**Low Lying Agricultural Lands and Coastal Squeeze: Seawater Intrusion and Subsidence**

Coastal habitats adapt to environmental and climate change, e.g., sea-level rise by migrating inland to retain their relative function and structure. Coastal squeeze occurs where coastal armoring or other barriers prevent this natural migration creating fixed margins between the land and sea(Doody, 2004; Lithgow et al., 2019).1, 2 Coastal squeeze may lead to the loss of intertidal habitats or even entire intertidal zones. The rate at which the loss takes place is dependent on factors such as the geographical formation of the coast (Doody, 2004). 1

Coastal armoring changes the natural dynamics of shoreline sediment transport. In coastal and riverine areas, sustained sediment supplies are important for maintaining shoreline position and for offsetting surface subsidence. Surface subsidence is the decline in surface elevation due to the loss of sediment deposits (USGS, n.d). 3 Trapped behind sea defense systems, wetlands, mangrove, and marshes become increasingly vulnerable to accelerated surface subsidence, erosion, and decline (Anthony et al., 2015). 4

Subsidence may also occur due to different forms of underground failure (USGS, n.d).3,8 In many areas, large tracks of wetlands have been converted to agricultural use (Hartig et al., 1997). 5  that have been protected behind coastal defense structures such as flood banks ([Doody, 2013](https://www.sciencedirect.com/science/article/pii/S0261517719300342?casa_token=d5G5nlXBrQEAAAAA:B2URjwtk_QSuOq5pjJ-myh74l9UH2TA8sDY-hppoj__rWyO2VWYv2-52jrqOYNMUr-TIjGxIUm4#bib8)).6 Supporting such agricultural enterprises has meat adopting irrigation practices that involve extracting potable water from deep underground aquifers. This leads to groundwater fluxes, saltwater intrusion, and deep subsidence (Chang and Clement, 2012). 7 This process is manifested on the surface of agricultural lands as tilting, sinking, and slumping of the soil surface. Deep subsidence has also been attributed to tectonic activity and deep basin processes that have destroyed agriculture infrastructure (Xiong, et al., 2019; Pontee, 2013) 8,9

**References**

[1] Doody, J. P. (2004). ‘Coastal squeeze’—an historical perspective. *Journal of Coastal Conservation*, *10*(1), 129-138.

[2] Lithgow, D., Martínez, M. L., Gallego-Fernández, J. B., Silva, R., & Ramírez-Vargas, D. L. (2019). Exploring the co-occurrence between coastal squeeze and coastal tourism in a changing climate and its consequences. *Tourism Management*, *74*, 43-54.

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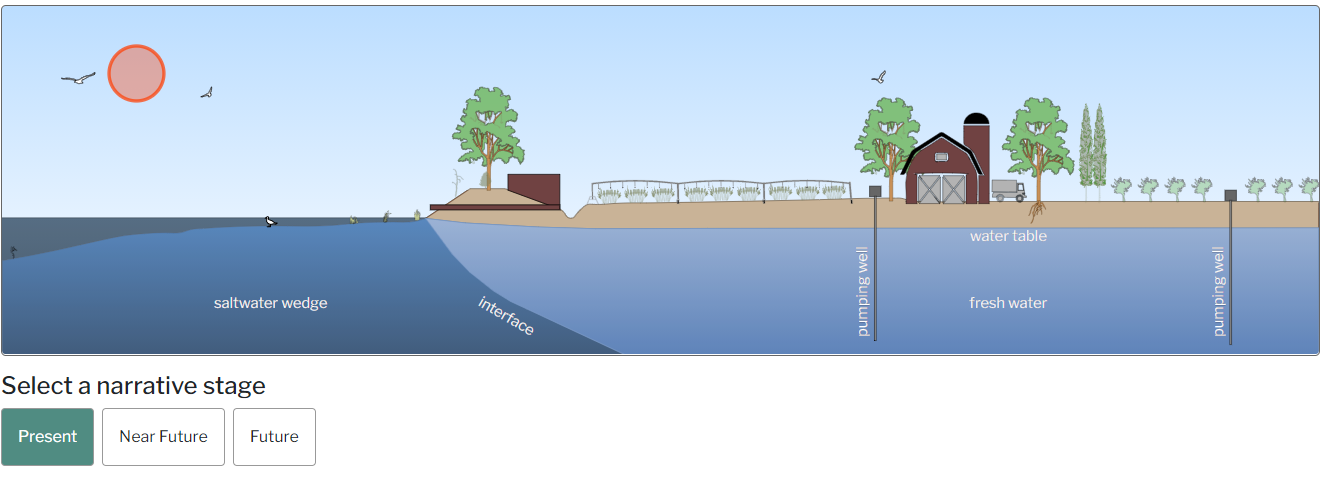
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[7] Chang, S. W., & Clement, T. P. (2012). Experimental and numerical investigation of saltwater intrusion dynamics in flux‐controlled groundwater systems. *Water Resources Research*, *48*(9).

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Zone 1

Zone 3

Zone 2

**Zone 1 (present)**

Coastal squeeze has led to the loss of the intertidal zone. Hence, a flood wall was constructed to protect the remaining farmlands in zone 2.

**Link to article**

Morley, S. A., Toft, J. D., & Hanson, K. M. (2012). Ecological effects of shoreline armoring on intertidal habitats of a Puget Sound urban estuary. *Estuaries and coasts*, *35*(3), 774-784. https://link.springer.com/article/10.1007/s12237-012-9481-3

**Zone 2 (near future)**

Overtime, higher rates of the removal of ground water from aquifers (for farming) compared to natural rates of recharge leads to saltwater intrusion into underground aquifer.

**Link to article**

Duan, Y. (2016). Saltwater intrusion and agriculture: a comparative study between the Netherlands and China. <https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1060822&dswid=-7709>

**Zone 3 (future)**

Further removal of ground water exacerbates the process of saltwater intrusion and leading ultimately to subsidence, i.e., slumping of the soil surface.

**Link to articles**

Tully, K., Gedan, K., Epanchin-Niell, R., Strong, A., Bernhardt, E. S., BenDor, T., ... & Weston, N. B. (2019). The invisible flood: The chemistry, ecology, and social implications of coastal saltwater intrusion. *BioScience*, *69*(5), 368-378. <https://academic.oup.com/bioscience/article/69/5/368/5487218>

Corbau, C., Simeoni, U., Zoccarato, C., Mantovani, G., & Teatini, P. (2019). Coupling land use evolution and subsidence in the Po Delta, Italy: Revising the past occurrence and prospecting the future management challenges. *Science of the Total Environment*, *654*, 1196-1208. <https://doi.org/10.1016/j.scitotenv.2018.11.104>

Gambolati, G., Putti, M., Teatini, P., & Stori, G. G. (2006). Subsidence due to peat oxidation and impact on drainage infrastructures in a farmland catchment south of the Venice Lagoon. *Environmental Geology*, *49*(6), 814-820. <https://idp.springer.com/authorize/casa?redirect_uri=https://link.springer.com/content/pdf/10.1007/s00254-006-0176-6.pdf&casa_token=XoydP2nKyVcAAAAA:U9bZbWghOp_sOZdyAzuAiNb3dztbMN3V2NL7Ky-YprCeqBuY6oq9W6h-VymlHReQs2ebtigjJ4MUSCijdw>

Piesse, M. (2019). The Mekong Delta: land subsidence threatens Vietnam’s “food basket”. *Strategic Analysis Paper*. <https://www.futuredirections.org.au/wp-content/uploads/2019/07/The-Mekong-Delta-Land-Subsidence-Threatens-Vietnams-Food-Basket.pdf>