IGWCO REPORT TO IGOS-13bis
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IGWCO IMPLEMENTATION
Final Report

Introduction

Since its approval in November 2003, significant progress has been made in the structural formation of the IGWCO theme and the implementation of its main elements. The development of GEO has opened opportunities for IGWCO to significantly contribute to this important global effort, and IGWCO has therefore streamlined a number of its activities to synchronize them with the GEO implementation plan. In 2006, a number of activities have been started, among them the development of a soil moisture network and the planning for a global runoff monitoring product. Oversight of the IGWCO has also been strengthened through shared secretarial services continued by JAXA for the Science Advisory Group and WMO by serving secretarial functions for the IGWCO Executive. Progress of some activities are however slower than expected due to shortages in resources, both financial and human capacity. The following paragraphs summarize the activities of IGWCO since the May 2005 IGOS meeting focusing on recent developments and plans for 2006 and beyond.

Precipitation

The objectives of IGWCO require time series of accurate gridded precipitation fields with fine spatial and temporal resolution for nearly all of the land areas of the world which rain gauges alone are not able to provide because they are often too sparse or inappropriately distributed. The Programme for the Evaluation of High Resolution Precipitation Products (PEHRPP) will yield a hypothesis-based assessment to see if they can provide either the basis for a more comprehensive product or insights into the best ways to combine the data. An integrated system will be developed through IGWCO after an initial assessment of the quality of the high resolution global precipitation products currently available. Although it has not been supported as a stand-alone project it is now part of a broader proposal under consideration by several agencies in the USA. The Programme is sponsored by the International Precipitation Working Group (Working Group of CGMS) and endorsed by GEWEX. A number of presentations of early results were made at the WWRP QPF05 Workshop in Boulder, Colorado, USA in June 2006. Further interim results were discussed at the Third Workshop of the IPWG in Melbourne, Australia in October 2006. In view of progress to date, the IPWG has recommended to its sponsors that an HRPP intercomparison workshop be held late in 2007, possibly at the WMO in Geneva, to discuss more advanced results, draw conclusions and make recommendations toward the development of integrated precipitation products. IGWCO continues to be supportive of a Global Precipitation Measurements (GPM) mission to be launched in the 2010-2011 time frame and will evaluate these methods to determine how they can be used as the basis for a new-generation Integrated Precipitation Product.

Soil Moisture

Soil moisture information is critical for understanding the global water and energy cycles, for predicting precipitation and for advising local water resource managers. Improved global observations and model estimates of soil moisture are needed on a priority basis. IGWCO will coordinate its soil moisture activities with the Global Climate Observing System (GCOS) plans to bring the best available *in situ* observations together with satellite data and the modeling and data assimilation capabilities of numerical weather and climate forecast

programs to produce an integrated soil moisture product. Developing global soil moisture information requires contributions from *in situ* measurements, satellite observations, and a reliable data assimilation framework. To obtain improved soil moisture information, it will be necessary to enhance both *in situ* sites and satellite data. As at present no global in-situ network for soil moisture exists, the development of a Global In-Situ Soil Moisture Network is at the centre of these efforts. This will involve network enhancement by expansion and standardization, dedicated soil moisture missions (support for SMOS, ESA's soil moisture ocean salinity satellite mission), and improved coordination of soil moisture data network planning, observing standards, and data exchange. IGWCO is addressing this issue through its International Soil Moisture Working Group (ISMWG), which is developing mechanisms for cooperation between national groups, and individual scientists that will enhance global soil moisture observation. The major outcomes of the ISMWG workshop held in March 2006 relate to the standardization of measurement protocols such as: Cross-Validation (site specific), temp, soil texture & bulk density, relationship with gravimetric soil moisture, density/depth of sensors, units of representation. With regard to network design, outputs relate to the network density, linkage of networks and the availability of metadata. Next steps in 2006 are the publication of the workshop report, set-up of a website, development of a White Paper. In 2007, a workshop is planned in Asia to address the widening of the working group framework and its formalization and embedding in existing initiatives as well as issue related to the hosting of soil moisture data. These activities are also in response to the request for near-term actions and interaction with GEOSS.

Water Quality and Bioindicators of Aquatic Ecosystem Stress

IGWCO plans to evaluate the potential of remote sensing data to assess areas where environmental stress is high so that a focused surface based monitoring program could be implemented in the region. With satellite data it should be possible to take the results of intensive bio-monitoring studies in selected basins and to generalize them to a regional scale. The following initiatives are being planned or carried out, respectively:

a) Development of a Freshwater Color Coordination Group
b) Multisensor Space borne Monitoring of Global Large Lakes: Towards an Operational Assessment of Trends in Water Quantity and Quality (University of Wisconsin [NASA Grant]).

The objectives of this project are the following: For a set of approximately 40 large lakes worldwide, produce satellite-derived maps showing fluctuations in area over the time of the study (and extending back to 2000 in some cases); evaluate the ability of the ICES/GLAS instrument to provide accurate measurements of lake level, for the same set of 40 lakes. For a second set of lakes, acquire both field observations using the GEMS/Water database and atmospherically corrected satellite imagery. The lakes would be classified using spectral and physical factors, and empirical models relating to satellite measurements, water clarity and other in-lake conditions will be developed. A large-lake water quality workshop on remote sensing methods for lake water quality assessment was held 7 November 2006 in Indianapolis, hosted by the North American Lake Society (funding by the US EPA). Participants came from the Universities of Minnesota, Nebraska, and Wisconsin. Topics discussed include remote sensing costs and data analysis considerations, as well as basic operational algorithms. A guidance manual is being prepared which will be useful for IGWCO and capacity-building considerations.

c) Capacity Building

Increased capacity building requirements will be addressed at a planned workshop in Latin America with the objectives to provide information on capabilities of remote sensing techniques for freshwater systems; provide a basic understanding of needed expertise, equipment, associated software and costs to analyze the image data; provide hands-on

experience in processing/interpreting remotely sensed images and to obtain input/feedback from workshop participants on water quality information needs, hardware, software, training needs and course effectiveness.

d) 1st GEO Inland and Nearshore Coastal Water Quality Remote Sensing Workshop, 27 February – 1 March 2007.
In accordance with the GEOSS Task WA-06-01, this workshop has the goal of bringing together remote sensing data providers and expert users in order to improve our ability and capacity to remotely assess/monitor inland and nearshore coastal water quality. Topics to be addressed:

- Inland Waters: state-of-the-art .
- Coastal Land Influenced Waters: state-of-the-art.
- Data reception and preprocessing and distribution of DB data.
- Remote Sensors (spatial resolution, temporal resolution, spectral resolution).
- Processing algorithms: atmospheric correction, air-water interface correction (sun and sky glint, foam), optical water quality variables; derived variables (e.g. eutrophication index, primary productivity).
- Calibration/validation issues; In situ sensors, sensor networks.

Recommendations to data providers and GEOSS members on immediate priorities for improving remote sensing capacity and utilization for water quality assessment and monitoring, as well as formulating short and long term strategies to identify, enable and implement enhanced capabilities are some of the expected outcomes of this workshop.

The Global Runoff Monitoring Project

Recognizing the need for a global hydrological product based on in-situ river and lake gauge observations and satellite observations based on altimetry that are currently available or under development, the global runoff monitoring product has been proposed during the CEOP/IGWCO workshop in March 2006. The basic rational for the development of this product is that global monitoring of runoff and lake storage is an important element of Integrated Global Observing Systems and an integral part of water resources management including prevention of water induced disasters. The objective of the project is to provide near real-time monitoring products of large scale rivers and lakes to observe and analyze surface runoff and lake storage variations and variability over time. ESA and GEO are interested in a Global runoff project. GEO has a main interest in promoting this project as an essential new observing system and would like to facilitate the implementation of this project. José Achache (GEO) is to work on finding funding for 300 stations globally, to measure fresh-water fluxes into the world oceans.

Application areas for Hydrological Services and research are with regard to support to regional and continental scale modelling and data assimilation and the potential to provide critical early warning information on floods, hydrological drought and water resources assessment for management purposes.

The building components of the project are outlined below:

i. The project builds on ESA's "Rivers and Lakes" Project that utilizes ENVISAT Radar Altimetry;
ii. Science input is provided by De Montford University, UK in developing the high resolution radar masks and echo interpretation algorithms to convert surface water radar echoes into variations of water levels in rivers and lakes;
iii. Reference data sets will be provided by GRDC in terms of both historical runoff data series and future provision of reference terrestrial water-level observation of selected river gauges

iv. Core-partners for the project will therefore be ESA, De Montofrd University and GRDC.
v. Emphasis is laid on the the establishment of close collaborative links with the Water Level Recovery Mission (WatER) that is currently under development

Amongst others, the following science and applications issues are considered in the development of the project:

Satellite altimeters used for years to measure inland water heights of a few special targets. Existing missions: ERS and ENVISAT instruments are specially configured to operate over non-ocean surfaces with sample same locations re-visited every 35 days. TOPEX and JASON-1 are optimized for ocean surfaces but could be also used under certain conditions for inland waters with a sample interval every 10 days. The problem is that inland water echoes are very complex and hard to interpret to get range to surface. A possible solution is to design range of re-tracking algorithms to deal with different shapes. Discussions were held with ESA during the Pan-GEWEX conference in Frascati (Italy) in October 2006 on the possibility of providing more real-time altimetry observational data to the WMO WHYCOS programme in support of GTN-H and the IGWCO over basin areas in Africa, Asia, and Latin America. The aim would be to calibrate the data via algorithm development and then make the data available through a website. ESA is ready to cooperate on the basis of identified user groups of the products generated. Meanwhile, WMO has supplied ESA with basin boundary coordinates for a number of basins to build the baseline information to process altimetry observational data for the derivation of discharge information.

For 2006 and extending into 2007, the following tasks are envisaged:

i. Formalization of the cooperation to develop and operationalize the project between ESA and WMO (end of 2006)
ii. Creation of a Task Team for the preparation of a project implementation plan based on existing projects and activities of the core partners with opportunities for linkages with additional partners
iii. Prepare 1 arc masks for priority areas including Asia
iv. Obtain gauge height time-series and rating curves for selected rivers
v. Obtain bathymetric information for large lakes and reservoirs to calculate volume changes in storage
vi. Operationalize NRT products for new lakes/rivers

The initial time scale for the development and implementation is about 3 years.

Global Terrestrial Network Hydrology (GTN-H)

Launched in 2000, the Global Terrestrial Network for Hydrology (GTN-H) is the result of the joint efforts of the WMO Hydrology and Water Resources (HWR) Department, the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). In the context of the IGWCO, GTN-H has the status of a complementary programme that supports the implementation of the IGWCO.

GTN-H comprises of existing networks, global databases covering ten variables amongst them GCOS essential climate variables and global data product centers, and is managed by a Coordination Panel. Basic objectives and activities focus on developing and improving the availability of hydrological data and information required addressing global and regional climate, water resources and environmental issues. Benefits will include: improved understanding of weather and climate change; and an understanding of the global water cycle in an integrated context of weather, water and climate. Other benefits will be the improved assessment of freshwater availability and variability, and the greater understanding

of large-scale hydrological processes. Central to achieving the objectives is the development of global-scale data products. A major area of activity within GTN-H aims to develop and implement improved approaches and tools for data collection, access and management to support GTN-H objectives, and here GTN-H is a key partner in implementation of the Integrated Global Water Cycle Observation (IGWCO) theme of the IGOS partners.

A meeting was held at the WMO on 2 October 2006 with the International Groundwater Resources Assessment Centre (IGRAC) based in The Netherlands. IGRAC has been identified as an important partner of the GTN-H that can provide support to IGWCO on the issue of groundwater. In the case of IGRAC, funding has been secured until 2009 and a major focus is to develop a concept paper by the end of November 2006 on the establishment of global ground water monitoring networks (including large aquifers). This is important since ground water is the primary source for drinkable water globally. IGRAC has now developed a global groundwater-monitoring plan, which is now open for comments before it will be finalized and implemented.

Global observations of large lakes and reservoirs have been viewed as an important goal to close the apparent gap in freshwater observations. During a meeting between WMO and the State Hydrological Institute of Russia in November 2006, basic agreement has been reached about the establishment of an Internal Centre of Data on Lakes and Reservoirs (HYDROLARE) in the first quarter of 2007 in St. Petersburg, Russia, hosted by the government of the Russian Federation. This will first build up a database on the 200 largest lakes and reservoirs. It is planned to hold the first meeting of a newly established International Steering Committee for HYDROLARE in April 2007.

Capacity Building

The opportunities for using Earth Observations to support water management are significant in every part of the world. The value of these observations and the systems needed to support them has been recognized by many organizations worldwide. Following the successful conduct of a capacity building workshop: “Capacity building in Latin America – Earth Observations in the Service of Water Management” in Buenos Aires, in October 2005, another workshop “Asian Water Resources Management Capacity Building Workshop” was held from 26-28 September 2006 in Bangkok, Thailand. A total of 121 policy makers, water resource managers and scientists from 22 countries attended, and a draft version of the Summary of Proceedings is available on the workshop website (http://www.a-a-r-s.org/ws-eowm/proceedings.php). The workshop was co-sponsored by GEO, IGWCO, JAXA, Univ. of Tokyo, AIT, UNU, WMO, WCRP, UNESCAP, and ICHARM. A key result was that 3 working groups were established to focus on Ground Water and Water Quality, Flood Management, and Drought Management issues. Further, Day 1 included a Workshop for Policy Makers that established the usefulness of IWRM, modeling and satellite data in response to increasing frequency and severity of floods and droughts in the region. Days 2-3 featured a Workshop for Water Resource Managers in which the urgent matter of arsenic contamination of drinking water in Bangladesh was examined and a specific task submitted to GEO in response. Also, the initiation of narrow-focus demonstration projects based on regional needs with tangible outcomes was recommended, as well as improving access to satellite data.

It is generally recognized that high-interest projects need to be identified to make use of satellite data, in which results can be tracked and documented. The goal is to provide feedback to experts who can then tailor data to fit needs of regional populations.

Looking ahead:

- WS reports to CEOS Plenary, IGOS-P, GEO Plenary in November 2006, Buenos Aires, Argentina.

- Follow-up discussion on demonstration projects within the framework of Asian Water Cycle Initiative (AWCI) to contribute to GEOSS, at the 2nd Asia Water Cycle Symposium and the GEO Asia Pacific Outreach Symposium, Tokyo, January 2007.

Coordinated Enhanced Observing Period (CEOP)

CEOP has been successful in establishing a prototype integrated observation system formed by combining different types of observations such as in-situ and satellite. In addition, the numerical weather prediction model outputs are merged with the observed data to provide spatially and temporally continuous coverage in a complementary way. The coordinated enhanced observation and model output generation were completed during the first Enhanced Observing Period (EOP-1), which extended from July-September 2001, the EOP-3 (from October 2002-September 2003), and the EOP-4 (from October 2003-December 2004).

The following major achievements have been made as of May 2006:

With regard to the data component, in-situ, satellite, and model output data are more than 50% completed and are available on-line through the respective archives and the Centralized Data Integration System. Significant portions of the archived data are available through the Distributed Data Integration System.

With regard to the science component the following results have been initiated or have been already achieved in the reporting period:
CEOP Special Issue of the Journal of Meteorological Society of Japan (JMSJ) to be published in February 2007 with 41 contributions submitted;
Publications in other journals, CEOP Newsletter (#1 – #9);
Water and Energy Cycle Simulation and Prediction (WESP): Model output validation; GLDAS; GHP/CEOP model transferability study; Model intercomparisons;
CEOP Inter Monsoon Studies (CIMS): Monsoon intercomparisons; diurnal, intraseasonal and seasonal variability; monsoon process study using models; impacts of local and remote forcing on monsoon systems;
Satellite: Algorithm development and validation (soil moisture, snow); data assimilation for land hydrology (soil moisture, surface fluxes).

With the conclusion of CEOP Phase I, three unique capabilities have been established and are functioning:
1. Convergence of observations from in-situ and satellite observations and model output data. 35 terrestrial reference centers have been established over the globe and from satellite observations, over 20 variables are being collected. Currently, 12 contributing NWP and Data Assimilation Centers are contributing to CEOP, enabling CEOP to provide a wide range of products.
2. Inter-operability arrangement: A well organized archiving system relating to data collection, processing, storage, and dissemination has been established. This system is based on a data sharing policy and using a metadata standard that is based on ISO TC/211 19115.
3. Data Management: The following systems are on-line available since June 2005: Distributed Data Integration System and the Centralized Data Integration System. The data management system encompasses functions such as Quality Assessment/Quality Control, access to data, and archiving of data, data integration and visualization, and information fusion.

Activities for the planned CEOP Phase II (2005 – 2010) have been initiated: The basic framework of the CEOP Phase 2 plan (which extends the existing data and observation processes and adds greater emphasis on the research and analysis components of CEOP)

providing for CEOP to meet its commitments to CEOS/IGOS-P Water Theme, WCRP/COPES and GEOSS, was endorsed. This next Phase of CEOP will, therefore, proceed in two stages (2005-2007; 2007-2010) that run from 1 January 2005 to 31 December 2010. The CEOP sessions at the Pan-GEWEX meeting (9-12 October 2006, Frascati, Italy) were dedicated to CEOP's overall implementation strategy. The emphasis was also placed on particular areas of cooperation between CEOP and GEWEX, especially the connection and merger with the GEWEX Hydrometeorology Panel (GHP), and the other core projects of WCRP. The assessments dealt with the degree to which the commitments made by agencies and organizations to CEOP, such as the provision of coordinated in-situ, satellite and model data, have been fulfilled, and the degree to which CEOP has been able to apply the resources it has to meet its observational and science goals. In keeping with the intent of the JSC recommendations, each step identified in the CEOP planning process included specific implementation strategies that will ensure close and effective connections to other national/international activities concerned with research of the Earth's water and energy cycle, especially GEWEX and the core projects of WCRP.

IGWCO Secretariat

JAXA, through its support of the IGWCO Secretariat has been an important part of the theme's success. JAXA has provided support through the organization of teleconference calls, hosting the first IGWCO planning workshop (held jointly with the 4th CEOP meeting), finalizing and printing the IGWCO brochure with ESA support. As from mid-2006, the IGWCO-Secretariat will be a distributed Secretariat with distributed responsibilities for JAXA and WMO as WMO has assumed responsibilities to chair the IGWCO Executive and provide secretarial support to the Executive Committee. Frequent interactions between JAXA and WMO parts of the Secretariat will ensure the continued smooth operation and coordination of IGWCO activities.

In its role to contribute to GEO, the IGWCO Secretariat has provided significant inputs to update the Water-related tasks for the GEO 10-year Implementation Plan.

As a follow-up of the Second IGWCO Workshop and CEOP Science Meeting at UNESCO in Paris, 28 February - 3 March 2006, plans are progressing to hold a third workshop from 12-16 March in Washington D.C. NASA/NOAA are offering to host the general CEOP/IGWCO meeting at the National Academy for Arts and Sciences. Current plans are to allot 2 days each to CEOP and IGWCO, with a joint CEOP/IGWCO session in between. Focus issues will include precipitation and capacity building. Main objectives of the workshop Objectives of the IGWCO Workshop include: (i) further developing the IGWCO implementation plan to define areas where IGWCO can build on the extensive data management and research capabilities that have been developed in CEOP; (ii) strengthening interactions between the IGWCO and the Global Earth Observation Systems of Systems (GEOSS), and addressing IGWCO actions that directly support the Group on Earth Observations (GEO) Water Cycle Societal Benefit Area; and (iii) developing plans for new IGWCO products, initiatives, and mechanisms. Those who are leading specific IGWCO thrusts [e.g., precipitation, soil moisture, runoff, Global Water and Sanitation Initiative/Global Water System Project, and Capacity Building] should come prepared to discuss their progress since our last meeting in 2006 in Paris. The recommendations from this meeting will be reported at the May 2007 Integrated Global Observing Strategy-Partners meeting and subsequent GEO meetings.

Future Plans

In 2006-2007 IGWCO will give a high priority to completing those aspects of its implementation plan that relate to the GEO work plan. One priority here is to take action in GEO WA-06 02 (Hydrological Ensemble Prediction) and to coordinate with GEO on several work plan goals including the organization of one or two water cycle workshops in 2007. In

the past a lack of resources has been an impediment to moving forward with a number of these activities. It is hoped that GEO will enable us to overcome these obstacles and make significant progress.

A focus will be placed on moving the Capacity Building activities forward through efforts in South America followed by a workshop in Asia and another in Africa in collaboration with the TIGER project. A related activity is the effort IGWCO directed towards the World Water Forum 4 that was held in Mexico City in the spring of 2006.

Of special importance is the fast-track development of a GEO Water Cycle Community of Practice. A first draft outline of a proposal for a community of practice is planned to be available for the next GEO Users Interface Committee meeting. A number of new topics will also be advanced in 2006. These include:

- The development of a flood project to fill an apparent gap in the Integrated Global Observing Strategy–Partners (IGOS-P) themes and possibly the GEO plan. A planning workshop will be proposed in collaboration with the International Centre for Water Hazard and Risk Management (ICHARM) Program (Japan) and other organizations.
- IGWCO will consider Drought as a possible demonstration project of how to link remote sensing and socioeconomic data. The formation of a UNESCO-IGWCO-GARS Working Group on groundwater and the establishment of an initial task list are also envisaged.

IGWCO Website:
Work is in progress for an IGWCO-specific website, to be online by December 2006. Currently, a cursory discussion of the IGWCO theme is presented on the CCSP and GEWEX websites. Within the over-arching context of IGOS-P, the IGWCO website will provide a main focal point from which reports, minutes, and other documents may be downloaded, PowerPoint presentations viewed, and relevant meetings announced. The site will be structured such that content flows sequentially from general to specific. It will also be rich in links to partner websites and will contain a private sector for communication within the SAG.

Upcoming Meetings

2nd Asia Water Cycle Symposium/GEO Asia Pacific Outreach Symposium
9-10 January 2007, Tokyo

1st GEO Inland and Nearshore Coastal Water Quality Remote Sensing Workshop
27 February – 1 March 2007, WMO, Geneva.

CEOP/IGWCO Meeting:
12-16 March 2007, Washington DC

HRPP Intercomparison Workshop:
Late 2007. WMO has tentatively agreed to host the workshop

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…with contributions from IGWCO partners