ACCESS
Arctic Climate Change
Economy and Society

SEVENTH FRAMEWORK
PROGRAMME

Project no. 265863

ACCESS

Arctic Climate Change, Economy and Society

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CO	Confidential, only for members of the consortium (including the Commission Services)	

ACCESS NEWSLETTER

Arctic Climate Change
Economy and Society

Issue No. 7
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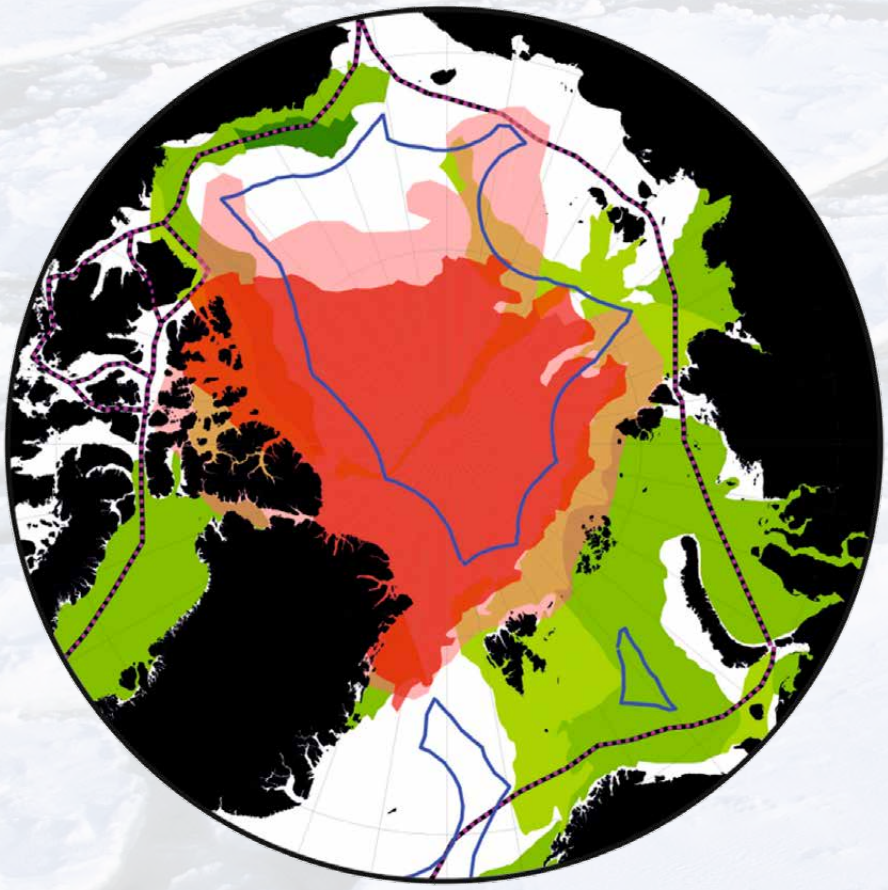
ACCESS Highlights



The development of the Marine Spatial Planning tool within ACCESS is highlighting areas of potential future conflict between users and the environment. Decreasing summer sea-ice (pink shows the sea-ice extent in September 2010, while red shows the sea-ice extent in September 2012) is opening up new areas for hydrocarbon exploration. Geological provinces in the Arctic with estimated significant undiscovered oil (USGS - http://energy.usgs.gov/RegionalStudies/Arctic.aspx), are shown in green (light green shows low potential, to dark green as highest potential).
Outer continental shelf claims beyond 200 M (blue line) under UNCLOS Article 76 will also provide access to new exploration areas, for example claims by Norway and Russia in the "Barents Sea Loop Hole". Increased shipping along the Northern Sea Route and through the North West Passage (pink and black dashed lines) may lead to conflicts over maritime space, and cause additional stress to marine ecosystems, e.g. acoustic disturbance.

This newsletter is produced three times each year by a consortium of 27 partner organizations from 10 European countries in the 4-year Arctic Climate Change, Economy and Society (ACCESS) project. ACCESS is supported within the Ocean of Tomorrow call of the Seventh Framework Programme. Objectives of the ACCESS Newsletter are to facilitate international, interdisciplinary and inclusive information sharing of our research highlights about natural and human impact associated with sustainable development in the Arctic Ocean in the context of climate change.

SEVENTH FRAMEWORK PROGRAMME

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Editorial

The ACCESS project has been underway for almost three years. As it progresses into its final year, the biggest challenge will be to synthesize interactions between the various ACCESS work packages and their respective "sectors". That requires building on the detailed knowledge gained in the five focus areas - climate, shipping and tourism, fisheries, resource extraction and governance – to impart a strong cross-sector analysis. ACCESS has initiated and progressed a number of activities to foster this effort and they are the focus of this newsletter.

A key approach for the synthesis is the Arctic Marine Spatial Planning (MSP) tool. Importantly it is one of the foremost methodologies to ensure a useful legacy of ACCESS project results to support sustainable development in the Arctic region. Developed as an essential element of the ACCESS project, it will contain information relevant for cross-sectoral understanding and planning. Here we highlight its status and show two interesting examples of its application.

Two other cross-sectoral activities organized by ACCESS in the last year are also featured in this newsletter. One is reporting from the breakout sessions that were an integral part of the 2nd annual General Assembly of ACCESS partners hosted by the University of Catalunia in Vilanova i la Geltrú, Spain in March 2013. The sessions tackled cross-sectoral topics of sustainable use of resources and services from Arctic ecosystems, maritime transportation, establishment of Arctic infrastructure and indicators for sustainable development. The process and the outcomes of these sessions have given the cross-sectoral way of thinking in ACCESS work a considerable boost, which will carry over to the upcoming General Assembly in Cambridge, hosted by the British Antarctic Survey in March 2014.

A second synthesis-oriented activity organized by ACCESS was a combined cross-sectoral summer school and synthesis meeting in Bremen, Germany. The summer school involved young scientists. It provided an excellent opportunity for them to listen, discuss and interact with experts representing the scientific and economic areas relevant for the Arctic. Furthermore it facilitated the young scientists to develop their own ideas on various cross-sectoral subjects, such as how researchers can better interact with indigenous populations, in small discussion groups. A snapshot from those discussions is also part of this newsletter.

These are just a few recent examples of the many ACCESS activities. The whole ACCESS team will strive to make the best use of the remaining time in the project duration in order to provide a legacy of better knowledge of the Arctic Ocean which will support society in ensuring sustainable development of the Arctic region.

ACCESS editorial board

ACCESS Cross-sectoral working groups progress

Development of the Marine Spatial Planning tool for ACCESS

Rosemary Edwards, Alan Evans, Lindsay Parson
National Oceanography Centre (NERC), Southampton - Maritime Zone Solutions Ltd

What is Marine Spatial Planning?

Marine Spatial Planning (MSP) provides a practical way to organise the use of marine space and the interactions of its users, both spatially and temporally. MSP aims to balance the demands for development with the need to preserve ecosystems, while also achieving social and economic objectives. Coastal states have started the process of MSP within waters under their jurisdiction, to integrate economic exploitation and social benefits with the duty to protect the marine environment and protect biodiversity. These rights and duties, towards exploitation of resources and protection of the marine environment, are reflected in two important global conventions; the United Nations Convention on the Law of the Sea (UNCLOS) and the Convention on Biological Diversity.

Marine Spatial Planning is a future-oriented process, offering a way to address and manage potential conflicts in advance. Most countries already designate or zone marine space for a number of human activities such as maritime transportation, oil and gas development, offshore renewable energy, and aquaculture. However, the limitation is that this is often done on a sector-by-sector basis and lacking consideration of effects either on other human activities or the marine environment. Consequently, this situation has led to two major types of conflict ; user-user conflicts (for example between hydrocarbon exploitation and fishing), and user-environment conflicts (for example between trawling and habitat destruction). These conflicts weaken the ability of the ocean to provide the necessary ecosystem services upon which humans and all other life on earth depend.

Implementation of Marine Spatial Planning

An effective Marine Spatial Plan should apply ecosystem based management (EBM), balancing ecological, economic and social goals and objectives towards sustainable development. The plan should be integrated across all relevant sectors and agencies, both nationally and regionally, and should be adaptive and anticipatory, with focus on the long-term, typically with a 10 – 20 year horizon. The OSPAR Commission define an ecosystem approach to sea use management as: " The comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of goods and services and maintenance of ecosystem integrity ".

The Arctic Ocean is surrounded by five coastal states and contains a large area of high seas. Individual ecosystems extend across political boundaries, highlighting the need for management plans and governance to be developed at a regional rather than national level. Examples include the development of Regional Fisheries Management Organisations to cover highly migratory or straddling fish stocks, and the recent Arctic Council agreement on Oil Pollution Preparedness and Response.

The involvement of stakeholders at all stages of MSP; development, implementation, monitoring and evaluation, is key to a Marine Spatial Plan's success. MSP aims to achieve multiple objectives (social, economic, and ecological) and should therefore reflect as many expectations, opportunities, or conflicts occurring in the area as possible, as well as respecting the rights of residents and indigenous peoples.

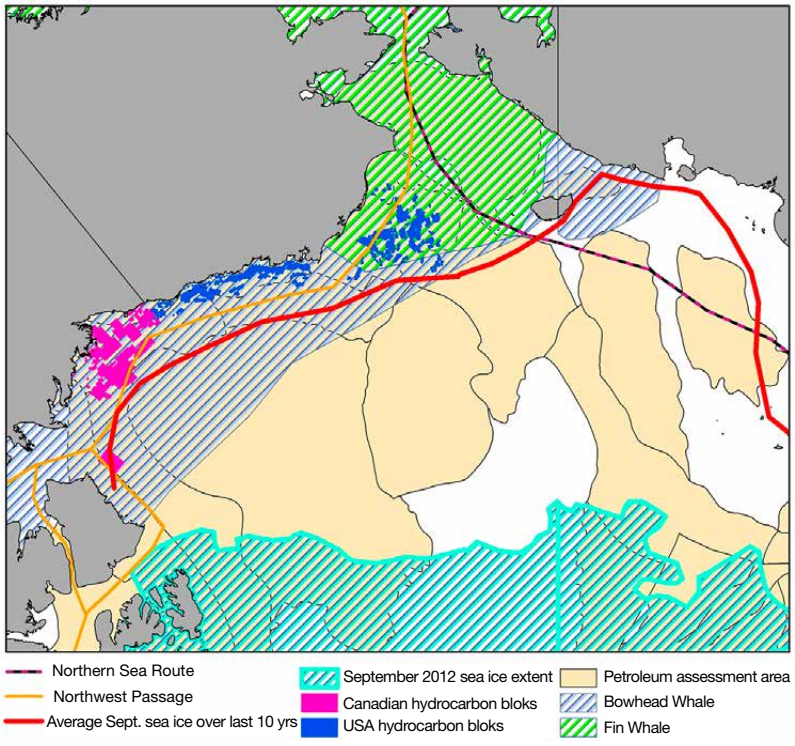

Figure 1 - Overlapping sectors in the Bering Strait region. Pale beige shows sedimentary basins which may be a focus for future hydrocarbon exploitation, see legend for other features.

Development of the Marine Spatial Planning tool for ACCESS

Marine Spatial Planning within ACCESS

ACCESS Task 5.8 provides the development of an integrated MSP tool, enabling the integrated study of information from all the sectors under review in ACESS, and each of the associated human activities related to and within these sectors. ACCESS will not produce a Marine Spatial Plan, but rather a system with which interdisciplinary planning could be effected, and which will act as a coordination tool. The use of a Geographical Information System (ArcGIS) allows us to visualise, store, manage, interrogate, access and cross-correlate data from all sectors. The regulatory, spatial and temporal information included within the MSP tool will be accessed by hyperlinked documents. Users will be able to visualise the various uses of marine space and easily identify overlapping activities leading to both user-user and user-environment conflicts. In the Arctic temporal changes are the driver behind future spatial conflicts, so it is vital that the spatial planning tool allows predicted temporal changes to be incorporated.

Figure 1 shows example output from the GIS for the Bering Strait region. We can see how the GIS allows easy visualisation of overlapping sectors and users of this maritime area. Bowhead and Fin whales, both of which are on the IUCN (International Union for Conservation of Nature) Red List for endangered species, migrate through these waters. As the Arctic experiences increasing ice-free periods activities such as commercial fishing, shipping and hydrocarbon extraction are all likely to increase. Shipping lanes from both the Northern Sea Route and Northwest Passage will pass through the Bering Strait, while further hydrocarbon exploitation off Alaska's North Shore will also add to the marine traffic. Potential clearly exists in this area for increasing conflicts, both between users-environment (for example acoustic disturbance [*e.g.* ACCESS Tasks 2.4.6 and 4.5.3], or collisions between vessels and cetaceans) and also user-user conflicts (for example hydrocarbon exploitation overlapping fishing grounds). Changing climatic conditions, and hence prey distribution, could also lead to changes in migratory patterns or distribution for marine mammals which will impact significantly on subsistence hunters (e.g. Task 3.6).

We can also interrogate the GIS to identify all overlapping sectors within a particular area, or at a particular point. Figure 2 shows an example where an individual well on the Norwegian continental shelf has been selected. The GIS is then showing all the overlapping sectors at that point; hydrocarbon blocks, shipping lanes, fishery bilateral agreements and areas (*e.g.* FAO, ICES), and maritime zones of different governance (e.g. OSPAR, coastal states EEZ), covering WP2 to WP5 of ACCESS, as well as physiographic data such as ice-coverage (WP1), bathymetry etc. The GIS therefore underpins the MSP tool, highlighting areas where if there are changes in one particular sector we can identify which others may be affected, both spatially and temporally.

The ACCESS MSP and GIS will continue to be refined in close conjunction with the ecosystem-based management assessment in Work Package 5. The MSP is ready for population with the data and results of other work packages during the final 12 months of ACCESS, and will provide an important resource in the governance and sustainable development in the Arctic Ocean.

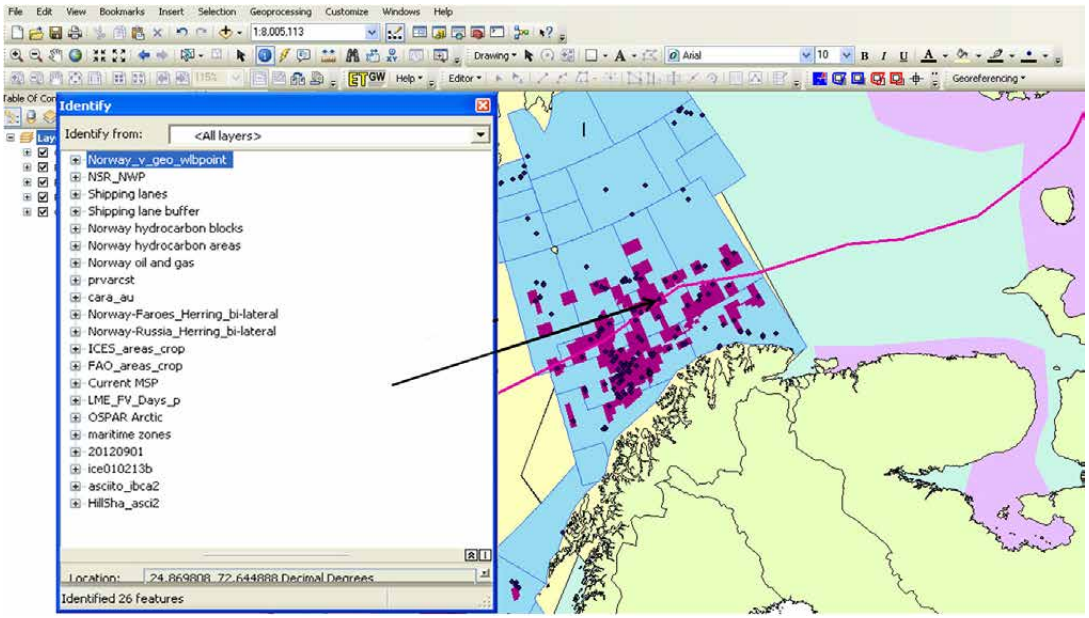

Figure 2 - Example from the GIS showing many overlapping layers. The GIS can be interrogated to show the overlapping sectors at any particular point.

The 1st ACCESS 'Cross-sectoral Summerschool' 23.-27. September 2013

Widening Arctic Understanding: First ACCESS Summer School

Michael Karcher
O.A.Sys - Ocean Atmosphere Systems GmbH

Young researchers and stakeholders were brought together with ACCESS experts to bolster interdisciplinary understanding of Arctic climate change and developments at the first " summer school " week at the House of Science (Haus der Wissenschaft) in Bremen, Germany in September 2013. Widely announced in Arctic relevant communications, participants were drawn from Austria, Denmark, France, Germany, Iceland, India, Russia, Sweden, United Kingdom and the United States. The summerschool was hosted jointly by ACCESS partners Alfred Wegener Institute – Helmholtz Centre for Polar and Marine Research (AWI) and Ocean Atmosphere Systems GmbH (OASys) and led by OASys. Experts from a variety of organizations set the stage with briefing lectures covering the relevant fields of change in the Arctic from scientific, economic and societal perspectives. There was ample time for cross-sectoral discussions. Four topics were the focus for students to develop their own ideas, as outlined below. They presented the results and discussed with ACCESS experts at a Work Package 5 / Synthesis session.

The following 'briefing-lectures' were given by renowned experts in their respective fields:

- *ACCESS project overview and concept of the summerschool* – Michael Karcher (OASys)
- *How to understand climate models/what are their uncertainties with a focus on the Arctic* - Frank Kauker/ Kathrin Riemann-Campe (AWI)

- *Observing physical properties of sea ice* - Marcel Nicolaus (AWI)
- *Changing Polar Low frequency over the northern North Atlantic in a changing climate* – Matthias Zahn (HZG)
- *Arctic Ocean Biology – from the surface to the deep sea* - Christina Bienold (AWI)
- *Arctic Conservation - act now or repair later?* - Gert Polet (WWF)
- *What do we know about current and future sources of Arctic air pollution and their impact?* - Anke Roiger (DLR) and Jennie Thomas (LATMOS-UPMC)
- *Oil Spills in Ice* – C.J. Beegle-Krause (SINTEF)
- *Climate change and the benefits of cooperation in harvesting shared fish stocks* – Nils-Arne Ekerhovd (SNF)
- *Introduction to Arctic Law and Governance* – Birgit Lode (IASS)
- *Security issues* – Andreas Raspotnik (The Arctic Institute)
- *Shipping in the Arctic* – Julia Köster (JADE-HS)
- *What global change science messages matter for Arctic governance?* – Sarah Cornell (Stockholm Resilience Centre)
- *Environmental Balance Modelling* – Anne-Sophie Crepin (Beijer Institute)
- *Marine Spatial Planning* – Rosemary Edwards (NOC)
- *Energy production in the Arctic Ocean: Status quo and prospects under Climate Change* – Sebastian Petrick (IFW)
- *The Economics of Global Resources Markets* – Timo Panke (EWI)

For the student breakout sessions after the lectures the following topics were chosen:

- *How can scientists better cooperate with local and indigenous people(s)?*
- *Industry – Science cooperation, beneficial for both sides?*
- *Developing a "socio-economic ecosystem" map*
- *What is needed in terms of student education/training to be prepared for the cross-sectoral challenges in Arctic research?*

Based on this material the students prepared articles for the present newsletter, which can be found after this introduction.

All presentations, information on the background of the lecturers, student presentations and the agenda can also be found on the project website:

http://www.access-eu.org/en/publications/access_workshops/cross_sectoral_summerschool.html

Sponsoring: In addition to the support from the 7th framework program by the European Commission via the ACCESS project, the summerschool was generously supported by the Helmholtz Graduate School for Polar and Marine Research (POLMAR) by allowing for travel cost support for non-ACCESS lecturers. In addition the AWI supported the meeting by sponsoring room rental and a reception for the students and lecturers. Travel costs, accommodation and subsistence were covered by the students.

What is needed in terms of student education and training to prepare for the cross-sectorial challenges in Arctic research?

Thomas Van Pelt, Nathanael Melia, and Ferdinand Oberle

As a closing activity in the ACCESS cross-sectoral summerschool (23-27 September 2013, at Haus der Wissenschaft, Bremen, Germany), student participants broke out into small teams and took up the challenge to address one of a set of questions developed by the leaders of the summerschool. Our three-person student group worked on the question: What is needed in terms of student education and training to prepare for the cross-sectorial challenges in Arctic research?

By the time we took up this question — the fourth day of the summerschool week — our student group was already steeped in thinking about cross-sectorial challenges. The first three days of the summerschool consisted of a wonderfully diverse series of presentations delivered by participating lecturers (Fig. 1). The presentations were themselves a kind of showcase of cross-sectoral challenges, with some presentations being quite broad and integrated and others being more specific, sparking a lot of discussion and questions about linkages to other sectors within the ACCESS project or elsewhere.

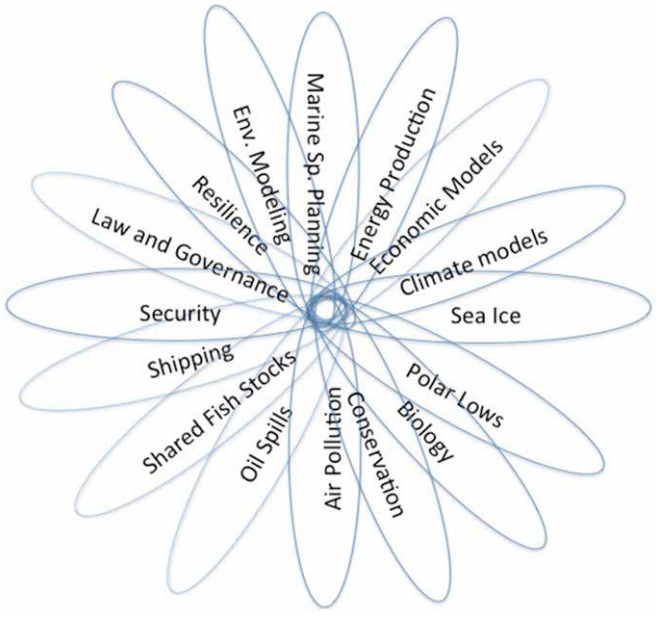

Figure 1 - A cartoon illustrating the range of lecture topics presented during the ACCESS summerschool. Within this concept, students sit at the intersecting center, being exposed to detailed information on each topic and also able to draw on the other topics to make cross-sectoral connections. For a successful cross-sectorial education all teachers must prepare to point out the cross-sectorial overlap of their specific subject, otherwise their teaching does not touch upon the center of the circle. Also, since lecturers for the most part participated in the whole summerschool, they also benefitted from their colleagues' lectures and from discussion.

We began our student breakout group work by outlining our thoughts on why preparation for cross-sectorial work is important. We observed the general problem of pigeonholing or stovepiping in science — go to any big research conference and you'll see a lot of small discipline-based groups talking with each other, and with a much smaller amount of cross-discipline discussion. But paradoxically, we see a rapidly growing set of examples of how cross-sectoral collaborations can increase the power, impact, and significance of scientific research.

Many academics and professionals have an understandable bias for their particular research topic, but it is vitally important to address the "so what?" question that may be asked by those not immersed in the topic. Not only will this add motivation behind a project and increase interest and engagement with stakeholders, but this will also highlight cross-sectorial pathways, allowing for potentially productive collaborations to be identified.

We further noted that considering the extreme logistical difficulties, the international shared interests, and the sense of urgency driven by rapidly changing sea ice conditions and consequent ecosystem and socioeconomic changes, research in the Arctic could be seen as a prime example of the potential benefits of cross-sectoral collaborations. With this in mind, we highlighted a range of activities that support education and training in cross-sectoral collaborations in arctic research:

- Workshops — targeted workshops that bring specialists from different disciplines together in pursuit of a well-articulated, cross-sectoral goal. Ideally such workshops will be professionally facilitated or have an objective leader who can bridge gaps and draw specialists out of their niches.
- degree programs — while 'inter-disciplinary' degree programs are increasingly common, they will ideally become fully mainstreamed and integrated so that they are a natural and accepted complement to discipline-focused programs.
- dedicated journals and / or special issues — having prestigious and widely-available outlets for cross-sectoral research will simultaneously reward the investment made by people doing cross-sectoral work and motivate students or professionals considering or starting cross-sectoral work. Special journal issues can be especially helpful in showcasing and contextualizing cross-sectoral research.
- Conferences — again, having quality opportunities to present cross-sectoral research, in dedicated conferences or symposia, or in special sessions within conferences, will both reward and inspire cross-sectoral work.
- Newsletters — newsletters that bring different threads of a research program together will directly facilitate cross-

sectoral thinking and promote practical opportunities for collaboration.

- Exchanges — creating opportunities for students, postgrads, and / or professionals to work in related but different labs or field sites will break down the traditional boundaries between disciplines and will strengthen existing collaborations or foster new ones.
- summerschools — by bringing a broad cross-section of students and professionals together for a summerschool explicitly focused on cross-sectoral thinking, the next generation of researchers will have a model for cross-sectoral thinking, and also (crucially) the researchers presenting to the students will themselves be freshly schooled in the cross-sectoral approach, via questions and discussion from students and their colleagues. The ACCESS summerschool provides an excellent example!

These things already exist to some extent, of course — our intent was to highlight the benefits and call for expansion. We also noted that these types of activities need solid institutional acceptance, rewards, incentives, priorities, etc. to be fully realized. When lecturers, professors, editors, and other professionals have enthusiastic backing from their employers, departments, and colleagues, they will be more effective in delivering cross-sectoral training and education. And based on discussion following our student presentation, we also suggest that co-funded projects from institutions with different priorities and cultures can make a big impact on improving cross-sectoral collaboration, and that field experience is also very important. Another topic that emerged from discussion is the importance of including local and indigenous people in cross-sectoral education and training — after all, local people are in most cases fundamentally and naturally 'cross-sectoral' in their perspective and engagement with their surroundings.

We identified the summerschool itself as a prime example of cross-sectoral training. The range of expertise brought to the summerschool group by the lecturers was both deep and broad (see Figure 1 for an illustration of lecture topics), and the summerschool organizers, provided a consistent emphasis on facilitating discussion and questions on cross-sectoral aspects of the lectures. We further drew attention to two big strengths of the summerschool: firstly, the visiting lecturers were for the most part not merely visitors — instead, they joined the summerschool as full participants and stayed through all of the presentations. This was a major boost for the cross-sectoral aspect, allowing additional follow up discussion among the lecturers and students, and also strengthening the 'train the trainer' aspect of having this kind of cross-sectoral education, with lecturers learning from each other and also from the students. Secondly, the summerschool culminated in short student presentations and discussion not only with the whole summerschool group but also with all of the participants in the main ACCESS Synthesis workshop that was held concurrently with the last two days of the summerschool. This meant that the summerschool students had not only the cross-sectoral training provided by the three-day lecture series, but we also were able to connect those lectures to the real-world, real-time issues being tackled by the Synthesis group within the ACCESS project.

These suggestions and thoughts have by no means answered the "What is needed in terms of student education and training to prepare for the cross-sectorial challenges in Arctic research?" question that was posed to us, but we hope our perspective may be of some use as 'food for thought', and we look forward to doing what we can to boost cross-sectoral work in Arctic research in the future. Thanks to the organizers of the summerschool, to the visiting and participating lecturers, to the Synthesis workshop participants for engaging with our summerschool group during their meeting, and to all our fellow students for stimulating questions and discussions!

The socio-economical ecosystem of the Arctic Ocean

Tanja Stratmann, Ima Kusumanti

In order to map the Arctic ecosystem, particularly the marine Arctic ecosystem, we developed a socio-economic ecosystem map. This contains subdivisions, such as marine ecosystem, climate factors, tourism, hydrocarbon resources, infrastructure (harbors), food production, transport and society (see the simplified model in figure 1).

The marine ecosystem can be mapped basically as a food web with primary producers, primary and secondary consumers and predators combined with biogeochemical facets such as sedimentation.

Primary producers, ice algae as well as phytoplankton, are impacted by the ice cover of the Arctic Ocean. Whereas the increased light penetration through the thinning sea ice has a destructive effect on the ice algae's photosystem living in the lowest 5 cm of the ice, the increased light penetration into deeper parts of the water column enhances the development of phytoplankton blooms below the ice. After the growth phase, the detritus of dead ice algae and phytoplankton cells is degraded in the upper water column. As a consequence, inorganic nutrients are released by the degradation process in order to serve as nutrient supply for new primary producers. Therefore, phytoplankton might actually benefit from a decreased ice extend. However, other hypotheses imply that the melting of sea ice causes a freshwater layer beneath the ice and therefore reduces the nutrient supply to the primary producers. Consequently, both ice algae and phytoplankton growth might be reduced under climate change conditions.

These primary producers are grazed by zooplankton, the first consumers in the Arctic food web. In case that some species are specialized on feeding ice algae, a retreating summer ice cover diminishes their feeding ground and threatens therefore their existence. Besides, some zooplankton species use the Melosira spp. strands hanging below the sea ice as nursery grounds implying that less sea ice limits their reproduction.

On the next level the secondary consumer feeding mainly on zooplankton is polar cod. This fish is subsequently predated by different seal species living in the Arctic. These seals depend on the sea ice to bear their pup and to start hunting. Additionally, some whale species such as bowhead whales and humpback whales depend on the zooplankton in the Arctic Ocean and compete with the fish species which again might change or already have changed their migration rates due to increasing water temperatures. Consequently the fishery sector is affected and fishermen might have to adjust their fishing grounds.

At the end of the food chain you find the polar bear and, of course, the human being. After giving birth to general twin-cubs on land the female polar bear depends on a more intact ice cover in order to reach and find the young seal pups they feed on. That is why polar bears are more or less as depended on the presence of sea ice as the primary producer ice algae.

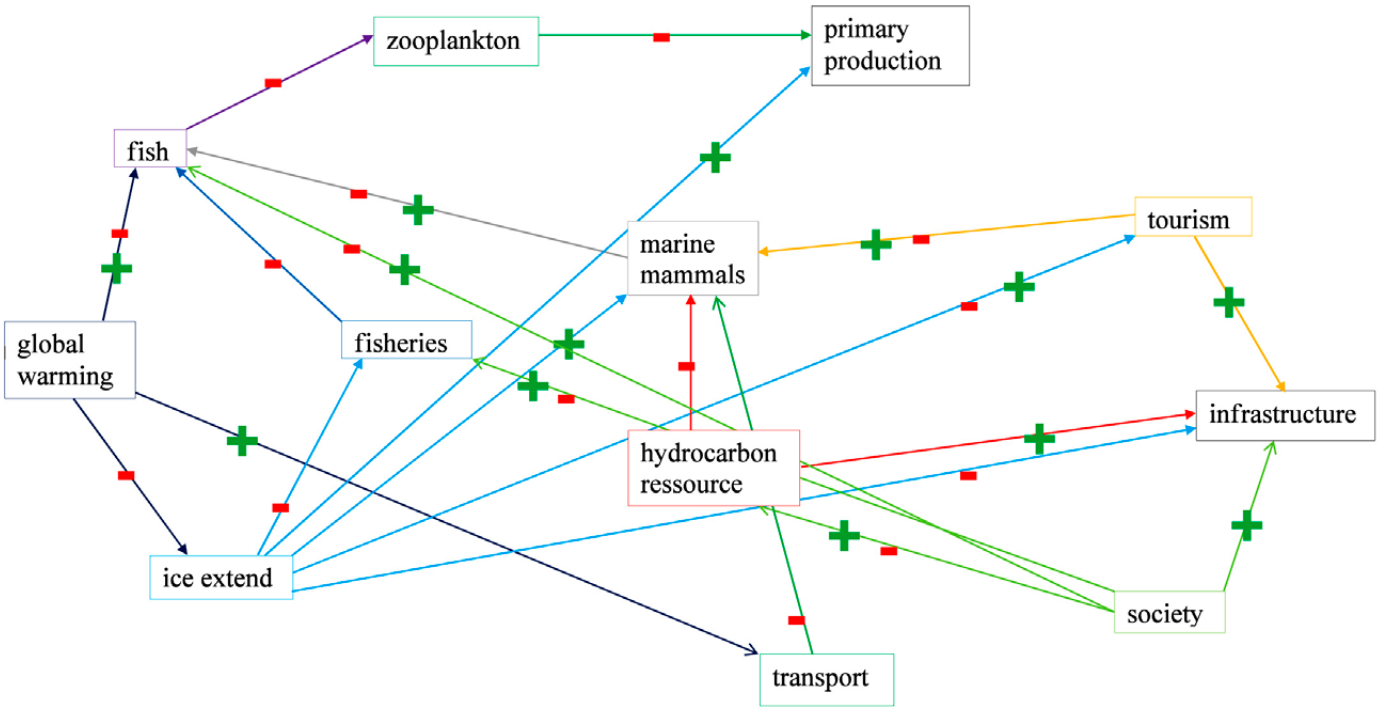

Figure 1 -Simplified socio-economic ecosystem map of the Arctic Ocean.

In order to go one step further from the more ecosystem-climate approach to the socio-economic approach we want to describe the interactions between climate, economy and the marine ecosystem.

In agreement with fishery scientists the policy makers agree on new fishing quota each year depending on the size of the fish stocks and particularly on the biomass of the spawning stock. In this way they impact the fish either positively or negatively. This is due to the fact that the production of a fish stock can increase if you fish a certain amount, but it can also collapse if you over-exploit it. However, these policy makers also strongly influence the fisheries since defining fishing quotas might also mean to prohibit fishing a specific species during the entire or part of the year. The people or a part of the people might, in cooperation with NGOs, decide not to consume a specific fish species or fish from a designated area. In this manner they can reduce fishing pressure. In addition, these people might have the power to force their government or stakeholders on a more international level to establish marine protected areas. Especially fish and marine mammals will benefit from this as fishing will probably be forbidden in these areas.

Fishermen also depend on cheap fuel for their boats and fishing fleets. Hence, they benefit from hydrocarbon exploitation in the Arctic shelf seas in case that this leads to reduced oil prices. However, if the exploitation of oil in this sensitive ecosystem causes major anthropogenic hazards, such as oil spills, the fishes or their prey might suffer or die. Consequently, the amount of fish that can potentially be harvested is reduced.

After catching the fish the catch has to be processed either on board or in fish factories ashore. Therefore appropriate facilities including harbors has to be build and maintained which requires transportation routes.

The subdivision " hydrocarbon resources " is again connected to several aspects of the socio-economic approach. The ice-free areas of the Arctic Ocean allowed the oil and gas companies to develop technologies to explore areas for potential drills for hydrocarbons and later on to exploit them. However, the production of this oil and gas needs stable conditions in terms of predictable government reactions, weather and climate. The last is linked in a loop to the exploitation of these fossil fuels, as a rise in exploitation leads to more oil and gas available for consumption. Their burning will enhance the concentration of CO_2 in the atmosphere which boosts the global warming. In the consequence the ice extend will decrease which opens new areas for further oil exploitation. Nevertheless, even when the summer ice will be disappeared in most parts of the Arctic, the conditions in this remote environment remain difficult. This is due to the fact that the ice cover stabilizes the surface waters, where heavy waves will occur without ice. Besides, the sun only shines half of the year and frequently occurring fog leads to really bad conditions with regard to vision.

The society in form of the government of the Arctic coastal states is involved since they decide whether in their exclusive economic zone (EEZ) hydrocarbon exploitation will or is allowed. They define which regulation and laws have to be applied and whether they trade off the establishment of oil platforms against the declaration of marine protected areas from which marine mammals will benefit. The policy makers also decide whether they oblige the drilling and exploitation companies to maintain a certain level of environmental protection or / and safety. Besides, the hydrocarbons have to be delivered to the costumers either via pipelines or via natural liquid gas or oil tankers, which again increases the transport and shipping in the Arctic Ocean.

However, all this construction and production work as well as the transportation leads to a lot of noise that damages marine mammals. Consequently, it requires further governmental regulation and draws the attention of scientists and NGOs such as Greenpeace or WWF.

The decreasing ice extend has positive effects for the subdivision " transportation " and the construction of facilities for resource extraction in the Arctic Ocean as cargo ships and tankers that don't cooperate with icebreakers they require ice free or almost ice free routes.

All these kinds of ships, including cruise ships, operate on fuel, which links to the resource extraction again. The burning of fuel releases black carbon trough the chimneys to the atmosphere. This augmented amount of particles in the atmosphere might lead to increased precipitation, particularly to enhanced snow, but might also fall down again and cover the snow. Consequently the formerly white snow will be greyish-black which reduces the albedo effect. In this manner the climate warning is boosted leading again to less ice extend. Hence, the transportation in the Arctic Ocean forms a feedback loop similar to the resource extraction feedback loop, whereupon a boost in transportation results in a stronger retreat of sea ice.

Tourism depends on unaffected nature without oil rigs and platforms since tourists generally book cruises through the Arctic in order to watch polar bears or seals. They want to see the rest of the sea ice before it disappears in the summer. In this context, the ships release a lot of carbon dioxide and black carbon in the first place, but the tourists, after returning home, might decide to increase their effort to protect the Arctic marine and terrestrial environment. This can be achieved, for example, by changing their behavior, supporting Arctic environment related NGOs or pushing their governments to rethink their Arctic politics.

Industry-science cooperation – beneficial for both sides?

Jessica Engels, Katy Hoffmann, Zoe Koenig, Amelie Tetzlaff

Coming from different backgrounds, it is always a challenging task to find a common basis to communicate. Even working within the same field can be complicated; the interaction between different fields for example science and industry can be even more complex. These difficulties are also intensified by the missing link in public perception between basic research and its application in industry.

An option to bridge this gap is to bring science as well as industry in people's mind at an early educational stage. We think is it is important that scientists are more active in imparting their knowledge to the public. An event like the Polar Week in France, where scientists introduce their topics in a suitable way to children, for example gives young people the opportunity to lose their timidity towards science. At a later educational stage like university, cooperation with industry might be beneficial for both, students and companies. Internships or inviting guest lecturers would give insights in the different working environments.

While people can relate their needs to industry, this connection is not that pronounced between science and public. This awareness can be used within a cooperation of science with industry to communicate their objectives and findings to a broader audience.

Scientists can on the one hand provide their non-profit dependent point of view to sensitize the industry for more sustainable and ecological proceeding. On the other hand, the industry as a mirror of the society and its needs shows the possible applications of basic science research and therefore bring this science closer to everyday life.

From a scientific point of view, industry brings money for research which supports explorations of the Arctic. Further bridging works would allow scientists to have a broader access to data and results obtained by the industry and *vice versa*. As monitoring the Arctic, a hard to access region, is a costly encounter, all the sampling efforts should be shared. Out of this interaction, something desirable for both sides could evolve like for example a large and more detailed database of which new questions can arise for the science part and a different access to knowledge and new project ideas for the industry.

Science-industry cooperation also has to cope with the different expectations of the two partners. While companies usually expect a short precise answer science, especially climate science, can only provide them with probabilities of certain outcomes. This could be solved if both sides adjust their expectations. Hereby, industry can give more attention to concepts of uncertainty while the scientists have to summarize their results to certain key outcomes.

Especially scientific environmental questions most often deal with long time span phenomena (century to geological scales) and its global impacts, seeming on a first glance very far from the daily life. Thus, cooperation with the industry with its more short term and need-orientated focus on the same issues can provide a link between both and highlights why long term studies are desirable. Most importantly, industries by their power and global/media presence provide an opportunity for scientific thoughts to have an impact on political directions and decisions. This can for example be on environmental issues to propose protected areas but also to push the sensitization of the population through video clips, conferences and others.

In order to make this cooperation work well, some precautions and efforts have to be taken on both sides. One of the most important challenges of the scientists is their relation to the money supplied from and the resulting expectations of the industry. Scientific independence is needed even if the funding comes from the latter. This in particular concerns the discussion of the results and conclusions drawn from it: they should be unbiased by industrial and personal wishes. The ability to make obtained results public and the gained knowledge usable for everyone worldwide is another crucial point that has to be taken into account: on the one hand, the interest of the industry in keeping this new results or techniques for themselves as an economical advantage; on the other hand, the researchers' interest in publishing under their names. All that points out how important the confidence and trust between both sides are when working together.

In conclusion, the rapprochement of those two very different identities in this time of globalization is desirable and necessary. Even or especially because it is a relationship based on funding and expected results, confidence and trust must be the baseline. Improvements have to be done on both sides so that joint efforts of science and industry can form a fruitful collaborate relationship that ultimately inure to the benefit of all living beings.

How can scientists better interact with local and indigenous people?

Anna Suslova, Laurent Oziel, Lea Hartl

Why is interaction desirable?

In the context of climate change in the Arctic, both scientists and local and indigenous people face radical changes. Open-minded interaction between natural scientists working in the region and the local population is vital for a mutually beneficial exchange of information. As scientists we often rely on local knowledge regarding terrain and safety issues when working in the field, or may enlist local helpers to perform long-term measurements or maintenance work on instruments we leave behind. We can gain valuable insights regarding past and present changes of the ecosystem and other information when interviewing locals.

The indigenous peoples of the Arctic are stakeholders in a rapidly changing region that is and will continue to be the focus of strongly diverse interest groups. Greater knowledge of all aspects and potential environmental and socio-economic consequences of actions taken will strengthen their voice as stakeholders and aid decision-making processes. Scientists should make an effort to invite local people to take part in and contribute to their projects, sharing information freely. We believe that both sides can greatly benefit from improved communication and interaction.

How can it be achieved?

The main issue that can inhibit interaction is a lack of trust on both sides. Establishing a strong relationship between partners that trust each other is a long-term process that requires patience and dedication.

Making use of the local school system could aid in the building of such relationships. Holding talks in schools would be a relatively simple way to familiarize the local population (at a young age) with scientific work and the ideas behind particular projects. Approaching specific key figures like teachers or opinion leaders may facilitate this more readily than working with larger, more bureaucratic organizations, where one would not be communicating directly with the people one wants to reach. As scientists, we should try to integrate the aspect of social and cultural exchange in our projects as much as possible and as early as possible. Otherwise it will not be possible to dedicate an appropriate amount of time and funding to this cause. Project proposals may be written bearing this in mind.

Effective communication between all involved parties is a key aspect of improving interaction. While scientists are usually able to communicate well with other scientists of the same field, understanding often deteriorates rapidly the further the person we are talking to is from our area of expertise, due to high skill and knowledge specialization (and the "ivory tower" mentality common among the scientific community). General social skills, communication training and presentation techniques should be an integral part of all scientists' training. If one wants to communicate well with certain people of a particular region, one should be able to explain the relevance of scientific concepts at a local level, as well as in a cross-sectoral context, while remaining flexible in one's approach and bearing in mind the diversity of the audience. Improving cross-sectoral collaboration and sharing information among the scientific community about successful interaction with local and indigenous people should also be a focus. Natural scientists could gain valuable insights from colleagues in working in other fields, where direct interaction with locals may be more frequent.

The story of Anna and Max showcases an ideal case scenario for successful interaction. Anna, a young indigenous girl from an Arctic village, chose to learn English and go abroad to study climate science after meeting Max, a charismatic climate scientist doing fieldwork in her region. Both Anna and Max greatly benefited from their cooperation. Max has since begun a large-scale, international outreach program working with young scientists and schoolchildren in the Arctic.

Figure 1 - Max Homes with students in Zhigansk, Siberia (Russia), 2008.

Assessing interactions between economic activities and climate change in the Arctic

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The ACCESS project held its second annual meeting at the Technical University of Catalonia in Vilanova, Spain, March 6-8, 2013. During this general assembly all ACCESS partners, stakeholders and advisory board members had opportunity to meet to discuss project progress. The ACCESS project emphasises issues that span across different sectorial activities and aims to produce several deliverables synthesising the ACCESS results at the end of the project. To start preparing for these important tasks, participants at the meeting were divided into four different focus groups to discuss issues of cross-sectoral relevance regarding the establishment of infrastructure in the Arctic Ocean (*e.g.* Oil platforms, aquaculture); Arctic Marine Transportation; Sustainable use of resources and services from Arctic ecosystems; and finally, Indicators for sustainable development within a 30 years framework.

The groups, comprising purposely cross-disciplinary and cross-work package delegates, each enjoyed two intense discussions and drafting sessions separated by a review break, and involved a variety of methods and props such as flipcharts, post-it notes and whiteboards. A final plenary brought together the essential results, which encouragingly highlighted a number of key areas of cross-group integration and synergy.

Establishment of infrastructures in the Arctic Ocean

The first session identified topics of relevant and significant interest for the establishment of infrastructures in the Arctic for example the environmental impacts from infrastructure, the role of the particular characteristics of the Arctic for establishment, the identification of hotspots, relations with activities on land, profit margins, existence of relevant regulations and their capacity to adapt to climate change. The second break-out session identified four types of infrastructures that deserve particular attention: infrastructure for oil and gas extraction, aquaculture, observing network and coastal infrastructure. For the first two the groups also built tables identifying potential interactions between particular aspects of this infrastructure with fisheries, aquaculture, oil industry, local peoples, tourism, transport, climate and local wildlife. Table 1 illustrates some relevant interactions that were identified and need to be studied further.

The first session identified topics of relevant and significant Arctic marine transportation

The Arctic marine transportation group was strengthened by stakeholders from Hapag-Lloyd and the German Ship-owners Association. They indicated their need for reliable, timely information in particular for planning voyages along the Northern Sea Route and better / more reliable communications and weather information, as well as improved hydrographic charting over most of the Arctic. The group identified key issues deserving further studies as: Arctic oil spills (liability, clean up technologies and methodologies); cruise ships (safety concerns for large cruise ships in Arctic waters and ship operations in remote areas); the IMO Polar Code (mandatory, non-discriminatory and harmonized binding rules are required, in particular on marine safety gear for the polar regions, ship's structural and machinery standards, and pilothouse competency / experience); hydrography / charting (only approximately 8 % of the Arctic Ocean is charted to international navigation standards); ship emissions (a global oceans issue - but black carbon may be a regional impact that deserves specific attention); Arctic Observing Network (any new network(s) must be fully integrated); and new ships (size, technology and innovation making the future in Arctic navigation).

Figure 1 -Break-out group 1 wrestling with the task of annotating infrastructure scenarios with comments / observations

Assessing interactions between economic activities and climate change in the Arctic

Sustainable use of resources and services from Arctic ecosystems

The Fisheries group was devoted to assess the sustainable use of resources and services from Arctic ecosystems, focused on fisheries and tourism. The group identified the key issues associated with the production of ecosystem services with regard to institutions: institutional challenges for sustainable development; challenges for economic activities; and climate change impacts.

For example the design of effective management institutions needs to put particular attention on the fishing rights of indigenous populations and on regulations for migrating or mobile species between different jurisdictions, *e.g.* salmon.

Some of the elements of climate change with direct impacts on the water column and thus on the potential to produce ecosystem services are identified as: sea ice, temperature, nutrients, salinity, stratification, and all of these instigate changes to the geographical distribution of fish stocks, with further impacts on fisheries and tourism.

The economic challenges that were identified for fisheries are for example:

- Local fishermen going out of business when the fish moves and only big boats can exploit the resource;
- Spread of information about spawning area that can lead to destruction of the spawning population by unscrupulous companies;
- Large costs to follow migrating stocks or control invasive species.

For tourism economics important challenges are identified as for example:

- disposable income;
- Availability of relatively inexpensive and socially acceptable fuels;
- Availability of infrastructure in a melting Arctic;
- The risk for spreading of diseases.

OIL PLATFORMS	Fisheries	Aqua-culture	Oil Industry	Indigenous peoples	Tourism	Transport	Climate	Local Wildlife
Visual pollution				■	■			
Jobs and local employment				■				
Revenue				■				
Disruption of access / area confiscation	■	■		■	■	■		■
Pollution	■	■		■				

Figure 1 - Interactions between oil platforms and other activities. The tick marks show evidence of interactions that deserve further investigation.

Indicators for sustainable development

This group assigned to assess indicators for sustainable development concentrated mainly on 3 issues:

- What are the aims of an indicator system?
- What are criteria for good indicators?
- Is it possible to operationalise "sustainable development" as a description of a state, or will we only be able to describe trends towards more or less sustainability?

The group agreed that indicators are a limited set of state variables or derived variables (along the notion common to the natural sciences) which demonstrate the state of a development, in case of ACCESS this is sustainable development. The group implicitly conceptualized sustainable development as a three-dimensional problem, including environmental, social and economic development. One part of the task was the definition of quality criteria to facilitate choice and prioritization of the indicators that form the indicator system. Examples of such criteria included: the ability to reflect trends and developments, data availability, their comprehension and transparency. Indicators must be well-defined and not unduly affected by natural variability.

Subsequently, during the plenary discussions of the results of all of the Breakout groups, it was recognised that there was a great opportunity to cross-link findings between the groups. For example indicators cannot alone provide a good understanding of development in the Arctic. They must be complemented by a deeper understanding of how the changes in the different indicators are related with each other. Hence the strength of well-defined indicators is to help developing our synthesis, understand and test practical pathways to sustainable development.

Results from the break out groups sessions have been used during the last year to help move forward several ACCESS tasks for example those related to providing indicators for sustainable development and the task devoted to building a framework for integrated ecosystem based management. This process will continue throughout the remaining time of the project and will assists in developing a truly cross-sectoral project synthesis.

Meetings and Workshops of great interest for ACCESS

in chronological order

1-2 April 2014

Sea Ice Prediction Workshop in Boulder, Colorado, USA.

The Sea Ice Prediction Workshop will be held at National Center for Atmospheric Research (NCAR) on 1-2 April 2014 in Boulder, Colorado.

The workshop goal is to plan for the 2014 SEARCH Sea Ice Outlook (SIO) and to advance the science of sea ice prediction by coordinating experiments, defining and developing data sets for initialization and validation, creating new and better metrics for evaluation, and discussing stakeholder needs.

Anticipated participants include SIO contributors, data experts, sea ice experts, experts on prediction from other fields, and U.S. agency program managers.

5-8 April and 9-11 April 2014

The Arctic Science Summit Week (ASSW) and *The Arctic Observing Summit (AOS)*, in Helsinki, Finland.

The Arctic Science Summit Week (ASSW) and *the Arctic Observing Summit (AOS)* meetings will be organized during April 5-8 and April 9-11, 2014 respectively. The meetings will be arranged in the facilities of the University of Helsinki and the Finnish Meteorological Institution located on the science campus Kumpula in Helsinki, Finland.

The ASSW is the annual gathering of international organizations engaged in supporting and facilitating Arctic Research. Its purpose is to provide opportunities for international coordination, collaboration and cooperation in all fields of Arctic sciences and to combine science and management meetings.

The ASSW and the AOS 2014 will address the common concern regarding the Arctic environment under the pressure of climate change and global economic demands for natural resources and seek feasible strategies for advanced Arctic Observing Systems to conduct systematic, reliable and cost-effective monitoring of long-term trends and rapid changes.

22-23 September 2014

Arctic sea ice reduction, at The Royal Society in London, UK.

This meeting explores the recent, rapid Arctic sea ice reduction. We will discuss the evidence for change, the inability of our climate models to predict these changes, the processes responsible for sea ice reduction and improved representation of these processes in climate models, and the impacts of sea ice change on local and global weather and climate.

website: http://royalsociety.org/events/2014/arctic-sea-ice/

24-25 September 2014

Arctic sea ice reduction, satellite meeting, at The Royal Society at Chicheley Hall home of the Kavli Royal Society International Centre, in Buckinghamshire, UK.

The satellite meeting will host presentations and discussion of the latest scientific developments in sea ice observation, model simulations, theory, and impacts on weather and climate. This would also include the polar ocean and atmosphere as they are affected by sea ice. The purpose of this meeting is that it offers a more informal forum for discussion among scientists.

website: http://royalsociety.org/events/2014/sea-ice-reduction-satellite/