Arctic Climate Impact Assessment

Gunnar Sander, August 2011

1. Project / publication	**Arctic Climate Impact Assessment (ACIA)** The assessment is reported in three documents: • "Impacts of a Warming Arctic: Arctic Climate Impact Assessment" (2004). Summary for policy makers – 142 pages. • "Arctic Climate Impact Assessment" (2005). The scientific assessment - 1047 pages. • "ACIA Policy Document" issued by the Fourth Arctic Council Ministerial Meeting Nov 2004 – 8 pages. The scientific report is only available in English. The overview report was published in 9 languages: Danish, Dutch, English, German, Greenlandic, French, Norwegian, Russian and Sami. The ACIA documents are available at http://www.acia.uaf.edu/
2. Initiator	The origins of ACIA can be found both in the global work on climate change by the Intergovernmental Panel on Climate Change (IPCC), the climate work of the International Arctic Science Committee (IASC) and the evolving mandates of two working groups of the Arctic Council, the Arctic Monitoring and Assessment Programme (AMAP) and Conservation of the Arctic Flora and Fauna (CAFF). IASC invited CAFF and AMAP to make a proposal for a project that was submitted to the IASC Council and Arctic Council for approval in May 1999. Several preparatory initiatives were then undertaken and led to a 12-page implementation plan. This was presented at the meeting of the Arctic Council in October 2000 (in Barrow, Alaska), where it was endorsed and adopted by the ministers (see details in Nilsson 2007, ch 5) Web sites of the organizations mentioned above: http://www.arcticportal.org/iasc/ , http://www.arctic-council.org/, http://www.amap.no/ and http://www.caff.is/
3. Objective	The overall goal of the ACIA was stated as follows in the implementation plan: • "Evaluate and synthesize knowledge about climate variability, climate change, and increased UV radiation and their consequences, and • Provide useful and reliable information to the governments, organizations and peoples of the Arctic region in order to support policy-making processes and to IPCC's further work on climate change issues. The assessment will include environmental, human health, and social and economic impacts and recommend further actions. This assessment will be conducted in the context of other developments and pressures on the Arctic environment, its economy, regional resources, and peoples." The list of short questions that should guide the assessment pointed to both current and anticipated changes in climate and climate impacts.
4. Geographical delimiation	The study encompassed the whole Arctic and used the AMAP definition of the Arctic. In the scientific report, it was nevertheless acknowledged that there are numerous and complex connections between the Arctic and lower latitudes. Each chapter of the report therefore described the area that was relevant to its subject. To strike a balance between general and special considerations, four major regions were identified based on differences in large scale weather- and climate-shaping

	factors. The regions were slices of the Arctic geography, covering a North Atlantic region, Siberia/Northern Russia, a North Pacific region and Northern Canada. Differences in climate trends, impacts and responses were considered for these regions.
5. Time horizon	ACIA had a review of past climate change in the Arctic that focused on the past two million years, and particularly the last 20 000 years that have been highly unstable. This was meant as a context for evaluating evidence of more recent climate change, which focused on climate variability in the 20th century and descriptions of the current functioning of the Arctic climate system (Chapter 2 in scientific report). For climate change scenarios, the ACIA baseline was 1981 – 2000. Three 20-year time periods were the foci for the studies of the 21th century: 2011 – 2030, 2041-2060 and 2071 – 2090.
6. Thematic focus	The ambition of ACIA was to provide a comprehensive evaluation of Arctic climate change, changes in UV radiation, and their impacts on the region and the world. The scientific report is divided into four sections: • Climate change and UV radiation change in the Arctic (chapter 2 – 5). This includes the Arctic climate system, indigenous perspectives on climate change, future climate change and observations and projection on ozone levels and UV radiation with impacts. • Impacts on the physical and biological system of the Arctic (chapter 6 – 9) These chapters discuss primary impacts. Observed changes and expected impacts are discussed for the frozen components of the Arctic (cryosphere), terrestrial ecosystems, freshwater ecosystems with implications for freshwater fisheries, and the marine systems with physical and biological changes and their implications for fisheries. • Impacts on humans in the Arctic (chapter 10 – 16) Challenges to managing biodiversity and wildlife is discussed in the first two chapters. Then follows a presentation of traditional practices of hunting, herding and fishing and gathering, and how these practices may be affected by ecosystem changes and changes in society and policies. Similarly, there are discussions of commercial fisheries, agriculture and forestry. Health implications of changes in UV radiation and climate are discussed in chapter 15, while the last chapter deals with impacts on infrastructure. • Future steps and synthesis (chapter 17 – 18) Chapter 17 discusses how multiple stressors like climate, UV, pollutants and societal changes interacts on local communities and how resilient strategies for coping with these can be developed. Chapter 18 is a summary for the whole Arctic and the four regions. There was no real discussion of policy responses to these changes in the scientific report; nor is it in the summary report. A separate policy document was negotiated between the Arctic governments. Central elements are mitigation, adaptation, enhanced observations and research, and further assessments.
7. Images of the future	The climate models were run for the 21th century. By the end of the century, Arctic temperature increases were projected to be 7 ^{o}C and 5 ^{o}C for the two emission scenarios applied (A2 and B2), most pronounced for autumn and winter. Precipitation was projected to increase from about 5 to 10% in the Atlantic sector to as much as 35% in certain high arctic locations for the B2 scenario. The season-ality of changes in future precipitation showed the same pattern as for temperatures. A substantial decrease in snow and sea-ice cover also came out of the model simulations.

	There was no attempt to bring these results further into one or a few overall scenarios where all the different types of impacts were presented in a consistent way (ref question 11). Looking at the key findings in the summary report, the statements about the future climate and its impacts are qualitative and addressing particular issues. That is also dominating the rest of this report. There are some exceptions where more quantitative forecasts are provided, for example on issues like future vegetation, increases in sailing season along the Northern Sea Route and changes in the permafrost extension.
8. Key driving forces	ACIA has a strong focus on climate impacts. Changes in the climate system and UV radiation are the major driving forces throughout the report, with primary impacts in the physical/biological system and secondary impacts on humans. Addition influences from other factors like pollutants, societal developments and policies are discussed particularly when addressing impacts on humans. Regarding the drivers for climate change, the study used the A2 and B2 scenarios from the IPCC Special Report on Emission Scenarios (SRES). These were in the middle range of the IPCC scenarios, with projections on global mean temperature increases of 3,5 ^{o}C and 2,5 ^{o}C respectively by the end of the century. The SRES scenarios were built along four narrative storylines that describe the evolution of the world in the 21th century. Different assumptions were made on factors like population growth, economic growth, energy, technological change, land-use and policies apart from climate policy. This was supported by quantitative modeling leading to different levels of emissions of greenhouse gasses. Neither the drivers in these scenarios nor the attribution of climate change are discussed in ACIA; these are seen as global issues to be dealt with within IPCC. ACIA takes the global scenarios as a starting point and follow their regional ramifications.
9. Uncertainties/ wildcards	Uncertainties are widely recognized throughout the whole ACIA report. There are for example ample discussions of the ability of climate models to simulate the climate system. The underlying assumption is that both ecosystems and societies must be understood as complex systems that are hard to predict. The same terminology as developed in IPCC is used for describing the likelihood of expected change.
10. Accomplishment and collaboration	The assessment was carried out by the IASC and the Arctic Council through its two working groups AMAP and CAFF. The work was led by an "*Assessment Steering Committee*" with ap. 30 members, including representatives from AMAP, CAFF, IASC, the lead authors of all chapters and representatives of Arctic indigenous peoples' organizations. An "*Assessment Integration Team*" was created for coordination. The work was supported by a small *secretariat* at the University of Alaska in Fairbanks and the AMAP secretariat in Oslo. The chapters were drafted by some 180 lead and co-lead authors and later peer reviewed by around 200 reviewers. The Arctic Council was provided oversight through progress reports and documentation at all their meetings. Policy recommendations based on the scientific findings was contentious particularly for the US Bush administration. From the onset, drafting these was a part of the scientific assessment. The task was handed over to the Senior Arctic Officials – the highest level of representation from the Arctic countries under the ministers – who ran a process of negotiations on the final text. ACIA should be considered as an expert-based assessment with some

	participatory elements. These include the use of traditional knowledge (see next question), and the inputs received through the Arctic Council, including the indigenous peoples' organizations.
11. Method	*Overall approach:* ACIA labels itself as a "science assessment" in the tradition of other major international assessments. IPCC is mentioned, but the practices within the Arctic Council – with AMAP as the most prominent actor – are also important for the way it was conducted. The essence of this is a critical analysis of the understanding of a problem that is inherently scientific in nature. It draws on the available literature rather than initiating new research, and is based on peer-review at all levels. The common purpose is to provide scientific advice to decision makers who need to develop strategies. (See ACIA chapter 1.4.1) *Models*: Basic for ACIA is the use of coupled atmosphere – land – ice – ocean models for analyzing past and predicting future climate. Five models were refined and run specifically for the assessment: • CGCM2 run by Canadian Centre for Climate Modeling and Analysis • CSM_1.4 run by National Centre for Atmospheric Research, USA • ECHAM4/OPYC3 run by Max-Planck Institute, Germany • GFDL_R30_c run by Geophysical Fluid Dynamics Lab, USA • HadCM3 run by Hadley Centre for Climate Prediction and research, UK The reason for using an ensemble of models was to reduce the uncertainty embedded in individual models. The model input was emissions of greenhouse gasses from the SRES scenarios. They typically delivered projections of changes in temperatures, precipitation, seasonality and the coverage of snow and ice. Downscaling from global models to the Arctic was applied, whereas regional models were considered too uncertain to be used (see ACIA chapter 4). *Variety of methods* In the scientific report, a number of different approaches can be found, both quantitative analysis and completely qualitative methods. One approach that was used frequently was analogue scenarios. This either means using past warm climates (temporal analogue scenarios) or current climates in warmer regions (spatial analogue scenarios) as proxys for future conditions. Analysis of empirical data and data from experiments was common. For assessing impacts on societies, a variety of social and economic models and approaches are available. In the Arctic Council assessment tradition, ACIA developed new standards for how to include *traditional knowledge*. Traditional knowledge is discussed in the beginning of chapter 3 and applied in a series of case studies documenting how different groups, first of all hunting and herding societies, have experienced climatic and environmental changes. The authors also of other chapters were encouraged to integrate indigenous peoples' perspectives. This can be found most clearly in chapter 12 on indigenous peoples' use of natural resources. These lay mans perspectives are acknowledged as valuable insights supplementing the traditional scientific analyses; it brought new information where science had no observations, it could serve as "ground truthing" for scientific observations and it was important for understanding the significance of the findings.
12. Sources of information	ACIA used first of all publications from the open, peer-reviewed scientific literature published up to February 2004. Other resources, such as technical publications by government agencies, were also included if they had been reviewed and were publicly available.
13. Strengths	ACIA was the first regional assessment of climate change worldwide. This meant a different framing of climate issues than looking at them as merely global (see

	Nilsson 2007, chapter 6 and 7). It also meant that new scientific approaches were developed and more nuanced insights about the region achieved. Strengths to be highlighted: • Effective mobilization of the scientific community and linkages to the global IPCC process gave high credibility. This was important in the political debate. • The combined use of scientific and traditional knowledge. Indigenous peoples were given a role as knowledge providers that they had not had before. Systematic methods were used in obtaining traditional knowledge. • The ACIA popular report is outstanding in communicating the messages. A scientific journalist wrote the text in collaboration with the scientists and a graphic designer. The use of illustrations and composition of the report is delicate and makes the information effectively communicated and easily understood - especially in the summary. This has made the report useful for a number of users long time after the end of ACIA (education, management, politicians, stakeholders etc). • The outreach activities. ACIA produced a communication and outreach strategy early in the process. This was important for working with the communicative aspects of the products in parallel with the scientific work and for being prepared for dissemination after the launch. The most important products for public outreach were the overview report, fact sheets and a film (18 minutes). • The scientific assessment and the development of policy recommendations took place within the same organizational structure, Arctic Council, as opposed to the global regime where these roles are divided between IPCC and UNFCCC. ACIA managed to find a division of roles between science and policy makers in elaboration of the policy recommen-dations that respected the integrity of both. It also seems that there has been reasonably good opportunities for dialogue across this divide in the process. • The attempts to address multiple environmental stressors and the interplay between climate change and other socioeconomic and cultural factors in determining local effects. This opens up for more nuanced discussions on vulnerability and adaptation to climate change. Here the regional approach has given a different framing of the issue than looking at climate change only from a global perspective.
14. Weaknesses	ACIA is not as coherence as it could have been. It can be discussed whether consistent future looking scenarios would have been a better approach that would have led to different scientific conclusions and better policy recommendations. What is more obvious is that that the different chapters in the scientific report are not integrated as good as they could have been. Results from the climate models were for example not used in the other chapters. Time constraints and the need to work in parallel instead of building on others' results is an important part of the explanation. The interaction between different disciplines therefore often seems weak. Nilsson even argues that there are two parallel framings of climate change through this report, one global and one local. Better integration was however achieved in the popular report. Social impacts of climate change to a large degree were framed as impacts on indigenous peoples. Nilsson (2007) explains this as a result of the role the Arctic Council played; indigenous peoples had strong voices that made their views legitimate in this organizational context. Other sub-regional or local stakeholders are not represented here; their views and knowledge were not incorporated in the same participatory manner, and the impacts upon them are not treated as extensively. Nilsson also sees the socioeconomic parts of the impact assessment as insufficiently developed. Her explanation is weak connections to and engagement

	from social scientific networks that could have provided broader insights. The final text of the policy recommendations did not go further than commitments that had already been made at the global level. This can be seen as a failure to incorporate findings from the regional assessment about the Arctic's vulnerability to climate change. On the other hand, many actors were relieved that a policy document came out of the process at all. After all, the initial position of the USA was to challenge the legitimacy of the Arctic Council as a forum for climate policy and the notion that science should determine policy. (Nilsson 2007) The document thus reflects the political constellations in the consensus-led Arctic Council at the time it was negotiated.
15. Attention and significance	Trying to summarize the influences of ACIA, I will say that it has influenced both climate science and the common understanding of climate change. Its political implications are more limited due to the general deadlock of the climate negotiations at the time writing. *Scientific influence* The general impression is that ACIA has a high rating among scientists. Among the Arctic Council assessments, it is often considered as one of their best assessments. It has influenced the research agenda on Arctic climate issues. *Further assessment-related projects* Conclusions from ACIA has contributed to initiate other Arctic Council assessments: • Arctic Oil and Gas Assessment 2007 • Arctic Marine Shipping Assessment (AMSA) 2009 • Snow, Water, Ice, Permafrost in the Arctic 2011 Though not formally called an assessment due to the controversies around ACIA, this is a selected update on natural climatic issues from ACIA. See http://www.amap.no/swipa/ Arctic Council also has started some initial work on adaptation to climate change in the Arctic, like the project "Vulnerability and Adaptation to Climate Change in the Arctic". http://portal.sdwg.org/content.php?doc=62 Further work on common approaches to climate adaptation in the Arctic Council so far has been limited, maybe due to the large regional differences in the actual impacts and societies. In Norway, NORACIA was a five year project covering Northern Norway and Svalbard. More detailed predictions about future climate change and impacts were elaborated and used for discussing adaptation in many sectors. http://www.noracia.npolar.no/ In a 2007 report on climate adaptation in Canada, ACIA is the starting point for discussing implications for Northern Canada. http://adaptation.nrcan.gc.ca/assess/2007/ch3/3_e.php Similarly, ACIA is a starting point in the reports evaluating climate change in Alaska as a basis for the governor's development of a climate strategy http://www.akclimatechange.us/index.cfm. *Dissemination activities and media coverage* ACIA received high attention in the media. The report was officially launched and presented at the Arctic Council Ministerial meeting in October 2004. A large number of journalists followed the press conference. In the first 6 months after, ACIA had higher press coverage than IPCC. The outreach activities were important to disseminate the results to a large

	audience. Especially in the USA, scientific authors actively challenged the policy of the Bush administration on skepticism or denial of climate change. Members of the steering committee and authors were active towards the press and participated in numerous briefings for politicians. For example, it was presented three times in the US Senate. *Political implications* As time goes, other factors than ACIA will influence events. The general impression nevertheless is that ACIA has been highly influential in framing the public understanding of climate change in the Arctic. This message was also communicated outside the Arctic. ACIA thus has laid a scientific basis for a public perception of the changing Arctic as a symbol for global climate change: "the canary in the mine". This has contributed to raise awareness of climate change as a problem and bring the issue higher up on the public and political agenda. Especially in the USA, it is probably right to say that it has contributed to a broader public acceptance of climate change as a problem. Though policy changes at the federal level have been slower, states, the business community, churches and other actors in the USA have taken action to combat climate change. At the international level, the knowledge about impacts of climate change has not been enough to overcome the political challenge of finding common responses to the problem. The insights about impacts on the Arctic have not led the Arctic governments to act coordinated with an Arctic approach in the UNFCCC negotiations. Arctic Council as such also seems to be more hesitating on common approaches to climate adaptation, though individual countries and regions have taken up the issue. However, it is possible to see a linkage from ACIA through AMSA to especially the adoption of the Search and Rescue agreement, as a kind of adaptive response to climate change on an issue where a regional body may have jurisdiction.
16. Relevance for the Fram Centre	ACIA is a core document for the Fram Centre in its work on Arctic climate issues.
17 Additional comments	This review is based on a review of ACIA undertaken for the "Assessment of Assessments", which was written after reading the ACIA documents and interviewing a handful of people who had been central in the ACIA process (ACIA chairs, AMAP representatives). For this update, further reading of the documents has been done. Especially for question 2, 13 and 14, it has also been very helpful to consult the PhD thesis of Annika Nilsson from 2007: *A Changing Arctic Climate. Science and Policy in the Arctic Climate Impact Assessment*. Linköping University, Department of water and environmental studies (2007). A short version can be found in Nilsson 2008: A changing Arctic climate: Science and policy in ACIA. In Koivurova et al 2008: *Climate governance in the Arctic*. Springer.