network of terrestrial isotope stations exists and all data are accessible. Especially for water balance studies, isotope observations using water stable isotopes could be used on an operational scale in riverine environments.

1.6 Evaporation

Evaporation is a critical value in the water balance equation as well as in water budget estimations over regions. However, direct observations are sparse and most evaporation values are in fact derived estimates. Evaporation in the context of the SOG's refers to "direct" measurements of actual evaporation. Because of the observing methods, even direct measurements are estimates. Terrestrial measurements on a global scale are declining in terms of spatial coverage at a time when traditional in-situ observations like evaporation pans and lysimeters are discontinued. Replacing traditional observation methods by using flux towers, evaporation estimates are made using eddy correlation and Bowen Ratio techniques. The number of these towers is very limited and data are not readily available on a global scale. Isotopic measurements can provide an effective method to derive evaporation as ratio of change of water stable isotopes between vapor and the residual liquid.

1.7 Vapor pressure / Relative humidity

Relative humidity is observed from in-situ networks with generally sufficient global coverage and is a basic variable for estimation of evapotranspiration as well as in use for water cycle studies and modeling. An equally suitable variable is vapor pressure as this variable is reported through the GTS, is directly useful for NWP modelling and estimation of the water vapor greenhouse effect and, given air temperature, can again be used to compute relative humidity. Sounding instruments using both IR and Microwave are used on satellite-born platforms. Radiosondes are the only operational method at present to observe vertical water vapor distribution. Column water vapor or precipitable water is estimated by microwave radiometers.

1.8 Soil moisture/Soil wetness

The observation of soil moisture or soil wetness (as a proxy for soil moisture) is important for hydrological forecasting in large river basins and likewise for modeling of the land surface module in coupled land-atmosphere models. A number of networks for soil moisture measurements exist in different parts of the globe. However, at this time there are no co-ordinated international networks for such measurements on a regular basis. In-situ measurements have been automated in many parts of the world recently. The use of advanced scatterometers allows derivation of soil wetness of the first few centimetres that however is only partially useful for hydrological studies and forecasting and need to be augmented by infiltration models, for example. On terrain, soil wetness can also be observed by passive microwave emission radiometry. On a global scale, with a spatial resolution of about 30-50 km, L-Band radar may provide spatial coverage. On a regional basis, a soil moisture index for Europe and Africa is derived from meteorological satellite data; this work is done within the framework of the EUMETSAT Satellite Application Facility for Land Surface Analysis (Land-SAF).

1.9 Snow depth and snow water equivalent

Seasonal snow cover is an important storage of water and largely regulates streamflow regimes and water resources management practices. Due to its high albedo, snow cover plays an important role in radiance and the land-atmosphere energy budget. Conventional terrestrial observation methods include snow-pillow networks and regularly worked snow depth measurement courses as well as networks of snow gauges. Derived from measured snow densities, snow water equivalent is calculated as an important hydrologic derived variable. On the northern hemisphere, snow observations are generally adequate but areal representativeness of snow cover thickness can often not be assessed with a high reliability. Satellite-based systems include AVHRR sensors. On a regional basis, passive microwave sensors such as SSM/I can be used to map extent and depth of moderate-thick snow covers. The overall important snow-water equivalent of snow packs should be derived on the basis of improved algorithms from microwave brightness temperature.

1.10 Biogeochemical (BGC) fluxes from land to ocean

These observations are intended to quantify the transport of matter and pollutants from the continents into the oceans. For global change analysis, especially carbon, amongst other elements is of major interest. Terrestrial observations are being made but temporal and spatial coverage as well as global access to such observations is insufficient at present. While the technology exists to provide water quality data with high precision for a large number of organic and inorganic components, space-based observations are so far very limited and not available in an operational mode.

1.11 Water use

In the management of water resources as well as the assessment of the potential natural flow of water in rivers for General Circulation Models and climate change studies, amongst others, information on water use is critical. However, at present only anecdotal information is available on this critical variable that is also highly heterogeneous in quality and availability (administrative, spatial and temporal). While sectoral information (mostly estimates) are available on a country basis, global consolidated information on water use both consumptive and non-consumptive is not yet existing and most existing information is extrapolated or derived from relatively few accessible data sources. In this situation, appropriate national organizations should be encouraged to develop a reporting model of spatially resolved sectoral water use. The USGS scheme (reporting by both political and hydrologic spatial units, for various economic/industrial sectors, on a five-year time step) could be used as an appropriate model format. Furthermore, countries should make the information on water use internationally available.

2. PRODUCT GENERATION FROM SELECTED VARIABLES (EXAMPLES ONLY)

Table 1 below provides examples of products that can be developed on the basis of the selected variables as described above and the spatial and temporal resolution that could be achieved if the products were supplied in an operational mode. Some of these products are expected to be generated in activities related to the Global Terrestrial Network – Hydrology (GTN-H).

Table 1. Examples for variable-derived products for hydrology, water resources, weather and climate applications

Product name	Content	Use (examples only)	Spatial resolution	Temporal resolution	Timelines
Discharge	Gridded runoff fields	Water balance computation	1^o x 1^o	Monthly	DT (delayed time)
Discharge	Point data	Weather and flow fore-casting; model validation	N/A	Daily	NRT (near-real time)
Discharge	Point data	Global water cycle analysis	By station (river-basin)	Daily/ Monthly	DT
Soil moisture	Gridded (preferably)	Weather and flow fore-casting; assimilation in models	TBD	Daily to monthly	NRT
BGC flux into oceans	By major watershed	Global BGC cycles analysis	By watershed	Daily to monthly	DT
Isotope composition	$\delta^{18}O$, $\delta^{2}H$, ^{3}H	Various	By station	Weekly to monthly	DT
Precipitation	Solid and liquid separately; point data	Regional water cycle analysis; Hydrological forecasting	1dx1d globally; 0.5^o x 0.5^o regionally; point data	Daily and monthly	DT
Precipitation, evapotranspiration	Point data	Real time data for assimilation in models, water budgets	Point	Daily	RT
Snow water equivalent	Gridded	Various	TBD	TBD	DT
Ground water fluxes	Aquifer withdrawal/re charge rates	Various	By aquifer	TBD	DT
Water use	Differentiated consumptive/ non-consumptive use	Various	Point or polygon	Monthly, annual	DT
Water use	Gridded consumptive/ non-consumptive use	Various	0.5^o x 0.5^o	Monthly	DT
Surface storage Flux	Volume changes in lakes and reservoirs	Water cycle analysis	Polygon	Monthly or seasonal	DT

Table 2 below provides a summary overview of the importance and usefulness of individual hydrological variables in relation to five thematic areas that are also served by information resulting from the operation of Global Observing Systems.

Table 2: Summary table of applications vs. hydrological variables

Variable	**Hydrologic, climate and weather forecasting**	**Climate variability, trend**	**Diagnosis, mitigation, adaptation**	**Sustainable development**	**Improved understanding of water cycle**
Surface water – discharge	e (v)	E	e	e	e
Surface water storage fluxes	e (v)	E	d	e	e
Ground water fluxes	D	E	d	e	e
Water use	-	-	d	e	e
BGC transport	-	-	e	d	e
Isotopic signatures	-	D	-	d	e
Precipitation	e (i,v)	E	-	e	e
Evaporation	D	-	-	d	e
Vapor pressure/ relative humidity	E	-	-	-	d
Soil moisture	e (v)	-	-	d	e (v)
Snow water equivalent	e (i)	e	-	e	e

e= essential; d= desirable; v= validation; i= input