European Commission

Climate change and coastal flooding

Around one third of the EU population lives within 50 km of the coast. Extreme sea levels in Europe could rise by as much as one metre or more by the end of this century. Without climate mitigation and coastal adaptation measures, annual damage from coastal flooding in the EU+UK could increase sharply from 1.4 €billion nowadays to almost 240 €billion by 2100. Around 95% of these impacts could be avoided through moderate mitigation combined with raising dykes where human settlements and economically important areas exist along the coastline. The extent to which adaptation can lessen the effects of coastal flooding and at what cost is sensitive to the investment strategy adopted.

© MissKlik - stock.adobe.com

Current effects of coastal flooding

Damage from coastal flooding in the EU+UK currently amounts to 1.4 €billion annually, which is equivalent to around 0.01% of current GDP. Almost half of this damage is shared by two countries: the UK (0.4 €billion annually) and France (0.2 €billion annually). Around 100,000 people are exposed to coastal flooding every year (Figure 1).

		High emissions		Moderate mitigation	
	Present	No adapt	Adapt	No adapt	Adapt
Damage (€ billion/year)	1.4	239	23	111	12
People exposed (million/year)	0.1	2.2	0.8	1.4	0.6

Figure 1. Annual damage and population exposed to coastal flooding for EU+UK in present and by 2100 under two emissions scenarios, with and without adaptation respectively. For adaptation, dykes are raised to a level of protection that maximises their economic benefit.

Impacts of coastal flooding without adaptation

Damage from coastal flooding is projected to rise sharply with global warming for all EU countries with a coastline, and the UK, if current levels of coastal protection are not raised. Annual damage grows to 239 €billion (0.52% of the EU+UK GDP projected for 2100) and 111 €billion (0.24% GDP) by 2100 under a high emissions scenario and a moderate mitigation scenario respectively.

© Patricia - stock.adobe.com

KEY MESSAGES

Severe impacts of inaction

Global warming is driving sea-level rise and intensifies coastal storms, resulting in more frequent flooding. If no action is taken, coastal flood impacts will be severe.

Significant benefits of mitigation and adaptation

Mitigation and adaptation could avoid around 95% of the damages that would be seen with no action.

95% of damages can be avoided

Investing now in coastal protection will have very large (and growing) benefits in the long term.

© Björn Wylezich - stock.adobe.com

About PESETA IV

The JRC PESETA IV project aims to better understand the biophysical and economic consequences of climate change. It does this by using projections of climate change for Europe from several climate models along with a set of climate change impact models. The project covers several sectors that are relevant to society and the natural environment, such as freshwater, agriculture, and coasts.

ec.europa.eu/jrc/en/peseta-iv

The largest absolute damages are projected for Germany, Denmark, France, Italy, the Netherlands and UK (Figure 2). For some countries, the damage represents a considerable proportion of future national GDP, e.g. 4.9% (Cyprus), 3.2% (Greece) and 2.5% (Denmark) by 2100 (high emissions). Although damage from coastal flooding is around 50% lower with mitigation compared with high emissions, it is still significantly greater than at present. This means appropriate adaptation measures are needed to lessen the effects of future climate change along the EU coastline.

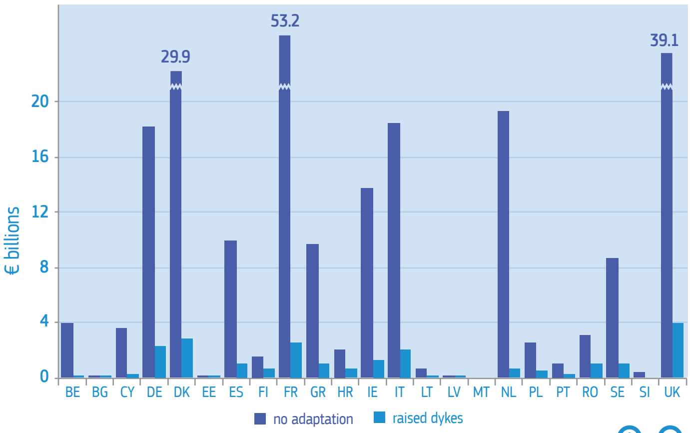

Figure 2. National annual damage without and with adaptation (high emissions by 2100).

Adaptation options to coastal flooding

There exists a range of adaptation measures to reduce future flood risk in coastal areas. These include natural (dunes) and artificial (dykes) structures, beach nourishment, forecasting and warning systems, flood proofing of infrastructures, and ultimately retreat from high-risk areas. Nature-based solutions, such as oyster beds, wetlands and salt marshes, create multiple benefits in addition to flood protection, such as increasing CO_2 storage, restoration of biodiversity, and offer recreational opportunities. They can also grow over time through the trapping of sediments. However, the projected rises in sea level extremes are so pronounced along Europe's coastlines that where human life may be at risk and high density, and where high value conurbations exist, the use of hard defence elements (dykes) will likely be unavoidable.

© fotoart-wallraf - stock.adobe.com

Reducing impacts with adaptation

If dykes are raised along EU+UK coastlines, to a level of protection for each section that maximises their economic benefit (avoided flooding) relative to their cost, then annual flood damage could be reduced significantly relative to no adaptation (Figure 2). Under the high emissions and moderate mitigation scenarios in 2100, the damage is reduced by 90% (216 €billion/year) and 89% (97 €billion/year), respectively. Likewise, fewer people would be exposed to coastal flooding. Moderate mitigation combined with adaptation could avoid around 95% of the economic impacts that would be seen with no mitigation and no adaptation action.

The average annual cost of adaptation for the EU+UK over the period 2020-2100 is 1.9 €billion/year in the high emissions scenario and 1.3 €billion/year in the mitigation scenario. The UK, Germany and France have the highest adaptation costs because of higher construction costs and amounts of coastline where additional protection is required. The average annual cost of additional coastal protection is about two orders lower than the estimated reduction in annual flood losses by the end of the century. This means that investing now in coastal protection will have very large (and growing) benefits in the long term.

The costs and benefits of raising dykes varies strongly between coastal segments in Europe. In urbanised and economically important areas the benefits of raising dykes tend to be several times the costs, which is the case for 19% and 23% of the European coastline under moderate mitigation and high emissions, respectively. However, for the rest of Europe's coasts, additional protection against coastal inundation is neither needed nor economically beneficial. This can be either because natural barriers will sufficiently safeguard against the projected rise in sea level extremes in areas with steep morphology, or because costs of raising dykes outweigh the benefits, which can happen in sparsely populated areas and along complex, winding coastlines.

Approach

Contact information: Michalis I. Vousdoukas, JRC Disaster Risk Management Unit.

Projections of sea level rise, waves, storm surges and tides under a high emissions scenario (RCP8.5) and moderate mitigation scenario (RCP4.5) respectively, were used to estimate extreme sea levels up to 2100.

These were used to generate flood inundation maps from which population exposure and damage were estimated using depth-damage functions. Future changes in population and economic activities are from the ECFIN 2015 Ageing Report.

The level of adaptation (i.e. height in cm of raising dykes) was determined for each section of coastline by identifying the raised height that maximises the sum over the project lifetime (up to 2100) of the costs and benefits associated with the investment, assuming discount rates of 5% (Cohesion Fund countries) and 3% (other Member States). The costs were calculated as the sum of national-level capital investment costs to raise dykes and maintenance costs. The benefits are the damage avoided by increasing the dyke height, calculated as the difference between future damage with and without raised dykes respectively.

For all PESETA IV publications - https://ec.europa.eu/jrc/en/peseta-iv