BF-DELTAS

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Discharge / Sediment
Local activities
Ocean waves/tides
Discharge / Sediment

Local activities

Sea level / Subsidence

Eco-hydrology  Geomorphology  Sedimentology

Socio-economics  Policy

Integration for Sustainability

BELMONT FORUM

Deltas
A key International Network of Funders of Environmental Research

Slides courtesy of Dr. Patrick Monfray
IGFA/Belmont Forum co-chair
Future Earth Governing Council member

The Belmont Forum gathers the world’s major and emerging funders of global environmental change research, and international science councils.

• Acting as Council of Principals for IGFA, a larger group of funding agencies.

• Australia/CSIRO
• Brazil/FAPESP
• Canada/NSERC
• China/NSFC
• European Commission/DG R&I
• France/CNRS&ANR, co-chair
• Germany/DFG&BMBF
• India/MoES
• Italy/CNR

• Japan/MEXT&JST
• South Africa/NRF, co-chair
• Sweden/SSEESS
• United Kingdom/NERC
• United States/NSF

• International Council for Science (ICSU)
• International Social Sciences Council (ISSC)
The “BF-DELTAS Team”

**USA:**  E. Foufoula-Georgiou and V. Voller (Univ. of MN); I. Overeem (Univ. of Colorado); S. Goodbred (Vanderbilt University); I. Harrison (Int. Union for Conservation of Nature); C. Vorosmarty and Z. Tessler (City College of New York); E. Brondizio (Indiana University)

**Japan:**  Y. Saito (Geological Survey of Japan, Japan);  

**Germany:**  S. Dech and C. Kuenzer (University of Wuerzburg); F. Renaud (United Nations Univ.);  

**France:**  E. Anthony (Aix-Marseille University);  

**U.K:** Z. Matthews, R. Nicholls, J. Dearing, A. Lazar, and A. Baschieri (Univ. of Southampton); J. Hutton (UNEP - World Conservation Monitoring Centre);  

**India:**  R. Ramachandran (Anna Univ.)  

**Netherlands:**  M. Marchand and T. Bucx (Deltares)  

**Bangladesh:**  K.M. Ahmed (Univ. of Dhaka); M.M. Rahman (Bangladesh Univ. of Engineering and Technology);  

**Vietnam:**  V. L. Nguyen (Vietnam Academy of Science and Technology); M. Goichot (World Wide Fund for Nature – Greater Mekong)  

**Norway:**  A. Newton (Norwegian Inst. for Air Research, Norway);  

**Brazil:**  S. Costa (University of Vale do Paraiba),  

**Canada:**  G. Lintern (Natural Resources Canada); P. Van Cappellen and H. Durr (University of Waterloo)  

**China:**  S. Gao (Nanjing Univ.)
Major science questions

1. How do climate change, pressure on resources, and engineering/infrastructure development make people, biodiversity, and delta ecosystems vulnerable? -- cascade of stressors

2. How is delta vulnerability to be measured? -- metrics of change

3. How do delta areas absorb extreme events? What are the hydrological and ecological thresholds underlying the integrity of a delta region? -- threshold behavior

4. What are the relevant local and regional hydrological, biophysical and social stressors for a particular delta system, how do these interact, and how do they vary spatially and over time? -- local to regional scales

5. How can one reduce future risk while attaining sustainable development? -- actionable scenario building

Work Packages (WPs)

1. Advance *science on resilience and sustainability* of deltas as critical coupled socio-ecological systems undergoing change (*Delta-SRES*)

2. Develop and deliver a science-based delta sustainability framework for risk assessment and *decision support* (*Delta-RADS*)

3. Build an international *repository of data* sets including physical, social, and economic data (*Delta-DAT*)

4. Develop *Global Delta Vulnerability Indices* that capture the current and projected physical-social-economic status of deltas around the world (*Delta-GDVI*)

5. Implement and demonstrate the developed modeling and decision support framework in selected deltas *in partnership with local stakeholders*, and open to door for global use and adoption (*Delta-ACT*)
A Few Highlights

1. Delta network analysis and vulnerability to change (Delta-SRES)
2. Models: from physics to decision support tools (Delta-RADS)
3. Historical trends in demographic and bio-physical parameters (Delta-DAT/ACT)
4. Climate-human-landscape coupling (Delta-SRES/RADS)
5. Global Vulnerability indices (Delta-GDVI)
6. Stakeholder Partnership (Delta-ACT)

Wax Lake delta, Louisiana Coast, USA

1- Delta Networks and Vulnerability

**Overall Question:** How does delta connectivity (in process and/or structure) control the overall system robustness to change?

**Approach:**
Develop a framework that can allow probing into the delta system connectivity in a systematic way and evaluating system changes in view of changes in one or more of its connected components (vulnerability analysis)

**Have developed:**
1. A rigorous framework for delta network analysis of topology and dynamics: Extracting subnetworks, Nourishment Areas, Upstream Areas.
2. Use this framework for building vulnerability maps
3. Define comparison metrics and relate those metrics with measures of robustness
1- Delta Networks and Vulnerability

Vulnerability Maps

Wax Lake Delta

Niger Delta
2- Modeling : Laboratory Deltas

Controlled Laboratory experiments: Form Deltaic Surface Evolution & Stratigraphy

St. Anthony Falls Laboratory
University of Minnesota

Experiment DB03, SAFL – see Sheets et al., 2007
Ganti et al., JGR-ES, 2011, 2013

2- Modeling : Integrated Models

Developing of Online Resources Modeling Examples focused on 3 DELTAS case-studies

http://csdms.colorado.edu/wiki/Labs_WMT_Ganges_Sediment_Supply
Developing of Online Resources Modeling Examples focused on 3 DELTAS case-studies

**The CSDMS Web Modeling Tool**

<table>
<thead>
<tr>
<th>Model (&quot;Sedflux2D&quot;)</th>
<th>Parameters (Sedflux2D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedflux2D v2.1 (10.1594/EDA/100161)</td>
<td>Basin filling stratigraphic model. Sedflux2D simulates long term marine sediment transport and accumulation into a 2D longitudinal basin over time scales of tens of thousands of years. It simulates the dynamics of strata formation of continental margins and includes turbidity currents and debris flows. <a href="http://csdms.colorado.edu/wiki/Model_help:Sedflux">Link</a></td>
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<td>subaerial...</td>
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<td>baselevel...</td>
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</tbody>
</table>

http://csdms.colorado.edu/wiki/Labs_WMT_Ganges_Sediment_Supply

**2- Modeling : Integrated Models**

A coupled model run of WAVES, CEM (coastline evolution model), Avulsion, and HydroTrend. The wave model drives longshore sediment transport. Two small rivers enter the coastal zone and deliver sediment. The river mouths of the two rivers prograde over the 100's of years. The avulsion is dynamic, and happens more easily when the pathway to the coast becomes longer.

http://csdms.colorado.edu/wiki/Labs_WMT_Ganges_Sediment_Supply
2- Modeling: Precipitation/ Inundation

Retrieval of precipitation from space (TRMM/GPM)

GPM: Global Precipitation Measuring Mission

Spatial correlations between inundation and precipitation over a per-delta optimized rolling window

(Ganges) (Mekong) (Amazon)

3- Trends: Demographic data

- Bangladeshi Household Income and Expenditure Survey
- Censuses, demographic and health surveys (DHS), and maternal mortality surveys (BMMS)
- Demographic Analysis: Population Projections
- Analysis of budget surveys: (Food, Mitigation, Inequalities)
- Vietnamese Household Living Standards Survey (HLSS)
- Historical trends in selected social and environmental indicators from the Mekong River Commission (MRC)
- Analysis of budget surveys
- Consumer Expenditure Surveys have been obtained from the Brazilian Statistical Office (IBGE).
3- Trends:
Shoreline Erosion
Mekong Delta shoreline variations (1965 – 2014)
ANALYSIS OF 6000 shoreline transects (100 m spacing) using Landsat and very high-resolution SPOT 5 images

TRENDS INFORMING DECISIONS
1. Disentangle the role of human vs. natural processes in shoreline vulnerability (mangrove clearance, modification of sediment supply, modification of delta plain).
2. Sustainable shoreline management cells, and options for the future. Recommendations regarding river sediment husbandry (channel-bed mining, future dams).

3- Trends:
Sundarban Erosion/Accretion
3- Trends: Land Use / Population Expansion

1990

2003
Kolkata’s urban agglomerate accounted for an increase of over a million people in the last decade alone.
Climate-human-landscape interactions increase flood potential.

Tidal inundated island 18 months after Cyclone Aila, May 2009

Figure 2. Results of the GPS elevation survey (Polder 32 transects in colored circles; Sundarbans transects in black... landscape is positioned at +1.5±0.10 m and, in the absence of embankment protection, is flooded at every high tide.)
5- Global Indices of Vulnerability

Anthropogenic Stress and Coastal hazard intensity indices

- **Amazon, Mekong, and Ganges** occupy very different places in the *risk space*.
  - **Amazon** – low anthropogenic stress, moderate hazard frequency/intensity, moderate governance score. **Low** rate of change of risk due to anthropogenic stress.
  - **Mekong** – moderate anthropogenic stress, low hazard frequency/intensity, moderate/low governance score. **Moderate/low** risk rate of change.
  - **Ganges** – very high anthropogenic stress, moderate hazard frequency/intensity, low governance score. **Very high** risk rate of change.

Estimated rate of change of risk due to anthropogenic stress (land subsidence, wetland loss...)

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**Anthropogenic Stress Index**

**Delta Hazard Index**
Local consultations in the three demonstration deltas at the sub-delta scale (Mekong: 2-3 April 2014, Ganges: 3-4 September 2014, Amazon: early 2015)

Join us tomorrow!

Deltas-in-Practice Workshop:
“Science-to-Action: Aligning science with stakeholder community needs in the Mekong and other delta systems”

Deltas in Practice 6: DP 6.3 (Friday 9 am – 12 noon)
The BIG Question

How to bring together disparate efforts on deltas, facilitate preservation of data, share models and research, build trust with stakeholders and truly affect management and policies for delta sustainability?

INTERNATIONAL YEAR OF DELTAS 2013:
A PROPOSAL

We propose that 2013–2014 be designated the International Year of Deltas to: (1) increase awareness and attention to the value and vulnerability of deltas worldwide, (2) promote and enhance international and regional cooperation at the scientific, policy, and stakeholder level, and (3) focus and accelerate a comprehensive research agenda towards understanding and modeling these complex socio-ecological systems as the cornerstone of ensuring preparedness in protecting or restoring them in a rapidly changing environment.

FORUM

International Year of Deltas 2013:
A Proposal

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There is an urgent need to rally the international community for a focused effort toward a holistic physical-socioeconomic understanding of deltas as critically delicate and vulnerable systems undergoing change. Such understanding is a basic requirement for their management, protection, and restoration.

We propose that 2013–2014 be designated as the International Year of Deltas (IVD) to:

1. Promote and enhance international and regional cooperation at the scientific, policy, and stakeholder level.
2. Increase awareness and attention to the value and vulnerability of deltas worldwide.
3. Focus and accelerate a comprehensive research agenda towards understanding and modeling these complex socio-ecological systems as the cornerstone of ensuring preparedness in protecting or restoring them in a rapidly changing environment.

Geornorphology, ecology, sediment engineering, hydrology, coastal oceanography, statistics, geography, history, anthropology, sociology, political sciences, and economics.

Basic research questions across these disciplines include the following:

1. What are the system dynamics of a delta, its main processes and reservoirs, feedback loops, system parameters, and relevant parameters that govern dynamic equilibrium states? How strong is the two-way coupling between the ecological communities of the delta top and the geomorphic (physical) template?
2. How does the delta system (distributaries, wetlands, lakes, lagoons, and coastal zones) self-organize into a dynamic structure capable of maintaining the subaerial delta over different time scales?
3. How do contributions in the Interim
1. SD2015 is a statement of urgency for global awareness and cooperation, a call-to-arms to the global community of citizens, scientists, policy makers, funders

2. SD2015 is a mechanism to bring countries together at all levels of science, policy, decision makers, and public

3. SD2015 is an opportunity to integrate and leverage disparate efforts for accelerating progress towards delta sustainability

4. SD2015 is the beginning (not the end) of a bigger effort and the springboard for a coordinated path forwards
“Sustainable Deltas 2015 Initiative”

Need your leadership and ideas to make SD2015 a success

1. Make your organization part of the SD2105 initiative effort – use the logo in your web site
2. Carry the message around and ask others to join
3. Share your data and models – NEED A CENTRAL REPOSITORY
4. Sponsor at least one lecture in your institution under the SD2015 umbrella
5. Summer institutes and training courses – connect them to SD2015
6. Science museum exhibits and public meetings -- increase awareness of deltas at risk
7. Think BIG – influence funding resources for SD2015+
8. ....