Swedish Agency
for Marine and
Water Management

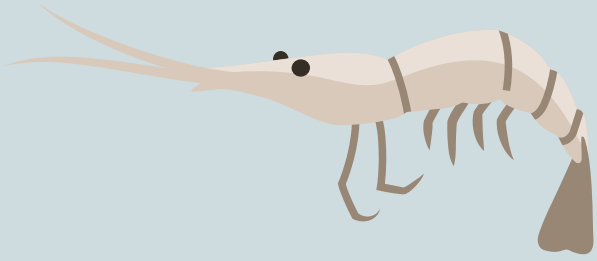
Swedish efforts to address ocean acidification, including links to climate change

SUSTAINABLE DEVELOPMENT GOALS, TARGET 14.3:
Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.

Executive summary

- Substantial emissions reductions in line with the Paris agreement will benefit the mitigation of both climate change and ocean acidification. The latter is a strong call for an upscaling of ambition in line with the Paris agreement and SDG 13.
- Specific adaptation options to ocean acidification are available but critically depend on the understanding of effects at the local scale. Other options aiming at reducing other environmental stressors can help to increase the resilience of ecosystems to ocean acidification (and vice versa). Implementation of marine protected areas and science-based ecosystem management can also contribute to an increase in ecosystem resilience. Adaptation is only feasible at the local scale and is not a long-term alternative to cutting CO2-emissions.

There are good examples of enhanced scientific collaboration at the national, regional and international levels. Yet, there is a need for a more strategic approach to address pressing data and knowledge gaps such as monitoring at the relevant spatio-temporal scale, understanding of the cumulative impacts of multiple stressors, and the modulating role of ecology and evolution. This knowledge is critical for the development and successful implementation of effective and cost-efficient tools to manage and address ocean acidification.



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Introduction and challenges

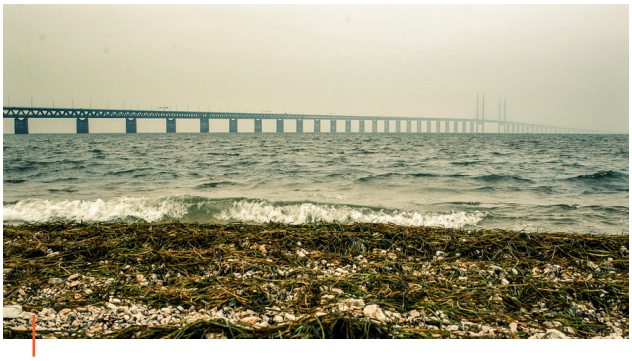
The IPCC Climate Change 2014 Synthesis Report finds that since the beginning of the industrial era, oceanic uptake of CO2 has resulted in acidification of the ocean. The average pH of ocean surface water has decreased by 0.1 units, corresponding to a 26 % increase in acidity, measured as hydrogen ion concentration. Earth System Models project a further global increase in ocean acidification for all RCP (representative concentration pathway) scenarios by the year 2100, with a slow recovery after mid-century under RCP2.6 (high mitigation). There is high confidence that ocean acidification will increase for centuries if CO2 emissions continue, and will strongly affect marine ecosystems.

Rising rates and magnitudes of warming and other changes in the climate and non-climate systems, accompanied by ocean acidification, increase the risk of severe, pervasive, and in some cases irreversible detrimental impacts. Some risks are particularly relevant for individual regions, while others are global. The overall risks of future global change impacts can be reduced by limiting the rate and magnitude of these changes, including ocean acidification. Long-term mitigation of ocean acidification can only be achieved by actions that reduce CO2-emissions. In the short-term, specific and general adaptation strategies are needed. For example, change in aquaculture practices has been shown to be an efficient way to minimize the negative effects of ocean acidification. Resilience of ecosystems to ocean acidification can be strengthened by implementation of marine protected areas, reduction of other, global, regional and local pressures or science-based ecosystem management (as described in Gattuso et al, Science Vol. 349, Issue 6243, 2015).

National efforts

Adaptation to ocean acidification is the aim of strategies developed by most other countries, but despite specific adaptation measures being potentially crucial for sustaining Swedish ecosystems, until now, Swedish efforts focus on the implementation of SDG 14.3 mostly by aiming at mitigation.

Sweden has a long record of accomplishment in environmental policies and introduced a carbon tax as early as 1991. Sweden now has the ambition of zero net-emissions of greenhouse gases by 2045. Also, the Swedish Parliament has adopted 16 environmental quality objectives (EQO), describing what state and quality of the country's environment are sustainable in the long term.



Swedish efforts to minimise and address the impacts of ocean acidifica-tion focus on the implementation of SDG 14.3 through established environmental collaboration and networks.

Emission reductions in line with the Paris agreement will benefit the mitigation of both climate change and ocean acidi-fication. Shifting from fossil fuels to renewable energy sources is key. More than half of Sweden's energy production now comes from renewable sources.

The Swedish parliamentary committee for environmental objectives has proposed new emissions targets and a new climate change strategy. The Swedish Parliament ratified the Paris agreement in November 2016 and the Swedish Government adopted a proposal for Sweden's first climate act in February 2017. The act and new climate goals will give Sweden an ambitious, long-term and stable climate policy in line with the requirements of the Paris agreement, with the aim of significantly reducing CO2 emission.

At present, the Swedish adaptation strategy to ocean acidification is non-specific and aims at a general increase in ecosystem resilience. SDG 14.3 "[...] address the impacts of ocean acidification" is implemented in Sweden in line with the overall ambi¬tion to achieve a balanced marine environment (EQO6) and Sweden's work towards the European Marine Strategy Framework Directive (MSFD) with a view to achieve Good Environmental Status (GES). Actions taken within this framework, such as eelgrass restoration, can provide multiple benefits, including mitigation of climate change ("blue carbon"), adaptation (e.g., reduced risk of coastal erosion, wave dampening) and support of biodiversity and marine resources.

Development of a more specific adaptation strategy requires local monitoring and research. Sweden supports research on ocean acidification both nationally and through international research cooperation. Several major project grants have addressed the direct and indirect effects of CO2-driven acidification on key species and ecosystems in Swedish coastal waters. These include effects of acidification on bloom-forming phytoplankton, early life-stages of invertebrates, calcifying shellfish and larger-scale mesocosm investigations in planktonic, and seagrass ecosystems. Swedish universities have pioneered research on ocean acidification and are major players in the field as highlighted by hundreds of scientific publi-cations and state-of-the-art ocean acidification research facilities.

Regional efforts

European cooperation of relevance to SDG 14.3 includes work in line with EU-legislation such as the MSFD, Water Framework Directive (WFD), Marine Spatial Planning Directive (MSPD) as well as the Sulphur Directive (SD). Sweden also contributes to achieving the EU climate targets, including energy efficiency. Regional conventions and collaborations with links to SDG 14.3 include OSPAR, HELCOM and ICES. A common denominator of these collaborations is the goal of sustainable management of the marine environment. A joint working group of ICES and OSPAR produced a comprehensive report on the monitoring of ocean acidification and its impacts. SDG 14.3 is also addressed by several of the working groups under the Arctic Council (e.g. AMAP, CAFF, PAME). The Swedish EPA (SEPA) provides expertise on climate change to working groups of the Nordic council of ministers (NMR). SEPA supports the environmental working group of the Barents Euro-Arctic Council and the implementation of an action plan on climate change. SEPA also provides expertise to the Arctic council's expert group on black carbon and methane. This group aims to develop a "Summary of Progress and Recommendations" based on the national reports and other relevant information, and to develop an ambitious, aspirational and quantitative collective goal on black carbon. The UN Convention on Long-Range Transboundary Air Pollution (CLRTAP) focuses on improving air quality on local, national and regional levels, on continents and oceans. SEPA currently chairs the convention.

The European Earth observation initiative Copernicus provides extensive amounts of open near real time and archived data from a series of Earth Observation satellites and six thematic services, supporting marine and climate change science and management.

International efforts

International efforts include Swedish work within Global Framework Conventions relevant to ocean acidification (e.g. UNFCCC, CBD, UNCLOS), regional and sectoral agreements, scientific collaborations such as IPCC, WOA, IPBES, and environmental networks such as IUCN. Swedish scientists contribute to the recently established SCOR Working Group 149 on Changing Ocean Biological Systems. In addition, there are several international initiatives such as the Global Ocean Acidification Observation Network GOA-ON, a collaborative effort to coordinate the monitoring of ocean acidification, and the International Ocean Acidification Coordination Centre (OA-ICC), which have Swedish representation. Swedish researchers are leading the capacity building program of the OA-ICC, building laboratories and organizing trainings in developing countries. The Group on Earth Observations (GEO) has initiated the Blue Planet Task, and is aligning its work on the coordination of Earth observation with the specific objective of supporting Agenda 2030 and the SDGs. Sweden also cooperates with various UN-organisations relevant to ocean acidification.

SEPA provides ongoing assistance to the government in connection to climate negotiations within the framework of UNFCCC and their recurrent COPs and working groups. SEPA is also coordinating a long-term global program on environmental and climate cooperation with countries of strategic importance.

Seagrass restoration can provide multiple benefits. Seagrasses support biodiversity and marine resources and contribute to the mitigation of climate change and ocean acidification through carbon sequestration.

GOOD EXAMPLES

Enhanced scientific cooperation at all levels: Sweden has an active and collaborative research community in the field of ocean acidification. Many projects have contributed, and are presently contributing, to improved understanding of the chemical and biological impacts of ocean acidification. Current projects are also identifying possible policy and management responses. Unique knowledge gained from Swedish regional studies of the Arctic and the low-salinity Baltic Sea is making valuable contributions to the wider international context.

Minimise ocean acidification: Sweden has an international reputation as a climate leader and has presented an ambitious climate strategy. Mitigation of ocean acidification and climate change partly share the same solution. Thus, there are opportunities for cross-fertilisation of SDG 14.3 with the Paris agreement and SDG 13. The latter should be used as a lever for an upscaling of Intended Nationally Determined Contributions (INDCs) and should also be highlighted in the conference's "Call for Action" document.

Address the impacts of ocean acidification: Ocean acidification and climate change are cross-cutting to other environmental questions, and solutions will require broad, effective and efficient collaborations. Sweden benefits from well-established legal frameworks, institutions and processes (national environmental objectives, EU directives, regional conventions, regular assessment cycles, management frameworks, international processes). This provides multiple opportunities:

- To help poor countries achieve energy independence and break reliance on fossil fuels through increased use of renewable energy sources. The potential to enhance climate action at local levels is demonstrated by recent Swedish initiatives (e.g. "The Climate Step", Klimatklivet);
- To help poor countries, specifically Small Island Developing States (SIDS) and least developed countries (LDCs), with adaptation and establishment of climate-proof (and climate-smart) infrastructure. The latter is an absolute necessity if the target SDG 14.7 is to be reached in the context of acidifying and warming oceans, rising sea levels and other climate related risks;
- To encourage integrated ecosystem-based management of marine, brackish, and freshwater systems,promote best practices and take collaborative action to improve the management of land, water, coastal and marine linkages. Such linkages are integral to understanding the impacts of ocean acidification in the low-salinity Baltic Sea system.
- To advocate for reductions of other stressors that have negative impacts on the ecosystem, with a view to increase the resilience of ecosystems and their ability to tolerate ocean acidification and climate change. The latter includes actions on dangerous substances and litter that negatively impact the marine environment, e.g. upstream actions that reduce terrestrial sources (links to S2S), and reducing fishing effort, eutrophication and coastal pollution;
- To highlight the importance of biodiversity and to advocate for increased MPAs. Lessons learned from regional collaborations, e.g. in the Arctic, should be valuable in a wider international context, in particular with a view to adaptive management and connective networks that can ameliorate the unavoidable impacts of climate change and ocean acidification.

Challenges and Gaps

- Implementation of SDG 14 requires translation of the SDG targets and indicators to national policies and targets. As a corollary, there is a need for a more explicit and strategic approach to address ocean acidification in the Swedish national EQO framework. Links of SDG 14.3 to other targets of SDG 14 (and other SDGs, notably SDG 13), need strengthening. Implementation of SDG 14.3 requires increased awareness of ocean acidification, its impacts and associated environmental management options.
- The timeline for the implementation of mitigation strategies at the global level is not sufficiently short to prevent the effect of ocean acidification on Swedish waters and associated industries. Fully addressing and minimizing ocean acidification in Sweden would require the development of a strategic research agenda deviating from a pure mitigation approach. Developing and implementing subsequent solutions requires a projection of effects in Swedish waters. This can only be achieved through:
- At present there is no sustained monitoring of ocean acidification parameters along Swedish coasts at high temporal resolution (weather; allowing to capture the present natural variability) and following best practices (SDG 14.3.1 methodology as developed by the SDG 14.3 custodian agency, the International Oceanographic Commission, IOC). To fully evaluate the exposure, this should be done on top of other key environmental local and global drivers.
- Understanding of the effects of ocean acidification on Swedish marine ecosystems and ecosystem processes (as distinct from marine species) is poor, yet needed for development of effective adaptation options. To bridge the observed physico-chemical changes to biological response, there is a need to understand:
- The cumulative effects of additional drivers (e.g. fishing, eutrophication, hazardous substances, climate change) and, specifically, if and how these drivers interact.
- Direct and indirect effects of ocean acidification through ecological interactions.
- The key role of local adaptation to present natural variability and the capacities of key species to acclimate and genetically adapt to ocean acidification over the medium to long-term.
- Evaluate, develop and implement strategies to address impacts on Swedish marine ecosystems and industries. Only a combination of monitoring with an ability to project impacts on marine species, ecosystems and industries would allow to successfully implement solutions and successfully manage Swedish ecosystems. These solutions include:
- Development of locally-relevant priority list of drivers based on both exposure and effects on key biological features.
- Identification on sensitive areas, species, ecosystems and industries would allow to prioritize ecosystem management (e.g. regulation of fisheries, marine protected areas).
- nnovations to increase ecosystems and industries resilience. For example, selection of resilient strains of key seafood species for aquaculture.
- The economic consequences of ocean acidification are poorly quantified. Research is urgently needed to identify:
- Key ecosystem services that will be negatively impacted by ocean acidification, and estimate their monetary value;Future costs and economic consequences of ocean acidification for Swedish coastal communities, and the Swedish national economy.
- Understanding of societal responses to the consequences of ocean acidification (as distinct from climate change) is lacking. To develop relevant policy tools there is a need to identify:
- The value of informative instruments in changing societal norms, and hence increasing public participation and engagement in addressing ocean acidification;
- Effective market-based policy-tools that aid mitigation and adaptation.

Compilations made by SwAM for SDG 14, Life below water

This document represents one out of nine compilations made by the Swedish Agency for Marine and Water Management (SwAM) to highlight Sweden's key efforts and initiatives for Sustainable Development Goal 14 of the 2030 Agenda for Sustainable Development. This report has been developed as a part of Sweden's work in support of The Ocean Conference in Lisbon 2020. It is based on the report developed for The Oceans Conference in New York 2017 and has been updated by the Swedish Institute for the Marine environment together with researchers and experts from universities, organisations and agencies including the Swedish Agency for Marine and Water Management.

The documentation focuses on a situation assessment and does not constitute a complete picture of Sweden's initiatives being carried out in order to achieve the goal and targets. A starting point for the content is operational areas within national authorities, but the content has also been expanded to include other significant aspects based upon existing contacts and knowledge.

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