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under discussion

The Arctic. Between Conflict and Cooperation

Threats of Irreversible Losses

Climate Change in the Arctic and the Consequences of Russia's War in Ukraine for International Research Cooperation

An Interview with Professor Antje Boetius

Professor Boetius is a marine researcher and Director of the Alfred Wegener Institute, the leading German institution in the field of polar and marine research. In an interview with International Reports, she explains why climate change threatens to cause irreversible losses in the Arctic, why the Russian attack on Ukraine has also severely impacted research in the polar region, and what she is still keen to find out about the Arctic.

International Reports (IR): *Professor Boetius, how many times have you been to the Arctic?*

Antje Boetius: Only counting the expeditions to sea that I've undertaken as a marine and deep-sea researcher, I've been there nine times so far. Each expedition lasted up to three months, often in ice-covered waters around the North Pole, and involved exploring the Arctic deep sea, in particular the seabed. In addition to these expeditions, I also regularly attend research conferences in the Arctic region, for example in Tromsø and Reykjavík. I've also been to Murmansk and Kirkenes. And then there was an unforgettable land expedition to Greenland last year.

IR: *Let's stay with the expeditions for now: how time-consuming is the preparation?*

Boetius: The Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, organises expeditions by sea, land and air. I myself am mainly involved in the seafaring expeditions. Undertakings of this kind often have a lead time of several years. Our research icebreaker Polarstern plays a crucial role here: there are very few icebreakers of this kind in the world that can be used to penetrate the ice and then explore the sea and the seabed below it. This is one of the reasons why we start coordinating internationally long before the start of an expedition, to establish which researchers from other countries will be participating, what expertise they can contribute and which research questions the expedition should be designed to answer.

IR: *Can you give us some examples of the questions that are investigated?*

Boetius: Nowadays, the focus is often on the impact of climate change on the Arctic. For example: how is it causing changes in weather phenomena, ocean currents, eddies and wave movements? How is it affecting fish and other life in the region, going right down to the deep ocean? A second important area is seabed research on the origin of the Arctic basins and the history of ice coverage. The seabed in the Arctic is quite poorly mapped. There can be inaccuracies of 100 metres with regards to depth, and underwater mountains are sometimes recorded kilometres away from their actual location. This is because the Arctic

seabed has so far only been roughly surveyed by military submarines that lacked the ideal instruments for this purpose – and because there are too few research icebreakers in the Arctic.

***IR:** When was the first time you went there?*

Boetius: That was in 1993. So I actually got to experience the "old Arctic" as it was back then. There were already some initial warning signs at the time, but most people didn't think that climate change could alter a region as quickly as it actually did in the Arctic. I'm lucky to have had the chance to visit the Arctic in its former state as a doctoral student, and even now I'm still able to draw on that for my research. Samples I took and records I made in 1993 now serve as reference points that allow me to document developments and show how changes in the climate directly affect life in the Arctic.

***IR:** What is the first thing that strikes someone who went to the Arctic in 1993 and returns to the same place today?*

Boetius: You really can observe climate change and its consequences with the naked eye. The most striking phenomenon is the sea ice. When I was in the North Pole region for the first time some 30 years ago, the sea ice there was about three to four metres thick on average. Today, we see a thickness of something like one and a half metres around the North Pole in summer – and sometimes the sea is completely free of ice. But you can observe climate change on land too, in the thawing of permafrost soils. I can give you a specific example: the Alfred Wegener Institute's research station on the Svalbard archipelago is built half on stone, half on previously frozen ground. There's now a crack in the building because the part that was built on what was supposed to be permanently frozen soil is sinking into the mud. This dwindling reliability of the ground surface is something a lot of people are experiencing in the Arctic today.

And then there's the social change too: the Arctic is an area of migration that is attracting more and more people from all over the world. Many of the towns in the Arctic – whether in Norway, the United States or Canada – are now very international and diverse. That's another change I've observed over time, apart from the scientific aspects.

***IR:** Let's take a closer look at the issue of climate change. We often hear that it's more obvious in the Arctic than elsewhere. Is this really the case, and if so, how exactly is this manifested?*

Boetius: Yes, it really is true. There are weather stations on land and at sea that all indicate that the warming of the Arctic region has progressed three to four times faster than the global average over the last 40 years. You can see it in the receding of the ice cover too. What is left at the end of summer decreases by about 13 per cent each decade. This is alarming, of course, because it throws the entire system off balance – and hence the life within that system.

IR: *The Paris Agreement set the target of limiting global warming to well below two degrees, and if possible, to 1.5 degrees. The latter now seems a distant prospect. What difference will it make in the Arctic if the temperature increase is limited to 1.5 degrees as compared to two degrees?*

Boetius: In a few years' time, we will have reached the amount of CO_2 in the atmosphere that would cause an average warming of 1.5 degrees – because we are unlikely to achieve climate neutrality quickly enough, that is, well before 2050. Nonetheless, a lot is happening in terms of energy transition. Already today, global warming is accompanied by so many extremes and so many shocks to life on earth that we can expect enormous upheavals in society. When, where and how this will happen is difficult to predict, but social change is driven by the displacement of people, the health risks and the economic losses that we're already starting to see – as well as by the enormous opportunities provided by increasingly affordable renewable energies. What is more, global warming of 1.5 degrees means about six degrees of regional warming in the Arctic, which will cause the sea and land ice and the permafrost to melt increasingly fast. This in turn will exacerbate climate change, extreme weather and the rise in sea level. One of the differences is that the Arctic will be ice-free every few decades if the global temperature increase is limited to 1.5 degrees, whereas this will occur every few years if the temperature rises by two degrees – with fundamental consequences for all life forms.

Dedicated researcher: Antje Boetius has been Director of the Alfred Wegener Institute since 2017.
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IR: *Why should this worry those of us who live well south of the Arctic Circle?*

Boetius: There are several reasons. First and foremost is the global rise in sea level – the loss of ice mass in Greenland, for example, crucially affects habitats on the Pacific islands and in coastal areas worldwide. And since the Arctic is warming faster than other regions of the world and losing ice, there is a change in the temperature gradient – the difference in temperature – between the northern polar region and the lower latitudes. Researchers assume that this has an impact on the polar vortex and the jet stream, in other words the strong wind bands that shape our local weather at high altitudes. As a result, certain weather patterns can settle over Central Europe for longer, for example, instead of passing by relatively quickly. This could result in, for example, prolonged heat and drought in summer – or deadly polar cold and massive snowfall in America and Japan, as happened last Christmas.

In addition, the thawing of the ground creates problems for infrastructure such as pipelines and transport routes. I already mentioned the example of our research station on Svalbard earlier. The same thing is happening with other infrastructure: there have already been oil spills in Russia as a result of tanks and pipelines breaking. Moreover, we're seeing shifts in fish populations and in the distribution of other wildlife, with consequences for biodiversity and ecosystems.

We also want to ensure that polar bears and the Arctic walrus survive. Another thing that worries me greatly is that there's a threat of irreversible loss if the sea ice continues to recede in the Arctic. And we're now seeing a negative trend in Antarctica for the first time too. Once species become extinct and more and more Greenland ice has melted, thereby raising sea levels, we can't reverse these processes.

IR: *On the subject of melting ice: there has been some debate about the extent to which there are certain critical tipping points that would lead to a runaway effect in terms of the disappearance of ice cover. Can you assess if we are actually on the verge of such a tipping point or even if we may have already passed it?*

Boetius: Physical tipping points are known from Earth's history. At such points, elements are changed into a different state by disturbances – for example the loss of sea ice at a certain level of global warming or the melting of the Greenland ice. Researchers have recently determined that we're getting dangerously close to some of the physical tipping points, especially in the Arctic region. The assumption is that biological tipping points – extreme species extinction – and social tipping points will be reached even faster.

IR: *Another frequently mentioned consequence of the melting ice is that raw materials that were previously virtually inaccessible might now become available for utilisation. What are we talking about here specifically?*

Boetius: The main focus is on natural gas, but there is also oil. Until now, sea ice restricted the exploration and extraction of these natural resources, simply because ice is an obstacle and a hazard for shipping and for infrastructure such as drilling platforms. When fragmented ice drifts on the water, pushed along by the wind, a passage that is free of ice one moment can very quickly become blocked. Ships travelling in the region to transport raw materials, for example, can get stuck. Ice can also build up so much pressure that it causes damage, in a worst-case scenario resulting in the threat of oil or gas leakage. That would be particularly devastating in the Arctic. Firstly, it would be extremely difficult to repair leaks or recapture spilled oil there, and secondly, the marine bacteria that could normally break down the toxic hydrocarbons over time work much more slowly in the cold waters of the polar region.

It is worth noting, however, that while estimates of the extent of raw material deposits in the Arctic were once extremely high, they have now been revised downwards again. In addition, local people are beginning to resist oil and gas extraction in many places in the Arctic, since this often conflicts with other resources that are important to the local population – namely endemic biodiversity, health and tourism. The importance of the latter has increased greatly in the Arctic region, and the last thing tourists want to see are oil platforms or oil-streaked ice.

In addition to gas and oil, there are also thought to be deposits of metals and rare earths – you might remember the episode of former US President Donald Trump coming up with the idea of buying Greenland for this reason. But here, too, I'd be rather cautious making predictions about the exploitation of these deposits. Any potential consequences would first have to be clarified with the population and First Nation representatives.

IR: *When the Cold War ended, people hoped that the Arctic would become a place of peaceful cooperation, especially in the field of research. Can you give a specific example or tell us about a particular situation in which you as a polar researcher were dependent on international cooperation?*

Boetius: Generally speaking, we obviously foster a culture of international cooperation in science and academia that works regardless of where our partners come from. If you ask me to give you a specific example of a situation in which we wouldn't have managed without this kind of cooperation, our large-scale MOSAiC expedition of 2019/2020 immediately springs to mind: here, researchers from 20 countries explored the Arctic over the course of a year on our Polarstern icebreaker, which was frozen on a drifting ice floe. In the middle of the project, the COVID-19 pandemic struck, meaning that many of the supply ships were no longer available. As it turned out, we were able to fall back on the Russian research icebreaker infrastructure to transport our people from one place to another. Otherwise we would have had to abandon the expedition. Our Russian partner institutes have indeed played an important and helpful role in enabling researchers

Endangered: As global warming progresses, the Arctic is threatened not only with reaching physical tipping points, but also with an irreversible loss of animal species. Photo: Mario Hoppmann, AWI CC BY 4.0.

to access the Arctic region and in terms of research itself. That's all over now – and it's already clear that there is no quick remedy in sight.

And since you just mentioned the end of the Cold War: the tradition of the Arctic as a region of cooperation actually goes back much further. For example, the Svalbard Treaty of 1920 is one of the oldest international cooperation treaties in existence and remains valid to this day. At the time, Norway was given sovereignty over the archipelago to ensure occupational safety – in connection with coal mining during that era – and environmental protection on behalf of all parties. For its part, the country has since been responsible for the peaceful development of the region and guarantees citizens of all signatory nations the opportunity to pursue economic and scientific activities there. The Arctic Council has also played a major role in securing the development of the Arctic region. If we look back at the recent past, it is clear that even despite the Russian war of aggression against Ukraine, at least the last remnants of the rules of collaboration are still in place: as far as I know, Russia continues to adhere to the Polar Code of the International Maritime Organization, which regulates the safety of ships operating in the polar region. Coordination with Norway on the conservation of fisheries resources is still ongoing too.

IR: *And yet the Russian attack on Ukraine in February 2022 also marked a turning point for research cooperation in the Arctic, didn't it?*

Boetius: Yes, of course. Spring 2022 was a watershed moment. In the wake of the sanctions imposed on Russia, collaborative research with Russian universities and other research institutions was immediately discontinued too. The German science organisations and the Federal Ministry of Education and Research took very determined action, and the European Framework Programme soon followed suit. The suspension of cooperation with Russian research institutions and Russia's withdrawal from the Bologna Process in this area are obviously having negative impacts on research, in the long term primarily for Russia itself and the next generation of Russian academics. As far as climate change is concerned, the Siberian region is crucial to understanding the evolution of Arctic sea ice and nature as a whole, as well as methane emissions from melting permafrost. In this respect, the end of cooperation is not just damaging to the region in question, it is also detrimental to our global understanding of the development of emissions. After all, we had a joint observation infrastructure for this purpose; now we can no longer invite each other to take part in future expeditions. This will hinder us in expanding our knowledge of the Arctic as a whole. It's a loss that has to be talked about – even though politically speaking there's obviously no alternative right now.

IR: *Not even within the context of international science?*

Boetius: Even as a scientist, I can't entirely ignore political attitudes and the overall situation. When the president of a Russian university that we used to work with writes a fiery letter welcoming the fact that Ukraine is now finally being "freed", it's simply no longer possible to work together to teach students. If we don't have a common understanding of values and reality and if our communication is no longer based on facts, then scientific cooperation simply doesn't work anymore.

Things are somewhat different at the personal level: individual scientists who are already conducting joint research on certain non-military issues or who want to apply for a fellowship, for example, should not be excluded purely based on their nationality. Germany's Federal Foreign Office and the Federal Ministry of Education and Research have agreed on this with the science organisations, also involving bodies at the European and international level. Nonetheless, cooperation has in fact been put on hold at an institutional level. Our laboratories in Russia are closed, and the contracts have been suspended. There is no dialogue at management level with people in the science system there.

IR: *Can you talk about the war at a personal level?*

Boetius: No, it's virtually impossible to exchange views on the subject – not least for the simple reason that, as we all know, in Russia even referring to the war as a war is enough to incur a severe prison sentence. Talking openly would simply entail enormous uncertainty and a huge risk, even if the people we talk to were willing to do so. Not being able to speak openly is something that hurts when you've known people for so long; in my view, it weakens mutual trust

too. Indirectly, the war is always present of course – even if you're writing a paper with someone from Russia about something as specific as the distribution of Arctic mussels, for example. Working creatively together, while at the same time reading about the most brutal atrocities in our newspapers here, with the Russian press talking about liberation – that really doesn't work well. Some people are able to cope with this balancing act, but most people I speak to find it extremely uncomfortable and have given up.

***IR:** Is it fair to say that research cooperation in the Arctic has reached an all-time low?*

Boetius: That's definitely the case, unfortunately. There are still some last remnants of cooperation and coordination. We are all trying to maintain these, but it's extremely difficult. And Russian science itself is certainly suffering the most.

***IR:** As we come to the end of the interview, let's focus on the future again: is there any particular question that you as a scientist are still keen to pursue?*

Boetius: One question I am very concerned with is why life in the deep sea responds so directly and quickly to changes at the sea surface, such as climate change. Here we're talking about organisms that actually live in permanent darkness and cold about four kilometres below the surface of the water. Yet it's possible to detect changes in the composition of communities that are caused by things actually happening so far away on the surface. Why is that? This is a question that is absolutely crucial in terms of the development of biodiversity and the role of human beings.

My second major project in the Arctic revolves around understanding the evolution of the Arctic Basin. There's a gigantic ridge system running through the middle of the Arctic Ocean, known as the Gakkel Ridge. I myself conducted the first ever research on the biotic communities on the seamounts of volcanic origin there: we mapped these mountains and found exotic life forms on the seabed. There are hydrogen-powered ecosystems that seem almost extra-terrestrial – ancient sponge gardens. So this is all about discovering and exploring life forms and landscapes that are not known anywhere else on Earth.

***IR:** And when will you go on your next expedition to the north?*

Boetius: A two-month expedition is due to set off in August that will again take me to many places I visited previously in 1993 and in 2012. Naturally I'm curious to see what I'll find there, 30 years after my first visit in connection with my doctoral thesis. It'll be my first major expedition in five years. What is more, the research icebreaker I mentioned earlier, the Polarstern, is now coming to the end of its life. It's more than 40 years old and will be replaced in a few years' time. Politically, it was a very important decision by the Federal Government that the ship should have a successor. This is a huge investment by Germany in the international polar research

infrastructure – and in the knowledge it enables us to generate. And of course it's also a geostrategically important investment to build a new icebreaker of this kind. It was by no means easy arriving at the decision, but when I speak to colleagues from Canada, the United States, Norway and Denmark, it's certainly regarded as a vital commitment to peaceful cooperation.

The interview was conducted by Sören Soika and Fabian Wagener – translated from German.

Dr. Antje Boetius is Professor of Geomicrobiology at the University of Bremen and Director of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, in Bremerhaven. Throughout 2023, she will be providing guidance and support for the work of the Konrad-Adenauer-Stiftung as a Fellow.