Can we avoid coastal squeeze through nature-based adaptation?

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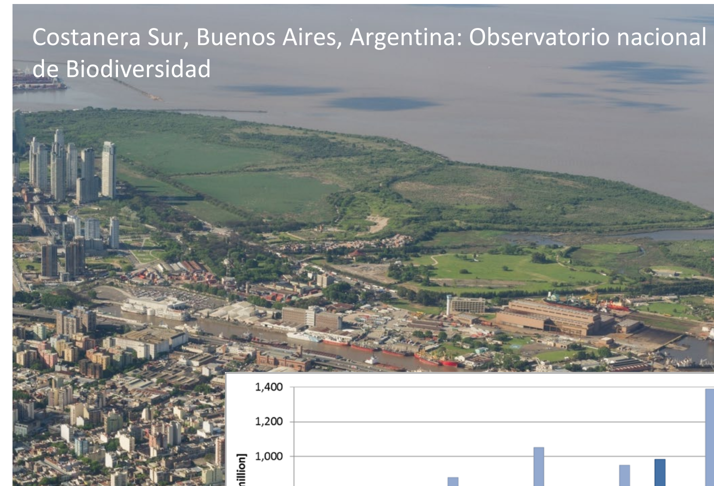
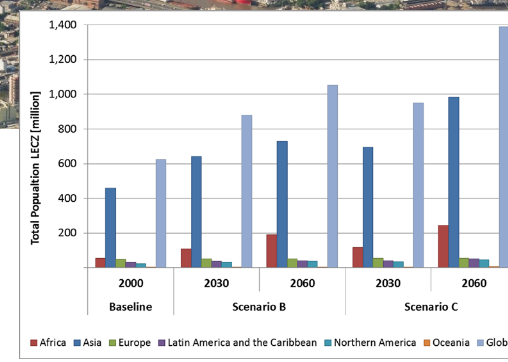
Coastal squeeze: a global challenge

'Coastal squeeze is one form of **coastal habitat loss**, where intertidal habitat is lost due to the **high water mark being fixed** by a defence or structure (i.e. the high water mark residing against a hard structure such as a sea wall) and the **low water mark migrating landwards in response to SLR**.' (Pontee, 2013).

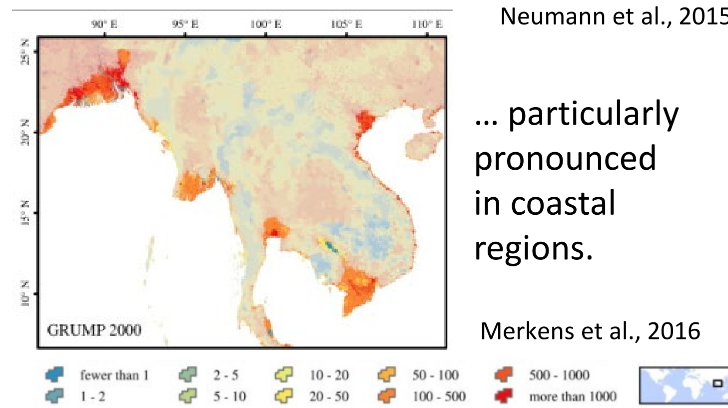


Costanera Sur, Buenos Aires, Argentina: Observatorio nacional de Biodiversidad

Global population growth....



Neumann et al., 2015



... particularly pronounced in coastal regions.

Merkens et al., 2016

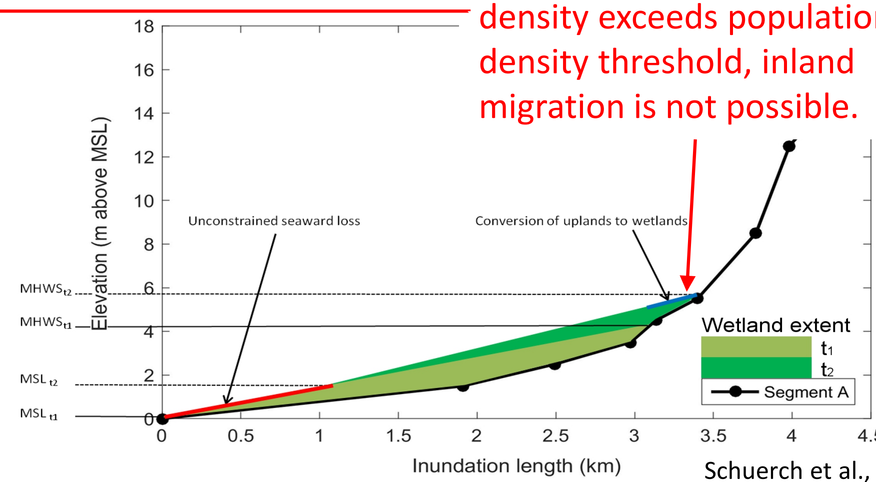
Ecosystem services of coastal wetlands

- Coastal protection:
  - → Wave and surge attenuation (Gedan et al., 2011; Möller et al., 2014)
  - → Protection against coastal erosion
- Carbon sequestration/storage:
  - → Burial rates exceed those of terrestrial ecosystems (McLeod et al., 2011)
  - → Potential carbon emissions where wetland are eroded.
- Habitat provisioning

Global Coastal Wetland Model

- **Coastal profiles**
  - → Based on floodplain data from DIVA database (Hinkel et al., 2014)
  - → Coastal profile construction, following Vafeidis et al., 2019
  - → Inland migration as a function of coastal topography and sea-level rise (SLR; Schuerch et al., 2018)

Where local population density exceeds population density threshold, inland migration is not possible.



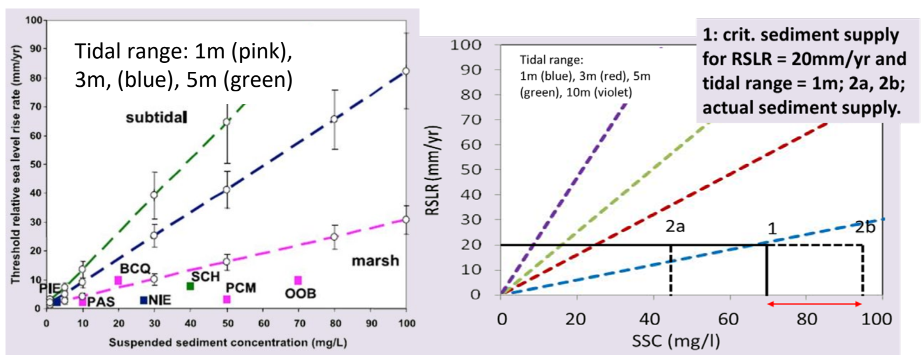
Schuerch et al., 2018

- **Population density threshold**

SLR scenario	Sea level 2100 (cm)	Accommmodation space scenario	Population density threshold (people km^{-2}) Lower boundary	Upper boundary
Low: RCP 2.6 (5%)	29	Business-as-usual (BAU)	5	20
		Managed realignment (MR) 1	20	150
		Managed realignment (MR) 2	150	300
		Sediment acc. only (HYS 2)	0	∞
Medium: RCP 4.5 (50%)	50	Business-as-usual (BAU)	5	20
		Managed realignment (MR) 1	20	150
		Managed realignment (MR) 2	150	300
		Sediment acc. only (HYS 2)	0	∞
		No resilience (HYS 4)	0	∞
High: RCP 8.5 (95%)	110	Business-as-usual (BAU)	5	20
		Managed realignment (MR) 1	20	150
		Managed realignment (MR) 2	150	300
		Sediment acc. only (HYS 2)	0	∞
		No resilience (HYS 4)	0	∞

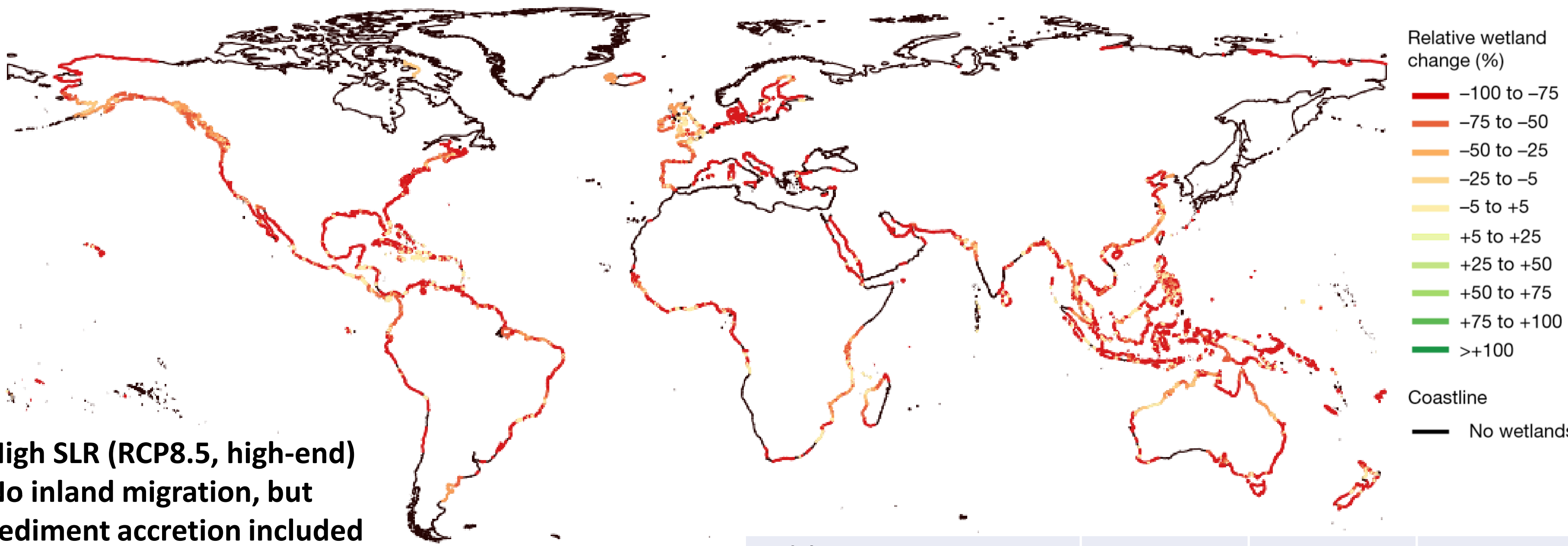
Schuerch et al., 2018

- **Critical sediment supply:**



- → Critical relative SLR (Kirwan et al., 2010)
- → Translated into critical sediment supply as function of relative SLR and tidal range
- → Seaward wetland loss occurs where actual sediment supply < crit. sediment supply

Baseline results

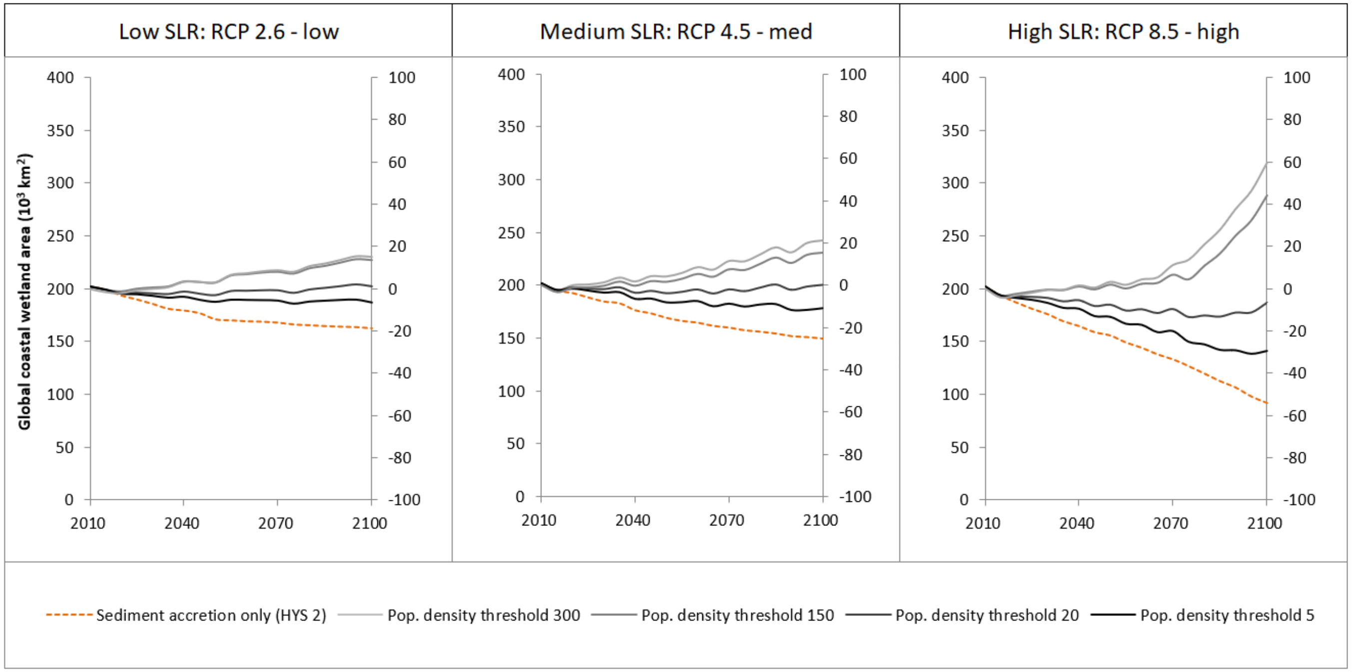


High SLR (RCP8.5, high-end)
No inland migration, but sediment accretion included

Model setup	RCP 2.6 - 5%	RCP 4.5 - 50%	RCP 8.5 - 95%
Sediment accretion only	-19.5	-26.0	-54.4

- Most coastal wetlands (tidal (salt and freshwater) marshes and mangroves) globally do not have the capacity of accrete sediment under high SLR scenarios.
- Not accounting for inland migration may lead to global wetland losses between 20 and 54 % (depending on the sea-level rise scenario.
- **Coastal squeeze is likely to be a global-scale problem.**

Scenario analysis



Schuerch et al. (2018), modified

- Accounting for wetland inland migration reduces global wetland loss for all sea-level rise scenarios
- An increase in global wetland area is possible where nature-based adaptation (e.g. managed realignment) is implemented on a large-scale

Accounting for inland migration increases global coastal wetland areas by:

- BAU: 12-47% (of original area) for business-as-usual scenario
- 20-97% (of original area) for moderate coastal retreat scenario
- 32-114% (of original area) for extreme coastal retreat scenario

	Simulated global area increase (in % of original area) compared to baseline scenario		
	RCP 2.6 - 5%	**RCP 4.5 - 50%**	**RCP 8.5 - 95%**
Pop. density threshold 5	11.8	14.2	24.2
Pop. density threshold 20	19.7	25.2	46.9
Pop. density threshold 150	31.7	41.4	96.9
Pop. density threshold 300	34.6	45.8	114.1

Discussion/conclusions

- Through vertical sediment accretion, coastal wetlands are unlikely to keep up with global SLR, particularly for high-end scenarios.
- Global coastal wetland loss through coastal squeeze is avoidable, if nature-based solutions to coastal management (e.g. managed realignment) are consequently implemented.
- Inland migration/managed realignment may be accompanied by the loss of long-standing wetlands, replacing them with young, potentially short-living ecosystems.
- This raises questions about the continued delivery of associated ecosystem services, such coastal protection, habitat provisioning and carbon sequestration (e.g. Mossman et al., 2012).

Managed realignment (Freiston Shore, UK East coast)

Thank you for attending and listening

Questions?

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