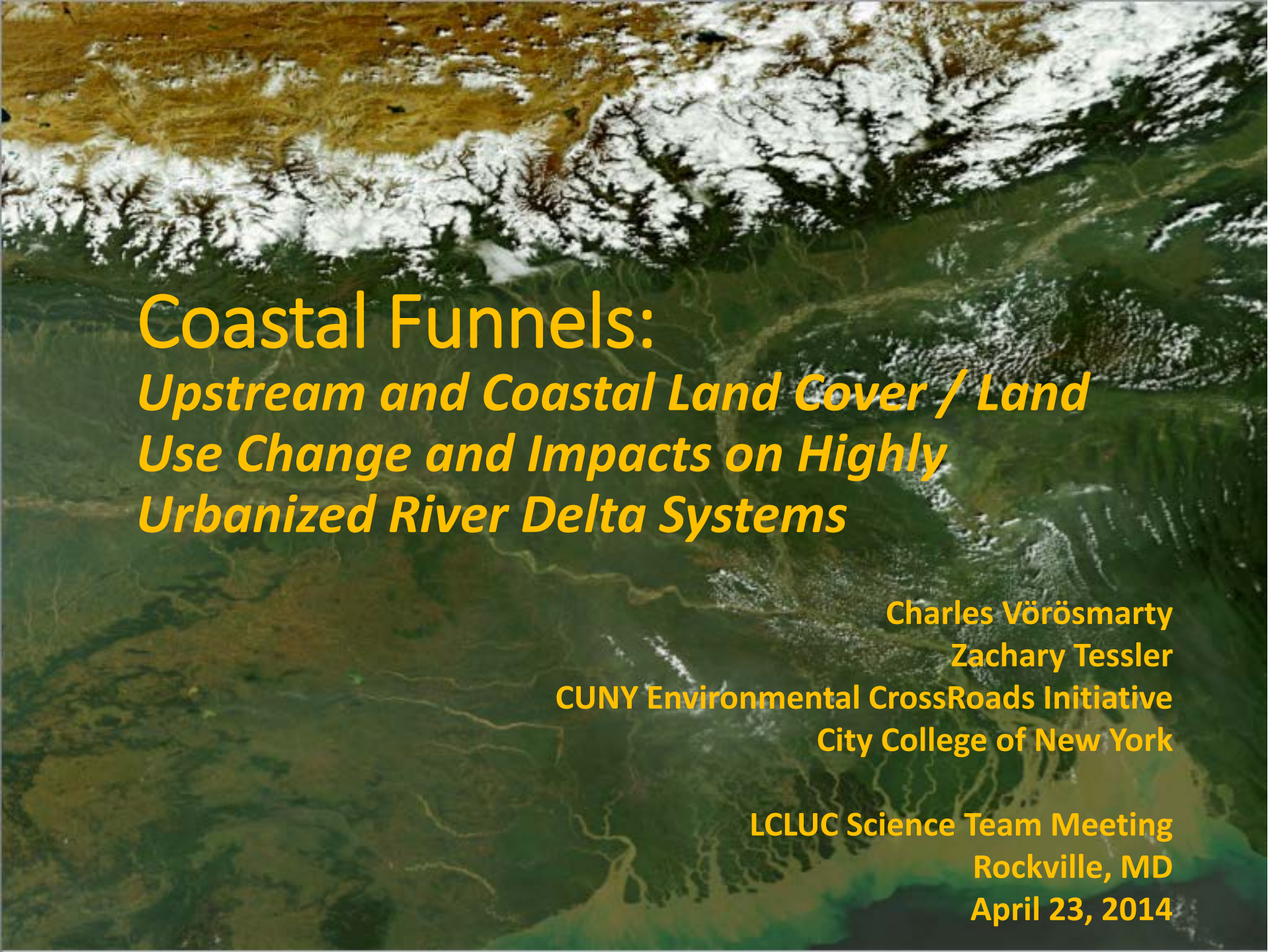


Coastal Funnels:

Upstream and Coastal Land Cover / Land Use Change and Impacts on Highly Urbanized River Delta Systems

Charles Vörösmarty
Zachary Tessler
CUNY Environmental CrossRoads Initiative
City College of New York

LCLUC Science Team Meeting
Rockville, MD
April 23, 2014

NASA Award Number NNX12AD28G

Land-Cover and Land-Use Change (*LCLUC*) Program

GLOBAL-SCALE ASSESSMENT OF THREATENED RIVER DELTA SYSTEMS: EVALUATION OF CONNECTIONS BETWEEN THE CONTINENTAL LAND MASS AND OCEAN THROUGH INTEGRATED REMOTE SENSING AND PROCESS MODELING

City University of New York: Charles J. Vörösmarty (PI), Zachary Tessler, Kyle McDonald, Balazs M. Fekete, Hansong Tang, Deborah Balk, Irina Gladkova, Michael Grossberg, Hannah Aizenman (PhD student)

University of Colorado: James P.M. Syvitski, Albert J. Kettner, Stephanie Higgins (PhD student)

Goal and Objectives

Our **Science Goal** is:

- To analyze how **the strength and variability of land-to-ocean links**--*as defined by riverine sediment fluxes, local anthropogenic activities, and ocean processes*--**produce impacts on coastal delta systems**, today and into the future.

Supporting Objectives:

1: **Identify Global Patterns and Extent of Coastal Delta Syndromes**

2: **Map Exposure and Vulnerability of Contemporary Populations**

3: **Assess Response of Deltas to Contemporary Environmental Stressors**

4: **Future Forecasts of Land-to-Ocean Links**

WE PURSUE TWO BROAD AVENUES OF INQUIRY:

A) SYNOPTIC AND COMPARATIVE

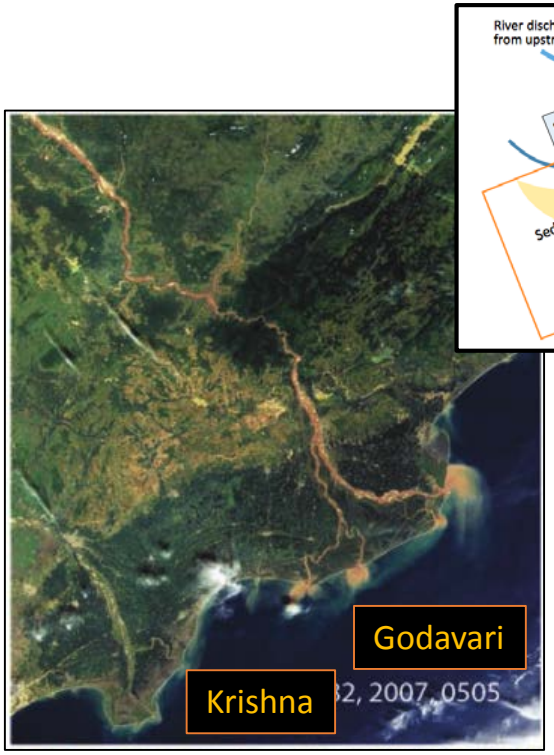
B) DETAILED PROCESS and REMOTE SENSING ANALYSIS

Recall: Deltas are dynamic geologic features that require riverine sediment deposited through flooding to keep pace with sea level rise

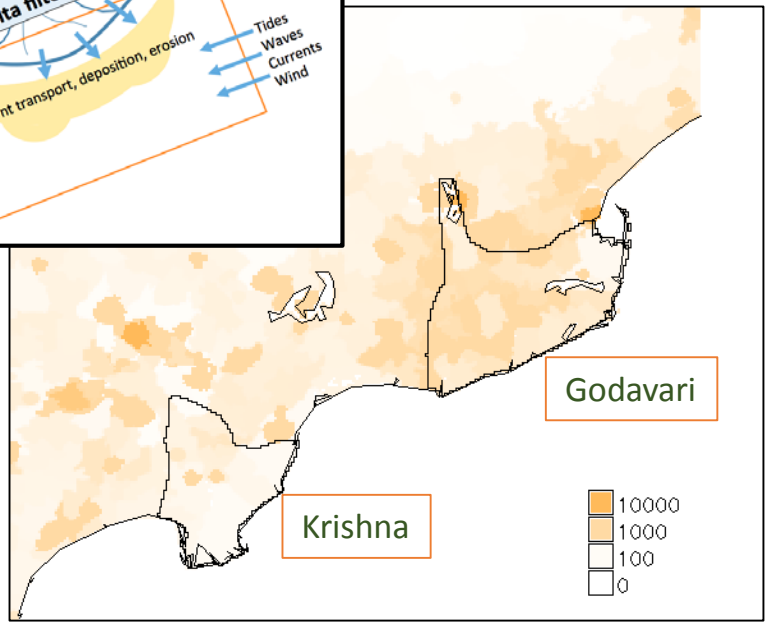
No two deltas are alike:

Environmental & human settings influence delta dynamics in complex ways

- Krishna and Godavari basins receive similar rainfall, have similar soil characteristics, basin size, discharge, etc.
- Same storm, Godavari discharges much more sediment to coastal ocean
- Combination of upstream sediment trapping in Krishna delta, and flood control on Godavari delta



MODIS (from Syvitski, 2009)

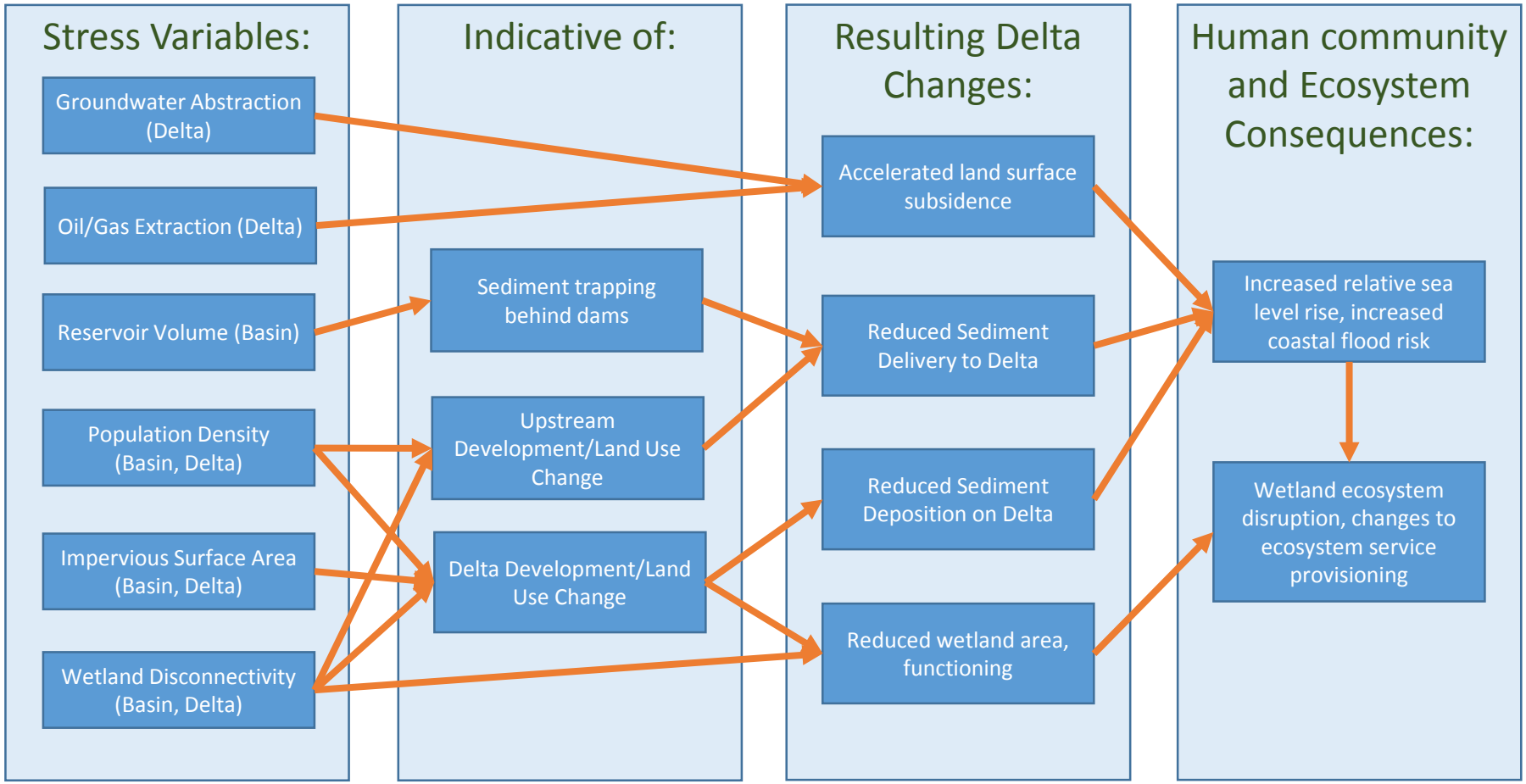


Population Density, GRUMPv1, persons/km2

Collectively, deltas are home to ca. 0.5B people--often in *urban agglomerations*--and thus constitute an important important global change and sustainability issue

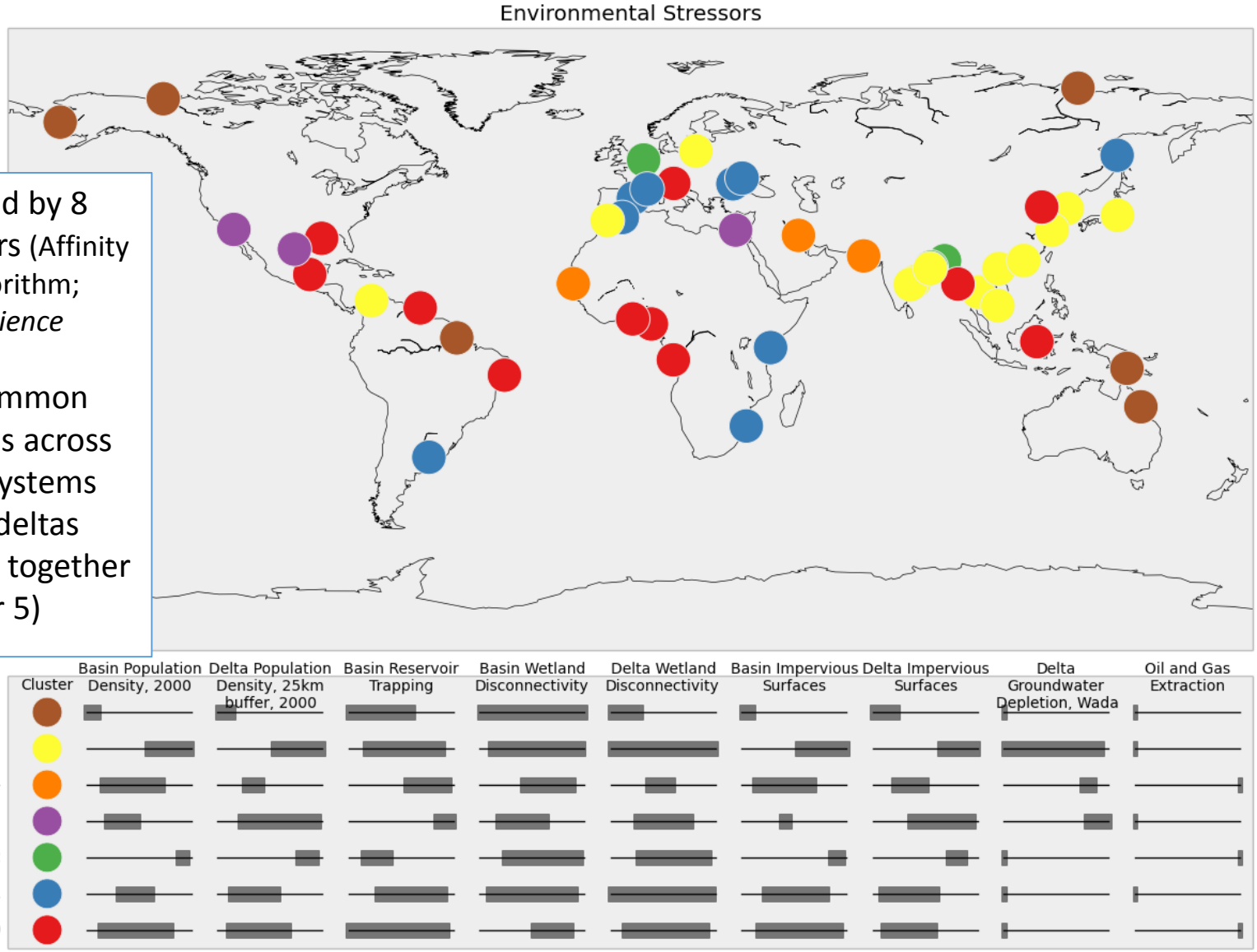
Hierarchical Classification System to Assess Vulnerability:

to evaluate the balance of human-derived vs natural stressors on deltaic systems and explore consequences…via mappable surrogates



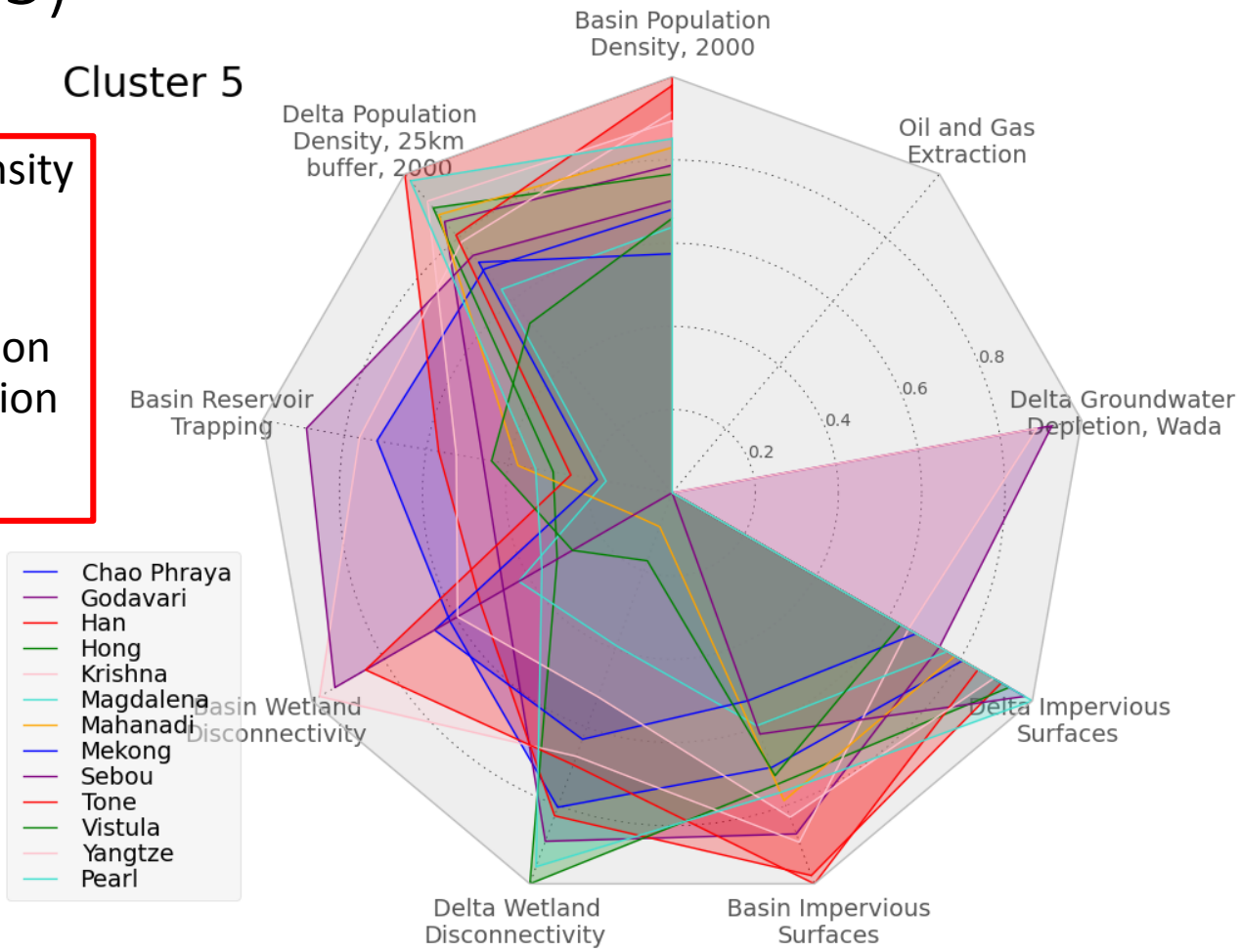
Delta typology of human management (environmental) stresses

- Deltas clustered by 8 stress indicators (Affinity Propagation algorithm; Frey & Dueck, *Science* 2007)
- Measure of common modes of stress across distinct delta systems
- e.g., East Asia deltas tend to cluster together (yellow, cluster 5)

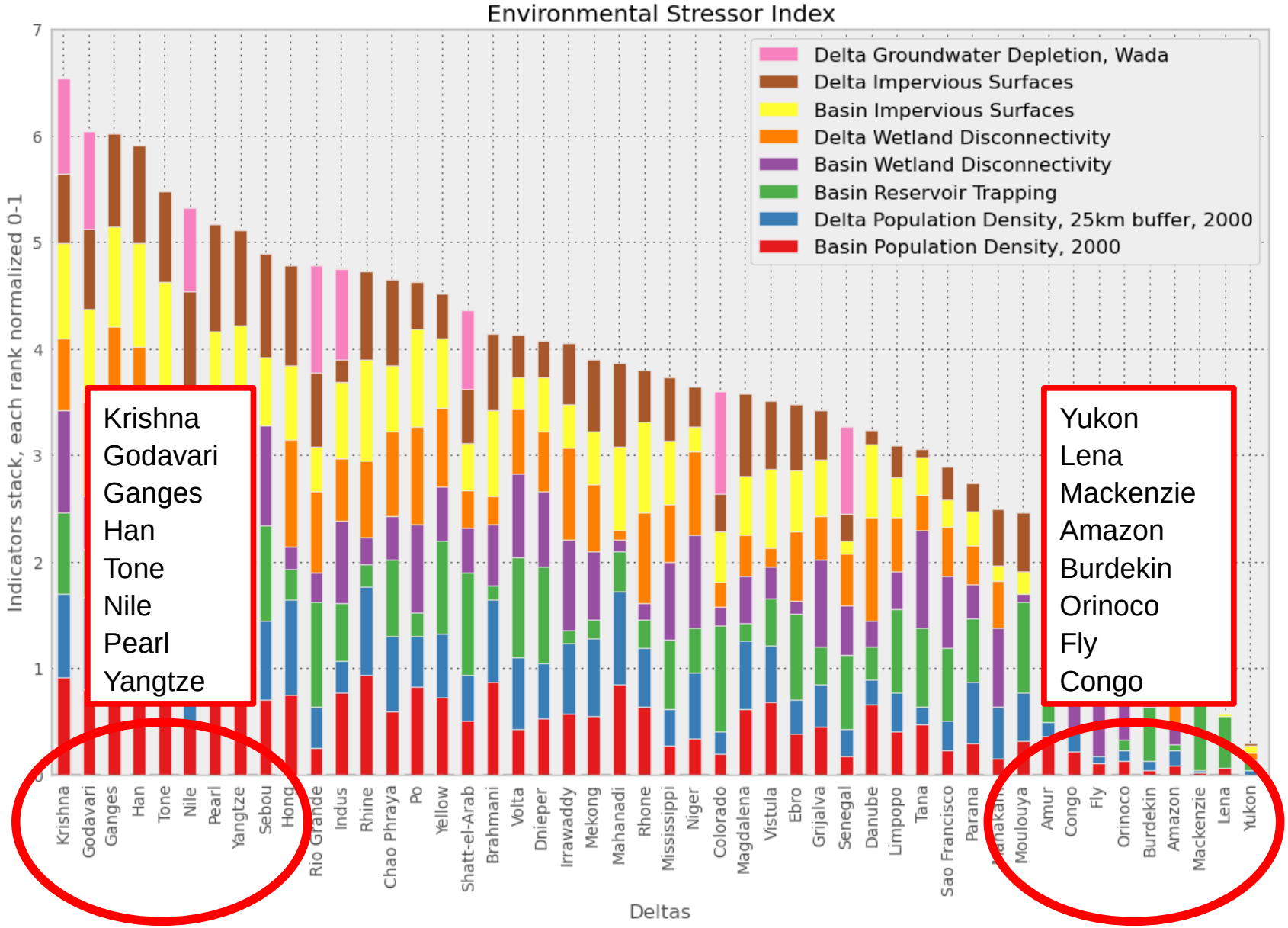


Highly urbanized deltas (Class 5)

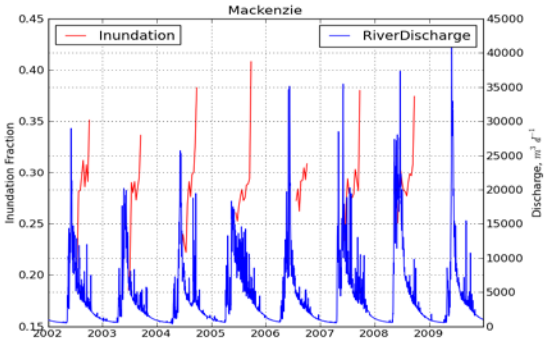
- High population density
- High impervious surface area
- Mostly low reliance on groundwater depletion (for agriculture)



Environmental Stress Index



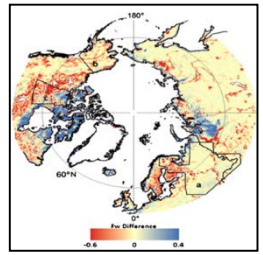
Discharge & Satellite-Detected (AMSR-E) Inundation Time Series Provide Background on "Climo-dynamic Hazards"

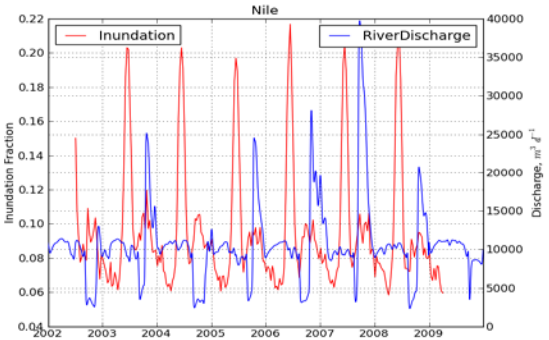


MACKENZIE

High lat., low development & population

--*River discharge leads….inundation follows ….then freezing*

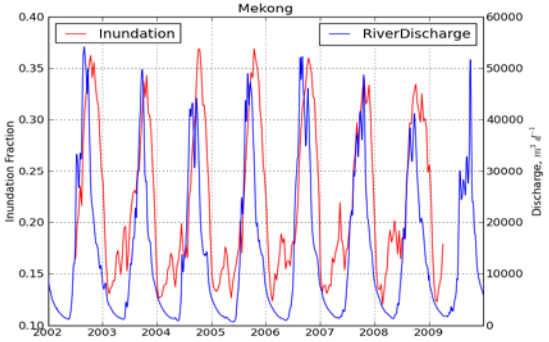




NILE

Arid zone, high agriculture & population

--*Completely engineered flows out of phase with flooding…inundation timed to cropping*

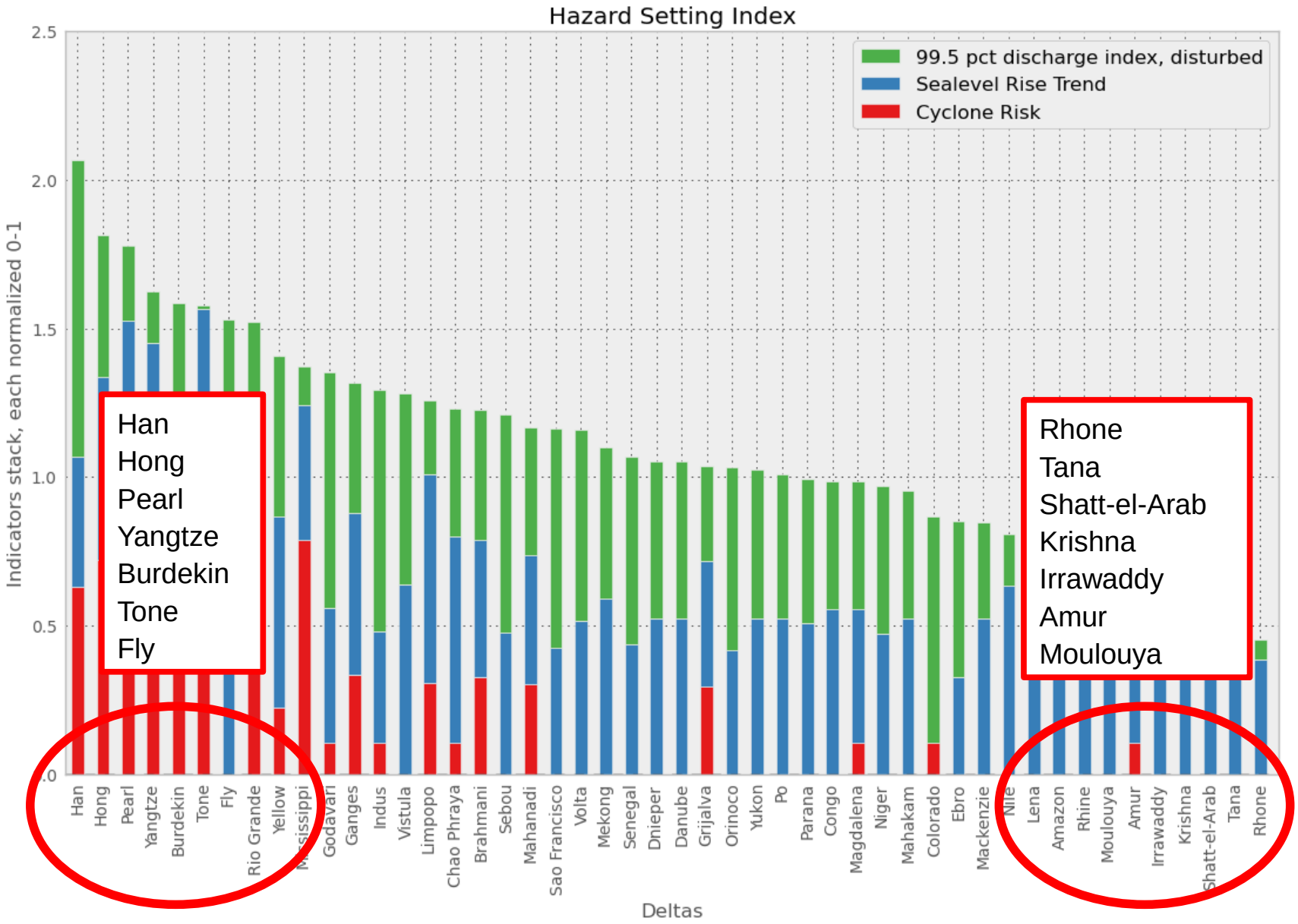


MEKONG

Low urbanization (3%), high cropland density

--*River flows lead to inundation…water use "as available" to satisfy irrigation demand, but w/ low flow use*

Background “Climo-dynamic Hazards”

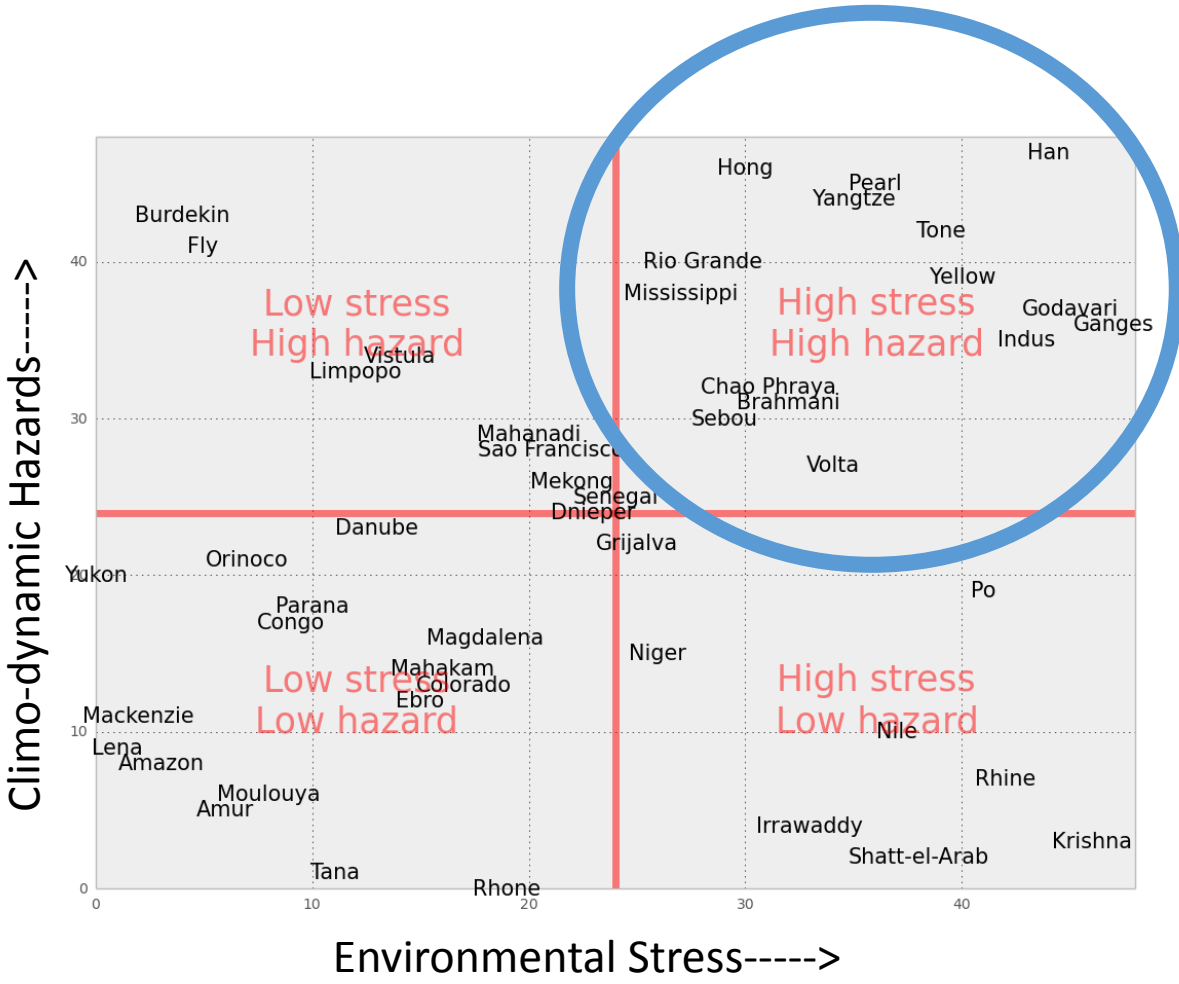


Delta "Hot Spots: Incident hazards vs stress

A spatial hypothesis

Which deltas under high stress are also exposed to high hazard?

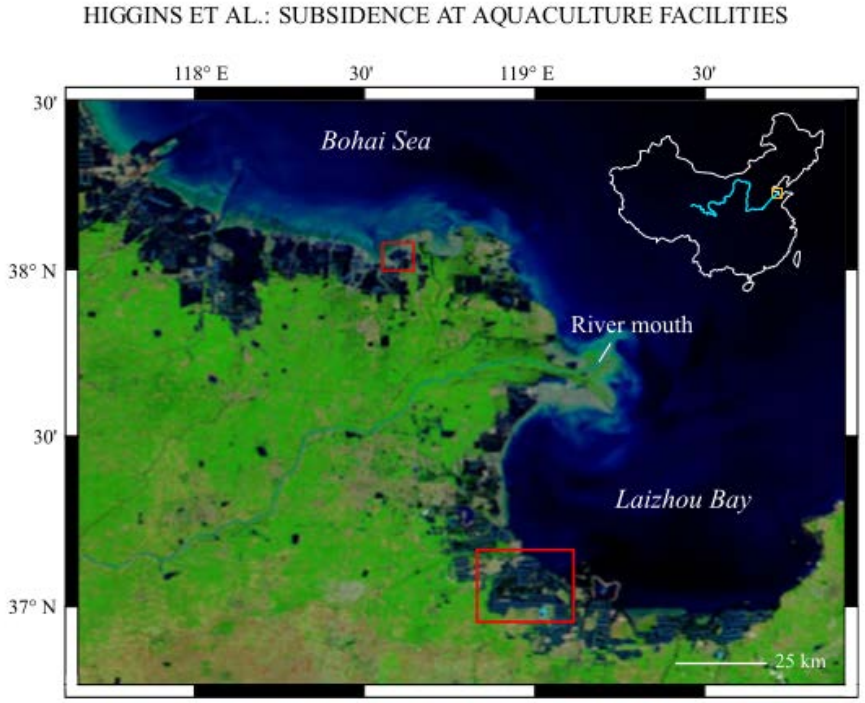
- Hotspots are predominately heavily urbanized Asian deltas:
  - Han
  - Pearl
  - Yangtze
  - Yellow
  - Godavri
  - Ganges
  - Indus



From 30,000-ft view to local

- Interferometric SAR* used to map subsidence in the Yellow River Delta and the Ganges Delta
- Yellow River Delta – Strong evidence of subsidence from groundwater extraction due to fish farms

**Envisat ASAR (ESA) &ALOS PALSAR (JAXA) from 2007-2011.*



Higgins, 2013, GRL

20-40 cm of ground subsidence per year!

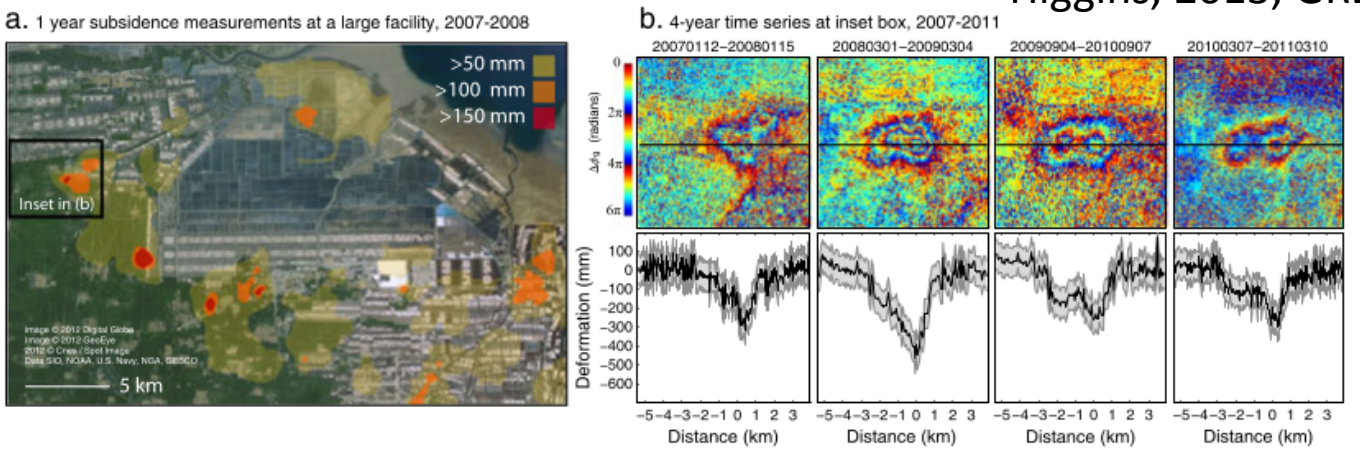
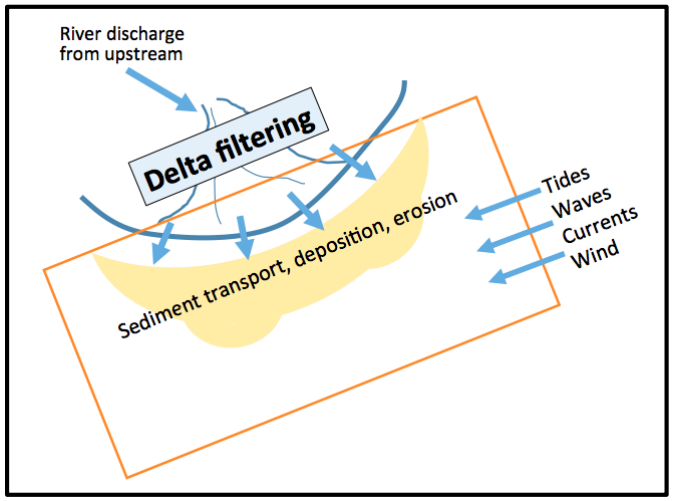
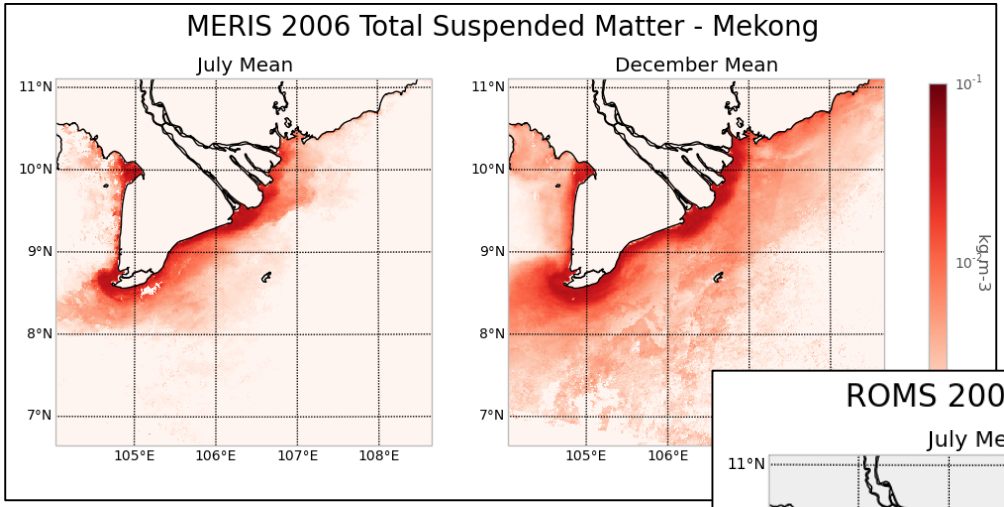


Figure 4. Subsidence at a large aquaculture and salt production facility in the southern part of the delta. (a) One year subsidence derived from ALOS PALSAR interferogram number 1 (20070112-20080115), overlain on satellite image of the same area. (b) Full time series of subsidence feature indicated by inset box in Figure 4a, with unwrapped cross sections of deformation. Maximum deformation values in these interferograms are –313 mm in 369 days, –466 mm in 369 days, –258 mm in 369 days, and –298 mm in 369 days.

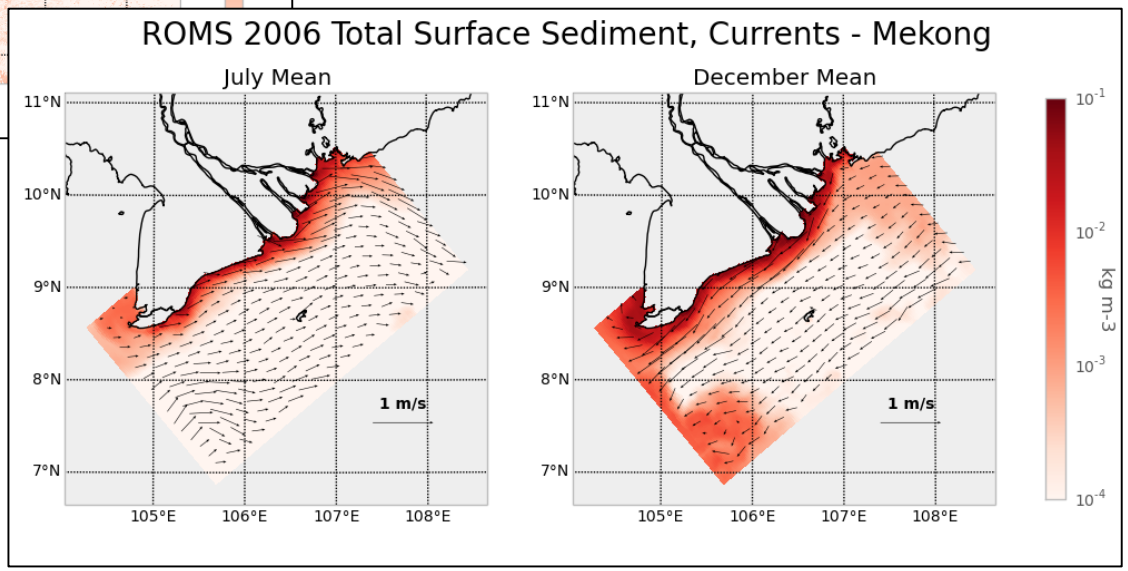
Coastal sediment process modeling – Mekong River Delta



MERIS total suspended matter, remote sensing



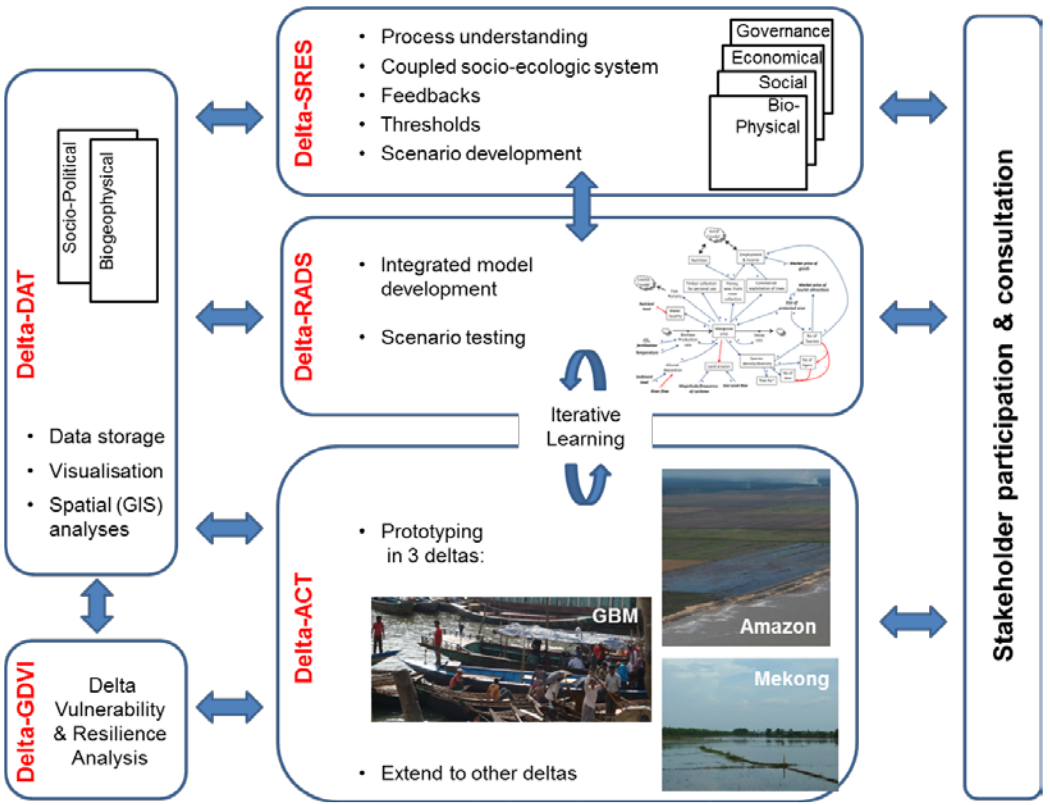
ROMS Total Surface Suspended Sediment Concentration, numerical simulation



Belmont Forum Collaboration

30 Participating Scientists from 13 Countries

DELTAS: Catalyzing action towards sustainability of deltaic systems with an integrated modelling framework for risk assessment



www.iyds-2013.org

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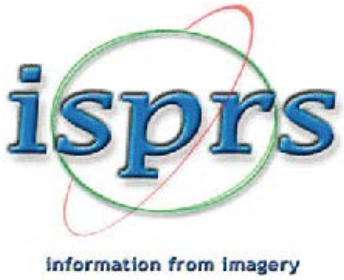
The Lena River Delta is the most extensive protected wilderness area in Russia.

Photo courtesy of USGS, EROS Data Center

Marine and lacustrine deltas around the world are economic and environmental hotspots. They occupy approximately 1% of the Earth's land area but are home to greater than 500 million people — all within 5 meters of present-day sea level. Deltas support high productivity, rich biodiversity, and

IYD Sponsors



Science-to-Action Workshop

Deltas in Times of Climate Change II
September 2014, Rotterdam

- "Aligning science with stakeholder and community needs in the Mekong Delta system"
- Dialog between scientists and stakeholders examining perceptions of risk and ecosystem trends, and the research/data needs to measure this
- Accepted for presentation in Rotterdam, Sept 2014