



Directly assessing the environmental, social and economic impact of Arctic sea-ice loss

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A €12 million multidisciplinary programme of research that harnesses
the expertise from 23 institutes across 11 European countries

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Rapid Arctic Change

The Arctic is undergoing rapid environmental change. Reduction in sea-ice cover has potential consequences not only to global climate, but also to the local and the global economy. Reduction in the amount of summer sea ice has extended the navigation season of key shipping lanes such as the Northern Sea Route. It has also made large reserves of oil, gas, and other minerals more accessible. Changes are resulting in increasing commercial activity and investment in the region, causing major consequences with important implications for Arctic inhabitants. Understanding what is driving such unprecedented change in this sensitive environment, and the possible future environmental, socio-economic, and geopolitical consequences, is a scientific challenge with major implications. Developing policies to balance the needs of human development in the Arctic with environmental protection is a challenge for the region and wider world.



A Complex Environment

The Arctic environment is complex, which causes uncertainty in the prediction of future change in the region. ICE-ARC aims to improve the understanding of present and future climate change by making direct observations on key aspects of the Arctic marine environment, including the sea ice, ocean, atmosphere, and ecosystem. The expertise required to cover this enormous spectrum of science can only be fulfilled by bringing together leading experts from around the world. Together the ICE-ARC team aims to:

- Improve understanding of climate change impacts on marine ecosystems;
- Assess socio-economic vulnerabilities and changes to living resources, both to Indigenous Peoples and others in the Arctic, and to the planet as a whole;
- Provide the information needed for effective strategies and management options for societal responses to climate change.

What does Arctic change lead to?

It is clear that global climate change is having an increasing effect on the Arctic, but Arctic change also has positive and negative impact on us all? Preliminary research has linked the reduction of Arctic sea-ice with changes in North American and European weather patterns. The expectation is that extreme weather events, i.e. floods, droughts, and storms, will become more common. This, for example, has a knock-on effect to the world food supply. Potential methane release from permafrost could have significant impacts on global warming.

Arctic change may influence global commerce through the opening of shorter sea routes between Asia and Europe. It may allow us to exploit new reserves of hydrocarbons, open up new regions for fisheries, providing food security, and creating exciting tourist opportunities. Multi-disciplinary projects like ICE-ARC help reduce uncertainty and allow informed policy options to be developed.



Improving Observations

Advancing technology for detecting Arctic Change

Continuous monitoring of a dynamic and changing Arctic environment is a formidable challenge that can now be achieved by cutting-edge polar technology designed to capture and communicate direct measurements taken in the field. Observational and modelling communities within the ICE-ARC programme agree that comprehensive measurements of key areas of Arctic change, including the ocean, sea ice, atmosphere and the ecosystem will help to reduce uncertainties.

ICE-ARC will deploy, in collaboration with other projects, numerous autonomous polar platforms across the Arctic; this will contribute to the extensive international Arctic observing network. The information captured by these platforms is sent directly to the laboratory where researchers develop a better understanding of the current status of the Arctic marine environment, as well as highlighting changes that occur throughout the lifetime of the project. The end result is an improved vision of the interlinked nature of the processes that amplify Arctic marine change.



Improving Modelling

Better Understanding Arctic climate and ecosystems

Quantifying and reducing uncertainties in climate model projections is a focus for the programme. Uncertainties in current climate models can only be reduced by increasing the understanding of how the Arctic ocean, sea ice, atmosphere, and the ecosystem interact with each other. This is why datasets captured by the team's direct observations of the Arctic marine environment are so crucial—they are used to determine how accurately computer models of sea ice, the atmosphere, and ocean are behaving. Our overarching aim is to deliver superior climate model on Arctic marine change. These datasets will also feed into socio-economic modelling in the project for selected climate simulations, which will ultimately enable the team to directly assess the economic impact of Arctic climate change.



Identifying Social Vulnerabilities

Communities, Ice, and Living Resources in North-West Greenland

Throughout Greenland, many people maintain a strong connection to the Arctic environment through customary activities of hunting and fishing. This includes those living in small, often remote, coastal communities, as well as those living in larger towns. These activities provide the basis for identity, livelihood, and food security.

This area of the programme aims to understand the consequences of current and projected changes in sea ice, environment, and socio-economic conditions on people's livelihoods. It will focus on resources on communities in the Uummannaq, Upernavik, and Qaanaaq areas of northwest Greenland. At the same time the team will aim to improve the understanding of how changes in the past affected those communities and their adaptive capacities, and survival strategies.

Scientific and policy-focused knowledge will be used by the team within ICE-ARC for understanding and responding to climate change challenges in order to safeguard Arctic marine living resources for human communities.



Costing climate change

Global economic impacts of Arctic change

Arctic change has the potential to trigger significant changes in global and regional economies because of the region's critical role in the global climate system. To date, most discussions about the economic implications of a warming Arctic focus on benefits to the region, with increased oil-and-gas drilling and the opening up of new shipping routes. However, there is little known about potential global economic impacts related to Arctic change.

Putting an accurate cost on climate change is not as easy task as we need to bring together current information from both the economic and climate community. In 2007 the UK Stern Review of the Economics of Climate Change did this very successfully through the use of an Integrated Assessment Model known as PAGE. We build on this approach by updating and adapting this model to include the latest information on Arctic change. The new model, known as PAGE-ICE, will estimate the annual economic gains and losses, in the EU and globally, associated with the projected changes in the Arctic over the next two centuries.

The development of the PAGE-ICE model will aim to address:

- How the transformative changes in the Arctic marine environment affects the global economy
- The potential economic impacts for the EU and other regional economies
- The potential economic impacts for specific industry sectors such as insurance and agriculture
- How key socio-economic impacts translate into policy and risk management scenarios

The mitigation of climate change must be a partnership between society, government, and industry; a key step in understanding how the Arctic influences the net cost of climate change is the development of PAGE-ICE.



ICE-ARC: Ice, Climate, and Economics - Arctic Research on Change

An international team of leading experts will, for the first time, directly assess the socio-economic impact of observed and projected climate change in the Arctic. ICE-ARC is a €12 million programme of research funded by the EU to improve understanding of the impact of climate change on the Arctic marine system. A multidisciplinary team will combine new observations of the Arctic atmosphere, ocean, ice, and ecological systems with climate models, which will improve climate predictions for the Arctic Ocean. In addition, a physical climate model will be combined with a leading economic Integrated Assessment Model. Through this new approach, the ICE-ARC team will estimate the monetary value of the projected physical changes upon the global economy and society.



ICE-ARC aims to provide robust scientific information to international politicians and policy makers during a period of heightened commercial investment in the region that is predicted for the next 10 years. This investment, driven by oil and gas, mining, shipping, and tourism industries, could reach \$100bn or more.

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ICE-ARC brings together 23 institutes across 11 countries:



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