Maximizing the Legacy of IPY in the Arctic

A scoping study for the Arctic Council

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EXECUTIVE SUMMARY

On the request of the Arctic Council, a Contact Group composed of representatives from the AC member states and Permanent Participants' organizations, as well as relevant international scientific organizations, has been carrying out a scoping study on mechanisms to maximize the legacy of the International Polar Year (IPY). A workshop on these issues was held at the Arctic Science Summit Week (ASSW) in Bergen on March 27, 2009.

The Arctic Council supports international coordination to maximize the legacy of the International Polar Year (IPY) within the following areas:

- Observations, data access and management,
- Access to study areas and research infrastructure,
- Education, recruitment and coordinated funding,
- Outreach, communication and assessment for societal benefit.

Sustained action on these four areas, in collaboration with relevant partners and with a decadal-scale view, will amplify the achievements of IPY and enhance the role of Arctic research in informing societal decisions at this critical time for the Arctic, its peoples, and indeed the global population that is affected by Arctic change.

1. General

The IPY 2007-2008 was an internationally coordinated scientific research and observation campaign in polar regions sponsored by the International Council of Science (ICSU) and the World Meteorological Organization (WMO). For the first time in the history of international polar years it put significant emphasis on the human dimension and the concerns of local and indigenous peoples such as requirements of sustainable development, impacts of globalization of world economy on local economics, wellbeing, languages, cultures and health. Through participation in IPY research, indigenous communities, for the first time in IPY history, assumed a role of a partner rather than a subject of research. It is of particular importance for legacy-related actions to take care of and incorporate the human dimension. A broad engagement of the Arctic residents, especially indigenous peoples, is equally important.

The AC should facilitate and guide adaptation to climate change and to evolving human use of the Arctic leading to increased resilience of the Arctic societies. While adaptation will be practiced at all levels from the individual to the corporate enterprise to the nation, the AC can facilitate and guide by bringing information and best practices across borders and across cultures.

In a number of issues, ensuring the Arctic and Antarctic IPY research legacy should naturally be seen as part of the same process. The AC should communicate with the ATCM about joint actions, where this is appropriate.

IPY showed the feasibility of addressing key environmental and social issues in the polar regions, but their nature requires a systematic and sustainable approach. A long term approach, such as the International Polar Decade (IPD), will be a decisive step in this direction. It should address critical long term issues for developing and improving international cooperation in polar research and observations, including data and information management, and environmental prediction. AC and ATCM could play an important role in organization and development of long term strategies for polar research, monitoring, and management.

2. Observations, data access and management

The SAON (Sustaining Arctic Observation Networks) initiative is an important legacy of the IPY aimed at sustaining high priority observing systems in the Arctic, improved coordination between and management of multidisciplinary networks, facilitation of data acquisition, access and dissemination. This process should be continued and further developed.

Access to research data is crucial for science itself and for ensuring societal benefit from multinational and multidisciplinary collaborations. AC should work with its member states on procedures that result in free and open access to data as described in the IPY data policy, taking into account relevant national legislation, and seek to ensure that relevant national organizations adhere to similar policies. This should constitute an important task for the follow-up of the SAON Recommendations.

The IPY standards and requirements for handling and access to research data have so far been only partially successful. A great potential and indeed a great urgency exist to secure the full legacy of IPY. The Arctic Council should be proactive on this key issue and task the suggested SAON Data Working Group to work together with the IPY Subcommittee on Data to securing IPY data, including making them free and easily accessible.

The Arctic Council could become instrumental in initiating the development of systems for the monitoring of human development and living conditions in the Arctic.

The importance of ensuring availability of standardized metadata is especially emphasized, as this is the crucial initial step. Highest priority should be given to assuring that metadata records are stored for all IPY data, and done so in such a way that the actual data can be moved into legacy databases in due course. IPY metadata should preferably be incorporated into established metadata bases, and can be achieved by a close cooperation between the IPY Sub-committee on Data and the proposed SAON Data Working Group.

A process should be initiated to look at IPY projects that have developed innovative technologies, tested methods, developed ways of cooperation with indigenous peoples, which could be successfully applied to other areas, other indicators, other topics, or other objects. An important task would be to assess this potential, naturally in cooperation with relevant organizations like IASC and IASSA.

3. Access to areas and infrastructure

Arctic research would be greatly facilitated by the sharing of information on the processes and requirements for access and research permits within Arctic countries. An information portal would be a useful tool. All Arctic states should provide information about all relevant up-to-date access regulations and administrative requirements. The IPY Sub-Office in St. Petersburg provided a very useful information service, which should be encouraged to continue. The AC could play a leading role in applying this approach to all Arctic countries.

The AC should encourage enhanced international access and coordination of the member states' infrastructural and research facilities in the Arctic, and task the Forum of Arctic Research Operators (FARO) to collect up-date and make necessary information available.

4. Education, recruitment and coordinated funding

The AC should continue to support education, recruitment and retention initiatives, such as the University of the Arctic (UArctic) and the Association of Polar Early Career Scientists (APECS), that are essential in promoting a culture of mutual understanding across national and disciplinary borders.

AC members should use their experiences gained from the IPY to consider potential mechanisms for improved education and research coordination and funding resources across the

Arctic. The AC should call on the member states to initiate a process of consultations involving Ministries of Science and Education and national funding and operational agencies to create a basis for internationally coordinated funding and shared infrastructure.

5. Outreach, communication and assessment for societal benefit

The IPY EOC (Education, Outreach and Communication) was very successful and communicated polar research and polar issues to a broad public. This success should be continued and organized in a sustained way. Possible partners in a post-IPY EOC would build on existing organizations such as IASC, SCAR, IASSA, national polar institutions, national funding agencies, APECS, UArctic, AC working groups, relevant international bodies, and other partners. The role of the AC working groups is especially important when it comes to communicating research results to policy- and decision-makers.

A post-IPY EOC network should among other tasks consider ways to improve access to modern information and communication technology (ICT) in remote Arctic areas and launch scientific results from IPY (and others) in local and indigenous languages in cooperation with existing education and research structures.

The AC should welcome the initiative of the WMO Executive Council of an International Polar Decade and work together with WMO, ICSU, IASC, SCAR and IASSA to assess scientific decadal needs.

The AC should take full credit for SWIPA as an IPY legacy created under its aegis. It should support the use of scientific data and information collected from the Arctic as a result of IPY to contribute to future assessments by the Intergovernmental Panel on Climate Change, as well as other efforts to address climate change, and future Arctic Council assessments.[1]

[1] From the "Antarctic Treaty-Arctic Council Joint Meeting Washington Ministerial Declaration on the International Polar Year and Polar Science", Washington DC, 6 April 2009. (http://www.state.gov/g/oes/rls/other/2009/121340.htm)

1. About International Polar Year (IPY)

1.1 Idea and history

The unique properties of the polar regions and their significance to the rest of the planet have for a long time attracted science to the polar areas. Previous polar years (1882-1883, 1932-1933, 1957-1958) have demonstrated the value of international scientific collaboration in the polar areas: due to climatic conditions, distances, remoteness and the scale of scientific challenges, cooperation makes it possible to execute projects that any single country cannot do.

The IPY aims to exploit the intellectual resources and science assets of nations worldwide to make major advances in polar knowledge and understanding, while leaving a legacy of new or enhanced observational systems, facilities and infrastructure. Arguably the most important legacies will be a new generation of polar scientists and engineers, as well as an exceptional level of interest and participation from polar residents, schoolchildren, the general public, and decision-makers, worldwide.[2]

The International Polar Year 2007–2008 (IPY) was an intensive, internationally coordinated scientific research campaign in the Arctic and the Antarctic sponsored by the International Council for Science (ICSU) and the World Meteorological Organization (WMO).[3]

IPY has emerged as the largest internationally coordinated planetary research effort in the past 50 years. It has engaged the intellectual resources of thousands of scientists – many more than expected and often from non-polar countries – representing an unprecedented breadth of specialties, from geophysical to biological to social sciences. IPY has been a truly international, interdisciplinary endeavor with over 160 endorsed science projects assembled from the ideas of researchers in more than 60 countries. Substantial new funding – more than USD 400 million – was pledged for IPY, which coordinated with and supplemented ongoing polar research and monitoring programs. In addition, novel system-level approaches, and observational and analysis technologies, including in-situ and remote sensing, were fundamental features of IPY science. Many IPY projects and their offspring will continue beyond the formal observational period, which ends in March 2009.[4]

This IPY recognized the importance of the human side of Arctic research and the inclusion of Indigenous perspectives in research. The IPY marks a beginning of an era where the people of the north are taking active part in the research process, both in defining the issues; do the research and monitoring; and communication of the results. This important new development, energized by amongst others the Arctic Council and the Indigenous Peoples Organizations of the Arctic is manifested in the University of the Arctic cooperation, increased cooperation between IASSA and IASC and inclusion of this perspective in global processes including those led by the UN.

1.2 Projects

Six IPY research themes were defined, which are supposed to be addressed by six interdisciplinary observational strategies.[5]

The polar regions provide a powerful context for teaching and learning, attracting a wide and diverse audience. Education, outreach and communication with the media were integral components of each major IPY 2007-2008 activity and were required parts of IPY projects. Knowledge-based education ensures a new understanding of polar issues and recruitment of

[2] http://216.70.123.96/images/uploads/framework.pdf
[3] http://www.ipy.org/index.php?/ipy/about/
[4] From: The State of Polar Research: a statement from the ICSU/WMO JC for the International Polar Year 2007–2008. http://www.ipy.org/index.php?/ipy/detail/state_of_polar_research/
[5] http://216.70.123.96/images/uploads/framework.pdf

future polar experts, and will together with outreach and communication secure global understanding and support for the value of polar knowledge. Some activities have global reach, such as synoptic measurements of the global environment, and others are nationally focused, such as educational activities woven into primary school curricula, while others have regional impact, such as the shared higher education efforts in the Arctic.

The IPY consists of altogether 228 projects that have been endorsed by the IPY, addressing these 6 major themes. More than 160 of these were funded or partly funded and implemented.

1.3 Achievements[6]

IPY highlighted the global importance of polar processes and the urgent need to understand and track the extremely rapid changes occurring at high latitudes. It resulted in a plethora of research activities and observations that would not have otherwise occurred, with a mutual appreciation of the value of shared logistical facilities, research capabilities and data.

IPY has generated an unprecedented set of environmental and socio-economic data, which provide a comprehensive snapshot of the both polar regions for two years. This dataset will lay a foundation for major scientific advances in knowledge and understanding of the polar regions and their role in the functioning of our planet. The full scientific legacy of IPY will evolve in the years and decades following the completion of the observational program described in the IPY Science Plan.[7] Already however, significant advances in scientific knowledge and understanding have begun to emerge.

The rapid pace of scientific advance and our increasing awareness of mankind's impact on the Earth system as a whole suggest that research and data from IPY 2007–2008 will leave a lasting legacy in many fields of science, particularly in providing a clearer picture of what future changes may occur and what effects they may have.

The planners of IPY 2007–2008 intended that it would pave the way for a new era of scientific progress in knowledge and understanding of the polar regions, and leave a vital legacy of sustained observing systems, increased international research coordination and collaboration, stronger links between researchers across different disciplinary fields, reference datasets for comparison with the future and the past, development of a new generation of enthused polar researchers, and full engagement and understanding of the public and decision-makers worldwide in the purpose and value of polar research.[8]

Box 1: Major IPY legacy achievements (not exhaustive):

- Observational systems, facilities and infrastructure
- Scientific and political cooperation
- Cross-disciplinary collaboration, synthesis and integration
- Creation of reference data
- A new generation of polar scientists and engineers
- Broad public interest and participation
- New, high-quality educational, outreach and communication initiatives and networks
- Engagement of Arctic residents, including indigenous peoples

In addition, IPY 2007– 2008 has advanced the participation of Arctic residents, including indigenous peoples, in polar science at all levels. These developments will enable future research to make maximum use of indigenous knowledge and for indigenous communities to benefit from

[6] Summarized from: The State of Polar Research: a statement from the ICSU/WMO JC for the International Polar Year 2007–2008.

[7] Allison, I., M. Béland and the ICSU/WMO Joint Committee for IPY, 2007: *The Scope of Science for the International Polar Year 2007–2008*. WMO/TD-No. 1364, World Meteorological Organization, Geneva.

[8] Rapley, C., R. Bell and the ICSU IPY 2007–2008 Planning Group, 2004: *A Framework for the International Polar Year 2007–2008.* ICSU, Paris.

scientific advances and are important building blocks in enhancing the research and knowledge sharing capacity among the peoples of the Arctic.

1.4 The Arctic Council and IPY

The AC has a history of fostering and promoting science. Its major assessments such as the Arctic Climate Impact Assessment (ACIA) and the Arctic Human Development Report (AHDR) have relied heavily on science, and it has, over the years, cooperated closely with the International Arctic Science Committee. Of central relevance to this report is that the AC promoted the idea of IPY from an early stage because it is of major importance to the AC mission in general as well as to the work under the working groups in particular. AC was also the home of the initial idea, and later the endorsing body that led to the creation of the University of the Arctic, an instrument to foster development of Arctic expertise within the Arctic region.

While the usefulness and importance of IPY to the work of the Arctic Council is evident, the reverse is also true: the AC through its member states is a significant contributor to the development of science in the region and can contribute to the long-term sustainability of certain activities that have flourished during IPY.

1.5 The Arctic Council IPY Legacy initiative

At the Senior Arctic Officials (SAO)[9] meeting in Svolvær, April 2008, the SAOs discussed the idea of an IPY legacy initiative. The rationale for the engagement of the Arctic Council in this regard is the importance of science to the Arctic region in general, and the role of science in decision-making on almost all issues before the Arctic Council and its members. Therefore, the Arctic Council has an interest in promoting science in general and in building upon the IPY effort in particular.

At the SAO Meeting in Kautokeino on 19-20 November 2008, the SAOs endorsed the IPY legacy initiative and expressed strong support for the importance to incorporate results of relevant IPY projects into all work of AC and for the AC to take an active role in fostering sustained IPY legacy. The issues identified in the proposal were considered to be the highly relevant, both sustained scientific cooperation and also on ensuring that the relevant IPY findings are communicated to inform decision makers and Arctic residents.

By approving the project proposal “Maximizing the legacy of IPY”, the SAOs set guidelines for what the present study should aim at. In particular, the SAOs emphasized that the legacy of IPY should reach beyond the pure scientific achievements to enable scientists, policy-makers, and Arctic residents to continue to work together to understand and to address the major scientific outcomes of IPY. This seems to be particularly important in the context of the wider attention the Arctic has seen the last decade due to the especially pronounced manifestation of climate change and, partly as a consequence of this, prospects of improved accessibility of natural resources there. On this background, the Arctic Council is the natural relevant body, and has a particular responsibility, to assess and realize IPY legacy themes in the Arctic.

Four IPY legacy themes are central to the work of AC programs and its overall goals:

1. **Observations, data access and management**
2. **Access to study areas and research infrastructure**
3. **Education, recruitment and coordinated funding**
4. **Outreach, communication and assessment for societal benefit**

These legacy themes are suggested to be considered for action by the AC with a focus on the immediate relevance for human societies and the natural environment on which their existence depends in the region, as well as the relevance for the future development in the Arctic.

[9] Senior Arctic Officials represent the ministers in the two-year periods between ministerial.

2. How can the Arctic Council contribute to convert IPY results into societal benefit?

2.1 The responsibility of the Arctic Council

The Arctic Council requires a solid scientific basis for its actions and has established several working groups with programs that bring scientific knowledge into the policy arena in useful ways. The role of the AC is to oversee and coordinate these programs. On this background, the Arctic Council is the natural relevant body, and has a particular responsibility, to assess and realize IPY legacy themes in the Arctic, with a view to further implementation in its member countries and elsewhere.

With the central role the AC is fulfilling in the Arctic, it is of major significance to further development of science in the region. At a general level the AC emphasizes the need to base decisions and actions on science. In more practical terms, as a major user of science, the AC and its member states contribute to the way science can develop.

Because the IPY of 2007-2008 has produced a wealth of new Arctic science, the Arctic Council should become aware of and use the relevant portions of this new knowledge to support the needs of the Arctic societies.

When future historians assess the IPY of 2007-2008, they should look also at how organizations such as the Arctic Council benefited from the IPY, and what the Council did to ensure that it received a high level of benefit. The Member and Observer States of the Arctic Council financed a very high percentage of the IPY and they should be at the forefront of efforts to build on this investment for public benefit.

2.2 Convert data into predictive models valid for the Arctic

Converting knowledge into societal benefit is a challenge. For doing this a process is required that bridges the many observations and studies of Arctic systems conducted before and during IPY and the development of predictions for the integrated geophysical, biological, and social system. While climate model runs for the Fourth IPCC Assessment Report show that it is possible, in principle, to predict centennial scale-term warming of the Arctic due to the greenhouse gas effect, decision making requires predictions of decadal time scales that take into account all relevant regional features, processes, and external factors. Unfortunately, unlike tropics, Arctic climate has been considerably less predictable on such scales, which resulted in a lack of suitable and capable predictive models for Arctic systems. The bulk of IPY observations, improved understanding of the many processes that take place in the region, now make it possible to review the predictability of the Arctic in the changing climate, and to ensure that models capture well all the factors contributing to it. The effort required needs to be very substantial and justifies a well-supported program of regional modelling of the Arctic climate, which would be fully compatible with ongoing experiments on prediction of the global climate system. A set of global climate model runs, which is now being facilitated by the World Climate Research Programme for the Fifth IPCC Assessment (AR5), will contain runs not only of centennial scale but also of decadal scale. Their results will be stored and made available for regional downscaling and verification of models. The Arctic research community will have therefore an opportunity to downscale global predictions, make runs for the historical part of the record, and counter model output with observations. The IPY geophysical observations will therefore be instrumental in verifying and calibrating the corresponding part of the climate model output. However, existing predictive techniques do not include ecological and social domains. They will have to be developed and tested against more complete data sets, which can help facilitate comparisons across disciplines, including the dataset generated during the IPY.

The highest priority for the Arctic science is to develop predictions on meaningful time scales for such issues as the future multi-year ice, evolution of ecosystems in the changing climate and acidified Arctic Ocean, and such social issues as e.g. human health. Due to unprecedented changes happening in the Arctic, reliance on local past 'climatologies' or extrapolation of recent trends will not be able to provide adequate guidance for the future. A prediction focus and framework, covering the physical, biological and social-economic and cultural features of the Arctic system, even one that starts with tentative forecasts, will represent the fastest and most effective way to exploit IPY science for the benefit of Arctic residents and global citizens.

2.3 Need for improved monitoring and assessment

The Arctic Human Development Report (AHDR), ACIA, the International Conference on Arctic Research Planning (ICARP II), projects of the IPY, and others, have documented in detail the changes occurring in the Arctic and the need for monitoring to assess the impact of change, and to communicate results to Arctic stakeholders. The ICARP II process identified critical research needs and outlined practical steps and organization to be considered. One such proposal was the establishment of coordinated and integrated Arctic observation systems that focus on social, biophysical, and ecological dimensions and include local- to global scale monitoring; and the build up of a meta-database of case studies on socio-ecological change and with it, a standardized format and common set of key variables. Indeed, following ICARP-II and ACIA, several IPY projects – and in particular SAON (Sustaining Arctic Observing Networks) initiative – have pointed to the need for close and long-term monitoring of Arctic change, including observations and data management. Improved monitoring of the Arctic is needed to gain full understanding of these processes and their impacts, followed by converting the knowledge into societal benefits.

2.4 Multiple facets of an integrated Arctic system

The ACIA report and the ICARP planning processes demonstrate the multiple facets, marine and terrestrial, physical and biological, local and global, of the Arctic system. IPY will emphasize the intensity and complexity of linkages among these facets and the rapid rates of change of many components. Although prediction for the Arctic system may start from weather and climate, real prediction skill for ice, ecosystems and health will require assets of and cooperation from meteorology, hydrology, oceanography, glaciology, biology, ecology, physiology, sociology, economics, and more. Progress on prediction skill for the integrated Arctic system, while enormously difficult, will represent an important enabling step for other regional or global systems.

Prediction induces focus, as suggested here on ice (for climate, sea level and transportation applications), ecosystems (for future fisheries, forestry, and biodiversity conservation) and health (for current and future Arctic residents), and identifies mutual dependencies: prediction of health requires prediction of food resources (ecosystems) which requires prediction of ice. Producing a useful prediction entails substantial risk (and requires changes in thinking and funding), but nothing focuses attention on quality, or on user expectations, like the requirement to produce regular and skilful forecasts. Prediction systems force us to think operationally, to assess the timeliness and quality of observations, to develop and use assimilation schemes, skill scores and error analyses, and to meet user needs. The requirements of a prediction process will advance communication and impact of Arctic science like no other activity.

Indigenous knowledge could play a role in understanding of variability and predictability of Arctic environment, as well as of human resilience, as it is based on many centuries of observations and a philosophical relationship between humans and nature that differs from the modern technology-based western science.

2.5 Role of local and indigenous communities in addressing natural and anthropogenic impacts on society

While much of the discussion focuses on environmental and social changes driven by the changing natural conditions, one must not discount the impacts of the globalized economy and the increasing use of natural resources in the Arctic. The economic, legal, social, cultural and other aspects related to these issues are of equal importance to Arctic residents, and in a number of cases are even more pressing that the environmental change.

The Arctic Council, in many ways, has pioneered the inclusion of local and indigenous peoples' observations of environmental change and their perspectives in scientific assessments, most notably in ACIA, where case studies supported the scientific findings. This ground-breaking work served as an impetus for the development of many collaborative interdisciplinary projects that attempted to synthesize local observations and mainstream science. IPY presented a unique opportunity as it created funding sources for such projects. Not only does such collaborative research enhance overall knowledge of the Arctic but it also builds lasting partnerships between Arctic residents and the scientific community. Arctic Council's IPY projects.

Through participation in IPY research, indigenous communities, for the first time in IPY history, assumed a role of a partner rather than a subject of research. The benefits of this partnership are multifaceted: knowledge sharing, building research capacity for on-going observations in remote locations, better understanding of the research needed to address socio-economic concerns of arctic communities, and many others.

The Arctic Council should support further development of new and the continuation of current projects that build on this legacy.

2.6 The role of the Arctic Council in converting knowledge into policy and action

Observations and data/management; access to areas; communication and societal use of research results; education, recruitment, capacity building, and coordinated funding are all IPY legacy areas that are of particular interest to the Arctic Council. The Arctic Council has shown support for ensuring that the relevant IPY findings are communicated to inform decision makers and Arctic residents – with the legacy reaching beyond the scientific achievements to enable scientists, policy-makers, and Arctic residents to continue to work together to understand and address the big scientific outcomes of IPY.

The new data from the IPY should influence significantly the work of the Arctic Council, but only if the Council can assimilate and study this new information. Thus it is imperative that the Council encourage and facilitate the rapid transformation of "data" to "information", especially in those areas of science relevant to the work of the Council. Similarly, other international Arctic organizations that rely on science in their work should engage in similar action. The Arctic Council should seek partnerships with these organizations when it is mutually beneficial.

The amount of research on global change and its impacts is growing, but significant gaps in knowledge concerning the nature of global change risks and ways to deal with them persist. This is where earth systems science, including human dimensions related science, is particularly important. Environmental and societal changes and other processes occurring at a rapid pace, combined with limited observational infrastructure, and a lack of timely, appropriate and reliable data and information networks, present Arctic stakeholders, government and the research community with new challenges. In social science research, new demands are placed on access to data for the study and modelling of these processes, and for understanding, measuring and predicting the impacts of change on social systems at various scales, and understanding the links with the rest of the world and their feedback mechanisms. The

integration of knowledge across disciplinary boundaries adds to the observed data and information requirements. These challenges need to be addressed in order to link the outcome of science with societal benefits.

2.7 The International Polar Decade

The WMO Executive Council made the following statement at its 60th session: *"The Council felt that the success of the first year of the IPY (2007-2008) implementation, great investments of the governments to this international campaign, growing requirements of scientific and local communities in a period of drastic changes in Polar Regions environment motivate the nations to continue and sustain high-quality observations and research for a more extended period of time. In view of this, Council recognized the unique opportunity for WMO in consultations with ICSU and other international organizations to consider the launch of an International Polar Decade as a long-term process of research and observations in Polar Regions to meet the requirements of climate change studies and predictions so as to benefit societal needs."*

Consultations are ongoing as to which decadal needs (in addition to climate change) there are, and which require or more efficiently can be met by a circum-arctic and international cooperation, including how an International Polar Decade (IPD) could be initiated and organized.

3. Potential AC Activities to Maximize the IPY Legacy

3.1 General concepts

3.1.1 Virtual organizations, observatories and networks

The concept of virtual organizations (VO) is not new in its nature. Its core is cooperation and networking by dispersed groups or individuals. However, new technological tools make it far more efficient. The NSF report[10] on VOs should be widely promoted to Arctic (and other) science.

Box 2: Virtual Organisations

A virtual organization or company is one whose members are geographically apart, usually working by computer e-mail and groupware while appearing to others to be a single, unified organization with a real physical location. (http://whatis.techtarget.com/definition/0,,sid9_gci213301,00.html)

A virtual organization is created by a group of individuals whose members and resources may be dispersed geographically and/or temporally, yet who function as a coherent unit through the use of end-to-end cyberinfrastructure systems. These CI systems provide shared access to centralized or distributed resources and services, often in real-time". According to the report "Cyberinfrastructure vision for 21st century discovery" (www.nsf.gov/od/oci/CI-v40.pdf), the overall philosophy of cyberinfrastructure is built on 4 pillars:

- High Performance computing
- Data, data analysis and visualization
- Virtual organizations for distributed communities
- Learning and workforce development

There are already many VOs operating in the Arctic; one could argue that part of Arctic Council work is carried out applying a VO approach – several of the assessments and some of the working group actions are done in this way.

Large projects are collaborating now (e.g. DAMOCLES-SEARCH-ARCTICNET) and they have shown considerable flexibility in marshalling resources e.g. sea ice teams of observers and modelers are collaborating in informal teams, as are ice sheet modelers. There is movement also to link efforts towards improved regional modeling, specifically creating Arctic regional models to function both as components of climate model but also provide appropriate resolution to key Arctic processes. The University of the Arctic provide around the globe co-ordinated education and sharing of university resources, and is also in itself managed using concepts of virtual organizations. These and many other elements of IPY activity provide both building blocks and momentum toward a new way of collaborating through VO that could well be one of the more revolutionary legacies of IPY. The result could be the key to cracking the complexity of Arctic-system change and possible response strategies of critical importance to northern residents.

The development of VOs is an important legacy of IPY. The Arctic is by nature a place fit for this kind of organizational thinking. The AC is encouraged to continue to promote VO approaches and actively look for opportunities to create efficiencies in the way it organizes future activities.

3.1.2 System approaches

The need to study the earth as a whole system has nicely been visualized since the advent of satellite observations that clearly showed broad-scale aspects of the earth functioning as a dynamic system on multiple time scales. Over time this recognition led to the general concept

[10] http://www.ci.uchicago.edu/events/VirtOrg2008/VO_report.pdf

of *earth system science*. Increased understanding of the earth system gradually made it possible to begin constructing global climate models, while growing computational capacity made it possible to run them for century-long time scales and with meaningful spatial resolution. Fully conceptualizing and accounting for the *linkages* among complex environmental systems and subsystems remains a challenge to the research community, however. IPY 2007-2008 resulted in significant advances in our ability to merge excellence in disciplinary research into system-wide approaches to environmental change and environmental issues. It also resulted in the development of portions of a circum-Arctic observing(?) network that will inform earth system synthesis for years to come.

It is now clear that environmental change is observed throughout all components of the Arctic system. A dramatic example is in the Arctic sea-ice cover, specifically the declining summer minimum spatial extent. Other changes are observed in the atmosphere (e.g. winter warming), the ocean (e.g. deeper penetration of warm Atlantic water into the Arctic basin), the cryosphere (e.g. increased surface melt in Greenland and the dynamic response in tide-water glaciers), the ecosystem (e.g. “greening”, seasonality and phenology), and human communities (e.g. the vulnerability of coastal villages and many aspects of food security). In all these areas the importance of variability has come to the fore as a result of advances made during IPY research.

The earth systems perspective encompasses studies of the human dimensions of Arctic environmental change. An example is the complex interactions among natural resource exploitation, changing legal regimes, societal constraints, and environmental changes in the traditional living space of reindeer herding nomads.

On the one hand, humans and their activities is an important driver of change. In this respect the major challenge is to understand what components of change that can be ascribed to human activities, and how degradation of the natural environment can be prevented and mitigated. On the other hand, humans are also affected by change and there is a need to understand how communities and countries are affected.

Future activities of the Arctic Council, wherever possible, should adopt a systems perspective.

3.2 Observations, data access and management

The need for a well coordinated and Sustaining Arctic Observing Networks that meets scientific and societal needs has been identified in numerous high profile reports and at a variety of workshops and conferences. Notwithstanding the many and frequent reports of Arctic change, our knowledge of the Arctic system is limited in many respects: there are temporal, spatial and disciplinary gaps in observing records, and data are often difficult to obtain or even unavailable. Sub-optimal observing and data management hamper our ability to monitor and study environmental and socio-economic and cultural change and their regional and global consequences.

Only circum-Arctic efforts in monitoring and research with a long-term perspective can guarantee that critical changes in the region with potentially severe impact on societies are identified and understood, and possible mitigation or adaptation measures are taken. Sufficiently long time series to interpret changes in a long-term context are scarce and distributed very unevenly in the Arctic; in some disciplines they are only in their starting phase or completely missing. IPY results will help scientists and users to assess the quality of the existing measurement network and to identify requirements for a more appropriate observation network.

3.2.1 Major long-term monitoring projects initialized through IPY

This section summarizes four initiatives on which the AC can contribute. In all cases, collaboration with other organizations is necessary. The order in which the projects are presented runs from an initiative with a major AC leadership role (SAON), to initiatives that have a global reach and to which the AC and its member states would contribute but not lead.

Sustaining Arctic Observing Networks (SAON)[11]

In November 2006, the AC urged all member nations to maintain and extend long-term monitoring of change in the Arctic[12], with a view to building a lasting legacy of the IPY. Further, the AC requested that AMAP work with other AC working groups, the International Arctic Science Committee (IASC), and other partners to create a coordinated Arctic Observing Network that meets identified societal needs.

In January 2007, the Sustaining Arctic Observing Networks Initiating Group (SAON IG), composed of representatives of international organizations, agencies, and northern residents involved in research, operational, and local observing, was formed to develop a set of recommendations on how to achieve long-term Arctic-wide observing activities that provide free, open and timely access to high quality data that will realize pan-Arctic and global value-added services and provide societal benefits.

Box 3: Further endorsements of the SAON process

At the Eighth Conference of Parliamentarians of the Arctic Region (Fairbanks, 12-14 August 2008), the Senior Arctic Officials asked the governments in the Arctic Region, the Arctic Council and the institutions of the European Union to "… *implement the recommendations from the International workshop in Helsinki in October 2008 on 'Sustaining Arctic Observing Networks', (SAON), as a legacy of the International Polar Year 2007 – 2009*."

The goal of developing an Arctic Observing Network as a legacy of IPY (WMO/ICSU) was endorsed by the WMO XV Congress in May 2007 and SAON was endorsed by the ICSU Executive Board in November 2008.

The EU Conference "The Arctic: observing the environmental changes and facing their challenges" (Monaco, 9-10 November 2008)" endorsed a "Monaco Declaration", which amongst others took note of the need to uphold the impetus launched by IPY and called for an important European contribution to support the future of the SAON process as well as take full benefit of (and work towards integration of observations from) the strong existing networks of the EU, UN, and internationally supported observation programmes.

The UNESCO conference in Monaco (3-6 March 2009) concluded amongst others with these recommendations:

#43: Given the limited number of observation networks in the Arctic, sustaining, strengthening and further developing long-term comprehensive multidisciplinary integrated pan-arctic observing systems is recommended.

#44: A mechanism should be established to facilitate international collaboration among operators, funding agencies, indigenous peoples' organisations and users of multidisciplinary observational systems and data over the Arctic region. The efforts of SAON (Sustaining Arctic Observing Networks) to do this should be acknowledged and supported. UNESCO and its IOC should request that member countries support these observation and monitoring systems.

With AMAP, on behalf of the Arctic Council, having the leadership of the SAON IG, a succession of workshops was carried out during 2007 and 2008 in Stockholm (Sweden), Ed-

[11] http://www.arcticobserving.org

[12] Salekhard Declaration: http://arctic-council.org/filearchive/SALEKHARD_AC_DECLARATION_2006.pdf

monton (Canada), St. Petersburg (Russian Federation), Incheon (Republic of Korea), and Helsinki (Finland).

Draft recommendations proposed by the IG were discussed in detail by 75 participants at the final Helsinki workshop (15-17 October 2008). Key issues for the implementation of a coordinated and Sustaining Arctic Observing system were building blocks, funding, data management, and organization. Based on this final meeting, the IG made recommendations in their report submitted in December 2008 to the AC for consideration at the Ministerial Meeting of the AC in April 2009.

Other key organizations and meetings have added to the momentum generated through the AC-led SAON process (*Box 3*).

It is important to recognize the potential so-called "Building Blocks" of SAON, whether long-standing or nascent operational monitoring, or hypothesis-driven integrated observational campaigns that in some cases integrate local knowledge.[13]

Global Cryosphere Watch

A scoping document to define the feasibility of developing and implementing a Global Cryosphere Watch (GCW) prepared by the GCW ad hoc group will be submitted to the WMO Executive Council in June 2009. The document is based on IPY scientific advances and on outcomes of consultation carried out within WMO, with outside organizations and agencies, and with the international scientific community. It proposed that targeted pilot and demonstration projects over the next two years should be implemented as soon as possible to demonstrate the feasibility of GCW.

Polar Satellite Constellation

One purpose of the Polar Satellite Constellation initiative is to leave a legacy data set compiled from multiple space agency satellite data portfolios comprising a broad range of "polar snapshot" products. In the context of IPY legacy activities, an equally important additional purpose is to strengthen cooperation between major satellite agencies, some of which are Arctic nations, ensuring coordination of polar observations beyond IPY.

The Space Task Group on IPY, which was formed by space agencies, actively coordinated space agency activities on polar observations and research. The results are:

- significant progress during the IPY toward acquiring comprehensive Arctic and Antarctic snapshots;
- an array of new data products that has been planned, acquired, and archived to address some of the key scientific goals of IPY;
- progress in engaging partners in the "Arktika" satellite project (Russian Federation)
- significant progress in building a space-borne component of the IPY data legacy.

The main remaining challenges include coordination and synchronization of acquisitions of overlapping multi-satellite datasets.

Polar Climate Outlook Forum

The concept of a Polar Climate Outlook Forum (PCOF) as a viable operational mechanism to facilitate effective interactions between climate service providers and users/stakeholders was developed at WMO/WCRP-CliC/IPY Workshop on "Climate Information and Prediction Ser-

[13] http://www.arcticobserving.org/images/stories/saon_report_final_web.pdf

vices in Polar Regions: Climate product generation, user liaison and training" (St Petersburg, September 2008). PCOF should bring together national, regional, and international climate experts to produce regional climate outlooks based on input from national meteorological and hydrological services, regional institutions, Regional Climate Centres and global producers of climate predictions. Through interaction with sectoral users, extension agencies, and policy makers, PCOF can assess the likely implications of the outlooks on the most pertinent socio-economic sectors in polar regions and explore the ways in which the outlooks could be made use of. The PCOF will be oriented toward the use of the future scientific achievements related to climate predictability in the polar regions in a changing climate.

3.2.2 Databases produced or initialized through IPY

The public availability of data and databases generated during IPY for future research and for the benefit of the society is a basic requirement for the IPY legacy.

A variety of metadata has been collected continuously during IPY[14].

The IPY Data and Information Service[15] has produced a database of IPY data repositories and contact persons. Although the majority of IPY data may be located from this information, it is still a challenge to secure all data, which is also in the interest of the AC as these data will be important for their assessments. Project leaders have all signed up to a good data policy that should make this possible.

IPY project databases are too many to list at this stage, and examples could be misunderstood as being meant exclusive. They provide as a whole a wealth of new information. It would be an important task to coordinate an inventory of databases from IPY projects.

3.2.3 IPY pilot activities with a potential to be followed up

There are a number of time-limited projects, which have no concrete plans or funding to be continued after IPY, although a follow-up would be desirable. Some of these projects have developed innovative technologies, tested methods, developed ways of cooperation with indigenous peoples, other inhabitants, various stakeholders and practitioners, which could be successfully applied to other areas, other indicators, other topics, or other objects. An important task would be to assess this potential and make it known to the scientific community, funding institutions and the public in order to secure that continuation of IPY-projects and development of new projects are based on efficient use of new information and practices obtained during IPY.

3.2.4 Gaps, synergies and partnerships

The SAON (Sustaining Arctic Observation Networks) initiative is already an important legacy of the IPY for coordination of multidisciplinary Arctic data acquisition, management, access and dissemination. This process should be continued and further developed.

SAON is challenging and difficult to implement. Monitoring is often under the control of several ministries within each nation and coordination at this level, let alone with a circumpolar perspective, is hard. The Arctic Council is a key instrument to facilitate the SAON process. The success of the European Environment Agency in streamlining environmental data from all its

[14] Databases produced from the IPY International Program Office include the EOI data base (a rich list of research topics, some of them un-fulfilled); the IPY project database (a searchable database of projects with investigators and countries); the IPY News, Blogs, and Contributions databases from ipy.org (a rich source of information and list of partners and supporters of Arctic research); the IPY google groups of project coordinators, educators, and media (the active heart of IPY).

[15] http://ipydis.org/

member countries can be used as inspiration for the potential AC role.

Access to research data is crucial for science itself and for ensuring societal benefit from multinational and multidisciplinary collaborations. AC should work with its member states on procedures that result in free and open access to data as described in the IPY data policy.

The IPY set out a standard and requirement for handling and access to research data. This was a very good initiative that, for a number of reasons, was only partially successful during the observance period of IPY but for which there exists great potential and indeed great urgency to secure the full legacy of IPY. The Arctic Council should be proactive on this key issue and task the suggested SAON Data Working Group to work together with the IPY Subcommittee on data to securing IPY data, including making them free and easily accessible. Time is particularly of the essence on this matter, and action is needed in the next year.

The importance of ensuring availability of standardized metadata is especially emphasized, as this is the crucial initial step. Highest priority should be given to assuring that metadata records are stored for all IPY data, and done so in such a way that the actual data can be moved into legacy databases in due course.

The Arctic Council could become instrumental in initiating the development of systems for the monitoring of human development and living conditions in the Arctic. The development of a system for long-term monitoring of human development in the Arctic is the focus of the Arctic Social Indicators (ASI) project – an Arctic Council endorsed project under the SDWG.

The Arctic Council should facilitate efforts to enhance and maintain observing systems which are crucial for the development and testing of predictive models for time and space scales useful for policy- and decision-making. Model-based predictions will be a strong basis for public and private actions affecting Arctic economic development and social sustainability.

A process should be initiated to look at IPY and other ongoing Arctic research projects and network projects that have developed innovative technologies, tested methods, developed ways of cooperation with indigenous peoples. Consultations with local inhabitants, various stakeholders and practitioners, should be performed to ensure successful applications to other areas, other indicators, other topics, or other objects. An important task would be to assess this potential, naturally in cooperation with relevant organizations like IASC and IASSA.

3.3 Access to study areas and research infrastructure

3.3.1 Access regulations and related difficulties

Achieving the goal of being able to understand and accurately predict the future trajectory of the Arctic system requires unconstrained access for research and monitoring across the Arctic.

The first Polar Year had coordinated observations as its basic idea giving a possibility to study a phenomenon for a larger area. Climate change can serve as an example of such a phenomenon to-day, requiring data from all the Arctic as well as knowledge of processes.

In the past, access to some areas in the Arctic has been severely hampered by bureaucratic and economic obstacles. Access to areas under national sovereignty has naturally to abide national laws and regulations. However, in some cases these regulations have been unnecessary complicated and or unpredictable.

Such obstacles have been especially challenging for scientists when moving across national borders. Bringing scientific instruments in and the same instruments back is one problem area. Another is taking samples for analyzing at a home laboratory and crossing a border with them. Additional obstacles are enormously high fees to pay for access permits and frequently changing regulations for filling in forms and customs regulations.

Usually scientists highly respect the need for national or regional authorities for doing full inspections. However, relatively small changes can be undertaken to facilitate the process for both national authorities and the involved scientists.

An important and highly valuable legacy of IPY could be to reconsider access impediments in all regions of the Arctic, building on achievements made during the IPY, and through inter-governmental consultations to improve the access situation for scientists in the whole Arctic on a long-term basis. This is a complicated, demanding, and politically complicated issue for which the forum and functions of the Arctic Council are uniquely suited.

Access regulations to protected areas (national parks, sacred sites, archeological sites etc.) are respected by all and is not an issue is this paper. The same applies for safety and rescue regulations, and for studies involving local residents and communities.

3.3.2 Research infrastructure

A huge problem in the Arctic is lack of transportation. In some areas, this is combined with border crossing issues, because there is no coordination between "ports of entry" and actual transportation links.

Building infrastructure in or for the Arctic as well as operating it is expensive. Infrastructure for Arctic research comprises usually terrestrial research stations, research vessels, helicopters, and/or airplanes. More lately we have plans for unmanned vehicles (drones) carrying instruments and increased use of polar orbit satellites.

Many of these ‘tools’ are not used in a cost-efficient way, often because some nations wish to refer to ‘our’ research station or an impressive icebreaker. For the darker part of the year much of this infrastructure is underused, or not at all.

Similarly, there are examples of clustering of national research stations in a small area, whereas we lack data from vast areas because of a total lack of observations. It may seem that we are locked into national thinking rather than opening up the discussion for international cooperation on using existing infrastructure efficiently.

The IPY has contributed to a more international attitude and insight into joint logistical planning. The satellite companies have made good offers to scientists, so they can discover the benefits (and limitations) by this important way of collecting data. Multinational funding of major research programs using vessels has contributed to using the most cost-efficient solution rather than only considering national vessels. Some nations have entered into bilateral agreements on the use of each others’ research stations or vessels.

We are in the beginning phase of a process in which international cooperation easily can create win-win situations by better use of existing logistics.

3.3.3 Gaps, synergies and partnerships

Arctic research would be greatly facilitated by the sharing of information on the processes and requirements for access and research permits within Arctic countries. An information portal would be a useful tool. All Arctic states should provide information about all relevant up-to-date access regulations and administrative requirements. The IPY sub-office in St. Petersburg provided a very useful information service, which should be encouraged to continue. The AC could play a leading role in applying this approach to all Arctic countries.

The AC should encourage enhanced international access and coordination of the member states’ infrastructural and research facilities in the Arctic, and task the Forum of Arctic Research Operators (FARO) collect, up-date and make necessary information available.

3.4 Education, recruitment and coordinated funding

IPY has both boosted activities in already existing recruitment structures, such as the University of the Arctic[16], with programs promoting mobility (GoNorth, north2north, and the Arctic Study Catalogue), the circumpolar delivery of "Arctic Studies" program, and joint master and PhD programs between Arctic Universities and colleges. Another main achievement of IPY is the establishment of the Association of Polar Early Career Scientists[17] (APECS) that promotes the community among young polar scientists and students globally.

Adequate and balanced recruitment and relevant training of young experts both in the north and globally must be secured and existing systems for comprehensive/extensive cooperation and exchange programs for scientists and students must be considerably strengthened. This will promote a culture of mutual understanding across national and discipline borders, which is an important aspect in ensuring that critical changes in the region are identified and understood and measures can be taken.

Coordinated research planning and funding is a critical issue. Traditionally, research funding (and priorities) is decided at national level. This is presently changing, and in Europe in particular, international funding is becoming more important. The bottom up process with expressions of intent in the initial phase of IPY as well as the process up to the International Conference of Arctic Research Planning (ICARP II) are examples of novel science community processes that help focus and identify research issues in the Arctic. The funding mechanisms are not yet fully equipped to respond to such processes. Experiences gained from the IPY process could be of value in developing ideas for improved research coordination and funding at the international level.

3.4.1 Education and recruitment

Nearly every Arctic Council member country will have experienced a surge in graduate students and Post-Docs during IPY, due partly to increased interest and publicity about polar research as an opportunity to 'make a difference', but due largely to funding increments. We can estimate, based on numbers from Canada and Norway, that Arctic-wide research during IPY has attracted more than 100 Post-Docs and several hundred new graduate students. These students have a broad international background: a recent next generation activity in the USA had 10 explicit international participants, and with an even wider international representation among the so-called 'US' graduate students.

The international participation in future Arctic research represents a very positive development, although overall funding and particular issues related to national funding and employment opportunities present crucial and urgent issues in the long-term retention and future recruitment of Arctic scientists. In addition to students directly related to IPY projects, the number of students seeking competence in and about the north is growing strongly. The enrolments in the interdisciplinary Arctic Studies Program of the University of the Arctic (UArctic) have grown beyond 1000 and the numbers with degrees in northern studies is growing fast. There is also a noticeable growth in students with origin from southern latitudes in this program, now being delivered at about 20 member institutions of UArctic.

These new researchers more often than not take an interdisciplinary approach, combine modeling with observations, and regard polar research as an attractive adventure and as a personally fulfilling career. Preliminary surveys suggest that they do not regard the typical academic career progression as desirable, inevitable or sustainable. In many cases they find support, encouragement, and career development assistance through topic-based formal or informal networks (e.g. with a focus permafrost or marine ecosystems). These topics often evolve from a regional or national basis and relevance but do not automatically or exclusively

[16] http://www.uarctic.org
[17] http://arcticportal.org/apecs/about

conform to traditional academic disciplines, and the students find themselves occasionally mismatched to existing academic curriculums and to discipline-specific funding and employment systems.

The University of the Arctic (UArctic)

The University of the Arctic has been the lead agent for IPY Higher Education in the Arctic and has grown during IPY into a unique and complete network of higher education institutions in the North, which enhances northern research and education cooperation. UArctic's 116 members include practically all of the universities and colleges in the Circumpolar North and several important research institutions and indigenous organizations. Totaling over 650,000 students and some 50,000 academic staff, the UArctic network provides a unique and complete northern university and research network built by its members and with support from governments.

The University of the Arctic can provide stewardship for a sustainable long-term legacy in higher education and research cooperation in the Circumpolar North that fosters the leadership of the next generation of IPY experts. Further, UArctic is committed to ensuring that the northern universities and colleges become key players in the development and sharing of knowledge in and about the North and that such knowledge is based on indigenous and local traditional approaches as well as modern science approaches to knowledge generation and sharing.

UArctic will work in close cooperation with the global polar research community, in particular the major polar science organizations, IASC, SCAR, and IASSA. The Arctic governments are encouraged to start cooperating more closely to increase circumpolar cooperation to ensure maximum use of the good investments in Arctic Higher Education and Research. This also includes improved use of the growing Arctic research capacity in the North through the work of the Arctic Council working groups.

The Association of Polar Early Career Scientists (APECS)

The development of the international and interdisciplinary Association of Polar Early Career Scientists (APECS) represents one of the singular accomplishments of IPY and an activity that has benefited greatly from explicit support from Arctic Council member countries. APECS has formal relationships with IASC (and, in the south with SCAR) and a central role in the future of polar research, Arctic and Antarctic.

We note the vital importance of opportunities and resources for APECS. Single events[18] and, to a surprising degree, locations (Svalbard!) represent crucial venues and opportunities for developing, encouraging, and propagating the ideas, influence and energy of these future Arctic researchers. The Arctic Council member countries should pro-actively develop and support these events and opportunities (and include early career scientists in planning and organizing such events) and all the Arctic Council programs and working groups should actively engage early career scientists in their activities and steering groups.

3.4.2 Funding

Two issues then arise for an Arctic legacy: sustaining the components of the IPY legacy for which there is broad, international consensus on the need, and identifying and continuing the

[18] the SCAR-IASC St Petersburg science conference, the up-coming Oslo 2010 IPY Science Conference, the IPY International Student and Early Carreer Scientist Conference in Whitehorse, 2009, on-going conferences like Arctic Frontiers, Arctic Change, Arctic Science Summit Week, specific programs like the IPY Post-Doc programs at University of Alaska, Fairbanks, an up-coming summer school at UNIS

opportunities and mechanisms for continued and enhanced multilateral coordination of those funding processes.

New funding from the Arctic Council members for Arctic research during IPY probably exceeded USD 180 million (for two years) on top of regular annual expenditures of approximately 400 million USD; non-Arctic countries contributed approximately USD 30 million additional funds to Arctic research during IPY. Several Arctic Council observer countries including the UK and China made investments in Arctic research and others, such as Germany, increased their already-substantial activities in the Arctic. A very approximate estimate suggests that IPY stimulated perhaps as much as a 25% increase for Arctic research (this total DOES NOT include substantial new investments in logistic capabilities or in major infrastructure, including icebreaking ships, implemented or announced during IPY). Perhaps as important as the quantity of additional research funds, the unanimous participation by researchers from every Arctic Council member country in IPY and the success in achieving incremental funding in most of the countries indicates strong political support for Arctic research during IPY.

Polar research communities and their representatives in the national research councils and science funding agencies in several countries have initial and tentative ideas and plans for one-time renewal, and in some cases continuation, of incremental IPY funding. As for the original IPY funding, developments and possible success in some countries will occur sooner than in others. In all countries, for both current and future researchers, the issue of continued funding has an urgency that the Arctic Council should highlight. The Arctic Council might also give consideration to the concept of an International Polar Decade which may prove effective in maintaining or increasing polar research resources in some Arctic Council countries.

We can identify three reasons for effective 'on-the-ground' coordination:

1. Pre-existing (pre-IPY) agreements and connections, particularly bilaterally or trilaterally among the research agencies of Arctic Council member countries and particularly with respect to research ships, probably ensured the successful and effective international and interdisciplinary use of those essential resources during IPY. Because research vessel operations often require two or three years of prior planning, these pre-existing coordination mechanisms probably played a strong role in determining the IPY programs in the Arctic Ocean.
2. A second factor, closely related, involves external coordination functions. The large EU-funded program, DAMOCLES, developed and implemented its own international coordination of research and resources, external to any IPY or Arctic Council mechanisms or influence. SEARCH, based on its substantial USA-provided resources and leadership, had a similar positive but external (to IPY or Arctic Council) influence on international collaboration in Arctic research.
3. Finally, it seems quite clear that informal and ad hoc arrangements, very often person to person (program manager to program manager), played an important and effective role during IPY. A more comprehensive review of the coordination details of various IPY projects, and of their successes or failures, might result in substantial revision of this initial assessment.

Nonetheless, IPY faced the problem with implementing multinational projects based (mostly) on national funding, and the JC had only an initial screening function of project proposals. If this was the lesson learnt, then the basic question is: What models can we envisage for a better multinational funding of multinational projects?

3.4.3 Gaps, synergies and partnerships

AC members should use their experiences gained from the IPY to consider potential mechanisms for improved education and research coordination and funding resources across the Arctic. The AC should call on the member states to initiate a process of consultations involving

Ministries of Science and Education and national funding and operational agencies to create a basis for internationally coordinated funding and shared infrastructure.

The IPY has stimulated substantial additional funding for Arctic research in most of the Arctic Council nations, and has succeeded, at least initially, in its goal of inspiring a new generation of scientists and engineers. Long-term post-IPY success in Arctic research depends on continued allocations of funding together with continued recruitment of new researchers - additional funding without new researchers will not produce needed results while recruitment of new talent without new funding will prove counter-productive.

The AC should continue to support education, recruitment and retention initiatives, such as the University of the Arctic (UArctic) and the Association of Polar Early Career Scientists (APECS), that are essential in promoting a culture of mutual understanding across national and disciplinary borders.

3.5 Outreach, communication and assessment for societal benefit

Both the complexity and the volume of measurements and other results of the IPY projects and possible legacy activities require very effective "condensation" and outreach processes in order to become available to administrators, stakeholders and the interested public in an understandable and timely way. Another challenge is to secure that scientific results are channeled into educational institutions and become part of the teaching agendas.

3.5.1 Outreach and communication

IPY has fostered a wealth of contacts between the scientific community and other crucial sectors of society, such as business, the educational structures, media and art, which have been very important for the visibility of IPY and public awareness on the importance of the polar regions to global change. An important factor for this success has been the IPY IPO, commitments of educators and Information offices many Polar Research organizations as well as the efforts of national IPY offices. These experiences should be considered in the legacy outreach aspect.

The IPY EOC committee has made an excellent effort in reaching out to a broad community and promoting polar research and polar issues far beyond what we earlier have achieved. The IPY EOC group will continue until the 2010 IPY conference in Oslo. The key issue how the polar EOC could be organized for the future, in order to broadly promoted polar issues.

The communication and outreach aspects of the IPY are to a large degree centered on the scientific aspects of the work that has been conducted during the event. The Arctic Council could play a major role in ensuring that the scientific results are placed in the context of society and governance.

A number of potential mechanisms for communication and outreach exist. Some examples include:

- "State of …" reports that in a concise and thematically balanced manner updates knowledge on the Arctic. Example: State of the Arctic Report/Arctic Report Card[19].
- Assessment of scientific findings in the context of societal needs, e.g. an assessment of the IPY findings in context of their relevance for Arctic people and future governance. The ACIA-process could be used as a model for such an assessment.
- Establishment of international outreach platforms, where new findings and important developments in the Arctic are presented to authorities, interested experts, media and the public.

[19] http://www.arctic.noaa.gov/reportcard/about.html

- "Rapid Response…" assessments focusing on emerging societal needs when there is no time, need, or capacity for thorough process like the ACIA approach, e.g. UNEP Rapid Assessment of Climate Change impact on Oceans[20] and others.
- Coordinated media initiatives, like IPY EOC committee's polar days, launches, radio, film, TV series, and web products.

3.5.2 IPY assessment

The Arctic Council has developed a strong tradition for developing and implementing major assessments as its core business. Assessments first of all contribute to new knowledge and its development in an Arctic and circum-polar context. This contributes to joint understandings of the scientific aspects of a problem area. Secondly, the assessment processes bring people together to work on joint projects over time. This brings common understanding on approaches to problem solving and understanding of the diversity of challenges in the Arctic region. And third, by enhancing knowledge and understanding, the assessments also contribute to enhance the capacity to act in Arctic Council member nations on the areas addressed by the assessments.

Here we summarize an ongoing assessment of the state of scientific knowledge on a subset of the Arctic system – namely the cryosphere – and explore options and potential AC roles in broader scientific and other assessments. The ongoing Arctic Council-initiated SWIPA[21] project focuses on key areas of cryospheric science where effects of climate change have potentially far-reaching implications for both the Arctic and the globe. In addition to the integration of information on the physical changes to the system, the project addresses the 'human dimension' and considers impacts on humans of climate change. SWIPA aims to integrate scientific information on the impacts of climate change on the snow, water, ice, and permafrost characteristics of the Arctic, considering impacts within the Arctic and beyond. The project will update the scientific information with results of relevant new research and monitoring in order to provide the Arctic Council with timely and up-to-date information on issues that are central to the climate change debate, and the implications of changing conditions in the Arctic.

Any assessment of IPY results, independent of its nature and timing, should be a combined effort of the Arctic and Antarctic research community and involve all relevant organisations like IASC, SCAR, ICSU, WMO, and IASSA.

While the intensive period of field study has ended, the work started during the IPY will continue for years as samples are analyzed, data are evaluated, models are updated and tested, and results are published and discussed. In the mean time, the Joint Committee on IPY plans to prepare a summary of the process and achievements of the IPY in draft form before the June 2010 Oslo Conference. This will not be a comprehensive assessment of scientific results.

An assessment of great potential value that could be implemented in the near term is that of assessing the decadal-scale needs exposed or amplified by IPY that should be supported in the longer term (Polar Decade Issues).

3.5.3 Gaps, synergies and partnerships

The IPY EOC (Education, Outreach and Communication) was very successful and communicated polar research and polar issues to a broad public. This success should be continued and organized in a sustained way. Possible partners in a post-IPY EOC would build on ex-

[20] http://www.unep.org/pdf/InDeadWater_LR.pdf
[21] SWIPA: Climate Change and the Cryosphere: Snow, Water, Ice, and Permafrost in the Arctic

isting organizations such as IASC, SCAR, IASSA, national polar institutions, APECS, UArctic, AC working groups and other partners. The role of the AC working groups is especially important when it comes to communicating research results to policy- and decision-makers.

A way to let Arctic communities directly participate in newly achieved knowledge is to place scientific results on the Internet in national and indigenous languages. These websites could summarize the content of Arctic websites and provide further links to English sites. As summaries, their preparation would not be too expensive. Some English sites could have abstracts in relevant languages. Also contact information to the scientific society, local authorities, institutions and stakeholders would make the site more interesting for local stake-holders.

For such a project to be successful, satisfactory Internet access in Arctic communities is assumed, which certainly is not always the case. The improved availability of modern information and communication technology (ICT) is an important challenge. The Arctic Council should take steps to support the improvement of ICT in poorly covered Arctic areas. A post-IPY EOC network should among other tasks consider ways to improve access to modern information and communication technology (ICT) in remote Arctic areas and launch scientific results from IPY (and others) in local and indigenous languages.

The AC should welcome the initiative of the WMO Executive Council of an International Polar Decade and work together with WMO, ICSU, IASC, SCAR and IASSA to assess scientific decadal needs.

The AC should take full credit for SWIPA as an IPY legacy created under its aegis. It should support the use of scientific data and information collected from the Arctic as a result of IPY to contribute to future assessments by the Intergovernmental Panel on Climate Change, as well as other efforts to address climate change, and future Arctic Council assessments.[22]

[22] From the “Antarctic Treaty-Arctic Council Joint Meeting Washington Ministerial Declaration on the International Polar Year and Polar Science”, Washington DC, 6 April 2009. (http://www.state.gov/g/oes/rls/other/2009/121340.htm)