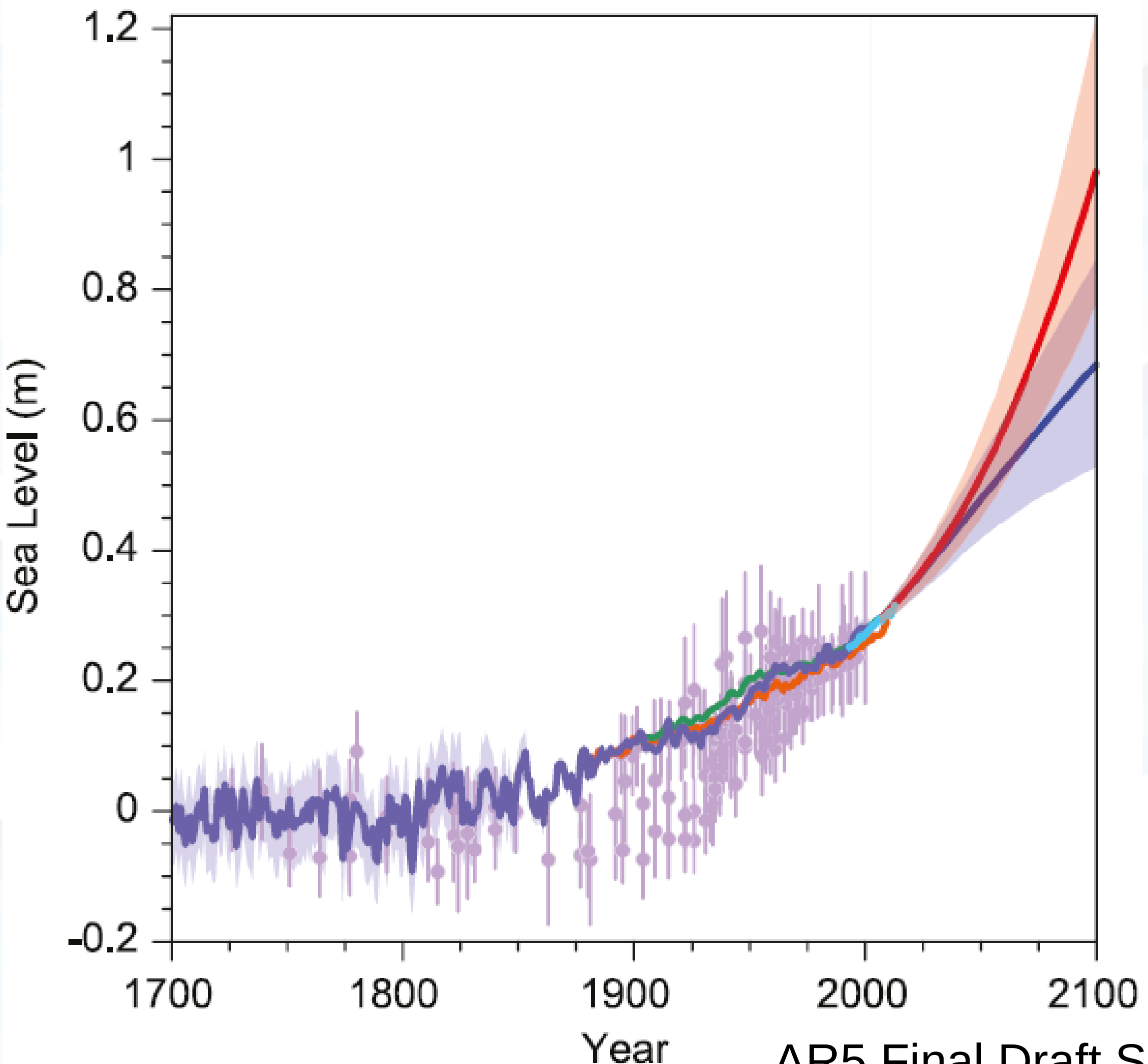
Impacts of Sea-level Rise

Andy Plater, School of Environmental Sciences

Plater and Kirby (2011) Sea-Level Change and Coastal Geomorphic Response. Chapter 3.03. Treatise on Estuarine and Coastal Science

Climate Change and Rising Sea Level



AR5 Final Draft September 2013

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Coastal Vulnerability to Extreme Events

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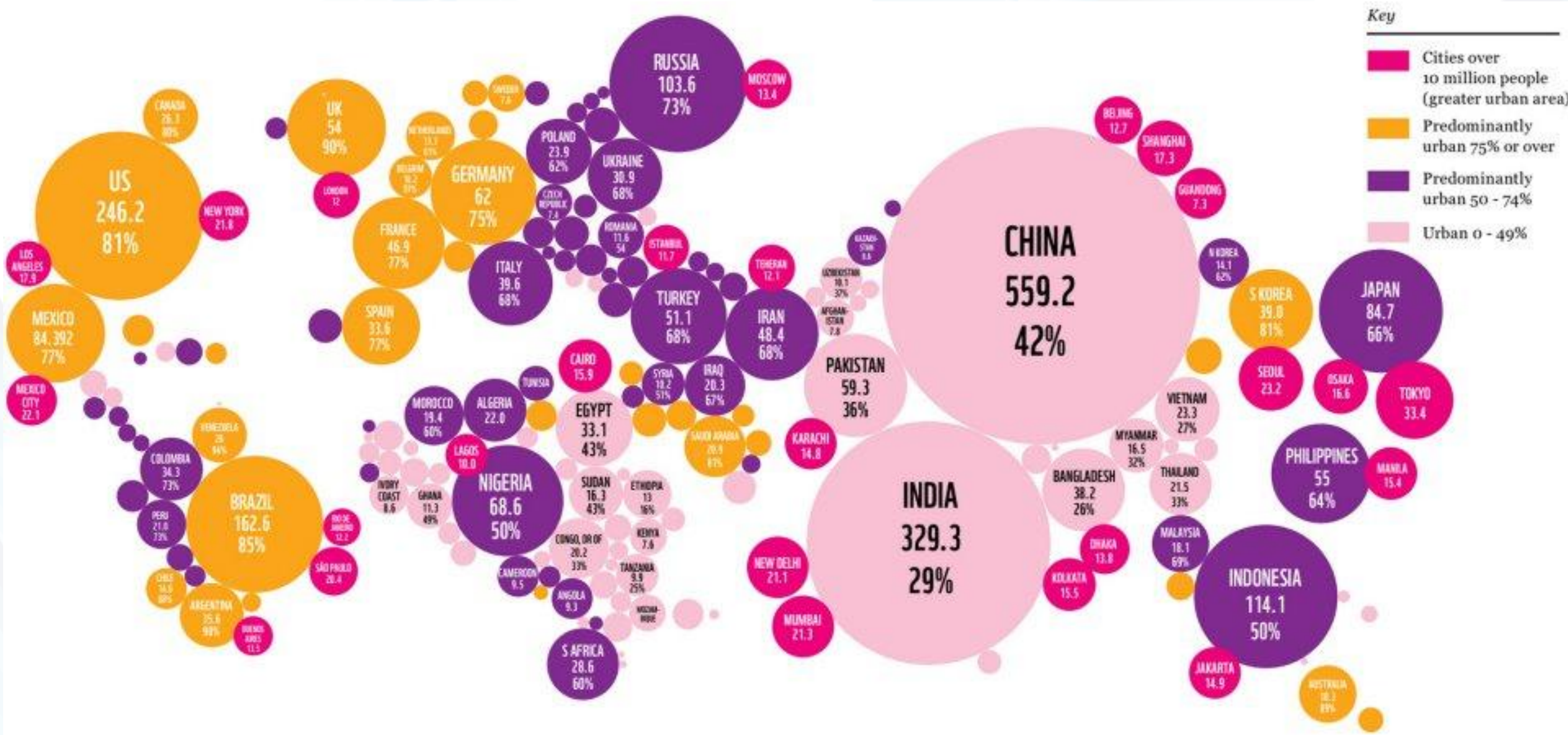
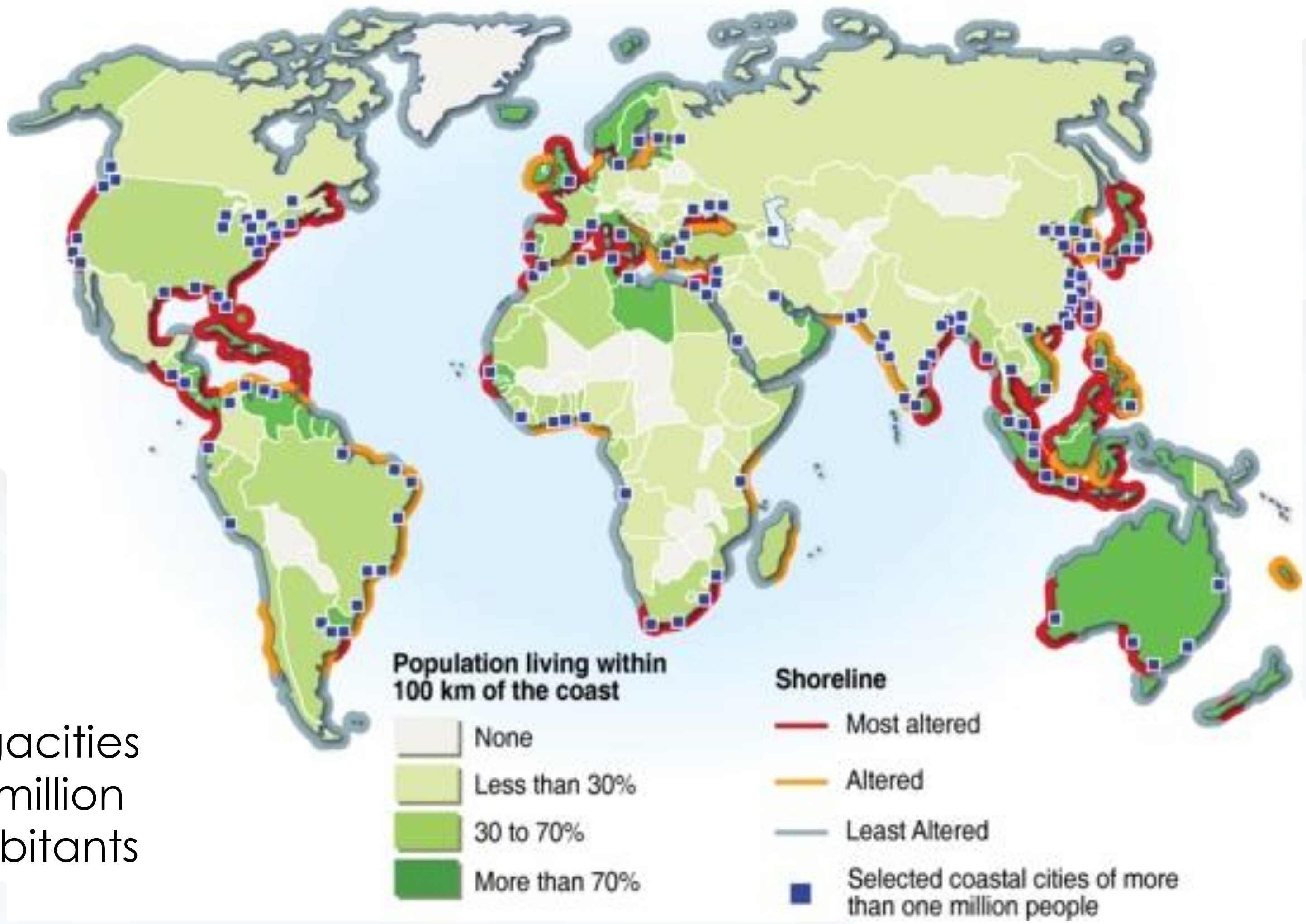


The number of people living in cities in each country of the world in 2010, together with the percentage of the population in countries with large urban populations.

Read more: http:www.businessinsider.com/small-cities-population-growth-by-2050-2012-5#ixzz2DQI6tIXN//



Megacities
>10 million
inhabitants

http://www.grida.no/graphicslib/detail/coastal-population-and-altered-land-cover-in-coastal-zones-100-km-of-coastline_7706

So… how bad is it… how high… where and when… and how likely?

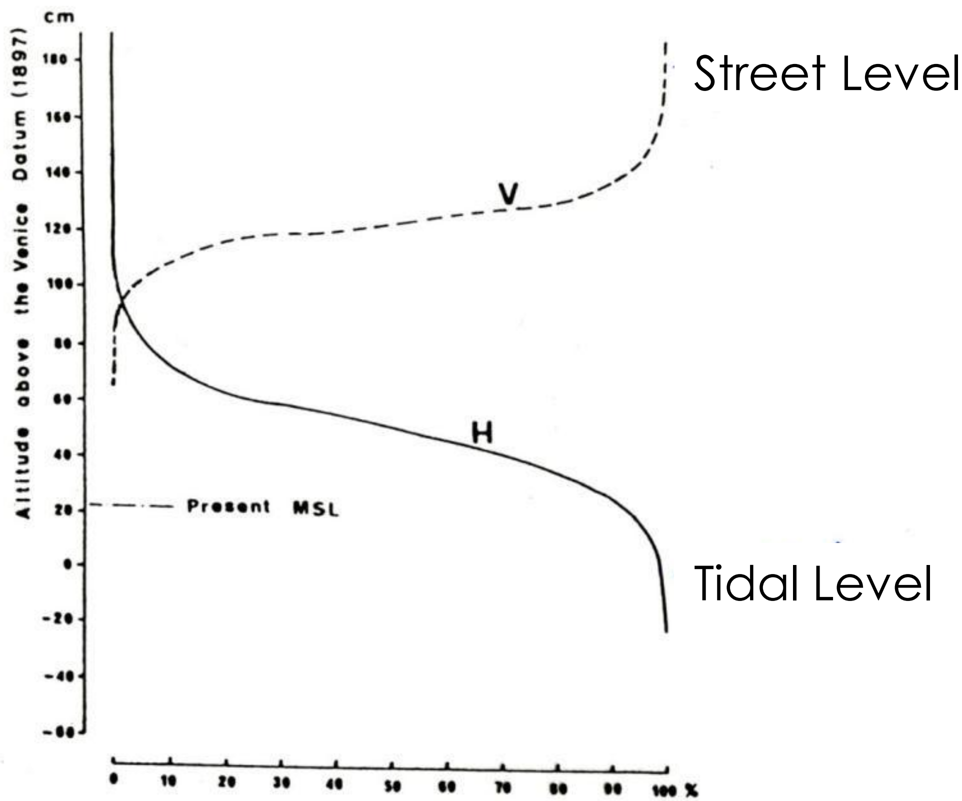
Catastrophic sea-level rise!!

When does sea-level rise flooding change from an inconvenience to a life-threatening hazard?

+ 30cm: St. Mark's Square flooded on 75% of tides, for 27% of the year

+100 cm: 40% of street level below MSL, St. Mark's Square >50cm below MSL

Pirazolli (1991)
http://www.jstor.org/stable/4297819?seq=7



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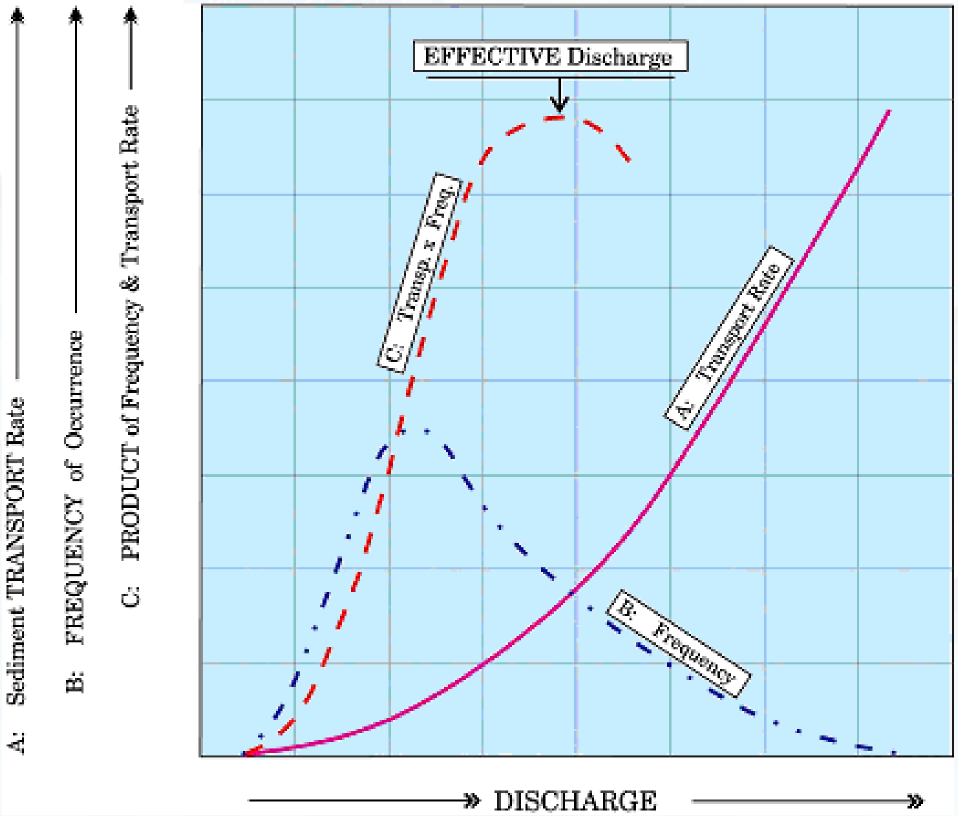
Magnitude & Frequency?



Wolman and Miller (1960)
http://geomorphology.sese.asu.edu/Papers/Wolman_and_Miller_1960.pdf

Gradual (mm/yr) vs.
Catastrophic (m/hr)

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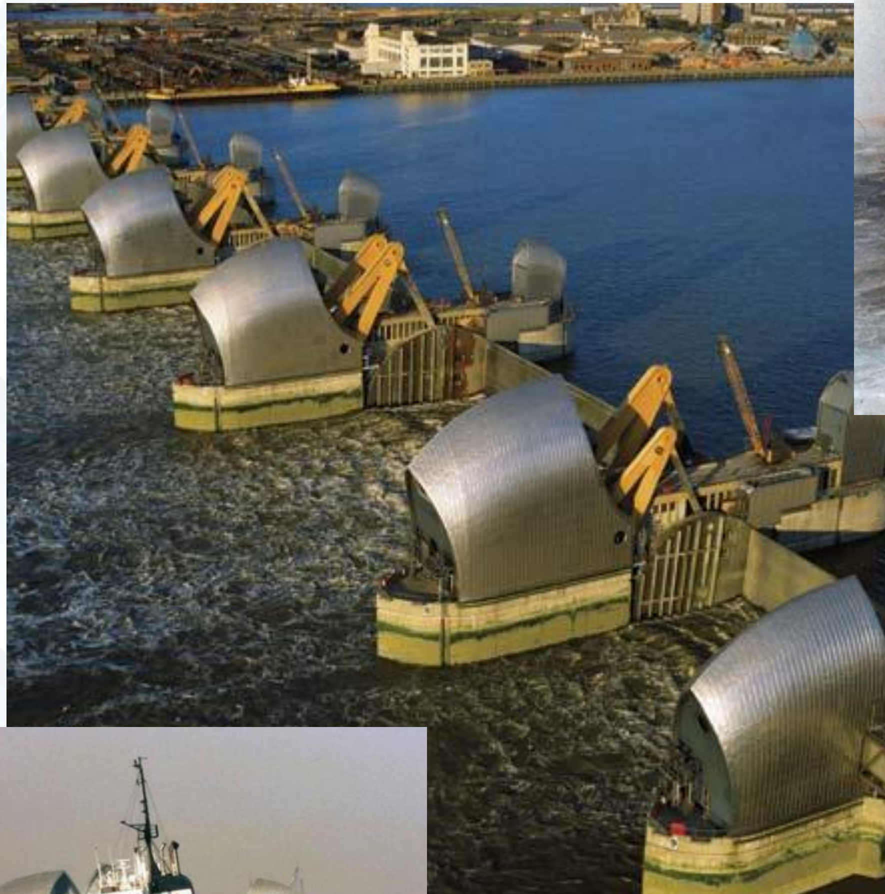
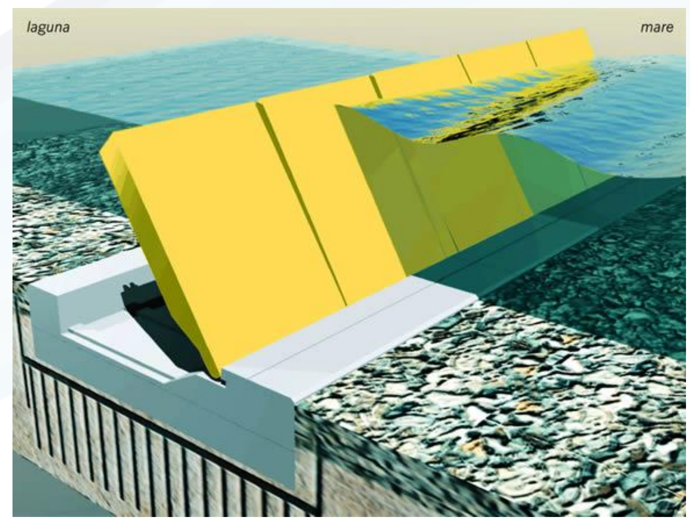
Sandy, 29th Oct 2012

- Largest Atlantic hurricane – winds up to 110 mph at sea
- Storm surge of up to 4.2 m
- More than 286 people killed across 7 countries (affected 24 states)
- 2nd costliest Atlantic hurricane: $50-68 billion in damages

Storm Surge Barriers:
Oosterschelde, Thames, Venice

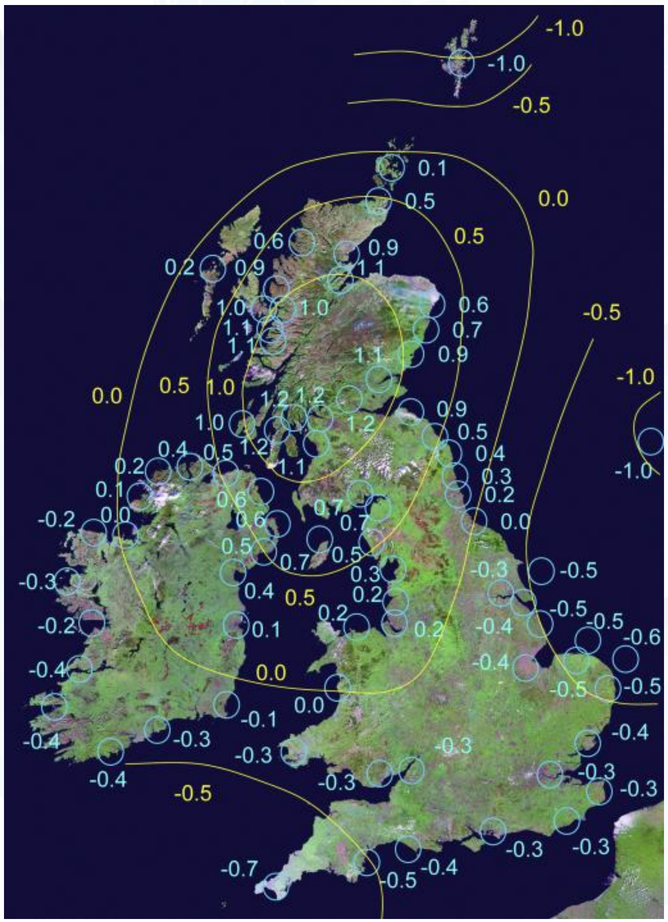




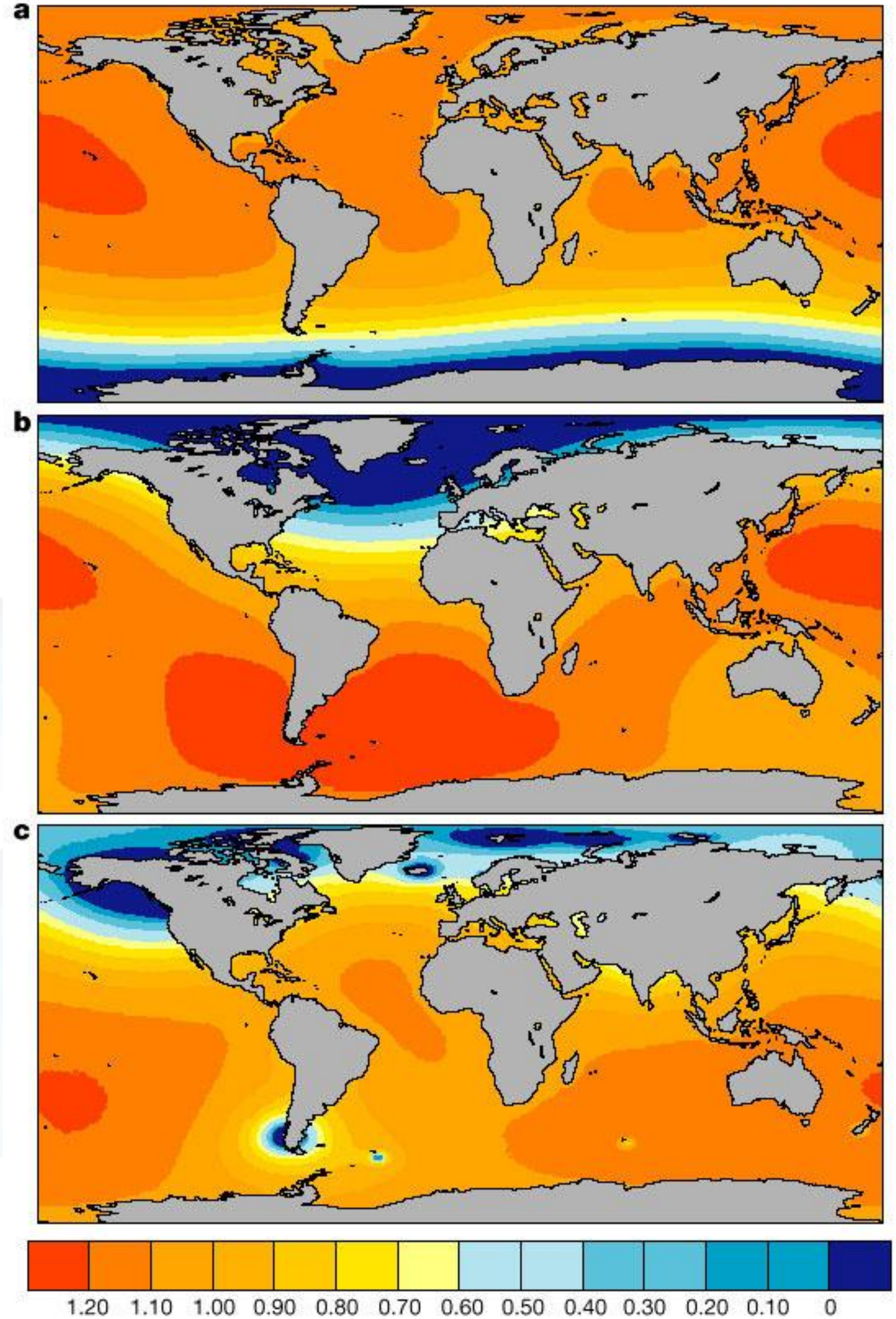
Sand Kite –
27^{th} October
1997

Providing better sea-level information for coastal decision makers.

Projections at regional/local scale



Shennan et al. (2012)
http://onlinelibrary.wiley.com/doi/10.1002/jqs.1532/pdf



Better Understanding of Coastal Response and Resilience:

environments
geomorphology
sediment and flow patterns
water quality
ecosystems
urban infrastructure
resources
economy
people

sea-level
extreme events
sediment supply
hydrodynamics
human interventions

Promoting Dynamic Coasts

Maintaining 'Healthy' Beaches

Increased water needs... more dams on rivers

- Changing hydrological regime
- Changing floodplain inundation frequency
- Changing water quality
- Displaced people(?)
- Reducing sediment flux – especially to coastal zone
- Changing coastal ecosystems

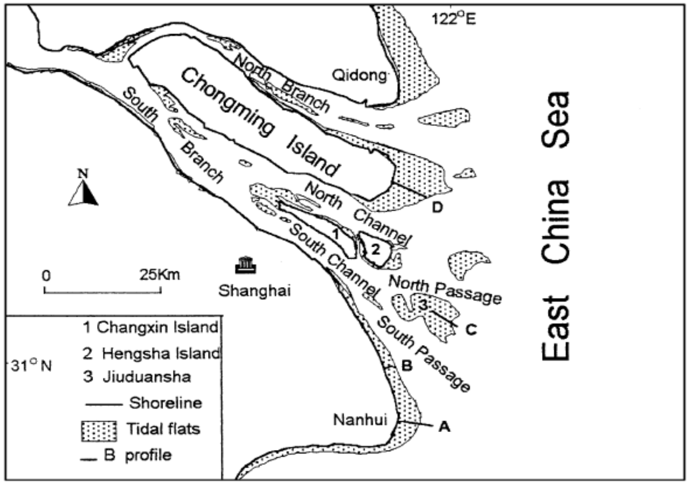
e.g. Colorado, Nile, Guadiana

Yangtze tidal flats

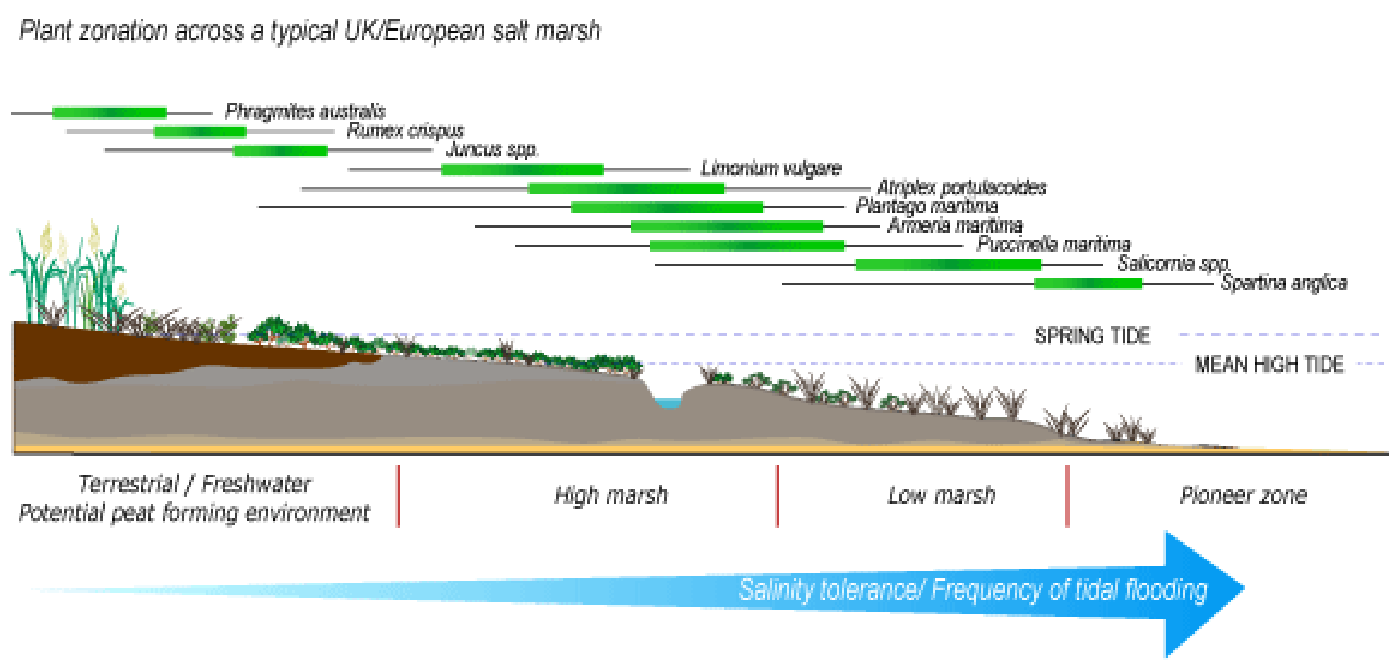
- Reduced sediment accretion
- Enhanced vulnerability to erosion

Table 1
Estimates of shoreline progradation rate (m/year) in the forward end of the river mouth based on historical records of seawalls and archaeological studies

Period	Lateral progradation (m/year)	Data source
Eastern shore of Nanhui		
6500–2000 BP	2	1
2000 BP–AD 713	17	1, 2, 3, 4
AD 713–1172	32	4, 5
AD 1172–1733	2	4, 5, 6
AD 1733–1882	40	4, 5, 6
AD 1882–1950	9	5
AD 1950–1995	35	5, 7
2000 BP–1995	17	1–7
Eastern shore of Chongming Island		
AD 825–1762	2	8
AD 1762–1955	7	8
AD 1955–1990	226	8, 9
AD 825–1990	10	8, 9



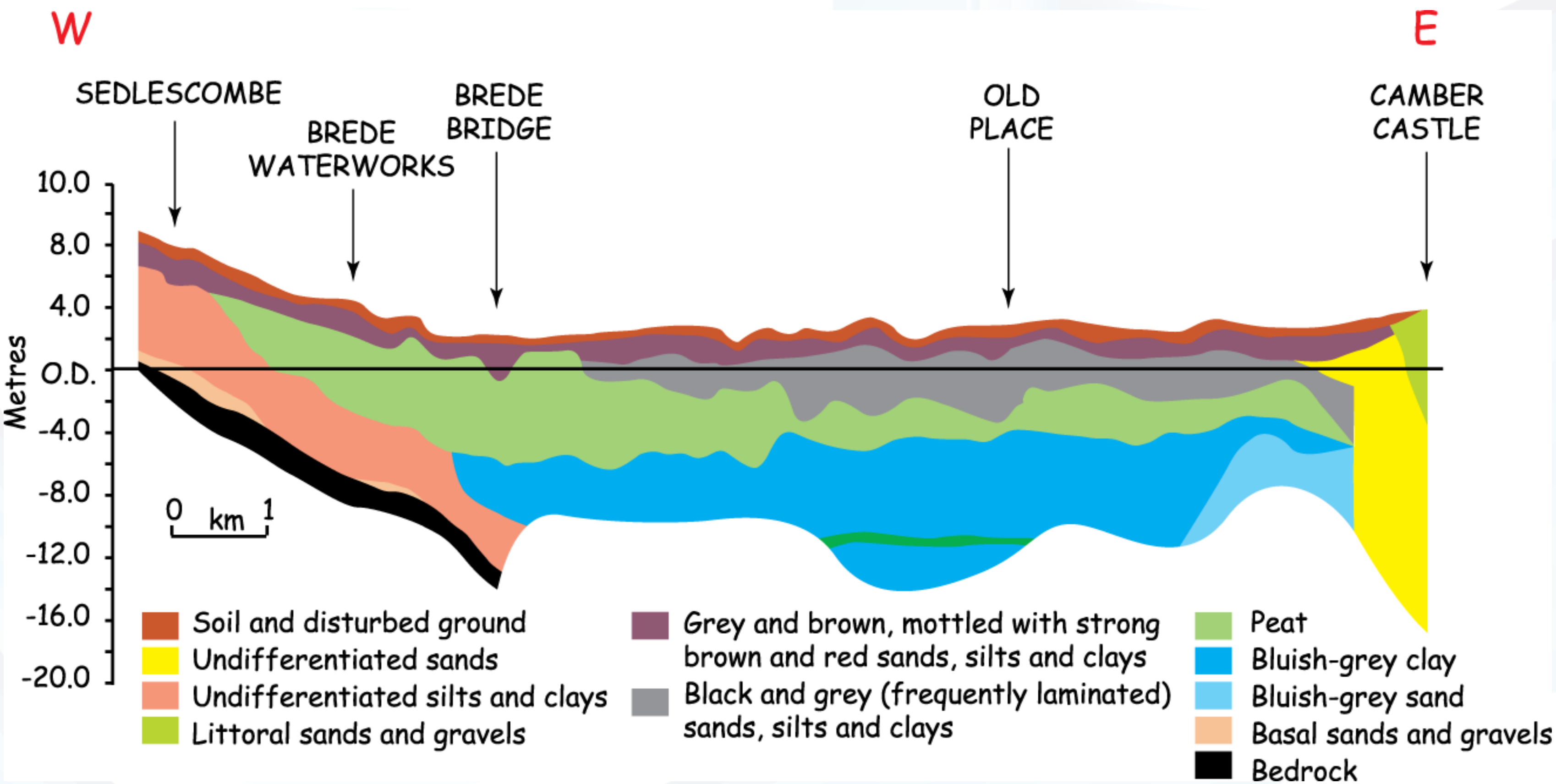
Coastal Wetlands:



A New Realignment continuum?

Present: estuary-sandflat-mudflat-saltmarsh

Potential: estuary-sandflat-mudflat-saltmarsh-reedswamp-sedge fen-fen carr *(Mangrove equivalent)*



Holocene sea-level rise 3-6 mm/yr, limited sediment

Persistent perimarine wetland in a barrier estuary

Plater, A.J. And Kirby, J.R. (2006). Estuarine, Coastal and Shelf Science 70 (1-2), 98-108

Tsunami villagers give thanks to trees

By Sunil Raman
BBC News, Tamil Nadu

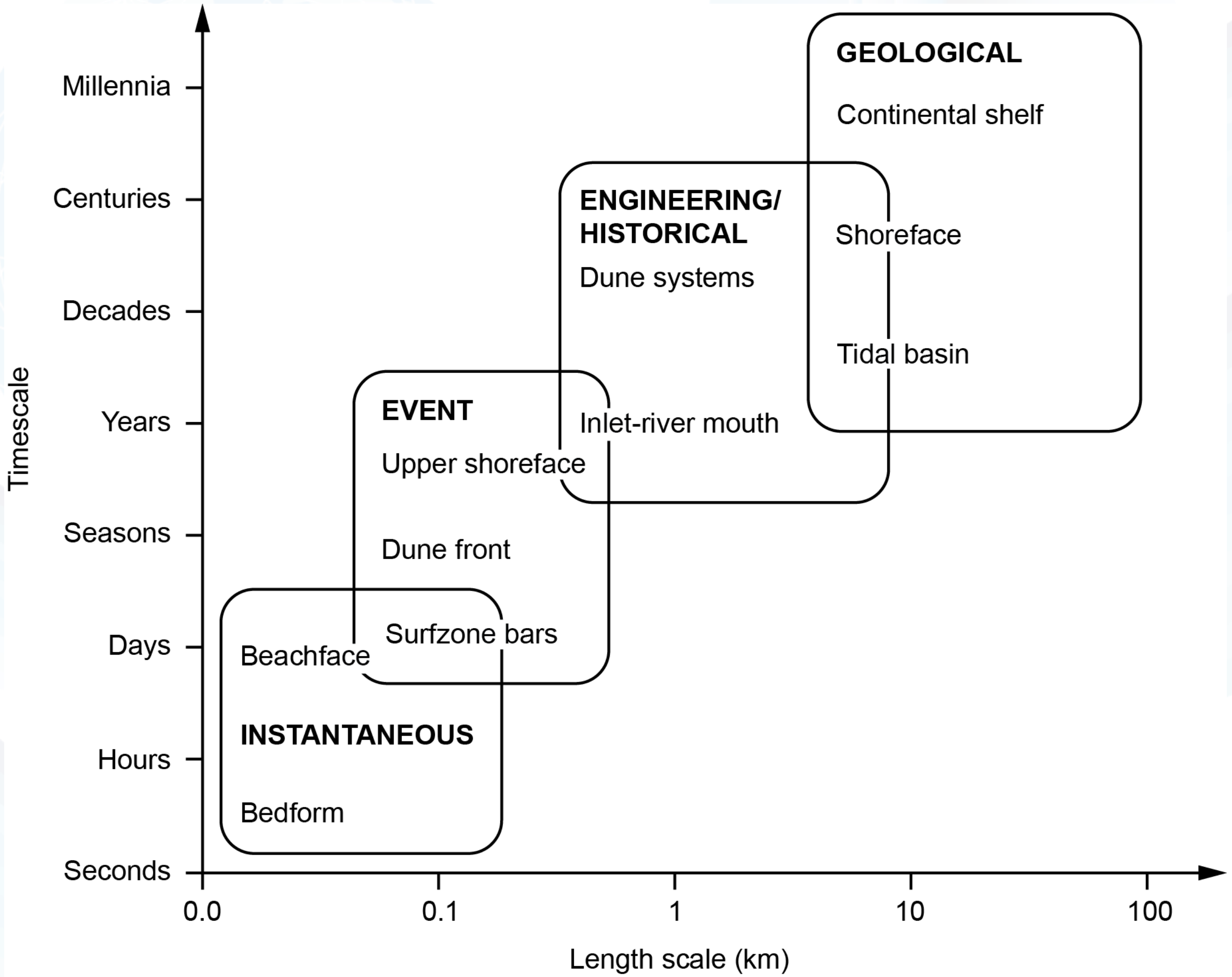
In 2002, a village in India's Tamil Nadu state planted 80,244 saplings to enter the Guinness World Records book.

Little did they realise at the time that the trees would save their lives.

When the tsunami roared into the coast of southern India on 26 December 2004 many villages and towns were crushed as the giant waves swept across open beaches.

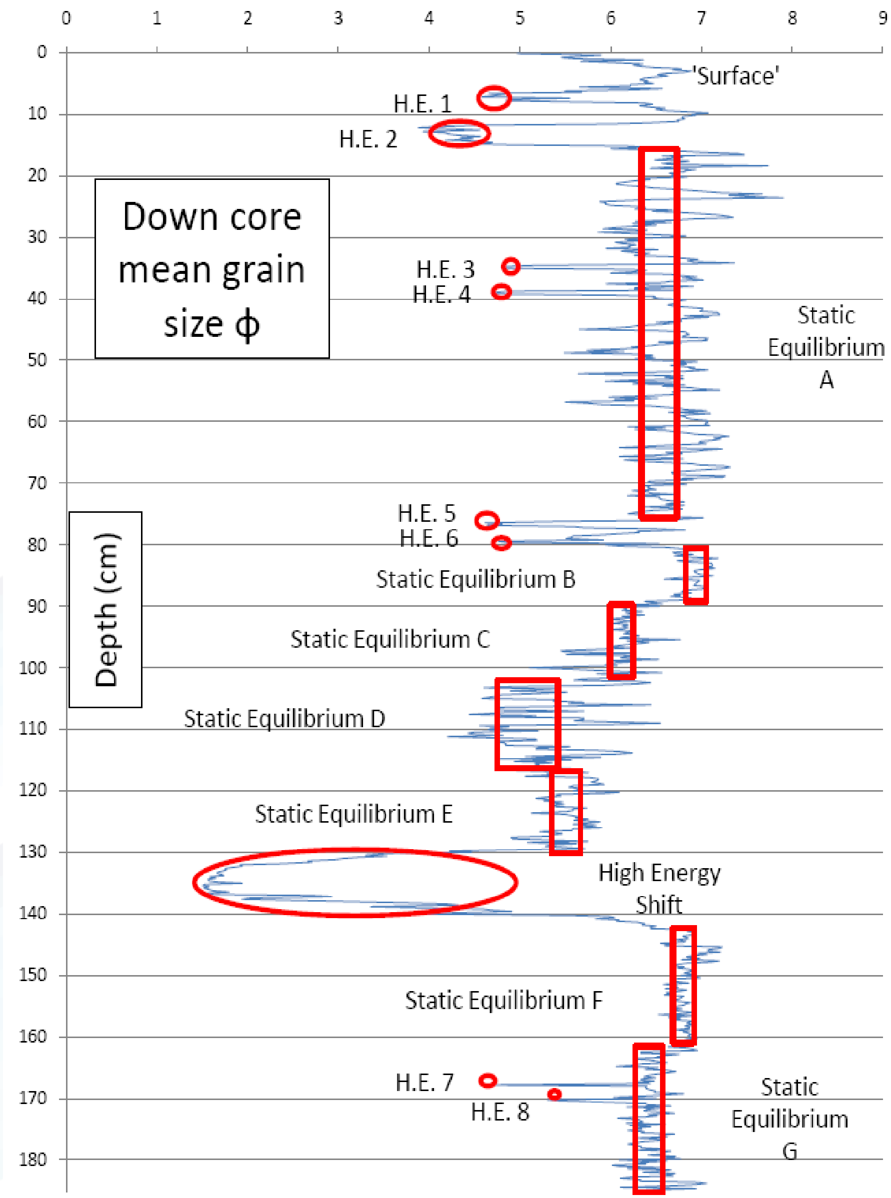
But the people of Naluvedapathy in Vedaranyam district, south of the Tamil Nadu's worst affected areas around Nagapattinam, remained almost unscathed.

Bridging Operational Scales...



After Cowell and Thom (1994)

Particle size evidence of barrier and lagoon system behaviour



Clarke et al. (in press)
The Holocene

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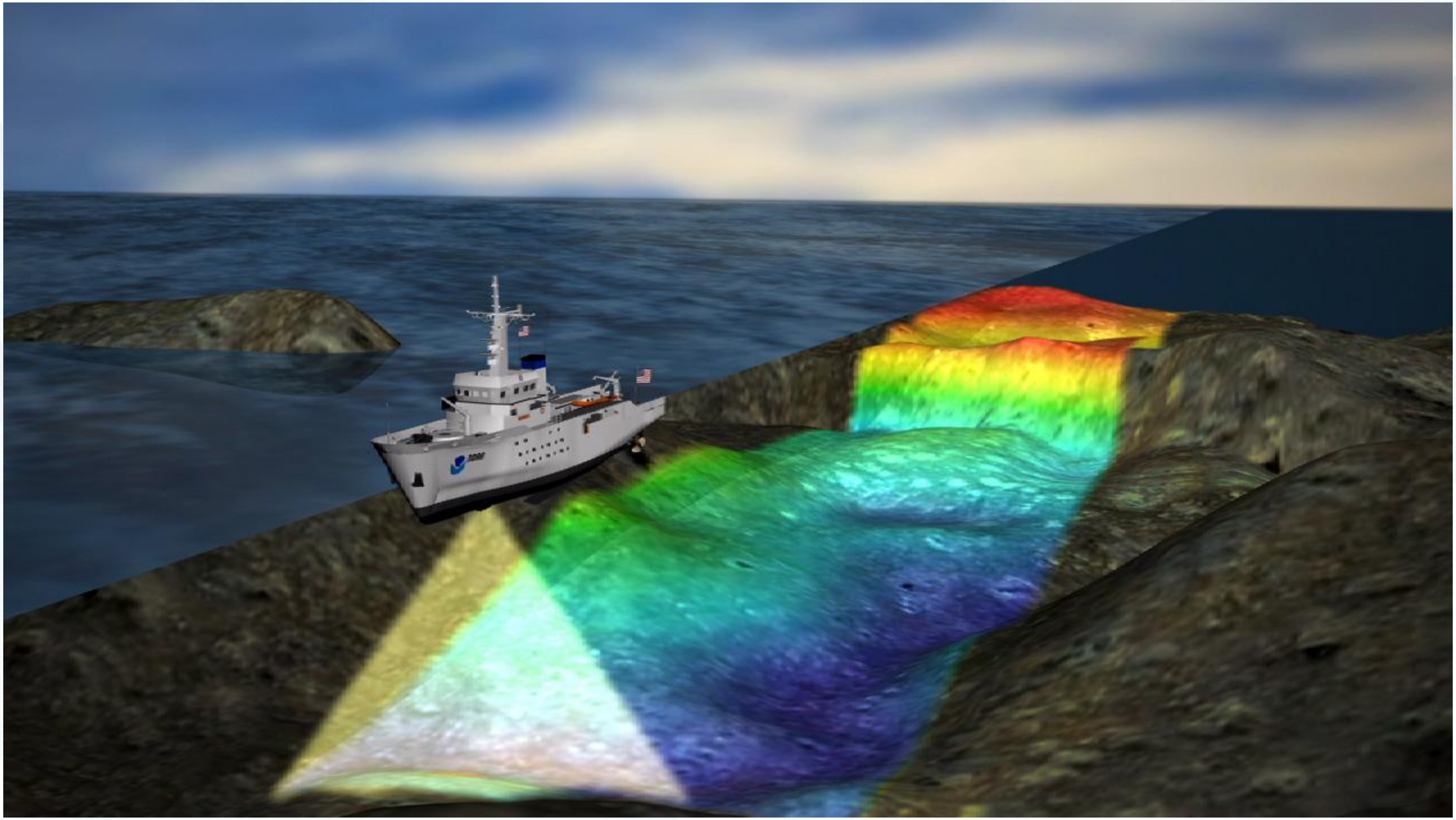
Drowned Landscapes:
Coastal Response to Rapid Sea-level Rise



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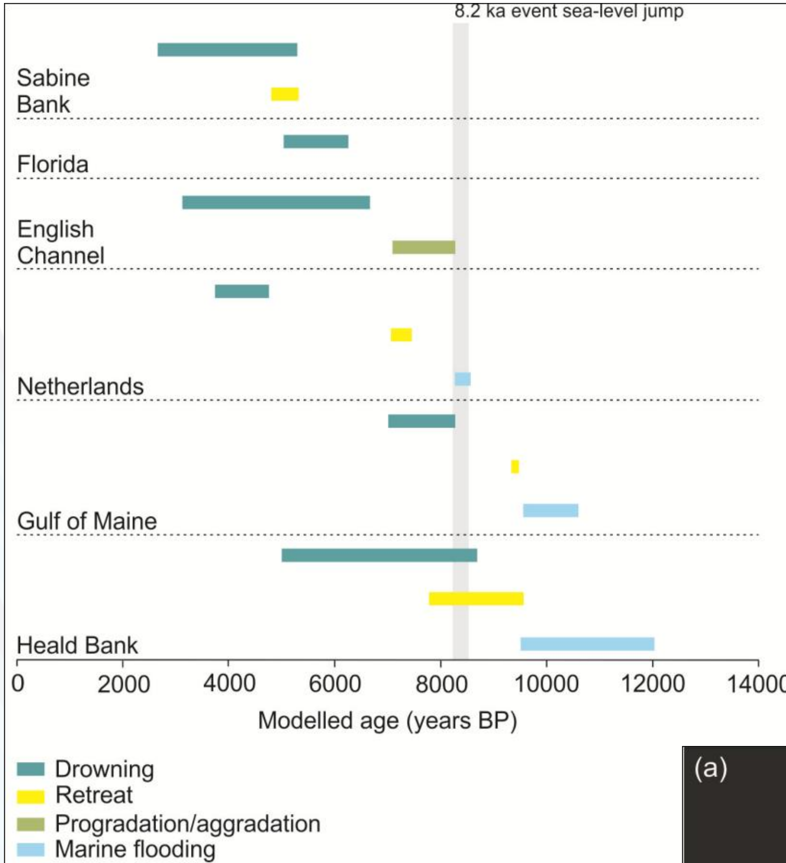
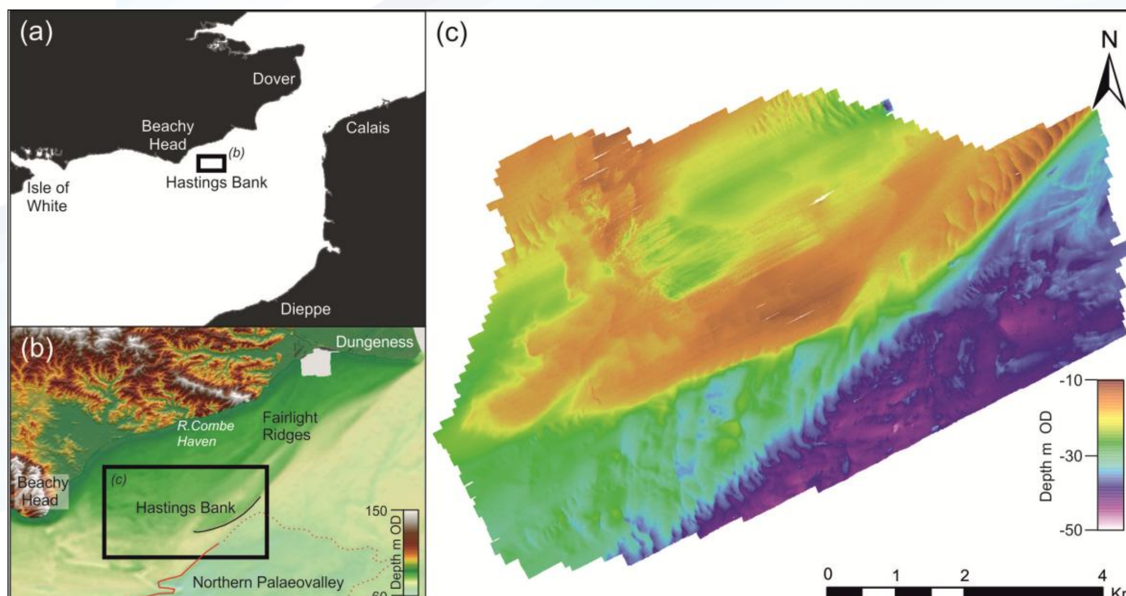


- English Channel seafloor geomorphology comparable to Lake Missoula floods (Gupta et al., 2007)
- Hastings Bank: drowned gravel foreland similar to present Dungeness (Mellett et al., 2012, Marine Geology v.315-318)
- Barrier beach response to 8.2 ka SLR



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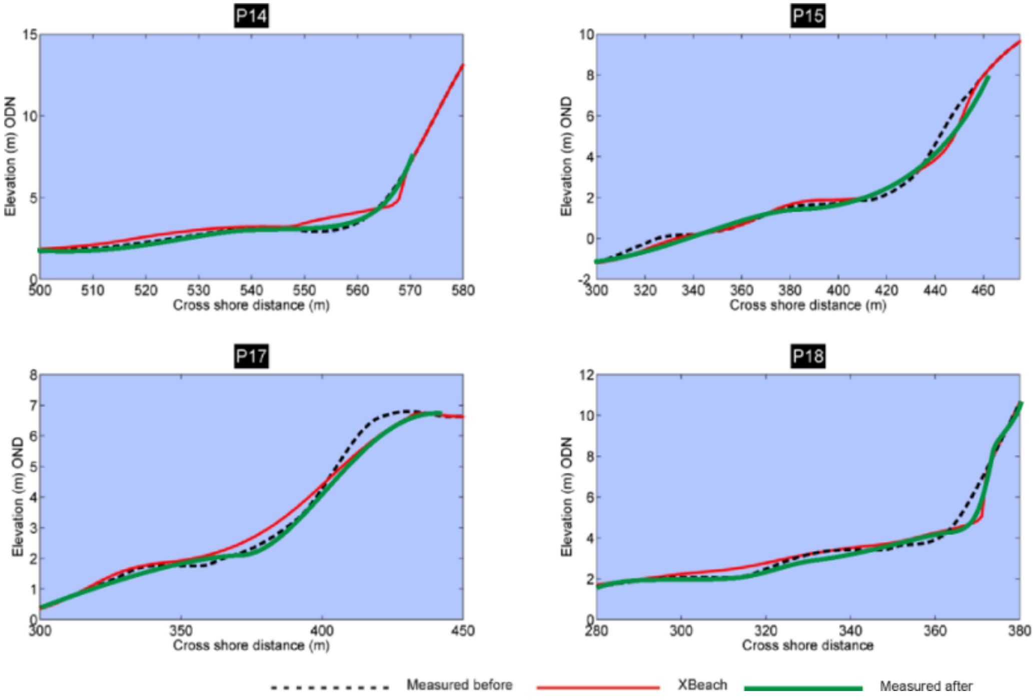
Dynamic Coastal Response:



e.g. Xbeach modeling

Esteves et al (2012)

e.g. Probabilistic shoreline retreat

Ranasinghe (2012)

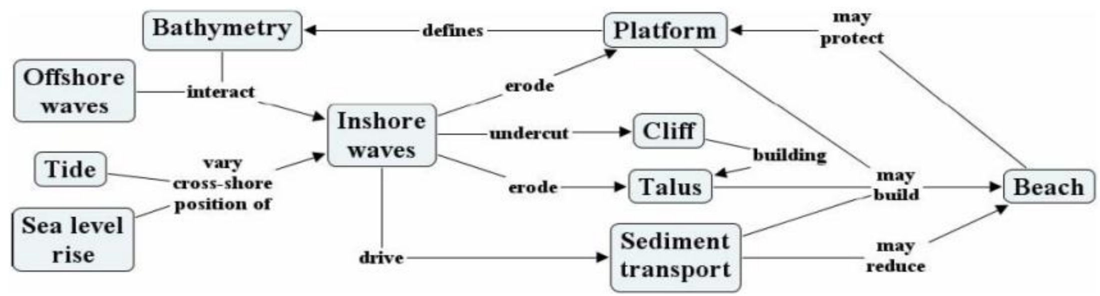
Panzeri et al. (2012)

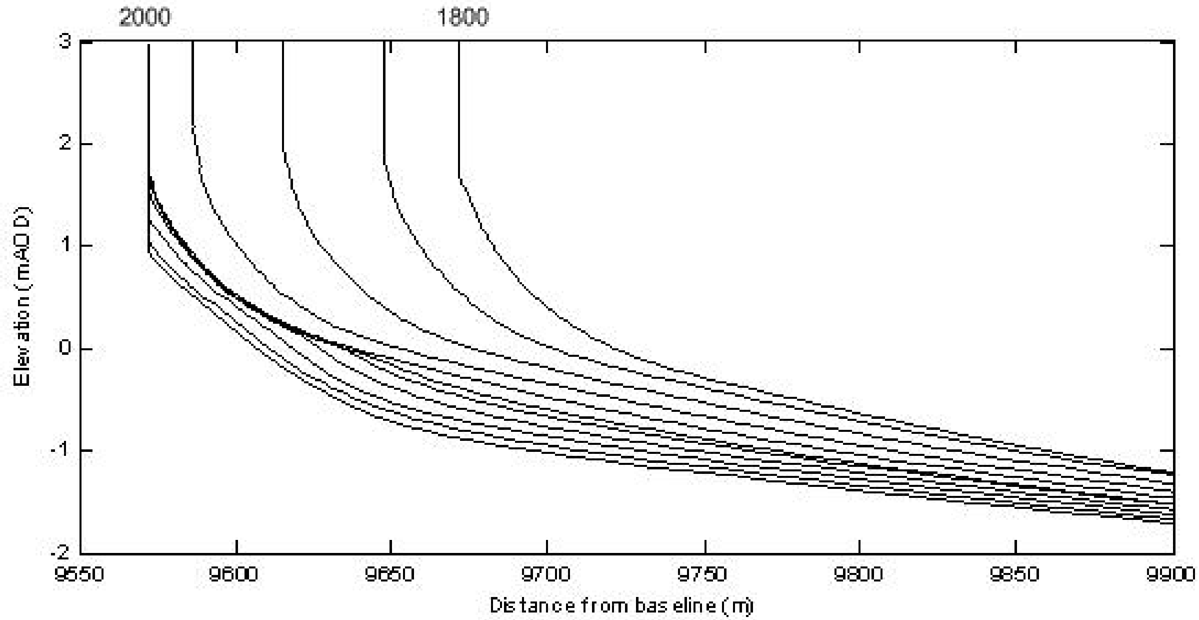
Integrated Coastal Dynamics and Shoreline Evolution

SCAPE – Soft Cliff and Shoreline Erosion

Changing coastal dynamics (sea level, storms, sediment supply) lead to changing coastal geomorphology

Walkden and Hall (2005)





Sustainable management of coastal resources: more than a science issue...

Arnstein, S.R. (1969) "A Ladder of Citizen Participation," Journal of the American Planning Association 35 (4), 216-224

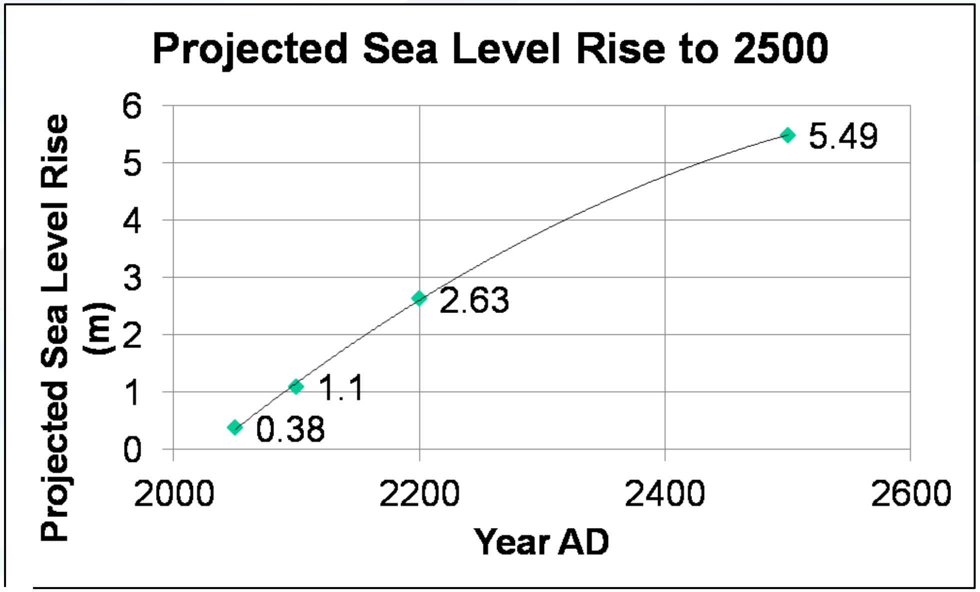
ARCoES Flood Risk Assessments to 2500 AD

Flood and coastal risk mapping requirement according to EA guidelines for NNB (Cefas, EDF, NDA)

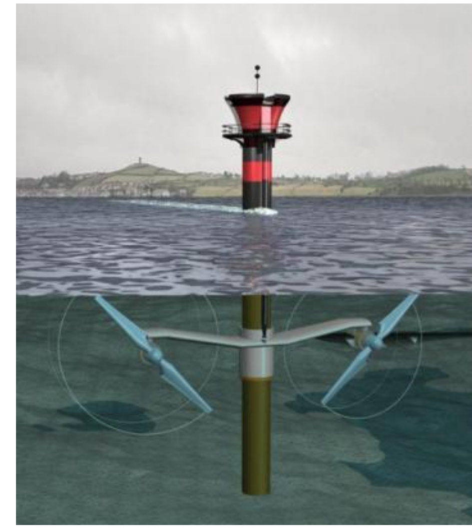
Jevrejeva et al. (2012) Global and Planetary Change 80-81, 14-20.

First assessments are based on low probability but plausible events from the higher Representative Concentration Pathway scenario values.

LISFLOOD-FP modelling



North-west Region Lowland: Landscape for Coastal Energy Infrastructure



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Summary

Providing decision-makers and stakeholders with reliable data at appropriate resolution – ***working in partnership*** to address issues of uncertainty, magnitude and frequency, limitations, caveats.

Promoting dynamic coasts: sedimentary and ecosystem ‘health’

Aiming to enhance coastal resilience by examining system behaviour across scales (time and space), bridging ‘process’ and ‘geological’ understanding

Using models for exploring coastal response, feeding into decision-support systems

Going beyond ‘communication’ - taking responsibility for sharing our knowledge more widely and developing shared learning through engagement.

Thank you for your attention...

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