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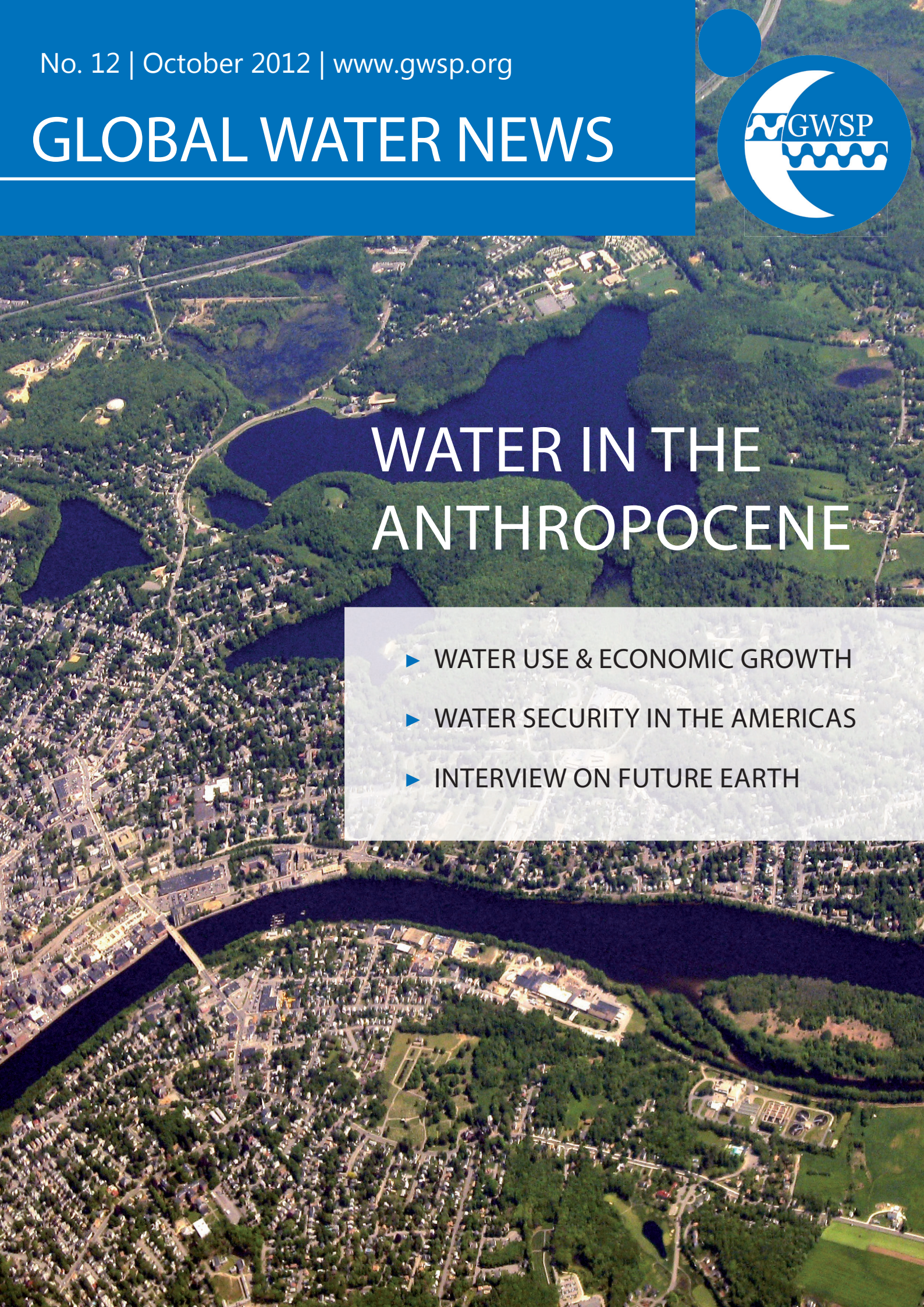
GLOBAL WATER NEWS



WATER IN THE ANTHROPOCENE

- WATER USE & ECONOMIC GROWTH
- WATER SECURITY IN THE AMERICAS
- INTERVIEW ON FUTURE EARTH

Imprint

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Editorial

by Claudia Pahl-Wostl

Each era in the Earth's history is unique. But the current epoch of what many call now the Anthropocene has an outstanding meaning for humanity. Human activities have started to become a major shaping force even of processes in the environment at global dimensions. Unfortunately this does not imply that humanity is governing our Earth wisely. To the contrary, challenges and problems accumulate and prospects are not too promising. The global change programmes respond to these challenges by launching a new programme – Future Earth. We are pleased that Jacob Rhyner, Vice-Rector in Europe of the United Nations University (UNU) has accepted our invitation for an interview on Future Earth.

The challenges ahead apply in particular to water, one of or even the most critical resource of the 21st century. That is why the upcoming GWSP conference has been put under the overall theme "Water in the Anthropocene" which is also the topic of this newsletter. The GWSP conference will take stock of achievements but will look as well ahead to identify priorities for global water research under a Future Earth Programme.

That water has become an issue of global concern is hardly contested any longer. About 10 years ago this was not the case. This issue was for example hotly debated during the first session on the global dimensions of the water problem in 2001 that we organized at the 1st joint conference of the global change programmes in Amsterdam, the Netherlands. The work of GWSP over the past decade has been instrumental to raise awareness in science and policy for the global dimensions of water problems. The joint projects of the Earth System Science Partnership (ESSP) on water, food and carbon have also been platforms for strengthening the collaboration between natural and social sciences what is supposed to become now the mainstream in a Future Earth Programme. The joint projects have a lot of experience to contribute in this respect.

The Global Water News welcomes Claudia Ringler and Francisco Meza as new members of the Scientific Steering Committee of the Global Water System Project, both well-known for their interdisciplinary work. In this Newsletter they present their views on important topics that need to be addressed under the overall theme "Water in the Anthropocene". Claudia Ringler wrote an article on water use and economic growth whereas Francisco Meza focused on water security in the Arid Americas. Another important topic – scarcity and virtual water flows - is addressed by Anik Bhaduri who has taken over the role of Janos Bogardi in the GWSP IPO. After having made invaluable contributions to GWSP as executive officer over the past years, Janos Bogardi has now made the transition to his well-deserved retirement stage – at least to some extent. We are fortunate that he will remain connected to GWSP as senior advisor and coordinator of a project commissioned by UNEP on International Water Quality Guidelines for Aquatic Ecosystems.

The transition in the research communities is also reflected in the events where GWSP had a major presence this year. GWSP organized a session at the World Water Forum in Marseille, France and at the Planet under Pressure Conference in London, UK, in March. A highlight was a session on Water Security organized by GWSP and UNESCO at the Forum on Science, Technology and Innovation for Sustainable Development prior the Rio+20 conference in Rio de Janeiro, Brasil. Richard Lawford, member of the Executive Scientific Steering Committee of GWSP, reported on the outcomes of a conference on the Water, Food, Energy Nexus and its implications for water governance and management in large river basins worldwide. This well-attended conference was organized in May by the Global Catchment Initiative of GWSP in collaboration with the International Institute for Sustainable Development in Winnipeg, Canada.

A remarkable dynamics can be noted in the German Water Community where a network called "Water Science Alliance" has started to establish itself over the past few years uniting research across disciplines and building bridges to policy and implementation. The 3rd International Water Research Horizon Conference organized by the Water Science Alliance in July this year served again as a networking event fostering new partnerships. The Global Water Needs Initiative of GWSP organized a Workshop on Enhancing water security for the benefit of humans and nature which identified several areas for future collaboration as highlighted in the summary in this issue of the Global Water News. This year´s World Water Week in Stockholm provided insights into the challenges of water and food security. With a session on the Water – Energy – Food Security Nexus GWSP and partners focused on multiple spatial and sectorial connections between water resources, food and energy production in large river basins.

The months to come will be important to set course in the global change programmes in general and in global water research in particular. GWSP has a lot to contribute and I am looking forward to this exciting times. I invite you to actively participate in the GWSP conference 2013 on "Water in the Anthropocene", an important event on our way towards a sustainable management of the world's water resources.

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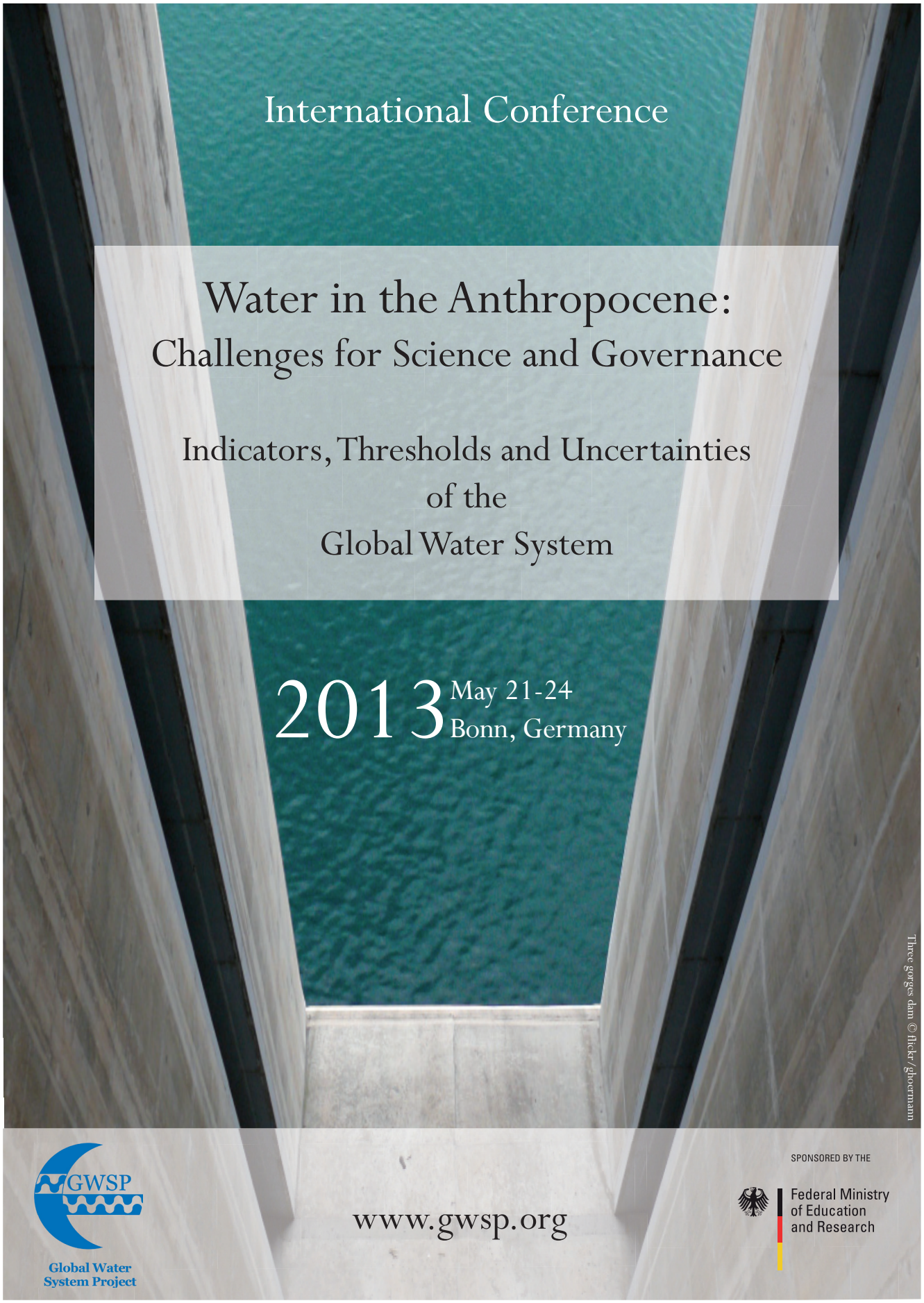
International Conference
Water in the Anthropocene:
Challenges for Science and Governance
Indicators, Thresholds and Uncertainties
of the
Global Water System
2013
May 21-24
Bonn, Germany
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Water in the Anthropocene: Challenges for Science and Governance. Indicators, Thresholds and Uncertainties of the Global Water System, 21-24 May 2013, Bonn, Germany

The Global Water System Project (GWSP) and its International Project Office are organizing an international conference on 'Water in the Anthropocene: Challenges for Science and Governance. Indicators, Thresholds and Uncertainties of the Global Water System' to be held at MARITIM Hotel, Bonn, Germany on 21- 24 May 2013. The conference is organized with the support of the German Federal Ministry of Education and Research (BMBF).

The focus of the conference is to address the global dimensions of water system changes due to anthropogenic as well as natural influences. The conference will provide the platform to present global and regional perspectives of world wide experiences on the responses of water management to global change in order to address issues such as variability in supply, increasing demands for water, environmental flows, and land use change. It will help to build links between science and policy and practice in the area of water resources management and governance, related institutional and technological innovations and identify in which ways research can assist policy and practice in the field of sustainable freshwater management. Participants from all continents and dealing with various water-related problems are expected to attend this conference.

Human activities impact the global water system and change the way water moves around the globe like never before. Thus, managing freshwater use wisely in the planetary water cycle has become a key challenge to reach global environmental sustainability. The focus of the conference is to address the global dimensions of water system changes due to anthropogenic as well as natural influences. Participants from all continents dealing with various water-related problems are invited to attend this conference.

Three conference themes are focused:

- Theme 1: Global Water System - Current State and Future Challenges
- Theme 2: Global Dimensions of Change in River Basins
- Theme 3: Balancing Water Needs for Humans and Nature

The conference will synthesize the major achievements in global water research within the last decade and mobilize the water community to collaborate on a joint vision of the future water world. In this regard, GWSP does explicitly take into account the structural changes within the GEC research landscape, especially Future Earth, the new global research partnership for global sustainability sponsored by the International Council for Science (ICSU), and actively embraces the challenges arising from these:

- bring together the practitioners, funders and users of research
- integrate disciplines and sectors for joint action towards sustainability
- innovate both scientific methods and the way of communicating the results

The final day of the conference with its Synthesising and Future Plenary will be entirely dedicated to this end. Join us and take part in developing the research agenda of tomorrow for global water sustainability!

The most valuable contributions to the conference will be featured in a special issue on Water in the Anthropocene within the Elsevier journal Current Opinion in Environmental Sustainability (COSUST) by the end of 2013.

Call for Abstracts

Abstract Submission will be open until November 15, 2012.

To submit an abstract and for further information, please visit our website:

http://www.gwsp.org/conference2013.html

Changing the History of the Earth: The Role of Water in the Anthropocene

by James Syvitski, Charles Vörösmarty, Sina Marx and Anik Bhaduri

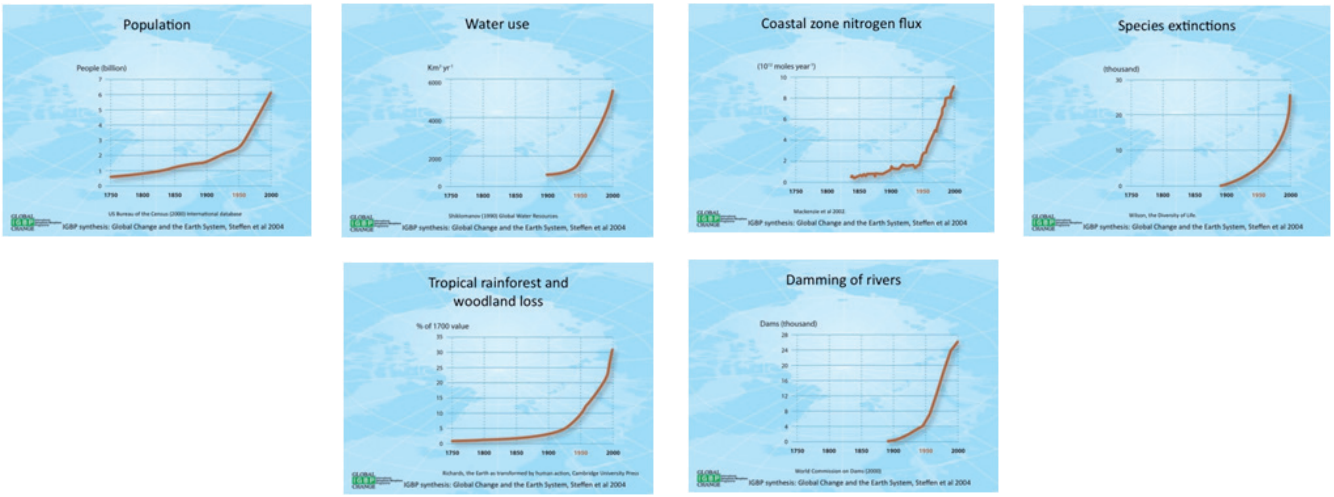
Humans as a global force

The history of our constantly evolving planet, which formed around 4.5 billion years ago, has seen many great biological and geological events. "Epochs" reflect noteworthy episodes along the Earth`s geological time scale with the shift from one to another epoch being marked by global events that change the history of the earth in fundamental ways, like a major change in climate regime, tectonics and volcanism or by the mass extinction of species.One recent and noteworthy event dates back only about 11,500 years when the retreat of the glaciers made way for the present interglacial period called the Holocene, creating much of the surficial geology which humankind lives and relies upon - like soils in the crop growing regions of the Earth, deltas and river deposits. While humans and their ancestors have influenced the environment in many ways for some million years, their impact becomes much more extensive during the most recent part of the Holocene. In this regard, the second half of the 20th Century is still more exceptional in our human history, with a shift from rural to a highly urban population, fueled during the "green revolution" by industrial agriculture - using fertilizers, pumped water, pesticides, mechanization, and particularly the use of fossil fuels. A great number of human activities have seen their kickoff points within this time and reached an arguably extreme acceleration at the beginning of the 21st Century (see Figure 1). The list of human activities and their impact on the water systems of the planet are long and important. We have accelerated major processes (e.g., erosion, nitrogen applied to the landmass) while decelerating others (e.g., loss delivery of river water and sediments to the world's ocean). In our quest for human security we have harnessed enormous amounts of fossil energy, dammed major riverways, destroyed aquatic ecosystems and their resident biota, and altered the Earth's climatology, chemistry, snow cover, permafrost, sea ice extent, glacial ice extent, ocean volume—all elements of the hydrological cycle. This very short time period may represent the beginning of a new geological epoch, the Anthropocene, representing the rapid alteration of the human relationship with the natural world in the history of our species, so that today we can call humankind a global force in its own right. The term Anthropocene reflects the increasing predominance of humankind in bringing about global environmental change. It suggests that the impacts of human activities must now be considered of global significance for future evolution of all living species - including ourselves. From a research position, it means that the human-water interactions must be viewed as a continuum and coupled system, requiring interdisciplinary inquiry like that which has characterized the GWSP since its inception.

Water as a global agent

Water plays a central role in all processes and activities supporting both humans and ecosystems. The existence and development of human beings in the Earth system depends on the storage and circulation of water - as liquid, vapor or ice - through biochemical cycles and a hydrological cycle fueled by the sun. Food, energy and other ecosystem services for humans and nature are all connected through multiple interactions and feedbacks within what is increasingly recognized as a global water system. A central tenet of the GWSP has been that humans are changing the character of this water system in globally significant ways without adequate knowledge about the system or its change. By diverting freshwater for agricultural, industrial and municipal use, our coastal wetlands are receiving less and less, and often polluted, freshwater. As a result we have decreased inland and coastal biodiversity, increased coastal salinity and temperature as well as contaminated agricultural soils and agricultural runoff. Many of the world's densely populated and heavily farmed deltas are becoming increasingly vulnerable to floods as a result of accelerated relative sea level rise caused by the disruption of sediment balance in deltas—this in turn arising from the diversion of

Figure 1: The Great Acceleration: Human activities and planetary response



river water and trapping of sediments in rivers upstream, extraction of oil, gas and water from the ground. Floodplain engineering in combination with rising global sea level, the trapping of sediment in reservoirs upstream as well as the destruction of mangroves are further aggravating the situation. The latter reflects the tradeoffs between food supply, the environment and water security as extensive shrimp farming, critical to local economies, is one of the main factors contributing to the reduction of mangrove cover. Action regarding the numerous tradeoffs between human and ecosystem water needs is often taken without the necessary information base that would be needed to evaluate the most essential water requirements and to prioritize water allocations wisely. Water security, both quantitative and qualitative, is therefore essential to all social and economic sectors by providing the single most essential - and non-substitutable - natural resource upon which we depend. While it is easy to say that w ter must thus be given high prominence on the global agenda, we find that there is no easy panacea that can be expected to bring about sustainability and to secure access to all of the water needed by all legitimate stakeholders, including the legitimate needs of nature.

Knowledge for action

The water sciences community has been making important strides toward understanding the complexities within the global water system and its dependencies with other systems. Major steps forward include the improvement in the resolutions and fidelity of atmospheric models in producing ever-reliable global-scale data sets, e.g.: high-resolution HydroSheds stream network system, the GWSP-supported GRAND reservoir database, the virtual water-trade concept, satellite systems to monitor the depletion of groundwater, and global-scale geospatial assessments of the threat to the world's river systems from human and biodiversity perspectives.

The history of our planet's water systems is certainly an ongoing story of transformation and an inadvertent macro-scale experiment performed by humanity. Scientific knowledge of the impact of these changes within the Earth System is urgently needed to avoid irreversible damage or setup for potential catastrophic consequences. Only a well-developed knowledge base will enable us to understand the role of Water in the Anthropocene better, and enable scientists to inform policy makers and the broader public appropriately to work towards a sustainable future. The current water crises across the world are essentially governance crises extending from the local up to the global. Infrastructure decisions today will take on greater importance tomorrow as dams age and fill up with sediment, levees age and begin to fail, and diversion systems collapse and lead to agricultural hotspots. Inclusive development is needed to guarantee an adequate and equitable livelihood for those living in poverty. Given the crucial role of water in human development, enhanced knowledge of the global water system is an essential step towards this end. Only collective action from science, policy and practice will enable us to change the history of the earth towards a sustainable future.

These and many other strategic water issues will be the subject of the GWSP Science Conference in Bonn, Germany (May 2013) entitled "Water in the Anthropocene: Challenges for Science and Governance. Indicators, Thresholds and Uncertainties of the Global Water System". The conference will be an important event in the evolution of the science of studying the global water system, aimed first at synthesizing a decade of development in the GWSP and affiliated partner organizations both within and outside the ESSP and then formulating a blueprint for the global water studies in the era of Future Earth. We welcome all water scientists, engineers, and decision makers to join together for this transformation into the next phase of the GWSP research agenda.

Anthropocene Facts

- We are adding a million-person city every 10 days for the next 87 years
- We move more rock and sediment then the forces of ice, wind and water. For instance we mine 8 to 9 Gt/y of coal and by 2030 this is expected to reach 13 Gt/y equal to what all world rivers combined deliver to our global coastlines. 1 GT is more than two Great Walls of China which is 6250 km long
- We mobilize Gt of sediment every year for our convenience (e.g. the Hong Kong airport) and pleasure (e.g. the Palm Islands of Dubai).
- 5 Asian Rivers have delivered an extra 2000 GT of sediment to the coastal ocean due to human activities such as deforestation over the last 1000 years
- On average we have built one large dam every day for the last 130 years. These dams and their reservoirs trap many Gt/y of sediment
- By pumping groundwater and hydro-carbons from low lying coastal areas we are sinking deltas 4 times faster on average than global sea level is rising
- Many of today's river floods have a human origin, e.g. Indus flood of 2010, Bangkok flood of 2011

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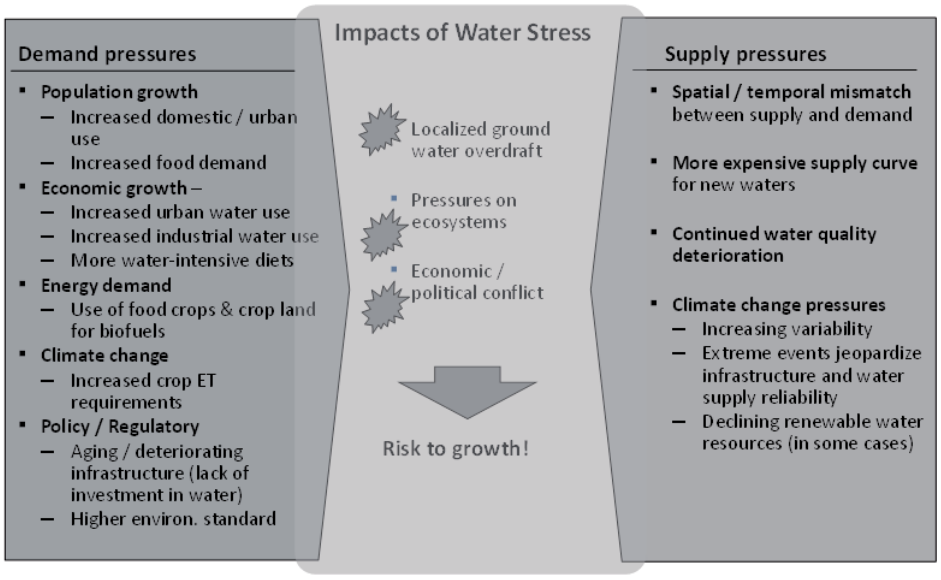
Water Use and Economic Growth in the Anthropocene

by Claudia Ringler

The Anthropocene is characterized by growing water demands and declining supplies. Water use has increased significantly since the Industrial Revolution, and most rapidly over the last four decades. And demand is expected to continue to grow rapidly, in part as a result of continued population growth, and as such is concentrated in Africa. The medium variant of the United Nations' population projections indicates that Africa will account for nearly half of global population growth between 2010 and 2050 more than doubling the total population on the continent. However, other regions and other stresses on both the supply and demand side of water also contribute to growing scarcity (Figure 1). Other key factors include economic growth, which drives increases in water demand for household, industrial, and agricultural uses as well as urbanization, which, in turn, contributes to dietary changes, with a general trend toward more water-intensive diets. Over the last decade, water has also been increasingly used for the production of first-generation biofuels. The production of biofuels affects water resources in two ways: directly through water withdrawals for irrigation and the industrial processes of feedstock conversion; and indirectly by increasing water loss through evapotranspiration that would otherwise be available as runoff and groundwater recharge. Climate change is increasingly impacting water availability and use through increasing temperatures and changes in the timing and distribution of rainfall as well as more frequent and severe flooding and droughts in many regions. Finally water quality, hitherto the key water-related challenge in the industrialized world, is becoming a or the constraint in emerging Asian economies.

Figure 1: Supply and Demand Pressures on Water Availability and Use

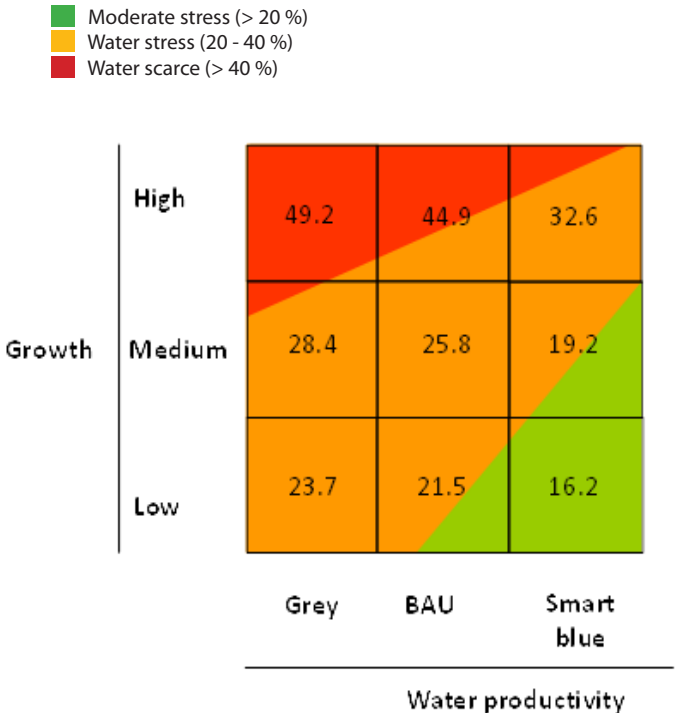


Are we limiting options for growth through poor water management and investment? While linkages between growing water scarcity and environment outcomes are somewhat established, links between water scarcity and economic growth are less clear. Thus, as we are surpassing thresholds of water stress through aggressively exploiting water resources, we might well compromise our future ability to continue to grow and improve human well-being outcomes. Past analyses linking water and economic growth have focused on the impact of economic growth on water use, generally trying to assess the existence or not of an Environmental Kuznets Curve, assuming an inverted U-shape relationship between per capita income and the use of natural resources. Results of these studies have been mixed inconclusive and that is, depending on the variable, data and method used, water use increases, decreases or shows little change with increasing national incomes. However, water use and availability also directly affect economic growth, with growing water scarcity limiting desirability or potential for investments. To assess this latter linkage—will growing water scarcity affect a country's economic growth, and if yes, how far can water productivity improvements reduce water-overutilization and thus sustain economic growth—alternative development pathways can be developed and assessed at various levels of economic growth. The well-known criticality ratio or water stress index, the ratio of water withdrawal to internal renewable water resources can then be used to identify development outcomes that put both populations and economic development at risk from water stress, with high criticality ratios (values above 40 percent) signifying severe water stress.

Three key alternative development pathways assessed include business-as-usual (BAU), postulating currently projected improvements in water productivity, which is used as a reference scenario. Under BAU, the domestic sector shows moderate improvements in water productivity (and energy efficiency) gains across domestic, industrial and irrigation uses. The "Grey" scenario focuses on production increases at all costs, without investments in efficiency improvements. Under this scenario, no water productivity improvements are achieved and energy efficiency gains are minor. Finally, the "smart blue" scenario focuses on high water use efficiency gains (and corresponding energy efficiency gains) across all water-using sectors. Under the smart blue scenario, the domestic

sector shows high improvements in leakage reduction and water efficiency gains, with the majority of total water productivity potential achieved in the industrial sector. These three development pathways were simulated at three different economic growth assumptions using IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT). Changes in the criticality ratio for the various economic growth and development scenarios are shown in Figure 2 for one example, Brahmani river basin in India.

Figure 2: Water stress in the Brahmani river basin, India, under alternative development and economic growth pathways of development



The "grey" water productivity scenario at medium economic growth, focusing on growth "at all costs" without accompanying investments in water use efficiency, results in a significant increase in water stress compared to business-as-usual with an additional 450 million people and 5.6 trillion GDP (at 2000 prices) being at risk by 2050. In a "blue" water productivity scenario, on the other hand, where countries invest in additional water productivity enhancements, economic growth is much more sustainable with ~1 billion people and ~US$17 trillion GDP less at risk due to high water stress as compared to business-as-usual by 2050. The "blue" productivity scenario helps both developing and developed economies reduce risk by moving towards sustainable water stress levels. For other growth regions like India, "blue" productivity is important, but not sufficient to mitigate unsustainable water uses – These countries will face difficult choices on priorities for water allocation. A smart blue world will also be key to enable the high growth needed to reduce today's malnutrition levels; and a medium growth blue world offers the best balance for sustainability.

How can we get there? Irrigation is, and will remain, the largest single user of water, but its share of world water consumption is projected to decline. As such, large gains can be made from saving water in irrigated agriculture. However, productivity improvement in domestic and industrial sectors can also make significant contributions in reducing the share of population and GDP at risk of water scarcity and should continue to be pursued. Particularly the industrial sector has been able to reduce water depletion levels considerably over the last years in the group of industrialized countries. These developments have shown that, while costly, large water savings in industry (and the domestic sector) can be achieved if the right incentives and regulations are put in place. Achieving water savings in irrigated agriculture, on the other hand, is more difficult, but there many options have yet to be explored in most developing country settings. Key among these are economic incentives, such as paying farmers for using water more efficiently, enhanced management of irrigation systems, removal of distortionary agricultural input and output price subsidies, judicious investments in new storage, and continued agricultural research toward increased crop per drop, including biotechnology research. A smart blue or high water productivity scenario not only de-risks economic growth, but also contributes to the Millennium Development Goals and Green Growth: Water savings across sectors and increased availability and use in water-scarce countries will increase food production and thus increase food affordability for the poor, directly contributing to reduced hunger. On the other hand, a grey development pathway would increase the economies and people at risk of water stress significantly, reducing water availability for food and the environment. Going "blue" should thus be part of the global and local development agendas to help ensure that all people on our planet have a chance at leading productive and healthy lives.

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Achieving Water Security in the Arid Americas: Emerging challenges at the beginning of the Anthropocene

by Francisco J. Meza

Contemplating the Earth from space gives us the impression that this blue planet would never suffer from water availability problems. However, as in any downscaling exercise, it is only when we perform a detailed examination we begin to realize that in many places of the world water abundance is rather a privilege than a normal operating condition.

Water is at the very basis of biophysical and socioeconomically processes, so that whenever we trespass thresholds of water availability, their functioning is seriously affected. That is why the availability of sufficient quantities and adequate quality of water to meet societal needs and build resilient ecosystems, a concept known as water security, represents a fundamental precondition to achieve sustainability. This integration of societal and ecological needs broadly represents an aggregated demand that must be seen as dynamic in nature, since societal requirements are often reexamined and adjusted to respond to population growth, technological changes and the accommodation of multiple and more sophisticated aspects of water demand such as recreational and spiritual needs. Freshwater supply is also subject of considerable modes of variability (from seasonal to interannual) so the difference between this supply and demand at a given time is a preliminary indicator of the level of water security. Dynamic global processes, such as climate change, land-use change, urbanization, population growth, and economic development (characteristic symptoms of the arriving era) produce evident biophysical effects that can seriously threaten water security. The latter two, if not accompanied by increasing efficiency, can produce unidirectional changes in water demand, increasing pressure over existing freshwater resources. Climate change and land use change, on the other hand, can have effects on both total demand and on the magnitude (and seasonality) of freshwater supply. The result is however not easy to anticipate. In some scenarios such as the ones obtained from precipitation reductions along with increased deforestation in mountain areas, significant changes in land cover can overcome climate change impacts, resulting into an increase in surface water availability, usually at the expense of water quality due to erosion.

Water (in)security is not only the result of supply and demand interactions driven by global change. Societal conditions such as institutional rigidity and regulatory aspects can aggravate this problem as they affect stakeholder's capacity to adopt long term horizons in their planning process and/or impede the incorporation of adaptive water management strategies. There is growing recognition of the importance of institutions and adequate legal frameworks to ensure water security. In this sense, researchers and policymakers are expected to establish interdisciplinary science-policy dialogues to distill basic scientific knowledge and transform it into actionable information for policy making.

Western North America, central Andes, and northeast Brazil are three regions that collectively represent the Arid Americas and share common features in terms of water security. Here severe water scarcity shapes landscape and constraints socioeconomic development. Global economic integration has accelerated growth and urbanization in the region, increasing water use, and changing consumption patterns. The region also exhibits a significant El Niño Southern Oscillation (ENSO) footprint in its climatic regime, showing significant correlation between the occurrence of droughts and floods and the magnitude of the anomalies of the ENSO index. In addition, the Intergovernmental Panel on Climate Change (IPCC) projects increasing temperatures and drier conditions in sixty percent of the Latin American region. As a consequence it is expected that the number of people living in water-stressed conditions would increase by 2100. From the ecosystem point of view, projected changes in precipitation, increases in evapotranspiration result in diminished groundwater recharge. As a consequence, riparian areas are modified, affecting ecosystem services that determine water quality and wildlife habitat. Numerous approaches have been applied to address problems of water insecurity in this region. Some of them focus on the supply side, favoring the investment in infrastructure to better regulate seasonal streamflows and make water available when it is needed. Others like cloud seeding, artificial infiltration of aquifers, and water reuse enrich the portfolio of alternatives. From the demand side, most of the approaches emphasize strategies that increase efficiency (either sectorial or at a basin level). Systems to allocate water, assign rights, establish priority uses, and balance human and ecosystem needs are also explored to complement the above mentioned policies, but they depend strongly on historical, political, and institutional context.

In view of the critical challenges faced by the Arid Americas to achieve water security, a network of researchers funded by the Inter-American Institute for Global Change Research (IAI), has launched AQUASEC, the IAI Center of Excellence for Water Security (http://aquasec.org). In 2012 IAI provided some initial support to encourage networking among AQUASEC partners across the American continent. AQUASEC's objectives are to promote water security through adoption and innovation with adaptive governance and management approaches

that are innovative and adaptive. Integrated research and strong science-policy dialogues are two of the most important and distinctive elements of this initiative since they are regarded as necessary conditions to strength water security. Taking a comprehensive approach we aim to study and represent the full range of uncertainties (social, ecosystem, and hydroclimatic), as well as to explore effective adaptation alternatives, facilitating decision making at all scales. We have identified several case examples using comparative, cross-basin and multi-country approach to extract most salient lessons and have engaged relevant decision makers and stakeholders in a collaborative and integrated modeling framework.

Water security is a cornerstone for sustainable development. As we enter the Anthropocene, it becomes more critical to view water management through the lens of flexible strategies and to gain insights by working within practitioners, with scientists and stakeholders.

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Interview with Jakob Rhyner on Future Earth

by Eva Flinkerbusch

Future Earth is being developed on behalf of a new Science and Technology Alliance for Global Sustainability. The Alliance, which co-sponsors Future Earth, brings together the International Council for Science (ICSU), the International Social Science Council (ISSC), the Belmont Forum of international environmental research funders, the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the United Nations University (UNU) and the World Meteorological Organisation (WMO) as an observer. Future Earth will deliver solution-orientated research for sustainability, emphasising the importance of interdisciplinary collaboration, co-designing research with its beneficiaries, improving the science-policy interface, building capacity in developing countries and engaging a new generation of scientists in global change research. It will build on the success of the international global environmental change (GEC) programmes (Diversitas, International Geosphere-Biosphere Programme, International Human Dimensions Programme, World Climate Research Programme, and their Earth System Science Partnership), in time, engaging all the existing projects of these programmes, whilst supporting an extended international research community to co-design and develop new, transdisciplinary research. Future Earth is being designed by an international team of scientific experts from across the natural and social science disciplines, sponsors and executives. The work of this 'Transition Team' is focussed on delivering a research framework, institutional design and stakeholder engagement strategy. A Transition Management Project, reporting to the Alliance, is being established

to manage this transition process and ensure a fully operational Future Earth initiative in 2014. This management project will be overseen by a Project Board, co-chaired by Steven Wilson (Executive Director of ICSU) and Jakob Rhyner (Vice-Rector, UN University) and will cover work streams such as funding, communications and outreach, governance arrangements, etc.

Jakob Rhyner joined the United Nations University in 2010. He is Director of the Institute for Environment and Human Security (UNU-EHS) as well as Vice Rector in Europe of the United Nations University (UNU).

He holds a PhD and diploma in theoretical physics from ETH Zurich. He has been active in numerous professional organizations and boards, such as the Fachleute Naturgefahren Schweiz (Experts Natural Hazards Switzerland), the Group of European Avalanche Warning Services, and research project evaluation boards of the European Commission. He has various international experiences, including as a guest scientist at L.D. Landau Institute of Theoretical Physics in Moscow, Former Soviet Union (1986), and Massachusetts Institute of Technology (1990-91). From 1988 until 2001, he was active in industrial research (energy technology).

Mr. Rhyner, being Co-Chair of the Future Earth Project Board, what is the uniqueness of the Future Earth initiative compared to other initiatives and projects on global change and sustainability?

The uniqueness consists in the inclusive approach. Future Earth is lead by the so-called Alliance, including ICSU, ISCC, the Belmont Forum, UNEP, UNESCO and UNU. This coordinated effort by science, funding and development organizations, has a real potential to reach a new level in defining and executing the agenda of environmental research.

Why is there a change in paradigms? What induced this change?

While environmental and social sciences are presently delivering high quality scientific results on a broad range, there is an increasing sense in the user community that these results are often not really fitting the needs of practice, which is facing growing challenges, but also chances induced by the global environmental change. This is what Future Earth aims to change.

Is the fact that we are now living in the Anthropocene linked with the emergence of Future Earth?

Yes. The term Anthropocene characterizes a phase of unprecedented rate of change of the environment, leading particularly high demands to those who try to understand the mechanisms and those who have to come up with sustainable solutions.

What are the major challenges to be solved or to be addressed on a global dimension pursuant to Future Earth?

One of the most important things is to recognize that the challenges may be very different depending on where on Earth you live. While parents in many parts of the northern hemisphere worry about guaranteeing their children a similar quality of life, parents in many other countries struggle for the bare survival of their children. Talking about global sustainability, Future Earth will have to deal with the fact that sustainability comes in very different disguises in different parts of the world.

Which role freshwater will play within Future Earth?

Besides air, freshwater is the probably most indispensable material. So questions around freshwater will play a most prominent role in Future Earth. By the way, one of the two first so-called Collaborative Research Actions by the Belmont Group this summer was on freshwater.

How far Future Earth will be solution oriented and demand driven?

Solution and demand orientation is the main focus of Future Earth. In my personal opinion this does not mean that basic research has no place. While solution oriented research aims at the solutions of today, basic research is often paving the way for those of tomorrow.

What could be the challenges in the transition from science partnership to co-design and co-production with business and other stakeholders at a global scale?

Scientists generally don´t have a good record of discussing with and actively listen to the world of practice. Moving away from the attitude that science alone knows the problems and the solutions, and developing real interest of what practice has to tell, might be one the hard parts.

How the Future Earth initiative will be funded in future?

While, with the Belmont group, a powerful group of funders is a member of the Alliance, the funding basis will have to be broader. I´m convinced that where Future Earth can make a convincing case for practice there will be funding opportunities.

How to link science appropriately with policy-makers and other stakeholders?

The most important step is to formulate questions not for, but with the policy makers and other stakeholders, to let them interfere with the development of the scientific agenda. This is no attack on scientific quality; scientists will have to continue to guarantee it.

On the website it is written "strengthening international science for the benefit of society". Is Future Earth only about the benefit of society? What about the benefit of nature?

We might have to explicitly add "nature" indeed. However I think it is implicitly there: The well-being of nature, in the long run, is a basis for sustainable societies.

How will the existing global environmental change programmes be involved in Future Earth? What will be the role of current joint projects like GWSP in the Future Earth initiative?

Many of the projects of the Global Environmental Programmes will be integrated in Future Earth.

We thank Jakob Rhyner for this interview.

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The Role of Scarcity in Virtual Water Flows

by Anik Bhaduri

Recent analyses of the evolution and structure of trade in virtual water revealed that the number of trade connections and volume of virtual water trade have more than doubled over the past two decades, and that developed countries increasingly draw on the rest of the world to alleviate the pressure on their domestic water resources. It is conceivable that in the future, the assessment of international trade in virtual water will gain further importance, similar to the assessment of internationally traded embodied carbon, which is high on the agenda in the debate about countries' responsibility for climate change.

A tool that is increasingly applied to the assessment of resource embodied in international trade is multi-region input-output (MRIO) analysis. MRIO analysis is a variant of input-output (IO) analysis, operating on large databases combining the input-output tables of many regions. Today, there exist only a handful of truly global MRIO tables with environmental satellite accounts, that are capable of being applied to questions pertaining to international trade of water embodiments of natural resources in general. The advantage of IO analysis over bottom-up techniques is its ability to cover the complete environmental repercussions facilitated through complex supply chains underpinning the production of commodities worldwide. Thus, IO analysis is able to quantify carbon or water footprints without systematic truncation errors that affect bottom-up methods such as process analysis.

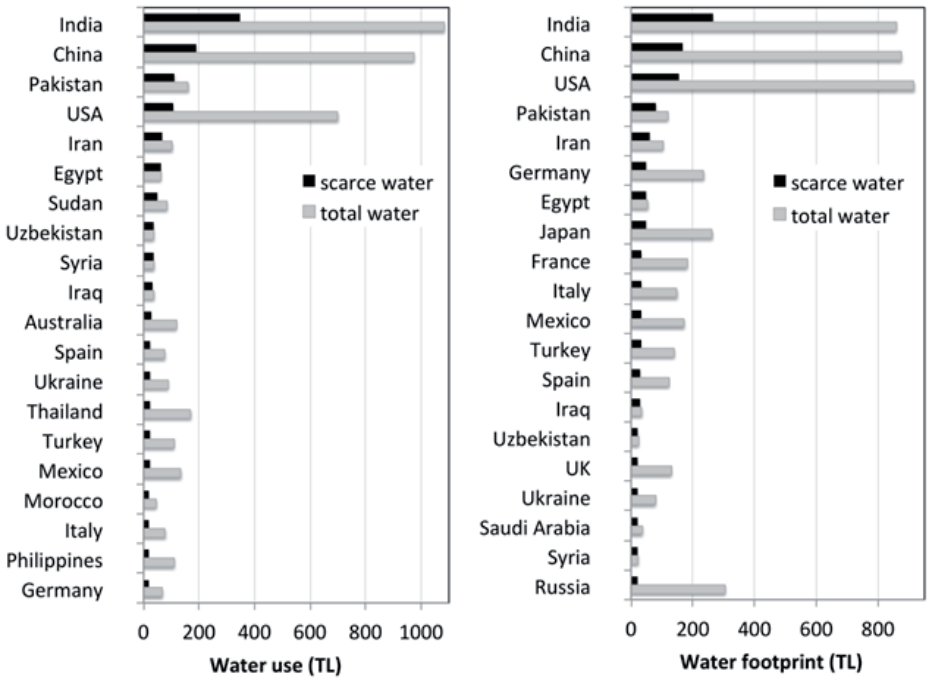
Differences in resource endowment and demand conditions are some of the basic reasons for trade to take place between countries. It is clear that regions can gain from trade if they specialize in goods and services for which they have a comparative advantage. A region is therefore considered to have comparative advantage in producing a water-intensive good if the opportunity cost of producing it is lower in that country than in its trading partners. By reporting on total national water use, existing input-output satellite accounts ignore such comparative advantage in terms of water resource endowments and increasing water demand conditions. Existing MRIO databases group together countries characterized by widely varying degrees of water scarcity. However, calculating global water footprints by adding the use of scarce water in one region to the use of abundant water in another region makes little sense, because such footprints would not be able to indicate regions and/or commodities in need of policy measures to mitigate water-related problems.

We have, therefore, constructed a water scarcity index that can be used as a weight for converting total water use into scarce water use, and characterize national footprints and trade balances in terms of scarce water. The water scarcity index we have used is based on a measure of water withdrawals as a percentage of the existing local renewable freshwater resources. Global data for this measure are provided by the FAO 2012. We use the water scarcity index directly as scarcity weights w specific for each country, and simply element-wise multiply (#) the water use account Q in order to obtain a scarcity-weighted water use account $Q^* = Q \# w$. The scarcity-weighted account Q^* is then subjected to the same Leontief demand-pull calculus as the unweighted account Q.

We find that out of total world's water consumption about 8,000 Tl (1 Tl = 1 Teralitre = 10^{12} L) only about 1,500 Tl can be classified as scarce. We find that 1,900 Tl, or about 24% of global water were embodied in internationally traded goods, with about 480 Tl of those being scarce water (32% of global scarce water).

We ranked countries with respect to their total and scarce water use yield substantially different results (Fig. 1). As expected, large and/or populous nations such as India, China, the USA, Brazil, Russia and Indonesia occupy top ranks amongst countries in terms of total water use. However, the introduction of scarcity weights sees relatively water-scarce countries such as Pakistan, Iran, Egypt, Sudan and Uzbekistan gain top positions, whilst relatively water-abundant countries such as Brazil and Russia drop in their ranks . The impact of the scarcity weighting on water use measures is least evident in severely water-scarce countries such as in the Middle East and North Africa, where almost all water consumed can be classed 'scarce'. It is most evident in water-abundant countries often located in equatorial regions such as Central Africa where hardly any water consumed can be regarded as scarce. Those countries record the most drastic decreases in their nominal water use.

Fig. 1: Twenty countries top-ranked in terms of their water use qx and scarce-water q*x (left panel) and their water footprint my and scarce-water footprint m*y (right panel)



In contrast to the territorial water use perspective portrayed in Fig. 1, the virtual water, or water footprint perspective shown in right panel sees developed countries such as the Japan, Germany, France, Italy and the UK gain in the ranking, both in terms of water and scarce water. Egypt, Iran, and Pakistan retain top positions, due to both their population size and their location in a water-scarce world region. In the water footprint perspective, the relative positions of countries are determined not only by their domestic water use, but also by the virtual water embodied in their imports. Unweighted water footprints from our study agree with those determined in previous studies. As with water use figures, the impact of the scarcity weighting on national water footprints is least evident in severely water-scarce countries such as in the Middle East, Central Asia and North Africa, and most evident in water-abundant countries often located in equatorial regions such as Central Africa and Central America.

With water becoming scarcer globally, virtual water trade is taking in increasingly important place in water policy discussions, and is often advocated as one in a set of feasible policy options to mitigate the spatial variability in water availability. However, before concrete policy implications can be drawn it is pertinent to identify whether a country is relatively water scarce in terms of virtual water consumption, and this is where the current literature lacks information. Studies published so far either indicate water scarcity without dealing with indirect effects that ripple through international supply chains, or quantify virtual water trade without considering scarcity. Our study is unique in that it has filled a research gap by using a Multi-Region Input-Output framework to quantify both the direct and indirect consumption of scarce water. The approach adds value to the literature on virtual water by identifying major global routes conveying pressure on water resources from centres of consumption to regions of water scarcity, thus facilitating water policy dialogue and formulation.

For detailed information see publication in ZEF Discussion papers: Manfred Lenzen, Anik Bhaduri, Daniel Moran, Keiichiro Kanemoto, Maksud Bekchanov, Arne Geschke and Barney Foran (2012): The role of scarcity in global virtual water flows. ZEF-Discussion Papers on Development Policy No. 169.

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GWSP at the World Water Forum, 12-17 March 2012, Marseille, France

by Eva Flinkerbusch & Ulrike Lussem

Every three years since 1997, the World Water Forum mobilises creativity, innovation, competence and know-how in favour of water. It gathers all stakeholders around today's local, regional and global issues that cannot be undertaken without all stakeholders into a common framework of goals and concrete targets to reach. The goal of the 6th World Water Forum is to tackle the challenges our world is facing and to bring water high on all political agendas. One week of discussions, hot debates, solutions and best practice sharing in order to achieve concrete solutions and commitments for the cause of water.

GWSP convened a panel session on "How to characterize the Future for a Sustainable 'Water World'," which focused on scenario development and feasibility. Scenarios have started to be widely used at different scales and complexity, they are crucial in promoting discussion and understanding between different groups in terms of a common possible future. Our water future is full of uncertainties whereby humans are the intrinsic source of most of them. It is therefore inevitable to link natural and social sciences, engineering and governance in creating scenarios for a sustainable water world. In other words: To build a long-term vision (by 2015) with appropriate scenario assessment toolkit including the development of relevant key global indicators for water issues covering educational, technical, historical, ethical, social economic, environmental and institutional aspects as well as those of cultural diversity.

In addition to updates of the target action plan the core outcome was to establish the Water Scenarios Science Community, a dedicated group of scientists, their institutions and other stakeholders. The Water Scenarios Science Community is formed as an open frame to involve all stakeholders interested in scenario formation and use. It was agreed upon the establishment of a steering group of the Water Scenarios Science Community to lead and moderate the further steps in creating task forces and convening workshops such as within the upcoming GWSP Science Conference "Water in the Anthropocene" in 2013 in Bonn, Germany (see also p. 8) and at the World Water Week in Stockholm, Sweden in 2013.

The need for and the interest to contribute to the coordinated work of the Water Scenarios Science Community was confirmed by the participants of the session. The International Institute for Applied Systems Analysis (IIASA) from Laxenburg, Austria has indicated its interest to address the development of comprehensive water scenarios within the framework of its emerging new water project. The Water Scenario Project of the World Water Assessment Programme (WWAP) will revise and restart its activities. Coordinated follow-up of the Water Scenario Workshop, supported by the German Research Foundation (DFG) in 2010 seems to be highly desirable. Policy makers, professional organizations (NGOs) expressed interest to participate in follow-up activities. The need for and the interest to contribute to the coordinated work of the WSSC was confirmed by the participants of the session. It was agreed that thematic workshops are to be held very soon to explore the momentum created in Marseille.

The participants of the session agreed upon a final list of commitments that includes steps such as a multi-disciplinary and multi-scale stakeholder involvement in creating scenarios, bridging the gap between the long-term view of science-driven scenario developers and policy makers' short term imperatives, achieving data-democracy as well as transparency and comprehensive data collection. Beside these topics another outstanding task was identified: The importance of communication should not be underestimated when promoting the benefits of scenarios and models to make different audiences understand what is at stake. The 6th World Water Forum, as the largest multi-stakeholder platform to address water challenges was the right stage and opportunity to form a Water Scenarios Science Community to get engaged in developing the next generation of complex set of multiple scale and multi-sectoral water scenarios.

Moreover GWSP was represented in the Exhibition hall with an information booth to disseminate GWSP publications, information material about the project and announcements of the upcoming GWSP conference in 2013 "Water in the Anthropocene". The new joint publication of GWSP and UNESCO-IHE , an E-Book on "River Basins and Change" was launched successfully at this major event togehther with UNESCO-IHE at the UN-Water booth. This E-Book contains the major contributions to the international GWSP conference on "The Global Dimensions of Change in River Basins" held in Bonn, Germany in 2010.

GWSP at the international Conference „Planet under Pressure - New Knowledge Towards Solutions“, 26 -29 March 2012, London, UK

by Eva Flinkerbusch & Ulrike Lussem

The international Conference “Planet under Pressure – New Knowledge Towards Solutions” was a large gathering of scientists concerned with global change and sustainability. It was convened by the Global Environmental Change (GEC) Programmes with the International Council for Science (ICSU) to assess the state of the planet and to explore solutions to impending global crises. More than 3000 delegates participated at the congress venue in London and over 3500 participated virtually via live webstreaming. The conference took place six weeks before the United Nations Conference on Sustainable Development, Rio+20 (Rio de Janeiro, Brazil, 20-22 June 2012) and provided the platform to develop papers which were to be presented during Rio+20.

As sustainable water resources management plays a vital role in achieving a global sustainable future, the GWSP was involved in a session entitled “Water: Integrated assessment, governance and management in changing conditions at global, regional and transboundary levels” co-chaired by Janos Bogardi. GWSP SSC Co-Chairs Claudia Pahl-Wostl and Charles Vörösmarty were the two keynote speakers. The session´s core was focused on freshwater, its availability, quality, consumption, management and governance. The session was part of the Day two´s major topic “Options and Opportunities” which should provide a platform for exchanging knowledge about ways of reducing the pressures on the planet, promoting transformative changes for a sustainable future and adapting to changes in the global system. GWSP was also represented with an information booth disseminating GWSP publications and information material. Besides the scientific schedule this conference was the first conference event presenting the new global 10-year initiative “Future Earth - Research for Global Sustainability.” Future Earth was finally launched at the Forum on Science, Technology and Innovation for Sustainable Development prior to Rio+20, 11-15 June 2012, where GWSP was also represented (see also article on the Forum on Science, Technology and Innovation for Sustainable Development on page 14).
For detailed information on the Future Earth Initiative see also: www.icsu.org/future-earth.

http://scidevnet.files.wordpress.com/2012/03/plenary-wordle4-e1333018102446.jpg

Most commonly used words in questions asked during the first three plenaries of the conference Planet Under Pressure

Conference on Water-Energy-Food Security: New Challenges and new Solutions for Water Management, 1- 4 May 2012, Winnipeg, Canada by Richard Lawford, Sina Marx & Karla Zubrycki

On May 1-4 2012, more than 80 international experts participated in the Water-Energy-Food (WEF) security nexus conference held in Winnipeg, Canada. Sponsored by the Global Water System Project (GWSP), the International Institute for Sustainable Development (IISD), and the National Aeronautical and Space Agency (NASA), the event featured a conference on the roles of governance and Earth Observations in dealing with the WEF nexus; a symposium on the bioeconomy and WEF issues; and a workshop to advance the analysis of WEF issues in catchments around the world. The conference highlighted the roles of governance and science in addressing WEF security issues. Factors and trends that limit progress include simplistic solutions, a lack of stakeholder engagement, inequities, unresolved transboundary issues, poor recognition of environmental flow needs, inadequate monitoring, and inflexible regulations, among others. Redefining th e role of players within governance structures and using Earth Observations (EO) more extensively needs to be encouraged. Governance identifies the role of governments and stakeholders in the management of water. Internationally, water governance has been advanced by the emergence of new institutions, projects and stakeholder roles. In North America, the International Joint Commission and the Red River Basin Com-

mission are examples of mechanisms that address transboundary concerns (e.g., droughts, nutrient loading).

Integrated Water Resources Management (IWRM) is a goal of many governance reforms. Other possible governance models include soft path approaches, indices and economic measures, polycentric governance models, and models for WEF scenario development. Strengthening governance across scales and sectors will be important for increasing the application of science to the WEF Nexus.

Earth Observations and the Water-Energy-Food Security Nexus: Data collection and information sharing across jurisdictional boundaries are essential for managing WEF issues, particularly in transboundary basins. The EO community acquires and provides basic data sets, develops integrated products, provides tools that facilitate the access and use of these data, and develops systems that integrate data with other information to facilitate decision-making. NASA programmes focus on the dissemination of basic satellite data products, the development of data assimilation capabilities, and the provision of tools to facilitate access to these data. Two variables used in making decisions related to the WEF nexus are soil moisture and evapotranspiration. An integrated soil moisture monitoring system that captures spatial and temporal trends in moisture conditions is under development. To maximize the benefits of satellite data in the context of "place-based" WEF policies, integrated EO research, mission continuity and enhanced operational services are required. The Group on Earth Observations (GEO) GLAM (Global Agricultural Monitoring) initiative, which was recently approved by the G20, supports this goal by facilitating the more effective coordination of existing efforts.

The Water-Energy-Food Security Nexus

Symposium on Using the Bioeconomy to address WEF Issues: In a "bioeconomy," organic materials are used for energy and the feedstocks for industrial processes. A multi-stakeholder initiative in the Lake Winnipeg Basin plans to use the bioeconomy framework to address nutrient loading in the lake. This approach will also lead to better management responses to floods and droughts. Harvested biomass from the basin would lead to the recovery of phosphorus and the production of biomass products such as cellulosic ethanol, bioplastics, biocomposites, and pharmaceuticals. This approach also enables a balanced economy by more effectively managing water on the landscape.

The Global Catchment Initiative Workshop: This workshop was part of a new GWSP Global Catchment Initiative (GCI) II initiative designed to assess how water managers in large basins address WEF issues. Surveys completed by experts from 11 large basins were reviewed and an early analysis was validated and modified through feedback from experts and policy-makers who deal with WEF issues. In particular, the GCI study addresses questions related to basin management, interaction between basins, and opportunities for improving governance and management.

The following issues/challenges emerged as priorities: Integration: Although river basins are a natural spatial unit for water management, the implementation of IWRM remains in its early stages in many basins, partly because agriculture and energy are managed on a national basis. In some basins, organizations charged with implementing IWRM lack the political leverage to enact integrated plans and policies. Building on national and transnational partnerships would enable the complex issues associated with WEF security to be addressed in the absence of full IWRM implementation. Institutions addressing water problems at a technical level can provide knowledge, collaborative frameworks, and leadership to advance politically integrated approaches. Political instability: Major and long-lasting negative influences in some basins are caused by political instability (e.g., the Okavango basin). Geopolitical security is essential for WEF security. The Changing Roles of Rivers: Changes in national economies, land use, and environmental conditions have affected the role of rivers, which in turn led to changing management expectations. Data Issues: The lack of groundwater and water quality data contributes to a laissez-faire approach to water management. In developed countries, models supplement data to support water assessments. In developing countries, assessments are rarely made, which leads to the continued deterioration of water quality and healthy environments. Monitoring Change in the Basins: The effects of climate change (e.g., more extremes) and land use changes need to be benchmarked in river basins so that the role of global trends versus local changes can be assessed.

Summary and Recommendations: Conference participants identified the following new directions and opportunities: 1) Targets (more specific than the Millennium Development Goals) should be established and monitoring programmes using extensive EO should be set up to monitor progress toward these targets. 2) New partnerships should be developed for the WEF Nexus and for related interests (health, ecosystems, and biodiversity) with representation from public and private sectors within a multi-scale polycentric governance framework. 3) A bioeconomy based on the benefits of managing water on the landscape and bio-industries should be promoted in the green economy framework. 4) Water should be fully included in calculations of environmental goods and services, making use of Earth Observations and related science.

Water at the ICSU Forum on Science, Technology and Innovation for Sustainable Development and Rio+20, 11-15 June 2012, Rio de Janeiro, Brazil by Richard Lawford

Thanks to the efforts of Claudia Pahl-Wostl, Co-Chair of GWSP, Michel Jarraud, Chair, UN Water and many others, the voice of water was heard in the bustle of Rio+20. In particular, Claudia Pahl-Wostl and Abdin Mohamed Ali Salih from UNESCO-IHP organized a session on water security at the International Council for Science (ICSU) Forum on Science, Technology and Innovation for Sustainable Development. The Forum which was held on June 11 to 15, 2012 at the Pontifical Catholic University of Rio De Janeiro, featured a week of presentations and discussions on all dimensions of Sustainable Development including climate, resources, environment, biodiversity, demographics, health, and water amongst others. The Forum was held immediately before the main Rio+20 meetings so recommendations from the Forum could directly impact the Rio+20 discussions. A central attraction for the Forum was the official launch of the ICSU Future Earth programme. A number of side events at the Forum provided opportunities for those interested to learn more about ICSU programmes, and to engage with officials with the Belmont Forum.

The Water Security Session at the Forum considered how adaptive management can be developed to address water security issues in a context of growing needs and water scarcity. Presentations were made by Gretchen Kalonji on UNESCO water programs, Ursula Oswald-Sprin of Mexico on the links of water with the physical and sociological needs of communities and Kuniyoshi Takeuchi presentation on floods and their impacts. Mr. Takeuchi promoted Sustainable Development Goals (SDG) as a way of dealing with extremes. Rick Lawford presented "Pathways for securing water to lower risk in the energy, agriculture and environment sectors." In addition to outlining the issues of water security he presented recommendations from a May 2012 GWSP/IISD/NASA conference on the Water-Energy-Food Security Nexus. Presentations in other sessions of the Forum made reference to water security and provided a broader range of perspectives on the topic. Scale considerations are important for understanding water security issues because global averages tend to obscure the hardships of water shortages associated with place specific issues and the challenges involved in finding local solutions.

The Rio+20 United Nations Conference on Sustainable Development was held on the outskirts of Rio de Janerio in a large conference centre. The exhibits which were located in a nearby exhibition grounds were impressive with a number of countries using this opportunity to showcase their progress in addressing environmental issues.

In general, policy issues were central to the Rio+20 discussions. Many groups used the conference to announce new publications or the launch of new projects. A special Water day featured a session chaired by Michel Jarraud (Secretary General of the World Meteorological Organization and Chair of UN Water). He reported on the results of a recent study in which UN Water had surveyed a number of countries on their water management needs. Integrated Water Resources Management (IWRM) was also discussed as one path to water security. Implementation of IWRM is complicated in some transboundary basins where nations are reluctant engage in multilateral river basin authorities because historic agreements appear to meet their needs. Clean water is a product of both effective land and water management. A cal l to manage land as well as water as a way to better address water issues creates opportunities to discuss ways to manage water on landscapes to maximize society's benefits. This connection may be reflected in the emphasis that Rio+20 was ready to place on the Water-Food-Land Nexus. Water was also featured in the exhibition booths of a number of countries. For example, sessions were held in the Japanese and European Union pavilions that featured talks on the role of Earth Observations in enhancing water security.

Another topic that is central to sustainability is consumerism. Although the focus of consumer sessions tended to be on labeling consumer products, several interventions emphasized the need to change consumption patterns and intensity. These changes go beyond individual projects to education, and challenge free market economies to find better ways to factor environmental considerations into their financial management procedures.

The Rio + 20 meeting ended with a 49-page statement summarizing the commitments of leaders from 192 governments to promote a sustainable future or in the words of the organizers, "the Future we want". The statement deals with water, food, energy, health and other sectors as well as cross-cutting topics such as governance, research, education, and Earth Observations and commits itself to setting and moving towards new Sustainable Development Goals. It also highlights the role of the UN in general and UNEP in particular in strengthening its ability to serve as the "leading global environmental authority".

RIO+20
United Nations Conference on Sustainable Development

„Enhancing Water Security for the Benefit of Humans and Nature“ – 3rd Water Research Horizon Conference, 10-11 July 2012, Berlin, Germany by Claudia Pahl-Wostl & Nina Wernsing

The 3rd Water Research Horizon Conference (WRHC) was held in July 2012 in Berlin, Germany. This year's event focused on „Managing Water Beyond IWRM: Target Setting, Instrument Choice and Governance“ and „New Approaches to Observation, Exploration and Data Assimilation in Water Research". The annual conference aims to promote new ideas that support innovative interdisciplinary approaches to facilitate bridge-building between various researcher groups from different disciplinary backgrounds and from different researcher communities.

On the first conference day, Claudia Pahl-Wostl, GWSP Co-Chair (Institute of Environmental Systems Research) and Klement Tockner (Leibniz Institute of Freshwater Ecology and Inland Fisheries) chaired a session on "Setting, meeting and monitoring targets and indicators for integrated water resources management", which dealt with integrated system analysis and evaluation to take into account all relevant sub-systems (economy, society, politics, ecosystems etc.) in water resources management. A good understanding of the structures, functions, and related services of surface and groundwater ecosystems as well as the multiple stressors impacting them is essential for the design of an adequate IWRM concept. However, ecosystem functions and services have not been adequately taken into account so far. The European Union developed an approach to implement the IWRM concept within the scope of the Water Framework Directive (WFD). Progress has been made in the scientific underpinning of the concept of the "good status" of aquatic eco-systems as targeted in the WFD, but some significant gaps remain. To fill these gaps a good understanding of the aquatic ecosystems and the services they provide is necessary, and their management has to match with the anticipated socio-economic development. In this respect, the session chairs emphasized the need for (1) a predictive approach that provides mechanistic models to forecast and evaluate changes in ecosystem processes and services under (rapidly) changing environmental conditions and (2) models that are able to predict and evaluate the responses of hydrological and ecological systems to management measures. To facilitate such predictive approaches a suitable set of indicators for the determination of a good ecological groundwater status has to be developed. Therefore, one of the session objectives was to identify and discuss new ways of defining indicators and targets that fit current water management challenges and allow us to achieve (and monitor) a favourable development of our water resources and ecosystems, with positive effect on societal development.

On the second day of the conference, Claudia Pahl-Wostl chaired an Open Space Workshop organized by GWSP, IGB (Leibniz-Institute of Freshwater Ecology & Inland Fisheries) and PIK (Potsdam Institute for Climate Impact Research), entitled "Enhancing water security for the benefit of humans and nature: a cross-scale integrated assessment". This event targeted experts from ecology, hydrology, economics and governance – scientists and practitioners – to identify mutual research interests and possibilities for collaboration and future projects. The workshop addressed the fact that human water security has often been achieved to the detriment of the environment and with negative impacts on the resilience of social-ecological systems. Experience with assessing Environmental Flow Requirements (EFRs) at river basin scale for different eco-hydrological and socio-economic conditions has shown that the establishment of sustainable EFRs within the scope of water resources management is often hampered by a lack of stakeholder involvement and by inappropriate governance structures. These challenges were elaborated during a previous workshop (November 2011, Bonn, Germany) organized by the Global Water Needs Initiative (GWNI) of the Global Water System Project, which brought together a group of world leading scientists in the field of environmental flows and water governance. The WRHC workshop built on the results from this GWNI event and facilitated discussions about major knowledge gaps on how to overcome trade-offs be-tween human and environmental water needs. Participants identified potential partnerships for research collaborations linked to an emerging international network of scholars, which had been initiated by the GWNI. They identified the following priorities for future research: (1) development and validation of a universally applicable classification system for sustainable EFRs based on eco-hydrological, socio-economic, governance and management characteristics; (2) global assessment of river systems based on a meta-analysis of existing empirical research results regarding the effectiveness of governance and management systems in the light of various challenges. A major conclusion from the workshop discussions is that more in-depth case studies research is needed to identify needs for action and to support change towards improved governance and management. Moreover, workshop participants dealt with questions related to water resources governance and management, such as: Which level of certainty in scientific knowledge is required for implementing effective poli-cies? Which mode of governance is appropriate to achieve change – would a combination be the best way to proceed? Can lessons be transferred from one case to another? Following these questions, further research priorities were identified that should be addressed in future collaborative projects.

WORLD WATER WEEK in Stockholm

„Addressing the Water – Energy – Food Security Nexus: Challenges and Solutions in (international) River Basins" – World Water Week, 26-31 August 2012, Stockholm, Sweden by Ralf Ibisch

This year´s World Water Week in Stockholm from 26-31 August provided insight into the challenges of water and food security. The risks of food and water insecurity, especially in urban areas, are producing socio-economical and political tensions and prices for energy and food are rising. The connection between efficient water use and food production are clear, but these goals are to be implemented by systematic sustainable water management in terms of both quality and quantity and on multiple scales.

The GWSP contribution to this year´s major water event was focused on multiple spatial and sectorial connections between water resources, food and energy production in large river basins. The seminar "Addressing the water – energy – food security nexus – challenges and solutions in (international) river basins" was held on Monday 27 August 2012. The session was organized by several partner organizations (amongst others BMZ, BMU, GWSP, UFZ). The seminar explored challenges and opportunities of the nexus in various transboundary basins and discussed the added value of IWRM as a commendable approach for managing the nexus under the premise of benefit-sharing, while considering inherent complexities and uncertainties. Several case studies were presented and showed key challenges as well as potential solutions in setting up appropriate governance mechanisms for a sustainable and secure water, energy and land management. The main outcomes of the seminar could be summarized as follows:

1) There is growing nexus awareness in international river basins, but this is not reflected explicitly in governance and management of water resources.
2) Water, land and energy resources have diverging governance regimes, making nexus management difficult.
3) There are strong linkages but also substantial trade-offs between water, food and energy security. IWRM can be seen as a pathfinder process for the implementation of an integrated natural resource management.
4) There is a need for structured and well designed Capacity Development in order to strengthen partners across boarders.
5) The Nexus dialogue on dams and water infrastructure optimization needs to be continued in order to improve benefits to people, nature and sustainable economic development and enhance water, food and energy security.

GWSP lecture held at Hessischer Kreis e.V. at 28 August 2012 in Frankfurt am Main, Germany by Ulrike Lussem and Eva Flinkerbusch

GWSP Senior Advisor Prof. Janos Bogardi was invited by the Hessischer Kreis to give a lecture on „Water – the Challenge of the 21st Century" on 28th August 2012 in Frankfurt am Main, Germany. Since more than 50 years the Hessischer Kreis promotes a non-party and independent dialogue between politics, economy, science, religion and culture. To this aim the Hessischer Kreis invites speakers to give lectures on interdisciplinary current topics. Beside Joachim von Braun, director of the Center for Development Research (ZEF) of the University of Bonn, which is the host of GWSP-IPO, who gave a lecture in 2010, renowned speakers such as Angela Merkel, Helmut Kohl, Uli Hoeness or Gerhard Schroeder were already among the contributors. Host of the evening was Freshfields Bruckhaus Deringer LLP, a major law firm, who invited to the Opern Turm in Frankfurt am Main, Germany. More than 115 guests attended and debated lively in a free discussion after the lecture. Among the guests were representatives of well-known banks such as Frankfurter Sparkasse, Deutsche Bank, Commerzbank, UBS Deutschland, KfW, J.P. Morgan, and well-known businesses like BMW Frankfurt, Lufthansa, Dyckerhof, Bilfinger - Berger, HEAG, Merz, Lahmeyer, and Deloitte. But also representatives of the local university and GIZ, the consulate general of France and the USA, law firms and insurance companies were seen among the attendants. Prof. Janos Bogardi contributed by his expertise to the promotion of water challenges to a wider circle to put the water agenda in mind of representatives of important societal institutions and stakeholders.

Janos Bogardi at Hessischer Kreis e.V.

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„Water & Food Security" – 2nd GEOSS Science and Technology Stakeholder Workshop, 28 - 31 August 2012, Bonn, Germany

by Gordon Young & Anik Bhaduri

The Breakout Session (Food and Water Security) in the 2nd GEOSS Science and Technology Stakeholder Workshop addressed water and food security issues within the broader context of global security issues. The session has produced the following recommendations as end products on how best to incorporate earth observation monitoring systems into the management of water and food security. 1) Placing water security within the much broader context: the many elements of global security in a world of change and uncertainty. 2) Policy- and decision-making in "silos" needs to give way to an approach that reduces trade-offs and builds synergies across sectors — a nexus approach". 3) Improved governance structures are needed that enable issues related to water, energy, food and environment to be considered within a single forum. 4) Need to develop plans for basin-wide management and maximize the use of Earth Observations and scenarios to make the decision process as transparent as possible. 5) Capacity development is essential to assist nations in managing their resources and achieving water and food security.

Gordon Young, President, International Association of Hydrological Sciences, and Anik Bhaduri, Executive Officer Global Water System Project, co-chaired the session. Four presentations were made on different aspects of the topic of Water and Food Security. Gordon Young set the tone of the session by highlighting the key objectives of the discussions, namely: i) to set water security within the broader framework of global security issues, ii) to define the elements of water security, iii) to focus on food security issues, iv) to elaborate on the relevance of global earth sciences, and v) to produce recommendations on how best to incorporate earth observation monitoring systems into the management of water and food security. In his presentation, Gordon Young also placed water and food security within the context of global security, where he highlighted key factors behind the on-going processes of global change, such as: population growth, climate change, and others. Elements of water security are comprised of diverse uses of water, including for human well-being (health and food security), economic development (energy, industry), social development and, equally importantly, water to sustain normal functioning of natural ecosystems. Moreover, water security is also associated with several water-related hazards such floods, droughts and pollution. In many cases, regions affected by water stress coincide with those where water is used unsustainably.

Anik Bhaduri made a presentation on the linkages between water and food security. He highlighted that with continued increase in population, limits are being met on the basic resource needed to produce food. Water gap will leave a food gap and affect global food security severely. Food crises may happen unless fundamental policy changes are made in future water use. What are the possible solutions? These will include strengthening the human dimension of water scarcity and quality management and policy, addressing land and water scarcity jointly, intensifying agricultural productivity with more efficient water use, efficient and equitable use and distribution of water, and fostering value-oriented water reuse. Anik Bhaduri also reported on the results of his joint research with several co-authors indicating that virtual water imports were positively associated with individual country's water scarcity. Effective tools are needed to support decision-makers in a more timely and coordinated manner in response to risks related to water and food availability. Earth observations are an important basis to provide such information. However, significant investment is needed as sufficient infrastructure for data collection and distribution often does not exist, especially in developing countries, impeding the ability to cope with variability and change. For existing data, the challenge lies ahead to integrate earth observation and monitoring systems for agricultural commodities, and identify new metrics and valid indicators that can be applied across sectors to assess inter-linkages.

GROUP ON EARTH OBSERVATIONS

Rick Lawford, Morgan State University, made a presentation on the role of Earth Observations in enhancing security in the Water-Food Nexus. He emphasized that water is the entry point for sustainable development and the green economy. Without water security it will not be possible to realize the sustainable development goals and to cope with the wide range of economic and social risks that will arise from climate change, disasters and manipulation by humans of the Earth's surface. Water security requires the ability to i) map the availability and quality of surface and sub-surface waters, ii) measure and understand how the water cycle varies and changes, iii) predict how the availability and quality of water resources will change on a range of time and space scales, iv) support the integrated planning and management of water resources both

nationally, internationally, and globally, and v) implement new technologies for water discovery and supply. What's needed are improved governance structures that enable issues related to water, energy, food and environment to be considered within a single forum, involve experts from different levels of government to interact with stakeholders and the public in consultative and decision making processes, seek fora where state or national leads can provide feedback which would be helpful to develop plans for basin-wide management and maximize the use of Earth Observations and scenarios to make the decision process as transparent as possible.

Jens Liebe, UN-Water Decade Programme on Capacity Development (UNW-DPC), highlighted that in Water-Energy-Food Security Nexus, capacity development is crucial to identify interconnections between sectors and actors, to promote learning and knowledge sharing across sectors and regions, to narrow the gap between the availability of solutions and skills and means to use them (e.g. technology), and to support decision-makers to develop appropriate policies, strategies and investments, and to explore and exploit synergies, identify and mitigate trade-offs. Capacity development is essential to assist nations in managing their resources and achieving water and food security, though eliminating the mismatch between availability of solutions and skills and means to use and benefit from them, overcoming a "silos" mentality for improved management. In this regard, Earth Observations can play an important role in providing data and developing tools which underpin sound resource management.

Announcements

New GWSP Scientific Steering Committee Members

CLAUDIA RINGLER is Deputy Division Director of the Environment and Production Technology Division at the International Food Policy Research Institute. She co-leads the Institute's water research program and is also a theme leader of the Water, Lands and Ecosystem research program managed by the International Water Management Institute. Her research interests are water resources management, in particular, river basin management, and agricultural and natural resource policies for developing countries. Over the last several years she has also undertaken research on the impacts of global warming for developing country agriculture and on appropriate adaptation and mitigation options. She has more than 80 publications in the areas of water management, global food and water security, natural resource constraints to global food production, and the synergies of climate change adaptation and mitigation.

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FRANCISCO MEZA is also a new member of the GWSP Scientific Steering Committee (SSC). Francisco Meza is the Director of the Centro de Cambio Global at Pontificia Universidad Catolica de Chile and Co-Director of the Inter-American Institute for Global Change Research Center for Water Security in the Americas AQUASEC. He is member of the International Panel on Climate Change (IPCC) task group TGICA and Lead Author of the AR5 of IPCC. His areas of research are focused on understanding impacts of Global Change on Agriculture, Forest and Water Resources and the development of adaptation strategies for these sectors. He has been lead investigator of several national and international grants and main advisor of a dozen of graduate students. He has also served as member of the advisory committee on Climate Change for the Ministry of Agriculture in Chile.

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GWSP IPO Staff Transitions

JANOS BOGARDI has now made the transition to his well-deserved retirement stage after having made invaluable contributions to the GWSP and its IPO over the past years. We are fortunate that he will remain connected to the GWSP community and the IPO as a senior advisor and as a coordinator of an interational project commissioned by UNEP on International Water Quality Guidelines for Aquatic Ecosystems. His passion for work and his excellent humor are truly inspirational, and his impact on GWSP work is highly appreciated and will always be. We are looking forward to continue working with him at GWSP -IPO.

ANIK BHADURI has joined GWSP recently in June 2012 as an executive officer (a.i.). Before joining GWSP, he was a Senior Researcher at the Center for Development Research (ZEF), University of Bonn. Anik Bhaduri obtained his PhD degree in December 2005 from the University of Wyoming. In his dissertation, using a political economy model, he explains why an upstream country might agree to a treaty that recognizes and enforces the water claims of a downstream country. After his PhD, he worked as a post-doctoral research fellow in resource economics for the International Water Management Institute (IWMI). He was involved there in doing the economic analysis of India's National River linking Project. His current research areas include sustainable land and water management, climate change impacts and adaptive water management through incentive based approaches, and role of scarcity in virtual water flow.

GWSP Publications

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•Boyero, L., Pearson, R., Dudgeon, D. et al. (2012). Global patterns of distribution in stream detritivores: implications for biodiversity loss in changing climates. Global Ecology and Biogeography 21, 134-141.

•Herrfahrdt-Pähle, E. and Pahl-Wostl, C. (2012). Continuity and change in social-ecological systems: The role of institutional resilience. Ecology and Society 17(2), 8.

•Huntjens, P., Pahl-Wostl,C., Camkin,J., Schulze, R. and Kranz, N. (2012). Institutional Design Principles for Climate Change Adaptation? Global Environmental Change, 22 (1), 67-81.

•Ignaciuk, A., Rice, M., Bogardi, J. J., Canadell, P., Dhakal, S., Ingram, J., Leemans, R., Rosenberg, M. (2012). Responding to Complex Societal Challenges: A Decade of Earth System Science Partnership (ESSP) Interdisciplinary Research. Current Opinion in Environmental Sustainability, 4, 1-12.

•Jain, S K, Vijay Kumar, and M Saharia (2012). Analysis of rainfall and temperature trends in North-East India. International Journal of Climatology (published online in March 2012, in press).

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•Jain, S.K. (2012). Sustainable water management in India considering likely climate change. Current Science, 102(2), 177-188.

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•Xia Jun, Qiu Bing, Pan Xingyao, et al., (2012). Assessment of water resources vulnerability under the climate change and human activities. Advances in Earth Sciences, 2012, 27(4), 443-451[in Chinese].

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THE GLOBAL WATER SYSTEM PROJECT (GWSP)

Organizational Framework

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, the international programme of biodiversity science.

Mission

The mission of GWSP is to understand the ways in which humans use the resources and influence the dynamics of the global water system and to advise decision-makers on how environmental and social consequences can be mitigated.

Earth System Science Partnership

DIVERSITAS an international programme of biodiversity science

GLOBAL CHANGE IGBP

IHDP International Human Dimensions Programme on Global Environmental Change

WCRP World Climate Research Programme