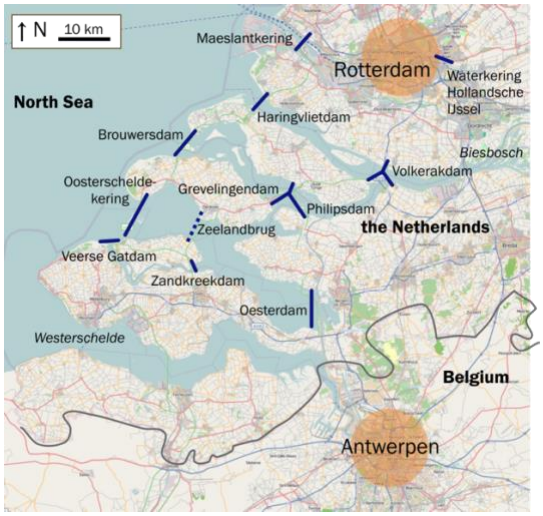
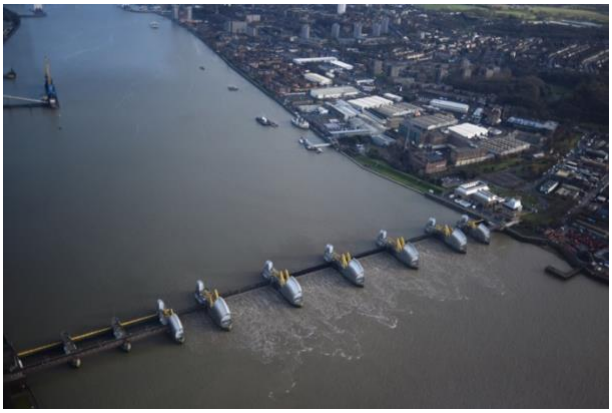
Maeslant barrier, the Netherlands



Map of the Delta Works

The Maeslantkering is on my travel wish list.[1] A Rick Steves tour itinerary reads: “Today we'll discover how a country stays dry when nearly half of its land is below sea level... with a tour of one of earth's largest moving structures — the Maeslant storm surge barrier....”[2] The Netherlands has been battling the sea for centuries. The flood disaster (Watersnoodramp) of 1953 prompted the Delta Works, a mega-project closing off multiple sea inlets, finished in 1997.[3]



The Thames Barrier, raised

Steel gate rotated up

The same Great North Sea Flood led to the Thames Barrier. It took 30 years to build and was completed in 1984: 10 steel gates that rotate up to the height of a five-story building. By its 40th anniversary, it had been closed 221 times to protect London.[4] The Thames Estuary 2100 Plan is reviewed every 10 years.

Also famous, or maybe infamous, is the MOSE: 78 steel gates that fill with air to rise up and hold back the sea. A response to the Great Venetian Flood of 1996, it was begun in 2003, and first deployed in 2020, after delays and scandal.[5] As higher tides come more frequently, the floodgates are more often closed, becoming a near permanent unattractive wall around a stagnant lagoon.[6]

MOSE = Modulo Sperimentle Elettromeccanico

Concrete seawalls, rocky revetments, dikes, bulkheads, and breakwaters are more common "hard" coastal defenses. The immobile barriers protect landward structures but disrupt natural tidal flows of water and sediment and shoreline flow of sand, and can lead to loss of beaches, wetlands, and habitats.[7] Beach nourishment is a temporary fix, needing repeated replenishment of sand, a finite resource.[8] Hard armoring is often expensive and requires maintenance. Walls can also falsely reassure, leading to more urban development in hazardous zones (maladaptive, because it increases exposure to flood risk).

Mangroves, salt marsh wetlands, seagrass, and coral and oyster reefs protect shores by dissipating the force of waves and stabilizing sediment, and additionally preserve habitat, provide food, and filter water, and some store carbon. These can be preserved, restored, and extended where present, as "soft" defenses with co-benefits. Full ecosystems take time to establish and require more space, but become more protective as they grow, self-recover, and migrate with rising waters.[9] Sediment-based beaches, dunes, and barrier islands also provide natural protection.

Hybrid defenses combine hard and soft features. For example, Staten Island's "Living Breakwaters" are artificial reefs made up of islands of concrete and rock designed with niches and crevices, offering the protection of breakwaters but also already welcoming nesting birds, migrating seals, and tidepool denizens like snails, crabs, and shrimp.[10] Eventually oysters will be added by the Billion Oyster Project that is building oyster reefs across New York Harbor.[11] Shoreline protection needs to fit the environment; living shorelines are favored for sheltered coasts.[12] Both natural and hybrid gray-green defenses are called living shorelines, nature-based initiatives, or soft protection.

Worldwide, more and more people live on the coast – a billion, or 14.6% of the global population, on 4% of the landmass.[13] Exposed to flood risk are: densely populated cities and countries where the population is concentrated on the coast; also small islands, sinking cities and deltas, and low-lying lands; also vulnerable places with less technical and financial resources to respond and adapt. Even without headline disasters, communities are grappling with flood events that occur with high tides, heavy rain, or big winds or waves, worsened by rising sea levels.[14] This becomes more than "nuisance" flooding if groundwater, wastewater systems, and infrastructure are impacted.

What to do? The US Army Corps of Engineers has proposals for Boston, Charleston, Houston-Galveston ("Ike Dike"), Miami-Dade (seawall rejected and not present in the second draft), New York-New Jersey, and Norfolk, Virginia.[15] The Norfolk seawall is the closest to starting construction, not without controversy.[16] Seawalls are not the only answer and protection is not the only adaptation approach to flood risk. What are other cities doing? Stay tuned!

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EXTRA: Japan is a special case because its seawalls were built for tsunami protection. See what the walls look like: Lim M, photography by Kyung-Hoon K, 2018. After tsunami, some Japanese are feeling walled-in (https://widerimage.reuters.com/story/after-tsunami-some-japanese-are-feeling-walled-in)

IMAGE CREDITS

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- MOSE. Alfredobi. Public domain.

SOMETHING TO DO

I am learning about my surroundings, the Salish Sea, Lake Whatcom, Nooksack River, etc. What waters are near you? Look on a map or try these digital tools:

- USGS Streamer lets you trace larger American rivers and streams upstream to their source or downstream to where they empty. (https://webapps.usgs.gov/streamer/)
- The USGS National Hydrography Dataset is more detailed, but takes a while to load. (https://www.arcgis.com/home/item.html?id=8ff0911acb2f4d4d879736d6a611a366). I chose Map View, closed the Layers sidebar on the left, and moused to my town. The key to the overlays is on the right, e.g. dotted lines for intermittent flows and arrowheads for flow directions.