Chapter 49. Salt Marshes

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1. Inventory

Salt marshes are intertidal, coastal ecosystems that are regularly flooded with salt or brackish water and dominated by salt-tolerant grasses, herbs, and low shrubs. They occur in middle and high latitudes worldwide and are largely replaced by mangroves in the subtropics and tropics (see Chapter 48). They are found on every continent except Antarctica (Figure 1). In areas of relatively little sediment delivery, salt marshes are highly organic and often peat-based. In contrast, salt marshes in areas of high sediment delivery, such as sheltered estuaries (see Chapter 44), are often well-developed with inorganic substrates.

2. Features of trends in extent

Salt marshes are among the most productive temperate ecosystems in the world. Contemporary salt marshes developed within the last 8,000 years in low-energy, coastal locations in response to rising sea levels (Milliman and Emery, 1968; Redfield 1967). Their ecology and global importance has been described in classic literature such as Chapman (1960), Ranwell (1972), Doody (2008) and Adam (1990). The physical stresses of salinity and flooding generate zones of salt-tolerant emergent vegetation, including such genera as *Carex*, *Spartina*, *Juncus*, *Salicornia*, *Halimone*, *Puccinellia*, and *Phragmites*. Marsh grasses contribute to the accumulation of organic matter and trapping of inorganic sediment. Salt marsh sustainability is mainly controlled by the relationship between marsh vertical accretion (due to sediment accretion, peat accumulation, belowground decomposition, subsidence) and sea level rise (frequency and duration of tidal flooding - Gagliano et al., 1981; Cahoon and Reed, 1995; Hatton et al., 1983; DeLaune et al., 1983). Other facts that impact their development and structure are tidal, wave and current action, erosion, freshwater influx, nutrient supply, and topography (Mitsch and Gosselink, 1993). Less than 50 per cent of the world's original wetlands remain (Mitsch and Gosselink, 1993) and current loss is estimated at 1-2 per cent per year (Bridgham et al., 2006) making wetlands one of the fastest disappearing ecosystems worldwide. Salt marsh loss coincides with a general historical degradation of estuarine ecosystems (Lotze et al., 2006). Just upstream from salt marshes are brackish marshes with lower salinity regimes, which are also highly productive, subject to the same stresses, and of equally great conservation concern.
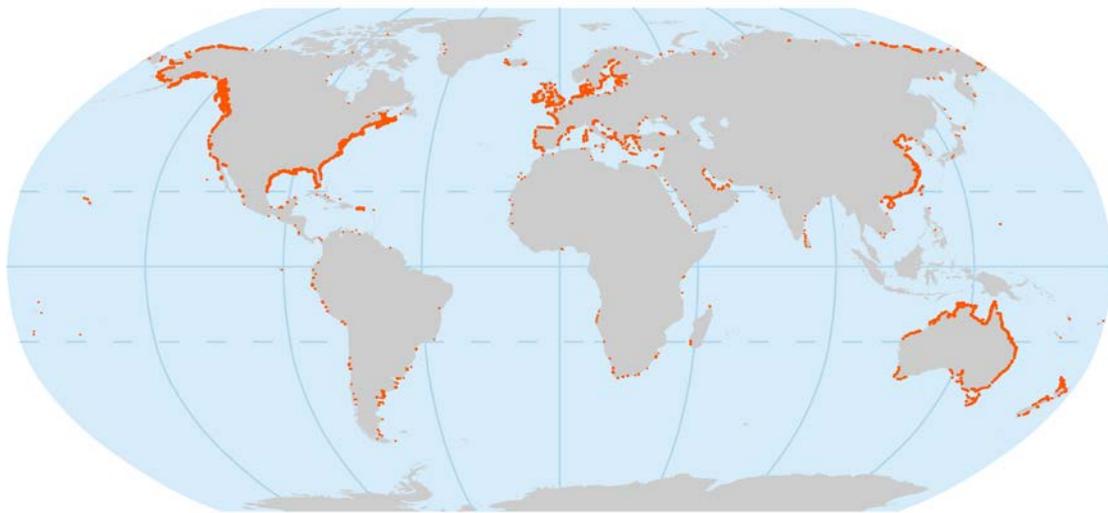
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 1. Salt Marshes (in orange). Source: UNEP-WCMC, 2015.

3. Major pressures linked to the trends

Over 60 per cent of the globe's population lives on or near the coast, and coastal populations are increasing at twice the average rate (UNEP, 2006a; Nicholls et al., 1999), making coastlines highly vulnerable to human activities. Salt and brackish marshes, formerly viewed as useless wastelands, were filled in for urban or agricultural development. Reclamation of land for agriculture by converting marshland to upland was historically a common practice. Coastal cities worldwide have expanded onto former salt marshes and used marshes for waste disposal sites. Airoldi and Beck (2007) estimate that countries in Europe have lost over 50 per cent of their salt marsh and seagrass areas to coastal development. Estuarine pollution from organic, inorganic, and toxic substances is a worldwide problem. Marshes have been drained, diked, ditched, grazed and harvested. They have been sprayed for mosquito control, and have been invaded by a range of non-native species that have altered their ecology. As one example, Massachusetts, United States of America, has lost 41 per cent of its salt marshes since the 1770s, with a loss of 81 per cent in Boston (Bromberg and Bertness, 2005; Figure 2).

Key threats to salt marshes are land reclamation, coastal development, dredging, sea-level rise (SLR), hydromodification, alteration of processes (e.g. sediment delivery, freshwater input) and eutrophication. Accelerated SLR is the largest climate-related threat to salt marshes. The Intergovernmental Panel on Climate Change predicts with

medium confidence a SLR of 0.26-0.98 m by 2100 (Church et al., 2013). Nicholls et al. (1999) predict that 1 m SLR will eliminate 46 per cent of the world's coastal wetlands. Some salt marshes can keep pace with SLR, but others, especially those cut off from their sediment delivery via levees and seawalls cannot (Day et al., 1995). Nutrient pollution, which destabilizes below-ground biomass and increase decomposition, is likely to exacerbate salt marsh loss due to SLR (Turner et al., 2009; Deegan et al., 2012). Subsidence, which contributes to relative SLR in some regions, is an additional stressor. The impact of SLR will depend upon accretion and subsidence rates and other processes that influence the marshes ability to grow vertically and/or to migrate inland. "Coastal squeeze" describes the limitation of marshes to extend landward due to boundaries (Pethick, 2001) such as paved areas, seawalls, and bulkheads from coastal development.
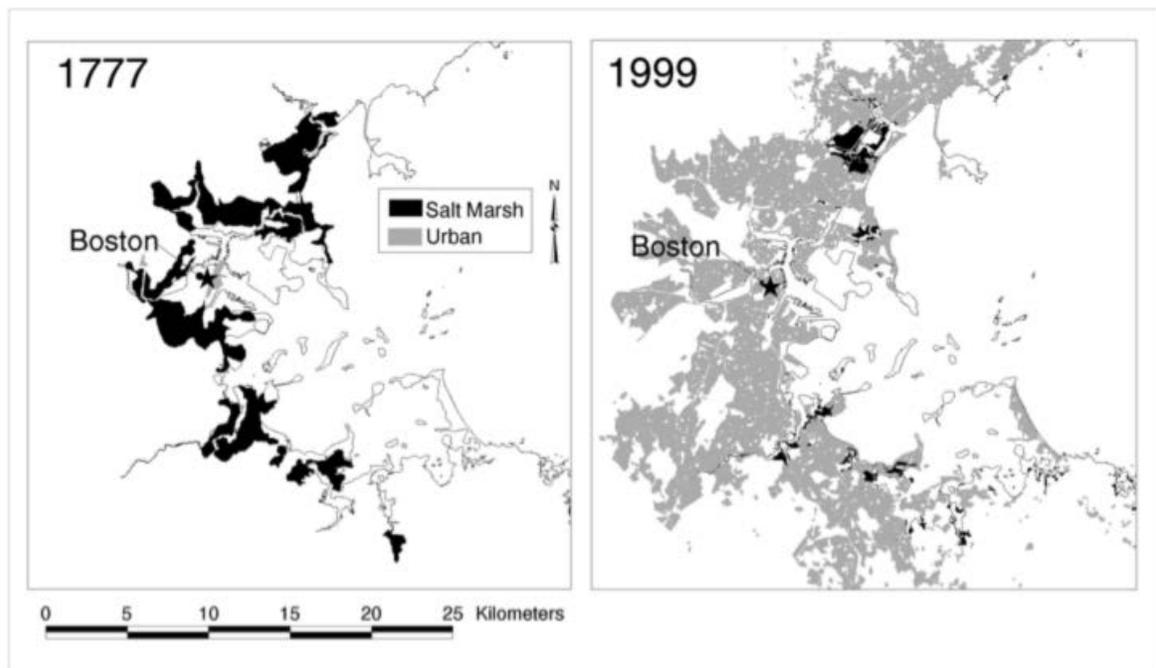
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 2. Salt marsh loss in Boston, Massachusetts, United States, between 1777 and 1999 (Bromberg and Bertness, 2005).

4. Implications for services to ecosystems and humanity

Salt marshes play a large role in the aquatic food web and the cycling of nutrients in coastal waters. They serve as critical habitat for various life stages of coastal fisheries that account for a large percentage of the world's fish catch (UNEP, 2006b). Over half of the commercial fish species of the East coast of the United States utilize salt marshes at some time of their lives (Beck et al., 2001). In addition to providing habitat for juvenile fishes, crabs, and shrimps, marshes support populations of some small forage fishes,

which come up on the marsh surface at high tide to feed on invertebrates (Shenker and Dean, 1979; Zimmerman et al., 2000). Many migratory shore birds and ducks use salt marshes as stopovers during migrations and some birds winter in the marsh. Wading birds, such as egrets and herons, feed in salt marshes during the summer. Continued marsh loss could therefore dramatically alter estuarine food webs.

SLR is increasing the vulnerability of coastal populations to coastal erosion, flooding, and storms (IPCC, 2007). Salt marshes serve as natural barriers to these coastal hazards. They serve as shoreline stabilizers because they attenuate wave energy and help prevent erosion (Costanza et al., 2008, Gedan et al., 2011, Moller et al., 2014; see Chapter 26). They also slow and store floodwaters, reducing storm impacts on coastal communities (Cobell et al., 2013). While wetlands do not provide complete protection against coastal hazards, even small salt marshes can provide significant shoreline protection (Gedan et al., 2011). Their preservation and restoration may significantly decrease the economic impact and human losses of extreme events such as hurricanes and tsunamis (Gedan et al., 2011).

Salt marshes remove sediment, nutrients, microbes, and contaminants from runoff and riverine discharge (Gedan et al., 2009), acting as sponges absorbing much of the runoff after major storms and reducing flooding. They sequester pollutants from the water that drains down from the land, protecting nearby estuarine areas and coastal waters from harmful effects. They play a major role in the global carbon cycle and represent a major portion of the terrestrial biological carbon pool. They store excess carbon in their sediments, preventing it from re-entering the Earth's atmosphere and contributing to global warming. Salt marshes are thus an important component of the world's "blue carbon" (McLeod et al., 2011) and currently are being incorporated into global carbon markets. Chmura et al. (2003) estimated that tidal wetlands sequester 10 times the amount of carbon sequestered by peatlands. Salt marshes also provide excellent tourism, education, and recreation services, as well as research opportunities.

It is clear that salt marshes provide enormous benefits to society in the form of "ecosystem services". In this regard, coastal wetlands (which include salt marshes) are among the highest valued coastal ecosystems (Costanza et al., 2014). The serious reduction in salt marsh area reduces their capacity to provide these critical ecosystem services (Gedan et al., 2009; Craft et al., 2009).

5.   Conservation Responses and Conclusions

As society has become aware of the environmental and economic values of salt marshes, efforts have commenced to slow their loss and even to restore degraded marshes. These are mostly local initiatives. Concerned individuals and dedicated groups both within and outside government are mobilizing to stop and even reverse the trends. Restoration may involve reconnecting areas to the estuary by excavating channels that had filled in, relying on the tidal flow to allow the marsh to restore itself. Other

restoration projects involve removing unwanted invasive vegetation, changing the marsh elevation, and planting the desired species. Monitoring of such projects would need to be done for years after restoration to see if methods are successful or need modification, and to learn how much time it takes before the restored marsh acquires the biodiversity and ecosystem function of a natural marsh (Craft et al., 1999; Zedler and Lindig-Cisneros, 2000; Rozas et al., 2005). Restoration of coastal marshes is now also included among strategies for climate adaptation planning (Arkema et al., 2013, Barbier, 2014) and mitigating greenhouse gas emissions (Olander et al., 2012), highlighting the multiple benefits that may be derived from salt marsh conservation.

Some international legal instruments and policy frameworks, such as the Convention on Wetlands of International Importance, especially as Waterfowl Habitat[1] (Ramsar Convention), the Convention on Biological Diversity[2], and Agenda 21 adopted by the 1992 United Nations Conference on Environment and Development, promote the conservation and wise use of wetlands and support economic valuation to support conservation. Economic valuation can be used to evaluate and compare development uses vis-à-vis conservation uses. Although some estimates have been made (Costanza et al., 1997, Minello et al., 2012), placing a monetary amount on these services is difficult and controversial. Many benefits are non-monetary, which makes comparisons difficult in decision-making (Barbier et al., 2011). Improving the assessment and valuation of salt marsh services could assist current conservation methods.

These important vegetated, intertidal habitats and the ecosystem services they provide, such as fisheries, sequestration of pollutants, and protection from flooding and storm surge, are under threat due to natural and anthropogenic forces. Efforts would be needed worldwide to preserve the remaining salt marshes and restore some of those that have been destroyed or impaired.

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[1] United Nations, *Treaty Series*, vol. 996, No. 14583.

[2] United Nations, *Treaty Series*, vol. 2226, No. 30619.

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