

Arctic Resilience Report Scoping Workshop

Stockholm, Sweden

26-28 September 2011



Stockholm Resilience Centre
Research for Governance of Social-Ecological Systems



**Stockholm
University**

Arctic Resilience Report Scoping Workshop

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PREFACE

The Arctic is changing so rapidly and in so many ways that dramatic changes to ecosystems and the lives of people in the region can be expected. Climate change is the most cited concern but other environmental changes along with rapid social and economic developments are happening at the same time. It is becoming increasingly important to understand what risks society faces in this new situation, including risks associated with abrupt changes that may fundamentally and irreversibly alter conditions for human societies.

At the Arctic Council meeting in Luleå, Sweden, 8-9 November 2011, the Senior Arctic Officials approved the Arctic Resilience Report as an Arctic Council project. This project will provide a science-based assessment of the risks of crossing such disastrous tipping points in the Arctic. The project will also identify strategies for governments and communities to adapt and transform in the face of change and this connection between knowledge about the Arctic to decision making is a critical element in the process.

The origin of the proposal for the Arctic Resilience Report that was presented to the Arctic Council was an initiative from the Stockholm Resilience Centre at Stockholm University and Stockholm Environment Institute in collaboration with the Resilience Alliance. This was further developed in dialogue with the Swedish chairmanship of the Arctic Council and the Swedish Ministry of the Environment. An important part of the preparation was a scoping workshop in Stockholm 26-28 September 2011. This report summarises the results of the workshop and also includes the proposal that was submitted to the Arctic Council.

We would like to thank all the participants of the workshop for their valuable contributions. They represented a range of expertise, including several scientific disciplines as well as indigenous' perspectives. It was a good start for a project that will take on the challenge of assessing resilience in the Arctic.

Gustaf Lind

Chair of the Senior Arctic Officials of the Arctic Council

Johan Rockström

Executive Director of the Stockholm Environment Institute and the Stockholm Resilience Centre

SUMMARY AND KEY MESSAGES

As part of the scoping activities for the Arctic Resilience Report, a workshop was conducted in Stockholm, Sweden, 26-28 September 2011, with participants from the Arctic Council working groups and invited experts. Based on the workshop discussion, the following key conclusions can be drawn:

- A resilience framework offers a useful analytical tool for risk analyses of potential thresholds that can result in abrupt and at times irreversible changes in the Arctic at local, regional, and pan-arctic scales.
- A resilience assessment can further contribute to preparing Arctic communities for change by analysing capacities to adapt and transform in the face of change.
- There are many related activities, as well as relevant expertise and data in the scientific community and within the Arctic Council to which a resilience assessment should connect.
- A resilience assessment should integrate expertise from different knowledge traditions, including indigenous traditional knowledge.
- The concepts, methodology and process of a resilience assessment need to be clearly linked to the needs of people living in the Arctic.
- A resilience assessment should include dialogue with decision making fora throughout the project.

ORIGINS AND CONTEXT FOR THE ARR SCOPING WORKSHOP

The Arctic region is currently experiencing rapid change - environmentally as well as politically and economically. Climate change is the driver that has received most attention, but a number of other drivers are also relevant for the Arctic, such as demographic change and increased global demand for the resources of the region. At the Arctic Council (AC) Ministerial meeting in Nuuk in May 2011 it was decided that a scoping exercise should be arranged during the fall of 2011 to review the need for an integrated assessment of multiple drivers of Arctic change, including an Arctic Resilience Report (ARR).

The scoping activities for the ARR¹ have been led by the Stockholm Environment Institute and the Stockholm Resilience Centre² in collaboration with the Resilience Alliance. A major activity has been a scoping workshop, which took place in Stockholm, Sweden³, 26-28 September 2011, with participation from experts⁴ and the Arctic Council working groups.

The Stockholm scoping workshop began with a half-day public plenary session, where the purpose was to introduce the concept of resilience⁵ and discuss how the ARR can be relevant to other ongoing Arctic assessments and initiatives.⁶ The remaining one day and a half, for invited experts and working groups only, was devoted to group discussions aimed at demonstrating the methodology of a resilience assessment and to some preliminary discussion about the ARR as a project. An Arctic Council Working Group meeting was held in parallel to the ARR scoping workshop.

As a result of the workshop, a proposal to start the ARR project was submitted to the Arctic Council for decision at the Senior Arctic Official's meeting in Luleå, Sweden, 8-9 November 2011. This report describes some of the key messages that came out of the Stockholm workshop and provides background for the submitted proposal (presented in Appendix C).

Purpose and approach for the ARR

While some changes in the Arctic may be gradual and proceed along existing trends, evidence indicates that many changes occur and will continue to occur rapidly and in abrupt ways. Abrupt changes often occur as a result of interactions among different driving forces. Social and ecological processes now interact with driving forces that are both internal to the Arctic (such as demographic change) and external (such as climate change). Abrupt changes arising from such complex interactions are difficult to predict. When thresholds are crossed, generating abrupt changes, the social and ecological consequences are also difficult to foresee. These can include dramatic reorganisations of social-ecological systems that have substantial impacts on human well-being. Such changes can affect the available livelihoods of people, the economic viability of communities, and the economic development of entire regions. Abrupt changes may also be difficult or even impossible to reverse even if the causes of shift

1 Funded by a grant from the Swedish Environmental Protection Agency

2 Including also the Beijer Institute of Ecological Economics

3 Hosted by the Swedish Polar Research Secretariat

4 Based on nomination from Arctic Council Member States and Permanent Participants as well as invited on an individual basis.

5 Program for this session is available in Appendix A.

6 The plenary session was filmed, and can be viewed at: <http://vimeo.com/31249885>. (The ARR video clips are titled: Welcome by Johan Rockström; Welcome by Gustaf Lind; Background and purpose of workshop; What is a resilience assessment; ARR panel discussion 1; ARR panel discussion 2.)

are removed or weakened. From a management point of view, these reorganisations pose a special challenge because they can be difficult to detect until it is too late to intervene.

A priority in efforts to understand Arctic change and the aim of the ARR process is to identify the risk for shocks and large shifts in ecosystems services in the Arctic, and how these might affect Arctic societies. The purpose is to prepare decisions makers for managing Arctic social-ecological systems in a period of rapid change with large uncertainties. The ARR will address the following questions:

- What are the most important risks for *abrupt shifts* in social and environmental systems in the Arctic as a result of interacting change processes and the impacts of shocks and stresses?
- What is the resilience to shocks and stresses in the Arctic, i.e. ability to persist change, to adapt to change, and to transform in case of crises?
- What are the most important strategies for governments and communities in order to build resilience of Arctic communities or to prepare for social transformations when this may be necessary?

The ARR project builds on and extends the approach developed in the Resilience Alliance assessment workbook.⁷ This includes active engagement with stakeholders in identifying both valuable aspects of the social-ecological system and drivers that affect them, followed by an iterative analysis of the system's dynamics and assessment of its resilience.

The workshop served as an initial meeting with stakeholders, including organisations representing the scientific community and higher education, representatives of Arctic Council Member States and Permanent Participants, and Arctic Council Working Groups. At the Arctic Change Assessment (ACA) workshop that was held in Oslo 28-30 September, 2011, a wider group of stakeholders were represented, including industry and local decision makers. These discussions have also informed the preparation of the ARR proposal to the Arctic Council.

⁷ Available at the Resilience Alliance's website: http://www.resalliance.org/index.php/resilience_assessment

WHAT IS A RESILIENCE ASSESSMENT? KEY CONCEPTS AND METHODOLOGY

To start off the workshop, key concepts in resilience thinking and the basic methodology for a resilience assessment was presented by Brian Walker from the Stockholm Resilience Centre (SRC) and CSIRO (Commonwealth Scientific and Industrial Research Organisation). The full presentation is available for viewing at <http://vimeo.com/31249885>, and the power point presentation included in Appendix D. The following is a short summary of some of the key points.

Understanding resilience

Ecosystems, social systems and social-ecological systems (SES) are self-organising systems - and the ecological and social domains are strongly interlinked.

There are *limits* to how much a system can be changed and still recover. Beyond those limits it functions differently, and the system changes to some other state.

One example of this is the change from shrub landscapes to grassland in the Siberian tundra in places where the soil has been compacted by vehicles. Another is the change from black spruce forest to a landscape dominated by deciduous trees after intense forest fires in Alaska. In both these cases, and in many other examples of ecological regime shifts, reversal of the shift is inhibited by positive feedbacks that keep the system in its new state.

Drivers of change exist on different scales, including local, regional, pan-arctic and global. Drivers of change also interact across scales. Moreover, social changes interact with changes in physical environment and ecosystems. The interactions can have greater impact on valued ecosystem services than each driver in itself.

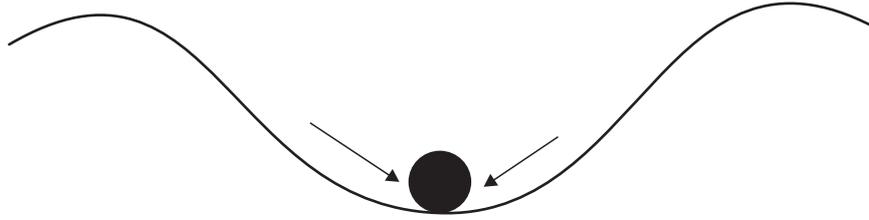
The resilience of a system is a measurement of its ability to respond to shocks while still keeping the same identity, which implies functioning in much the same kind of way.

Resilience is defined as the capacity of a system to absorb disturbance and re-organise so as to retain essentially the same function, structure and feedbacks – to have the same identity.

A stable resilient system

One way of illustrating resilience is to think about it as a ball in a basin. In a resilient system, there are forces that push the ball back to the bottom even if there are some forces, including shocks, which may want to push the ball up one of the sides.

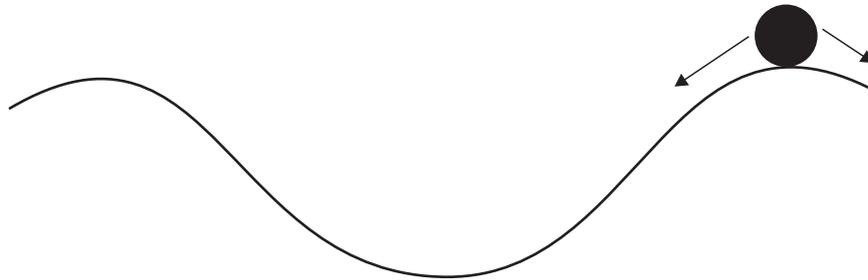
The system is resilient as long as shocks to the system do not push the ball outside the basin. As long as the ball stays in the basin, the system maintains its identity.



An unstable system

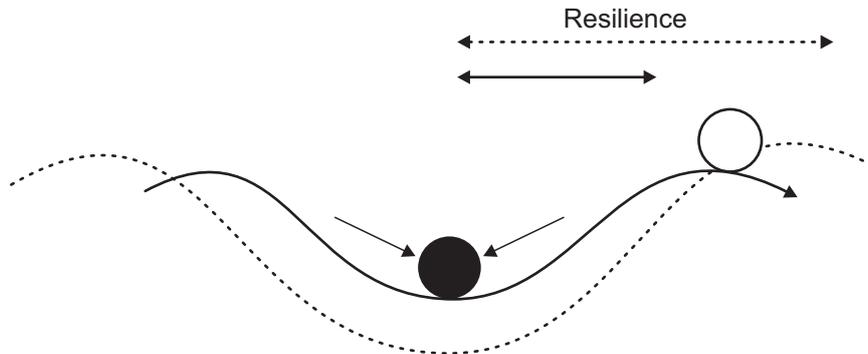
When the ball is at the top of the basin, the slightest push can move it outside the initial system. This means that it will stay the same only if no more changes push the ball further away from its basin of attraction. The system is said to be close to a threshold.

The closer the ball is to a threshold, the smaller the shock needed to shift it away from its previous stable state. The system thus has a lower capacity to absorb disturbances and keep the same identity when the ball is at the top (close to a threshold) than when the ball is at the bottom of the basin.



Resilience of a system can change

Resilience can be lost or gained when some characteristics of the system change, here illustrated by the shift from the dotted to the straight line. The threshold (top of basin) has moved and the ball is thus more likely to move to another basin of attraction when exposed to the same push as in the first diagram.



Conducting a resilience assessment

Some large changes are already occurring in the Arctic and more are likely. Many of these will affect the resilience of social-ecological systems in the Arctic, which increases the likelihood of crossing thresholds if the system is exposed to a shock.

A resilience assessment prepares us for these changes by identifying potential for large shifts in ecosystems services that affect human well-being.

Often more than one driver of change is at play and a resilience assessment includes analysing their interactions and their consequences, for example how climate change and its impacts interact with social changes.

A resilience assessment is an iterative process that starts by defining the system to be studied: “Resilience of what?” which includes defining the time scale and focus (e.g. a specific region). The second step is to identify which shocks and disturbances that system is exposed to: “Resilience to what?”

The next step and core activity of the process is to assess the risk that the system will reorganise in such a fundamental way that it no longer functions in the same manner, passing a so-called threshold. It includes assessing the resilience to specific shocks that have been identified but also the general resilience of the system.

A resilience assessment includes analysing the need for adaptation and also the need and possibilities for moving into a new regime without losing core values when a change of the system is inevitable (or desirable).

The aim of a resilience assessment is to inform decision making and the final step is to look at strategies for managing and building resilience.

A first attempt at identifying the “Resilience of what” and the “Resilience to what” for the ARR was done during the second day of the workshop. A summary is given, starting on page 9 (“A very preliminary resilience assessment”).

RELATIONSHIP BETWEEN THE ARR AND OTHER ARCTIC ACTIVITIES

In addition to introducing the resilience concept, an important purpose of the workshop was to ensure that the ARR makes proper links to other relevant activities within the Arctic Council, including assessments conducted by Arctic Council Working Groups. The workshop also provided an opportunity to start discussions about collaborations with international organisations representing relevant scientific expertise.

The following is a summary of points that were brought up in the two panel discussions in the Monday afternoon open session.⁸ It is divided between general points that were brought up by the panellists and the audience and a list of on-going activities that are relevant to the ARR.

General points

Content/Focus of ARR

- The ARR should “avoid re-inventing the wheel”. One way to ensure this is to integrate with and make use of research that is ongoing or has already been completed. For instance, lots of data were collected during the International Polar Year (IPY) that could be (re-) analysed with a resilience lens.
- The ARR could make a strong contribution on the topic of “transformability,” acknowledging that we all have to be prepared to change by thinking about our capacity to change.
- There is currently too little collaborative research and common understanding across different scales/levels of analysis (national, region, local etc). By using findings from research focusing on the local level and by engaging directly with actors at the local levels, the ARR could play a role in filling this gap.
- It would be helpful if the ARR picks one area/case study that shows clearly what resilience is, also in terms of practical application and the methodology used.
- Given the major climatic and other feedbacks from the Arctic to the rest of the world, there are many important stakeholders residing both inside and outside the Arctic.

On integrating indigenous knowledge in the process

- People residing in the Arctic are main stakeholders; alas, indigenous peoples could have a large role in the process, structure and conceptual framework of a report like this. The importance of integrating indigenous peoples’ knowledge was also one of the most important lessons learned from the International Polar Year (IPY).
- Five ways in which the ARR could contribute to furthering and strengthening use of indigenous knowledge in the process were suggested: 1) ARR could support early and detailed documentation of indigenous knowledge; 2) Refurbish analysis/systematic synthesis of existing datasets; 3) Serious discussion of how we integrate indigenous knowledge at all stages of the process;

⁸ The summary below reflects the discussion and suggestions at the Stockholm workshop. It does not necessarily imply that the ARR project can take on all the suggested tasks.

4) Develop an indigenous conceptualisation of what we mean by change; and 5) Bring indigenous and “expert” knowledge system together to create a “structure of indigenous knowledge”.

- By integrating a synthesis of previously collected “indigenous knowledge” in its work process, the ARR could provide “pan-arctic local knowledge as pertaining to change in the North”, something which is currently missing. This could also be a process of linking AHDR-II⁹ to the ARR.

On linking with the policy process and providing policy recommendations

- Many remarks were made on the topic of policy recommendations, and there was wide agreement that the ARR should have a strong connection to policy, including comments that providing policy recommendations is a pre-condition for a report of this kind.
- Importantly, policy recommendations are not only about science, but need to be translated into policy options. As the resilience framework is designed to highlight different potential futures, it would be desirable to discuss the relationship between policy options and different trajectories.
- One of the main challenges is to make sure that the results of the ARR are continually fed into the political process. A framework/process for delivering policy recommendations must be established already at an early stage in the ARR, and the ARR should be incorporated into the workflow of the AC.
- On integrating the ARR into the AC working process, it was noted that the ARR should report regularly to SAO meetings.
- The point was raised that ownership by one (or more) WGs is preferable to the ARR being a national programme, as joint AC ownership becomes bigger when linked to a WG, which would also help formalise the ARR’s role under the AC.

Ongoing relevant initiatives

Initiatives by Arctic Council Working Groups

- Much of CAFFs¹⁰ work overlaps with ARR, and could be complementary to each other. One example is the Circumpolar Biodiversity Monitoring Program (CBMP), which collects data on how biodiversity in the Arctic is developing. The Arctic Biodiversity Assessment, due to be completed in 2013, is also directly relevant to the ARR process.
- PAME¹¹ is undertaking an Arctic Ocean Review. The current work phase focuses on enhancing international governance of oceans by conducting a gap analysis of existing treaties. The ARR could add value to this process.
- The ARR could potentially be a great complement and support to the Arctic Change Assessment (ACA), especially since both ARR and ACA deal with issues that cut across all working groups.

9 Arctic Human Development Report-II

10 Working Group on the Conservation of Arctic Flora and Fauna

11 Working Group on Protection of the Arctic Marine Environment

- Ecosystems based management (EBM) manages for uncertainty. Resilience could shed light on that uncertainty by identifying potential thresholds and by developing scenarios. It is important to coordinate with EBM initiatives in the Arctic Council.

Ongoing initiatives and support offered by other international organisations

- WWF's project, "Rapid assessment of circum-arctic resilience" is driven by the fact that choices have to be made, some already now if we want to guarantee Arctic functions in the future. This project can add a lens of social-ecological resilience thinking and application to the ARR, as well as the ACA.
- ISAC¹² could support the ARR by 1) providing scientific information and 2) initiate a feed-back process to ensure a scientific process that is socially relevant. Ongoing relevant activities include workshops bringing together a broad range of stakeholders, with the aim to reach common understanding of how we should respond to environmental change in the Arctic. Additionally, ISAC has applied for funding to initiate an "Arctic Observing Summit", where the aim is to oversee how the information from various Arctic activities and initiatives can be better used for assessment purposes.

Several organisations offered to support the ARR process by sharing already available data and expertise:

- IASC¹³'s network of scientists could support the ARR by providing data and other sources of information to make it as reliable as possible. Such integration would also allow for new questions to be raised from already collected data.
- The EEA's¹⁴ methodological experience of pan-European environmental assessments can provide guidance to a process such as the ARR. The EEA could also provide data, among others through the "Shared Environment Information System" and "State of the Environment" reports. Lastly, EEA could support the ARR in continuous communication with policy makers.
- As an organisation and network for social scientists, IASSA has a lot of information and knowledge that is useful in ensuring that both indigenous and non-indigenous perspectives are accounted for in the ARR. This can be furthered by selecting the focus definition through a social science lens, i.e. one that is policy, community and people relevant, tapping off the different social science disciplines within IASSA, such as anthropology, linguistics and politics.
- With membership institutions across the North, University of the Arctic (UArctic) can play a strong role in providing "knowledge developed in the North, by people living in the North", and also to ensure that new findings are anchored in an Arctic context. In addition to research, UArctic can contribute to communications aspects of the ARR, across scientific, educational and indigenous communities.

12 International Study of Arctic Change

13 International Arctic Science Committee

14 European Environment Agency

A VERY PRELIMINARY “RESILIENCE ASSESSMENT”

The second day of the workshop was devoted to demonstrating the resilience assessment methodology. By conducting a very preliminary assessment, it was also a first attempt at identifying some issues that need to be addressed in a resilience assessment of the Arctic. The discussions were carried out in four smaller groups that reconvened several times to compare and synthesise major point in the group discussions. One purpose of the groups was to ensure focus on different scales.

Within the overall context of global change and Arctic change, the following focal scales were chosen in advance: pan-arctic, regional – Canadian archipelago, regional – Barents region, and local/community level. The groups discussed resilience of what, the most important drivers of change and potential regime shifts/tipping points in the systems of focus.

Below is a summary of some major issues that came up in discussion. The workshop did not allow time for discussing management/policy options, which is an important part of a full resilience assessment.

Resilience to what? Major drivers of change

The groups identified a large number of drivers that are relevant for assessing resilience in the Arctic. For the purpose of this report, these have been categorised into drivers that are linked to physical changes in the environment, drivers that are primarily social and drivers that very clearly include both physical and social background causes (even though the distinction between categories is not always clear cut). These lists should not be seen as exhaustive but rather as illustrative of issues that came up in this particular workshop.

- Physical changes in the environment (e.g. climate change) and drivers that primarily result from these and their secondary impacts on the physical environment
 - climate change
 - sea level rise
 - increase in wave action
 - thawing of permafrost
 - reduced sea ice
 - ocean acidification
 - changes in fish biomass
 - erosion
- Drivers that are primarily social
 - resource demand
 - migration (in and out of the Arctic)
 - militarisation
 - geopolitical changes
 - social change in outside world restricting markets (e.g. fur)
- Management regimes
 - large-scale industrial projects
 - changes in political stability affecting cooperation and investment opportunities
 - education and education flexibility
 - institutional change (property rights and connections to outside world)
 - urbanisation and connectivity
 - local-global connection
 - environmental ideologies

- Drivers that incorporate both social and physical aspects
 - oil and mineral exploration
 - opening of shipping routes
 - changes in economies and distribution of wealth due to changes in fish biomass
 - outside financial investment/control of arctic region
 - migration towards the north driven by land demand
 - increased tourism
 - infectious diseases (possibly surprises)
 - infrastructure development (e.g. dams)
 - adaptations to climate change (also incl. responding to new opportunities)

There may also be a need to distinguish between gradual drivers (incremental change) and shocks. Examples of shocks that were mentioned were loss of subsidies, loss in services, and oil spills. Moreover, gradual changes can lead to tipping points that in turn become shocks to the system or drivers of change. One such example of a potential tipping point driver is ocean acidification, where pH below a critical level can lead to ecosystem changes. Other examples relate to social systems, e.g. changes in political stability (which is necessary for collaboration and creating capacity to deal with issues), and changes in institutions (property rights regimes), or a community losing its school.

Sources of resilience

Specific resilience refers to the ability of some aspect of social ecological systems to deal with a shock or change. However, efforts to increase resilience of some aspect of a system to a specified set of disturbances can unwittingly reduce the resilience of other aspects of that system to other, non-specified (perhaps novel) disturbances. It is therefore also important to consider general resilience. This is the general ability to deal with shocks and other changes without the system losing its identity.

The workshop participants identified a number of factors that are relevant for general resilience. Examples are the following (divided into broad categories with specific examples):

- Well-being
 - Physical and mental health
 - Optimism (hope)
 - Creativity
- Environmental
 - Biodiversity (incl. ecosystem, species, genetic)
 - Connectivity
 - Diversity of ecosystem livelihood options
- Governance
 - Functioning government
 - Education and functioning transfer of knowledge; learning/experimental spaces
 - Access to information and communication channels
 - Health-care system
 - Connectivity/mobility
 - Enabling institutions
 - Innovation climate

- Economic
 - Well-functioning global markets that include environmental price
 - Diversified economy
- Rapid response
 - Early warning systems (fast for acute development)
 - Preparedness for surprise
- Shared heritage
 - History of survival
 - History of living on the land
 - Cultural identity – strong stories of place
 - Adherence to basic ethical principles
- Political diversity/Sense of belonging
 - Access to land and rights to resources
 - Sense of belonging to a place where you have certain rights
 - Family network, other networks of people
- Societal flexibility
 - Time to adjust
 - Flexible livelihoods

Identifying potential tipping points

The difference between tipping points and drivers of change was not always easy to uphold in the discussions. The table below provides examples of some potential tipping points, where the focus is on potential rapid shifts and their consequences. The purpose is not to present exhaustive analyses or to assess the likelihood of any of these regime shifts, but to illustrate the concept of tipping points that are relevant in the Arctic context as perceived by the workshop participants.

	Social	Economic	Biophysical
Local¹	Sealing and fishing → oil and gas extraction, transportation, tourism Critical level of substance abuse: functioning vs non-functioning community Loss of traditional knowledge Shift in food consumed from one species to another (e.g. caribou → moose; shift from focus on transfer of knowledge by individuals to formalisation of education centralisation vs decentralisation of government	Fish processing factory vs no factory	Ecosystem shift, e.g. a system supporting pelagic species replaced by benthic dominated system and vice versa
Regional²	Health care access Migration and gender issues: From moving out to moving in Success vs. failure of governance regimes to protect e.g. reindeer herding	Restructuring of the Norwegian fishing fleet Shift from subsistence to market economy Profitability of mines and other industries determining whether they close or not Relocation Generational shift Communications: all-season road, deep sea port, internet Intercommunity trade or not	Permafrost disappearance Rapid draining of lakes Dangerous to travel on ice Loss of sea ice, e.g. ice cover below 50% in basin Loss of snow cover Ocean acidification reaching critical pH Sufficient ice free time to allow commercial transit of NW passage Temperature thresholds for different species at different parts of life cycles Regime shift in the fish food chain Collapse of Arctic cod → trophic cascades Loss of keystone species Inundation by sea level rise Increased shrubiness Tree line movements Extreme precipitation
Pan-Arctic	Cooperative political environment ↔ aversive politics (securitisation) Critical mass and connectivity of higher education, leading to people staying	Shipping regime shift (days of possible ice-free shipping affecting companies strategic decisions)	Ice cover to ice free in the summer Greening of the Arctic Arctic amplification Methane release Arctic surface water temperatures rise above 12C?
Global	Overcrowding leading to international migrations Collapse of UN system	Global economic recession Shipping costs elsewhere Energy market shifts	Ocean circulation Albedo feedback Acceleration of hydrological cycle Connectivity invasive species

15 The group focusing on the local level included knowledge about Russia: Arkhangelsk region (forestry and land-use change); urban region; Northern Yukon/NW Territories: small inland village; Northern Norway fishing villages; hunting in west/north Greenland; coastal community in Iceland

16 Examples from Canadian archipelago and Barents region

General comments on the ARR process

Many general comments came up in the discussion including both issues that need attention and comments about the ARR. The following is a list of comments that relate specifically to the ARR process.

- You cannot understand or manage a system by focusing on one scale; you need at least three scales – the focal scale, one above and one below. Increasing resilience at one scale (or pursuing efficiency at one scale) can reduce resilience at other scales. Maintaining *resilience* at a regional scale can require *transformational* changes at local scales.
- Rather than focusing solely on human perspectives on adaption in the Arctic, there is a need to focus on ecosystem services and management (fisheries, forests) and how they are resilient. Human resilience is tied closely to ecosystems services and there is a need to understand how the *systems* work and how they are resilient. The interaction between the social and ecological is the resource.
- While a resilience framework is important, one must be as concrete as possible and learn from previous data collection in the Arctic Council. Furthermore, the resilience theory must be grounded in context and not treated as a stand-alone framework, and should aim to understand long-term changes in the Arctic.
- It is extremely important to engage in a continuous process of reporting and communication with the Arctic Council Working Groups already from the start, so that findings are translated into policy recommendations not only at the very end, but throughout the entire project process.
- It is important to integrate indigenous people – both as scientists and as “civil observers”
- Need to think about multiple changes in the Arctic – not just climate change. One such change is a cultural change. At the same time, the ecosystems and ecological perspective must not be forgotten, but rather incorporated and considered when choosing case studies.
- Having a rolling time scale (2030/2050/2100), and zooming in on every 10-years, would be very beneficial from a policy perspective (100 years= the life of an old whale)
- Livelihood, ecosystem services, food security was mentioned by all groups

Methodological points

- Importance of cross-scale interaction; social-ecological focus; threshold; surprise – connectivity
- Helpful to identify thresholds and to create scenarios that are clear and communicated

Going from knowledge to action

- Translation of ideas to local context
- Translation of ideas into various decision contexts
- Identify leverage points for change

APPENDICES

A: Agendas of the ARR scoping workshop

Monday 26 September	
11.00 – 13.30	Working lunch for WG Chairs/Executive Secretaries and Chairmanship/ACS
14.00	Open session: Arctic Resilience Report Scoping workshop. (separate program below)
15.55	Coffee break
16.15 – 18.00	Open session continues
19.00	Dinner organised by Ministry of Foreign Affairs and Ministry of the Environment (together with other AC activities)
Tuesday 27 September	
08.30	Scoping workshop expert meeting (including AC working group representatives). “Resilience of what? Resilience to what?” Defining the Arctic system. Discussions.
10.00	Coffee break
10.30	Scoping workshop expert meeting continues
12.30	Lunch
14.00	Two parallel sessions: Swedish SAO chair and WG chairs Continued workshop discussions. Framework for resilience assessment
15.30	Coffee break
16.00	Parallel sessions continue
18.00	End of session
18.30	Informal buffet dinner for workshop participants
Wednesday 28 September	
08.30 -11.00	Final session scoping workshop Next steps in ARR process: planning for interim report, future workshops funding etc.



Open Session of the Arctic Resilience Report Scoping Workshop

Beijer hall, Royal Swedish Academy of Sciences, Lilla Frescativägen 4A, Stockholm

Monday 26 September 2011

14.00	Session 1: Arctic Resilience Report (ARR) & Introduction Welcome by local host Björn Dahlbäck, Swedish Polar Research Secretariat Session Chair: Björn Dahlbäck
14.05	Welcome! Ambassador Gustaf Lind, SAO chair Johan Rockström, Executive Director, Stockholm Resilience Center and Stockholm Environment Institute
14.15	Background and purpose of workshop Annika E Nilsson, Stockholm Environment Institute
14.25	What is resilience? What is a resilience assessment? Presentation and interactive discussion led by Brian Walker, Stockholm Resilience Center
15.55	Coffee break
16.15	Session 2: Linking the ARR to other Arctic activities Session chair: Johan Kylensfierna, Stockholm Environment Institute
16.20	Panel 1: Linking the ARR to the Arctic Council's activities Arctic Monitoring and Assessment Programme (AMAP): Lars-Otto Reiersen, AMAP Executive Secretary Conservation of Arctic Flora and Fauna (CAFF): Mark Marissink, chair of the Arctic Biodiversity Assessment Emergency Prevention, Preparedness and Response (EPPR): Ole Kristian Bjerkemo, EPPR chair Sustainable Development Working Group (SDWG): Mikael Anzén, SDWG chair Arctic Contaminants Action Program (ACAP): Andrey Peshkov, ACAP chair Protection of the Arctic Marine Environment (PAME): Elizabeth McLanahan, PAME vice-chair
16.50	Panel 2: Linking the ARR to other research initiatives International Arctic Science Committee (IASC): David Hik International Arctic Social Sciences Association (IASSA): Grete Hovelsrud University of the Arctic: Ketil Hanssen International Study of Arctic Change (ISAC): Maribeth Murray WWF: Martin Sommerkorn European Environment Agency (EEA): Nikolaj Bock
17.30	Concluding discussion

This workshop has been generously supported by the Swedish chairmanship of the Arctic Council and the Swedish Environmental Protection Agency.

B: List of participants

Participants of the three day Arctic Resilience Report scoping workshop¹⁷

Surname	First name	Affiliation	E-mail
Bock	Nikolaj	EEA	nikolaj.bock@eea.europa.eu
Carmack	Eddy	Resilience Alliance	eddy.carmack@dfo-mpo.gc.ca
Clement	Joel P	U.S. Department of the Interior	Joel_Clement@ios.doi.gov
Corell	Robert	Global Environment and Technology Foundation & University of the Arctic	global@dmv.com
Crépin	Ann-Sophie	Beijer Institute, Sweden	asc@beijer.kva.se
Daae Olseng	Christine	AMAP	christine.daae.olseng@amap.no
Dahlbäck	Björn	Swedish Polar Research Secretariat	bjorn.dahlback@polar.se
Dickson	Cindy	Arctic Athabaskan Council	cindy.dickson@cyfn.net
Dobromyslova	Victoriya	Ministry of Regional Development, Russia	Viktoriya.Dobromyslo@minregion.ru
Einarsson	Niels	Stefansson Arctic Institute, Iceland	ne@unak.is
Evengård	Birgitta	University of Umeå, Sweden	birgitta.evengard@climi.umu.se
Forchhammer	Mads C	Aarus University	mcf@dmu.dk
Hanssen	Ketil	University of the Arctic	ketil.hanssen@hifm.no
Hik	David	IASC	dhik@ualberta.ca
Hovelsrud	Grete	CICERO, Norway	g.k.hovelsrud@cicero.uio.no
Johansson	Margareta	Lund University & Royal Swedish Academy of Sciences	margareta.johansson@nateko.lu.se
Lilliesköld	Marianne	Naturvårdsverket, Sweden	Marianne.Lillieskold@naturvardsverket.se
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Murray	Maribeth	ISAC	murray@arcticchange.org
Neraal	Marianne	Nordic Council of Ministers	mane@norden.org
Nilsson	Annika	Stockholm Environment Institute	annika.nilsson@sei-international.org
Olsson	Marie	Stockholm Environment Institute	marie.olsson@sei-international.org
Peterson	Garry	Stockholm Resilience Centre	garry.peterson@stockholmresilience.su.se

¹⁷ An additional 70 people attended the open session.

Sommerkorn	Martin	WWF	msommerkorn@wwf.no
Walker	Brian	Stockholm Resilience Centre & CSIRO	brian.walker@csiro.au
Vlasova	Tatiana	Russian Academy of Sciences	tatiana.vlsv@gmail.com

Participants of the Arctic Council's Working Group meeting

Surname	First name	Affiliation	E-mail
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Levit	Lev	AC secretariat	lev.levit@arctic-council.org
Peshkov	Andrey	ACAP Chair	chairman@ac-acap.org
Shearer	Russel	AMAP Chair	Russel.Shearer@ainc-inac.gc.ca
Reiersen	Lars-Otto	AMAP-ES	lars-otto.reiersen@amap.no
Marissink	Mark	CAFF & Naturvårdsverket, Sweden	mark.marissink@naturvardsverket.se
Barry	Tom	CAFF Executive Secretary	tom@caff.is
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Lunde	Synnøve	EPPR-ES & Norwegian Coastal Administration	synnove.lunde@kystverket.no
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Lind	Gustaf	SAO Chair	gustaf.lind@foreign.ministry.se
Anzén	Mikael	SDWG Chair	mikael.anzen@foreign.ministry.se
Fortin	Claudette	SDWG-ES, CANADA DEL	Claudette.Fortin@ainc-inac.gc.ca

C: Proposal to the Arctic Council

The below proposal was submitted to the Arctic Council Senior Arctic Officials meeting in Luleå 8-9 November 2011

PROPOSAL FOR AN ARCTIC RESILIENCE REPORT (ARR)

Based on scoping activities conducted since the Nuuk Ministerial meeting in May 2011, this document outlines a proposal of a new project under the auspices of the Arctic Council – *The Arctic Resilience Report (ARR)*. The ARR is a process to analyse the resilience of linked human and environmental systems in the Arctic. It aims to:

- Identify the potential for shocks and large shifts in ecosystems services that affect human well-being in the Arctic,
- Analyse how different drivers of change interact in ways that affect the ability to withstand shocks, and
- Evaluate strategies for adaptation and transformation in the face of rapid change.

The issue and matters to be addressed

The Arctic region is currently in a period of rapid social, economic, and ecological change. While some changes are likely to be gradual and continue existing trends, the interactions among the different driving forces may also lead to consequences that are difficult to foresee. This includes dramatic reorganisations of social-ecological systems that can have substantial impacts on human well-being. Such changes can affect the available livelihoods of people, the economic viability of communities, and the economic development of entire regions. Shifts can be difficult to predict and they may also be irreversible even if the causes of shift are removed or weakened. From a management point of view, these reorganisations pose a special challenge because they can be difficult to detect until it is too late to intervene.

A priority in efforts to understand Arctic change - and the purpose of the ARR process - is to identify the potential for shocks and large shifts in ecosystems services in the Arctic, and how that might affect society. The contribution of the ARR to the Arctic Change Assessment (ACA) is to address the following questions:

- What are the most important risks for *abrupt shifts* in social and environmental systems in the Arctic as a result of interacting change processes and the impacts of shocks and stresses?
- What is the resilience to shocks and stresses in the Arctic, i.e. ability to persist change, to adapt to change, and to transform in case of crises?
- What are the most important strategies for governments and communities in order to build resilience of Arctic communities or to prepare for social transformations when this may be necessary?
- A possible focus for an issue-oriented pilot case study could be food security, in dialogue with indigenous peoples. An appropriate pilot regional case study could be agreed upon.

The analysis will include identifying policy options for Arctic decisionmakers.

Background

The scoping workshops for the ARR¹⁸ and the ACA in the last week of September 2011 showed a need for new approaches in assessing Arctic change.

The scoping phase of the ARR has included consultations with experts from all Arctic countries and several indigenous peoples organisations. It has provided the base for collaboration with international organisations that represent relevant communities of experts.

Resilience analysis can support on-going efforts to further develop ecosystem-based management in the Arctic by providing scientifically based scenarios of possible futures.

The ARR can also contribute to the follow-up of the International Polar Year (IPY) by providing a framework for integrating research findings into a context aimed at decisions makers.

The ARR project builds on a well-established methodology for obtaining an overview of interacting drivers of change across a range of scales. The ARR project will further develop this methodology to contexts that are relevant for the Arctic and to ensure that the information becomes relevant, integrated with the ACA, and leads to decision makers.

Costs and funding

The scoping phase of the ARR has been funded by Sweden via the Swedish Environmental Protection Agency.

The estimated cost for these activities for 2012-2015 will be provided by Sweden. This will cover scientific leadership and secretariat, project meetings, some workshops, communication, including production of outreach material and reports.

Time for participating experts and their travel expenses needs to be covered by each country.

Additional funding for regional workshops, capacity building, and local activities needs to be raised by separate funding applications to relevant organisations and agencies.

Relationship to other Arctic Council activities and other regional and international fora

Specific issues within the ARR will be developed in close cooperation with AC WGs¹⁹ and their on-going assessment processes and with different expert groups.

The ARR will contribute to the proposed Arctic Change Assessment (ACA)²⁰ by identifying potential threshold effects that can have large impacts on human well-being.

18 The scoping phase of the Arctic resilience project has been led by Stockholm Resilience Centre and Stockholm Environment Institute in cooperation with Resilience Alliance (RA). By providing access to its network of resilience experts, the RA will continue to support the project. Contacts have also been established with several Arctic organisations that have strong international networks of relevant experts, including IASC, IASSA, UArctic and ISAC, all of which have expressed an interest in participating.

19 Each working group has nominated or been invited to nominate a relevant contact person and the suggested Project Steering Committee will ensure that the WG will be informed about progress throughout the project.

20 The organisational relationship with the ACA will partly depend on how the ACA process proceeds; we will aim towards an arrangement with communications channels that ensure coordination of activities with the ACA when relevant but that the ARR is managed independently of the ACA.

This project can provide initial insights about drivers and their interactions that the ACA later on could pursue by targeted activities.

The ARR will support previous and new initiatives in relation to ecosystem based management (EBM) by contributing to the required capacities that will be needed for developing this decision-making process.

Recommendations

Sweden asks for approval to initiate the proposed project.

Annex 1

Project organisation

A *project steering committee* (PSC) will be established with representatives from AC WGs and organisations with which there is a formal collaboration. We propose that the steering committee will be chaired by Johan Rockström, Executive Director of Stockholm Resilience Center and currently also executive director of Stockholm Environment Institute. Sweden would welcome other Arctic states to act as co-chair and will investigate the possibility for this. The mandate for the steering committee should be time-limited in line with the expected project life-length to 2015.

The role of the project steering committee is to oversee the project, to report to AC SAOs and PPs and to keep the AC WGs informed about project progress. It will also make decision in connection with selection of an Assessment Integration Team (AIT) and scientific leaders for different project components. The PSC would also be responsible for overseeing the scientific and national review processes. Decision on full terms of reference for the steering committee and final appointments of members would rest with the AC.

The *Assessment Integration Team* (AIT) will consist of experts, including the scientific leaders of all case studies. Its role is to provide scientific input and support integration throughout the process and to lead the writing of overall project outputs, such as an interim report in 2013 and a final report in 2015. The members of AIT should represent a broad range of expertise and pan-arctic geographical coverage.

The ARR will be managed jointly by the Stockholm Resilience Centre (SRC) and the Stockholm Environment Institute (SEI). A local project management team will guide the project, including responsibility for ensuring good management practices and for developing a plan for internal and external communication. The local project management team will report to the Project Steering Committee (PSC) and should also be represented in the AIT.

Project implementation and work plan

The guiding principles for the ARR are to analyse interactions among social and ecological processes across scales, to ensure interactive engagement with user communities to produce outputs throughout the process, and to actively promote capacity building as part of the project. It is built around three types of activities: case studies, integration and capacity building. This is a preliminary description to be developed in detail by the proposed Assessment Integration Team.

- **Case studies** Case studies will be used to develop the resilience analysis methodology in contexts that are directly relevant to user communities and decision makers in the Arctic. Tentatively there will be two types of case studies. One could focus on a limited region and its interactions across scales from the local to the pan-Arctic and global scales, and the other may focus on specific

issues. The case studies will be carried out in cooperation with relevant partners (regional partners for the regional case studies and appropriate expert groups, WGs, or on-going processes for issue-focused cases). The rationale, budgeting, partners and sub-project leadership for each case study should be elaborated before activities are initiated and the decision rest with the PSC.

- **Integration** Integration activities are at the core of the ARR and will take place throughout the project. The initial integration phase will map potential shocks and the risk of tipping points across the Arctic. Other tasks include refining the resilience analysis methodology (e.g. by drawing on lessons from related work on vulnerability and adaptation), reviewing available relevant literature, and providing background information for case study workshops regarding major drivers and issues. Later in the project, the integration will also focus on comparing different case studies to identify lessons that are relevant across the Arctic. A tool for integrating information is scenarios of potential futures.
- **Capacity building** A resilience analysis is ideally an on-going process that continuously takes new developments into account. A major task in the project, if dedicated funding is secured, is therefore to build capacity within the Arctic to continue using resilience assessments as a tool for dealing with rapid change after the project is finalised. A possible products outcome is therefore a resilience assessment “tool-kit” that can be used by groups who want do their own analysis, e.g. at the community level, along with a set of training and support resources to enable these tools to be used effectively. The capacity building component could be developed in cooperation with University of the Arctic and interested PPs.

Draft work plan

2011	3rd - 4th Q	Scoping and proposal to SAOs Decisions by SAOs November 8-9 Report and documentation from scoping workshop Develop basic outreach material about the project
2012	1st Q	Identify members of Projects Steering Committee Develop terms of reference for a Project Steering Committee and appoint members Develop terms of reference and identify potential core members of AIT Develop strategy for additional funding, including support for case studies and capacity building Develop draft outline for interim report, identify potential authors Initiate planning for capacity building activities Develop communication plan
2012	2nd Q	First meeting of the Assessment Integrations Team and the Project Steering Committee April 2012 Decide on implementation plan Select pilot case studies Select lead authors, initiate work on interim report
2012	3rd Q	Initial pilot case study workshop(s)
2012	4th Q	Small pan-Arctic workshop and second meeting of AIT and PSC (northern Sweden) Possible second case-study workshop(s) Draft text for part I and II of interim report Draft text for part III of interim report based on initial case study results Select additional case studies

Arctic Resilience Report Scoping Workshop

2013	1st Q	Meeting of AIT and PSC Review of interim report Initiate production of interim report
2013	2nd Q	Interim report for Ministerial meeting May 2013 Possible pan-arctic workshop with experts and stakeholders to develop an initial set of scenarios
2013-2014		AIT and PSC meeting approximately every half year Continued development of capacity building efforts Continuation case studies
2014	3rd -4th Q	Synthesis of case study results. Further develop scenarios Writing and review of synthesis report
2015	1st -2nd Q	Production and delivery of final project report May 2015 Ensure continuation of capacity-building efforts outside project Outreach event/conference
2015	3rd - 4th Q	Communication follow-up

D: Presentation by Brian Walker, "A primer for a resilience assessment of the Arctic"

A primer for a resilience assessment of the Arctic

Brian Walker

September 2011

Ecosystems, social systems and social-ecological systems are self-organizing systems

-- and in SESs the ecological and social domains are strongly interlinked

There are *limits* to how much a system can be changed and still recover

Beyond those limits it functions differently, and the system changes to some other state

Western Australian wheatbelt



From clear to turbid lakes



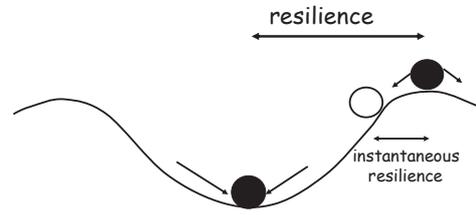
Siberian tundra: shrub → grass regime shift
(thanks to B. Forbes)



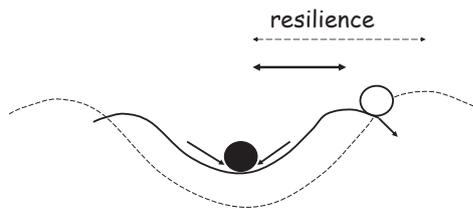
Resilience

"The capacity of a system to absorb disturbance and re-organise so as to retain essentially the same function, structure and feedbacks - to have the same identity"

The ability to cope with shocks and to keep functioning in much the same kind of way



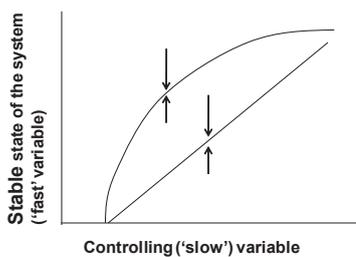
ball-in-a-basin metaphor for stability and resilience



The shape and size of the basin can change
- thresholds move, and so resilience changes

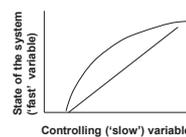
The closer a system is to a threshold, the smaller the shock needed to shift it across

Commonly assumed response of the **equilibrium (stable)** state of a system to changes in its controlling variable

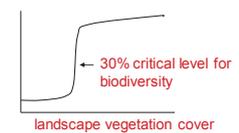


Kinds of thresholds ("tipping points")

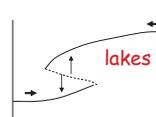
(a) No threshold effect



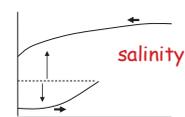
(b) Step change



(c) threshold, alternate stable states



(d) irreversible threshold change



Western Australian wheatbelt



stable state: water table at depth stable state: water table at surface

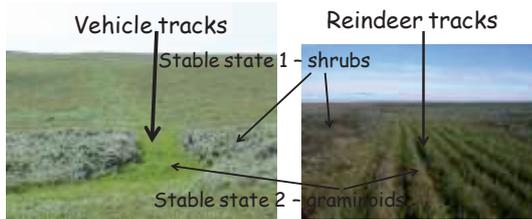
Threshold - degree of tree clearing in the catchment: → rising water table

From clear to turbid lakes



Stable state: low P in water, oligotrophic Stable state: high P in water, eutrophic
Threshold: - P in sediment → water P → algal conc. → anaerobic water → high P solubility (+ve feedback)

Siberian tundra: shrub → grass shift



Threshold: soil compaction and nutrients → grass > shrub dominance → more grazing (+ve feedback)

You cannot understand or manage a system by focussing on one scale.

need at least 3 scales - the focal scale, one above and one below

Increasing resilience at one scale (or pursuing efficiency at one scale) can reduce resilience at other scales

Leads to three related aspects of a resilience approach:

three related attributes of social-ecological systems :

- **resilience** - 'specified' (particular thresholds / regime shifts) and
- 'general' (resilience of all parts of the system to all kinds of shocks)
- **adaptability** (capacity to manage resilience)
- **transformability** (capacity to become a different system)

A Resilience Approach to Planning/ Development

step 1. Defining the system - resilience of what and to what?

- system boundaries, scales, stakeholders, governance
- key assets, values, ecosystem services ('of what')
- disturbances, shocks, trends and drivers ('to what')

step 2. System dynamics (assessing resilience)

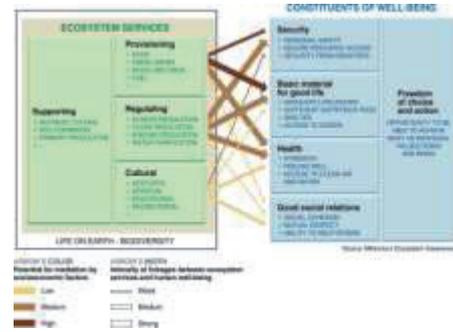
- specified resilience; thresholds and controlling variables
- general resilience and adaptability
- transformability

step 3. Strategies for managing/ building resilience

Step 1 - Resilience of what?

- what is the region - the "focal" scale
 - scales above and below?
- what is the "system"? how many 'bits' are there?
 - which need to be included in the assessment? (farming systems, forests, rivers, towns, ?)
- people and governance - the 'stakeholders', and formal and informal institutions, governments
- what do you value in, and from, the system? (valued goods and services)
- trends, how did it get to be like it is now? (develop a timeline, a historical profile)

Valued goods and services the Millennium Ecosystem Assessment framework



For each valued G&S, what are the underlying, controlling variables that determine it?

Do any of them have threshold levels?

This set of controlling variables determines the state of the system at any time, and its resilience

e.g. for 'biodiversity':

- area of each habitat type (ecosystem)
- condition of each type
- connectivity
- feral pest species

Resilience to what?

- what is the "characteristic" disturbance regime? (storms, floods, droughts, fires, ?)
- rare shocks? (climatic, occasional pests, ?)
- completely novel shocks? (new markets, new species/diseases)
- trends and drivers? (climate change, demography, energy prices, ?): extend the timeline from Step 1

A Resilience Approach to Planning/ Development

- step 1.** Defining the system - resilience of what and to what?
- system boundaries, scales, stakeholders, governance
 - key assets, values, ecosystem services ('of what')
 - disturbances, shocks, trends and drivers ('to what')

step 2. System dynamics (assessing resilience)

- specified resilience; thresholds and controlling variables
- general resilience and adaptability
- transformability

step 3. Strategies for managing/ building resilience

Step 2 - assessing resilience

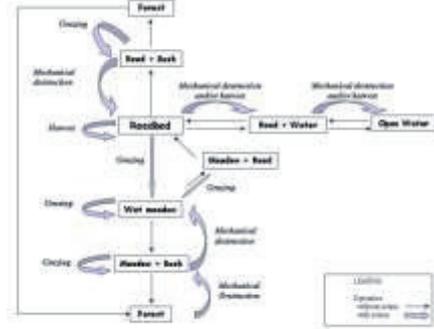
i) 'specified' resilience – thresholds, controlling variables, and drivers (trends)

Thresholds - occur on controlling variables

Change in controlling variables - due to *drivers* (external, or higher scale)

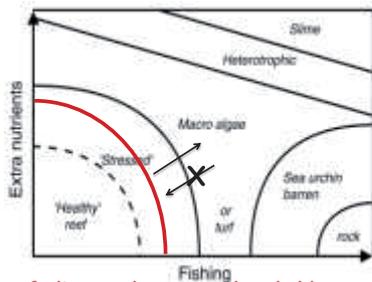
How do you determine thresholds?

- i) known thresholds
- ii) TPCs (thresholds of potential concern)
- iii) conceptual models of change
e.g. state-and-transition models; which transitions might have thresholds on them?
- iv) analytical models
 - statistical models of early warning signals (eg rising variance, critical slowing down, spatial auto-correlation)
 - dynamical models



State-and-Transition model of the Camargue wetland system in the Rhone delta. Boxes = alternate states (or transitional states) Arrows define how interventions mediate the transitions.

Phase-shifts on coral reefs
multiple controlling variables, multiple "states"



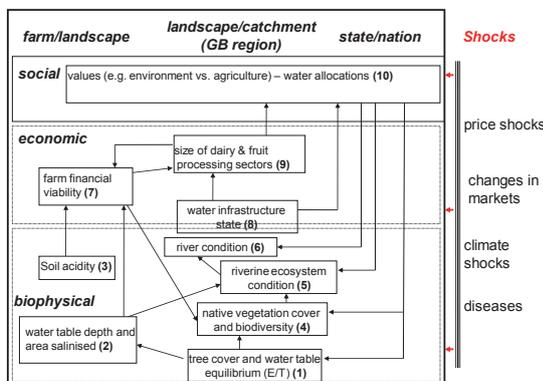
effect of climate change on threshold positions After Bellwood et al, Nature 2004

What are the links (feedbacks) between the focal scale and the scales above, and below?

What feedbacks occur between the sub-systems of the Arctic?
eg, between:
terrestrial, marine, fisheries, transport, energy, ??

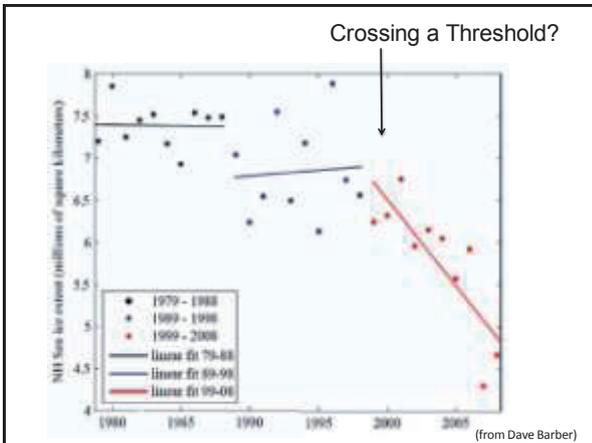
(Remember: thresholds occur where there is a change in feedbacks)

10 thresholds in the Goulburn-Broken catchment, Australia



Arctic thresholds and regime shifts?

- sea ice
- ocean pH ?
- marine biota?
- terrestrial ?
- social - demographic?
 - governance (Nunavut as a regime shift)
 - from the 'cold war' to co-operation?
 - transportation (major passage) as a new attractor?



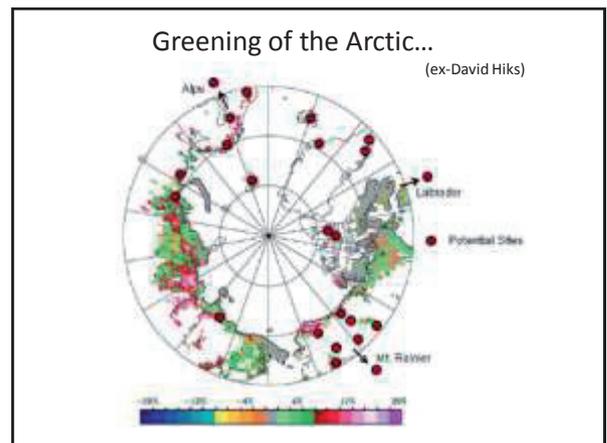
**decreasing alkalinity
(nano- → pico-plankton)**

?

**the ascendancy of
pelagic food chains**

Photo: R. Hopcroft

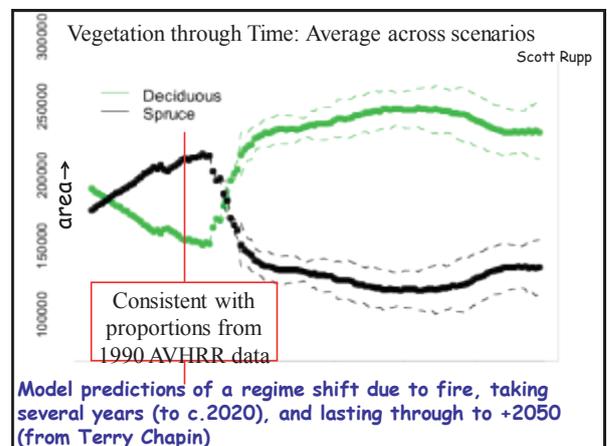
(apologies to Eddy Carmack)



Changes in Alaska fires (T Chapin)

**intense fires,
mineral soil exposed,
forbs, aspen and birch
germinate and dominate**

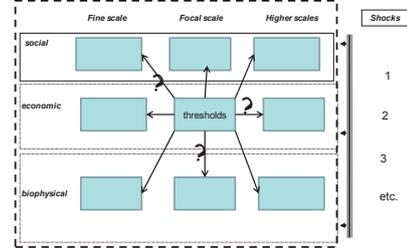
low severity fires,
peat remains intact,
only black spruce germinates



Siberian tundra: shrub - graminoid shift



interacting thresholds across scales and domains



(ii) general resilience

specified = resilience "of what" , "to what"

- BUT making the system very resilient in one way may inadvertently cause it to lose resilience in other ways

general resilience = resilience of any/all aspects of the system, to all kinds of shocks (including novel shocks)

what determines resilience, in general?

- diversity
- modularity (connectedness, network structures)
- tightness of feedbacks
- openness (immigration, inflows, outflows)
- reserves /reservoirs (seedbanks, nutrient pools, memory)
- social capital (trust, leadership, social networks)
- overlapping institutions, polycentric governance
- adaptive governance
- other?

In the Arctic - which are changing? At what scales? Are any of them limiting, or a problem?

managing resilience

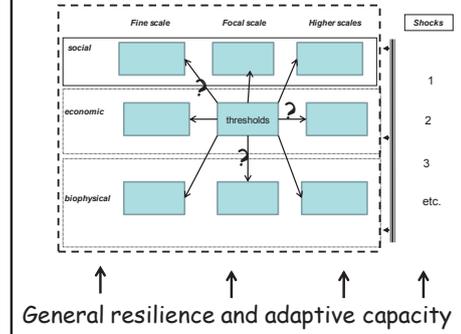
- learning about thresholds and how to stay away from (or cross over) them,
- changing the positions of thresholds

depends on adaptive capacity

- self-organising ability
- leadership, social networks and trust (social capital)
- human capital (skills, education)
- options (levels of natural, built and financial capital)

(note overlap with general resilience)

interacting thresholds across scales and domains



Adaptation or transformation?

Resilience, *per se*, is not 'good' or 'bad'

Undesirable states of systems can be very resilient (woody weeds, dictatorships, saline landscapes, inner city slums)

A system state that once was considered to be a 'desired' state can become 'undesirable' through changes in external conditions (context)

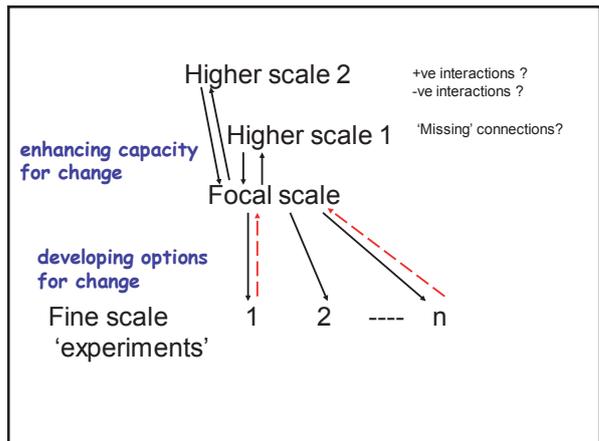
Does further adaptation simply amount to digging the hole deeper? (the first rule of holes!)

if a shift into a "bad" state has happened or is inevitable, or if the current state is no longer a desirable one, the only option is **transformation**

"transformability" - capacity to transform into a different kind of system; a new way of living, and making a living

determinants of transformability

- preparedness to change (getting beyond the state of denial)
- options for change (new 'trajectories' - emerge from support for experiments, novelty, continual learning)
- capacity to change (levels of capitals, 'social capital', higher-scale support)



In which parts of the region/ system do you need to build resilience, and which parts need transformational change?

Arctic marine reserves?

a possible component of anticipatory transformational change? (from T.Chapin)

- Crisis: Disappearing arctic sea ice
 - Walrus, seals, polar bears require sea ice
 - Coastal community subsistence based on sea mammals
- Salmon as an alternative subsistence resource?
 - Salmon are migrating north as sea ice retreats
 - Design marine reserves for fishery that does not yet exist
 - Institutional vacuum
 - Manage oil development to protect stream gravels
 - Ice roads rather than gravel roads
- No vested interests opposed to reserves

Maintaining *resilience* at a regional scale can require *transformational* changes at local scales

- resilience and transformability are not "opposites" ; they are compatible aspects of a complex adaptive system that functions at multiple scales

A Resilience Approach to Planning/ Development

step 1. Defining the system - resilience of what and to what?
 - system boundaries, scales, stakeholders, governance
 - key assets, values, ecosystem services ('of what')
 - disturbances, shocks, trends and drivers ('to what')

step 2. System dynamics (assessing resilience)
 - specified resilience; thresholds and controlling variables
 - general resilience and adaptability
 - transformability

step 3. Strategies for managing/ building resilience

Step 3 - Strategies for managing/ building resilience

1. Kinds and scales of interventions

- i) policy and institutions
- ii) financial (assistance /taxes /penalties)
- iii) information (management guidelines /education / training)

2. Sequencing and timing of interventions

3. Develop an adaptive management program (treat policy and management as an experiment)

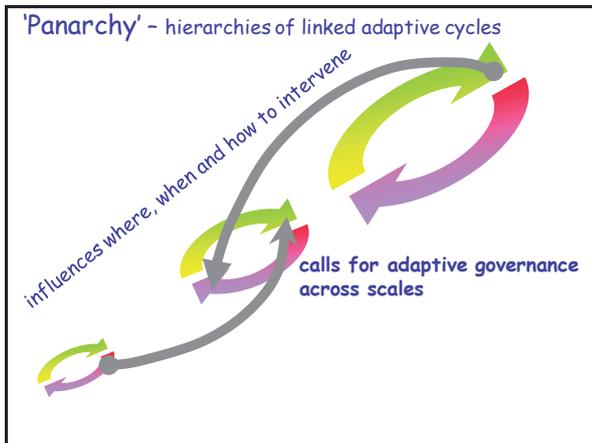
4. Is transformation called for? (re-visit 1. and 2.) identify transition pathways

ecosystems, social systems, SESs and STEs all go through **internally** generated cycles of change - adaptive cycles

the appropriate timing, and kind, of intervention for managing resilience depends on the phase of the cycle the system is in

Phases of an adaptive cycle





In summary:

How do you *do* a resilience assessment, and how do you apply it to planning and management?

There is no 'recipe', no set procedure or sequence of actions

A Resilience Approach to Planning/ Development

- develop a multi-scale, adaptive cycle perspective of the system
 - learn about thresholds
 - don't try to aim for some "optimal" state ; avoid states that are *not* wanted and let the system self-organise within the range of acceptable states
 - maintain general resilience and embrace change
 - promote and sustain diversity, of all kinds
 - restrict control of environmental /ecological variability
 - encourage learning, innovation and experiments
 - be ready for and capable of transformational change
- beware of partial solutions!

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