Global Water Resources

Using Science and Technology to Meet a Strategic Resource Challenge

C.J. Vörösmarty NOAA-CREST Distinguished Scientist (The City College of New York) and Director, CUNY Environmental Cross-Roads Initiative……and many partners

CREST-NESDIS Annual Technical Meeting
Silver Spring Metro Complex 3
7 December 2009

PRECIPITATION & WATER RESOURCES (CREST Thrust Area-3)

Hydro-Climate (Thrust Area 3a)

at: CCNY, HU, UPRM

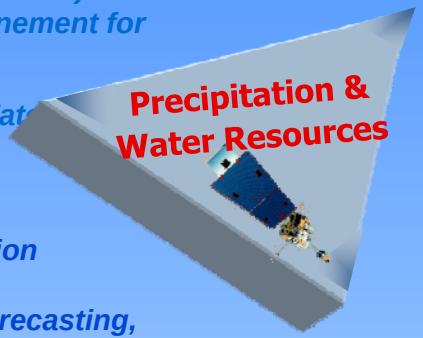
(NOAA-NESDIS, -NWS, -MDL, & OAR, & CIMMS)

NOAA Missions:

1. Weather & Water Science Technology (NESDIS)
2. Infusion Program through Algorithm Refinement for Current Satellite Instruments (NESDIS)
3. Climate Missions (NESDIS)
4. Serve Society's needs for Weather and Wat Information (NWS)

CREST GOALS:

1. Improvement of satellite-based precipitation (rainfall/snowfall) retrievals,
2. Improvement of precipitation and flood forecasting,
3. Understanding interaction between climate variability & precipitation,
4. Validation of satellite-based precipitation products for improving their algorithms.



Land Hydrology

at: CCNY & UPRM

(NOAA-NESDIS, -NWS, -MDL, & OAR, & CIMMS)

NOAA Missions:

1. Reduced loss of life, injury, and damage to the economy
2. Better, quicker, and more valuable weather and water information to support
3. Improve decisions
4. Increased customer satisfaction with weather and water information and services

CREST GOALS:

1. Improvement of land surface emissivity retrieval for a better weather prediction modeling
2. Improvement of soil moisture retrieval and hydrological modeling for better FFG, Flash Flood Guidance maps (NOAA-NWS)
3. Implementation of an automated algorithm for sea ice mapping for the future GOES-R ABI (NOAA-NESDIS)
4. Snow proprieties retrieval and analysis of snowpack behavior changes

"Global Water Resources"

at: CCNY

(NOAA-NESDIS, -NWS, …)

NOAA Missions:

1. Weather & Water Science Technology (NESDIS)
2. Climate Missions (NESDIS)
3. Serve Society's needs for Weather and Water Information (NWS)
4. Ecosystem management and stewardship (NOS)

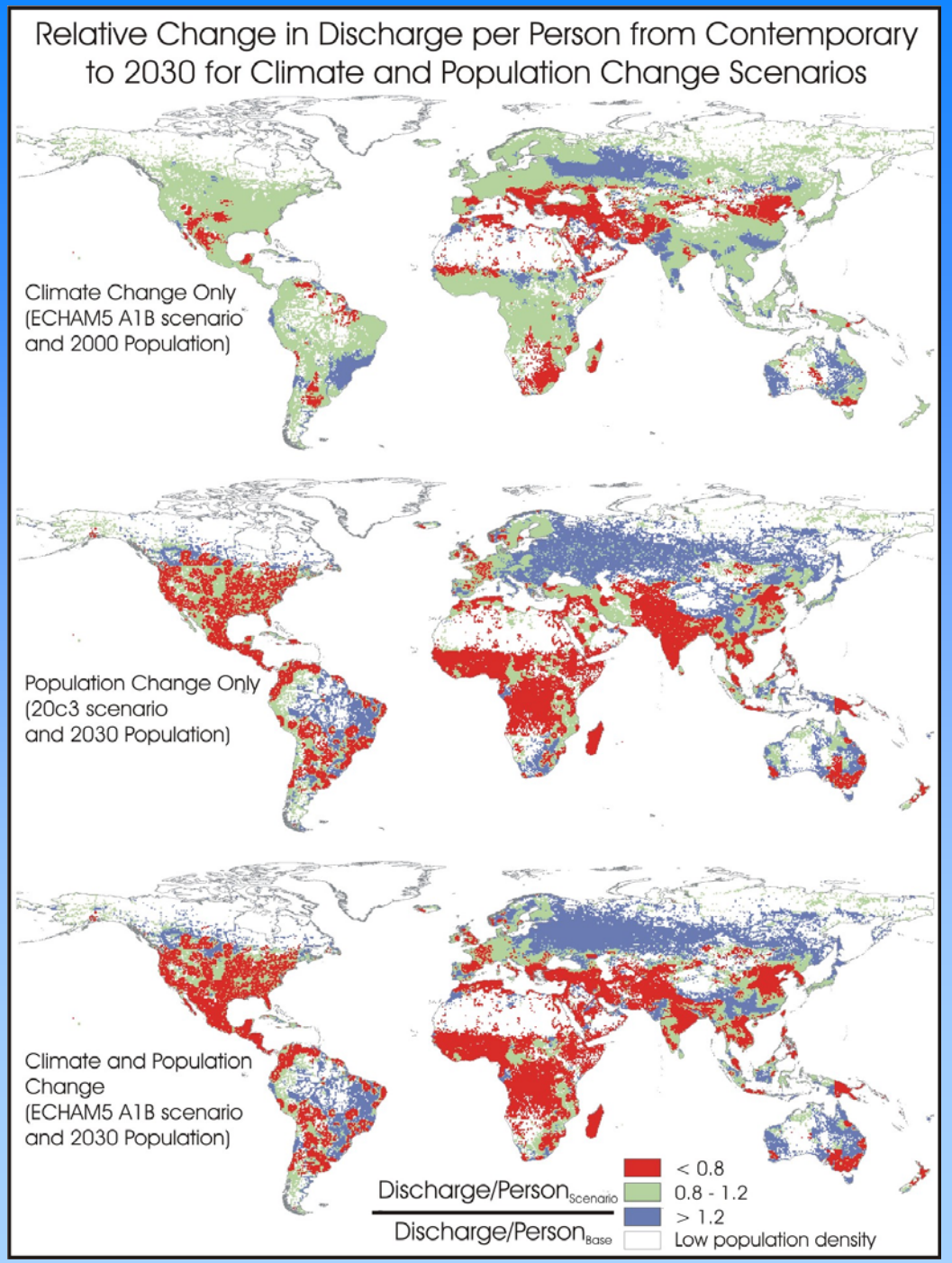
CREST GOALS:

1. Assess impacts of climate change
2. Enhance relevancy of geophysical products
3. Articulate land-to-ocean links
4. Build awareness of ciriticality of global water resource threats

CREST GOALS:

1. ***Assess impacts of climate change***
2. *Enhance relevancy of geophysical products*
3. *Articulate land-to-ocean links*
4. *Build awareness of criticality of global water resource threats*

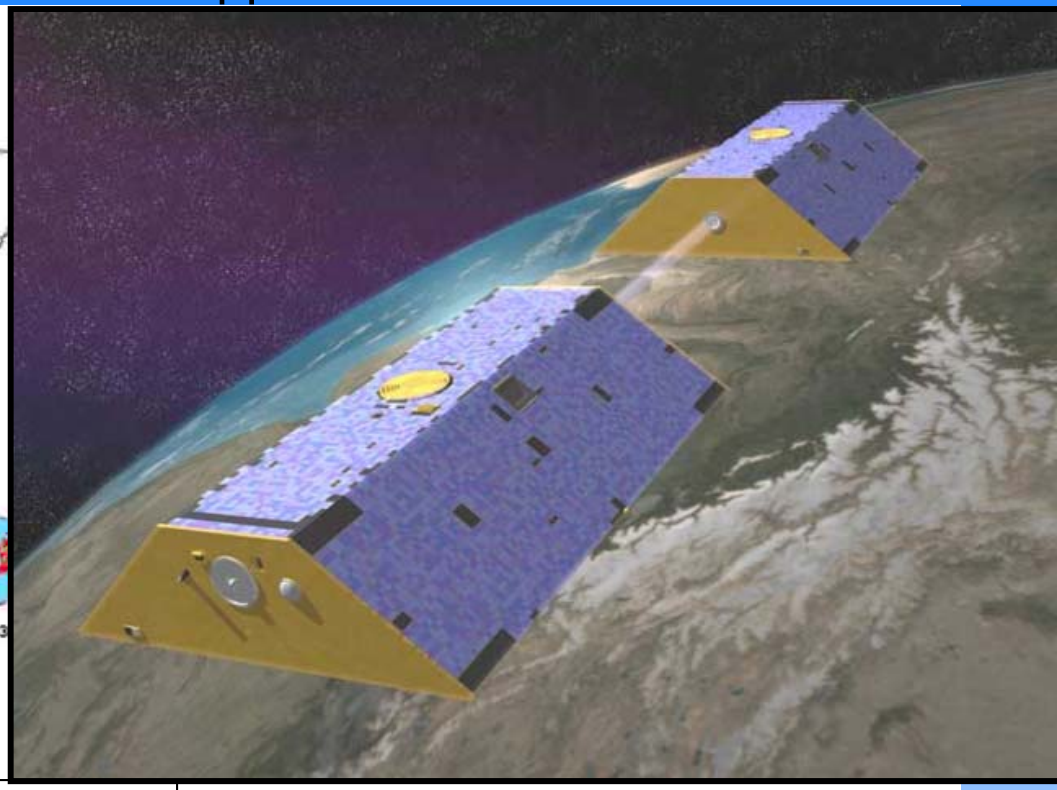
- Climate Change only part of our water resource worries
- Population growth and economic development another critical issue



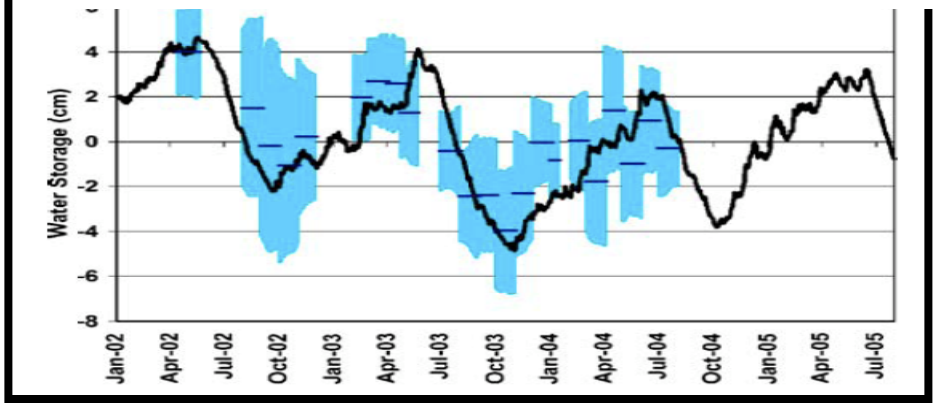
Work of CUNY Environmental Cross-Roads Initiative for National Intelligence Estimate (NIE)

Irrigation & Urban Water Use in Excess of Sustainable Supplies

Documentary evidence and simulations now converging



GRACE Δstorage for Mississippi



Western US Basin Transfers

Great Man-Made River Project, Libya

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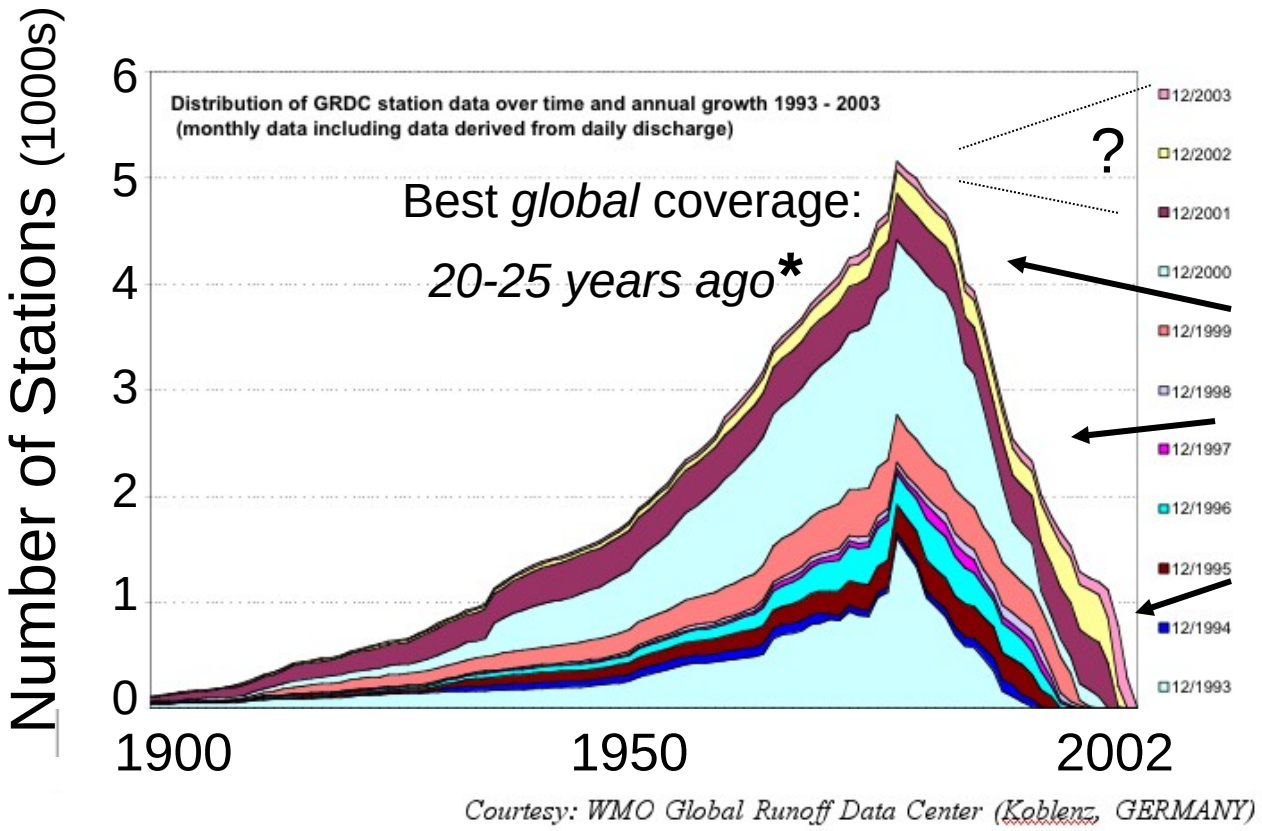
HISTORY OF OUR "Ground Truth" INFORMATION BASE

- WMO Global Runoff Data Center Archives



Courtesy: WMO Global Runoff Data Center (Koblenz, GERMANY)

Future data availability highly uncertain

- Data Bank Closure
  - -- Commercialization of data
  - -- Legislative challenges/IP rights
- Station network losses
- Delays in data reduction & reporting
- Worst in developing world

Colors refer to archive "date stamp"

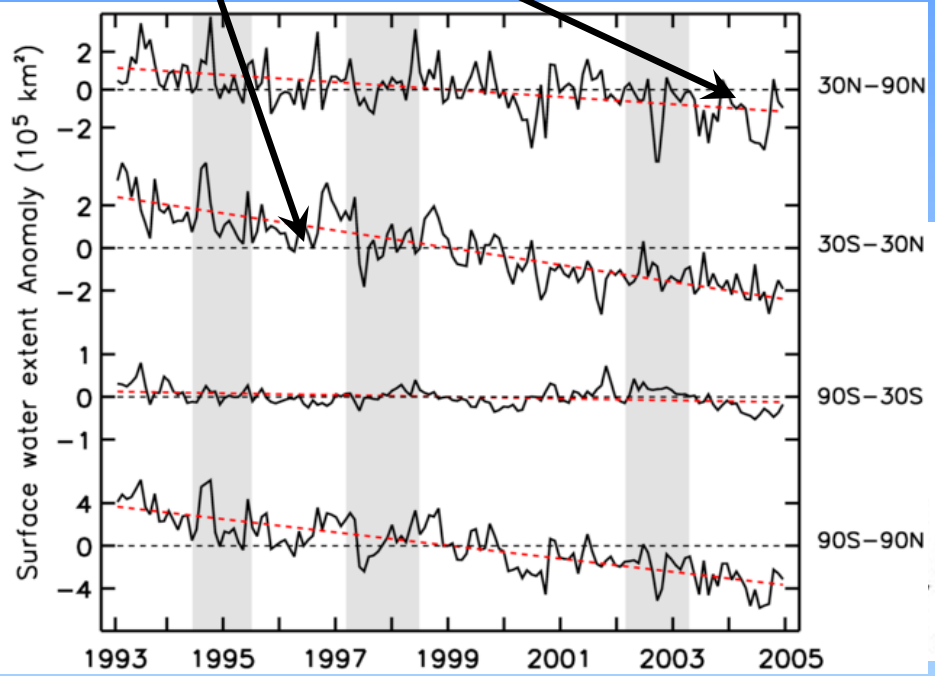
*Additional records certainly exist (e.g. national collections) --but currently unconsolidated & often in difficult-to-use, non-digital formats; dedicated global archive is in decline

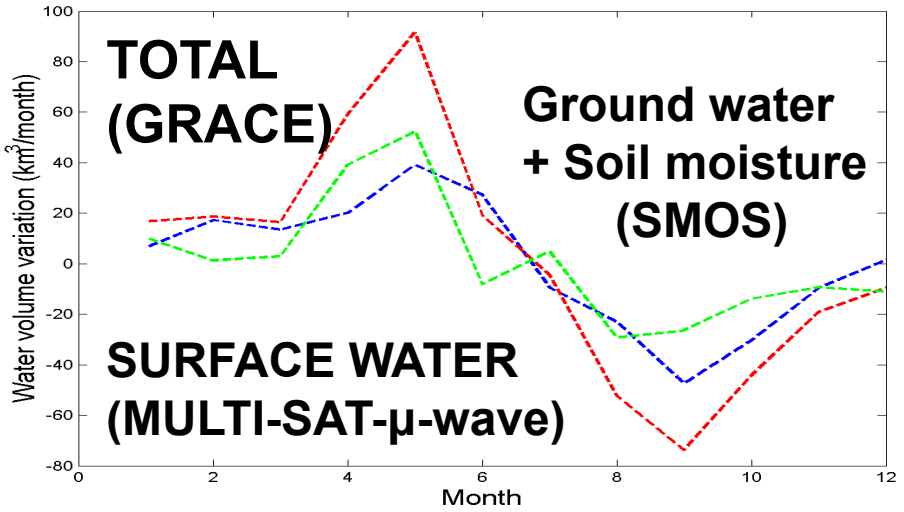
Vörösmarty 2002; Hydro. Proc.

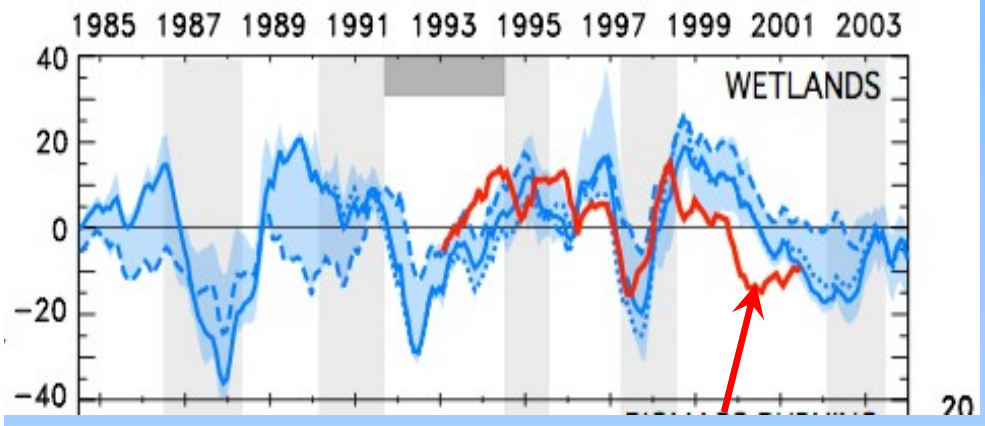
Terrestrial Hydrology & Water Cycle Products [flood extent, (soil moisture, snow water equivalent), runoff, deep storage, precipitation evaporation] beginning to be used for hydrology and climate studies, methane and carbon studies, evaluation of recent changes at regional scales

Are Tropical Changes Associated With Population Increases?

Are Boreal Changes Associated With Warming?







Calculated CH_4

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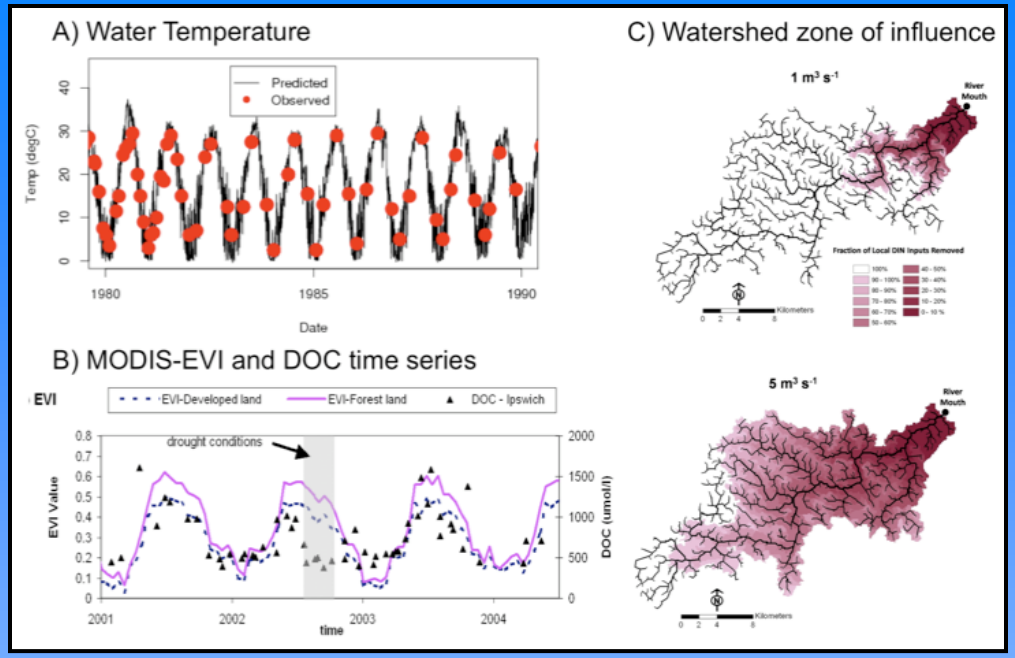
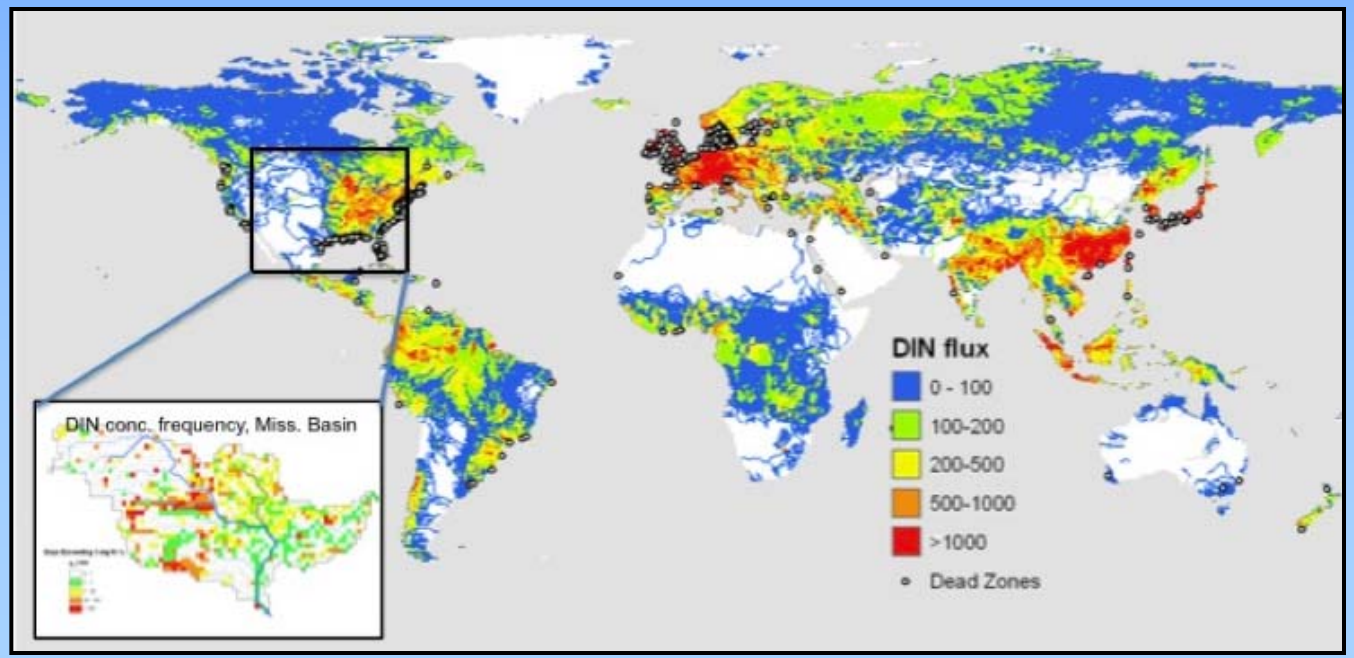
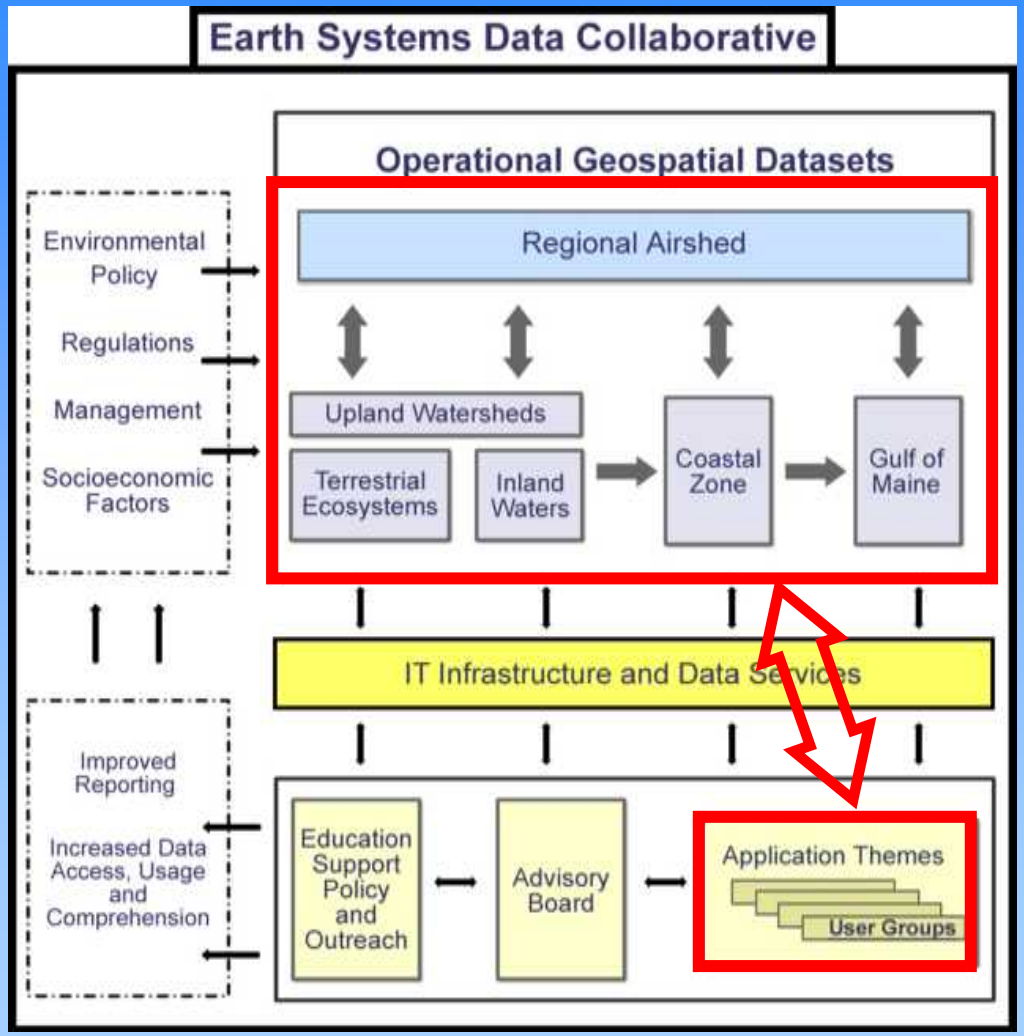


Emerging Capabilities to Simulate In-basin, In-stream & Time-varying Land-to-Ocean Constituent Fluxes

FrAMES: Framework for Aquatic Modeling of the Earth System

(Fekete, Wollheim, Vörösmarty)





Viewing continental and regional domains as an Interacting Environmental System, for

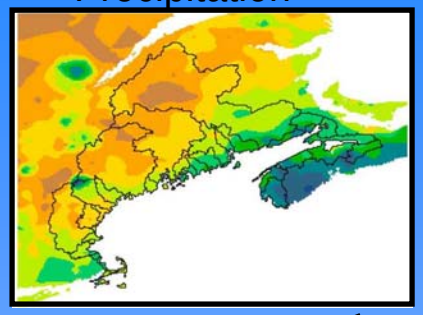
- *Environmental Surveillance*
- *Trajectories of Change*
- *Modeling and Analysis of Management Options*
- *Outreach and Education*

EARTH SYSTEMS DATA COLLABORATIVE

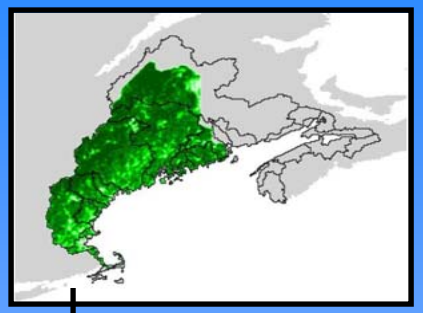
A Regional Prototype System of Systems for Environmental Surviellance

e.g. INPUTS

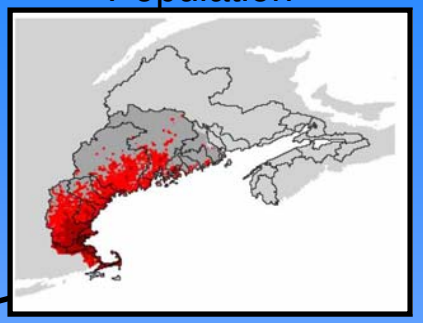
Precipitation



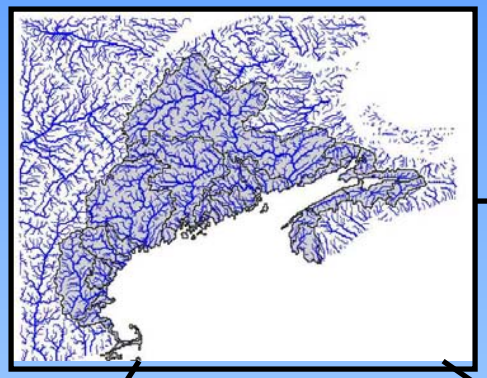
Land Cover



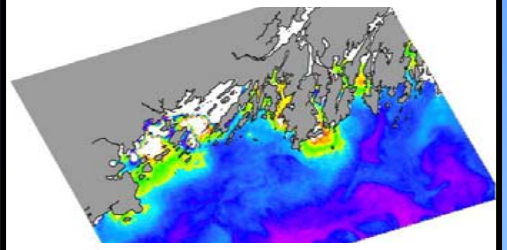
Population



High Resolution River Networks (GM-WICS)



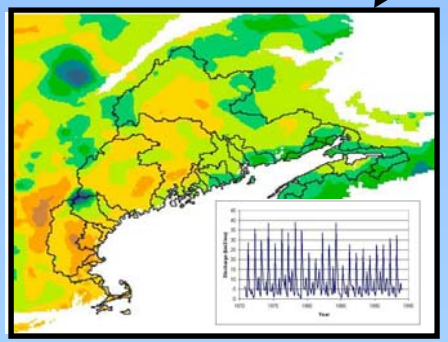
From: MODIS, assimlation models



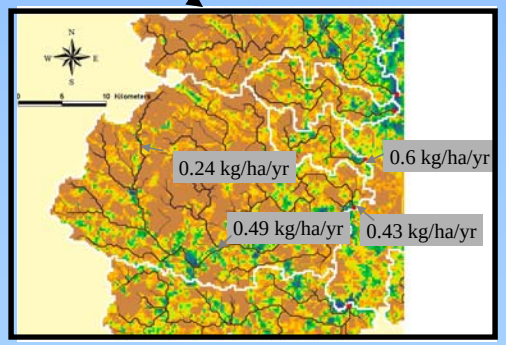
(μg C L^{-1} d^{-1}) 3/17/05

River Plumes & Coastal Zone Metabolism

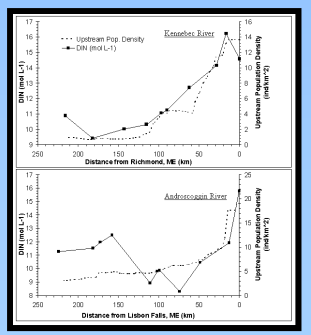
e.g. OUTPUTS



Runoff, Streamflow, Habitat Mapping

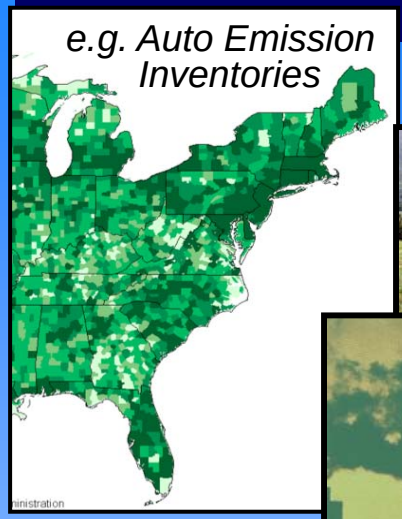


N Fluxes

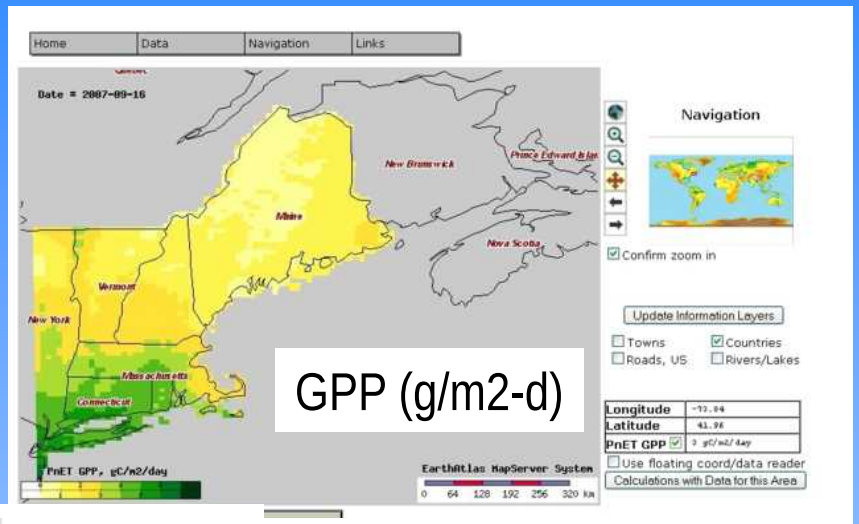


Regional Summaries, Report Cards, Alerts, & Indicaors

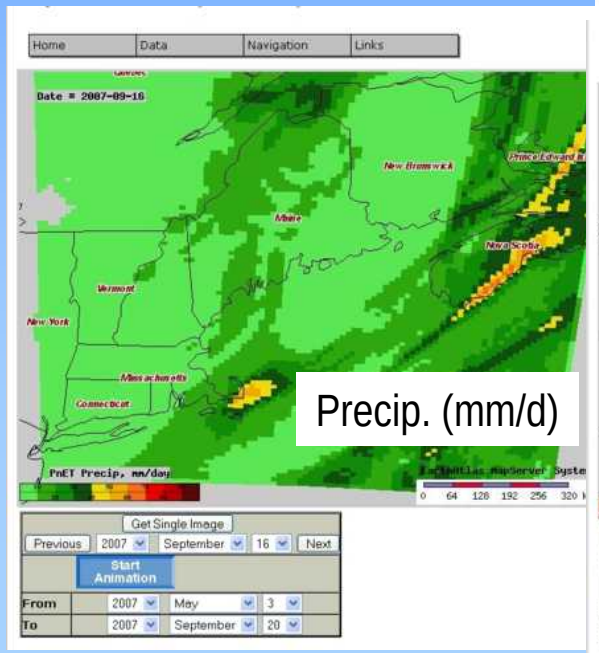
The Day Has Arrived Where We Need to Think of Regional Carbon Inventories, Industrial "Metabolism" and Regional Ecosystem Management

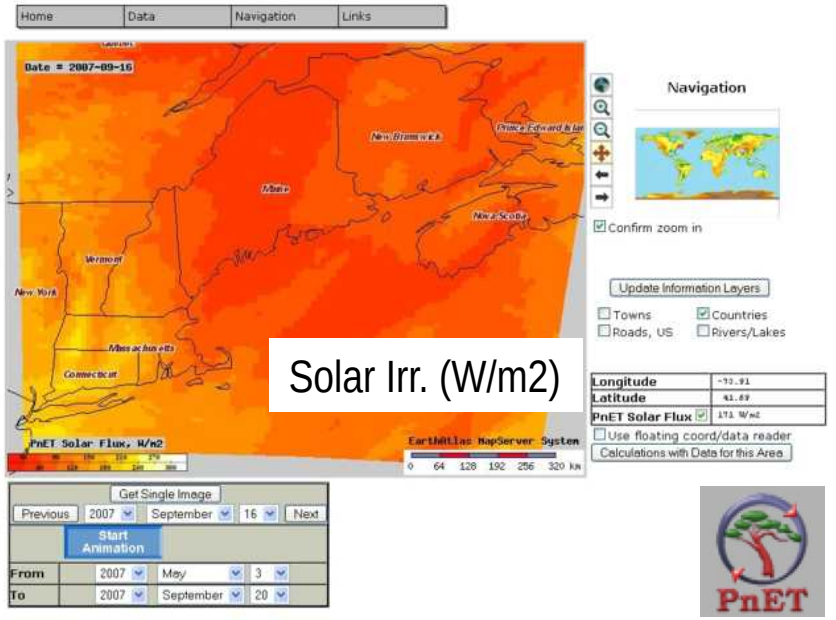


Links to National Climate Service



16 Sept. 2007





University of New Hampshire
Earth Systems Data Collaborative

Four Working Groups

CaribEST Integrated Enterprise

Science/Application Issues

Cross-cuts

1. Water Resource Sustainability

- Regional Water Resource Classif-ication System
- Coastal Aquifers
- Land use-water impacts
- Climate change
- Water pollution

…….and others

2. Extreme Event Vulnerability

- High resolution models
- Downscalng
- Populations, sectors, &infrastructure at risk
- ENSO/NAO
- IPCC contribution

…….and others

3. Monitoring, Integration, Dissemination Systems

- Hydromet
- Deforestation
- Identifying gaps
- Demonstrating value of satellite remote sensing
- Designing optimal networks for 1, 2

…….and others

4. Training & Outreach

- Undergraduate
- Graduate
- Practitioners
- Exchange programs
- Certification

…….and others

April 2010 Demos

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4. ***Build awareness of criticality of global water resource threats***

Three Targeted Points of Engagement on the Global Front

- GWSP "Global Scale Initiative"

- GTN-H and Its Coordination *(in conjunction with WMO and GCOS)*

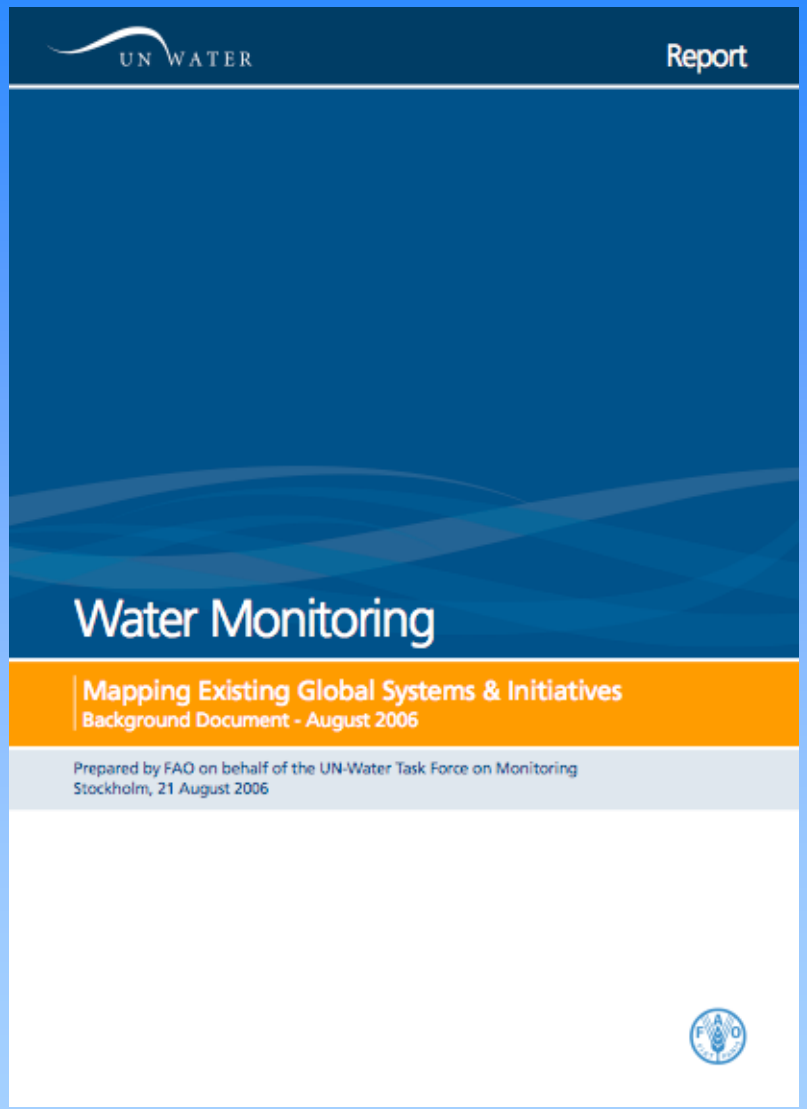
- UN World Water Assessment Programme

(24 participating UN agencies)

Innovation-averse?

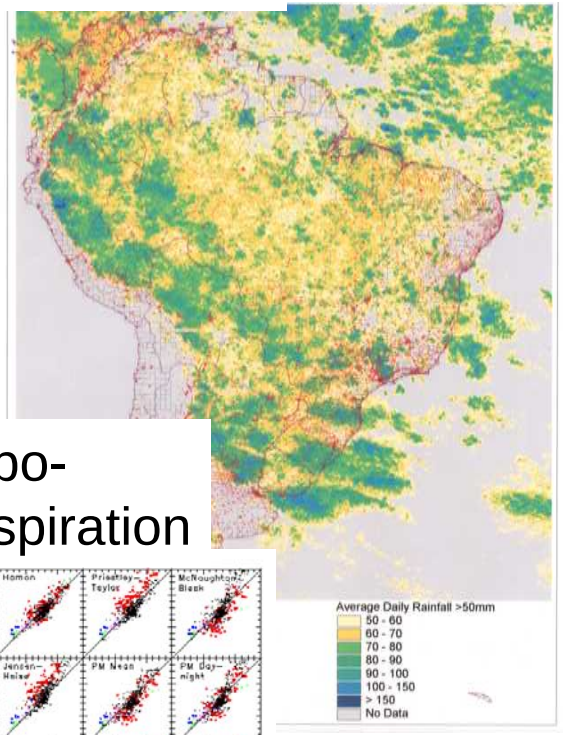
- “irregular updating”, “key information still missing”, “some monitoring systems …. of little use”, “monitoring systems poorly described”

- ***And then the statement “impressive progress using global spatial information”***

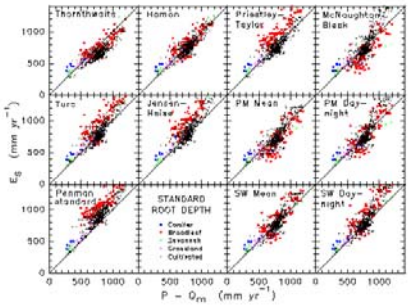


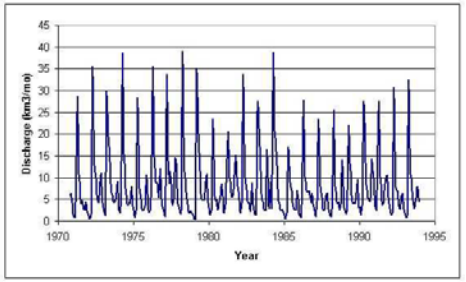
WATER RESOURCE MODULE

Precipitation



Evapo-transpiration





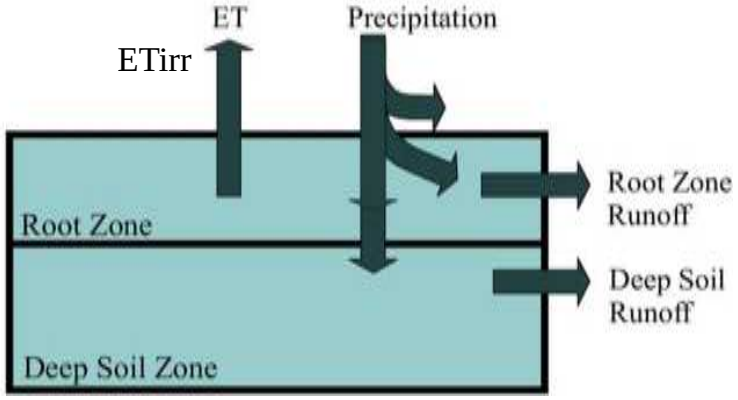
Discharge=
Basin & Inter-basin Resource

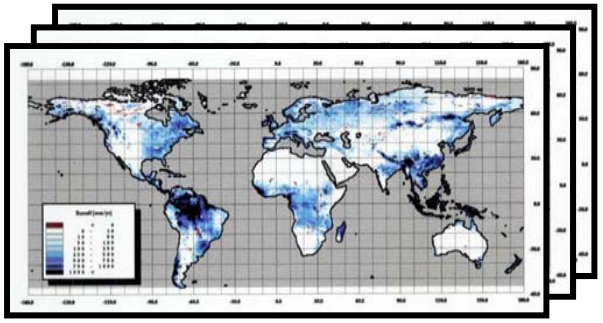
Lateral Transport

Digital River Networks

Cal/Val

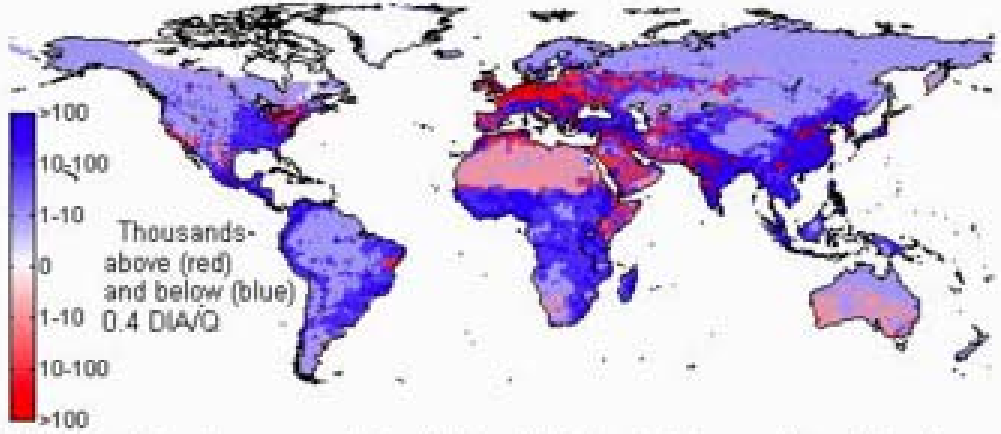
Managed Water

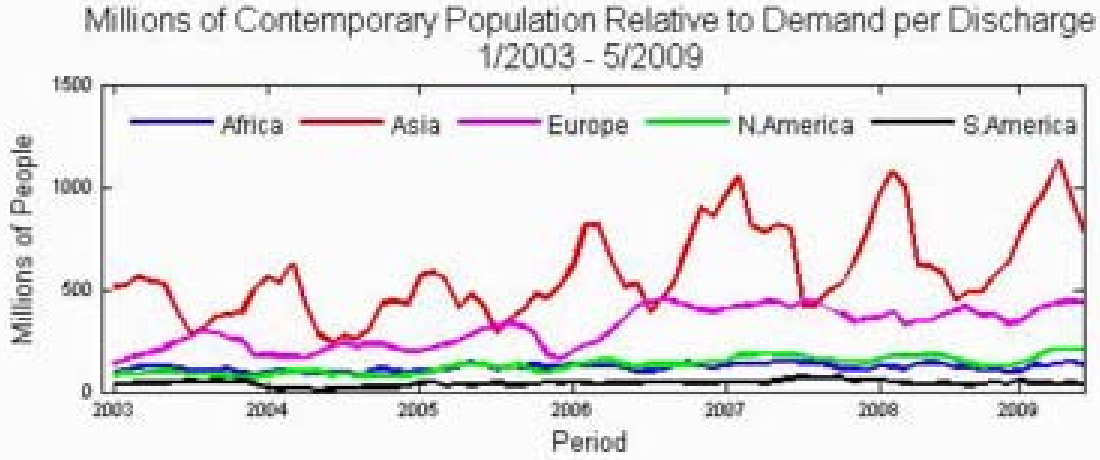




Runoff=
Local Water Resource

Pilot Study on Indicators (PSI)





Water Use Index (DIA/Q):

The water Use Index is based on a scarcity threshold of > 0.4 (ratio of mean annual demand to supply, Falkenmark (1998)). The annual demand refers to the agriculture, domestic and industrial water demand on a monthly basis. The Water Balance/ Water Transport Model (WBM/ WTM) provides the monthly discharge corresponding to the period January 2003 to December 2008 used here. The input data for the WBM/WTM model includes air temperature from the National Center for Environmental Prediction (NCEP) and combined precipitation products from the GPCP /CMORPH project.

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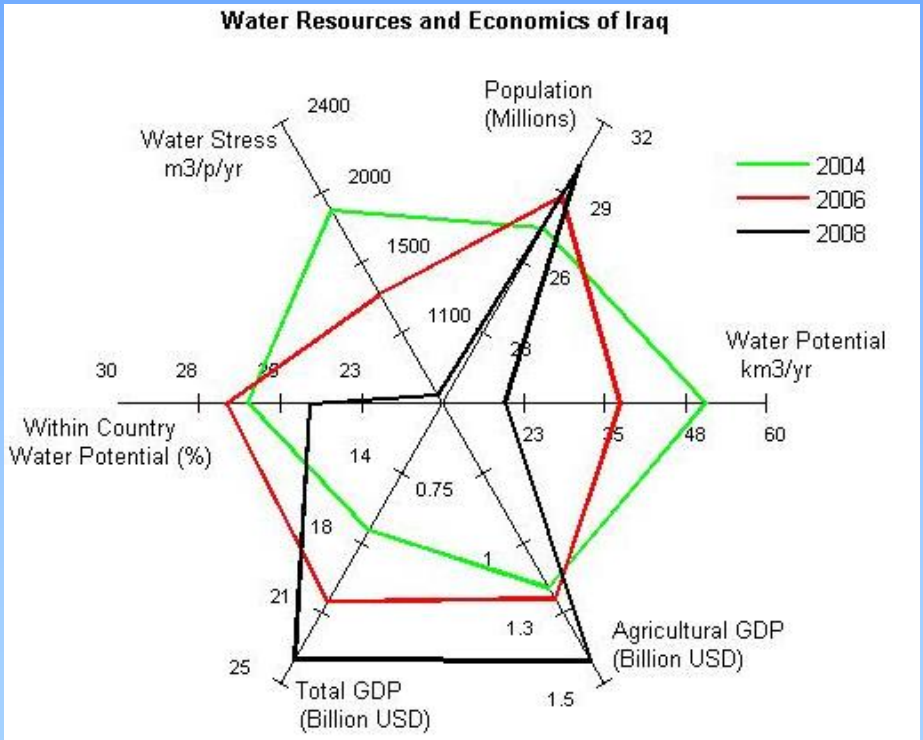
Multi-national water resource accounts:

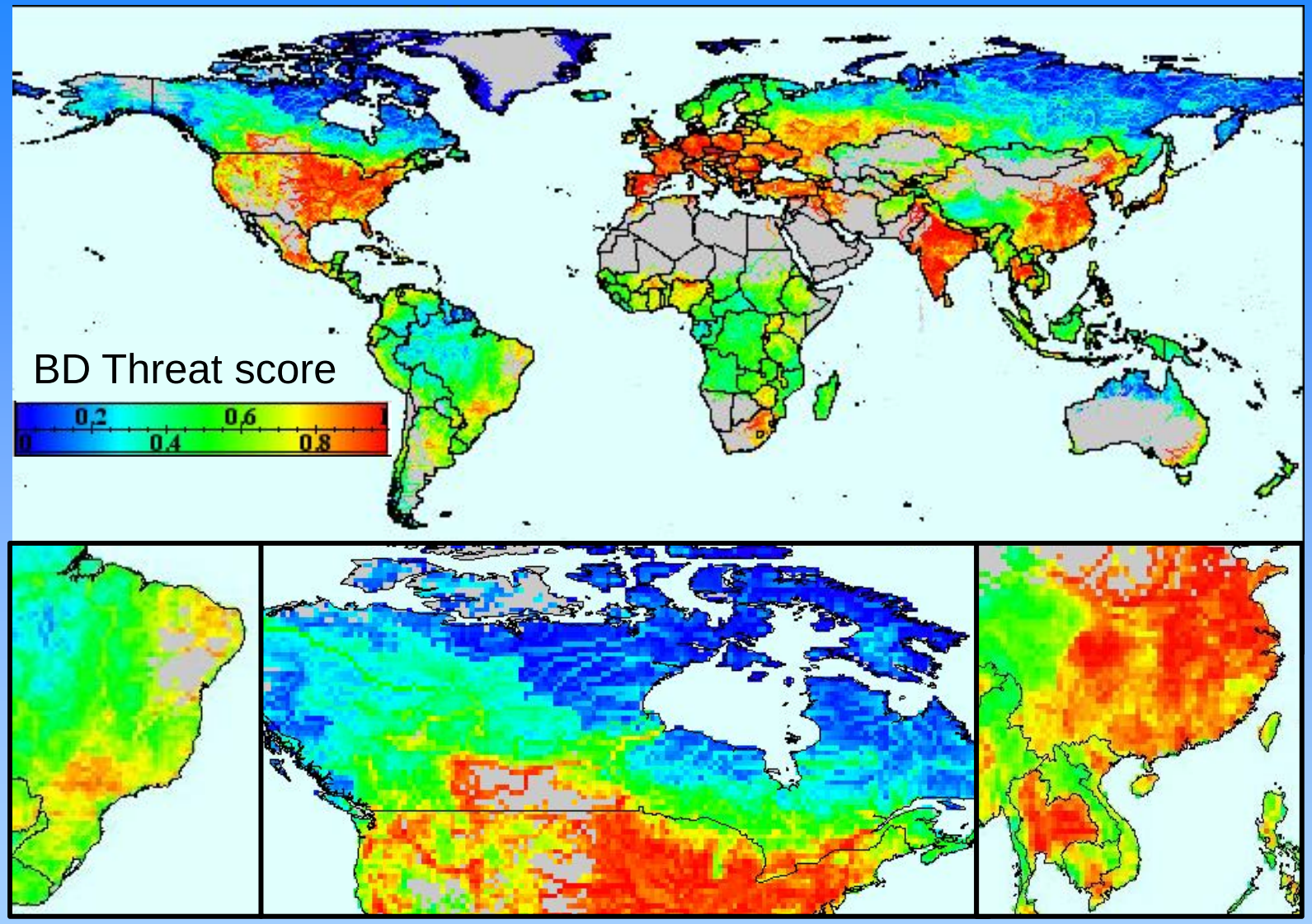
--Turkey, Iraq and Syria

Severe drought conditions in Iraq and Syria in 2008, detected by PSI.



- Water potential estimates include in-country runoff plus transboundary inputs, based on GPCC (Global Precipitation Climatology Center) monitoring PPT product
- Other global precipitation products currently being tested

Threat to Biodiversity

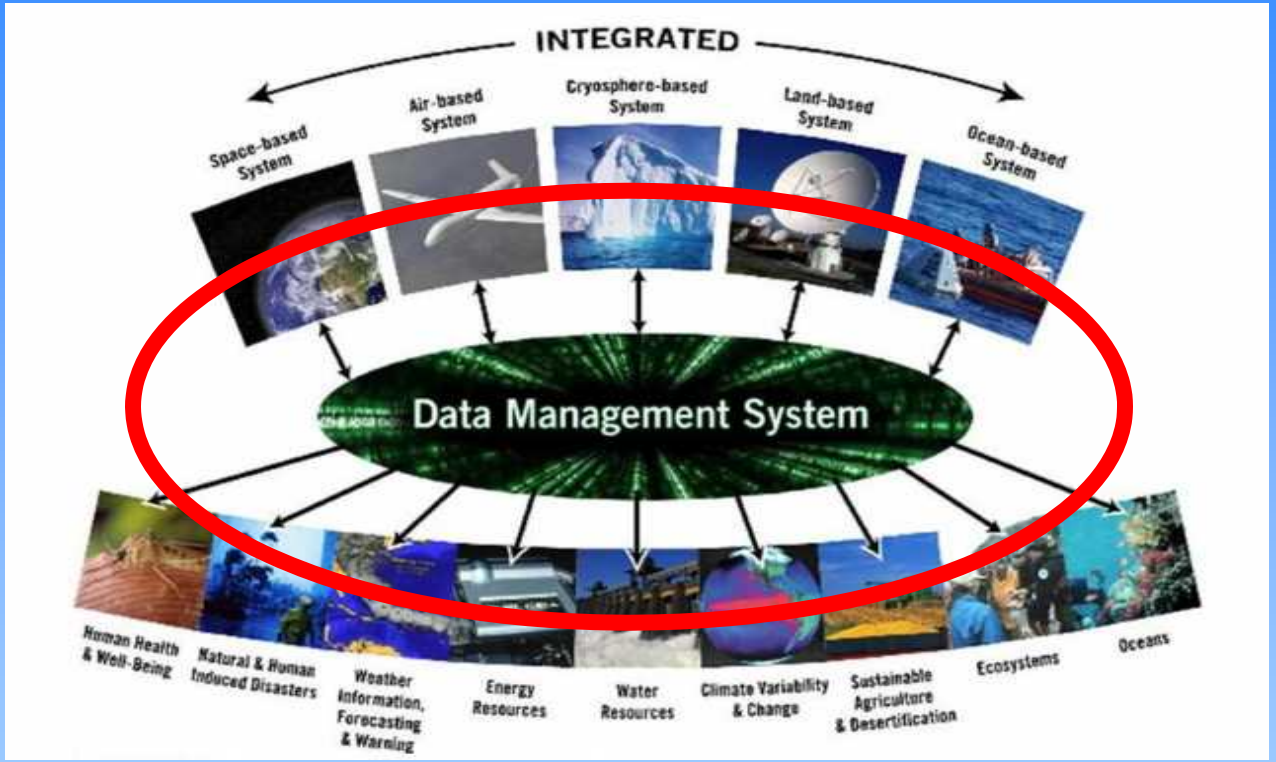


- Pandemic
- Generally correlated to population, agriculture, development
- Non-local transboundary and broad transition zones prevail

Vörösmarty et al., Nature (in review)

Broader Vision

- *Palpable need for IT-based tools, workspaces & services to unite users with data*
- *Operational data streams capable of supporting a large set of target applications*



"GEOSS will build on and add value to existing Earth-observation systems by coordinating their efforts, addressing critical gaps, supporting their ***interoperability***, sharing information, reaching a common understanding of user requirements, and improving delivery of information to users".

GEOSS Web SITE: earthobservations.org