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EXECUTIVE SUMMARY

One of the aims of INTAROS is to build additional capacity within Indigenous and civil society organizations, government agencies and scientists on community-based and citizen science observing in the Arctic. There is no single 'right' way of undertaking community-based observing. The approach will vary and what is suitable to ensure effective monitoring will change from one place to the next although there are a number of features which, in many cases, will be shared. One of the most effective ways to build capacity in community-based observing is through bringing people together and enabling the participants to share their experiences related to community-based observing, discussing and agreeing on what works, when and why.

Over the course of the INTAROS project, from Dec. 2016 to May 2021, the project has organized or co-organized 40 workshops, dialogue meetings, seminars and other events on community-based monitoring (CBM) in the Arctic and Sub-Arctic. The events have been attended by at least 600 people, including representatives from five Arctic Indigenous Peoples (Inuit, Sami, Evenk, Gwi´chin and Komi Izhma), and citizens of all eight Arctic nations. It is noteworthy that there have been some 200 youth among the participants, mostly from Arctic Russia.

The events have contributed to >400 pages of proceedings, technical reports and publications on community-based observing in the Arctic. Summaries of the discussions at most of these events have already been widely circulated. In this document, we highlight 12 of the events on community-based observing, including seven workshops, one international conference side-event, three online meetings, and one in-service training course. These events were held in Alaska, Canada, Greenland, Norway, Germany, Russia, and online during Covid-19.

In many discussion sessions at the events, participants were concerned about how to connect CBM programs with top-down observing approaches and associated management decision-making processes. In the last part of this document, we therefore discuss the challenges and opportunities for connecting CBM programs with top-down observing approaches and associated management decision-making processes, drawing on a review by Hajo Eicken and colleagues (2021).

Connecting CBM programs and top-down observing approaches can lead to improved information products and enhanced efficiency and sustainability of observing programs (Eicken et al. 2021). It can also promote stronger linkages between CBM programs and natural resource management decision-making processes. Core principles central to such linkages are: 1) matching observing program aims, scales, and ability to act on information; 2) matching observing program and community priorities; 3) fostering compatibility in observing methodology and data management; 4) respect for Indigenous intellectual property rights and the implementation of Free, Prior, and Informed Consent; 5) creating sufficient organizational support structures and ensuring that CBM programs link with decision-making processes on natural resource management; and 6) ensuring sustained community members' commitment. In the document, we present and discuss suitable interventions to overcome challenges in adhering to these six principles.

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1. Introduction

One of the aims of INTAROS is to build additional capacity within Indigenous and civil society organizations, government agencies and scientists involved in community-based observing in the Arctic. This document contains an overview of highlights from the experience-exchange workshops undertaken by INTAROS to build the capacity of civil society organizations, public staff and researchers in community-based observing (Chapter 2). It furthermore discusses the challenges and opportunities for connecting CBM programs with top-down observing approaches and natural resource management decision-making processes (Chapter 3).

2. INTAROS experience-exchange workshops on community-based observing

In this chapter, we provide an overview of the experience-exchange workshops organized or co-organized by INTAROS and we present the key findings from the discussions at each workshop. We also provide links to the proceedings.

2.1 Overview of experience-exchange workshops on community-based observing

We would like to highlight 12 workshops and events on community-based observing and citizen science organized or co-organized by INTAROS from Dec. 2016 to May 2021. Table 1 summarizes the location of the workshops, times, and host organizations.

The participants in the events were community-based observing practitioners, community members, government staff, policy-makers, scientists and youth from all eight Arctic countries and from Germany and Japan. Topics discussed during the experience-exchange workshops varied as the organizers considered the specific interests of the participants. In general, topics included how to sustain community-based observing, who uses the information generated and how decision-making processes are influenced, whether there was interest in sharing the information with others beyond the current users of the community-based observing program, and the barriers and opportunities that exist for doing so. Separate proceedings have been prepared for most of the workshops (Table 1). In the following sections, we present further information about each of the 12 workshops in chronological order.

Table 1. Experience-exchange workshops and related events engaging community-based monitoring practitioners and community members, government staff, policy-makers and scientists (Dec. 2016 – May 2021)

	Workshop*	Dates	Host	Proceedings
1	Nuuk, Greenland	December 6–8, 2016	NORDECO, *Piniakkanik Sumiiffinni Nalunaarsuineq* (PISUNA) and NUNAVIS	Unpublished report

2	Fairbanks, Alaska	May 10, 2017	International Arctic Research Center, University of Alaska Fairbanks, Yukon River Inter-Tribal Watershed Council, ELOKA, and NORDECO	Fidel et al. 2017
3	Quebec City, Quebec, Canada	December 11–12, 2017	ELOKA, Yukon River Inter-Tribal Watershed Council, NORDECO, Nansen Environmental and Remote Sensing Center, University of Alaska Fairbanks	Johnson et al. 2018
4	Komi Izhma, Zhigansk and Olenek Districts, Russia	September 2017, September 2018, April 2019	Centre for Support to Indigenous Peoples of the North, the Republic Indigenous Peoples Organization of Sakha Republic, NORDECO	Enghoff et al. 2019
5	Longyearbyen, Svalbard	December 6, 2018	Nansen Environmental and Remote Sensing Center	Iversen et al. 2019
6	Berlin, Germany, 2nd Arctic Science Ministerial	October 26, 2018	UArctic Thematic Network on Collaborative Resource Management	Unpublished report
7	Longyearbyen, Svalbard	March 7–8, 2019	Nansen Environmental and Remote Sensing Center and NORDECO	Poulsen et al. 2019
8	Sapporo, Hokkaido, Japan	June 27–28, 2019	Hokkaido University	Lee et al. 2019
9	Nuuk, Greenland	October 22-24, 2019	Greenland Climate Research Centre, University of Alberta, NORDECO, Mombetsu Sea-Ice Museum	Danielsen et al. 2020
10	Online (due to Covid-19), First European Polar Science Week, Grand Challenges Session	October 29, 2020	European Space Agency, the European Commission	Anon. 2021
11	Online (due to Covid-19), Arctic User Knowledge Network	February 22, 2021	NORDECO	Enghoff et al. 2021
12	Online (due to Covid-19), Arctic Science Summit Week	March 26, 2021	ELOKA, Nansen Environmental and Remote Sensing Center, NORDECO	Video available

* The project also made many presentations and contributions to e.g. panel discussions at international or national conferences and meetings but they are not included here.

2.2 Nuuk workshop, December 2016

At the start of the INTAROS project, a workshop was held in Nuuk with Greenland-based CBM practitioners, government staff, representatives of Inuit Circumpolar Council Greenland, staff of the International Centre for Reindeer Husbandry (Kautokeino), and scientists from Greenland Institute of Natural Resources. The workshop was convened in cooperation with the Nordic Resource Management Project of the Nordic Council of Ministers, and the PISUNA (*Piniakkanik sumiiffinni nalunaarsuineq*) program. During one session of this workshop, the aims and objectives of the INTAROS project on capacity-strengthening in CBM were presented and discussed with the participants with a view to obtaining their feedback on the further planning of the CBM activities. This session was organized by Martin Enghoff, Michael K. Poulsen and Finn Danielsen.

Relevant link: No report is available.

2.3 Community-based monitoring workshop, Fairbanks, Alaska, May 2017

This workshop offered an opportunity for practitioners of CBM and other observing programs to come together to exchange experiences and perspectives (Fidel et al. 2017). Some 10 CBM programs from Alaska and Canada were in attendance. Additional participants included researchers and government officials currently involved in CBM. The workshop was held at the University of Alaska's International Arctic Research Center as part of the 2017 Week of the Arctic activities that concluded the U.S. Arctic Council Chairmanship. Representatives from the Arctic Council working groups, Alaska and U.S. agencies, and the public were invited to a two-hour dialogue immediately following the workshop focusing on the use of CBM in decision-making and assessment. The meeting was organized by Maryann Fidel, Hajo Eicken, Noor Johnson, Olivia Lee, Colleen Strawhacker, Lisbeth Iversen, and Finn Danielsen.

Participants noted the need for and value of good observations, and the importance of making observations available in order to contribute to Arctic observing efforts. Sharing these data is extremely important and efforts need to be put into creating platforms for sharing CBM data. The more the information gets distributed, the more valuable it becomes. Documented observations can be valuable into the next century and they can serve as a benchmark for measuring future changes in the environment. These observations are important because community members often have an intimate knowledge of their environment that visiting scientists may not.

While participants noted the importance of community observations, they also identified challenges and barriers. The global and national stakeholders want information from rural areas but it can be difficult for communities to respond to this demand. Technology is a huge help in understanding emerging and important issues that need a response and understanding who has the capacity to respond but it is important to bear in mind that many small rural communities do not have Internet. We need to figure out how to pull together the little information we have and build the broader picture. One component of this is the need for an inventory of networks involved in CBM (arcticcbm.org; Johnson et al. 2016; Danielsen et al. 2020). Communities need to be able to set observation priorities, because what communities see as important is central to their future livelihood and economy. Priority issues for northern communities are: a stable economy, more jobs, and health care.

Monitoring should not be done for the sake of monitoring; what is needed are strategic interventions to help people figure out how to adapt. Northern communities are facing multiple

stressors from climate change and pollution. Issues that need to be dealt with within the next 10 years. There is a great need for information because, without information, it is hard to make choices. Information should inform action, so how do you get the information into the hands of those who are acting? And at the right scale? Currently, people are acting and adapting to changes. No one is waiting for the next report to tell them how to adapt.

The Arctic Climate Impact Assessment started engaging people different from the type these assessments usually do, and we need to do more of this. A school curriculum needs to be developed to train the next generation of Indigenous scientists, with younger children and at the university level. The universities have a role to play in educating the next generation of community observers. There is a role for the arts and theater in adaptation as well. Government agencies should also support this effort.

State and Federal agencies in Alaska often underestimate the risks of industrial development so there is a need to make a more compelling argument that CBM be included in studies assessing the impacts of industrial development. There is need for a statutory change that would require CBM bodies to be set up to monitor the impact of industrial development. 'Many villages are in constant disagreement with the federal and state agencies, which is one of the reasons we collect our own data.'

There is a need to build capacity and reform our resource management agencies to incorporate community observations into management and create more co-management entities. Communities are often expected to do the work with no pay and this is not acceptable. There is a need to infuse the communities with funding. We also need to respect that it takes time to make the connections and get good information from communities. CBM is not about what communities can do to answer scientists' questions. It should be turned around: what can scientists do to answer communities' questions? Through these types of collaboration, scientists could produce relevant, robust knowledge. There are many aspects of science and community wisdom that intersect; we should build on these. As part of these efforts, scientists need to gain a better understanding of what traditional knowledge is. It is important to respect the holistic nature of Alaska Native perspectives.

Overall, it was concluded that there is a wide variety of excellent CBM work occurring across the Arctic but that there is room for improvement in some areas. Below are some of the good practices and needs that were identified during the workshop and dialogue meeting.

Good practice in CBM programs would: be collaborative, co-producing knowledge and projects; gather information that is relevant to communities, and adaptation needs; empower Índigenous peoples to address local decision-making needs; utilize traditional knowledge to fill information gaps, especially baseline conditions; avoid duplication by building on what is already in place; build bridges between two worlds, native and science; have data-sharing agreements in place, which are co-created by all parties involved and clear to all participants; share data with participating communities in locally accepted forms of communication (plain language reports, stories, newsletters); contribute to communities through training, employment, honoraria; provide the information needed to inform decision-making needs; be inclusive, including youth, elders, and women.

CBM programs need to:

- Shorten the distance from data collection to action by putting relevant information in the hands of those doing the adapting; science is too slow to address the rapid changes people are experiencing
- Collect data that is used to inform the management of wildlife, fish and the environment, as regulations are not keeping up with the fast changes people are experiencing, which can cause hardship for those living off the land
- Enhance cooperation for sharing data
- Understand that limited Internet connectivity makes communication and real-time data-sharing difficult; find creative ways to effectively communicate
- Engage communities in a greater role to identify monitoring needs with attention to changes that are occurring across many communities
- Support networks of Native communities, so that they can identify shared priorities and identify how science can best contribute
- Work to change the system whereby Alaska Natives are forced to work within a system that does not reflect their way of thinking
- Build relationships of trust
- Support education so that scientists understand Native ways, and Native youth and others get involved in science
- Build effective networks so we know what others are interested in, and can share lessons learned about adaptation
- Work to: change funding systems so that they fund community priorities and not just academic priorities; increase sustained funding opportunities for monitoring; educate funders about funding needs to properly document traditional knowledge; support sustained priorities so they do not change with the 'political wind'
- Develop programs that monitor the impacts of industrial development

While much progress has been made in this field, much more work is still needed to refine CBM programs to address the 'climate crisis' Alaska Native peoples are experiencing, and continued energy is needed to build responsive CBM programs that can support Alaska Native peoples in building a sustainable future that preserves culture and community.

Relevant link:
"https://www.researchgate.net/publication/321001860_INTAROS_Community_-Based_Monitoring_Experience_Exchange_Workshop_Report?channel=doi&linkId=5a0663d64585157013a3c085&showFulltext=true"

2.4 Community-based monitoring workshop, Québec, Canada, December 2017

A workshop was held in Québec at the Québec Convention Centre on December 11-12, 2017 concurrently with the Arctic Change 2017 Conference (Johnson et al. 2018). The workshop offered an opportunity for practitioners of CBM and observing programs from northern Canada to come together to exchange experiences and perspectives. Representatives of ten CBM programs attended. Additional participants included representatives of co-management boards, northern research institutions, Inuit organizations, philanthropic organizations, and programs focused on developing or adapting tools for data management and sharing. The objective of the workshop was to facilitate an exchange of ideas and information among CBM practitioners from Canada. An agenda for the workshop was developed based on input from participants.

The agenda included time for brief presentations from CBM programs, breakout and plenary discussion groups, and time for networking. The meeting was organized by Noor Johnson, Maryann Fidel, Finn Danielsen, Lisbeth Iversen, Michael K. Poulsen, Donna Hauser, and Peter Pulsifer.

One of the topics discussed was the motivations for implementing CBM programs. Motivations differ but include the possibilities of influencing decisions about industrial development and regulations in fishing and hunting. Gaining a better understanding of the challenges and opportunities of climate change and social and human health conditions is also a key motivating factor, as is the option for participating in education and capacity building. Similarly, the motivation for individuals to be involved in CBM varied but included addressing the practical needs of communities. Other sources of motivation for individuals included developing a better understanding of the environment and sharing knowledge and learning from each other.

There were a variety of attributes being monitored by the CBM programs in attendance. Many people and organizations are using CBM-generated information, including: individuals, hunter trapper organizations, civil society organizations, industry, and government organizations at all levels, especially wildlife management agencies.

Good practices are considered practices that have proven to work well for CBM programs. These included CBM practices that are supported by the community, provide capacity building opportunities, link Indigenous knowledge and science, and document Indigenous knowledge. Trust among community members and scientists is also important.

Challenges that CBM program representatives have faced included the ability to secure long-term funding, leading to gaps in data records over time. Other challenges included reconciling science and community priorities, linking quantitative with qualitative approaches, and meaningful dissemination of information. There were also challenges related to avoiding misconceptions of how the data can be used, timeliness of producing accessible data, community burnout, and difficulties in growing a program. Other challenges included a lack of technical support, limitations in community infrastructure and connectivity, and difficulties in influencing change. There was also a general agreement that CBM programs need to evolve, building on what we have learned rather than doing things the way they have always been done.

Relevant link:
https://intaros.nersc.no/sites/intaros.nersc.no/files/Quebec_CBM_Report_Final%20%281%29.pdf

2.5 Community-based monitoring workshops, Arctic Russia, 2017-2019

INTAROS has been implementing a community-based monitoring (CBM) capacity development process among selected Indigenous Peoples' communities in Arctic Russia since September 2017 (Enghoff et al. 2019). The process has built on pilot activities that ran from 2012 to 2016. From 2017-2019, the work involved 20 smaller workshops and meetings. The workshops and meetings were organized by Vyacheslav (Slava) Shadrin, Nikita Vronski, Rodion Sulyandziga, Martin Enghoff and Finn Danielsen. The organizations involved have mainly been the Centre for Support to Indigenous People of the North (CSIPN), the Republic Indigenous Peoples' Organization of Sakha Republic, and NORDECO.

The CBM activities have primarily been implemented in communities in Zhigansk and Olenek districts in Sakha Republic, which is home to the Evenk Indigenous communities. The Indigenous communities are heavily dependent on the natural resources living in these remote areas of the Arctic. Both districts have Indigenous communities making important local use of living resources but who are, at the same time, facing serious challenges in relation to accessing these resources due to changes in resource availability and threats. The threats include pollution and resource depletion caused by various forms of mining and the oil and gas industry, as well as companies utilizing and increasingly monopolizing the fish resources. The areas are classified as traditional areas of occupational use. This is a legal status that gives Indigenous communities in Russia a degree of protection but, in practice, it has proved difficult to enforce this status in relation to protecting the rights of Indigenous communities.

The workshops and meetings focused on introducing CBM and building capacity to undertake CBM in the communities. Subsequent workshops have focused on how concrete CBM activities are being implemented in the respective communities. An average of some 10-15 people were involved in each workshop and meeting. Different communities have been involved in the INTAROS CBM process for different lengths of time, with some starting in 2017, others in 2018 and a few in 2019. The status as of May 2019 was that eight different CBM groups were actively undertaking CBM within the targeted areas. Key participants in workshops and meetings have included local fishers, hunters and herders, local Indigenous peoples' representatives, various members of local authorities, and school students and teachers.

As a result of the CBM capacity development process, CBM activities are well underway in the two districts. The local communities and local Indigenous peoples' representatives are interested in and supportive of the CBM activities. The use of CBM is generally understood and seen as a relevant activity that will provide the local communities with an improved way of developing and presenting local knowledge on resources and resource use. Using CBM as a way of trying to influence management decisions on natural resources is seen as a key feature of being involved in CBM. Local authorities are supportive of the activities. The Republic Indigenous Peoples' (IP) organization is taking a leading role in activities and ensuring linkages to the communities. Input from the CBM groups (information, analysis and recommendations) has been used by the Republic IP organization to seek influence over the management of a number of subject areas related to resource management at both Republic and District level. Organizing and communicating information is being undertaken using short and relevant forms, which are filled out by the CBM groups and which include resource information, analysis of information and suggested actions.

There have mainly been three challenges to the CBM capacity development process in Zhigansk and Olenek districts. First, collaborating with official governance structures. The official governance of many natural resources is centralized in a way that is not conducive to local management arrangements. Some of the official government structures are not in favor of collaborating with local stakeholders. Second, organizing communities and ensuring continued management support to program. The area is vast, communities live far from each other. Due to a history of centralized natural resource management, where local interests have been neglected, the community members see challenges in running a program where local observations are at the center. The local IP organization in charge of program management is also challenged in terms of its resources to provide management support to the program. Third, long-term funding. It is difficult to find long-term funding. From 2012-2016, prior to INTAROS, funding (for the time and travel costs of facilitators) could only be secured for one

year at a time. The program partners were therefore continuously seeking other funding opportunities and simultaneously adjusting program administration and implementation for maximum sustainability.

Relevant link: A technical report is available:
http://intaros.eu/media/1650/process-report-yakutia-cbm-dec-2019-final.pdf

2.6 Stakeholder dialogue, Longyearbyen, December 2018

A stakeholder dialogue workshop was organized by Lisbeth Iversen (NERSC) and Alexandra Meyer (NUNATARYUK) in Longyearbyen, Svalbard in December 2018 (Iversen and Meyer 2019). The aim of the workshop was to initiate a dialogue on knowledge, challenges and possibilities related to climate, nature, and the environment on Svalbard. A central question asked was how research on climate and the environment can be of use for the local community in Longyearbyen. Different local actors were invited to give short statements about what they see as the most important challenges and possibilities related to climate, nature, and the environment within their sector, as well as what knowledge is needed. The workshop was a part of a research school on cross-disciplinary science in the Arctic and collaboration with local communities 2-7 December 2018, at the premises of the University Centre in Svalbard (UNIS).

The workshop started with thematic introductions and statements by local actors from Longyearbyen Lokalstyre, UNIS, Arctic Safety Centre, Svalbards Næringsforening, Visit Svalbard and the Governor of Svalbard. The second part of the workshop was arranged as a dialogue café. The workshop discussed and listed a range of challenges in terms of climate change and socio-economic development, and the workshop developed a number of options for improving collaboration between scientists and the local community/authorities in Longyearbyen.

Relevant link: Proceedings from the stakeholder dialogue in Longyearbyen is available:
http://intaros.eu/media/1549/report-from-workshop-v5-1-final.pdf

2.7 Side-event at the 2nd Arctic Science Ministerial in Berlin, October 2018

In conjunction with the 2nd Arctic Science Ministerial, a side-event was organized in Berlin by Natsuhiko Otsuka (Hokkaido University), Malene Simon (Greenland Climate Research Centre), Hajo Eicken (University of Alaska Fairbanks), and Finn Danielsen (NORDECO). The side-event involved six presentations and a panel discussion on how education and research institutions can contribute to increasing the number of Arctic resource managers and scientists who are able to facilitate, implement and operationalize participatory approaches to natural resource management in practice.

Several challenges to capacity development in collaborative natural resource management in the Arctic were discussed. First, while there is broad interest in education in community-based science and in how to link different disciplines, current training in these fields is mostly undertaken on a small-scale, in an *ad hoc* manner, and outside of formal education institutions. Second, it takes significant time to get people through university-based courses, and many practitioners within government agencies and Indigenous governance institutions do not have either the means or the time to complete conventional university courses. Third, there are few permanent positions available in collaborative natural resource management and there is thus a

risk of creating false hopes of employment on the part of trained students and community members who might expect that the training would lead to paid positions.

The importance of connecting science with society and decision-making in the 'real' world was identified as key at the event. It was stressed that there is a need to develop competence within the Indigenous communities. The new UArctic Thematic Network on Collaborative Resource Management should support small organizations and build on what already exists. However, it should be recognized that organizational development takes time. The network could also provide the youth with tools for collaborative management where they themselves define and shape training courses. In Japan, successful capacity development activities have included summer schools and symposia on sea-ice, jointly undertaken by fishers, researchers, municipal authorities and the government. It was also suggested that the network could encourage further collaboration between communities and technology companies.

There is a significant need to develop internationally-accepted standards for human qualifications that represent other 'ways of knowing'. The network could play a vital role by putting standards in place that acknowledge this. There also exists a need for further demonstration and provision of guidance on co-production of knowledge; the network could develop courses that fulfil the requirements of both governments and traditional knowledge holders. Partner institutions could bring infrastructure for courses and reach out to resource co-management bodies in their respective countries to understand training needs and to receive input regarding which aspects of course development to emphasize. Finally, it was suggested that the network could also urge education and research institutions to prioritize collaborative natural resource management.

The meeting concluded that there were many different perspectives on collaborative management and monitoring. There was broad support for establishing a Thematic Network in UArctic to strengthen efforts to develop capacity in collaborative management and monitoring across the Arctic. Moreover, the discussions contributed to getting collaborative approaches to resource management and monitoring into the 'Joint Agreement' coming out of the 2nd Arctic Science Ministerial.

Relevant link: https://www.nordeco.dk/2nd-arctic-science-minesterial

2.8 Cruise expedition monitoring workshop, Longyearbyen, March 2019

The large expanse of the Arctic and the many remote parts that are rarely visited by scientists or anyone at all is a challenge for environmental monitoring. Cruise ships are regularly reaching otherwise rarely visited places, particularly in Svalbard, Greenland and South East Alaska. Tour guides and passengers can contribute meaningfully to environmental monitoring in the Arctic.

In March 2019, a workshop at UNIS in Longyearbyen offered an opportunity for cruise operators, citizen science programs, local government and scientists in the Arctic to come together to exchange experiences and perspectives (Poulsen et al. 2019). The workshop was organized by Michael Køie Poulsen (NORDECO), Lisbeth Iversen (NERSC), Naja Elisabeth Mikkelsen (International Arctic Science Committee), and Finn Danielsen (NORDECO). The focus of the workshop was on working towards agreeing simple methods that can be used alongside the normal cruise activities at sea and on land, and which can be reported on, as far

as possible, using the same format. Such approaches can be meaningful to all involved and may make the cruises an even richer experience for both guides and guests.

Some cruise operators are already participating in environmental monitoring. It may be possible to learn from existing efforts, build on these, and extend the participatory monitoring to even more cruises. Cruise expeditions have the potential to support environmental protection efforts by obtaining information that can help scientists conduct conservation research and provide a better basis for management decisions.

Relevant link: The proceedings from the workshop is available:
http://intaros.eu/media/1635/2019-report-aeco-workshop-v4.pdf

2.9 Collaborative resource management workshop, Hokkaido, Japan, June 2019

UArctic is a cooperative network of universities and other organizations concerned with education and research in and about the North. Thematic networks are a fundamental component of UArctic. Thematic networks comprise networks of 'experts' in specific areas. They can strengthen northern institutions by sharing expertise, and can carry out training, education, knowledge sharing and research cooperation. They operate independently and can serve as a gateway for reaching expertise on the part of other UArctic programs. Thematic networks are envisaged to reflect UArctic's principles and values, including the key role of Indigenous peoples in northern development. They use the UArctic identity in their work, following normal procedures.

The topic of the workshop in Hokkaido was how to develop a new Thematic Network that aims to develop capacity in collaborative management and community monitoring in the Arctic (Lee et al. 2019). Collaborative management is about local stakeholders playing a central role in the decision-making process. Community monitoring is monitoring led and undertaken by local stakeholders. The workshop also included important experience exchange on community-based monitoring and management and resulted in increased capacity and better agreement on key issues related to community-based monitoring and management. The meeting was organized by Natsuhiko Otsuka, Martin Enghoff, Finn Danielsen, Olivia Lee, Jason Akearok, Hiroyuki Enomoto, and Lene K. Holm. The workshop was co-funded by the Government of Denmark.

Relevant link: Proceedings are available at: http://intaros.eu/media/1649/proceedings-uarctic-sapporo-workshop-27-28-june-2019-31-jan-20.pdf

2.10 UArctic course for public resource managers in Greenland, Nuuk, October 2019

An in-service course in collaborative resource management in the Arctic was held for public resource managers and recently-graduated Greenland-based students in Nuuk in October 2019 (Danielsen 2020). The course was jointly organized by the UArctic Network on Collaborative Resource Management and INTAROS. The course comprised lectures, group discussions and exercises. A total of 25 participants attended the three-day course; this included staff from all five municipalities of Greenland. The course plan, reading materials, course program, lectures and exercises are freely available from the Thematic Network website at the link below.

At the end of Day 1 and Day 3, assessments were undertaken in collaboration with the participants, aimed at adjusting the format and the content of the course, generating ownership

of the course process among the participants, and synthesizing key lessons that might be useful for future courses in collaborative resource management in the Arctic.

Overall, the respondents found it a successful course. It explained the importance of collaborative resource management and provided the trainees with very concrete and useful tools. The program's mix of learning approaches, i.e. discussions, lectures and group exercises, was highly valued. The explanations provided were considered clear and understandable and the dialogue constructive.

Several respondents liked the exercises where they used digital platforms for CBM programs to answer management questions, as well as the specific case from Nuuk Fjord. It was proposed that all municipal staff in advisor positions (*erhvervskonsulenter*) in Greenland should attend the course in the future and that the course should be livestreamed, offered free of charge and on a permanent basis.

In terms of the course content, it was suggested that more attention should be given to concrete examples of collaborative decision-making in practice, including methods and how to begin them. It would be good to have more time to discuss the challenges that each course participant has faced in their daily work of supervising and assisting decision-making and management of resources. It was proposed to further clarify in advance of the course whether it is intended to be a theoretical course, a course where hunter/fisher knowledge is shared through anecdotes, or a practical course on how to set up collaborative management processes.

In terms of the course process, some lectures were considered too long and complicated, and more group discussions and daily summaries were requested. It was also suggested that there should be more careful consideration of the composition of group members so that all key perspectives are represented in every group. Finally, it was suggested that a small booklet be prepared with the key take-home messages and methods.

Relevant link: Course Program**:** https://www.uarctic.org/media/1600603/iv-programme-english-pdf.pdf. Course Tool Kit and Training Materials (course plan, reading materials, course program, lectures and exercises) are all available from the Thematic Network website (course overview: https://www.uarctic.org/media/1600608/curriculum-overview-pdf.pdf)

2.11 Grand Challenges Session, European Polar Science Week, Online, October 2020

Session at the First European Polar Science Week organized by Finn Danielsen, Peter Pulsifer and Martin Enghoff "Cross-weaving Citizen Science, Local Knowledge and Scientific Research in the Arctic".

The session included several presentations, a panel of five experts, had 30+ participants and highlighted the following: in the new Central Arctic Ocean fisheries agreement, cross-weaving of knowledge approaches is mandatory but further work will be required to find out how this should be undertaken in practice (Anon. 2021). In Greenland, community-led observing has led, and continues to lead, to many natural resource management proposals but policy initiatives and frameworks are needed to enable cross-weaving. In Svalbard and Greenland, expedition cruise operators visit areas of the Arctic that nobody else goes to. The operators are eager to expand cooperation with scientists and citizen science programs. Overall, substantial theoretical work has been made on the needs for cross-weaving knowledge approaches. The Multiple

Evidence approach is one approach. In the coming years, it will be very important to move further from theory to practice with cross-weaving of knowledge approaches in the Arctic.

Mobilizing all relevant knowledge, observations and data on the Arctic environment will be transformational. It will bring about a better understanding that will be able to transform natural and social science research and natural resource management in the Arctic. This has great potential to impact the lives of Arctic peoples.

Key barriers include:

- Insufficient respect among scientists for the knowledge and observations of community members
- Incomplete understanding of how to obtain and use data from different people (with varying beliefs, epistemologies, rationalities and cosmologies) and different knowledge systems in mutually beneficial ways
- Lack of shared protocols enabling cross-weaving, and insufficient dialogue on how to ensure knowledge synthesis
- Lack of government policy in support of cross-weaving knowledge
- Asymmetric power relationships (and financial resources)
- Digital divide

Key research needs – and opportunities are:

- Develop a holistic data 'ecosystem': bridging conceptual, political and geographic distances
- Establish an understanding of how to obtain and use data from different people and different knowledge systems
- Develop ways to enable knowledge production and monitoring across scales
- Explore appropriate ways for combining Indigenous and local knowledge, CBM data, and science data for improved 'real-world' decision-making
- Improve coordination of research efforts (related to cross-weaving knowledge) and mobilize all research results for operational contexts
- Further develop observing-logistics and research infrastructures, including cyber infrastructure for cross-weaving knowledge

Relevant link: The whole session is available on YouTube: https://youtu.be/ljUTNlw4slM

2.12 Arctic User Knowledge Network workshop, Online on Zoom, February 2021

International agreements emphasize the importance of engaging community members and local knowledge/user knowledge in decision-making on resource management (Enghoff et al. 2021). Among the international management bodies of greatest importance to the lives and livelihoods of Arctic resources users are: NAMMCO (the North Atlantic Marine Mammal Commission), CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), JCNB (Joint Commission on Narwhal and Beluga), NAFO (the Northwest Atlantic Fisheries Organization), and ICES (the International Council for the Exploration of the Sea).

In recent years, several initiatives have been taken to further integrate user knowledge with scientific knowledge. The current status is, however, that government agencies' decision-making on quota-setting and resource management still do not fully consider user knowledge in several cases because such decisions are taken on the basis of advice from international

management bodies. The international management bodies base their work on inputs from scientists in the different countries. In practice, there is limited user knowledge flowing to these management bodies and there is limited use of whatever user knowledge finds its way to the international management bodies. While the international management bodies are supposed to incorporate user knowledge into their advice to governments, this rarely happens in practice.

The aim of the workshop was to exchange experiences and stimulate increased practical and systematic use of local knowledge/user knowledge in the international management bodies' advisory services. The participants in the meeting came from Greenland, Canada, Alaska, Sweden and Denmark as well as from NAMMCO and CITES. The workshop was held in Greenlandic and English (Zoom, separate channels simultaneous translation). Co-funding for the workshop was provided by the Nordic Council of Ministers Arctic Cooperation Program and CAPARDUS.

From the discussions, it was clear that many international management bodies and national bodies claim that user knowledge is relevant. Inclusion of user knowledge is often stated as a requirement in the various agreements/objectives or legislation related to these bodies. This being said, however, it is also clear from the workshop discussions that ensuring the actual use of user knowledge for management decision-making is a major challenge in most decision-making processes. Even if there are, in some areas, structures promoting user knowledge, actually implementing it is reportedly not easy and not successful in many cases. So we see more talk than practice. In Greenland, there are now movements (with a new executive order) towards ensuring a more structured and legally-required use of user knowledge. As is the case now in most of the Arctic, there are bits and pieces feeding into the national/international level. Being invited as a guest to speak at meetings or to occasional dialogue meetings is not the same as ensuring structured and continuous input of user knowledge into management decisions. There is a major challenge in translating nice ideas into practice. It can probably only be done if user knowledge systems are funded and legally-required and with proper legal backing.

Possible actions to promote the further incorporation of user knowledge and its greater influence in various management bodies include:

1) Develop structured and systematic collection of user knowledge nationally, knowledge that is legally required and considered equally important to the management processes as input from scientific studies.
2) Develop explicit demand within the various national and international management bodies for the incorporation of community observing data into all biological population assessments.
3) Explicitly mentioning the involvement (or absence) of community observing data in various assessment reports related to living resources.
4) Ensure better, continuous, legally-required and structured dialogues between holders of user knowledge and scientists. Encourage joint analyses to be undertaken and published in reports.
5) Through international management bodies push (1) for more coverage in time and space by community observing programs, and (2) to make more user knowledge available in web-based, searchable databases.
6) International management bodies should promote the value of user knowledge by showcasing the use of user knowledge and demonstrating how to use the information in a way that is scientifically credible and acceptable to peers.

7) Further involve users/hunters in relevant committees, not just as observers but as real members; further involve users/hunters in surveys and in national government delegations.

Relevant link: The proceedings will be made available on the website of the UArctic Thematic Network on Collaborative Resource Management:
https://www.uarctic.org/organization/thematic-networks/collaborative-resource-management/

2.13 Session at the Arctic Science Summit Week, Online, March 2021

The session highlighted the fact that responding to accelerating social and environmental change in the Arctic requires informed decision-making on a community scale, drawing on both Indigenous knowledge and relevant and accessible research-based information. This ASSW session attempted to enhance and expand on the use and usability of data and information within Arctic community-based research.

The meeting focused on efforts to advance Indigenous knowledge and data sovereignty, collaborative and user-driven research with Arctic communities, the development of community data management systems, and understanding Arctic community requirements for usable research. Lessons were shared that highlighted strategies regarding technical approaches to community data stewardship, capacity building, development of user tools, and evaluating the use and usability of research outputs. While the session was focused on information use at the community scale, it also addressed the value, considerations, and opportunities for sharing community-based data and knowledge within regional to pan-Arctic observing networks. The session was organized by Noor Johnson, Finn Danielsen, Roberta Glenn, and Lisbeth Iversen.

Relevant link:
https://intaros.nersc.no/content/assw2021-session-id85-use-and-usability-data-and-information-within-arctic-community-driven

3. Challenges and opportunities for further enhancing community-based and citizen science observing in the Arctic

A topic raised by the participants at several of the workshops was how to connect CBM programs with top-down observing programs and associated management decision-making processes. We have therefore chosen to cover this topic in more depth. The coverage takes its point of departure in the discussions held in the many experience-exchange and capacity development workshops and sessions undertaken over the last four years. In this section, we discuss key challenges and interventions for connecting bottom-up CBM with top-down observing approaches and associated management decision-making processes. The chapter is a slightly modified version of the previously published review of the topic by Hajo Eicken and colleagues (Eicken et al. 2021).

Based on the discussions at the workshops and reviews of the literature, we have identified six broad aims, associated benefits, and challenges that derive from improved linkages between top-down and bottom-up, community-based observing approaches (from Eicken et al. 2021). Challenges that may prevent these benefits from being realized also are discussed and summarized in Fig. 1.

1. Improved fit between aims and scales in monitoring programs. Linking top-down and bottom-up efforts can help to achieve better fit across different observational scales. CBM typically focuses on phenomena and processes at a fine scale commensurate with management or mitigative actions. In contrast, top-down, global scale observing systems address climate or ecosystem scale variables that matter to local communities but may not be as relevant if collected at a coarse scale and with insufficient granularity. Such potential mismatch can be addressed through downscaling and upscaling of observations at the planning and implementation stage (Pratihast et al. 2016), including CBM-derived guidance on placement of sensor systems that are part of larger-scale top-down efforts. Both alignment of aims and integration of remote sensing and *in situ* observations are further advanced through careful selection of target monitoring/observing variables that serve a larger constituency and provide shared benefits (Fig. 1). Connecting bottom-up CBM with top-down observing will play a key role in further promoting the opportunities for Indigenous and local knowledge to influence decision making processes related to natural resource management.

Nevertheless, mismatches in aims and missions of government agencies and local entities continue to hamper ability or interest of management agencies to access, understand, and act on community-driven observations and guidance (Fig. 1.1; Eicken 2010; Johnson et al. 2015, 2016, 2018; Lubilo and Hebinck 2019). Despite recent progress (Armitage et al. 2011; Kendall et al. 2017; Tengö et al. 2017), government agencies and academia continue to struggle to understand the nature and relevance of CBM and the Indigenous and local knowledge that informs many CBM efforts. Misconceptions include a perceived lack of CBM reliability and failure to appreciate equivalency of information generated through CBM and by professional scientists (Johnson et al. 2015; Costa et al. 2018). In part, historical and power relationships may create an adversarial dynamic, e.g., between multi-level actors that are part of co-management or between researchers and community members (Armitage et al. 2011; Long et al. 2016). Bureaucratic or political hurdles and lack of resources may make it difficult for government agencies to rely on CBM for decision support. The lack of reward structures in academia for work focused on actionable, solutions-oriented science remains problematic as well. Finally, international bodies advising governments on resource management are slow to establish procedures that take CBM observations and knowledge into account (Nordic Council of Ministers 2015; PAME 2017; Danielsen et al. 2017). These are all challenges, which impact the opportunities for CBM programs to influence the relevant decision making processes at regional, national or international level.

2. Better match between observing program and community priorities. Many of the benefits that derive from CBM and well-aligned top-down observing, such as filling critical information needs for local decision-making or ensuring sustainability of relevant programs, can be tied to well-aligned priorities between communities and observing programs. When priorities align, as in the Arctic and Earth SIGNs project, substantial benefits can be achieved, such as local learning and action alongside robust international datasets.

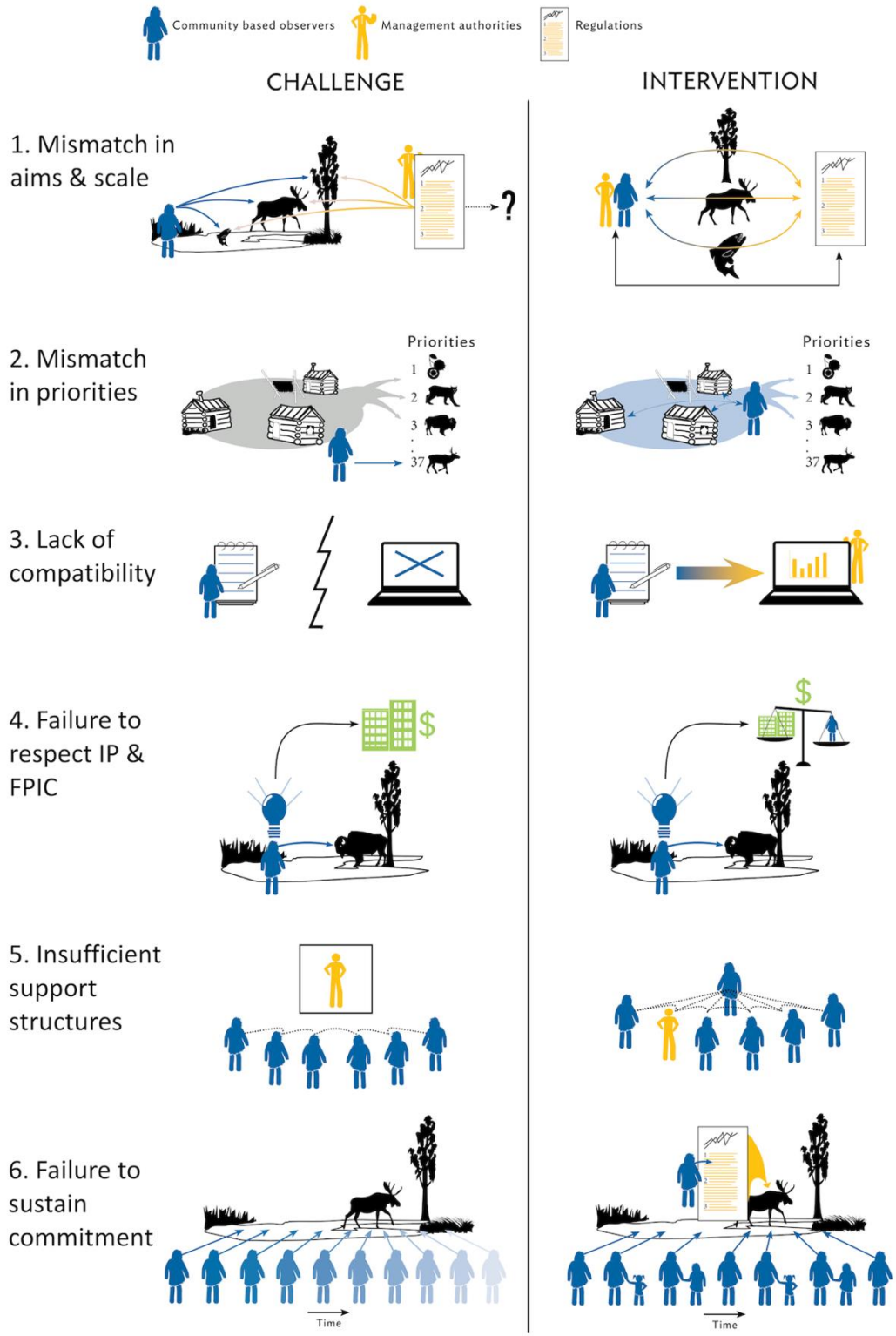

Figure 1. Summary of challenges and interventions in linking bottom-up and top-down observing. Each panel corresponds to issues and interventions discussed in the text. Input through community observations into resource management regulations is shown in yellow, while transfer of intellectual property (symbolized by light bulb in panel 4) into applications and associated generation of revenue ($) are shown in green. The most promising interventions include a focus on knowledge co-production principles covering the appropriate scales and priorities (1, 2), data management responsive to CBM needs and capacities (3), respectful and appropriate use of CBM data (4), use of proper incentives and support partnerships (5), and intergenerational engagement to sustain efforts (6). Abbreviations: FPIC, free, prior, and informed consent; IP, intellectual property. Reproduced with permission from Eicken et al. 2021.

Contrasting priorities between what is designated to be observed and what is valued by communities, present a challenge at different levels (Fig. 1.2). While locale-dependent, many communities value individual and community health, food security, economic opportunities, and other aspects of fate control, such as participation in the regulatory process or place-based education. In contrast, many observing programs focus on topics based on outside perspectives, some directly derived from top-down, large-scale frameworks, and may address community priorities only marginally or not at all. University researchers often focus on large-scale processes that may be of little interest at the local level. Regulatory frameworks may constrain government agencies on the type and scales of information that is collected. Communities are diverse and establishing monitoring priorities that reflect consensus can be difficult (Wheeler et al. 2016).

3. Greater compatibility between observing methodology and data management. Co-design and co-creation of observing and data management protocols (Shirk et al. 2012) is an effective mechanism to overcome the major interoperability challenges that hamper integration of observing systems (Parsons 2013; Godøy and Saadatnejad 2017). The same holds true in principle for linking CBM programs to large-scale, top-down efforts, but is poorly explored in practice (Pulsifer et al. 2012; Fidel et al. 2017; Johnson et al. 2021). Such interoperability challenges can be tied to the disconnect between scientists' focus on tracking state variables and system dynamics and outcomes-oriented observing in community-driven monitoring (Fig. 1.3; Pulsifer et al. 2011, 2014). The latter typically focus on a single topic, but often draw on a broad suite of tracked variables, many embedded in Indigenous and local knowledge (Krupnik et al. 2010). The former, in contrast, attempt to integrate data arising from multiple sources to inform systems-level understanding and predictive skills in a broader range of applications (Lindstrom et al. 2012).

Mismatches in the scale and granularity of data generated and managed through these networks also play into interoperability challenges. Thus, data derived from satellites, scientific transects, or point sources are associated with very different data format, entry, curation, and archival modalities compared to CBM data obtained across a broader landscape based on resource use and other factors (Fig. 1). The latter type of data often are excluded from global-scale data management centers because of perceived incompatibility and concerns about Intellectual Property Rights and licensing. At the same time, incorporation of CBM outputs and perspectives into research has been found to enhance the quality of the science (Mercer et al. 2010; Eerkes-Medrano et al. 2017).

4. Respect of Indigenous intellectual property rights and Free, Prior, and Informed Consent. Respecting the rights of participating Indigenous and local communities as central aspects of all CBM programs is critical to successful co-design and co-creation between top-down and bottom-up approaches. Best practices in collaborating with Indigenous and local communities have been formulated (e.g., Borrini et al. 2004; Tengö et al. 2021). Careful consideration of ethics and methodology of knowledge sharing can result in greater recognition of community priorities and concerns, with better information products and support through top-down observing efforts (Castleden et al. 2012).

CBM programs operate within a broader context of research practice in which communities often are approached by well-intentioned outsiders interested in collaboration but without long-term commitment to understanding the local context of knowledge production and use (David-Chavez and Gavin 2018). Past failures of research collaborations to deliver final products that

meet community information needs have led to greater sensitivity to ethics in research practice. This includes the need for awareness of and respect for existing protocols and frameworks for meaningful engagement of Indigenous peoples based on Indigenous rights, such as Free, Prior, and Informed Consent (FPIC). Some guidelines exist that describe how to appropriately engage Indigenous and local knowledge (e.g., the Tkarihwaié:ri Code; CBD 2011, see also ITK and NRI 2007). Indigenous communities and organizations have raised the need for regionally appropriate and specific ethics protocols and research agreements (ITK 2018) and examined FPIC through a northern lens (Gladstone and Singleton-Polster 2016). However, more work is needed to advance implementation of specific protocols, e.g., at the level of Institutional Review Boards in Alaska.

Some research and CBM programs have unclear agreements on data ownership and use (Costa et al. 2018). It is important that communities maintain control over data and that community members have access to the data with long-term data storage solutions as part of CBM design (Johnson et al. 2021). CBM can be a very important step in the efforts of Indigenous and local communities to claim their rights to knowledge and their share of any benefits accruing from this knowledge through, e.g., the Access and Benefit Sharing Mechanism of the Convention on Biodiversity. This, however, requires adherence to FPIC and clear agreements on data ownership and data use that prevent potential misuse, such as private companies using CBM-derived information for their own commercial benefit without providing any compensation (Posey 1998).

5. Sufficient organizational support structures. Community-driven CBM programs and activities that connect successfully with top-down approaches hinge on organizational support structures that sustain the effort from the community up to the government level. These include institutional buy-in, long-term employment or volunteers, and sustainable funding. When the local and larger scale support structures align, monitoring efforts benefit from long-term continuous observations and result in cost-effective, sustainable monitoring programs with strong local participation that are culturally relevant and have scientific value (Fry 2011).

However, such support structures are often lacking. Programs may be established without any insight into existing organizational or institutional landscapes in the area. Instead of properly incorporating CBM activities into local organizations with a track record of success, parallel "island" structures are set up that wither and detract from existing successes (Costa et al. 2018). Typically, natural resource management programs require 5-10 years of external support before self-sufficiency, with some CBM programs not sustained over this minimum period of time and therefore unable to achieve their main objectives. Further, CBM programs are too often established without proper connection to the various important decision making processes that are relevant for the key natural resource management issues at local, regional or national scale.

CBM programs also may be initially developed with scientists in academic institutions that provide the organizational, administrative, or technological support, but then need to transition these support roles to an appropriate community-run entity over the long-term. Such research-to-operations transitions, while fundamental to the evolution of observing system implementation in general, remain challenging (Wilson 2010). This is true for both top-down and bottom-up approaches, as illustrated by recent reviews (Lee et al. 2019).

6. Sustained commitment of community members. To fully capture the effects of natural variability in climate or environmental systems typically requires observations at the timescale of a decade and beyond (e.g., Eicken 2010). Sustaining community members' commitment

beyond this time scale accrues other benefits, such as greater effectiveness in translating monitoring results into management guidance. The strength of some – though not all – of the co-management institutions in Arctic Alaska and the Inuvialuit Settlement Region with a long history of, e.g., marine mammal CBM (Huntington 1992; Meek 2013; Ostertag et al. 2018) speaks to this issue.

Nevertheless, fatigue among community members and participant turnover at the community level were considered significant challenges for one in five of Arctic CBM programs surveyed (Danielsen et al. 2020). Such turnover potentially jeopardizes long-term CBM sustainability, including continuity of the resulting data records (Conrad and Hilchey 2011). Frequent staff turnover at the management authority level is problematic as well. Poor fit between CBM design and the local context is a key source of loss of engagement among community members (see above, Fig. 1.6). This issue is exacerbated by observing protocols that consume too much time and resources, as well as insufficient feedback on CBM results and management outcomes. Also, proper recognition of CBM observers' contributions and central role in achieving management outcomes is critical, including use of CBM information for actual management decisions at higher levels.

Conclusions. To reap the full benefits from closer links between top-down and bottom-up observing approaches, challenges identified (Fig. 1, left) need to be overcome. Danielsen et al. (2020) specified 38 different interventions to address such challenges. We synthesize and expand these findings to arrive at broader conclusions and potential next steps.

A major factor in addressing challenges is to rely on co-design, co-management, and co-production principles. While definitions of knowledge co-production may vary, observing and monitoring efforts benefit from pragmatic approaches that draw on some of the following. First, involve community representatives and CBM program facilitators in observing program planning and evaluation (Tredick et al. 2017; Fig. 1.1). Protocols should prioritize community feedback and involvement (Fig. 1.2). Participatory scenarios may help with prioritization (Preston and Lovecraft 2017). Consideration should be given to community data priorities and needs (Shirk et al. 2012). Second, further develop "good practices" and protocols to allow government agencies and international scientific organizations and management bodies to incorporate CBM-derived information in their decision-making (Fig. 1.3; Danielsen et al. 2021). Third, focus on program sustainability in CBM design and implementation. Tie into the existing organizational and governance structures in the area and use data collection tools and approaches that are easily incorporated into daily community activities (Ison 2008; David-Chavez and Gavin 2018; Fig. 1.6). Fourth, include youth and school groups to build future monitoring capacity and sustain interest across generations (Fig. 1.6; Spellman et al. 2018). Fifth, encourage the use of protocols to enable respectful engagement with Indigenous and local knowledge (Fig. 1.4).

Equitable support to team members from communities that is on par with that received by scientists is critical (salary, recognition as co-authors; Fig. 1.5). Regular feedback to community members with CBM findings and updates on how the findings are used for decision-making are an important part of incentive structures. Recognition of scientist engagement also is important, including added emphasis on community engagement in academic and government assessment and promotion.

Data co-management with an emphasis on data ownership and use rights that draws, e.g., on concepts of Indigenous data management (Pulsifer et al. 2011), is an important corollary to the

co-production approaches outlined above. Encouraging managers of scientific data repositories to adjust data formats to become receptive to data from CBM programs and to provide focused support of CBM programs keen to connect with scientific data repositories are further steps to take.

Finally, a great help in overcoming challenges is raising awareness within government agencies and scientific organizations on the value of CBM, Indigenous and local knowledge, and the usefulness of incorporating information from CBM programs into scientific data repositories in support of systems-level understanding and future decision-making. The continued connecting of bottom up with top down monitoring in order to arrive at more informed decisions on natural resource management being taken at appropriate decision making levels, is considered essential. Such work also may bring different constituencies together to share information, promote advocacy on the importance of using CBM-derived information, and provide training on CBM activities and evidence collection from CBM as part of a research and monitoring portfolio. In all of this, it needs to be recognized that institutionalizing CBM programs within existing organizations is a capacity building process that takes time and must be based on trust and confidence.

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