Adaptation and Migration in Asia's Drowning River Deltas

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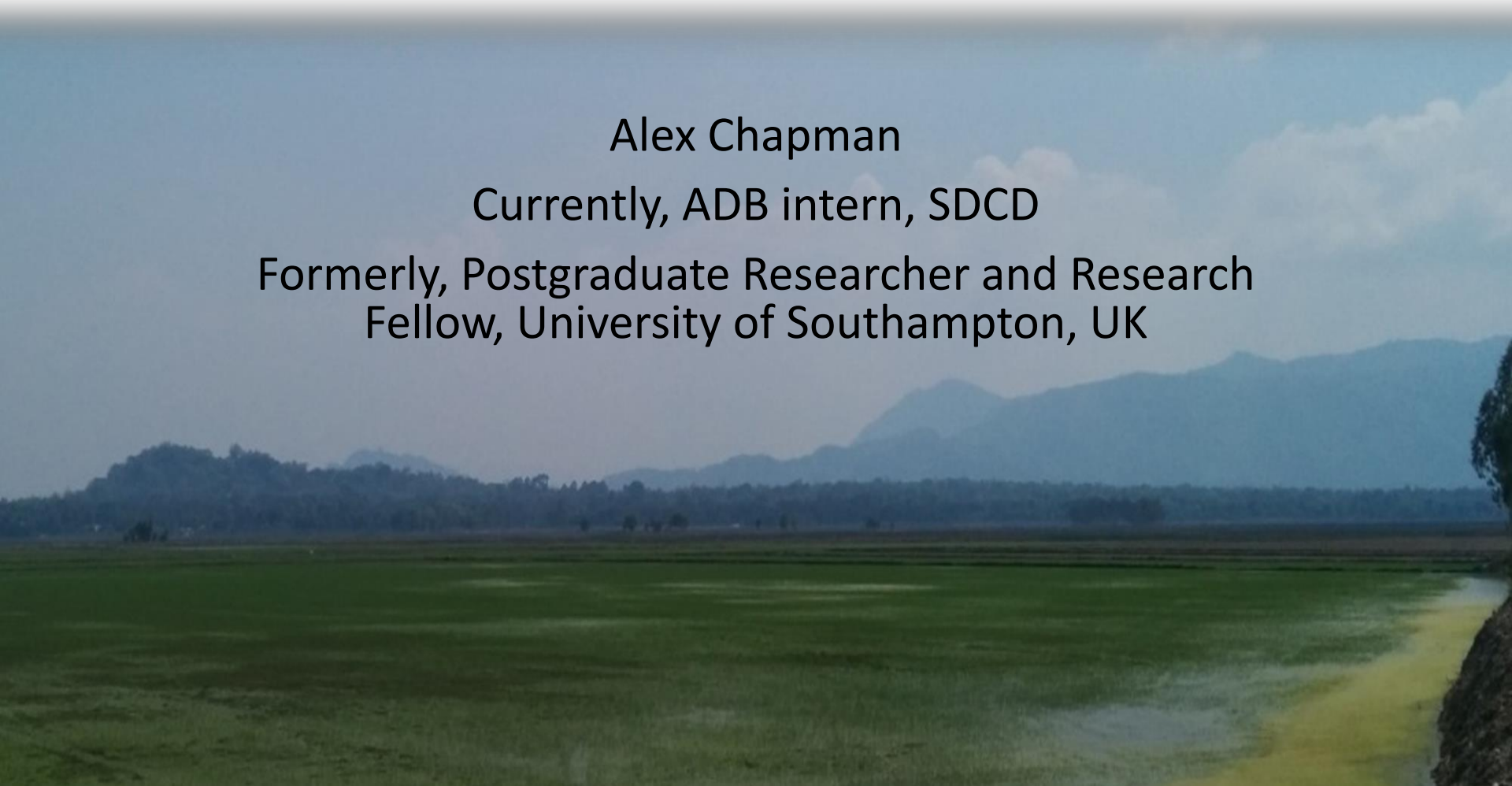


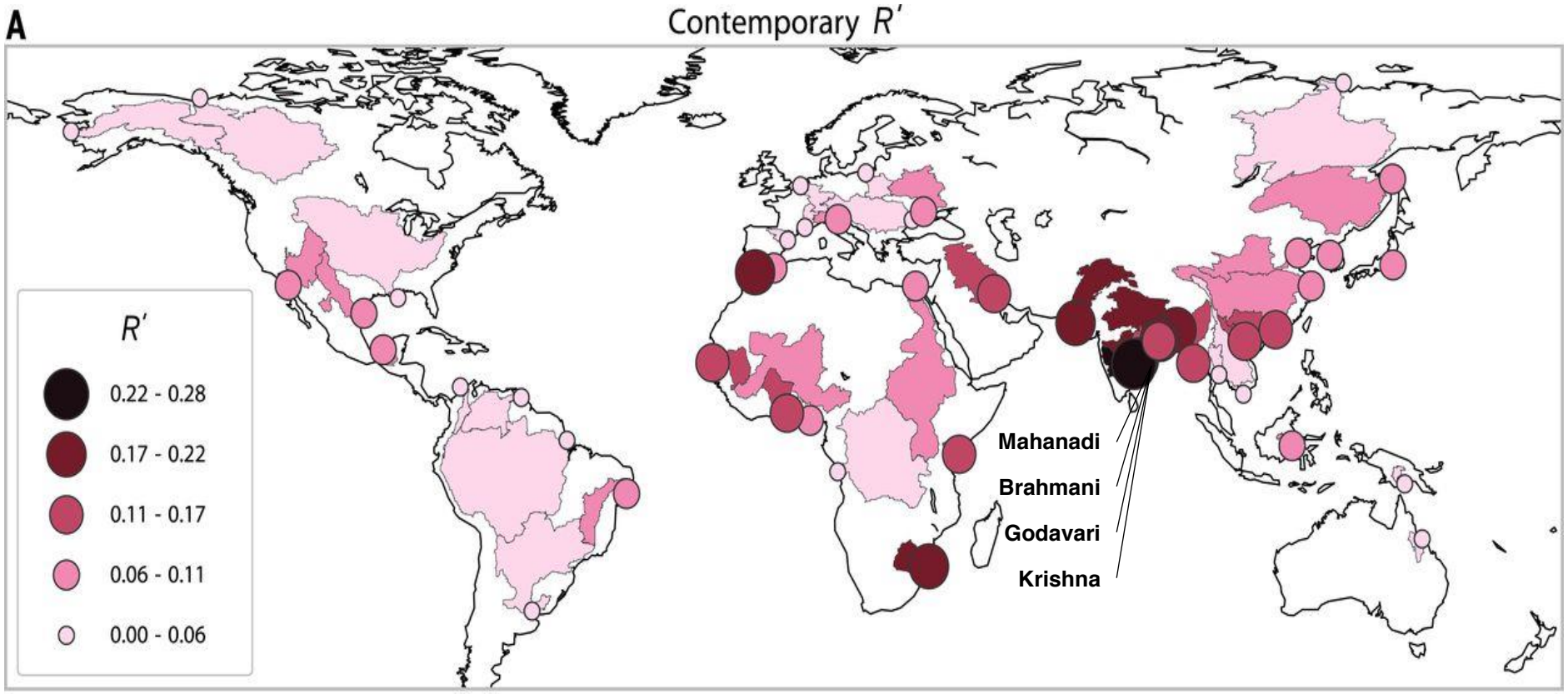
Original data from two projects which have the University of Southampton as a lead partner (STELAR, DECCMA)… and my doctoral thesis

- Other partners include: *University of Exeter, University of Hull, University of Dundee, Basque Center for Climate Change, Kulima Integrated Development Solutions, Plymouth Marine Laboratory, FAO, MET office, Bangladesh Institute of Engineering and Technology, University of Dhaka, Centre for Environmental and Geographic Information Services, Bangladesh Space Research and Remote Sensing Organisation, South Asian Network on Economic Modelling, Water Resources Planning Organisation, Jadavpur University, Center for Environment and Development, Chilika Development Authority, Sansriti, National Remote Sensing Centre, Mekong River Commission, Durham University,*

Rice

- Staple food item for half the world's population
- Including ca. 900 million people subsisting on <1.25 USD/day
- Asia's biggest Exporters: India, Vietnam, Thailand, Myanmar, and Pakistan
- And big producers: China and Bangladesh

The world's threatened deltas, concentrated in South and East Asia



Tessler, Z. D., Vörösmarty, C. J., Grossberg, M., Gladkova, I., Aizenman, H., Syvitski, J. P. M., & Foufoula-Georgiou, E. (2015). Profiling risk and sustainability in coastal deltas of the world. Science, 349, 638–643.

Mekong, Vietnam (pop. 18 million) *and Cambodia*

- Estimated relative sea-level rise: 6 – 40 mm/yr (0-5 m.a.s.l)
- 3rd largest rice exporter in the world (majority from the Mekong Delta)
- 9th largest sediment flux on earth

Syvitski, J., Kettner, A., Overeem, I. Hutton, E., Hannon, M., Brakenridge, G., Day, J., Vorosmarty, C., Saito, Y., Giosan, L., Nicholls, R. (2009) Sinking deltas due to human activities. Nature Geoscience, 10: 681-686

Irrawaddy, Myanmar (pop. 3.5 million)

- Estimated relative sea-level rise: 3.6 – 6.0 mm/yr (0-5 m.a.s.l)
- More than 40% of national rice production on less than 1% of land area
- 3rd largest sediment flux on earth

(m.a.s.l = Meters Above Sea Level and refers only to the majority and not the entirety of the delta)

Ganges (GBM), Bangladesh *and India* (pop. 125+ million)

- Estimated relative sea-level rise: 8 – 18 mm/yr (0-10 m.a.s.l)
- Bangladesh the 6th largest rice producing nation (self-sufficient)
- Largest sediment flux on earth

Indus, Pakistan (pop. 1.5 million)

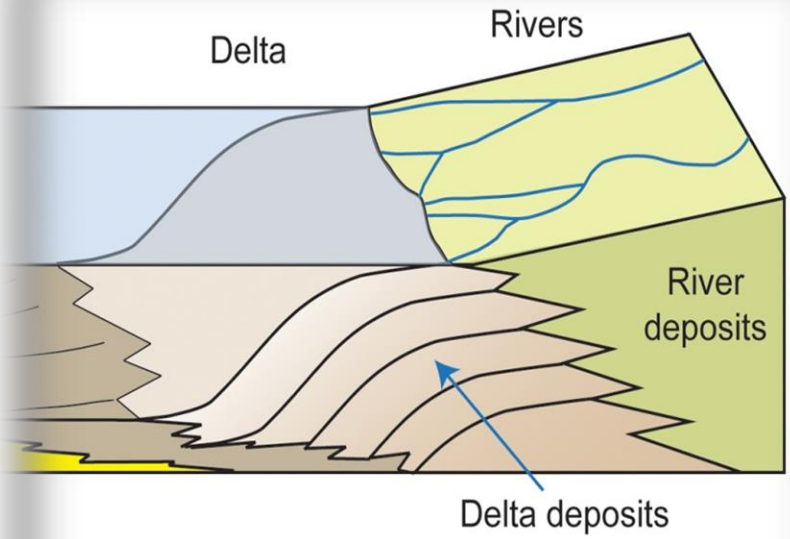
- Estimated relative sea-level rise: Min. 1.7 mm/yr (0-10 m.a.s.l)
- 5th largest rice exporter in the world
- Previously one of the largest sediment fluxes, now very little

Chao Phraya, Thailand (pop. 18 million)

- Estimated relative sea-level rise: 13+ mm/yr (0-5 m.a.s.l)
- 2nd largest rice exporter in the world
- 83% decline in sediment flux since early 20th century

Accelerators of *relative* sea-level rise in river deltas

- Climate Change-induced sea-level rise
  - 20th century: ca. 1.7 mm/yr
  - 21st century: ca. 3.2 mm/yr
- Natural subsidence
- Key subsidence accelerators
  - Groundwater extraction
  - Urbanisation
  - Aquaculture expansion
- Key sediment accretion reducers
  - Upstream dam/reservoir trapping
  - Sand mining/dredging
  - Dyke construction



Cazenave, A. et al. (2013) Sea Level Change. Climate Change 2013: The Physical Science Basis. IPCC

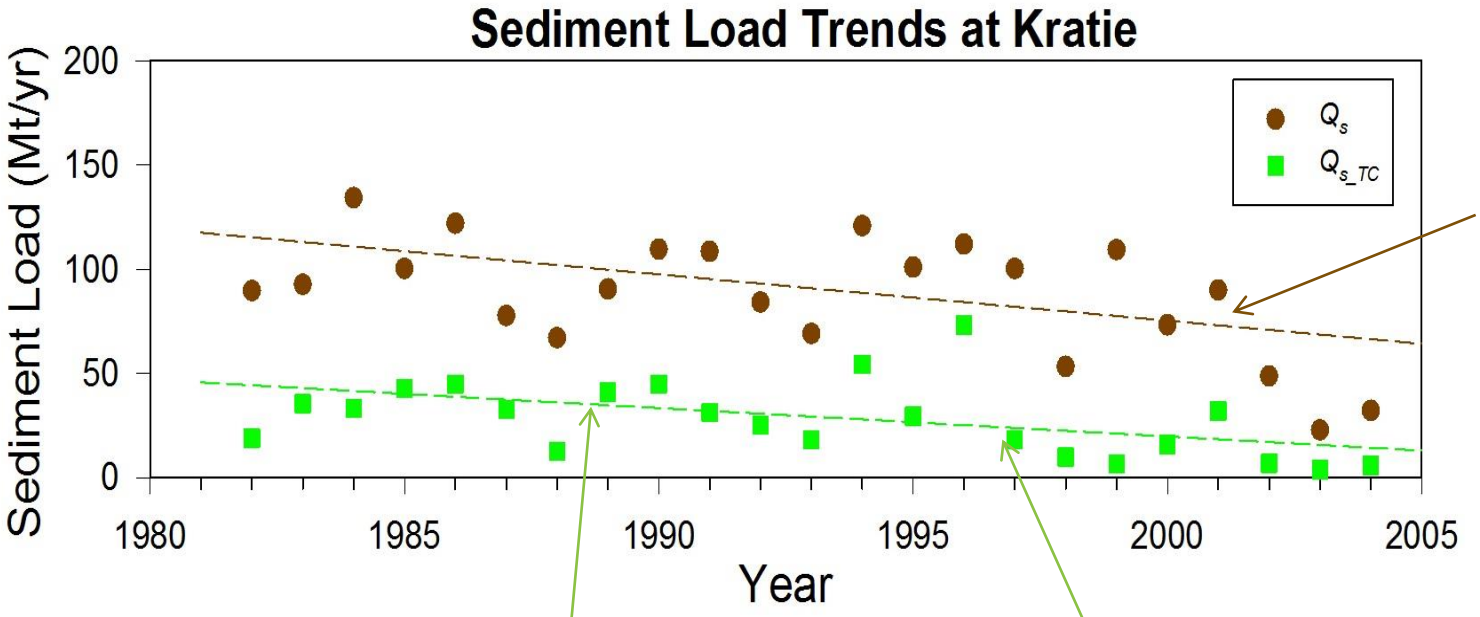
Syvitski, J. P. M., & Saito, Y. (2007). Morphodynamics of deltas under the influence of humans. Global and Planetary Change, 57, 261–282.

Erban, L. E., Gorelick, S. M., & Zebker, H. a. (2014). Groundwater extraction, land subsidence, and sea-level rise in the Mekong Delta, Vietnam. Environmental Research Letters, 9, 84010.

Higgins, S., Overeem, I., Tanaka, A., & Syvitski, J. P. M. (2013). Land subsidence at aquaculture facilities in the Yellow River delta, China. Geophysical Research Letters, 40, 3898–3902. article.

An additional factor discovered…

(Published by members of our team in Nature last week)



Climate change accountable for 64% of Mekong sediment decline

Falling sediment flux in the Mekong (2-3% per year)

Tropical cyclones account for approx. 32% of the total sediment load

Darby, S., Hackney, C., Leyland, J., Kummu, M., Lauri, H., Parsons, D., Best, J., Nicholas, A., Aalto, R. (2016) Fluvial sediment supply to a mega-delta reduced by shifting tropical-cyclone activity. Nature, doi:10.1038/nature19809

Adaptation options

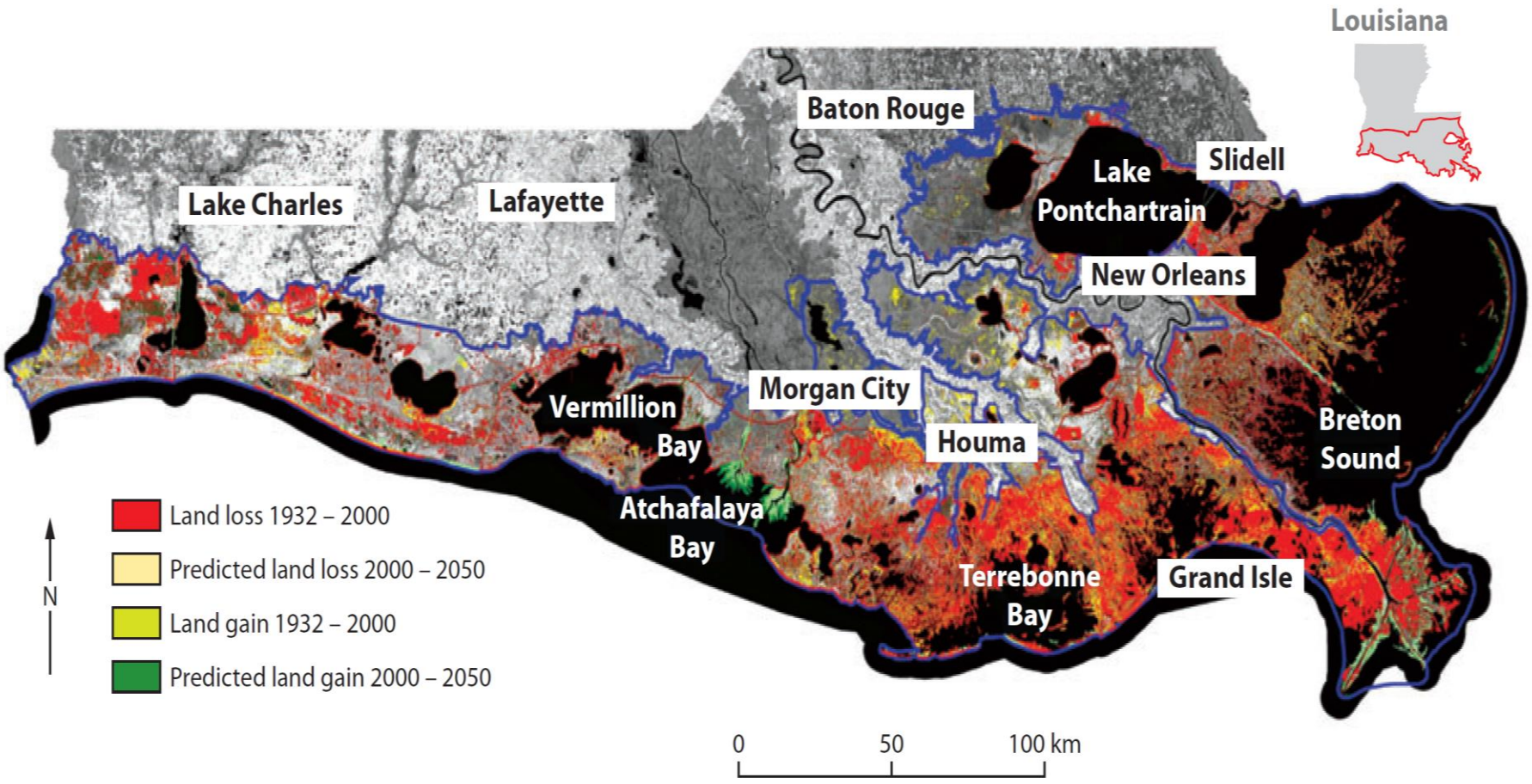
- *"The current view by much of the management community is that coastal protection is the best strategy for future SLR up to 2–5 m, and beyond 5 m that retreat would be the best (or the only) strategy." (Ibáñez et al., 2013)*

- **Protect – "rising dykes"**

- Accommodate – "rising grounds" "living with the flood" (ecosystem based adaptation?)

- *Retreat*

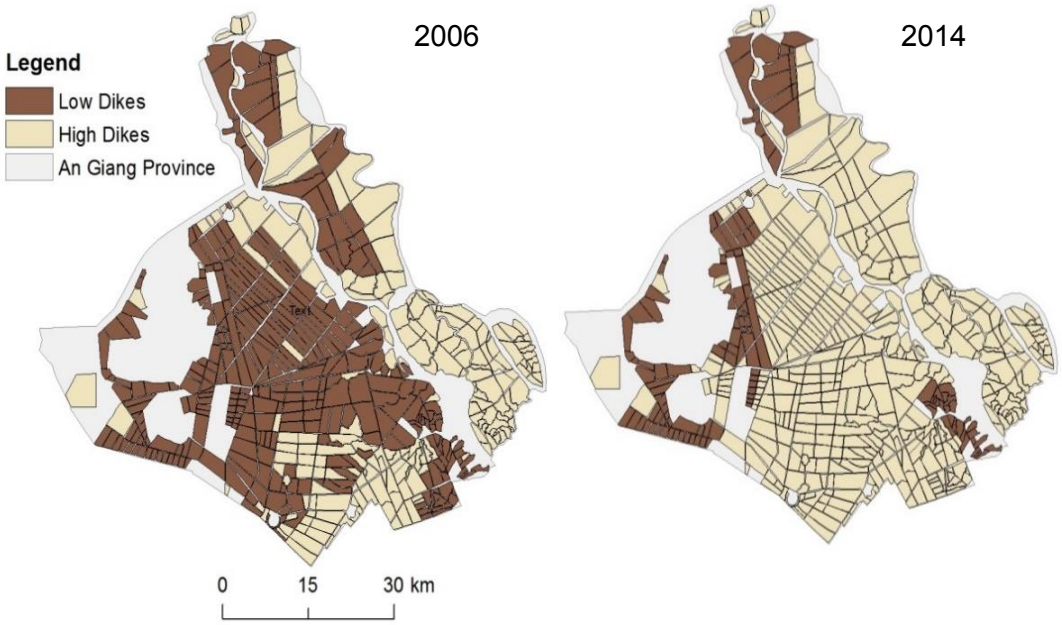
A warning from the Mississippi…



Blum, M. D., & Roberts, H. H. (2012). The Mississippi Delta Region: Past, Present, and Future. Annual Review of Earth and Planetary Sciences, Vol 40 (Vol. 40, pp. 655–683).

Protect

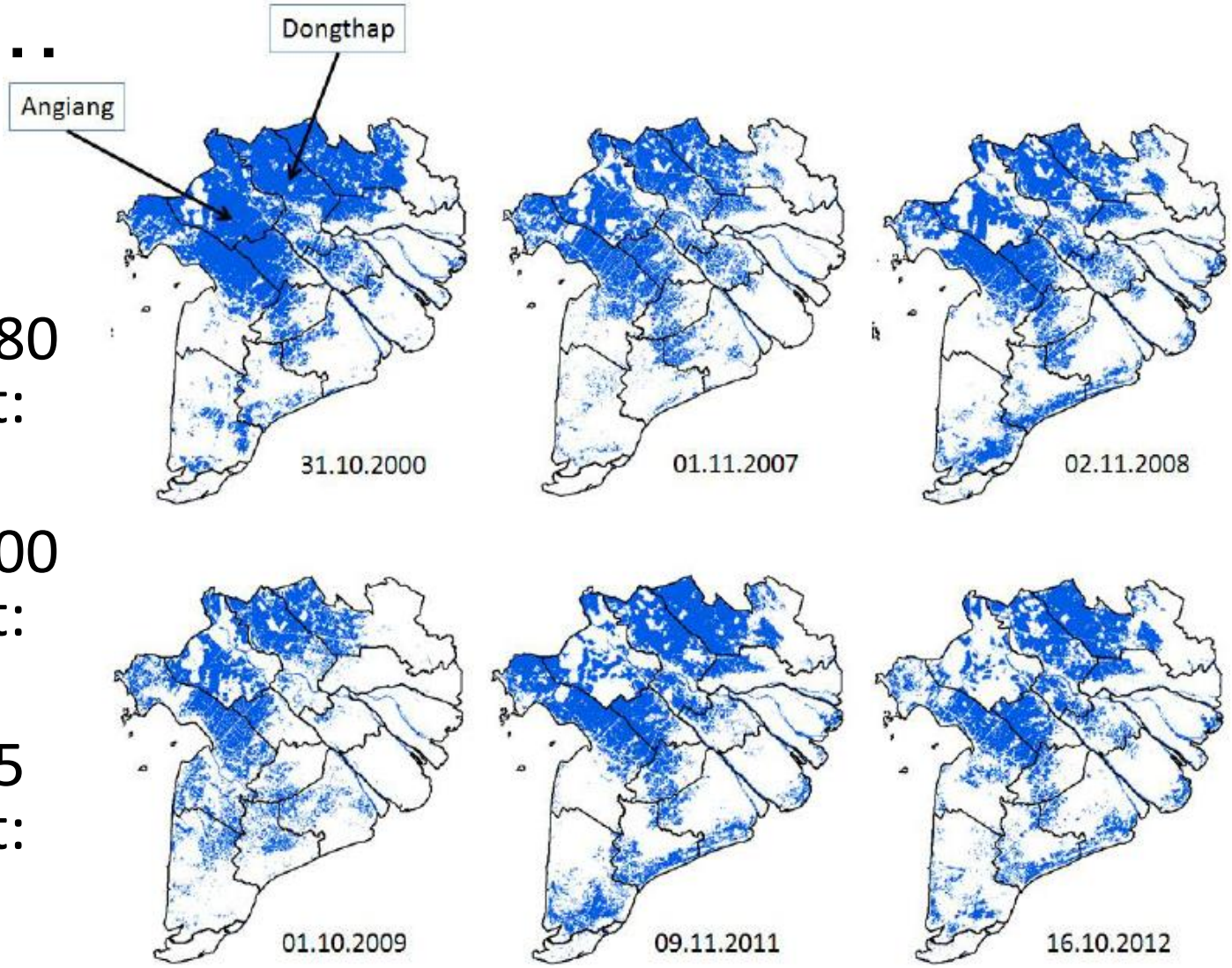
An Giang Province, Mekong Delta, Vietnam (population: 1.8 million)



Alex Chapman, doctoral thesis: http://eprints.soton.ac.uk/400969/

A natural reaction to disaster…

- 2000 – ca. 480 dead (height: 4.9 meters)
- 2001 – ca. 300 dead (height: 4.7 meters)
- 2011 – ca. 85 dead (height: 4.3 meters)



Duong, V., Van, T., Nestmann, F., Oberle, P. 2014. Land use based flood hazards analysis for the Mekong Delta. IAHR

Advantages of **protect**, as reported by empowered stakeholders

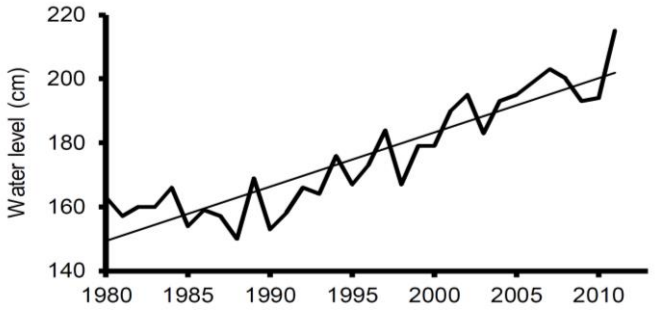
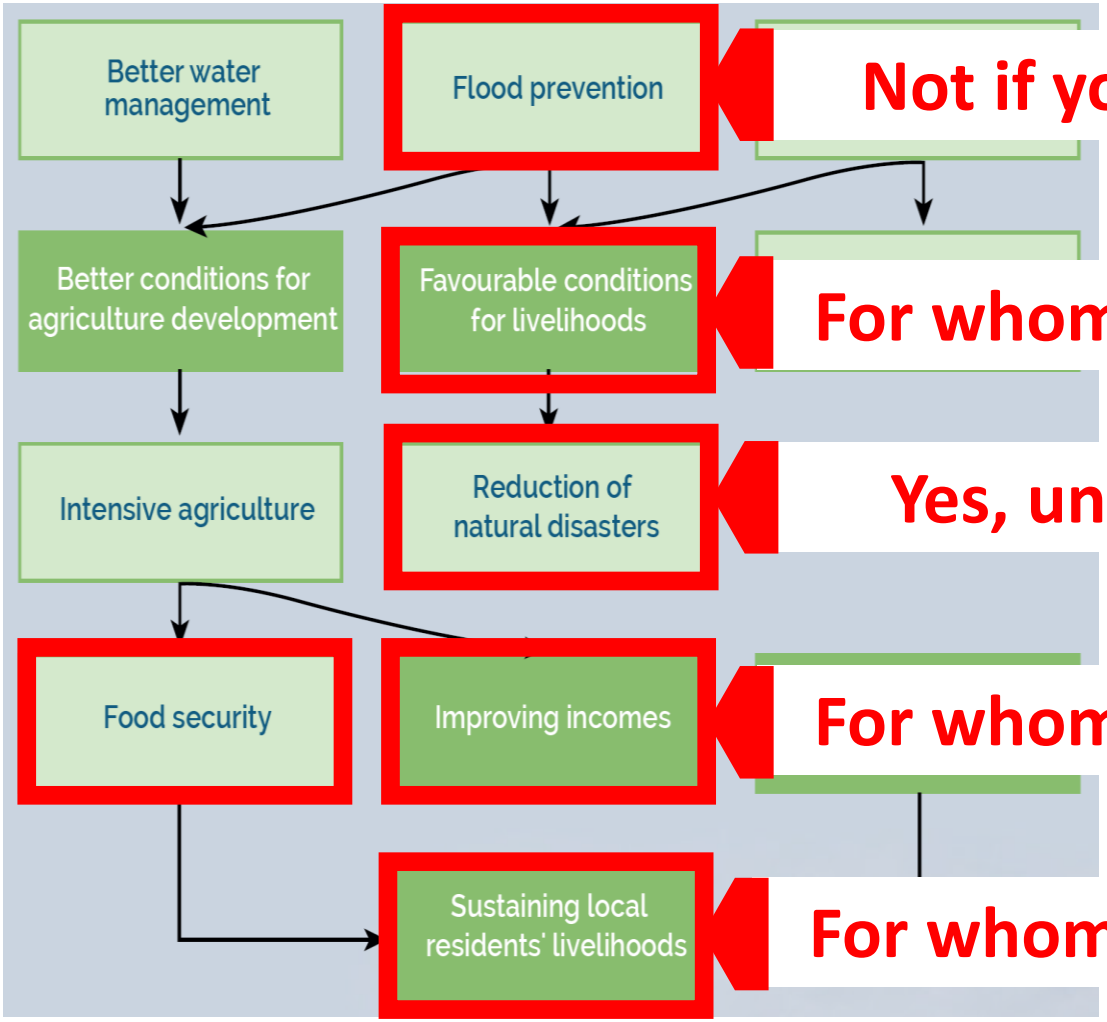


Figure 6. Maximum water levels at Can Tho



Not if you live downstream

For whom? And for how long?

Yes, unless a levee breaks

For whom? And for how long?

For whom? And for how long?

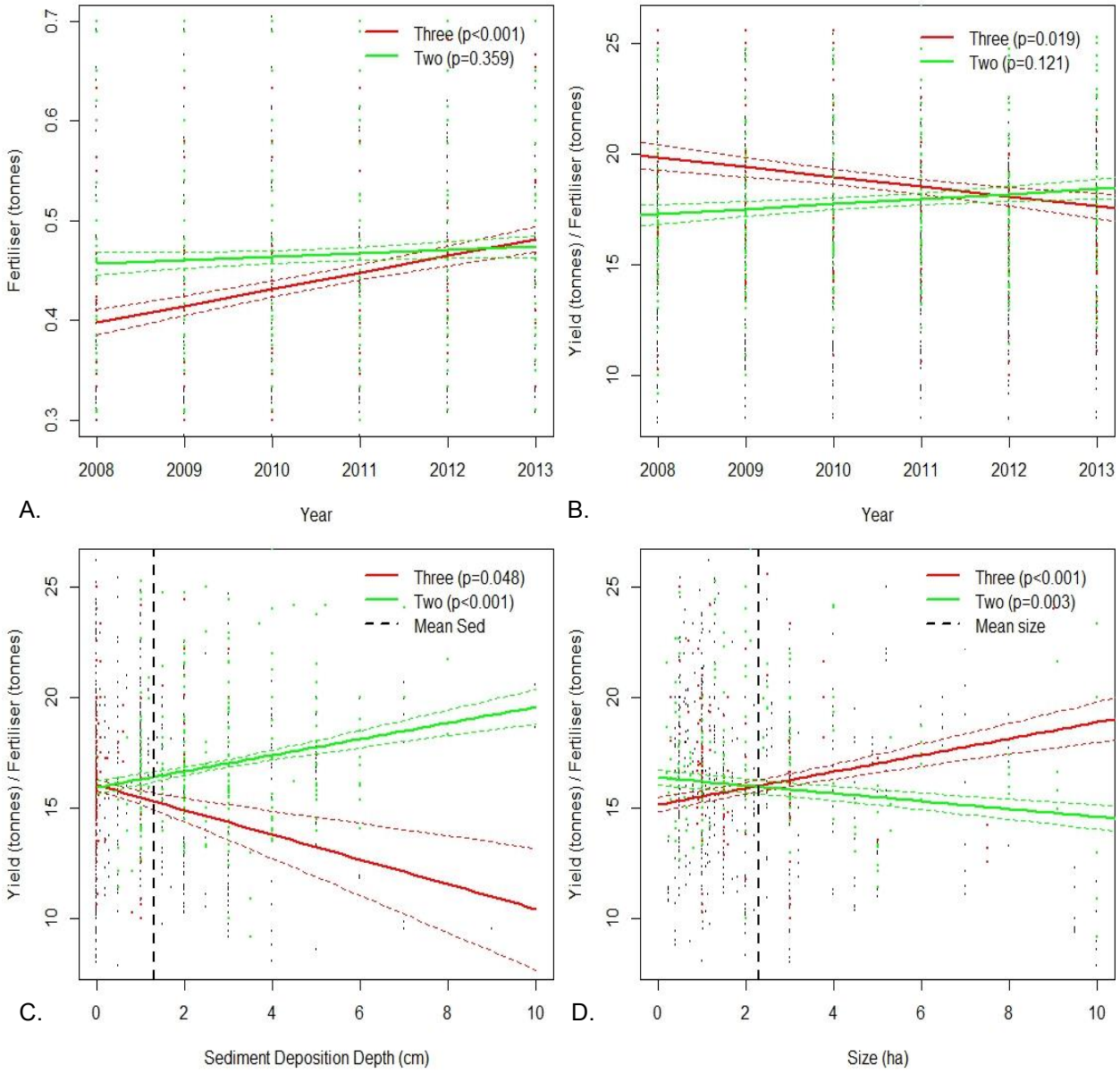
Challenging assumptions in the Mekong

Trends behind the high dykes

Trends behind the low dykes (still receiving flooding and sediment)

In fact, we can put a value of about $190 (±50) /yr on sediment for the average farmer still receiving it.

Fertilisation value, potentially mixed in with some pest and disease cleansing



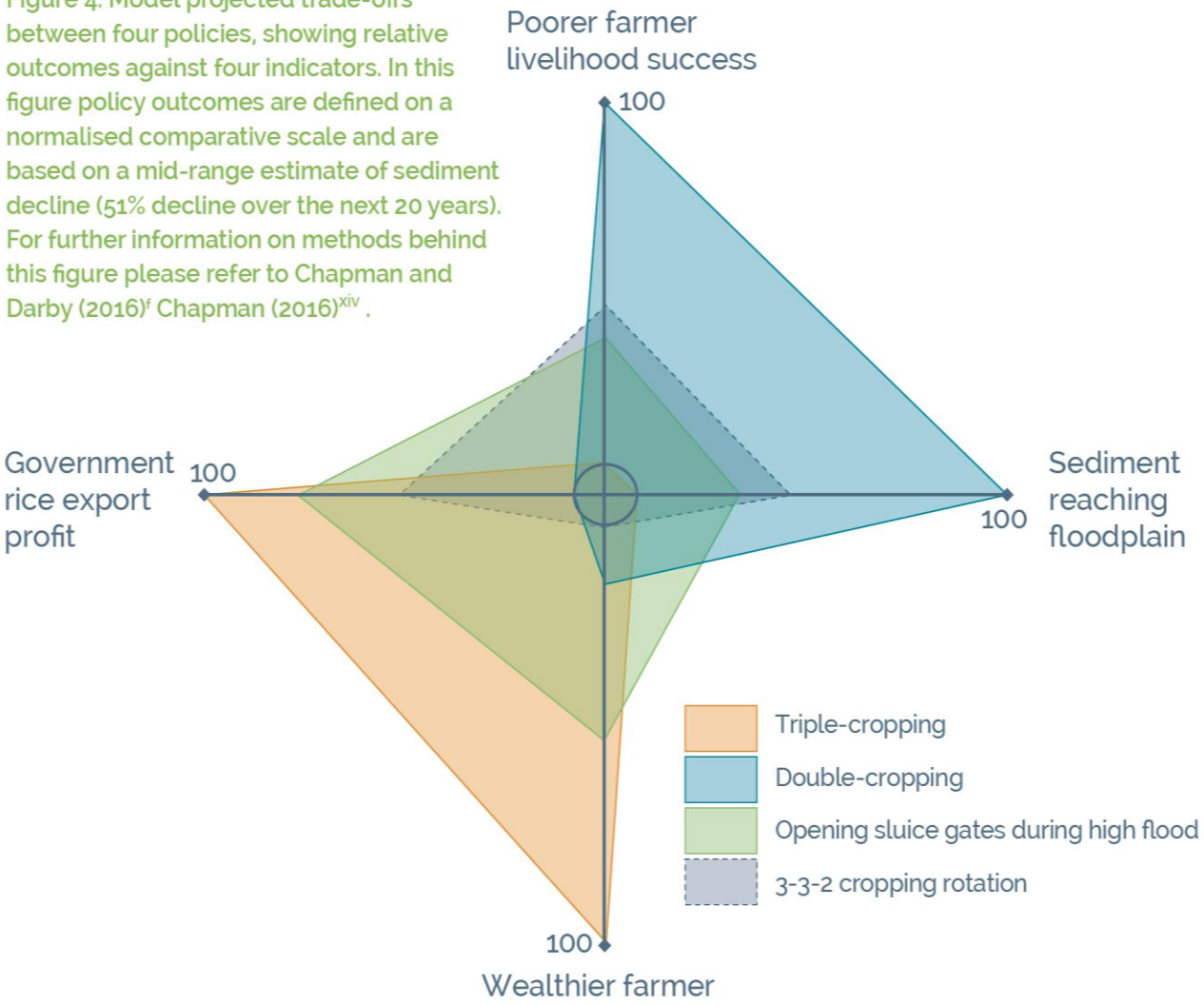
Chapman, A. D., Darby, S. E., Hồng, H. M., Tompkins, E. L., & Van, T. P. D. (2016). Adaptation and development trade-offs: fluvial sediment deposition and the sustainability of rice-cropping in An Giang Province, Mekong Delta. Climatic Change.

Trade-offs in the Mekong

In fact, it's only 5-15 years until the average farmer becomes worse off under triple-cropping

And, there is a huge trade-off between wealth groups

Figure 4: Model projected trade-offs between four policies, showing relative outcomes against four indicators. In this figure policy outcomes are defined on a normalised comparative scale and are based on a mid-range estimate of sediment decline (51% decline over the next 20 years). For further information on methods behind this figure please refer to Chapman and Darby (2016)[v] Chapman (2016)[xiv] .



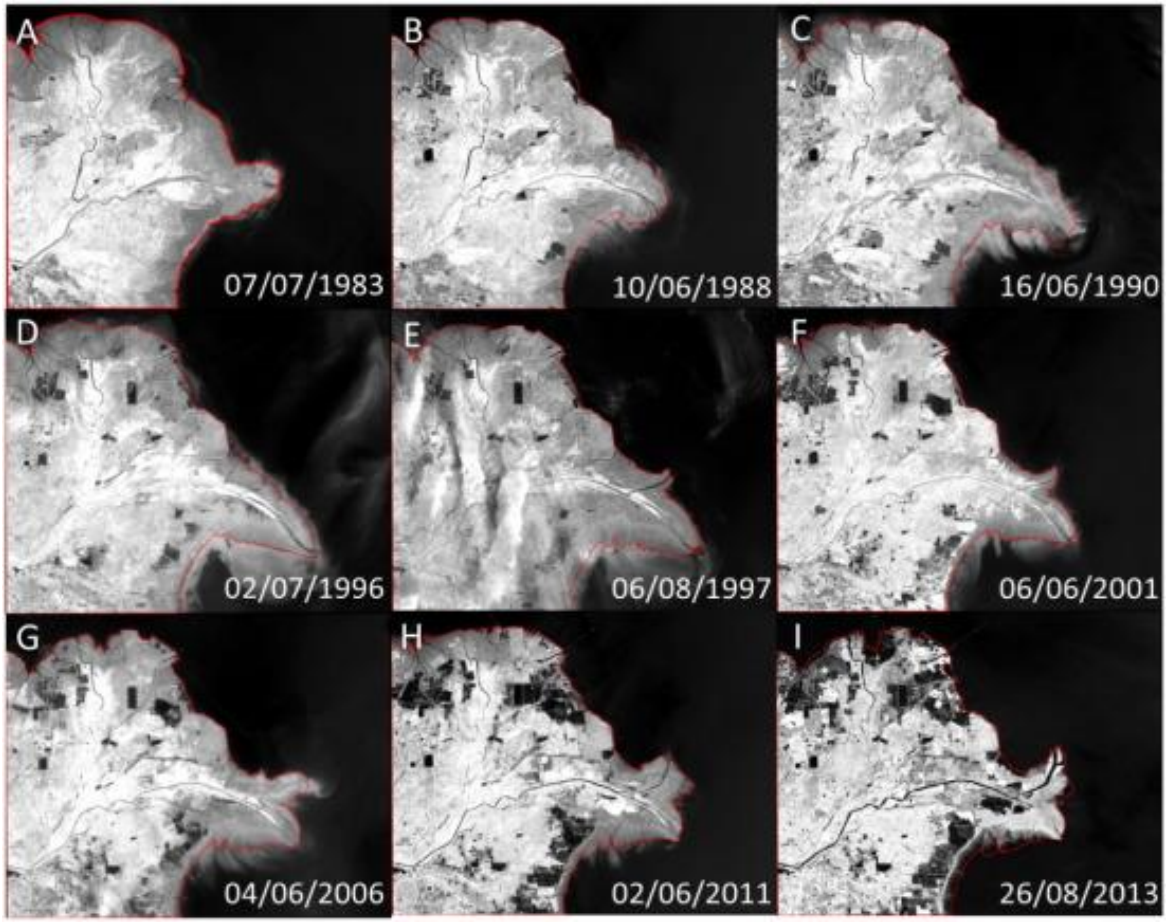
Chapman, A., & Darby, S. (2016). Evaluating sustainable adaptation strategies for vulnerable mega-deltas using system dynamics modelling: Rice agriculture in the Mekong Delta's An Giang Province, Vietnam. Science of the Total Environment, 559, 326–338.

Can these findings be extrapolated?

- More research needed
- We have word-of-mouth evidence from the Mahanadi, Irrawaddy, and Ganges deltas regarding benefits of sediment to agriculture
- Sediment-related yield losses are likely hidden behind rapid increases in yield thanks to seed development, increased fertilisation, technology, and management practices
- The land building benefits of sediment are indisputable

Accommodate: fighting back in the Yellow and Mississippi Deltas

- Kong et al. (2015) show that careful balancing and management of sediment budgets and river diversions at the basin scale can move sediment deposition to the coast and combat loss of the Yellow delta.
- Louisianna (Mississippi) Master Plan for sediment restoration likely to begin implementation in next few months



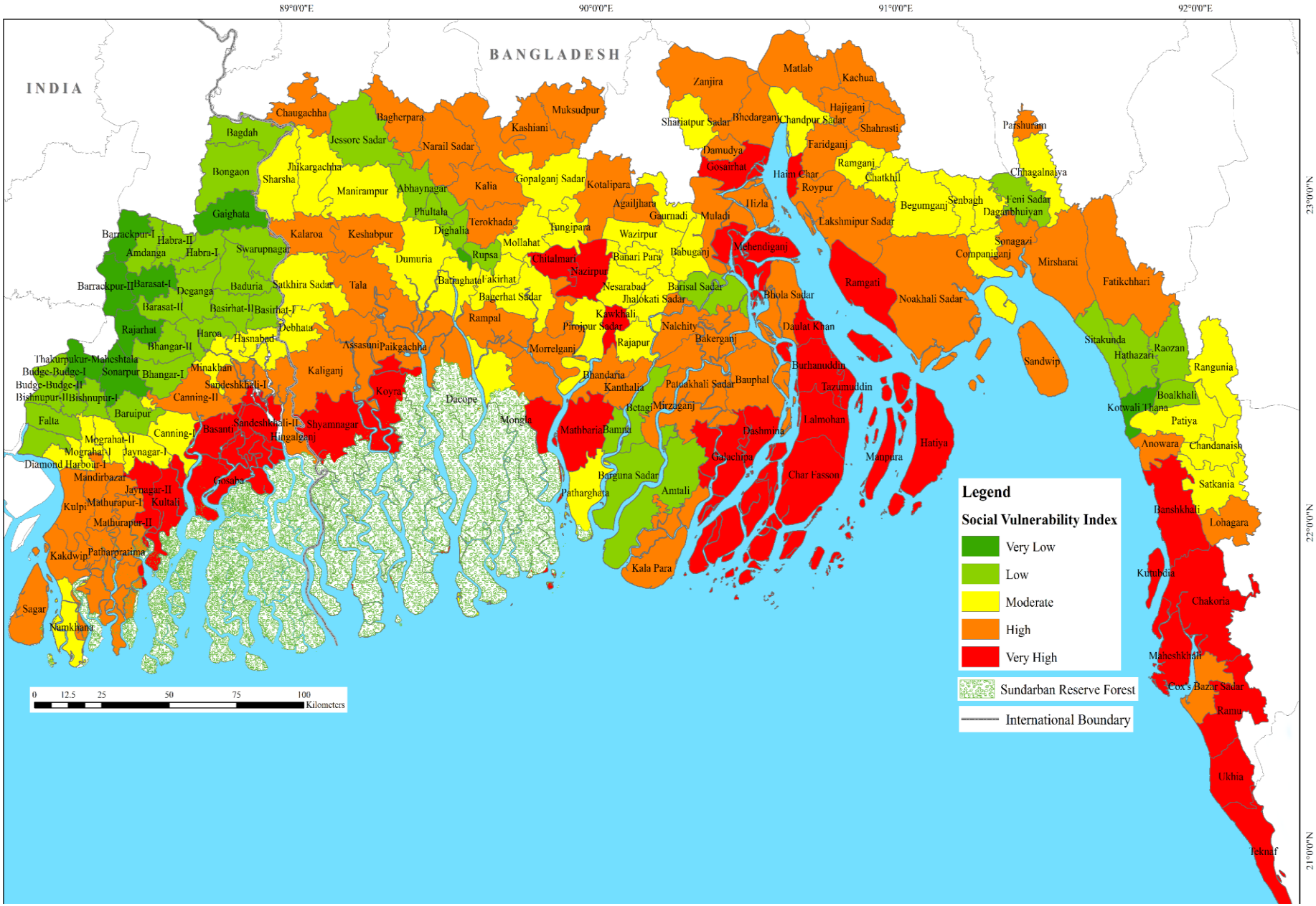
Kong, D., Miao, C., Wu, J. Jiang, L., Duan, Q. (2015) Bi-objective analysis of water-sediment regulation for channel scouring and delta maintenance: A study of the lower Yellow River. Global and Planetary Change. 133:27-34.

Accommodate: in summary

- A longer term strategy
- A pro-poor strategy
- A more resilient strategy (other benefits include diversification, and lower susceptibility to fertiliser prices)
- Strategy needs complementing with systemic disaster risk reduction action
- A strategy which requires breaking away from ‘path dependency’
- But… a strategy that is being undermined by the sacrificing of sediment through dam construction across Asia
- Over 100 dams in the pipeline on the Mekong and its tributaries

The **Retreat** is already underway

- Unplanned or 'autonomous' adaptation
  - **Remittance-based migration**
  - Permanent relocation
- Ad-hoc relocation of populations
- *Strategically planned relocation of populations*



Vulnerability indicators: household size, dependency ratio, disabled persons, sex-ratio, work participation rate, agricultural dependency, poverty, Kutcha Housing (temporary structures), and the rural population. Unpublished work by Shouvik Das, researcher at the School of Oceanographic Studies, Jadavpur University and member of the DECCMA team

Remittance style migration hugely prevalent

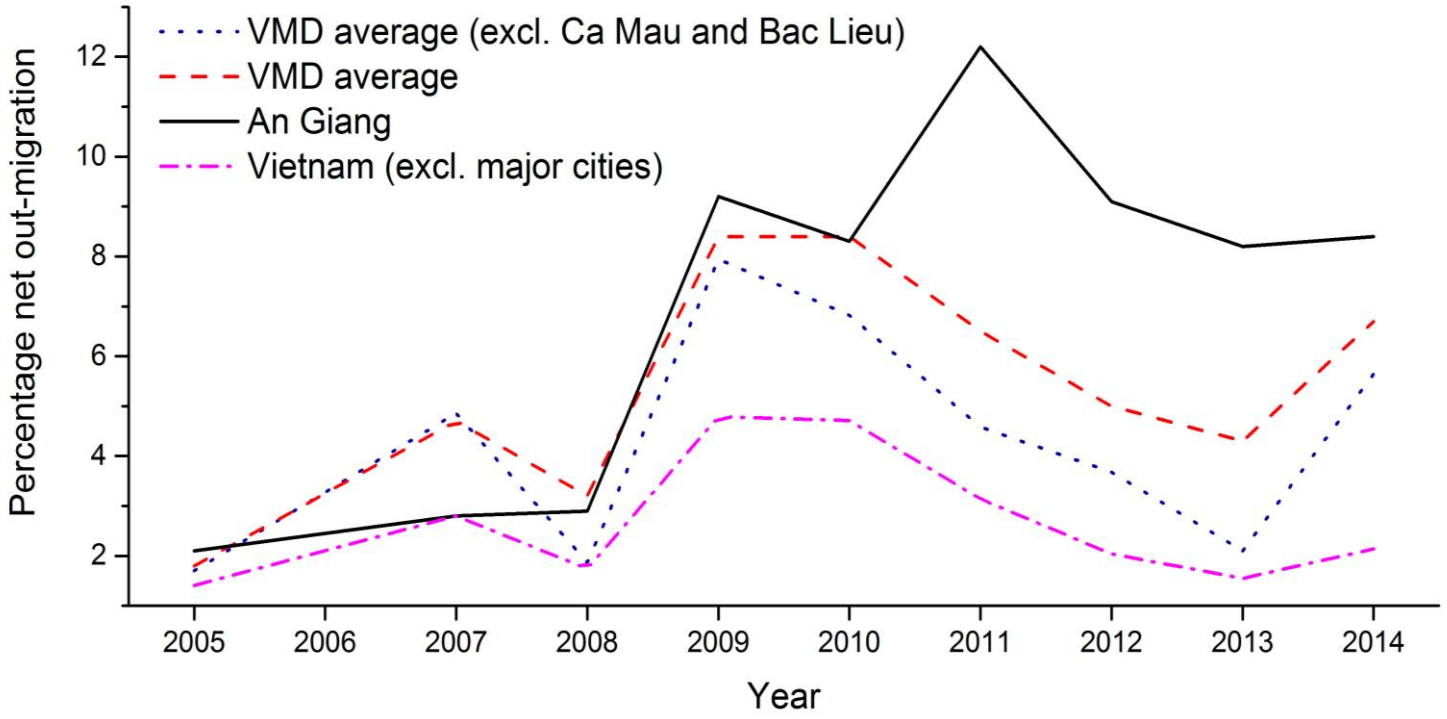
DECCMA

- We surveyed 8713 households in the Bangladesh portion
  - 34% were migrant households
    - 23% were internal migrants
    - 11% were international migrants
  - Only 5-10 years ago researchers were estimating internal migrant rates at 9-12%
  - Early suggestion is that the average age of migrants has fallen dramatically.

- In the Mahanadi we found an overall rate of 23%
- Highest migration rates correlate well with the high vulnerability areas
  - Highest rates of female headed households are left behind

Is this unique to delta regions?

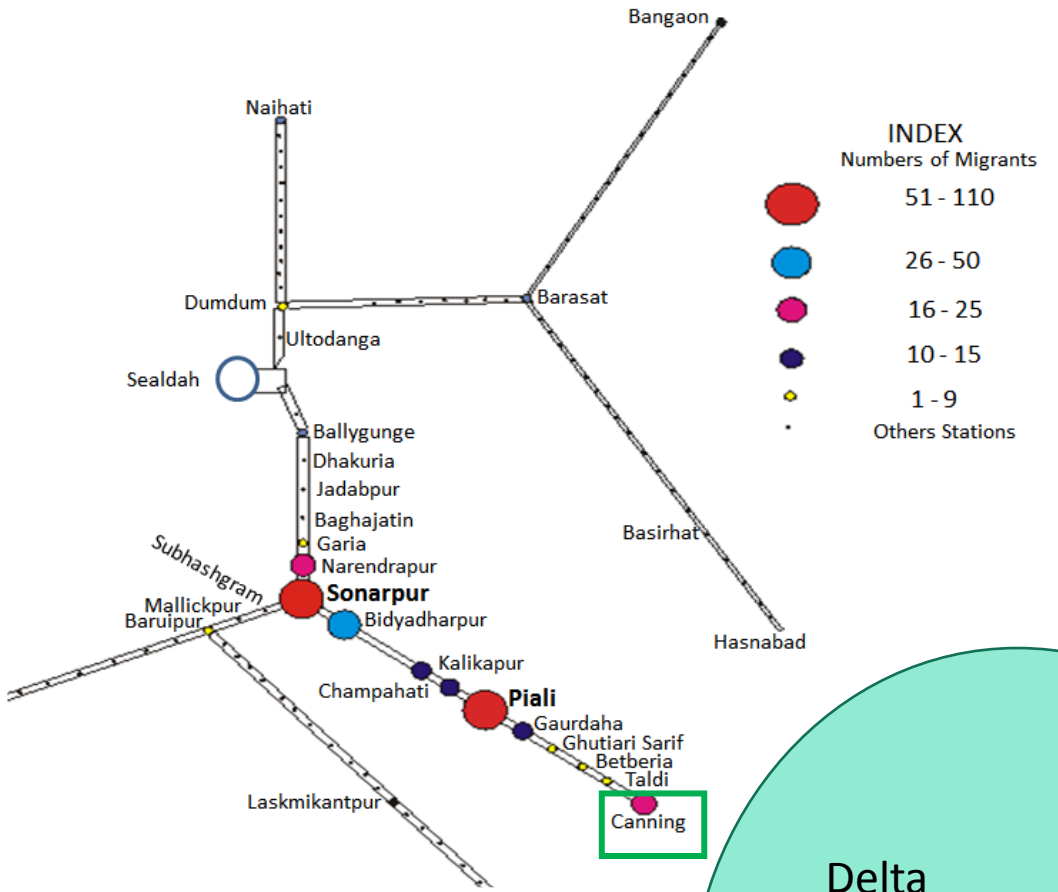
- Evidence from the Mekong says yes
- Delta rates can be distinguished from general trend of urbanisation
- Highest rates found in low lying coastal zone **and** intensely diked areas



Based on data from the General Statistics Office of Vietnam

Policy analysis: planned relocation / migration

- Unplanned nature of current migration means practicalities dominate decision making
- Ad-hoc relocation already taking place, often to equally high vulnerability areas



Early insights from the DECCMA project (unpublished): http://www.geodata.soton.ac.uk/deccma/

Summary

- **Protect** may be the right strategy (normative) but there will be winners and losers
- If we are going to sacrifice sediment let's make sure we are fully informed of the trade-offs and alternatives first
- The sediment resource is dwindling across the world, time is of the essence
- **Retreat** is inevitable in some areas but we are a very long way from being ready for it

Strong opinions in the academic literature

- *“a more functional adaptation strategy based on restoration can be envisioned […]The central element of this alternative strategy is the idea of ‘rising grounds’ (vertical aggradation), instead of rising dikes’” (Ibáñez et al., 2013)*

- *“Delta management should focus on precautionary spatial planning, and on maintenance or restoration of historical sediment delivery and accretion rates” (Vermaat and Eleveld, 2013)*

But the reality is different…

- Mekong Delta Plan published in 2013
  - Huge scientific endeavour by Dutch agencies in collaboration with Vietnamese government departments
  - Concluded that strategically encouraging sediment deposition is essential

- In 2015: Decision No. 101/QD-BNN-TT
  - Targeting expansion, intensification, and value chain improvement of triple rice-cropping through to 2030
  - Apparently incompatible with sediment deposition

Relevance to ADB… my first impressions

- 1 targeted delta adaptation project: Cauvery Delta
  - Key rice growing region
  - 80% reduction in sediment flux (therefore likely sea-level rise issues)
  - But, data on the Cauvery Delta almost non-existent
  - Appears to adopt the 'protect' (dyke-based) strategy
  - Flooding through dyke overtopping seen only as a negative
  - Couldn't find analysis of sediment-related impacts in project documents
- 3-4 projects working partly in delta regions (connectivity in the Mekong) but not explicitly on adaptation
- An opportunity?

India: Climate Adaptation in Vennar Subbasin in Cauvery Delta Project https://www.adb.org/projects/44429-013/main#project-pds

Much more to come…

- Processing of further 4,500 in-depth surveys in Ganges (India and Bangladesh) and Mahanadi under way
  - Greater insight into remittance style migration as an adaptation
- ‘Receiving area’ survey commencing now (several thousand surveys expected)
  - First look at the migrants themselves and particularly permanent relocation
- **February 2017 policy workshop in the Mekong Delta to be attended by multiple stakeholders**
  - **How can we optimise adaptation and dyke policy in the Delta?**
- Data not good enough in many key deltas (including the Cauvery and Irrawaddy), new projects needed
- Policy development and options need exploring for ‘deltas beyond saving’ e.g. the Indus?

Thanks

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DECCMA

CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

http://www.geodata.soton.ac.uk/deccma/

STELAR-S2S

http://www.stelar-s2s.org/

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