The Global Water System Project (GWSP): Focus on Drylands

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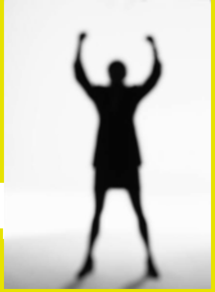
Charles J. Vörösmarty
Co-Chair of GWSP SSC
www.gwsp.org

A Collaboration of the *Global Environmental Change Programmes*

A joint project w/ financial support from:

The NEESPI / LCLUC Drylands Meeting
Urumqi, China, Sept 16-20th 2007



CENTRAL TENET OF THE GWSP

Humans are changing the global water system in a globally-significant way, but without…..adequate knowledge of the system and thus its response to change

GWSP is Science-Driven but Policy-Informing and organized around 3 science themes:

1. Quantify change and its sources
2. Uncover feedbacks in the global water system
3. Assess system adaptation and resilience

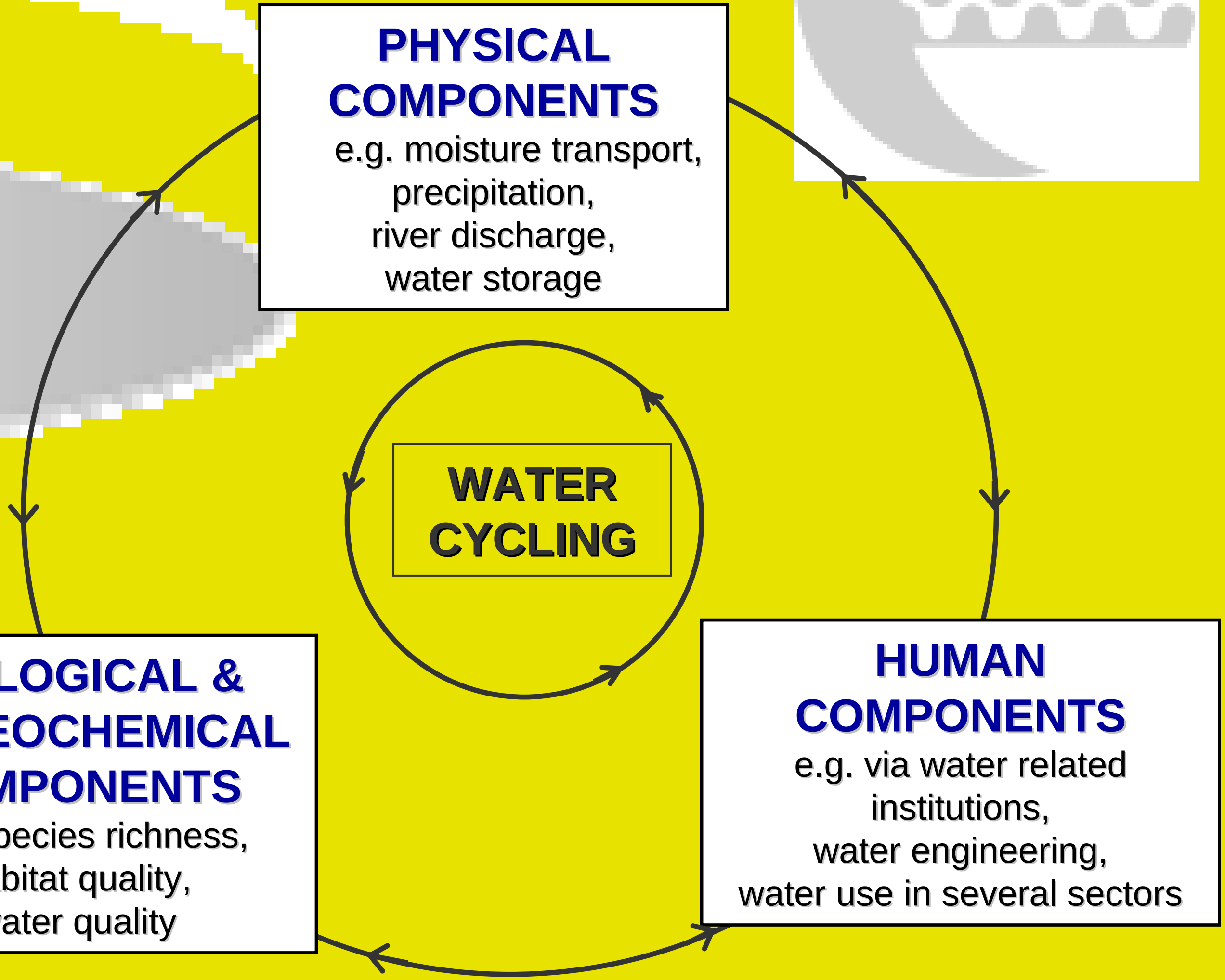
Earth System Science Partnership

GWSP Global Water System Project

The Global Water System

<u>Working definition</u>

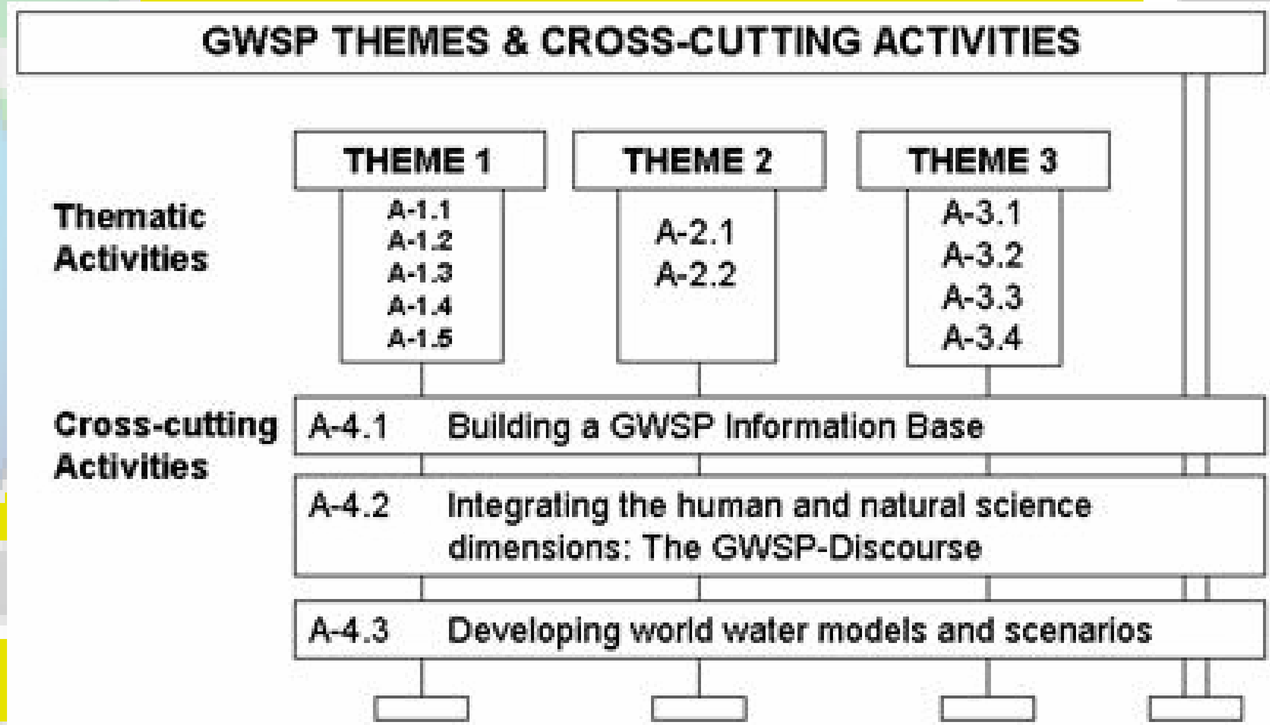
The global suite of water-related human, physical, biological and biogeochemical components, and their interactions



GWSP Implementation Strategy

- **Programme definition and initiation (2 years)**
  - **Finalize research plan**
  - **First SSC meeting February '05**
  - **Results: 1. First fast-track activities (n=10)**
    2. Regional offices established
    3. Initial sponsorship
- Production phase (3 years)
  - Three new prioritized activities: plan to be launched in the fall of 2007
  - Broaden community participation
  - Stakeholder involvement
- Data synthesis and application of results (5 years)
  - Data synthesis, application and distribution of results

Scientific Framework



Theme 1 - Magnitudes and Mechanisms of Change

A-1.1 Water Governance and the Global Water System
A-1.2 Land Cover Changes and the Global Water System
A-1.3 Climate Change and the Global Water System
A-1.4 Water Diversions and the Global Water System
A-1.5 Nutrient and Sediment Transport and the Global Water System

Theme 2 -Linkages and Feedbacks

A-2.1 Linkages at Different Spatial Scales in the Global Water System
A-2.2 Legacy of Human and Natural Interactions in the Global Water System

Theme 3 - Resilience and Adaptation

A-3.1 Water Requirements for Nature and Humans
A-3.2 The Nature of Adaptive Capacity of the Global Water System
A-3.3 Approaches to Enhancing Adaptive Capacity (the role of institutions, governance, industrial transformation)
A-3.4 The Provision of Ecosystem Goods and Services by the Global Water System

International Project Office Bonn

- •Eric Craswell (Executive Director)
- •Dr. Marcel Endejan (Deputy Executive Officer)
- •Daniel Petry (Fast-Track Activity Co-ordinator)
- •Lara Wever (Administrative & Finance Officer)

Liaison Activities w/ AffiliateGroups

- Other ESSP Joint Projects
- GECPS (WCRP/GEWEX, IHDP, IGBP, DIVERSITAS
- IGWCO, GEOSS, IHP, WWAP
- NEESPI and Other Adopted Case Studies

Facilitation, Coordination & Communication

10 Fast Track Activities

- Lexicon
- GWS Atlas
- Water Indicators
- Environmental Flows
- Governance Workshop
- GWSP-LOICZ Partnership
- Advanced Institute
- Case/Regional Studies
- Science Article
- WWDR-Review

Formulate agenda
Oversight

Identify outputs
Execute activities

Science Steering Committee

- •Charles Vörösmarty (Co-Chair, Executive Committee)
- •Joseph Alcamo (Co-Chair, Executive Committee)
- •Dennis Lettenmaier (Executive Committee)
- •Robert Naiman (Executive Committee)
- •Claudia Pahl-Wostl (Executive Committee)
- •Stuart Bunn
- •Malin Falkenmark
- •Joyeeta Gupta
- •Felino Lansigan
- •Changming Liu
- •Jose Marengo
- •Christer Nilsson
- •Eric Odada
- •Jay O'Keeffe
- •Taikan Oki

GWSP National/Regional Groups

- •Japan, China, U.S., India (under discussion)
- •GWSP-Asia w/ Southeast Asia (under discussion)
- European (neWater, Framework study teams)

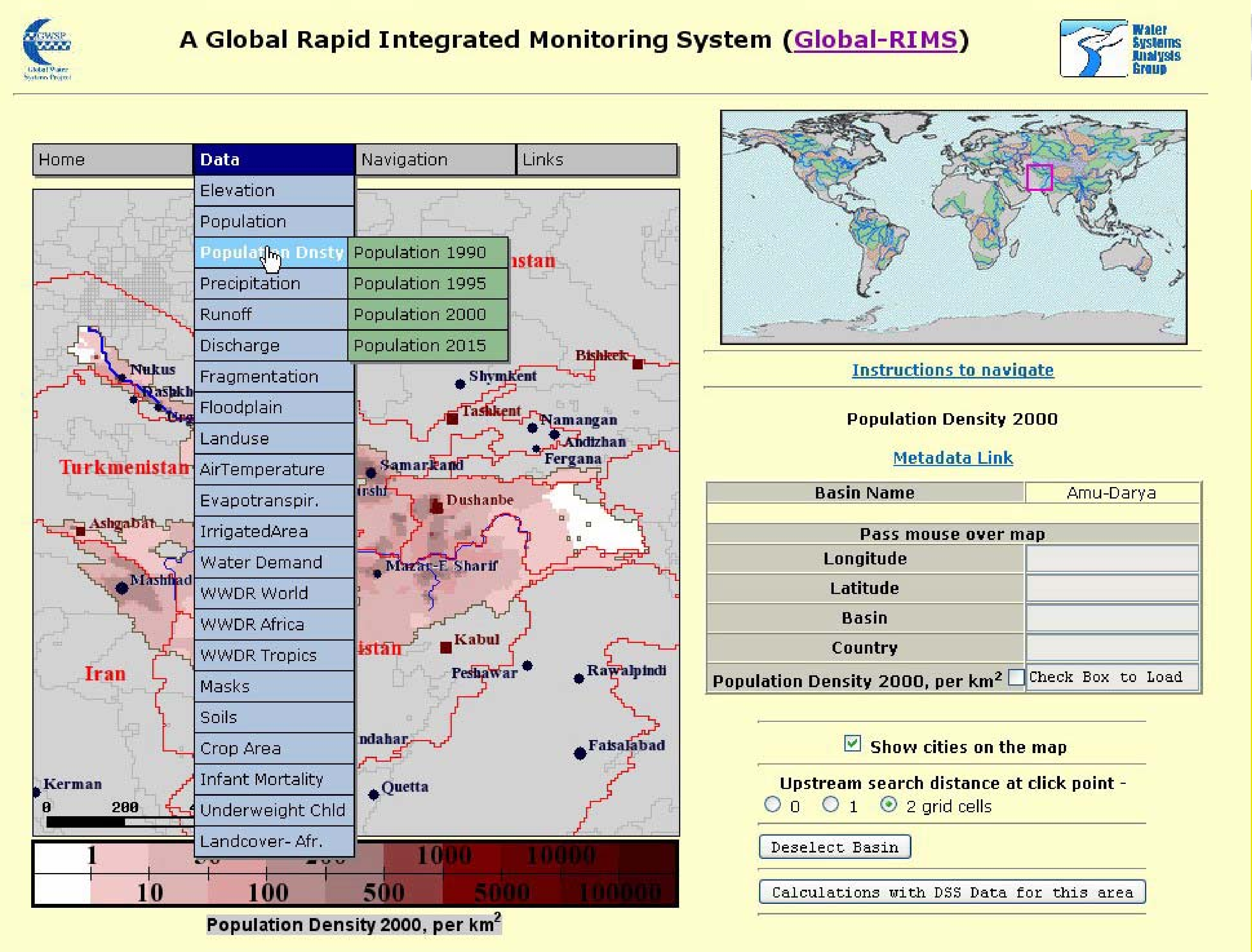
Earth System Science Partnership

GWSP Global Water System Project

Global-RIMS (Atlas, Indicators)

includes regional, continental and global datasets at resolutions from 6’ to 30’

Functuanallity of system: Data mounting; Data preprocessing; Data navigation and display



Data calculation and manipulation system

Calculations with RBIS-UNEP Data for Selected Area

Macro Calculator for Selected Area

Parameter	Unit	Symbol	Parameter	Unit	Symbol	Parameter	Unit	Symbol
Elevation	m	D1	Irrigated Area	km^2	D13	Population Density 1990	per km^2	D25
Precipitation 6'	mm/yr/grid	D2	N Load	T/grid/yr	D14	Population Density 1995	per km^2	D26
Runoff, CMP 6'	mm/yr/grid	D3	AirTemperature Calculated	Degrees Celsius/grid/yr*	D15	Population Density 2000	per km^2	D27
Actual Evapotranspiration	mm/yr*	D4	Infant Mortality Rate	deths per 10,000	D16	Population Density 2050	per km^2	D28
Discharge	km^3/grid/yr*	D5	Runoff	mm/yr*	D17	Population 1950, Total	per grid	D29
Discharge Corrected	km^3/grid/yr	D6	Irrigated Area (402)	percent per gridcell	D18	Population 2000, Total	per grid	D30
Water Use 2000, Agricultural	km^3/grid/yr	D7	Water Use 1960, Agricultural	km^3/grid/yr	D19	Population 2030, Total	per grid	D31
Water Use 2000, Domestic	km^3/grid/yr	D8	Water Use 1960, Domestic	km^3/grid/yr	D20	Discharge Calculated	m^3/grid/sec/yr*	D32
Water Use 2000, Industrial	km^3/grid/yr	D9	Water Use 1960, Industrial	km^3/grid/yr	D21	Discharge Composite	m^3/grid/sec/yr*	D33
Cultivated Land Mask	fraction	D10	Precipitation Observed 1deg	mm/grid/yr*	D22	Runoff Modeled	mm/yr*	D34
Crop Area	fraction	D11	Flood Plain	value	D23	Discharge Variability	ratio	D35
Cell Area 6m	m^2	D12	Low Slope	value	D24	Active Streamorder	1-10 scale	D36

*Time Series default units- See instructions.

Enter equation using dataset symbols from the above table. Example- **(D1 + D2)/2 + sqrt(D3)**

Equation - (D6-D7-D8-D9)*1000000/D30 Force range to: Min= Max=

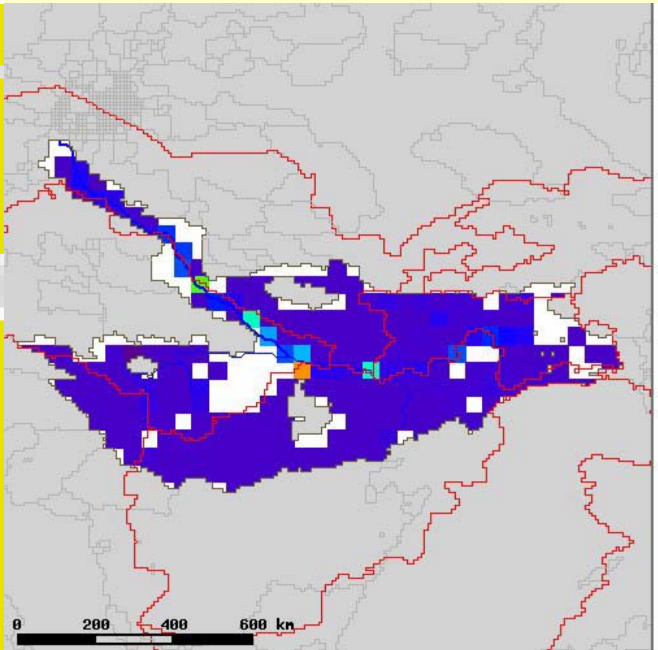
Options - Equation for Cell Cumulative: CC = Number of grid cells: NC.

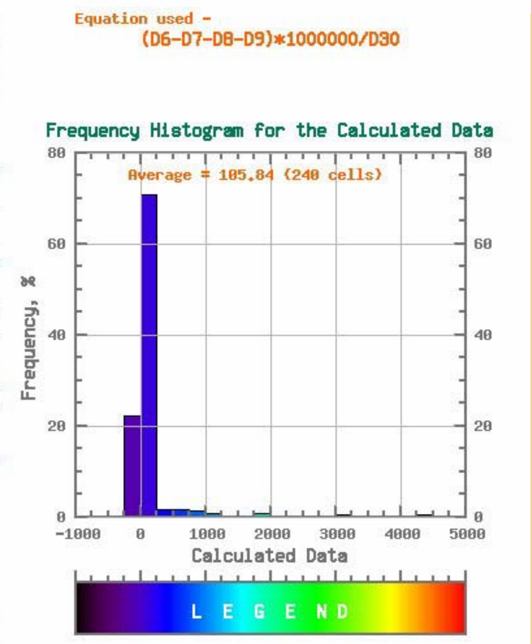
All arithmetic operators could be used, such as: + - * / ** **(?:)**, as well as most of commonly used scalar functions (help), such as **sqrt(), abs(), exp(), log(), sin(), cos(), tan()**, etc.

Parameters and functions are case insensitive, and spaces are allowed. ☐ Use Log Scale ☐ Use high resolution for data alignment

Do Calculations | Reset | ☑ Replace Illegal Operation with "nodata" | ☐ Get Results as Data | Legend: ○ B/W ◉ Rainbow | Return to Data Explorer

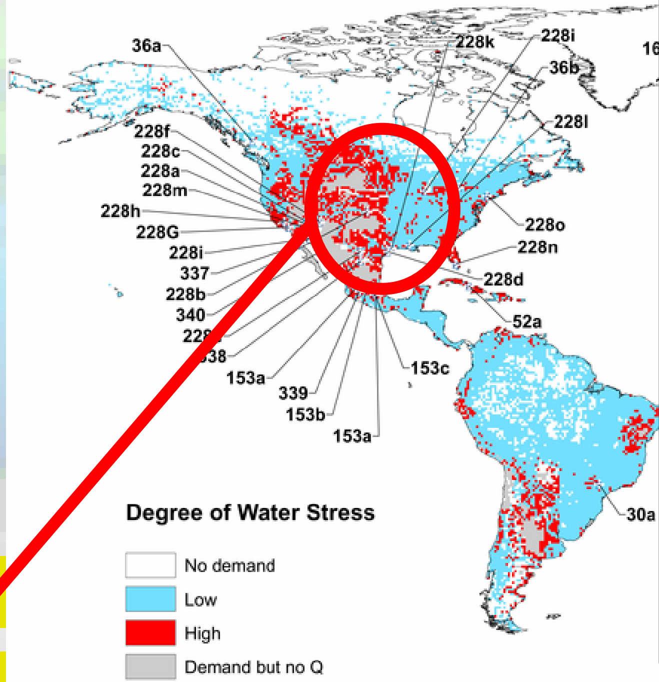
Calculation Results for Selected Area



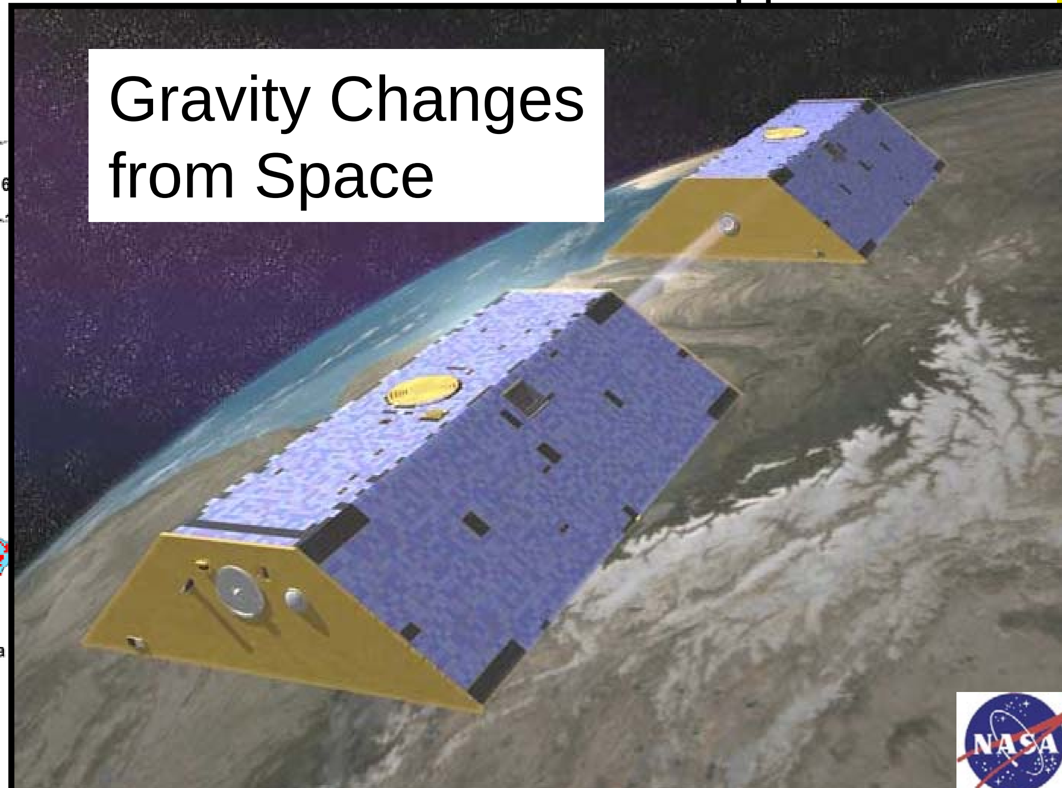


Currently water use exceeds water resources over ~ 20% of Amudarya drainage basin

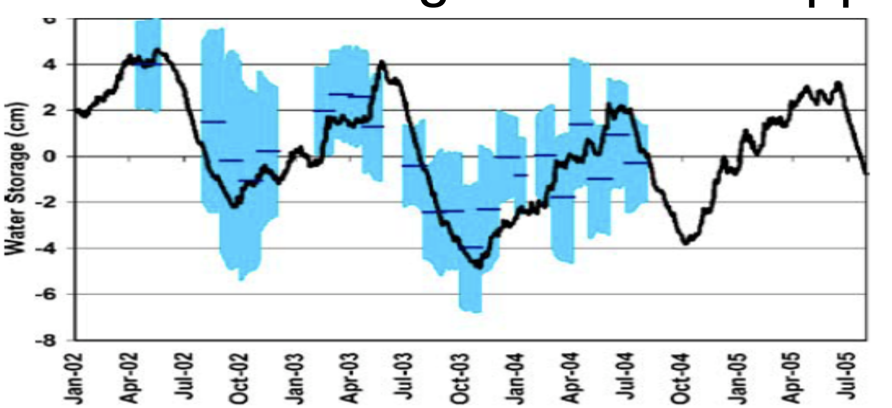
Irrigation & Urban Water Use in Excess of Sustainable Supplies



Gravity Changes from Space



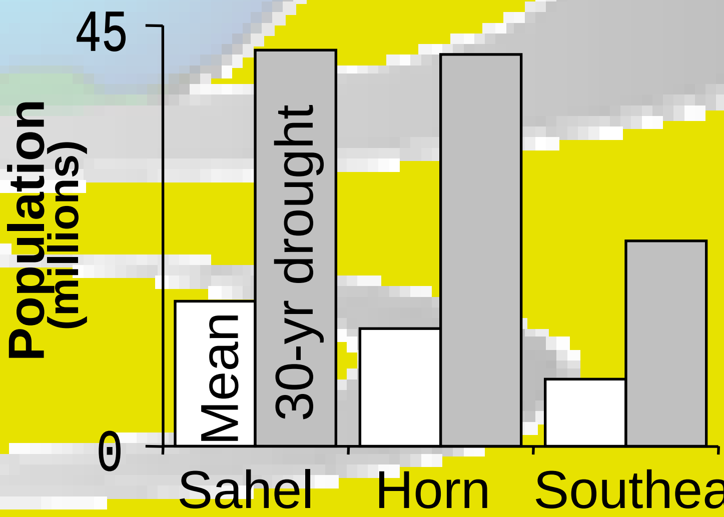
GRACE Δstorage for Mississippi

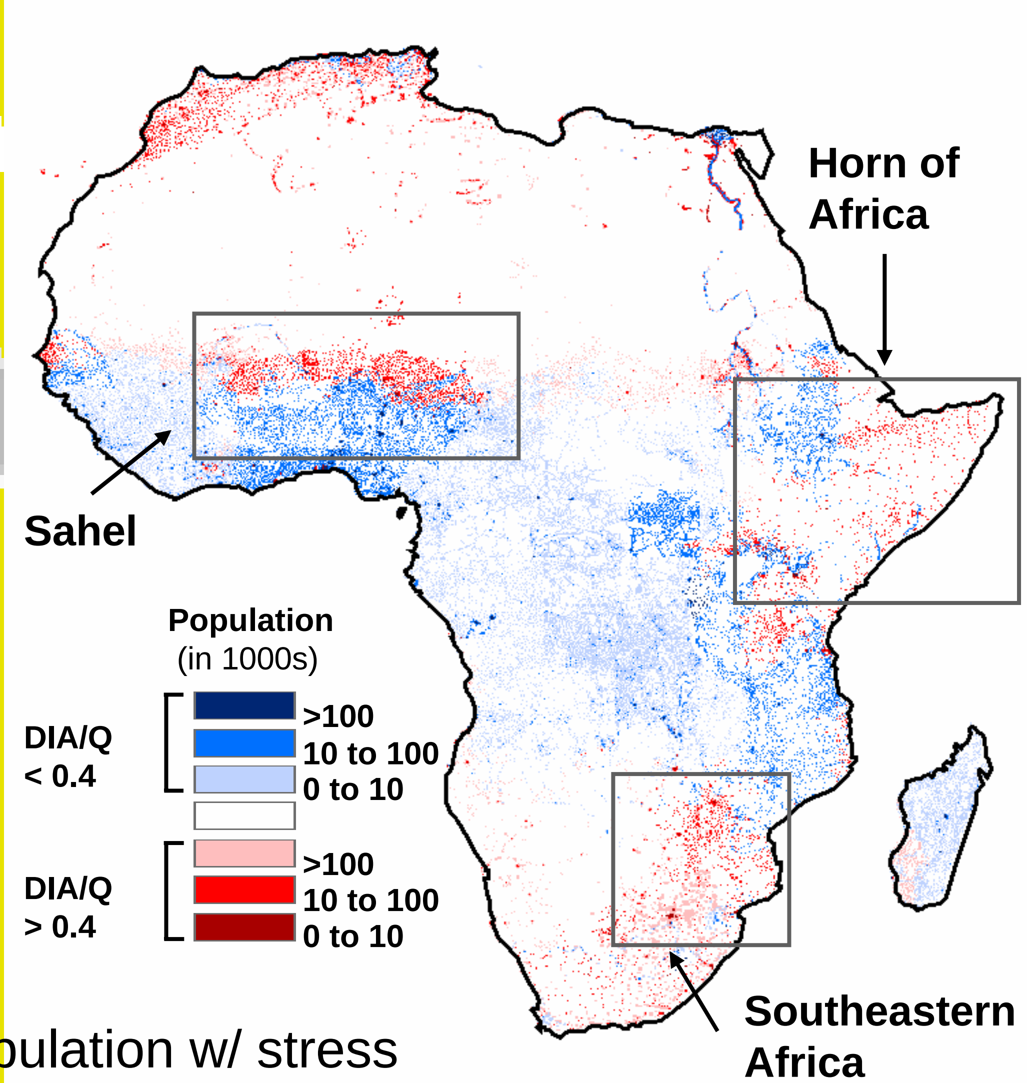


UNIVERSITY *of* NEW HAMPSHIRE

Drought Is Key Feature of African Security Issues

Population Above and Below Water Stress Threshold During Drought
-- 30-year duration statistics





Continental total: Mean --> 25% population w/ stress
30-yr drought --> 40%

Vörösmarty et al. 2005

WBM/WTM ... WBMPlus

- **WBM/WTM**
  - **1-D physically based macroscale hydrological model (Vörösmarty, 1998)**
  - **WTM Routing based on river network (STN)**
- **WBMPlus**
  - **WBM + irrigation + reservoirs; daily time step (real time routing, irrigation, reservoirs)**

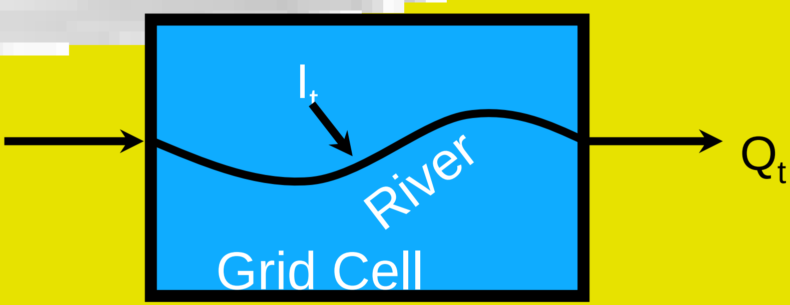
Flow routing model

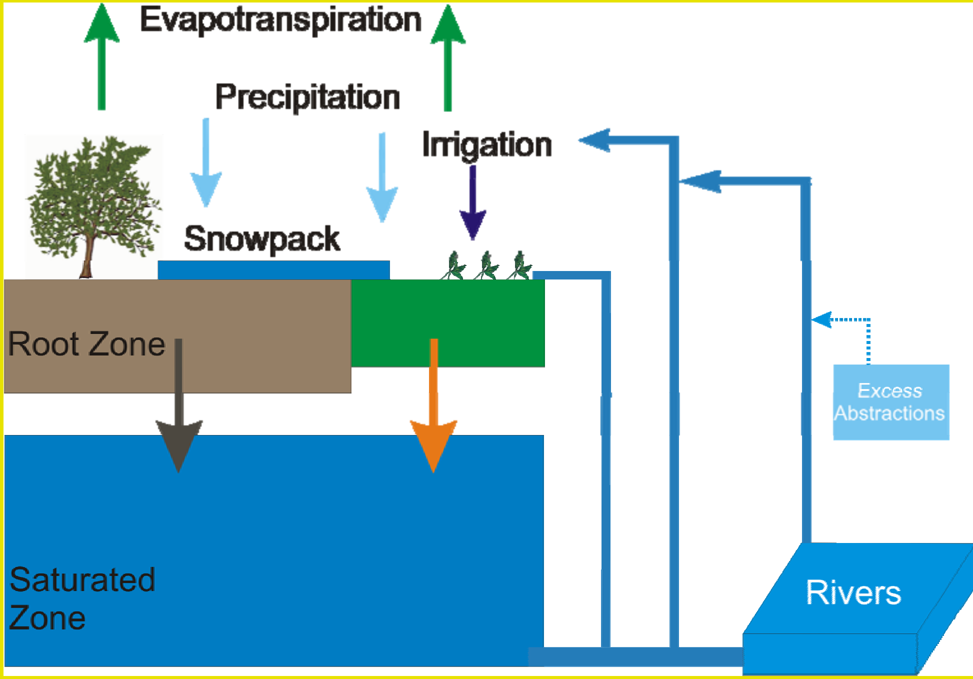
$$Q_{t+1} = C_0 I_{t+1} + C_1 I_t + C_2 Q_t$$

Coefficients C_0, C_1, C_2, = f(River Geometry)

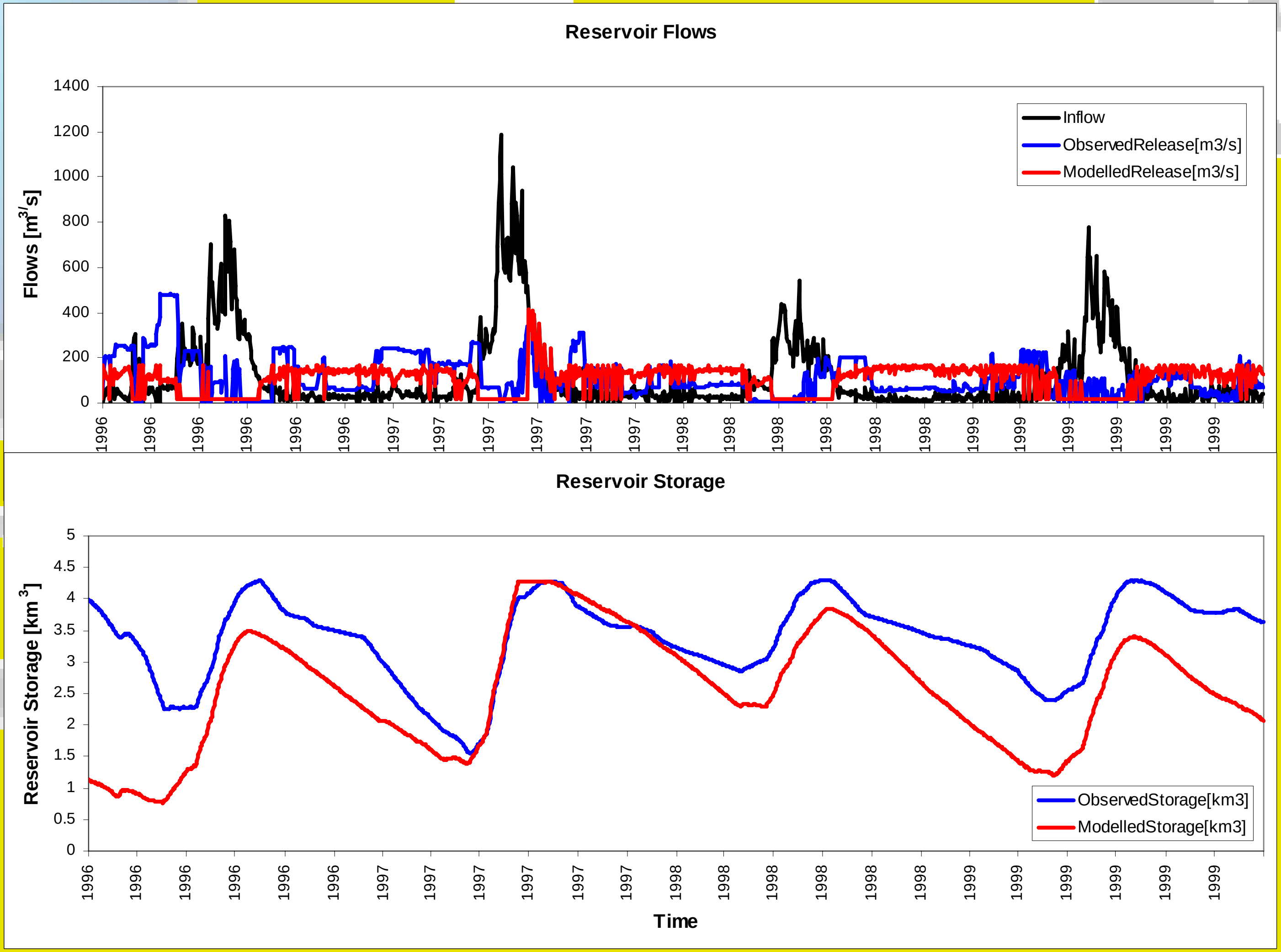
Q = river discharge from grid cell

I = locally generated inflow to river (less irrigation)

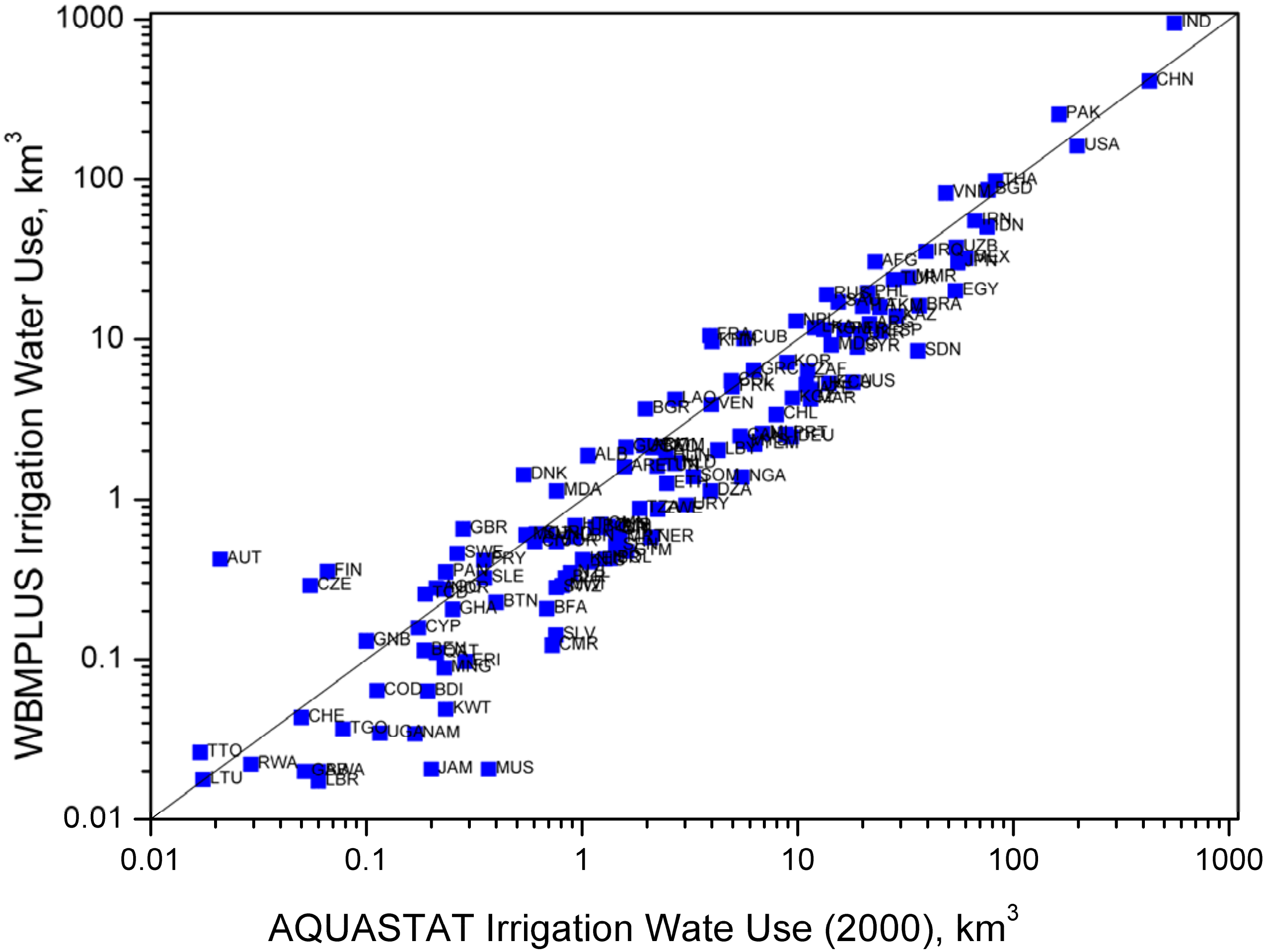




Reservoir Routing

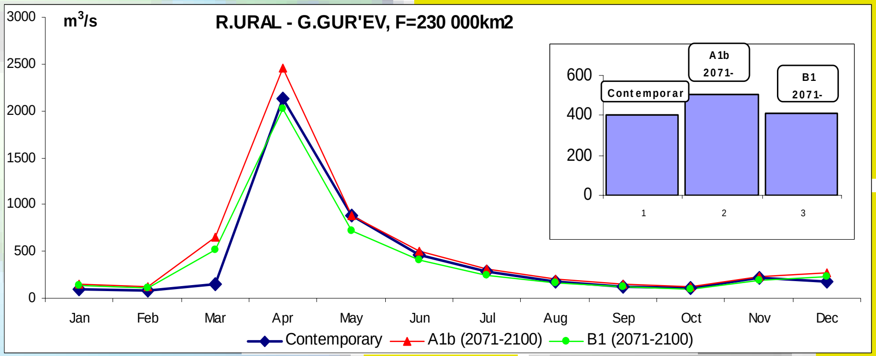


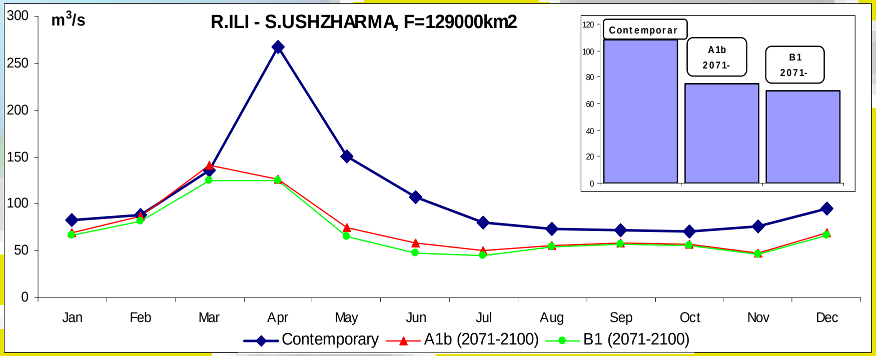
WBM Irrigation Results

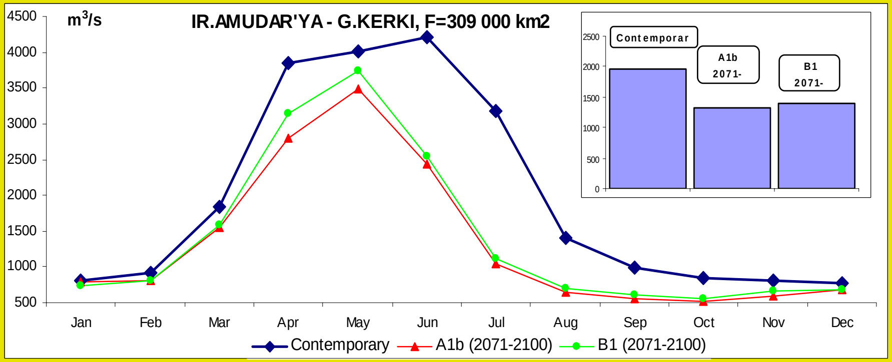


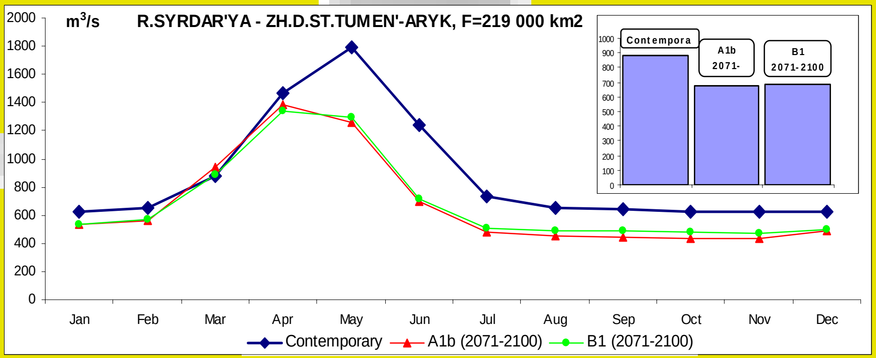
Simulations of WBMPlus with ECHAM-5 A1b and B1 scenarios

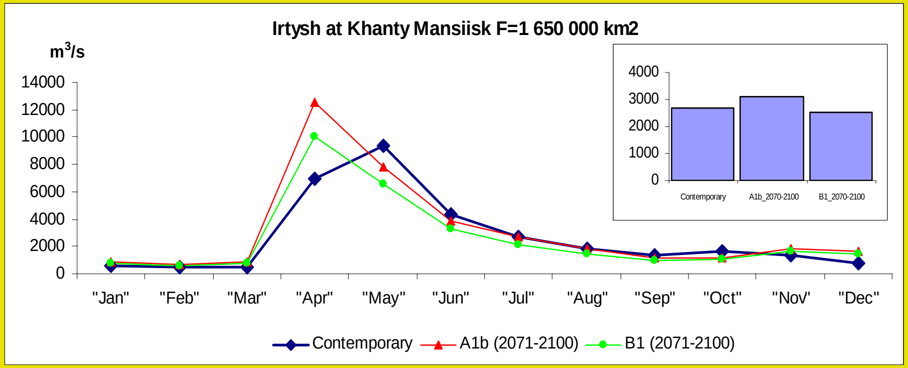
Large river basins in Central Asia



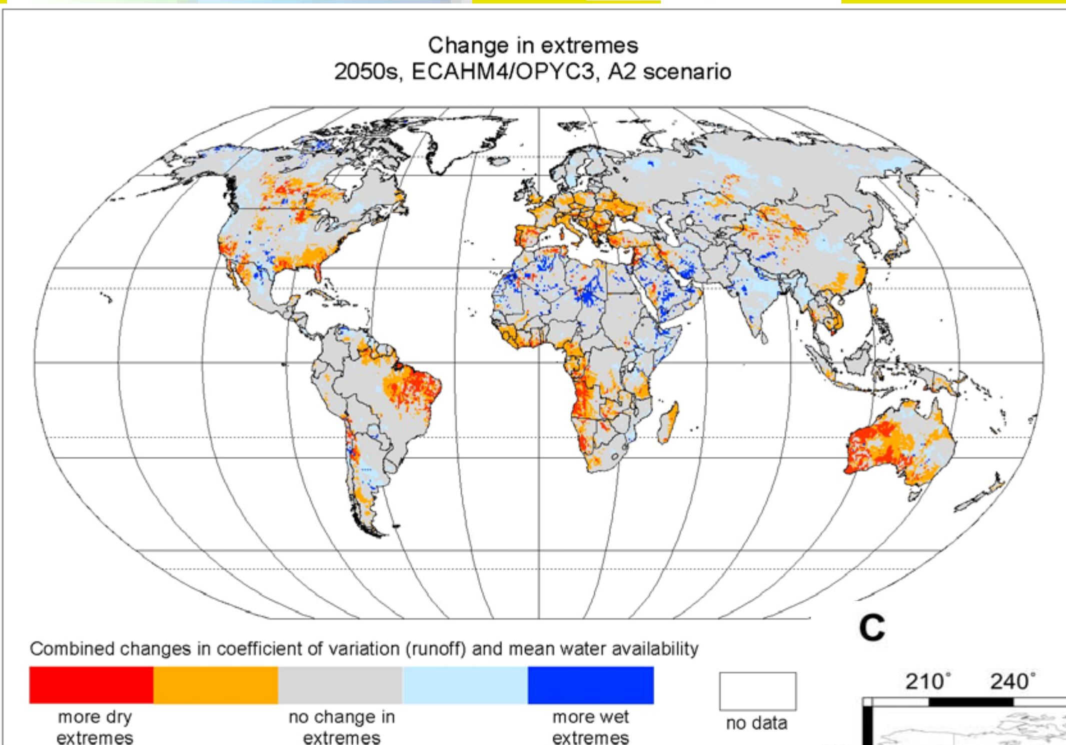






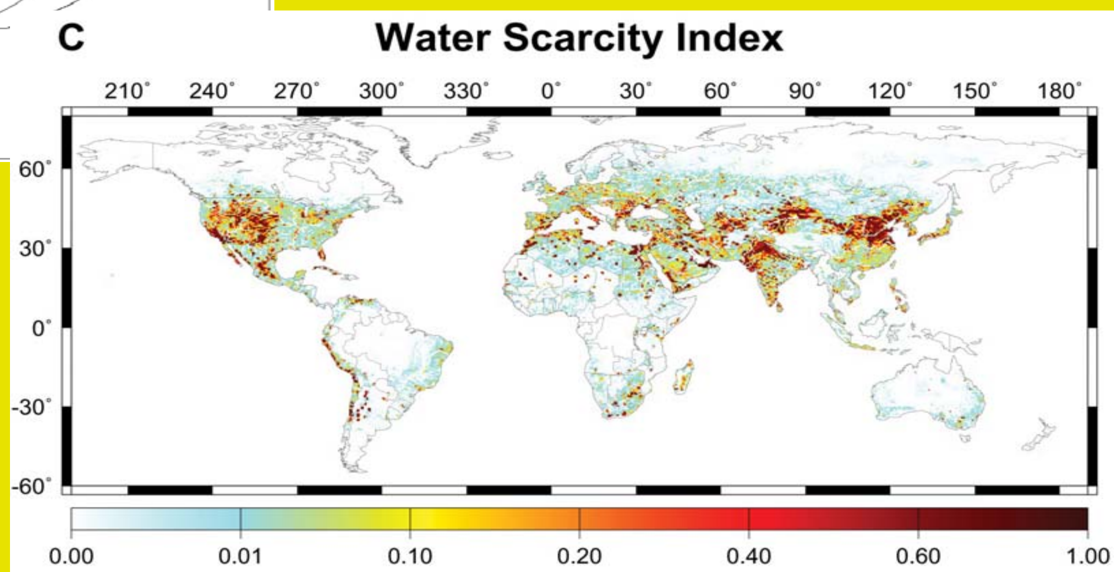


New Integrated Study Area
GLOBAL-SCALE INITIATIVE (GSI)



Modelling
the impact
of climate change
on the GWS

Alcamo et al.
(submitted)



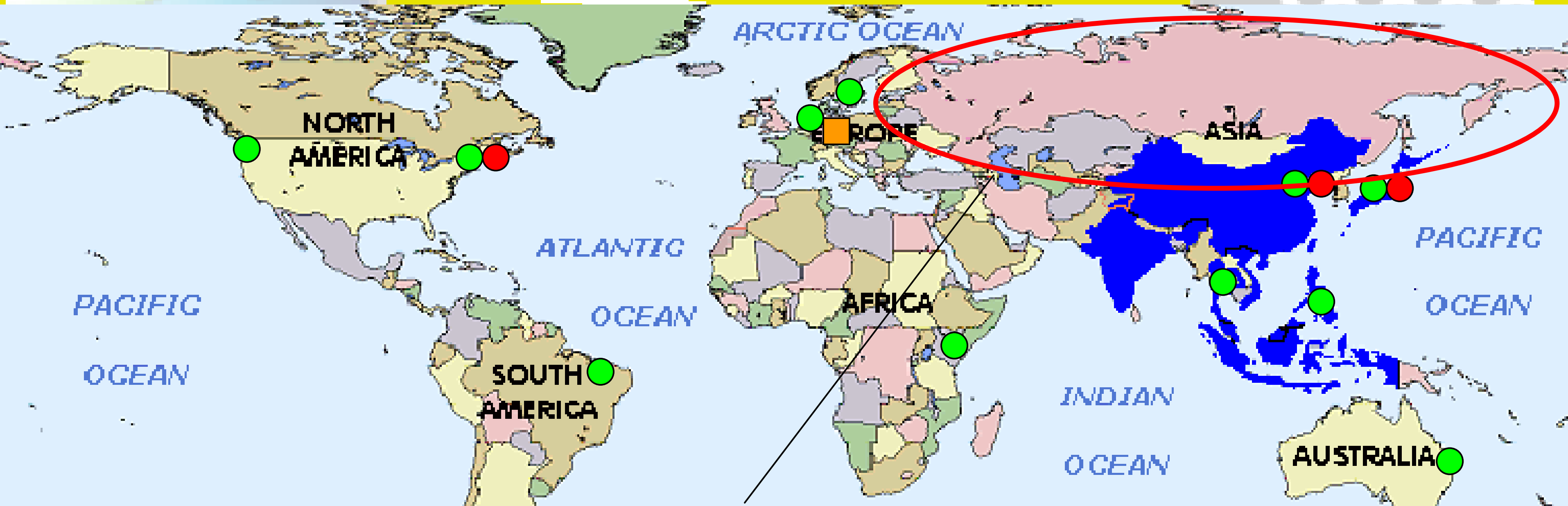
Oki & Kanae
(2006)

GWSP Regional Case-study Criteria

*…or the way we choose our regional studies to support the "**G**" in GWSP*

- *driven by continental-to-global perspectives*
- *link to highest degree possible biogeophysical, biology, biogeochemistry, human dimension perspectives*
- *focus on change-detection, attribution, feedbacks, and/or impacts*
- *achievable, trackable, product-driven*
- *targetted to engage other groups*
- *help answer key question of pandemic local or systematic GWS change*
- *help in comparative studies*

GWSP – A Growing World-Wide Network



NEESPI adopted as regional focus project, bringing important high-latitude/arid/semi-arid perspectives to GWSP

Legend

- GWSP Asia Network
- Member of Scientific Steering Committee
- National GWSP Committee
- GWSP International Project Office

Earth System Science Partnership

GWSP Global Water System Project

NEESPI Has a Broad Portfolio of Water System Studies

- Of 84 funded proposals, ~30 water-themed:

  6 Water and Land Use/Cover Change
  3 Hydrological Extremes
  3 Water Use and Engineering
  3 Integrative
  1 Coastal/Shelf Systems
  5 Cryosphere/Permafrost
  6 Snow
  2 Data Support
  1 Inland Water Quality

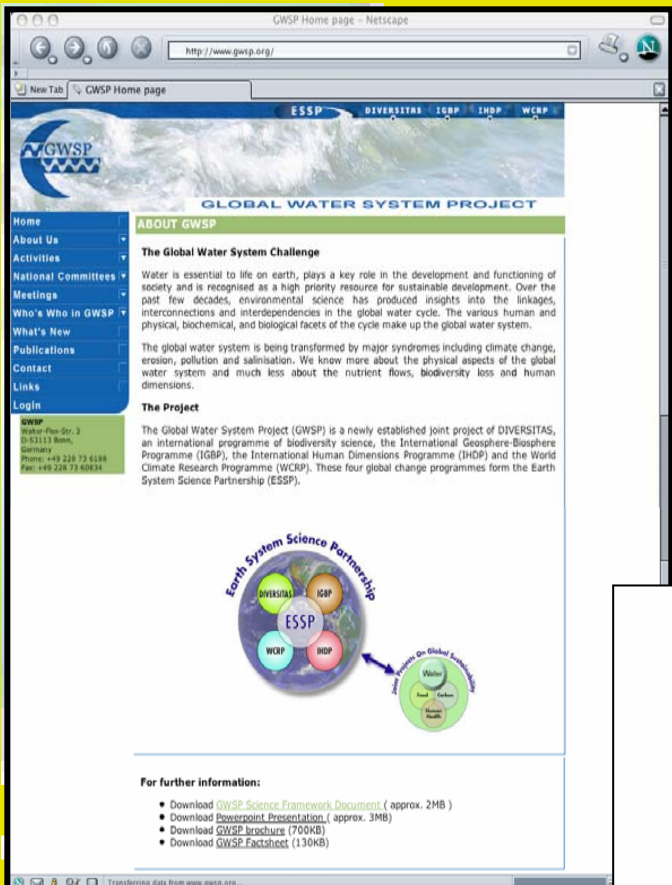
- Several Approaches
  - Broad-scale *in situ* and remote sensing
  - Modeling and geospatial analysis
  - Integrated data systems
  - Field studies

NEESPI Themes Meet These Criteria

- Multi-dimensional change over broad continental area (LUCC, Climate, Population Growth, Water Engineering, Emerging Economies)
- Region critical to Earth System (planetary heat balance, trace gases, fw fluxes to ocean)
- Impacts transend disciplinary realms and affect water, energy, C, constituents, & human systems

What Can NEESPI & GWSP Do for Each Other?

- NEESPI science issues strongly water-related
- NEESPI an ideal regional focus study of GWSP
- Attribution studies (*GWSP Question1*) & resilience / adaptability / governance issues (*GWSP Q3*) are clear avenues of collaboration w/ NEESPI
- Jointly developing hydrometeorological data integration & indicators of N. Eurasian water system state would be mutually beneficial (*GWSP Indicators and Atlas Cross-cutting Themes*)


GWSP Home page – Netscape

http://www.gwsp.org/

ESSP DIVERSITAS IGBP IHDP WCRP

GWSP

GLOBAL WATER SYSTEM PROJECT

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ABOUT GWSP

The Global Water System Challenge

Water is essential to life on earth, plays a key role in the development and functioning of society and is recognised as a high priority resource for sustainable development. Over the past few decades, environmental science has produced insights into the linkages, interconnections and interdependencies in the global water cycle. The various human and physical, biochemical, and biological facets of the cycle make up the global water system.

The global water system is being transformed by major syndromes including climate change, erosion, pollution and salinisation. We know more about the physical aspects of the global water system and much less about the nutrient flows, biodiversity loss and human dimensions.

The Project

The Global Water System Project (GWSP) is a newly established joint project of DIVERSITAS, an international programme of biodiversity science, the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP) and the World Climate Research Programme (WCRP). These four global change programmes form the Earth System Science Partnership (ESSP).

For further information:

- Download GWSP Science Framework Document (approx. 2MB)
- Download Powerpoint Presentation (approx. 3MB)
- Download GWSP brochure (700KB)
- Download GWSP Factsheet (130KB)


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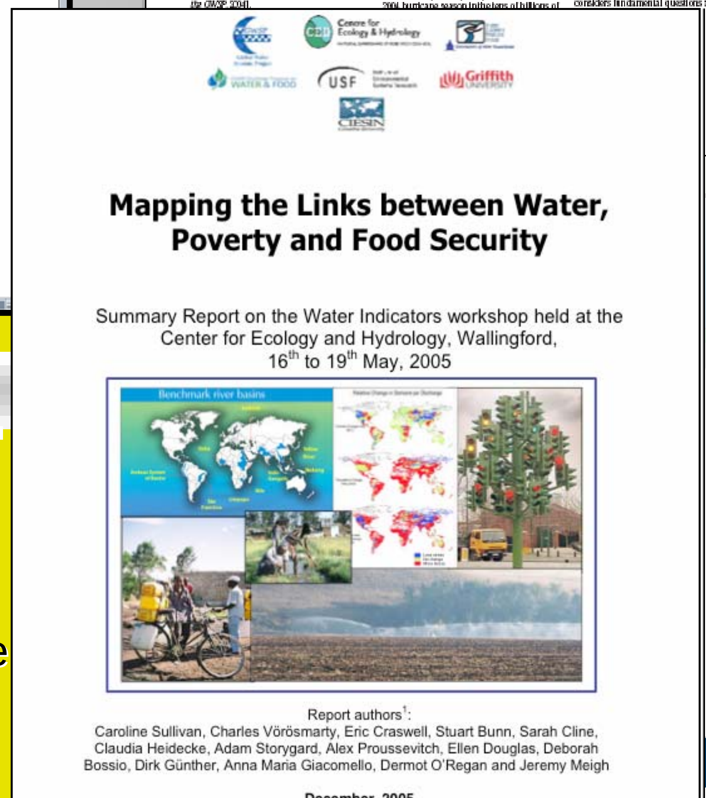
Humans Transforming the Global Water System

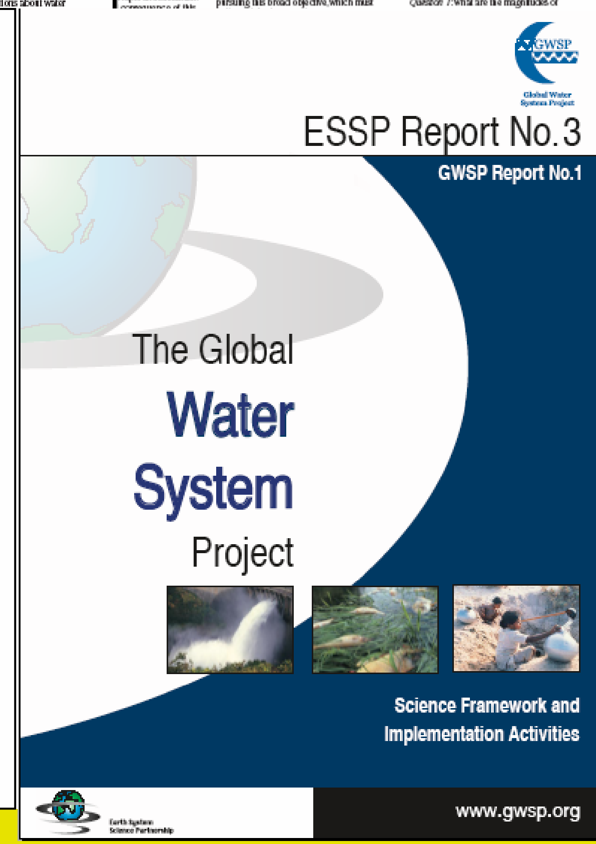
Fig. 1. The Global Water System under natural conditions is a complex amalgam of pools and dynamics, linked through complex interactions defined by the physics, biogeochemistry, and biology of the planet.


Mapping the Links between Water, Poverty and Food Security

Summary Report on the Water Indicators workshop held at the Center for Ecology and Hydrology, Wallingford, 16th to 19th May, 2005

Report authors[1]:
Caroline Sullivan, Charles Vörösmarty, Eric Craswell, Stuart Bunn, Sarah Cline, Claudia Heidecke, Adam Storygard, Alex Proussevitch, Ellen Douglas, Deborah Bossio, Dirk Günther, Anna Maria Giacomello, Dermot O'Regan and Jeremy Meigh

December 2005


GWSP
Global Water System Project

ESSP Report No. 3

GWSP Report No.1

The Global **Water System** Project

Science Framework and Implementation Activities

Earth System Science Partnership

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