Ocean acidification

Innholdsfortegnelse

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The world's oceans are becoming more acidic. Over the past 200 years, the average acidity of surface waters has increased by about 26 per cent worldwide, and Arctic waters are particularly vulnerable. Ocean acidification is causing problems for marine organisms with calcareous shells, such as the marine snails known as sea butterflies.

Planktonic species such as sea butterflies are an important part of the diet of many fish, seabirds and marine mammals. If sea butterflies or other important species are lost, whole food chains may be disrupted and ecosystems will be changed. Photo: Erling Svensen, UWPhoto ANS

STATE

Oceans becoming more acidic

Norwegian sea areas, especially in the Arctic, are more vulnerable to ocean acidification. This is because cold water can absorb more CO2 than warmer water, and because freshwater input from rivers and melting ice weakens the buffering capacity of the seawater to counteract acidification. Ongoing changes of the water cycle due to climate change, such as increased precipitation, river runoff and melting of sea ice, may make the oceans more vulnerable and less resilient to acidification.

CO2 levels in Norwegian waters rising

Monitoring of pH and dissolved CO_2 shows that the CO_2 content of seawater in Norwegian waters is increasing. This is caused by increasing CO_2 emissions due to human activity and higher levels of CO_2 in the atmosphere.

Arctic Ocean Acidification (2013) - Short (3 minute) version from AMAP on Vimeo.

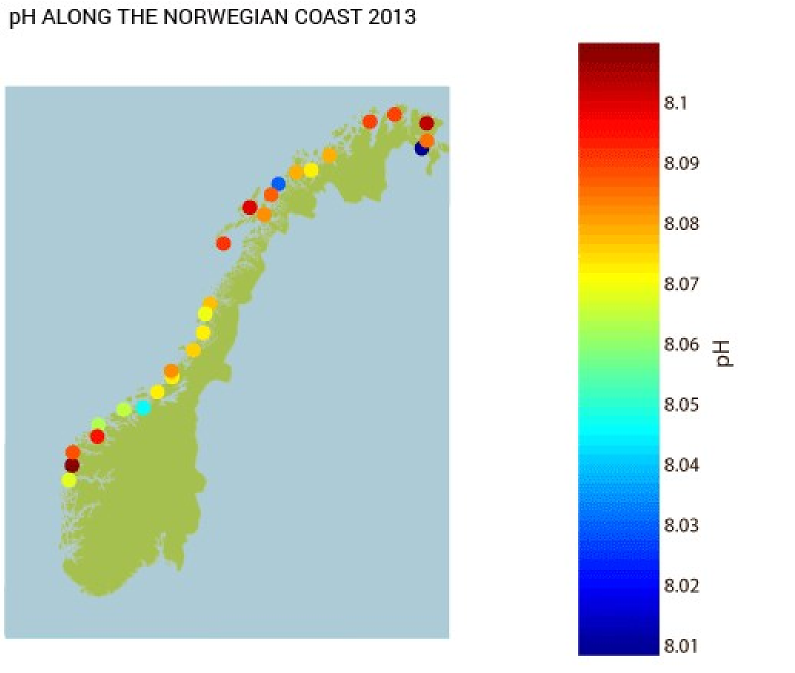
Carbonate essential for marine life

The increase in acidity in itself can lead to serious effects for marine life, but acidity also contributes to changes in seawater chemistry that may lead to equally serious impacts on marine organisms. As the CO2 concentration in seawater increases, the content of carbonate ions drops. Carbonate is an essential building block for many marine animals and algae that form calcareous shells or skeletons. Examples of such organisms are sea butterflies and cold-water corals.

So far, monitoring has shown that most Norwegian waters have sufficient carbonate. However, the deep waters of the Norwegian Sea (below 2000 metres) are undersaturated with respect to carbonate. Carbonate deficiency is natural in deep water, but the zone of carbonate undersaturation is expanding upwards through the water column, by about 10 metres a year in parts of the Norwegian Sea. In the longer term, it may reach areas where cold-water corals grow. Cold-water corals are found at depths down to 1000 metres.

Clear seasonal variations – long-term trend uncertain

Monitoring shows clear seasonal variations in pH in the upper 100 metres of the water column in Norwegian waters. This variation is natural and closely linked to biological activity. In spring and summer, algae grow and absorb CO2, and the seawater becomes less acidic. In autumn and winter, the algae die and decompose, releasing CO2 and making the seawater more acidic again.

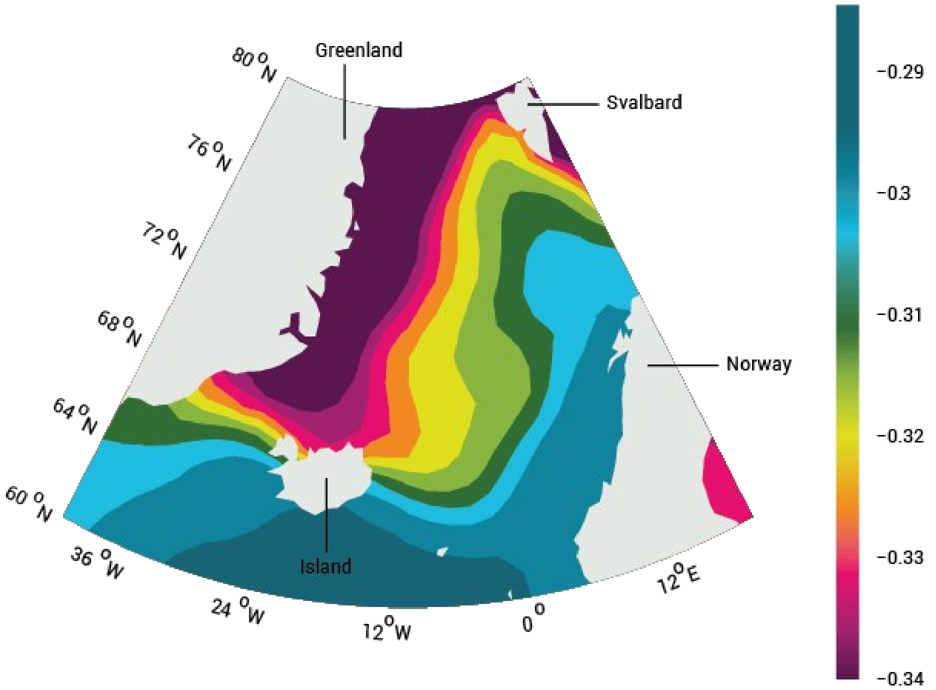


Source: NIVA, 2014 /environment.no

Data from the North Sea also show large variations in pH from year to year, almost as large as the seasonal variations. It is therefore necessary with continued monitoring over multiple years before any long-term trend in pH can be identified in the North Sea.

In the Norwegian Sea and the Barents Sea, on the other hand, scientists have been able to show a downward trend in pH by comparing recent monitoring data with the results of research cruises in the 1980s and 1990s. In parts of the Norwegian Sea, the pH of the surface water has decreased by 0.11 units over the past 30 years. This means that the surface water has become roughly 30 per cent more acidic.

CHANGE IN SURFACE OCEAN pH IN THE 21ST CENTURY



Source: Bellerby et al., 2006 / environment.no

IMPACT

Species at risk from ocean acidification

As seawater becomes more acidic, less calcium is biologically available. This can cause problems for animals that need calcium in the form of carbonate to build shells or skeletons. Many different groups of animals are at risk, including plankton, shrimps, lobsters, gastropods, bivalves, starfish, sea urchins and corals. In the worst case, many species may go extinct or be outcompeted by other species that are more resilient to acidification.

Planktonic species such as sea butterflies are an important part of the diet of many fish, seabirds and marine mammals. If sea butterflies or other important species are lost, whole food chains may be disrupted and ecosystems will be changed.

There are many cold-water coral reefs and reef complexes along the Norwegian coast. These are extremely slow-growing structures, and some are believed to be several thousand years old. Coral ecosystems provide food and habitats for other marine species. Coral reefs consist of an upper layer of live polyps and a lower layer of dead coral skeletons. The dead zone of the reef is likely to be especially sensitive to ocean acidification. If it disintegrates because the water is deficient in carbonate, the entire reef will be in danger of collapse.

Lower pH may in itself have negative impacts, but so far there is little information about the impacts on marine species.

Research has also shown that changes in pH can influence the availability of nutrients and trace elements for marine organisms. Their availability may increase or decrease as pH drops.

What about the future?

Reducing global CO2 concentrations in the atmosphere is to date the only known possible mitigation measure for ocean acidification. At present, it seems likely that the CO2 concentration will continue to rise for many years, so that ocean acidification will become an increasingly serious problem in the foreseeable future.

The impacts of ocean acidification have only just begun to be noticable. To start with, CO2 dissolves in surface waters, lowering the pH. The effects gradually spread to deeper and deeper waters. This is a very slow process, and pH levels in the world's oceans will therefore continue to sink for many years.

Modelling indicates that seawater will become several magnitudes more acidic during this century. This will influence seawater chemistry and therefore have impacts on ecosystems both in coastal waters and in the open sea. The greatest changes will occur in the Arctic.

Impacts expected to become more serious

Marine food chains in Arctic waters are relatively simple compared with those in tropical waters, and ecosystems are vulnerable if important species such as sea butterflies disappear. It is highly probable that ocean acidification will have major impacts on ecosystems in these waters, but our knowledge is still limited.

Interactions between ocean acidification, climate change and pollution may exacerbate the negative impacts. However, the picture may not be as consistently negative as first thought. Scientists expect different groups of organisms to respond in different ways. More recent research suggests that some species with calcareous shells can compensate for increased acidity by using more energy to build their shells, provided that they have adequate food supplies.

RESPONSE

Monitoring and research under way

Ocean acidification is a relatively new field of research that has been developing rapidly in recent years. It is therefore expected that a good deal of new knowledge about ocean acidification will become available in the time ahead.

Monitoring ocean acidification

In 2010, the Norwegian Environment Agency started to monitor ocean acidification in Norwegian waters. In the first instance, the aim is to find out more about natural variability in Norwegian waters and how quickly acidity levels are changing as a result of anthropogenic CO2 emissions. To obtain a clear picture of the changes that are taking place, it is not enough merely to measure changes in pH. Measurements of changes in the concentrations of other carbon compounds are also needed

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- The oceans play a key role in the carbon cycle. Gases in the atmosphere and gases dissolved in seawater or fresh water are in equilibrium. As the CO_2 content of the atmosphere rises because of anthropogenic emissions, more CO_2 is therefore absorbed by seawater.
- CO_2 reacts with water (H_2O) to form carbonic acid, and this reaction releases hydrogen ions into the seawater, lowering its pH (in other words making the seawater more acidic). This process is called ocean acidification.
- Some of the hydrogen ions react with carbonate ions in the seawater to form bicarbonate. This removes carbonate from the water, making it less accessible to living organisms.
- Carbonate is essential for organisms that build calcareous shells and skeletons, which consist of calcium carbonate. These organisms may meet serious problems as carbonate levels drop.
- It is estimated that the oceans have so far absorbed about 50 % of all the carbon dioxide released into the atmosphere by human activity. Acidification is reducing the capacity of seawater to absorb CO_2, and it is estimated that the oceans are now absorbing 25 % of CO_2 emissions.