



**Global Water
System Project**



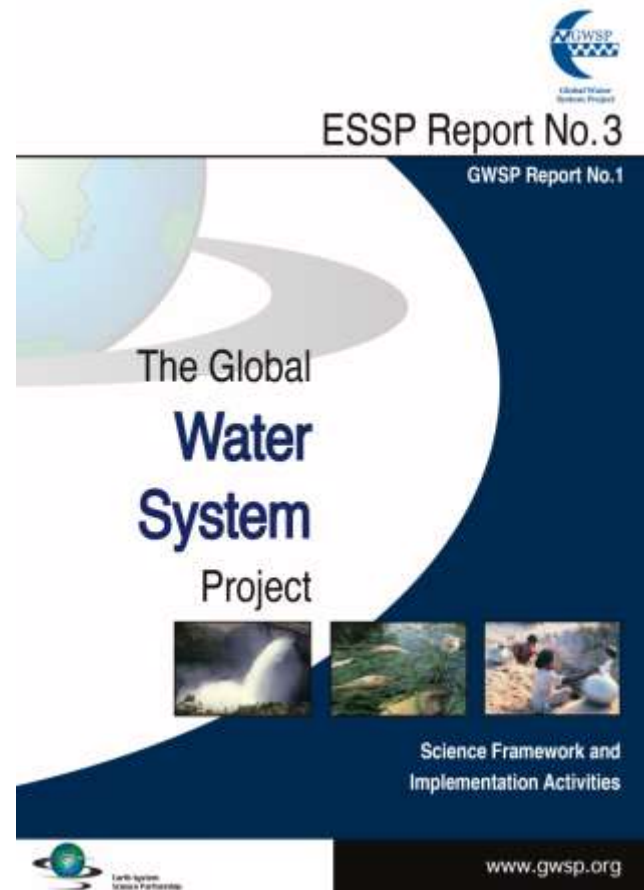
**Earth System
Science Partnership**

The Global Water System Project (GWSP) and Extremes

Rick Lawford and Holm Voigt

The central tenet of the GWSP is that ...

...human-induced changes to the water system are now global in extent, yet we lack an adequate understanding of how the system works and how society can best adapt to rapidly-evolving new system states.



The mission of the GWSP is to ...

...***understand*** the ways in which humans influence the dynamics of the global water system and to ***inform*** decision makers on how the environmental and socioeconomic consequences of these impacts can be **mitigated**.

Timeline: 2005 - 2014

Medium-term strategy: Three integrative study areas

SPECIAL INTERESTS

Climate change

Governance &
Adaptation Strategies

1. **Global Scale Initiative:**
Ranking of threats to the GWS, states and trajectories of change
2. **Global Catchment Initiative:**
Bringing the global perspective to river basin research & management
3. **Global Water Needs Initiative :**
Humans and nature – balancing goals and needs

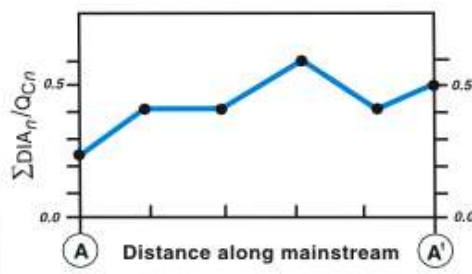
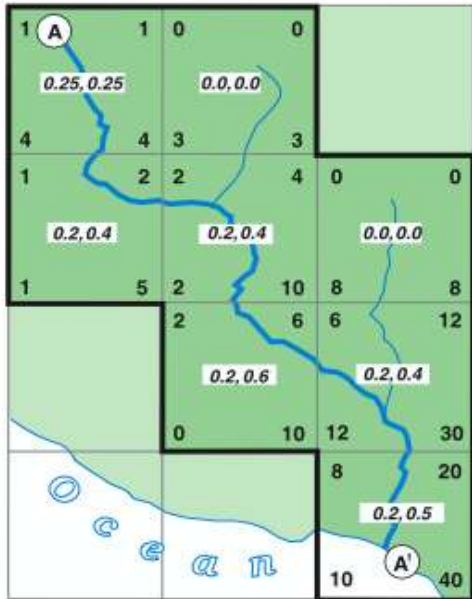
Simulation modelling
& scenarios

Observations

METHODS & TOOLS

Policy Outreach & Capacity Building

CALCULATION OF KEY WATER INDICATORS



DIA_n = domestic, industrial, agricultural water use ($\text{km}^3 \text{ yr}^{-1}$) in cell n

$\Sigma DIA_n = DIA$ in cell n plus all upstream cells ($\text{km}^3 \text{ yr}^{-1}$)

$$= \sum_{i=1}^n DIA_i$$

R_n = locally-generated runoff (mm/yr)

A_n = area of cell n (km^2)

$QL_n = 10^6 * R_n * A_n =$ locally generated discharge ($\text{km}^3 \text{ yr}^{-1}$)

$QC_n = \sum_{i=1}^n QL_i =$ river corridor discharge ($\text{km}^3 \text{ yr}^{-1}$)

$DIA_n/QC_n =$ local relative water use (unitless)

$\Sigma DIA_n/QC_n =$ water reuse index (unitless)

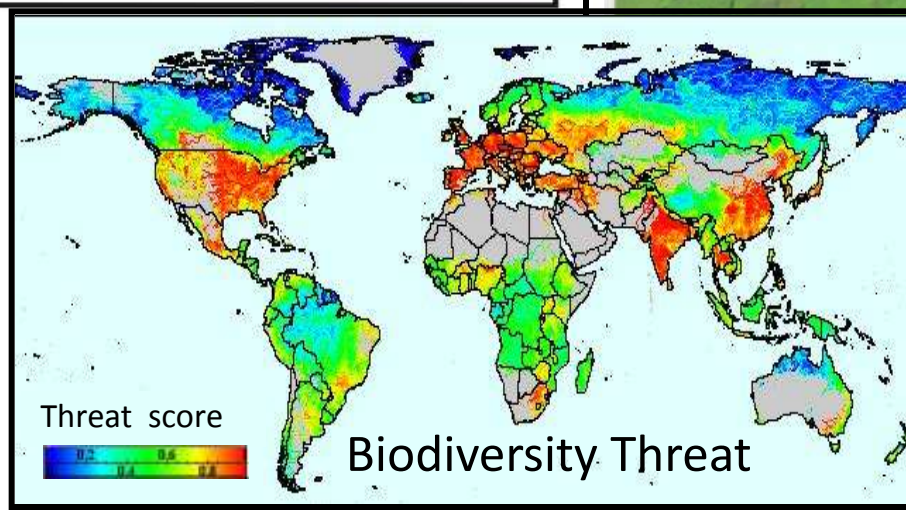
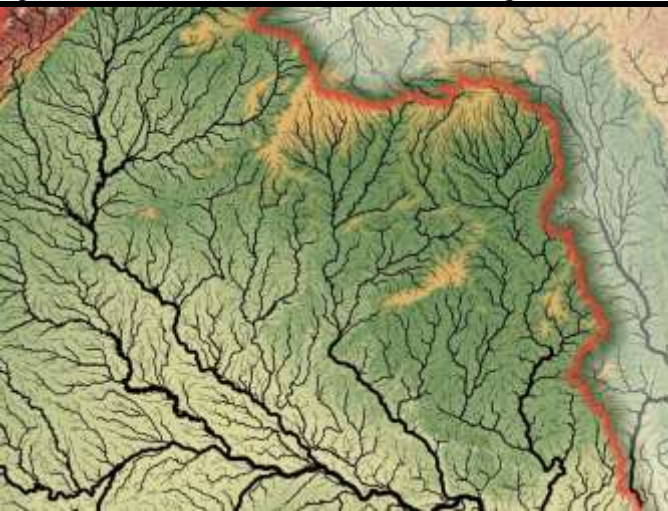
Key (cell n)

n = position of cell in river network

n = total number of upstream cells plus cell in question

$\frac{DIA_n}{QC_n}$ $\frac{\Sigma DIA_n}{QC_n}$
 QL_n QC_n

- DEFINE WATERSHED STATE BASED ON LOCAL AND RECURSIVE INDICES
- GOOGLE AND OPEN MAP SERVERS
- MAP SYSTEM STATES OVER MULTI-SPACE & TIME SCALES



Digital Water Atlas

Purpose and intent: describe the **basic elements** of the Global Water System, the **interlinkages** of the elements and **changes** in the state of the Global Water System by creating a consistent set of **annotated maps**

First version published March 2008



Status

- **69** global maps
- **141** web links to other info/data sources
- **> 100,000** visits
- **> 360** registered users from **> 30** countries
- **> 2300** dataset downloads
- **Position 3** in Google search for “water atlas”
- Last update of maps: **Sept 2008**



Maps

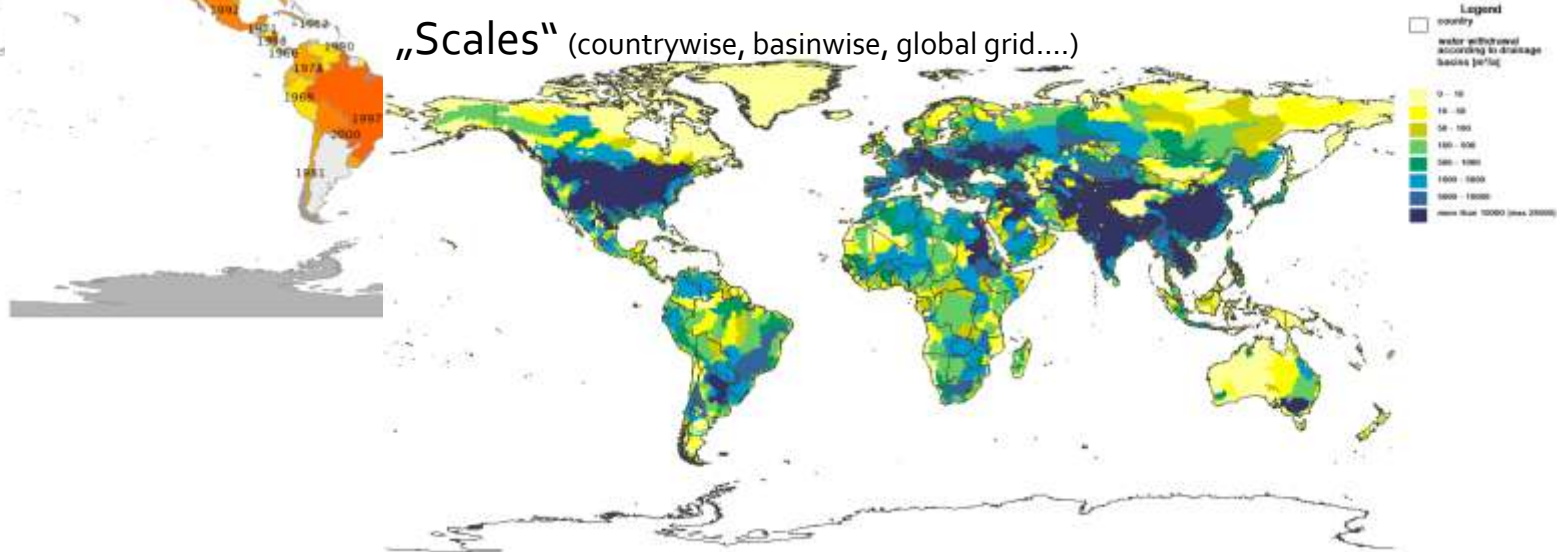
„Basics“ (precipitation, evaporation, runoff...)



„Add ons“ (water law, groundwater conflict potential, virtual water flows...)



„Scales“ (countrywise, basinwise, global grid...)



Key Themes of the GCI Survey

- 1) Impact of Global Change on River Basins** (Climate Change Impacts on River basins, Impacts of Large Scale Land Use Patterns and Demographic Change)
- 2) Long Distance Connectivities and Linkages of River Basins** (Connectivities and Linkages Between River Basins and the Earth System, Connectivities and Linkages Within River Basins, Virtual Water Flows Between River Basins)
- 3) The Role of Governance in River Basin Management** (Impacts of National and International Actors on River Basin Processes, Influence of Global and National Governance on Water Resources in River Basins)

The lake Winnipeg basin is the only North American basin included in the GCI study.

Global Governance Studies

Basin governance - emerging insights

- *Tension between decentralization and centralization*
- *Tension between line-hierarchies and network governance*
- *Tension between basin and political boundaries*
- *Problems of institutional spatial misfit and vertical interplay when new institutions are implemented following hydrological principle*
- *Lack of sectoral integration - principle of ecosystem goods and services promising approach for integration*
- *Change at operational level slow despite change in political rhetoric and supportive political frameworks*
- *Reluctance of stakeholders to acknowledge uncertainties*
- *Evidence supports need to focus on processes of learning and change*

	Framing Question 1: What are the magnitudes of changes in the GWS and what are the key mechanisms?	Framing Question 2: What are the main linkages and feedbacks within the earth system, arising from changes in the GWS?	Framing Question 3: How resilient and adaptable is the GWS to changes and what are sustainable management strategies?
GSI	Digital Water Atlas		
GCI	Workshop: Methods for detection and attribution of non-stationary hydrological processes (October 2011, Xi'an, China)		Workshop: Assessment of basin response to environmental factors (Late 2011/Early 2012)
GCI	Phase II study with emphasis on the Water-Food-Energy Security Nexus		
GWNI			Workshop: Development of a methodology for environmental flow assessment (May 2011)

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Governance		Workshop/paper: Virtual water flow in the global water system	Special Issue Eco&Society: Global Governance
Water and Migration	Ph.D. study	Ph.D. study	Ph.D. study
	Are extremes the forcing factor in human migration in some locations?		
Water and Health	Health and extreme events?		
Water-CC Mitigation and Adaptation	Paper on water and mitigation	Synthesis paper on droughts	=GCI

GWSP after 2014:

Governing Water Across Scales and Sectors

- GSW (Global State of Water) successor of GSI&GCI, upscaling, global water cycle, water scenarios, Digital Water Atlas etc. Key joint output with „GREW (GEWEX) „Global Water Report Cards“
- WGA (Water as Global Agent) the role of water in other sectors (succ. of GWNI +)
- GPM (Governance, Policies, Management) society-nature interface and interactions at all levels for the water sector and beyond

GWSP and Extremes

GWSP could provide a framework for the assessment of the impacts of Extreme events in terms of their sensitivity to changes in human activities.

Possible opportunities:

- utilizing GWSP resources (indicators, Digital water atlas) in studies of extremes.
- introducing some survey questions related to extremes into the phase 2 GCI survey that would allow cross-basin analysis.
- using the GWSP global governance concepts to review the responses of people to extremes and to identify the role of socio-economic factors in the impacts of and responses to extremes.