GLOBAL WATER NEWS
No. 4

Global Water System Project

Earth System Science Partnership

No. 4 | October 2006 | www.gwsp.org

EDITORIAL

The contents of this issue of Global Water News reflect the diverse and accelerating pace of GWSP activities following the third meeting of the Scientific Steering Committee (SSC) in Oaxaca, Mexico in March 2006. The meeting was held immediately after the World Water Forum in Mexico City at which the GWSP and associated projects GEWEX and NeWater set up a joint display booth. In this issue the lead article by SSC member Christer Nilsson is about river fragmentation, which has significant ecological consequences that are an important focus of the GWSP. Another scientific article concerning green water credits was the subject of one of the public Water Lectures that the IPO organised in Bonn this year. This issue includes reports on three meetings held in 2006 on topics including global dam databases, water governance, and 'hotspots' in Asia. Finally, we feature a think-piece from SSC member Claudia Pahl-Wostl on integrated assessment. Bridging the gap in thinking between different disciplines remains a major challenge. In this regard, the GWSP systems approach to water at a global scale should provide new and pertinent insights to the human, ecological, biogeochemical, and physical dimensions of global environmental change. This is a worthy goal and, on a personal note as I prepare to hand over to a new Executive Officer, I want to record my appreciation for the opportunity to contribute to this important project.

Eric Craswell
Executive Officer, International Project Office (IPO)

A WORLD DOMINATED BY FRAGMENTED RIVERS

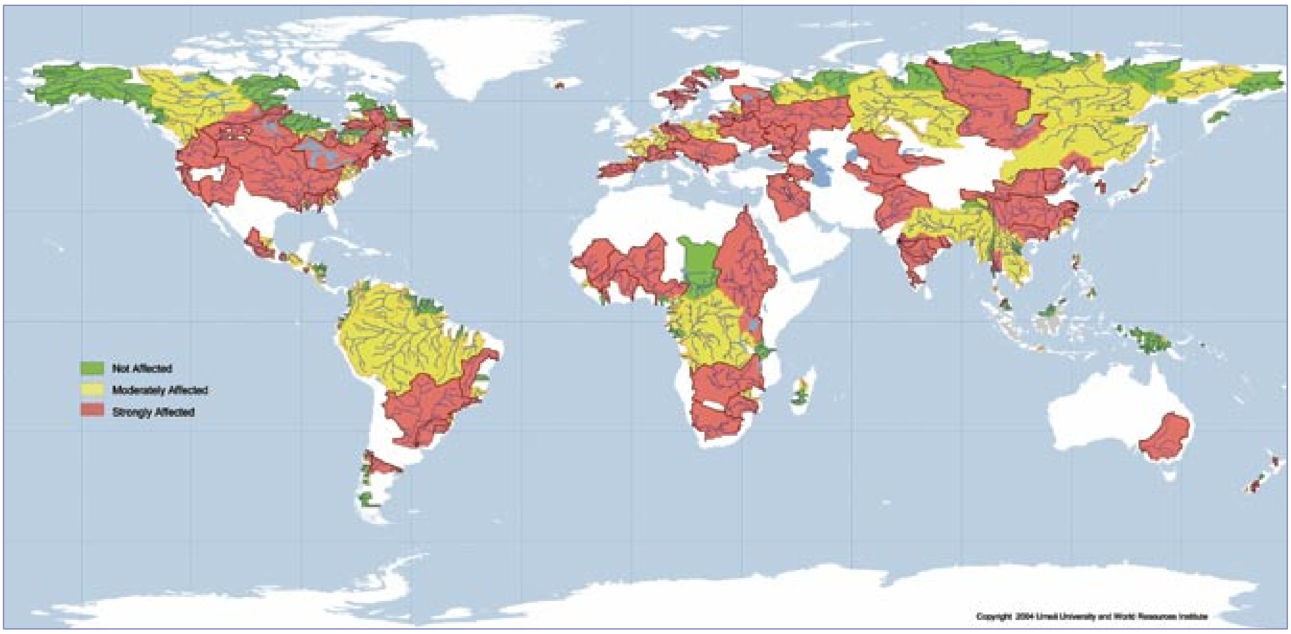
Most of the rivers in the world were originally characterised by large variations in flow. Humans have experienced great difficulty in adapting to this natural variability. They have instead made comprehensive changes to river systems by constructing dams and diverting the water, to satisfy the human need for water, energy and transport, and other purposes. Today there are about 50,000 dams in the world with heights above 15 m. These dams can retain more than 6.5 trillion m^3 of water, which represents about 15 % of the annual global runoff.

More than 300 dams are considered to be giant dams. They satisfy at least one of the criteria regarding height (at least 150 m), dam volume (at least 15 million m^3) or storage capacity in the reservoir (at least 25 billion m^3). The recently constructed Three Gorges Dam on the Yangtze River in China is regarded to be the largest so far – it is 181 m high and the reservoir has a capacity in excess of 39 billion m^3 of water. If we consider that the reservoir is 600 km long, it is easier to appreciate how gigantic this construction is.

Large dams significantly alter surface water flows.

The effects of dams on ecosystems are generally well known. These comprise both upstream and downstream effects due to impounding, flow regulation and fragmentation of the landscape. Impounding schemes completely destroy the terrestrial ecosystem. They also eradicate the rapids, which obviously affects the organisms that demand fast-flowing water. Impounding can also give rise to oxygen deficiency, the emission of greenhouse gases, sedimentation of silt and liberation of nutrients when new reservoirs are created. Resettlement of people when developed areas are flooded can create health problems, social, cultural and religious problems, and comprehensive changes in land use patterns. It is estimated that between 40 and 80 million people have been forced to move because their homes have been flooded. This is a tragic development since in most cases sustainable agricultural communities are destroyed to provide support for unsustainable cities.

Figure 1. *Classification of the impact of dams in the form of fragmentation and flow regulation on the 292 large river systems in the world. River systems are treated as units and are represented on the map by their catchment areas. Red, yellow and green denote great, moderate and little or no impact respectively. White areas denote areas of land not encompassed by large river systems. Systems that have not been considered owing to unreliable data are shown in grey.*



Manipulation of flow may hinder development of the river channel, drain wetlands close to the river, reduce the productivity of river banks, lower the dynamics of delta regions, and eradicate communities of organisms in the water. Dams also hinder the spread and migration of many organisms, resulting in populations or entire species of fish being eradicated. One very clear example of what flow regulation can give rise to is the devastation of New Orleans in the Mississippi delta last year. Regulation of the river over many years has reduced the size of the delta and lowered its level, and necessitated the construction of extensive river walls to keep out the waters. When hurricane Katrina arrived, the protective walls did not hold, and 80 % of the city was flooded.

At the end of the 1980s, I began a compilation of the world's dams. Information was collected concerning all rivers with an annual mean flow greater than 350 m^3/s. The objective was to find how closely dams are situated on these rivers, and how heavily their flow is regulated. The work may now be considered finished at the scale employed. There are only a few small areas in Malaysia and Indonesia that remain, but runoff data there are so poor that it is impossible to decide whether there are rivers in these countries that are sufficiently large to come within the investigation.

A total of 292 river systems have thus been considered. They have been divided into three categories in view of the degree of impact which the dams have: strong impact, moderate impact and little or no impact. Fig. 1 shows how these three categories are spread over the world. There are about the same number of large river systems where the dams have no impact or strong impact (120 and 104 respectively). Only 68 of the large river systems have been classified as being moderately affected by dams. Of the ten river systems in the world that carry the most water, the dams on six have moderate impact and on four strong impact. Dams on both the world's two river systems with most water (Amazonas-Orinoco in South America and Congo in Central Africa) have moderate impact, while dams on the third largest river in terms of water volume, the Yangtze, have a strong impact. The largest free-flowing river in the world is the Yukon in Alaska. It is in twenty-second place in terms of annual mean flow. Most of the large river systems on which the dams have no impact are in North and Central America, while Australasia has the highest proportion of systems with no impact, 74 %. Europe has both the smallest number (five) and the lowest proportion (12 %) of systems where the dams have no impact.

One third (102) of the large river systems have no dams at all. This means that there are 18 unaffected systems that have single dams on their tributaries. Europe has the lowest number of rivers without dams (only three rivers in North-West Russia – Pechora, Mezen and Onega). The continent which has the most (35) large river systems without dams is North and Central America. Twelve large river systems (nine in Europe and three in North America) have so many dams that less than one quarter of their length is free of dams.

The largest degree of regulation (428 %) is found on the Volta River in West Africa. This means that its reservoir can store more than four years' normal runoff without any water having to be discharged. In North and Central America, the Manicougan and Colorado rivers are both regulated more than 250 %, and in South America the Rio Negro is the large river system that is most heavily regulated. The most heavily regulated large rivers in Asia are the Shatt Al Arab (which is formed by the confluence of the Euphrates and Tigris) in the Middle East, and Mekong in Thailand. Europe and Australasia have no large rivers with degrees of regulation exceeding 100 %.

Many of the rivers in the world are subjected to extensive water abstraction, primarily for irrigation. Most of this water evaporates, which means that the rivers dwindle. The rivers that are most heavily affected do not reach the sea during the whole year or parts of the year. Changes like this have devastating consequences for plant and animal life in the delta regions and the sea. Most irrigation, in terms of the irrigated area and the water that is available, takes place on rivers that are already extensively dammed. In most countries there is also a strong coupling between population, economic activity and degree of impact. The exceptions are rivers in sparsely populated northern regions, which are heavily exploited for exportation of hydropower.

The annual number of newly constructed dams reached its peak in the 1970s and has since decreased. Today, dams are being planned or constructed on 46 of the large river systems I have studied. There will be between one and 49 dams per river system, and most are located in developing countries. Almost one half of the new dams are situated on four river systems, 49 on the Yangtze, 29 on Rio de la Plata in South America, 26 on Shatt Al Arab and 25 on Ganges-Brahmaputra in South Asia. New dams are also being planned in several large river systems which are today unaffected, for instance on Jequitinhonha in South America and on Cá, Agusan, Rajang, and Salween in Asia.

One of the advantages of having a global overview of how the world's rivers are affected by dams is that it is easier to judge the effect of new dams and regulation schemes. It is also easier to judge the aggregate contribution of the regulated rivers to energy production and water management in various countries, and to evaluate the remaining river systems and to draw up nature conservancy strategies. Since it is expected that regulated and free-flowing rivers will be affected differently by future changes in climate, rates of runoff and sea levels, the global overview may make it easier to make preparations for the new challenges. One conclusion that can be drawn from the international perspective is that, owing to their small numbers, the free-flowing rivers should be valued even more highly than has been the case so far.

Further reading

Dynesius, M. and Nilsson, C. (1994). *Fragmentation and flow regulation of river systems in the northern third of the world.* Science 266: 753-762.

McCully, P. (1996). *Silenced rivers. The ecology and politics of large dams.* Zed Books, London, UK.

Nilsson, C.; Reidy, C. A.; Dynesius, M. and Revenga, C. (2005). *Fragmentation and flow regulation of the world's large river systems.* Science 308: 405-408.

Scudder, T. (2005). *The future of large dams. Dealing with social, environmental, institutional and political costs.* Earthscan, London.

World Commission on Dams (2000). *Dams and development. A new framework for decision-making. The report of the World Commission on Dams.* Earthscan, London.

Christer Nilsson
Contact: christer.nilsson@emg.umu.se
Landscape Ecology Group, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden
Member of the GWSP Scientific Steering Committee

GREEN WATER CREDITS FOR RAINWATER MANAGEMENT BY FARMERS

Issue

Water scarcity is undermining food security, economic development, human welfare and ecosystem services; shortages are increasingly felt in cities. The source of all fresh water is rainfall. Globally, 70 % of fresh water is green water, held in the soil and accessible to plants, whereas only 11 % of fresh water is accessible stream flow and groundwater. Soils also deliver blue water – groundwater and stream flow that can be tapped for use elsewhere. Currently, 36 % of the accessible water is abstracted, of which 70-80 % is used for irrigation; the proportions are much higher in drylands (Fig.1)

Nearly all investment goes into abstraction and delivery of water from streams and accessible groundwater; replenishment at source is neglected; green water is ignored – by engineers because they cannot pipe it or pump it, by economists because they cannot price it, and by governments because they cannot tax it.

To meet the Millennium Goal on hunger will require doubling water use by crops by 2050. Even with much-needed improvements in efficiency, irrigation cannot do it alone. A shift in policy is required – from runoff management towards rainwater management. This means greater water-use efficiency in rain-fed farming, and soil management to reduce runoff and increase green water and groundwater recharge.

Contrary to popular belief, water scarcity is not caused by low rainfall. In drylands, rain-fed crops use only 15 to 30% of the rain. Most of the rest is lost as damaging runoff and evaporation losses from bare soil, especially before planting, and during early growth. Farmers are suppliers of water but poor soil management means excessive runoff; on degraded land, 95 % of rain may be wasted. Runoff carries away the topsoil; floods damage life and property, and fill reservoirs with sediment that reduces water storage and hydro-power generation (Table 1).

Solution

Soil use and management is both the problem and the solution. Better soil and crop management can enhance infiltration threefold, reducing overland flow and erosion in proportion, and reduce evaporation from the soil (Figs. 2 and 3). This means more water in the soil for crops, and more groundwater recharge and stream flow. The immediate beneficiaries are the downstream users who need a reliable water supply but do not want the floods, sedimentation of the reservoirs, and damage to infrastructure that uncontrolled runoff brings. Benefits upstream include improved resilience to external shocks by building assets: green water resources, stabilised soils, narrowing the hunger gap, and diversified rural incomes.

At present, rainwater management is not optimal because:

- Water management by farmers is incidental to their farming activities – unrecognized and unrewarded; they are paid for their crops and livestock, not for delivering water;
- Farmers have limited access to information and training for best practices; often they cannot afford to implement best practices, even though they produce higher crop yields; inadequate land and water rights are a disincentive.

Green Water Credits are proposed to rectify the market failure by paying farmers for specified water management activities that keep the soil where it ought to be and deliver more, and more secure blue water flows (Fig.4).

Figure 1: *Green and blue water flows in Kenya. Data from Falkenmark and Rockström 2004*

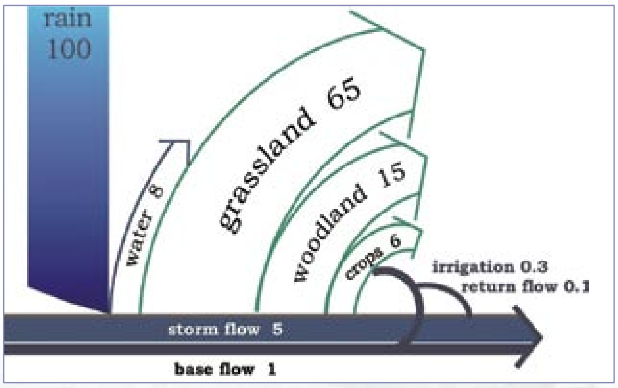


Figure 2: *Partitioning of rainwater into green and blue water flows. After Rockström 1997*

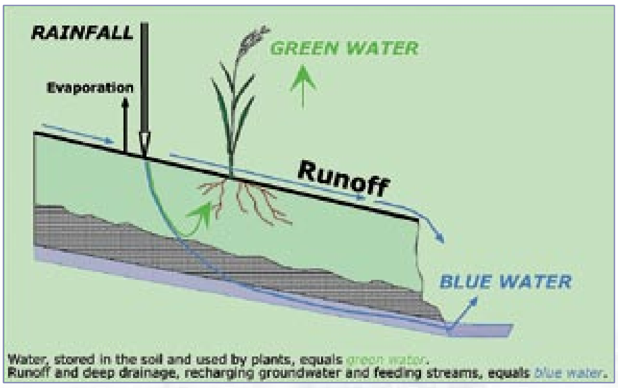


Table 1: *Upstream and downstream consequences of poor rainwater management*

Upstream	Downstream
• Less green water for crops, exacerbating the effects of dry spells and drought, resulting in yield losses, food insecurity and loss of livelihoods	• Food insecurity
• Flash floods • Damage to local infrastructure • Soil erosion	• Floods • Damage to infrastructure • Siltation of river channels and reservoirs
• Lowering of water tables, failure of wells • Failure of springs, reduced river base flow	• Uncontrolled river flow, high peak flows, reduced or no dry-season flow • Less hydropower and damage to turbines • Less and less-reliable urban water supply • Less water for irrigation • Less water for natural ecosystems especially in the dry season

Proof-of-Concept

The nub of the matter is to persuade people downstream to pay for what they now receive free. This year sees the start of a proof-of-concept project supported by International Fund for Agricultural Development (IFAD) and the Swiss Agency for Development and Cooperation to demonstrate the viability and feasibility of Green Water Credits in the Tana Basin in Kenya – selected from a short list of basins in West and Eastern Africa (Droogers et al 2006). We draw upon existing experiences of payments for environmental services (Grieg-Gran et al 2006). National partners in Kenya include the Ministry of Agriculture and Ministry of Water and Irrigation, the Kenya Agricultural Research Institute Socio-economic program and Kenya Soil Survey, University of Nairobi, ETC East Africa Consultants, and local financial institutions. The international team comprises ISRIC-World Soil Information (Wageningen), Stockholm Environmental Institute, International Institute for Environment and Development (London) and the Agricultural Economics Research Institute (The Hague).

References

Falkenmark, M. and Rockström, J. (2004). *Balancing water for humans and nature*. Earthscan, London

Droogers, P. et al (2006). *Green water credits: Basin identification*. Green Water Credits Report 1, ISRIC – World Soil Information, Wageningen

Grieg-Gran, M. et al (2006). *Lessons learned from payments for environmental services*. Green Water Credits Report 2, ISRIC-World Soil Information, Wageningen

Rockström, J. et al (2005). *Sustainable pathways to attain the Millennium development goals: assessing the key role of water, energy and sanitation*. Stockholm Environmental Institute

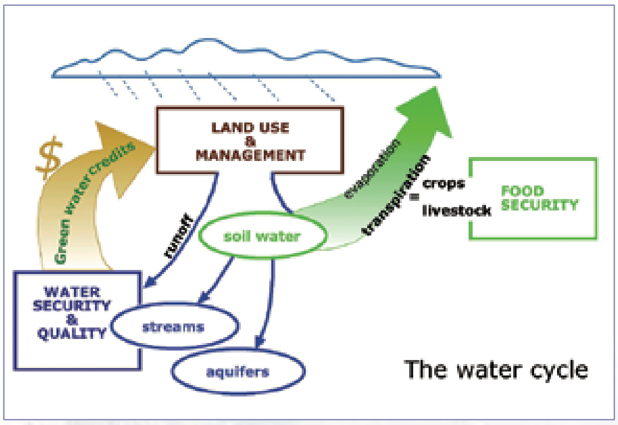
David Dent and Sjef Kauffman

Contact: david.dent@wur.nl and sjef.kauffman@wur.nl

ISRIC - World Soil Information

Figure 3: *Green water management techniques*

Figure 4: *Green Water Credits closing a virtuous cycle*



3rd GWSP SSC MEETING IN OAXACA, MEXICO

On 23-24 March 2006 the 3rd GWSP SSC meeting was held in Oaxaca, Mexico. Amongst the items discussed were the organisational project structure, the Fast-Track Activities and their transformation into longer-term project activities, and possible areas of collaboration with partner programmes.

The meeting was attended by the GWSP SSC and by representatives from the four global environmental change programmes (DIVERSITAS, IHDP, IGBP, WCRP), the Earth System Science Partnership (ESSP), the Global Energy and Water Cycle Experiment (GEWEX) and the Challenge Program on Water and Food.

Participants in the GWSP Scientific Steering Committee meeting in Oaxaca, Mexico.

GWSP DAM AND RESERVOIR DATABASE WORKSHOP

Reservoirs and other water engineering works are a central part of the modern global water system and represent a fundamental interaction between humans and a major geophysical cycle central to the functioning of the Earth system. The construction and operation of these hydraulic structures generate a wide range of impacts – both positive and purposeful as well as negative and often inadvertent. The consequences encompass elements of hydrology, constituent transport, biodiversity, ecology, fisheries management, biogeochemistry, greenhouse gas emission, social science, transboundary diplomacy, energy security, and economics. Because these interactions within engineered waters are so broad, complex and multifaceted, the issue lends itself well to interdisciplinary study, and for this reason has been one focus of the early GWSP science agenda. From an ongoing global assessment of the impacts of these facilities pursued over the last 10-15 years, there is a consensus emerging that dams and reservoirs constitute a global-scale phenomenon, but the full dimensionality of the issue has yet to be articulated.

From April 11-13, a group of 16 experts from around the world was convened in the Washington DC area for the purpose of initiating work to harmonize the growing number of geospatial data sets that depict the world's dams and reservoir systems. It was seen as fundamentally a community-based effort in order to bring unity to these data sets, to execute quality control, to identify and acquire new data holdings and to avoid duplication of effort.

The workshop participants were constituted into three Working Groups (WG). A Conceptual Model WG was convened to define the specific input data fields and potential indicators that would be derived from the integrated data base. A Technical WG identified the mechanism by which the effort could move forward using state-of-the-art information technology capabilities. New high resolution data sets and technical tools will enable integrated data bases to be developed and analyses to be performed over the fully global domain but with high geographic specificity. A set of protocols was discussed to harmonize the placement strategies of individual reservoirs, using existing computer codes (e.g. ELDRED, GHAAS/Global-RIMS) in conjunction with high resolution data sets based on Google Earth, GeoNET, and HydroSHEDS. Baseline maps would also be conjoined to the dam/reservoir data sets to document change in natural vs modified system state. These would include high resolution data sets on human population and urbanization, irrigable areas, water use, land cover, etc. An Impacts and Applications WG was also convened to formulate a strategy for addressing five major strategic issues associated with dam construction and reservoir operation and based on the unified data base. The strategic issues planned to be addressed are: (i) biodiversity impacts, (ii) discharge and runoff change, (iii) sediment balance, (iv) contributions of artificial impoundments to the global water supply, and (v) social science issues (transboundary conflict/cooperation, human health). Dam/reservoir information and supporting data bases would be customized to each application.

An Implementation Plan to schedule the effort and outline key milestones was drafted, and a Workshop Report to be cast as a GWSP Issues in Global Water System Research series was begun. A second, follow-on workshop is scheduled for the March of 2007 in Durham, New Hampshire (USA), with the goals of reviewing initial technical progress and adjusting methods as necessary, refining the mission statement of the group and enriching the initial set of perspectives by entraining additional data providers and users.

If you wish to receive more information or wish to participate in the upcoming workshop, please contact the GWSP IPO.

Charles Vörösmarty, Cathy Reidy, Carmen Revenga, Marcel Endejan
Contact: gwsp.ipo@uni-bonn.de

GWSP ASIA NETWORK WORKSHOP IN GUANGZHOU

Dr. Jianyao Chen from the Sun-Yat-sen University, in cooperation with the Chinese National Committee of GWSP (CNC), hosted the 2nd workshop of the GWSP Asia Network. About 40 participants from 12 countries participated in the meeting that took place 8-11 June 2006 in Guangzhou, China. The main purpose of the meeting was to discuss issues related to dams and megacities in the Asian region. Financial support was provided by the Asia Pacific Network (APN).

The first day of the meeting was convened jointly with the International Conference on "Hydrological Sciences for Managing Water Resources in the Asian Developing World" that was co-sponsored by the International Association of Hydrological Sciences (IAHS), the World Meteorological Organisation (WMO), the United Nations Educational, Scientific and Cultural Organisation / International Hydrological programme (UNESCO-IHP), the Chinese Ministry of Water Resources, and other international and domestic sponsors. Prof. Changming Liu (member of the GWSP Scientific Steering Committee and chairman of the CNC), Jun Xia (Executive VP of the GWSP CNC) and Charles Vörösmarty (Co-chair of the GWSP Scientific Steering Committee) delivered keynote speeches at the joint plenary conference sessions. The first workshop day concentrated on issues related to dams, irrigation and water transfer. The wide variety of topics covered included water management, water quality, sedimentation, biodiversity conservation, the impacts of dams on the hydrological cycle, on ecosystems and on land use, and the development of dam databases. It was recognised that the availability of data and information about dams in the region is inadequate – despite the large number of dams in Asia and the importance of their (positive and negative) impacts on society and environment – and that there is a need for further research, particularly on upstream/downstream relationships and vulnerability issues.

The second day of the workshop focused on megacities and covered topics such as water security in urban areas, the use of sub-marine groundwater resources for water supply, virtual water trade, and problems related to intensive groundwater extraction. Groundwater issues, including the decline of groundwater levels and groundwater pollution, were considered of the utmost importance in the region. The assurance of good (ground and surface) water quality is also a challenging issue that needs further investigation and monitoring activities. For in-depth studies a database with information about total population, population growth, source of water, quality of water, and water price for different cities or urban regions would be very helpful.

In addition to providing a communication platform for important water-related issues in Asia, the workshop was an opportunity to strengthen the ties between the GWSP and the Earth System Science Partnership (ESSP) projects MAIRS (Monsoon Asia Integrated Regional Study) and LOICZ (Land-Ocean Interaction in the Coastal Zone). In the strategic planning of the new MAIRS programme, water is one of the five key environmental issues in monsoon Asia (the others are energy, air quality, food security, and disasters), whereas the fact that many large cities are located in the coastal zone suggested the need for strong co-operation with LOICZ.

As follow-up to the workshop, members of the GWSP Asia Network will jointly approach donor agencies and work on proposals related to the important topics that have been identified. The abstracts of the presentations held at the workshop as well as the presentations are available for download at the GWSP website. To get further information about the workshop, the GWSP Asia Network or the involvement in related activities, please contact the GWSP IPO or the National Committees in China or Japan.

Marcel Endejan and Eric Craswell
Contact: gwsp.ipo@uni-bonn.de
GWSP IPO

INTERNATIONAL WORKSHOP ON GLOBAL WATER GOVERNANCE

From 20-23 June 2006 GWSP convened an international workshop in Bonn, Germany, to promote global thinking on water governance. Thirty-eight participants, from backgrounds such as political science, international relations, geography, economics, law and anthropology, came in response to an open call for papers from all parts of the world. Presentations and discussions focused on global water problems: Will the adoption of technological solutions help to ease tensions in the Middle

East with respect to water management? Will an understanding of the multiple scales of governance enhance the effectiveness of policy in the Mekong or in the Danube? Will enhanced opportunities for trade and its implications for agriculture have significant impacts on water in China? Does resource scarcity have a higher chance of leading to conflict than resource abundance? Should the large water footprint of the developed countries – resulting from importing products embodying large quantities of water – imply that Europe should import less of such products, or will this have in fact devastating effects on the economies of developing countries? How do different levels of water governance relate to each other in managing water resources? Which of the future possible scenarios of the future development of global water governance is likely to be more efficient and effective?

While the first part of the workshop concentrated on presentations of the participants' research, the second part was reserved for working group discussions. The aim of these discussions was to identify research and policy gaps in the field of global water governance. From these discussions we expect to develop a comprehensive research agenda on global water governance as a basis for future collaborative activities. One item will be a book on ideas of governance for the future. A second idea concentrates on more basic research actors, networks and paradigms of evolving global water governance. A third more applied research proposal aims at analyzing the performance and effectiveness of global mechanisms in the field of water governance. Case studies could address global water fora, international water law and conventions. Finally, the workshop organisers will work towards improving the quality of the manuscripts received so that we can finalise these for two special issues of two scientific journals. All in all, the workshop led to the establishment of a very interesting group of scholars in a number of disciplines working in the area of water governance, ideas for a comprehensive work programme, and several proposed products and products in preparation. To that extent the workshop was an extremely stimulating process which augurs well for future developments.

The workshop was initiated by the GWSP Scientific Steering Committee members Claudia Pahl-Wostl, University of Osnabrück, Germany, and Joyeeta Gupta, UNESCO-IHE, the Netherlands, in cooperation with Nils Petter Gleditsch, Peace Research Institute Oslo, Norway.

The workshop programme, abstracts and presentations are downloadable from: **http://www.gwsp.org/govworkshop_presentations.html.** Please contact Daniel Petry at the GWSP IPO (**daniel.petry@uni-bonn.de**) if you are interested in getting involved in any of the follow-up activities or wish to have more information about the GWSP's activities on water governance in general.

Working Groups discussed different aspects of global water governance during an international workshop in Bonn.

Joyeeta Gupta, Daniel Petry, Claudia Pahl-Wostl, and Nils Petter Gleditsch
Contact: Daniel.Petry@uni-bonn.de

HOW TO INCLUDE THE HUMAN DIMENSION IN WATER ASSESSMENTS?

The Global Water System Project aims at developing a sound interdisciplinary science base to better understand the global water system and inform policymakers about present and emerging challenges. How to achieve this ambitious goal? It will be important, but by far not be sufficient, to develop a new generation of global water models in which processes linked to human activities are better represented. From a scientific perspective it would not do justice to the complexity and richness of social processes to reduce them to model parameters only. From the policy perspective one can question if such models will have a real policy impact. What is needed is to embed the development of models and the integrated knowledge base directly into policy processes. This builds the necessary communication interface and space for mutual learning between science and policy, and at the same time offers the social scientist the possibility to learn more about the dynamics of policy processes, about the social construction of an issue in the policy domain, and the role of scientific information in such processes.

One can learn here from developments in the field of integrated assessment. Integrated Assessment (IA) may be defined as an interdisciplinary process to integrate the knowledge from different disciplines and different stakeholder groups to evaluate a problem situation from a synoptic und local perspective:

(i) IA should support decision processes

(ii) IA should help to identify desirable and possible options

Hence IA builds on two major methodological pillars:

- Approaches to integrate knowledge about a problem domain
- Understanding of policy and decision making processes

Whereas initial work in IA focused mainly on models as tools for integration and portrayed policy processes as optimization by an individual decision maker, the above definition reflects current advanced practices of IA. Integration comprises scientific and stakeholder knowledge, and employs a wide range of methods. Policy processes are perceived as polycentric multi-scale processes where learning and evolutionary change play a major role. Assessment is not just a passive process where information is developed for some elusive decision or policy maker. Stakeholder participation may enrich the assessment by including stakeholder perspectives, and the participatory process is already part of the policy implementation. From a social science perspective, the approach chosen can be linked to the tradition of participatory action research, where the active engagement of researchers with stakeholders is part of the research process.

In polycentric governance, stakeholders and the public are actively involved in policy development and implementation; one may talk of a co-production of knowledge, of co-decision making. To better understand such processes one needs improved concepts for participatory governance that integrate the knowledge and experience of diverse fields.

At the level of river basin management such approaches have started to find more widespread application. In many cases the lack of access to water of sufficient quantity and quality is not caused by technical or environmental factors, but by the absence of effective and fair governance regimes. The growing awareness of complexities, unexpected consequences of management strategies, and the increase in uncertainties from global change have provided arguments for a change towards more integrated, adaptive and participatory water management regimes. The EU-funded NeWater project (New Approaches to Adaptive Water Management under Uncertainty) has the ambitious goal to develop and implement innovative approaches to water management that take into account the full complexity of the systems to be managed, and where the human dimension has a central place. First results, for example, provide evidence that adaptive management in relation to climate change is limited in prevailing designs, practices and ideas surrounding river basin management. Addressing impacts of climate change may support a reframing of issues of river basin management to shifting the focus from flood management to a wider basin management view that includes storage, and buffering of flow and capacity upstream, and takes into account ecosystem services.


© C.M. Tarr

Similarly the framing of water issues at global scale may be reframed when emerging challenges derived from global water scenarios become apparent. Will such insights lead to more cooperation or even more conflicts? To be able to better understand potential developments we need to better understand the nature of global water governance (See also the article of Joyeeta Gupta et al. on the workshop on global water governance). But in particular, the exchange with policy processes should be actively sought. To promote progress in capacity building in this field, which is urgently needed, the GWSP, NeWater, and TIAS (The Integrated Assessment Society) have initiated collaboration by organizing summer schools. Furthermore they are collaborating in the organization of the upcoming International Conference on Adaptive and Integrated Water Management (CAIWA – see **www.usf.uos.de/projects/caiwa/index.htm).**

Have you become curious to learn more about adaptive water management or do you want to become a member of TIAS? The following web pages will give you access to more information: **www.tias-web.info and www.newater.info.**

Claudia Pahl-Wostl

Contact: pahl@usf.uni-osnabrueck.de

Institute for Environmental Systems Research,

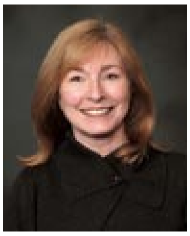
University of Osnabrück

Member of the GWSP Scientific Steering Committee

ANNOUNCEMENTS

New GWSP Executive Officer

Dr. Lydia Dümenil Gates will take up the position of the GWSP Executive Officer as of December 2006. Lydia is a recognized leader in international global change research (climate and water issues) with a global perspective on water resources. She is very familiar with the global change community, in Europe and North America, and has experience in administering global change programs of the World Climate Research Programme (CLIVAR – Climate Variability and Predictability) and the U.S. National Science Foundation. She has also been involved in GEWEX (Global Energy and Water Cycle Experiment) and other projects related to the GWSP. We believe that Lydia's strong science and management background and interdisciplinary interests will be great assets to the GWSP.



Lydia Dümenil Gates
Contact: lydia.dumenilgates@uni-bonn.de

New member of the GWSP Scientific Steering Committee

Dr. Hong Yang has been appointed as a new member to the GWSP Scientific Steering Committee. She is a Senior Research Scientist at EAWAG (Swiss Federal Institute for Environmental Science and Technology) and leads the group for global water, food and environmental studies. Her main research topics are agricultural productivity changes and marketing reform in China, land use changes and environmental impacts, resource and environment management, regional development, global water scarcity and food security, and implications for international trade. Her expertise will be of high value to the GWSP Scientific Steering Committee and we cordially welcome her!

Hong Yang
Contact: hong.yang@eawag.ch

Other news from the GWSP Scientific Steering Committee

Stuart Bunn, member of the GWSP Scientific Steering Committee and Director of the Centre for Riverine Landscapes at Griffith University, was nominated to join the Task Force on Education and Capacity building for the Ecohydrology Programme of the UNESCO-International Hydrological Programme. He was also nominated the "Water Champion" for the Earth Dialogues meeting in Brisbane (21-24 July 2006) chaired by Mikhail Gorbachev **http://www.brisbane-festival.com.au/p_earthdialogues.htm.** (see websiteadresse for further information)

Robert J. Naiman, member of the Executive of the GWSP Scientific Steering Committee and Professor in the College of Ocean and Fishery Sciences and College of Forest Resources, University of Washington, has accepted the position as Chair of the Scientific Advisory Committee of the Ecohydrology Programme, of the UNESCO International Hydrological Programme. Bob is also Chair of the DIVERSITAS Freshwater Biodiversity Task Force, and will be able to play a key role in forging cooperation between the international programmes in this important field.

Charles Vörösmarty, Co-Chair of the GWSP Scientific Steering Committee and Director of the Water Systems Analysis Group at the Institute for the Study of Earth, Oceans and Space (EOS) at the University of New Hampshire, has been appointed to the United States Arctic Research Commission by President George W. Bush. The Commission, which is composed of seven presidential appointees, is charged with establishing the national policy, priorities, and goals necessary for federal programs in basic and applied scientific research concerning the Arctic.

Project Endorsement

The following two projects have been recently endorsed by the GWSP:

1. Using Regional Climate Change Scenarios for Studies on Vulnerability and Adaptation in Brazil and South America
   The main goal of this project is to provide high resolution climate change scenarios in the three most populated basins in South America for raising awareness among government and policy makers in assessing climate change impact, vulnerability and in designing adaptation measures. Principal Investigator: Dr. José A. Marengo, CPTEC/INPE-Center for Weather Forecasts and Climate Studies, National Institute for Space Research, Brazil.
   Contact: marengo@cptec.inpe.br

II. Consistent assessment of global green, blue and virtual water flows in food production

The project will derive for the first time a model-based, global yet geographically explicit quantification of green, blue and virtual water flows for the present and for scenarios of climate change and atmospheric CO_2 enrichment. Thus it will contribute to the GWSP science framework in terms of a thorough quantification of interactions between physical and biological/biogeochemical components of the global water system, and the role of humans within this. Principal Investigator: Dr. Dieter Gerten, Potsdam-Institute for Climate Impact Research (PIK), Germany.

Contact: gerten@pik-potsdam.de

Further information on the endorsed projects and on the GWSP endorsement procedure is available at:
http://www.gwsp.org/endorsed_prj.html
http://www.gwsp.org/get_involved.html

Other IPO news

Lara Wever, foundation Finance and Administration Officer in the GWSP International Project Office, plans to further her studies and will leave her position at the end of 2006, after three years. Lara made a significant contribution to the initiation of the office procedures and the smooth functioning of the International Conference held last year in Bonn, and of the many other meetings and workshops that she helped organise. Her efficient ways and sunny disposition will be missed by the SSC, other IPO staff and colleagues.

Ruyan Joanne Siew recently left the IPO after a three-month stint as summer intern. Joanne was visiting from the Bren School of Environmental Science and Management at the University of California at Santa Barbara, and made a valuable contribution to the organization of the Governance Workshop, and follow-up database development activities.

Launch of new GWSP report series

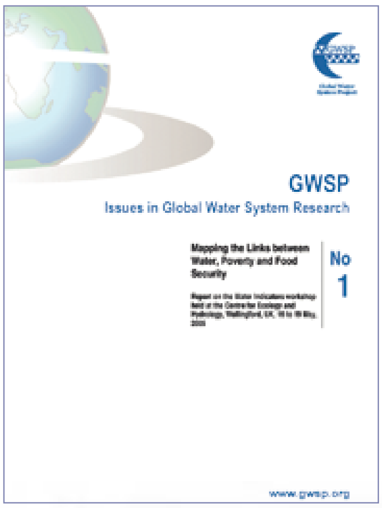
The GWSP has launched its first edition of the report series 'Issues in Global Water System Research'. The first issue on 'Mapping the Links between Water, Poverty and Food Security' reports on the results of a workshop held at the Center for Ecology and Hydrology in Wallingford, UK, 16-19 May 2005. The report is available online on the GWSP website. Hard copies can be ordered via email at *gwsp.ipo@uni-bonn.de.*

New Online Teaching Curriculum: Adaptive River Basin Management

The NeWater Project (New Approaches to Adaptive River Basin Management under Uncertainty) together with the GWSP, will launch a new teaching curriculum on adaptive river basin management. The curriculum, which will be made available as downloadable modules on the internet, is aimed at Masters level students but may also be suitable for teaching at the PhD level. The NeWater project has an explicit aim to provide an effective outreach mechanism for scientific results, methodologies and tools to various levels of stakeholders in the water sector, including education at the university level, policy, and water management practitioners.

The first set of downloadable modules will introduce concepts and methods of adaptive management and integrated water resources management, and will be launched by the University of Osnabrück and Wageningen University in September 2007. A specific number of ECTS (European Credit Transfer System) credits will be recommended for each module. Interested educators may download and adapt modules as needed. Modules will include presentations with scripts, exercises and projects, and discussion questions. A complementary training course on teaching adaptive water and resources management will also be provided in April 2007 in order to prepare interested instructors in the teaching of adaptive water management.

More information is available from
Daniel Petry (*daniel.petry@uni-bonn.de*) or
Caroline van Bers (*cvbers@usf.uos.de*)



IMPRINT

Publisher:
The Global Water System Project
International Project Office

The Global Water System Project (GWSP) is a joint project of the Earth System Science Partnership (ESSP) consisting of four Global Environmental Change Programmes: the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP) and DIVERSITAS, an international programme of biodiversity science. The *overarching question* of the GWSP is how human actions are changing the global water system and what are the environmental and socio-economic feedbacks arising from the anthropogenic changes in the global water system.

Contact:
GWSP International Project Office (IPO)
Walter-Flex-Str. 3
53113 Bonn
Germany
Phone: + 49 - 228 - 73 61 88
Fax: + 49 - 228 - 736 08 34
Email: gwsp.ipo@uni-bonn.de
www.gwsp.org

Editors:
Lara Wever, Eric Craswell

Publishing Management:
Lara Wever

Layout:
Karina Waedt, DTP-Produktion, Bonn, Germany

Printers:
Rautenberg Media & Print Verlag KG, 53840 Troisdorf, Germany

CONTENTS

Editorial
by Eric Craswell 1

Lead Article
A world dominated by fragmented rivers
by Christer Nilsson 1

Green Water Credits for rainwater management by farmers
by David Dent and Sjef Kauffman 4

3rd GWSP SSC meeting in Oaxaca, Mexico 6

GWSP dam and reservoir database workshop
by Charles Vörösmarty, Cathy Reidy, Carmen Revenga, Marcel Endejan 6

GWSP Asia Network Workshop in Guangzhou
by Marcel Endejan and Eric Craswell 7

International Workshop on Global Water Governance
by Joyeeta Gupta, Daniel Petry, Claudia Pahl-Wostl, and Nils Petter Gleditsch 7

How to include the human dimension in water assessments?
by Claudia Pahl-Wostl 8

Announcements 10

Imprint, Contents 12