



COMMENTARY

# Wetlands: A Natural Defense Against Climate-Induced Flooding

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This commentary examines the ability of wetlands to reduce climate-induced flood damage. Wetlands have been identified by many scientists as reducing flood risks and damages in both urban and coastal environments (Tong et al., 2025).

Flooding is known as one of the most devastating and damaging natural events occurring around the world. Floods can cause severe destruction to homes and infrastructure, costing millions of dollars (Fairchild et al, 2021). Flooding occurs when there is an overflow of water on land that is normally dry (NOAA, 2025). Flooding is caused by natural or human-related events such as heavy rainfall, storm surges, ocean waves, or structural failures such as broken dams or levees (NOAA, 2025). Since the pre-industrial period (1850–1900), the global surface temperature has risen by nearly 1.5 degrees Celsius and continues to rise (NASA, 2024). This warming is altering the hydrological cycle, resulting in the atmosphere holding and releasing more moisture, which increases extreme precipitation and flood risk (Tabari, 2020). The increase in flooding events caused by global warming and the rise in extreme weather events has led to damage to the structure and function of wetlands (Sun et al., 2022). Furthermore, rising sea levels



driven by melting ice sheets, as well as altered snowmelt patterns, further contribute to flooding events (IPCC, 2021).

Wetlands play a key role in reducing flood risks and damages (Tong et al., 2025). Wetlands act as carbon sinks, provide habitat for various organisms, and act as natural water filters in the environment (National Geographic, 2025). In addition to their ecological importance, wetlands are highly effective in mitigating flood-related damage across the world. They function as natural sponges that absorb surface runoff such as rainwater, snowmelt, or floodwaters, and slowly release water back into the hydrological system (USEPA, 2025). Tong et al. (2025) state that wetlands can reduce peak flows in urban rivers or streams by 30%–50%, reducing the risk of flooding. In coastal wetlands, marshes and estuaries have reduced flood damages by up to 35%, saving millions of dollars in flood-related damages annually (Fairchild et al., 2021).

Table 1 shows the economic value of different types of wetlands and how they reduce the effects of floods. Floodplains and urban wetlands can reduce damages by 54%–95%, with annual avoided losses of \$126,000–\$459,000 for communities (Watson et al., 2016), and similar protective effects have been shown in recent urban studies (Tong et al., 2025; Sauer et al., 2024). Coastal marshes lower storm damages by 14%–37%, often valued at \$1.9–\$32 million per event, while estuarine wetlands reduce losses by 20%–37%, providing about \$2.7 million per estuary per year in protection (Fairchild et al., 2021). Using Fairchild et al.'s (2021) per-hectare flood-protection value of \$4,772 per ha per year, and Laruelle et al.'s (2025) global area estimate (~69–77 million hectares), global estuaries provide roughly \$332–\$369 billion per year in avoided flood damages. Treated as a natural asset at a 1.5% discount rate (Li and Tsigaris, 2024), this corresponds to \$22–\$25 trillion in present value. Furthermore, Fairchild et al. (2021) predict that by 2100, coastal flooding will affect 5% of the world's population, with damages estimated to cost up to 20% of global GDP per year. Additionally, Taylor & Drunkenmiller (2022) estimate that each hectare of wetland loss increases annual flood damage by roughly \$1,800, and by more than \$8,000 in developed areas from 2001 to 2016. This highlights the importance of protecting and incorporating wetlands into flood mitigation practices.

**Table 1:** *Wetland types, flood reduction and economic benefits from key studies.*

Wetland Type	Flood Reduction (%)	Economic Value (USD)	Notes / Citations
Coastal Marshes	14–37	1.8M–32M per event	Fairchild et al. (2021); Sun & Carson (2020);
Floodplain/ Urban	54–95 across typical events; up to 84-95% in major storms (local) 20–37% (annual to 100-yr storms)	126K–450K annually (local scale)	Watson et al. (2016); Tong et al. (2025); Sauer et al. (2024)
Estuarine	35 (100-yr storm)	2.7M per estuary per year	Fairchild et al. (2021)

**Note.** Coastal marsh studies provide empirical and modeled evidence of storm-flood reduction (Fairchild et al., 2021), reductions in cyclone property damage (Sun & Carson, 2020), and storm-surge attenuation (Rezaie et al., 2020; Sheng et al., 2022). Urban and floodplain wetlands reduce peak runoff and store stormwater during extreme rainfall (Watson et al., 2016; Tong et al., 2025; Sauer et al., 2024). Estuarine wetlands buffer estuaries during rare but severe storm events (Fairchild et al., 2021).

Furthermore, global assessments show that wetlands generate some of the highest ecosystem service values of any biome, largely due to their flood regulation, coastal protection, and water management functions (Costanza et al., 2014; de Groot et al., 2012; Russi et al., 2013). Unfortunately, global wetland area declined sharply from 330 million to 188 million hectares between 1997 and 2011, representing a loss of 43% (Costanza et al., 2014). Tidal marshes and mangroves declined by 22% from 165 to 128 million hectares, while swamps and floodplains were reduced by 64%, from 165 to 160 million hectares (Constanza et al., 2014, Table 3). This loss of wetlands largely reflects conversion to agriculture, aquaculture, and urban development; these are land uses that provide short-term economic returns but eliminate the much larger long-term ecosystem service benefits wetlands generate (Constanza et al., 2014). To place a value on this loss, Constanza et al. (2014) estimated the value of wetlands in terms of ecosystem services at USD 140,174 per hectare (2007 dollars); when adjusting to 2024 dollars, this value rises to roughly USD 252,000 per hectare per year, representing an annual loss of roughly USD 35.8 trillion in ecosystem service flows, or about 32% of global GDP.

Based on the research presented, wetlands play a crucial role in reducing the impacts of climate-induced flood damage and are a vital resource to humans as we navigate the uncertainty of climate change. Urbanization and climate change put wetlands at risk; however, effective policy, protection, and land-use planning are critical to defending against flooding. Wetlands

should be recognized as a natural infrastructure that defends against flooding and must not be overlooked in future climate adaptation strategies.

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