Hart & Coleman (2004) WDD

VU University Amsterdam

SPICOSA

DINAS COAST

climate changes spatial planning

Deltas are sinking, but how to meet the consequences?

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A response to Syvitski et al. (2009)

nature geoscience

PROGRESS ARTICLE

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Sinking deltas due to human activities

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Many of the world's largest deltas are densely populated and heavily farmed. Yet many of their inhabitants are becoming increasingly vulnerable to flooding and conversions of their land to open ocean. The vulnerability is a result of sediment compaction from the removal of oil, gas and water from the delta's underlying sediments, the trapping of sediment in reservoirs upstream and floodplain engineering in combination with rising global sea level. Here we present an assessment of 33 deltas chosen to represent the world's deltas. We find that in the past decade, 85% of the deltas experienced severe flooding, resulting in the temporary submergence of 260,000 km². We conservatively estimate that the delta surface area vulnerable to flooding could increase by 50% under the current projected values for sea-level rise in the twenty-first century. This figure could increase if the capture of sediment upstream persists and continues to prevent the growth and buffering of the deltas.

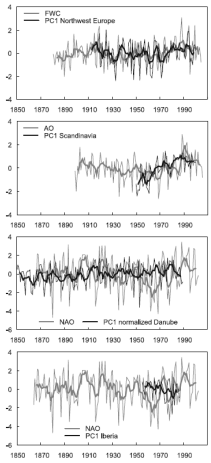
Claimed:

- 28 out of 33 deltas are sinking (~7 mm y^{-1}), this is due to humanity, .. and inhabitants become more vulnerable
- "it remains alarming how often deltas flood, .. , trends seem to be worsening". – really?

we suggest: net subsidence ≠ increase in vulnerability,

and if so, what can we do?

Is the flooding trend worsening?

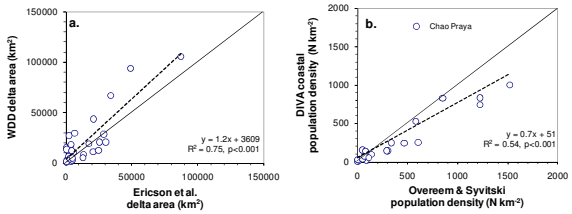


literature:

- Kundzewicz et al (2005, and IPCC 2007): no evidence for a climate-related trend, but flood damages are increasing
- Bouwer et al (2008; 2010): no systematic trend towards more extreme discharges in Europe; no trend in disaster losses after correction for wealth and population increase

So, not the flooding itself, but the consequences

Subsidence and vulnerability – the data used



Did our own analysis, independent of Overeem & Syvitski (2009) or Ericson et al (2006); using

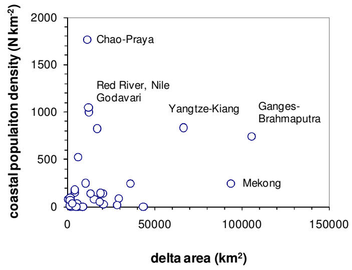
- DIVA tool (Hinkel & Klein, 2009: combines database, GCM, GEqM) and the World Delta Data base (WDD, Hart & Coleman, 2004).
- Covariance analysis with PCA

And: our data bases are comparable

Subsidence and vulnerability – indicators

Supplementary Table S1 | Variables extracted from the DIVA tool for 33 deltas* that have been used in the PCA.

variable name	Description	abbreviation in DIVA	Spatial scale in DIVA**
area under 2m AMSL	area in the coastal zone with elevation below 2 m AMSL derived from GTOPO30 digital elevation dataset	areaunder1+2	coastline segment
coastal slope	slope of land up to 3 m above max surge level (degrees).	Slope	coastline segment
net uplift or subsidence	Uplift or subsidence (mm/yr), uplift is positive.	Upsub	coastline segment
wave climate	wave climate based on LOICZ classes: 0 no waves permenant sea ice; 1 0-2.5 m, 2: 2.5-3.5 m, 3 3.5-5 m, 4 5-6.5 m, 5 > 6.5 m	Wavclim	coastline segment
coastal population density	population density on the coast, that is in a zone of 2.5 km behind the coastal segment.(N/km^2)	Copopd	coastline segment
dike height	sea dike height, calculated height of a dike on a segment (m)	Sdikehght	coastline segment
maximum surge height	maxsurge = 1 in 1000 surge height + 3 (m), including high water level, above mean sea level	Maxsurge	coastline segment
people actually at risk of flooding in 2100, for A2 and B1	People at risk of flooding : average number of people flooded per year by storm surge allowing for the effect of flood defences. Aggregated as sum of coastline segments within administrative unit (x1000/yr).	Paf	admin unit
potential floodplain in 2000 (below 1/1000 surge height) and 2100, for A2 and B1	Land area below the one in one thousand flood level, ignoring sea dikes (km^2)	Potfloodplain	admin unit
People potentially flooded in 2000 and 2100, for A2 and B1	People in the flood hazard zone: people living below the 1000 year surge (administrative level). Aggregation rule, sum of coastline segments within administrative unit. (1000s of people)	people potentially flooded, ppf	admin unit
relative sea level rise in 2100, for A2 and B1	Mean change in relative sea level compared to the reference year (1995) weighted by segment length (within administrative unit). It considers (1) human-induced climate change under the selected scenario, (2) uplift/subsidence due to glacial-isostatic adjustment and (3) natural subsidence of deltaic areas (m)	Rslr	admin unit
total area of natural wetlands	sum of area of all coastal types of wetlands in an administrative unit (km^2)	sumnatural-wetlands	admin unit
average river discharge	mean discharge reported at a station nearest to the sea (m^3/s)	Avgdisch	river segment



Quite a few are possible, we used two socio-economic ones:

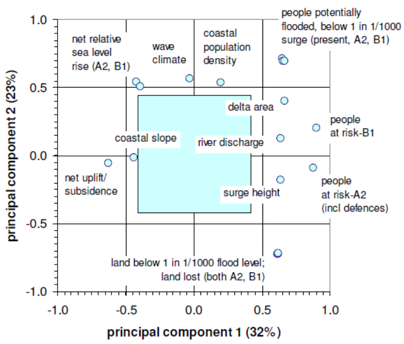
•Population at risk

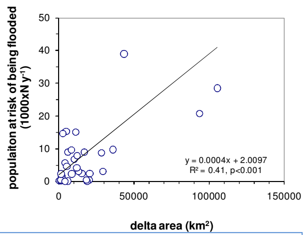
•Area of land at risk

related these to geophysical indicators: coastal morphology, subsidence, potential marine and fluvial flooding;

included SRES scenarios

Subsidence and vulnerability – covariance





Stepwise regressions:

- People at risk = f(delta area, land below 1/1000 flood level, coastal population density), r^2: 0.41, 0.53, 0.62
- Land flooded = f(net RSLR, river Q), r^2=0.22, 0.33

- discharge, surge height, and delta area covary with PC1, opposite to net SLR, net subsidence or coastal slope;
- Land lost and people at risk (vulnerability!) correlate with the former

Subsidence and vulnerability – conclusions

so if vulnerability is a function of river discharge, storm surge height, and delta area,

•Large deltas (Yangtze, Ganges) with high population density combine a high risk with a high accommodation potential to mitigate flooding risks > space should allow flood retention planning/engineering, maintenance of historical sediment delivery and accretion patterns.

•Limited space and high population density (Chao Praya): seek adaptation means outside the delta proper.

•Low population density (Lena, Yukon, Fly): let natural dynamics prevail, irrespective of area available.

And how to meet the consequences?

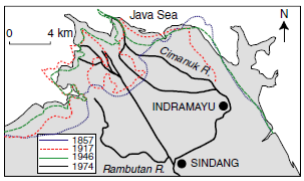
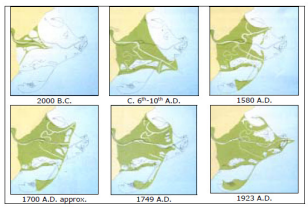


Fig. 9 Growth of the Cimanuk delta, north Java, during and since the colonial period (after Hehanussa et al. 1975). Given the rapid

Lavigne & Gunnell, 2006



Rodriguez Santalla (EUROSION rep)

- vulnerability is highly localised: where possible accommodation space needs to be charted in land use planning.
- Upholstering historical accretion patterns is useful, dubbed 'building with nature'
- hence flooding is not 'alarming' since it brings at least some of the necessary sediment
- However, historic accretion of deltas has often been sustained by land degradation in the catchment

Thank you



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stroming

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leven met water

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WWF

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Deltas on the move
Making deltas cope with the effects of climate change

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