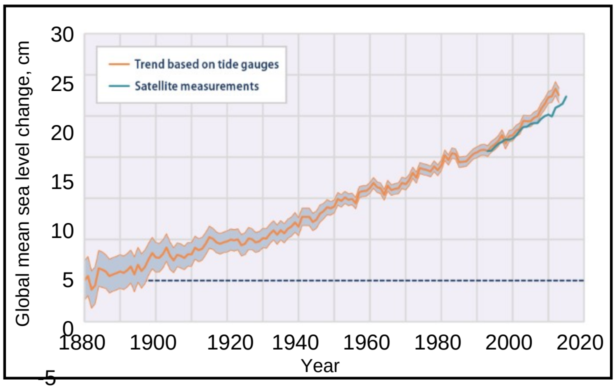
How will rising sea level affect our coastlines?
… and what can be done to adapt to rising sea levels?

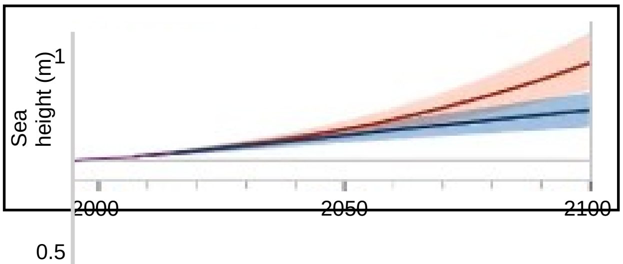
Rising sea level

Tide gauge data shows that global mean sea level has risen since 1880, but this data, coupled with modern satellite data (blue line on graph below), shows that the rise is accelerating. Sea level is currently rising at 3.6 mm y^{-1} (or the height of a normal drinks can every 34 years). This is because our planet is warming. More than half the rise is due to melting continental ice sheets and glaciers; the rest is due to the expansion of the warming ocean water.



Global mean sea level change, 1880 – 2015.
(US Environmental Protection Agency – public domain).

Scientists have made physics-based computer models of climate, ice sheets and glaciers to explore how sea level will change in the future. These models are based on humans continuing to influence the Earth's climate system by releasing greenhouse gases into the atmosphere and are called 'Representation Concentration Pathway', or RCP models. The range of projections of the computer models to 2100 can be seen in this graph:



(© International Panel on Climate Change (IPCC) Report on the Ocean and Cryosphere, 2019).

The dark pink line shows the projections of the RCP8.5 model, where greenhouse gas release continues to grow. It shows nearly one metre of sea level rise by 2100 (the pale pink shows the uncertainty in the model). The dark blue line shows the RCP2.6 model projections where greenhouse emissions are reduced to 'net-zero', giving a rise of just 40 cm (or a stack of three drinks cans) by 2100 (pale blue shows uncertainty).

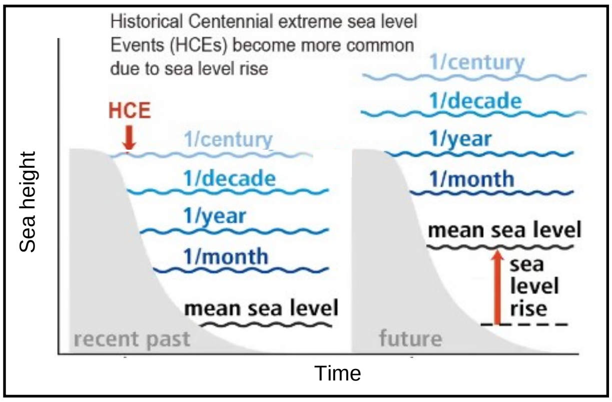
The projections beyond 2100 are:

- RCP8.5 model – a 3.5 metre rise by 2300 (range from 2.3 – 5.4 metres)
- RCP2.6 model – a 1 metre rise by 2300 (0.8 – 1.2 range)

So, global mean sea level will rise by at least one metre in the next 300 years and maybe by more than three metres.

How will sea level rise affect our coastlines?

The diagram below shows how sea level rise will affect our coasts:



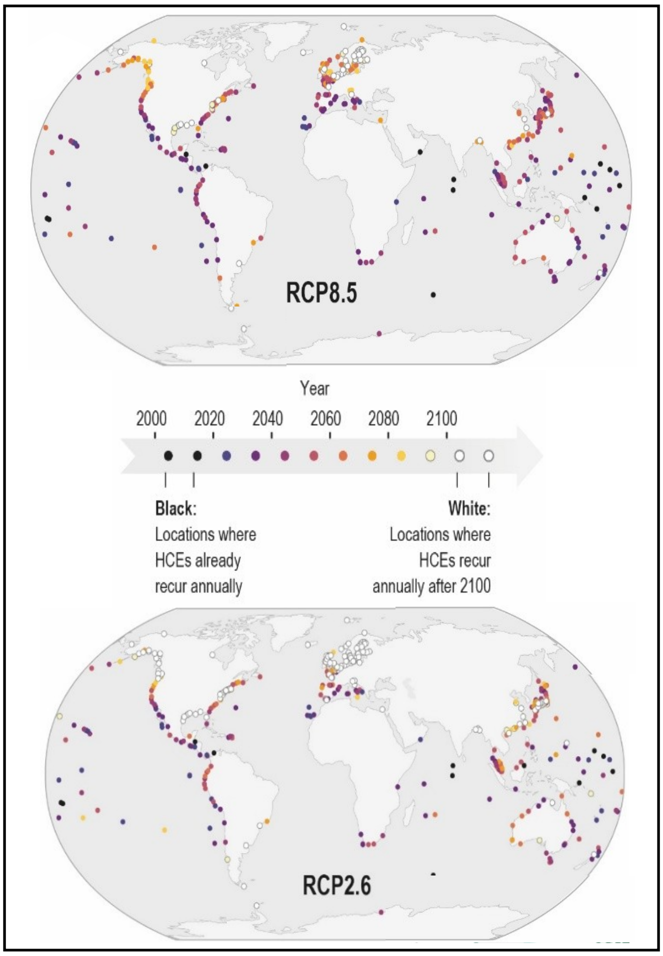
(© International Panel on Climate Change (IPCC) Report on the Ocean and Cryosphere, 2019).

The illustration on the left shows coastal sea level today. Only once in a century does a storm cause sea level to rise so high that it floods the coastline (a Historical Centennial event, HCE). The right-hand illustration shows that, with sea-level rise, flooding events that used to happen once in a century will happen every year instead.

The local effect of global sea level rise will depend on the type of coast and the geographical location. The major three global danger zones are coastal cities, large inhabited deltas and island atoll communities, although it will affect most coastal communities in some way.

If coastal cities do nothing, they are at moderate risk, but if they adapt they can keep the risk low. The situation is poor for large inhabited deltas, like the Ganges Delta, and very dangerous for island atoll communities, whatever they do. Some low-lying atolls have already been completely overcome by rising sea level, within the lifetime of even young people.

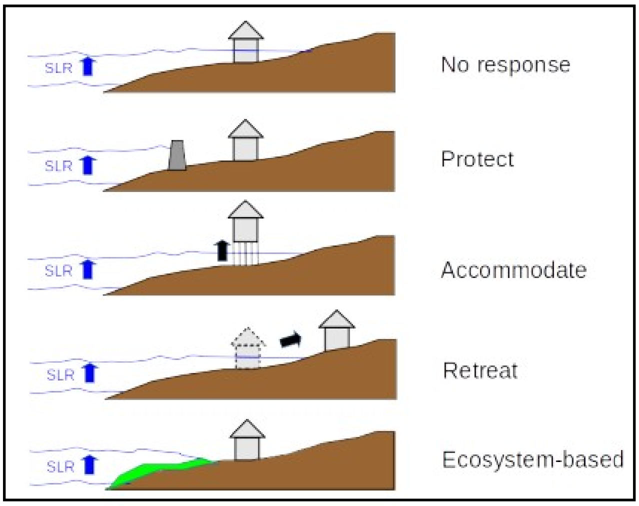
The world maps show the effect of regional sea level rise on extreme flooding events (HCEs) in coastal areas where we have a good record of observations. The two maps show where and when coastal floods that used to occur once-per-century will happen every year, according to the two models, the high carbon emissions (RCP8.5) and the low carbon emissions (RCP2.6) model – where global warming is kept below 2°C. They show that the low emissions scenario will buy us some time before the effects occur, but a response to rising sea level will be needed, no matter what emission scenario we follow.



(© International Panel on Climate Change (IPCC) Report on the Ocean and Cryosphere, 2019).

Adapting to rising sea level
Different ways of responding to sea level rise are shown opposite.

With sea level rise (SLR) and no response, coastlines become flooded. We can build expensive barriers to protect coastlines or use local methods, like building houses on stilts, to adapt. Many countries and communities where there are few funds available, are adopting the 'managed coastal retreat' method, where people are moved further inland or moved elsewhere, but this can be costly too.



(© International Panel on Climate Change (IPCC) Report on the Ocean and Cryosphere, 2019).

Experiments are being carried out on ecosystem-based responses where biological methods can protect coastlines. For example, widespread planting of mangrove trees is helping to stabilise coastal mudflats in tropical deltas, like the Mekong Delta. This will reduce the rate of erosion of the densely populated delta lands and the impact of flooding as sea level rises. It is often the poorest communities which are most at risk from sea level rise.

Your coastline
Discuss with your class how sea level rise is likely to affect your coastline and how coastal communities and the government might respond.

……

The back up

Title: How will rising sea level affect our coastlines?

Subtitle: … and what can be done to adapt to rising sea levels?

Topic: A discussion of how climate change projections might affect sea level and what the impacts of sea level rise are likely to be, particularly for coastal cities, inhabited deltas and atoll communities. Possible adaptation methods are also considered.

Age range of pupils: 14 years upward

Time needed to complete activity: 30 minutes

Pupil learning outcomes: Pupils can:
- describe the current sea level trend and computer model projections for the future;
- explain how rises in sea level will cause problems during storm events;
- explain which coastal communities are most at risk from rising sea level;
- describe different methods that can be used to adapt to sea level rise.

Context:
This Earthlearningidea explores how sea level rise in response to climate change might affect coastal communities and how these communities might adapt to this rise.

Following up the activity:
Discuss what the couple shown in the photograph below might be thinking and planning to do as they view their flooded coastal home in the distance.

Coastal flooding caused by a hurricane.
(*NOAA – public domain*).

Underlying principles:
- Tidal gauge and satellite data are showing that sea level is currently rising at an accelerating rate.
- Further data is showing that around half of this rise is from the melting of continental ice, while the remainder is the result of warming and expanding ocean water.
- Sea level rise will cause future coastal flood events to become more frequent and greater.
- Some coastal communities have much more capacity to adapt to rising sea levels than others.
- Several different methods of adaptation to sea level rise are possible.

Thinking skill development:
Using the data to picture the likely consequences of sea level rise on coastal communities is a construction activity. Considering how these might affect coastal area involves bridging and may cause cognitive conflict.

Resource list:
- none

Useful links:
Search for 'net-zero' on the Earthlearningidea website to find other Earthlearningideas relating to climate change mitigation or adaptation, as in the table on the last page.

The complex IPCC report can be found at: https://www.ipcc.ch/srocc/ and a summary with lesson plans for teachers at: https://www.oce.global/en/resources/class-activities/climate-our-hands-ocean-and-cryosphere
Details of the mangrove experiment are at: https://ecoviva.org/7-reasons-mangroves-matter/ .

Source: Chris King of the Earthlearningidea Team, based on the International Panel on Climate Change (IPCC) Report on the Ocean and Cryosphere, 2019. With grateful thanks to Valérie Masson-Delmotte of the Laboratory for Sciences of Climate and Environment in Paris and a member of the IPCC, and Andres Payo of the British Geological Survey for expert contributions and advice.

This information was as accurate as possible in spring 2021

The ‘How will the ‘net-zero’ target affect your local area?’ series of Earthlearningideas

Topic			**Earthlearningidea title**
Introduction			How will the ‘net-zero’ target affect your local area?
Possible mitigation measures	Use alternative energy sources	Solar	Harnessing the power of the Sun
		Wave	Harnessing the power of waves
		Wind	Farming the wind: through onshore and offshore windfarms
		Tidal	Tidal energy
		Nuclear	Nuclear power - harnessing the energy of the atom
		Nuclear waste	Nuclear waste disposal
		Biofuel	Liquid biofuels: keeping our wheels turning into the future
		‘Blue’ hydrogen	Blue hydrogen: the fuel of the future? *Also:* Hydrogen of many colours
		Geothermal – hot rocks	Deep geothermal power from ‘hot dry rocks’: an option in your area?
		Geothermal – flooded mines	A new use for old coal mines
		Hydro – small scale	Small-scale hydroelectric power schemes
		Heat pumps	Heat from the Earth
		Waste – incineration	Energy from burning waste
		Waste – methane	Energy from buried waste
	Stop fuels releasing greenhouse gases	Carbon capture	Capturing carbon?
	Store energy from sources that give irregular energy supplies	Batteries	Nuclear batteries: the future?
		‘Green’ hydrogen	Green hydrogen used to even out renewable energy supplies? *Also* Hydrogen of many colours
		Hydro – storage	Matching supply and demand using stored water
		Compressed gas	Storing gas underground: What can we store? How can we do it? How will it help?
	Provide raw materials for new technologies	Electric vehicles	Electric vehicles: the way to go?
		Insulation	How do I choose the best insulation?
	Remove carbon form the atmosphere	Enhanced weathering	Speeding up nature to trap carbon dioxide
		Tree planting	Let’s plant some trees
Possible adaptation measures		Coastal flooding	How will rising sea level affect our coastlines?
		Inland flooding	Inland flooding: a Sheffield case study
		Landslides	Landslide danger
		Agriculture	The future for global agriculture