Global Water System Change
Impacts on Deltas

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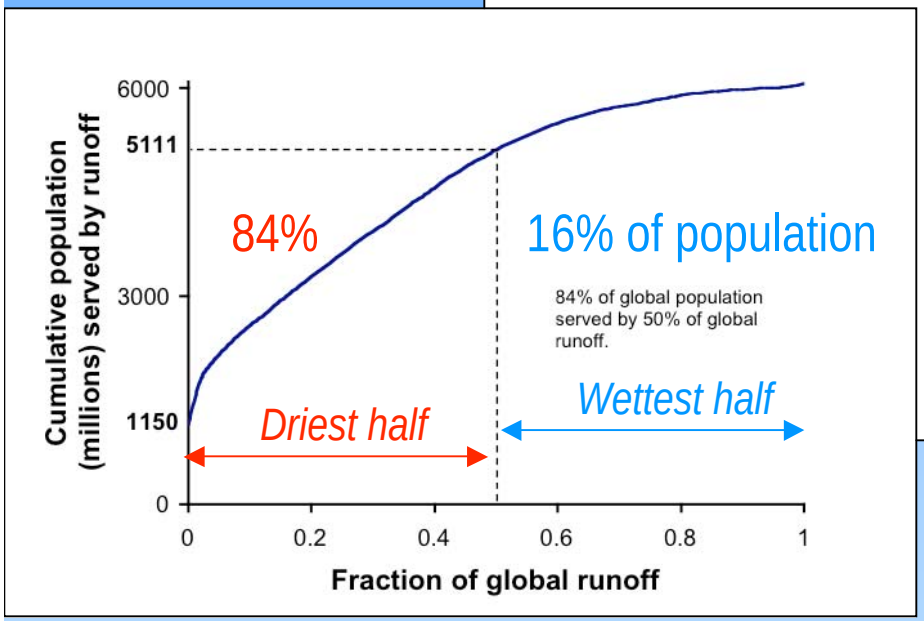
Earth System Science Partnership

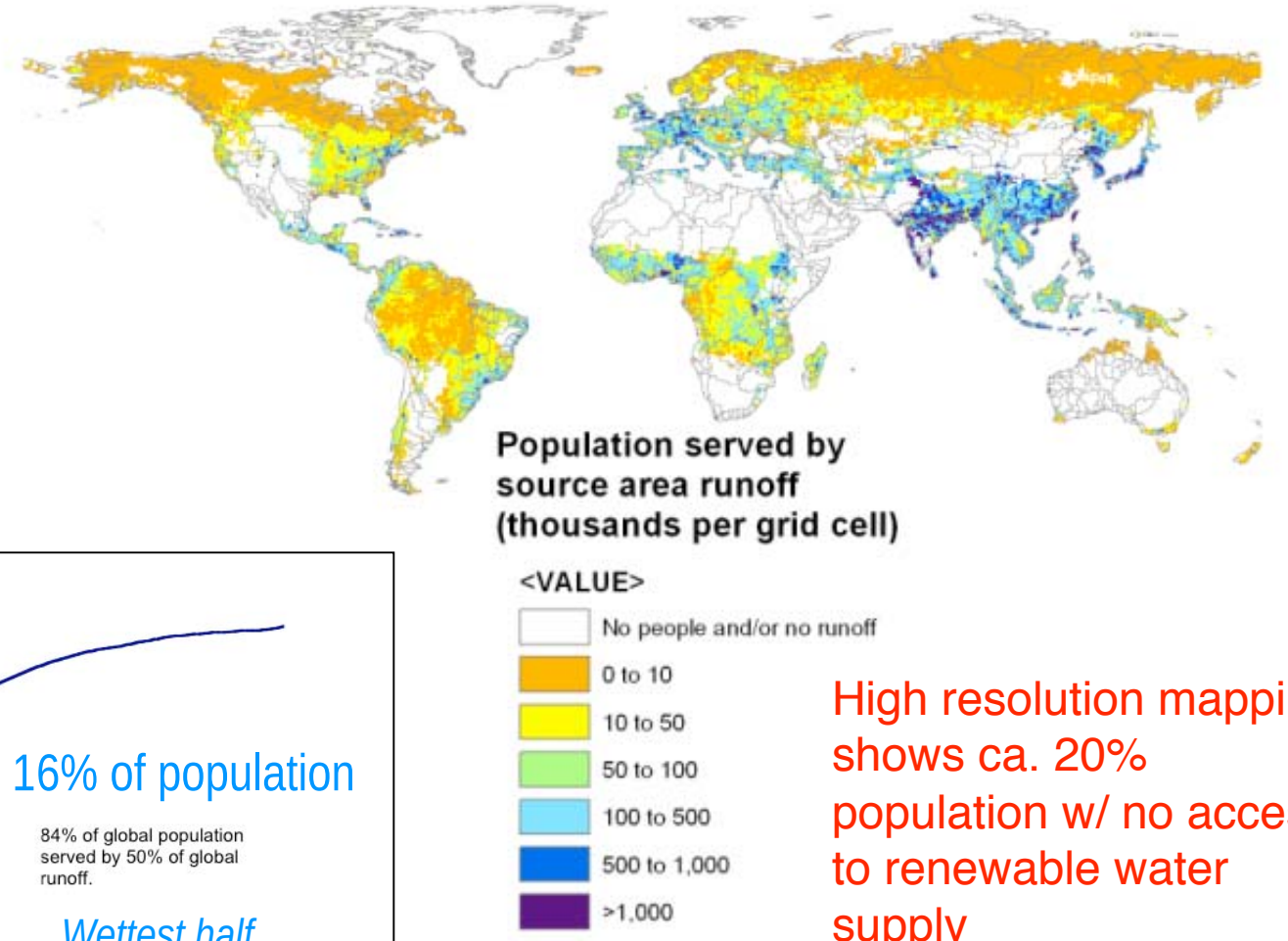
GWSP Global Water System Project

GWSP/LOICZ/CSDMS Workshop
Dynamics and Vulnerability of River Delta Systems
Boulder, CO *25 September 2007*

Humans Interacting w/ the Global Water Cycle--

The Picture Today



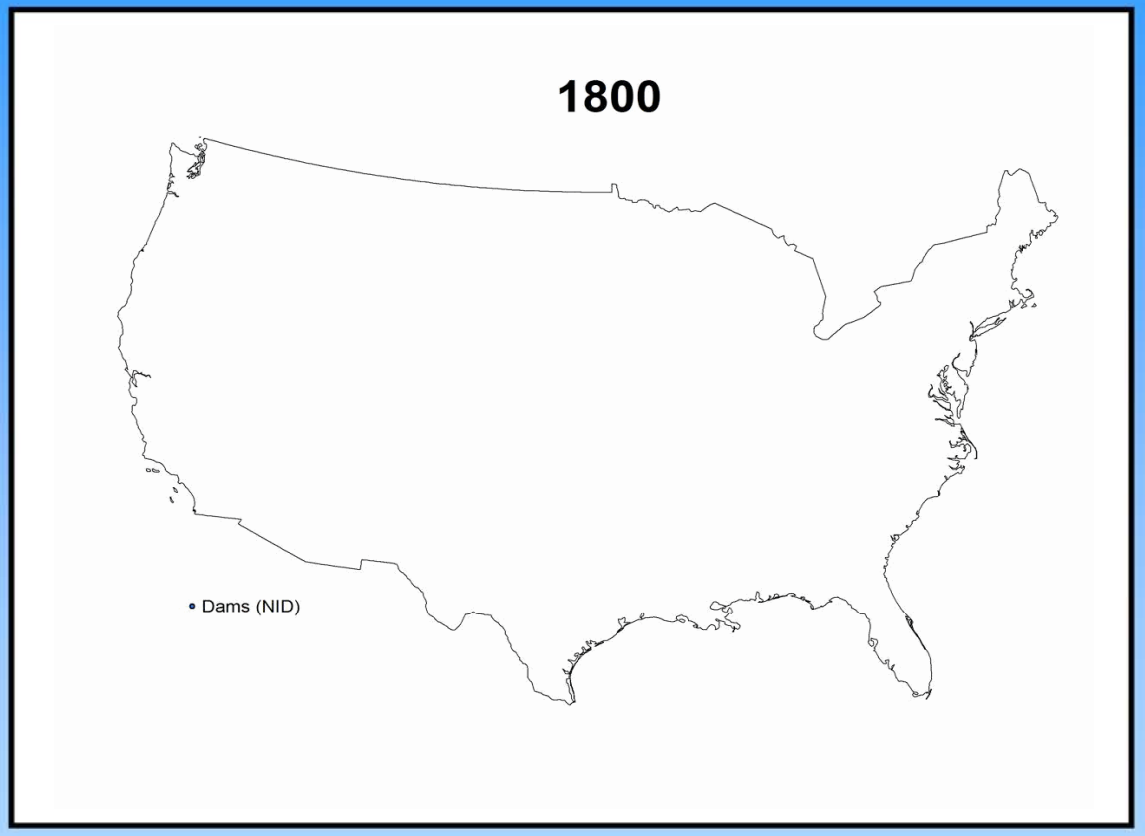


High resolution mapping shows ca. 20% population w/ no access to renewable water supply

Vörösmarty et al. (2005), Millennium Assessment, Conditions & Trends Working Group

- Importance of upstream source areas: note Amazon/S. Asian contrast
- Dry half to experience increasing population growth and development

History of US Dam and Reservoir Construction



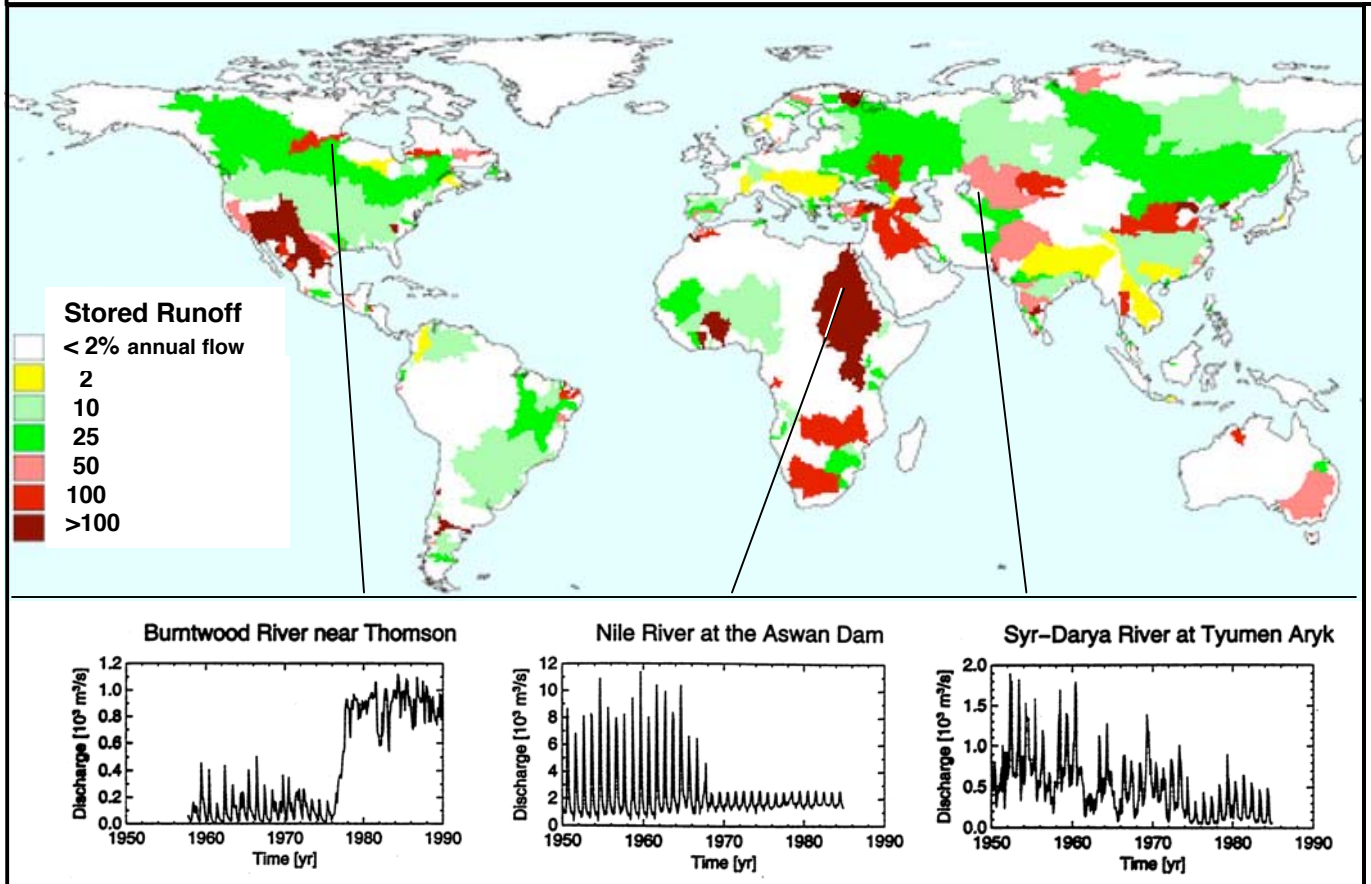
PRESSURE TO CONTINUE PANDEMIC ENGINEERING OF SURFACE WATERS

…emblematic of water development globally

Source : National Inventory of Dams

PANDEMIC ENGINEERING OF SURFACE WATERS

Distortion of Natural Hydrographs



- 700% increase in water held by river systems
- Several years of residence time change in many basins
- Tripling of river runoff travel times globally (from 20 up to 60 days)
- Substantial impact on aquatic biodiversity
- Interception of 30% of continental TSS flux

Framing Committee/GWSP 2004, Eos AGU Transactions

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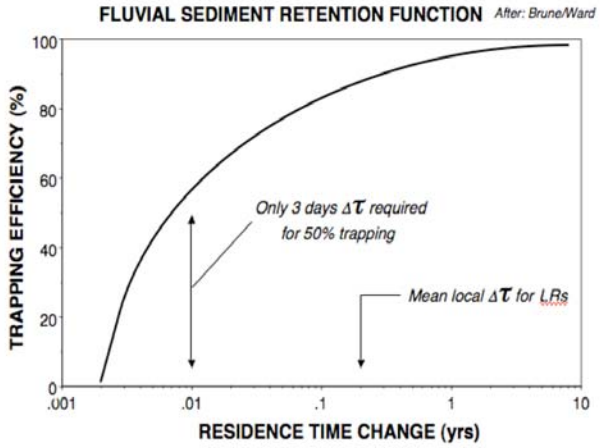
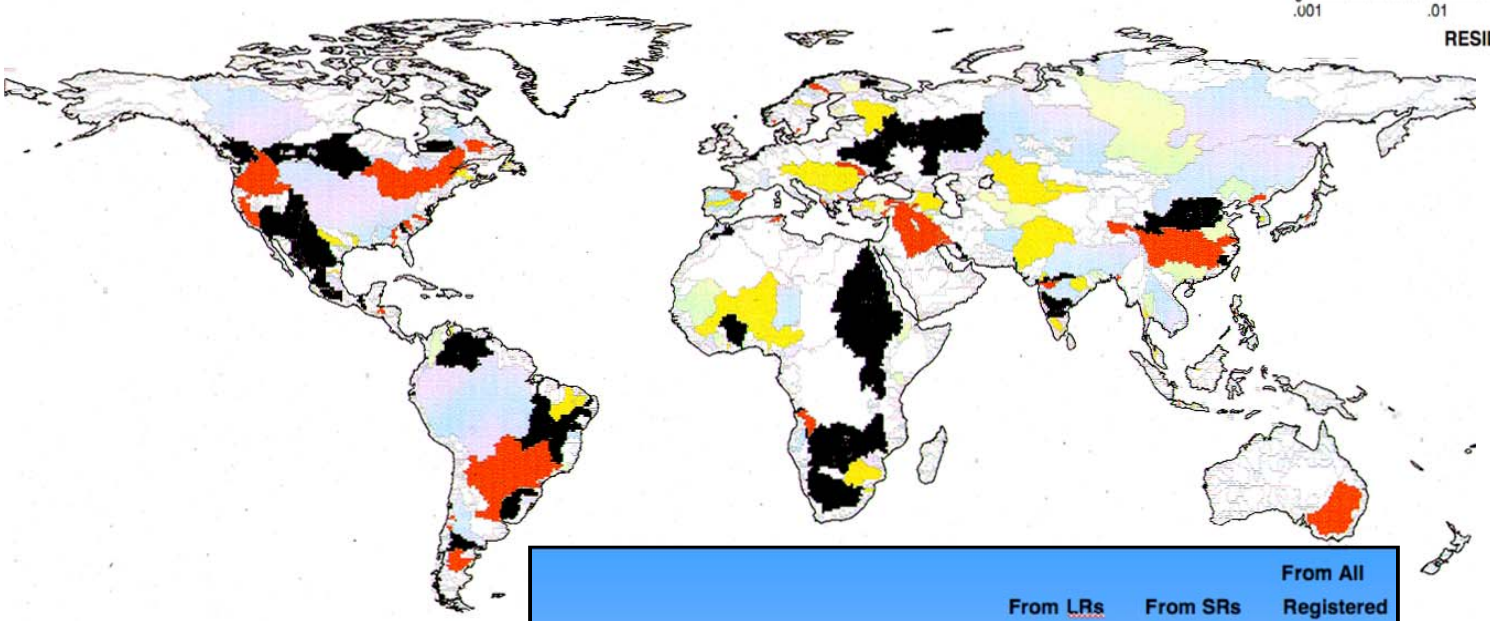
Human Impact on Land-to-Ocean Links

--Fluvial suspended sediment trapping substantial

--Registered largest reservoirs *only*

(>0.5 km^3 max. storage)





Basinwide Trapping Efficiency (%)

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100

	From LRs n=633	From SRs n=44,367	From All Registered Reservoirs
Mean % Retention: Regulated Basins	30	23	53
Mean % Retention: All Basins	16	12	28
Fractional Contribution to Global Retention	57%	43%	

Our major challenge

Vörösmarty et al. 2003
Syvitski et al., 2005

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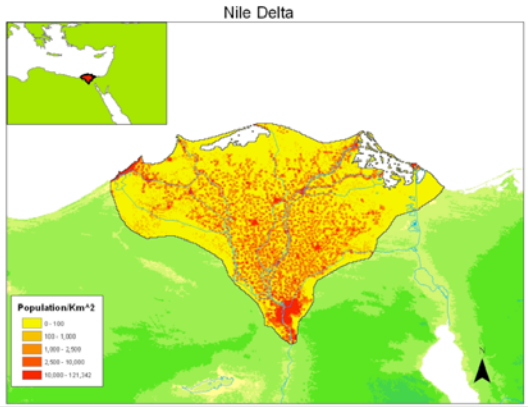
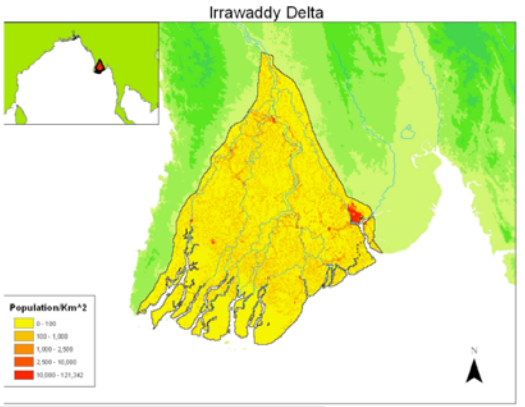
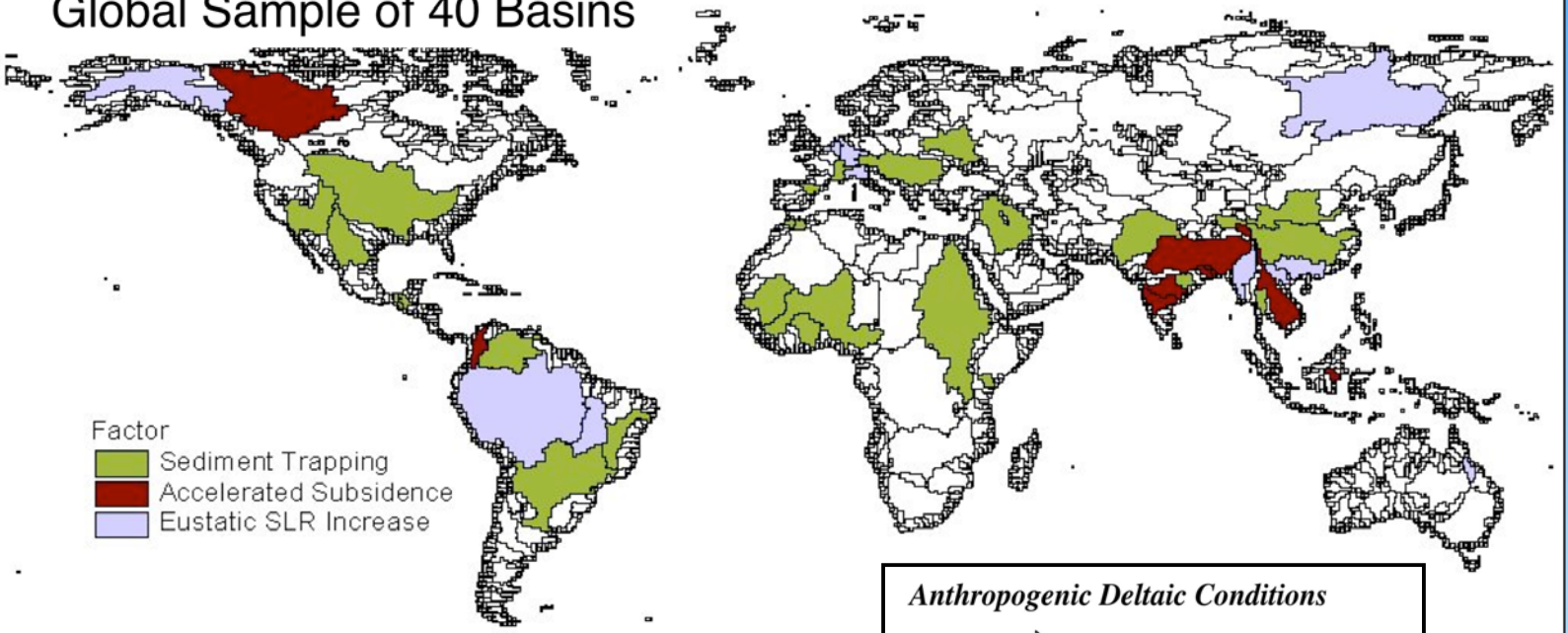
Deltas Under Threat

Major Sources of Chronic RSLR: Eustatic Sea Level Rise Only Part of the Story





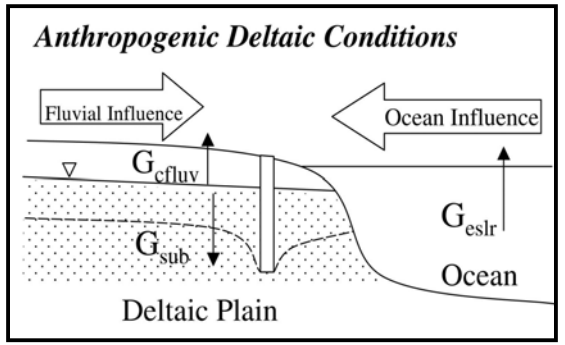
Global Sample of 40 Basins



Sources of Change:

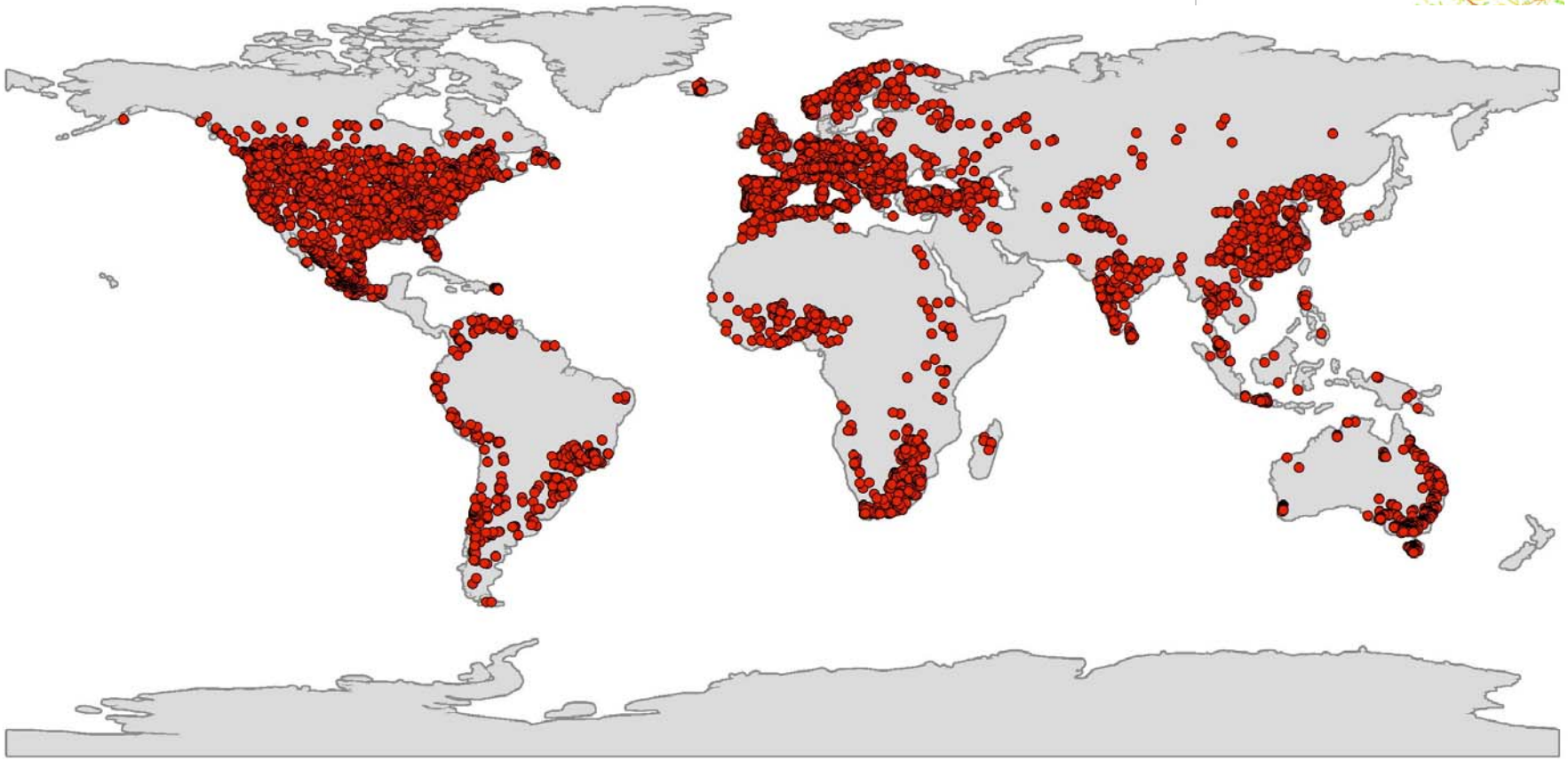
-- 5 Eustatic Sea Level Rise
-- 8 Groundwater/petroleum extraction
-- 27 Upstream sediment trapping & diversion

Ericson et al., 2006, *Global and Planetary Change*



Global Reservoir and Dam (GRanD) Database

Currently ~ 6600 dam locations referenced to SWBD polygons and HydroSHEDS river network

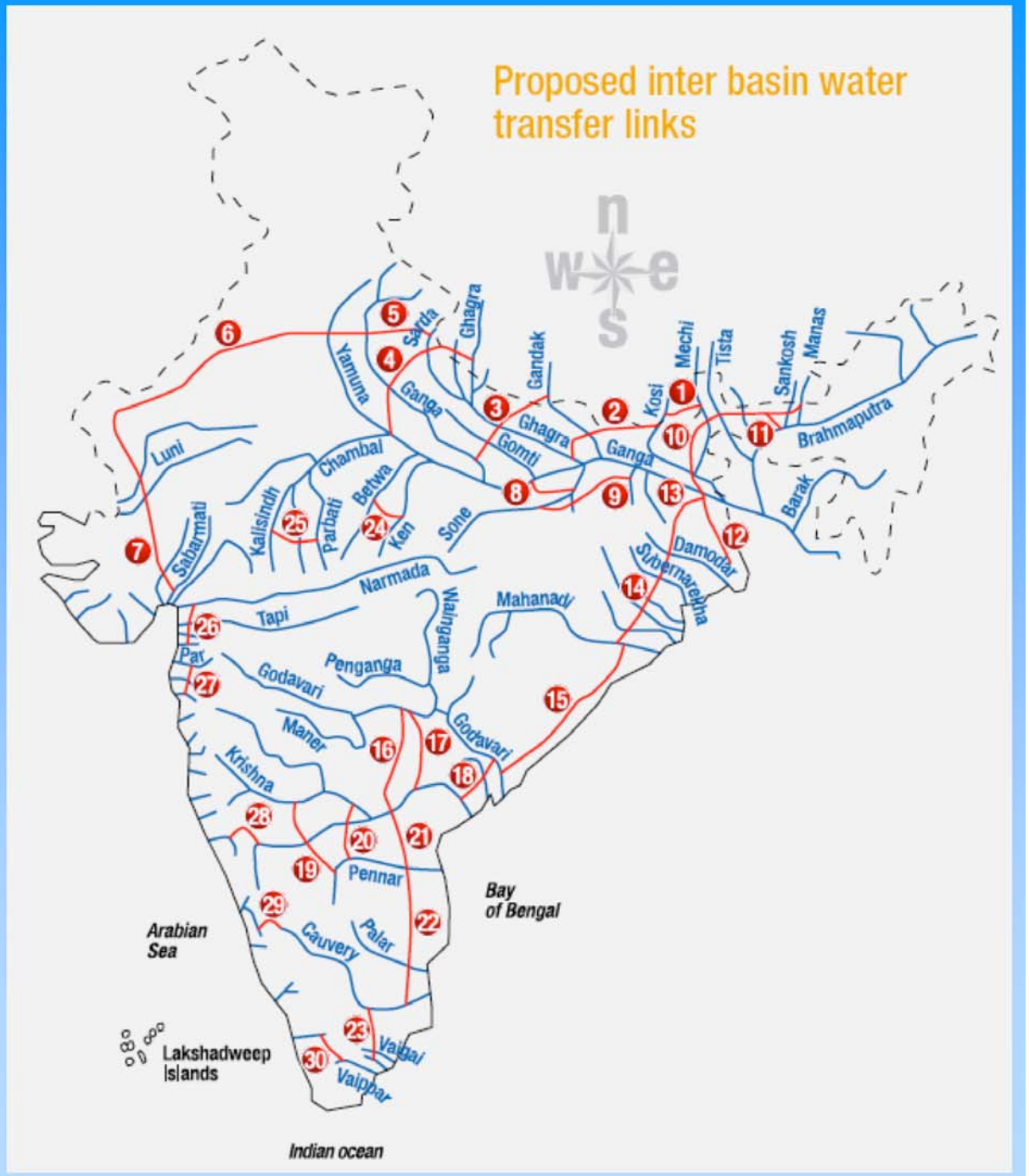


~ 2600 reservoirs ≥ 100 Mio. m^3

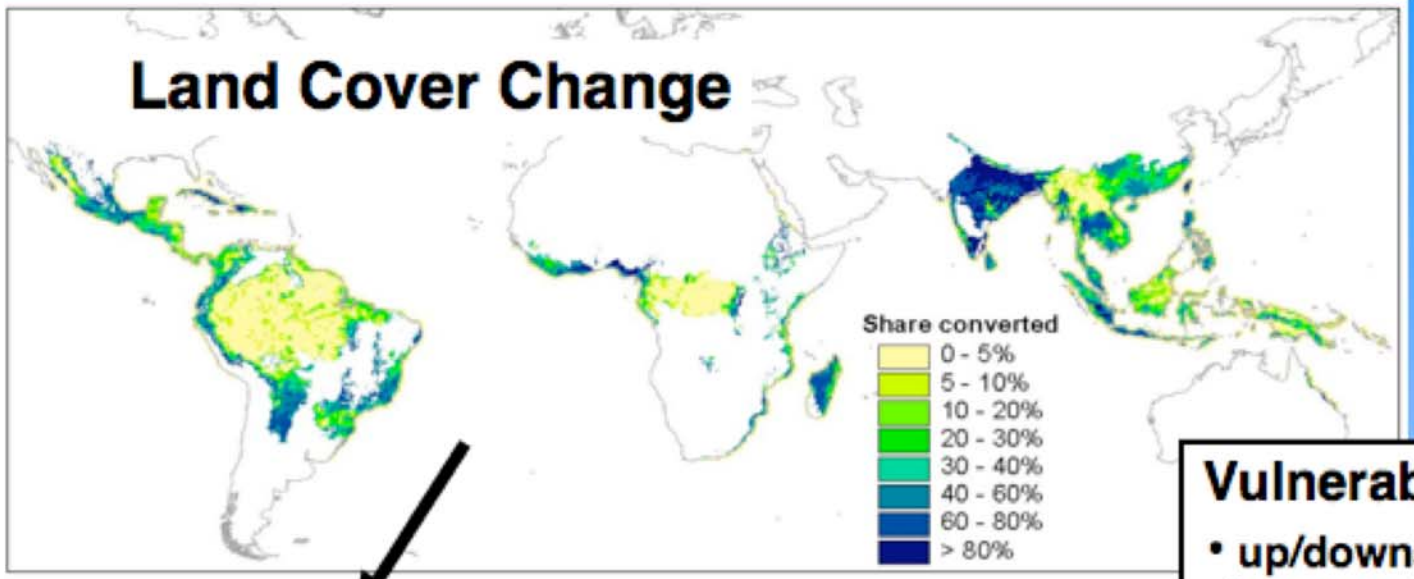
Total storage capacity ~ 6000 km^3 (>80% of world total)

Inter-Basin Transfers & Flow Diversions

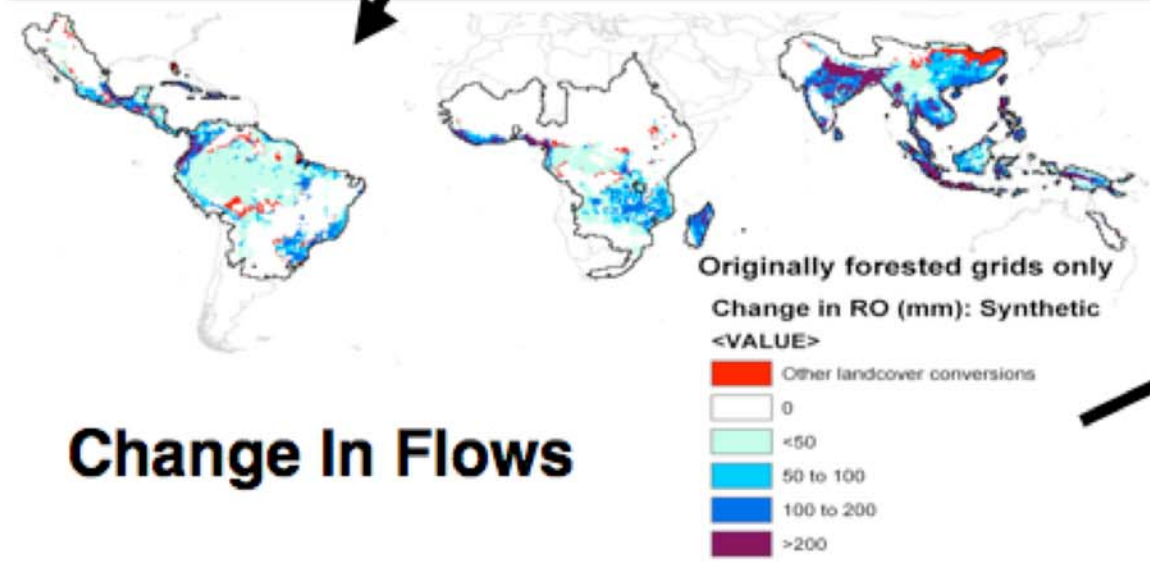
- Costly ‘hard path’
- Engrain patterns of overuse
- Biodiversity impacts (+/-): Unique to donors / recipients



POTENTIAL SOURCE OF CONFLICT:
Upstream-Downsteam Links



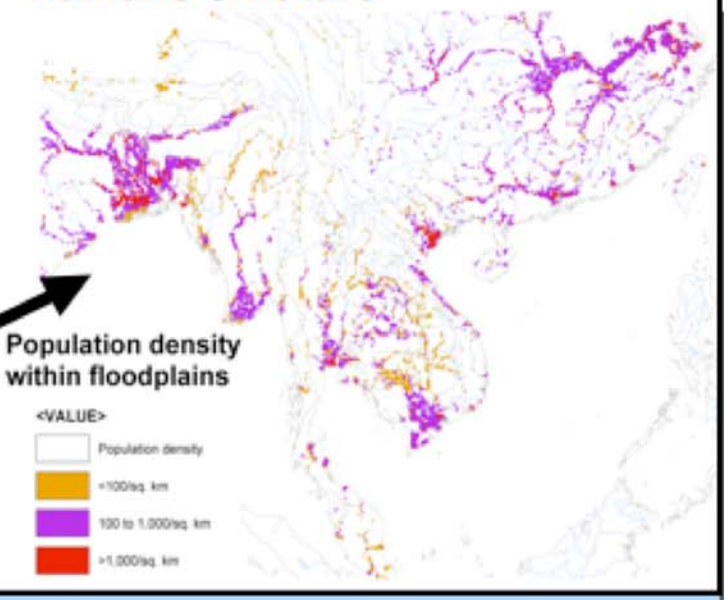
NEW CLASSES OF "teleconnections"



Change In Flows

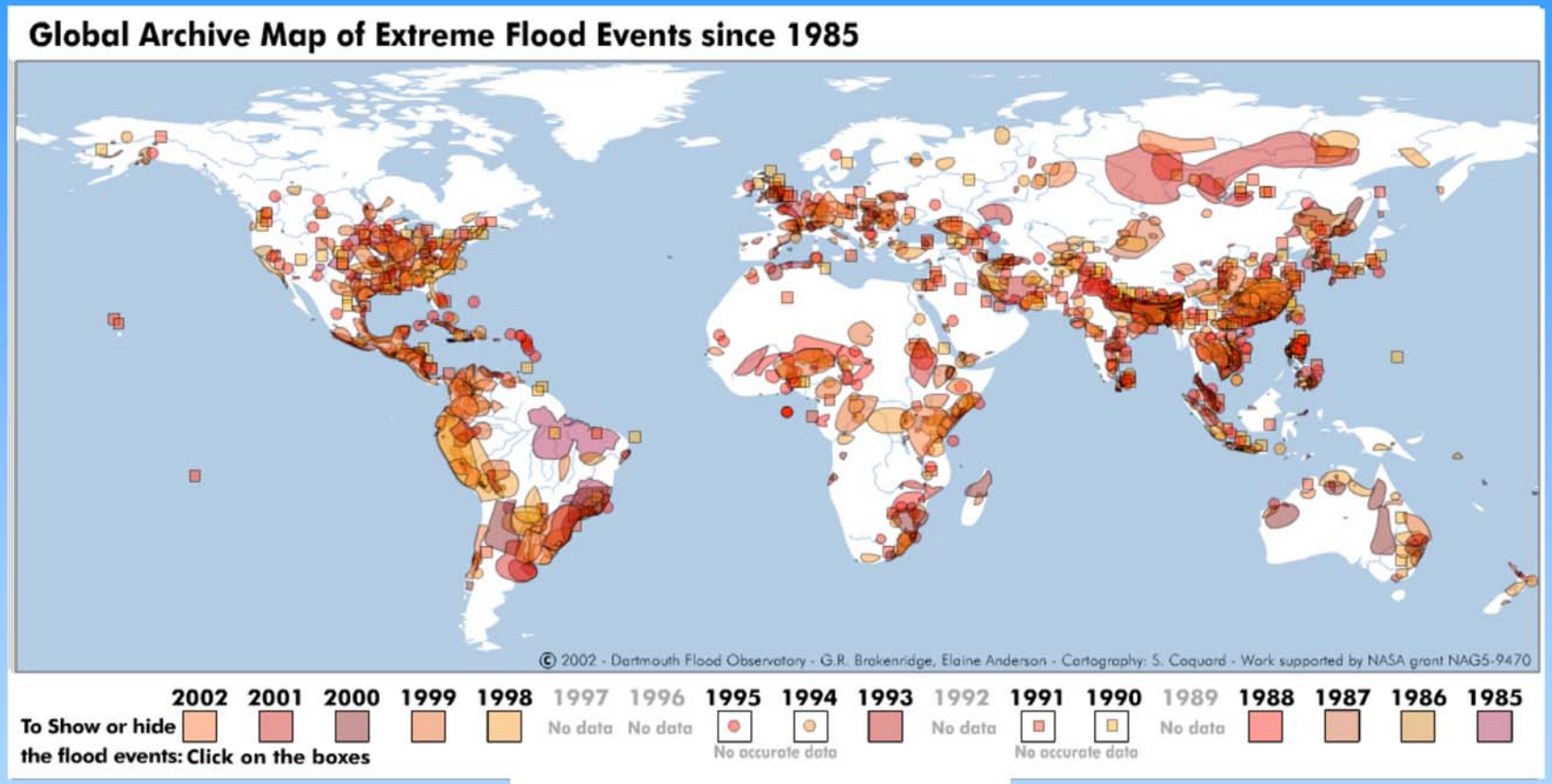
Vulnerability Translated

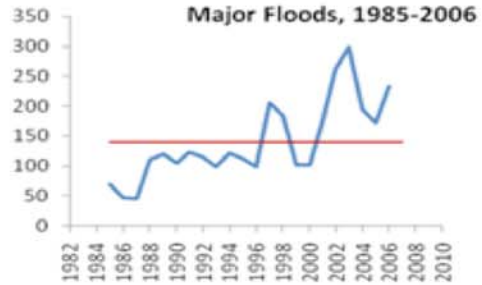
- up/downstream stakeholders
- humans & nature



Douglas et al. 2007, WRM

FLOODING IS A FUNDAMENTAL FEATURE OF THE HYDROSPHERE -- *Right down to the coastal zone*



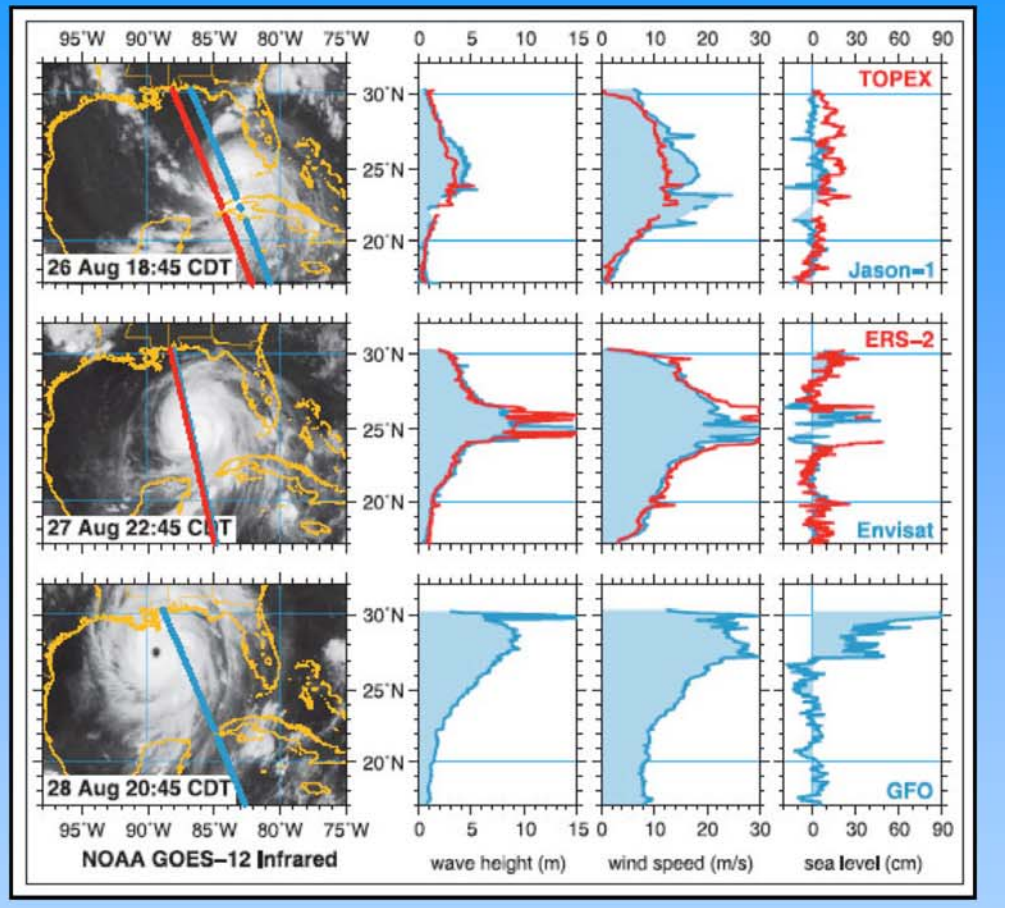


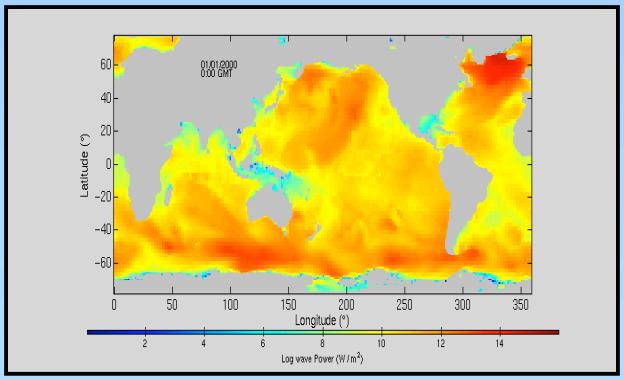
Dartmouth Flood Observatory

Images courtesy of R. Brakenridge

Oceanward Factors: "Slow Burn" of RSLR, Coastal Erosion Punctuated by Extreme Events

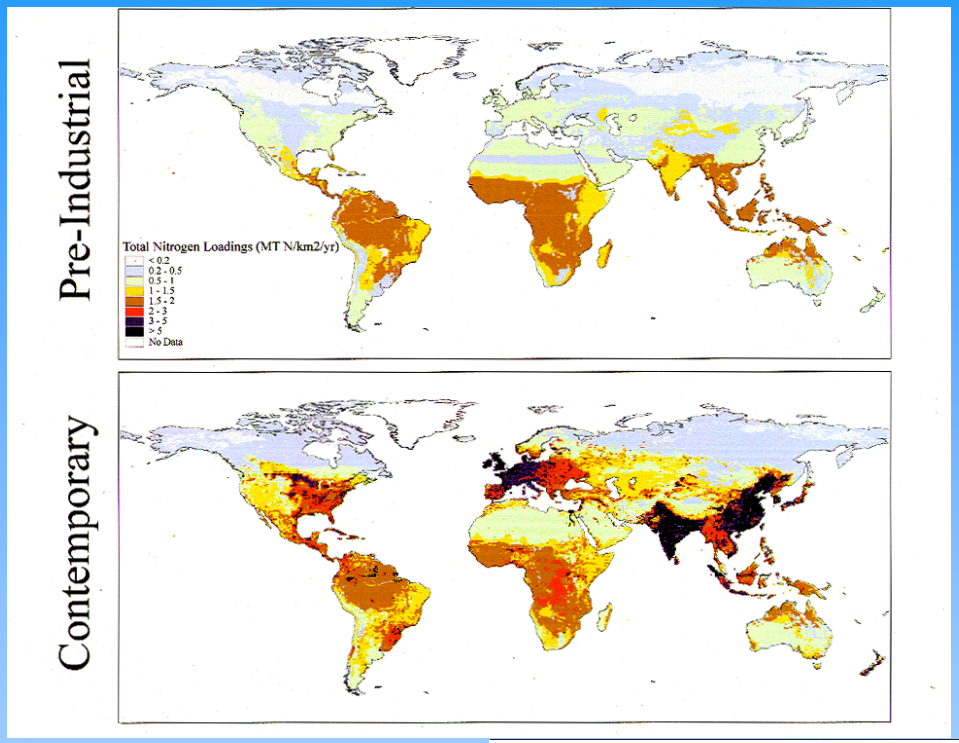
Hurricane Katrina 2005: A Flood





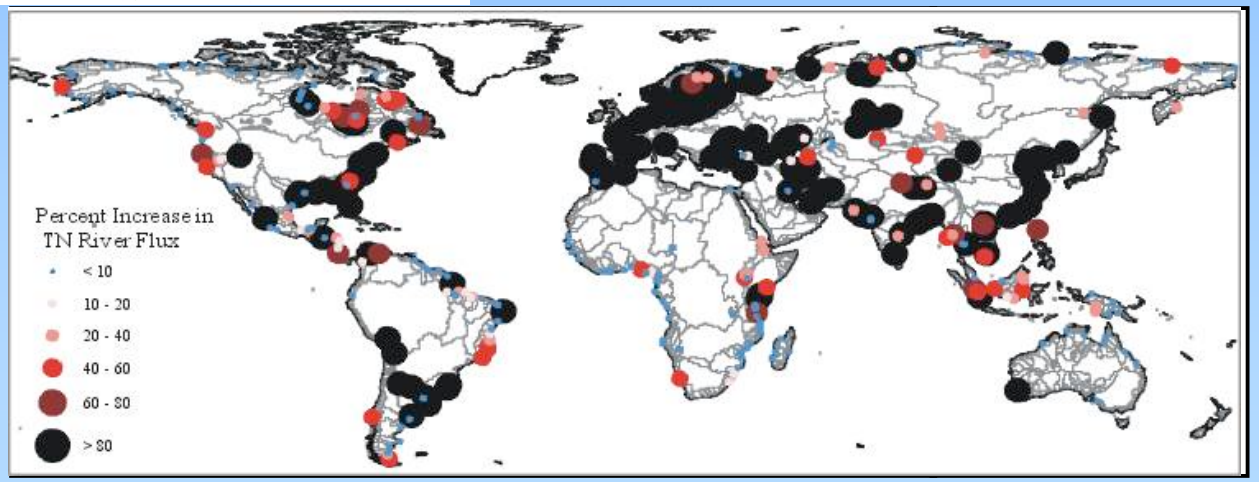
3-hrly wave power

Water Supply-- Doubling of Global Nitrogen Pollution



Terrestrial Loading

% Change in River Fluxes



Green et al. 2004; Biogeochemisty

What to Scope at This Scoping Workshop?

- Develop ideas for interdisciplinary & integrative science to better understand diverse processes affecting deltas
  - Not just SLR …. upland engineering, gw and hydrocarbon abstraction, land use/cover change
  - Not just sediment ….H_2O, nutrients
  - Not just long-term, chronic change … events critical
- Tangible products: digital map of river-coastal delta complexes; geographies of long-term vulnerability and of upland/ocean events; now-cast/forecast systems
- Raise awareness through these tangible products around which the policy & management communities can take action