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3 "OUR ICE, SNOW AND WINDS": FROM KNOWLEDGE INTEGRATION TO CO-PRODUCTION IN THE RUSSIAN *SIKU* PROJECT, 2007–2013

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Introduction

This paper explores the story of the Russian SIKU ('Sea Ice Knowledge and Use') [2] project, a local component of the international effort in knowledge documentation and co-production during the recent International Polar Year (IPY) 2007–2008. SIKU project activities in other Arctic areas in Alaska, Canada, and Greenland were covered extensively in scores of international publications (cf. Krupnik et al. 2010a; Aporta 2011; Gearheard et al. 2013). Yet it was not until late 2013 that the full account of the Russian SIKU appeared in Russian, in the book called *Our Ice, Snow and Winds* (hereafter OISW—Bogoslovskaya and Krupnik 2013). Most of its 400 printed copies were shipped to local partners and Russian educational and heritage institutions, while barely a handful books reached western libraries and journals (Trukhanova 2014). In this paper, we share some lessons of the Russian SIKU activities that expand the experience of the larger SIKU team and of other social science projects during IPY.

Fig. 1 Cover of the Russian SIKU book, *Our Ice, Snow and Winds* (2013)

Like other SIKU efforts, Russian SIKU was a collaborative program with the goal to record local ecological knowledge (LEK) related to Arctic sea ice and climate change. It was a collective project of a large team made of scientists, experts from indigenous communities, and staff workers from local

1 Sadly, the second co-author, Lyudmila Bogoslovskaya (17.03.1937–18.02.2015), passed away on February 18, 2015. This paper is dedicated to her lasting legacy in promoting partnership in studies of ecological culture and subsistence practices of the Arctic peoples.

2 The *SIKU* acronym for the project title was deliberately created to match the word *siku*, the most general term for sea ice in all Eskimo languages (Inuit/Inupiat/Inuktitut, Yupik, Yup'ik), from Chukotka to Greenland.

research and environmental agencies. Another task of the Russian SIKU, also common to many IPY 2007–2008 initiatives, was to raise awareness and appreciation of indigenous cultures and knowledge among scientists, agency managers, and science planners. Eventually, the Russian SIKU team included more than 30 people; twenty of them became contributing authors to the summary volume (OISW 2013).

Russian SIKU embraced the ethics and general approach shared by other SIKU activities in Alaska, Canada, and Greenland (Krupnik et al. 2010b: 7–14). It initiated monitoring of ice and weather conditions by local village observers; compilation of indigenous terminologies for ice, snow, winds, and weather-related phenomena; and documentation of elders and hunters' narratives related to the use of sea ice, safety in ice hunting and traveling, and practices of ice- and weather forecasting. Unlike most other SIKU efforts in North America, the Russian team engaged professional climate scientists, ice and weather monitors, and marine biologists. It explored ways to match instrumental ("scientific") data on ice, climate, and marine animals with indigenous observations and ecological knowledge. Thus, the story of the Russian SIKU illuminates many transitions in partnering, sharing, and building relations with northern communities that were critical to knowledge co-production as its eventual outcome.

Fig. 2 Map of the Russian SIKU area (by Matt Druckenmiller)

Russian SIKU Activities

The planning for the Russian SIKU started in 2005–2006 (Krupnik and Bogoslovskaya 2007: 77). Residents from five rural communities took part in the project for different time periods in 2006–2010: Sireniki (population 507) on the Gulf of Anadyr shore; Novoe (New) Chaplino (population 440) and Yanrakynnot (population 338), in the southeastern fjord zone of the Chukchi Peninsula; Uelen (population 740) on the Chukchi Sea shore; and Vaegi (population 502), in the interior tundra. The project also engaged senior experts from the former communities of Naukan (Nevuqaq) at East Cape/Cape Dezhnev and Old Chaplino (Ungaziq) at Cape Chaplin that were closed and relocated by the Soviet authorities in the 1950s. Support to the project was provided by the *Shared Beringia Heritage Program* of the U.S. National Park Service, Alaskan Office; the Russian Institute of Cultural and Natural Heritage in Moscow; and local agencies under the Administration of the Chukchi Autonomous Area ('Chukotka,' in Russian). Two small local institutions supplied key staff for the project: the Natural-Ethnic Park Beringia (now Beringia National Park) with its main office in the town of Provideniya, and the Laboratory of Multidisciplinary Studies, Russian Northeastern Research Institute (SVKNII) in the city of Anadyr. Local Chukchi and Yupik researchers and park rangers, including Victoria Golbtseva, Vladislav Nuvano, Arthur Apalu, Alexander Borovik, Natalya Radunovich, Nadezhda Vukvukai, and others, served as prime contributors to the study and to the book (OISW 2013), as its main outcome. Lyudmila Bogoslovskaya was the Russian project coordinator, together with Igor Krupnik, the SIKU project leader; together they also co-edited the Russian summary volume.

IPY 2007–2008 was the first major international initiative in the polar regions that actively sought indigenous peoples' participation in research and viewed their knowledge as a valued contribution to scientific exploration of the global processes (Krupnik et al. 2005; Krupnik and Hovelsrud 2011). In spite of its noble goal, the overall IPY ethos was dominated by physical sciences, such as climate studies, oceanography, glaciology, meteorology and atmospheric research. IPY planners aspired to augment such physical focus of their venture via addition of a certain "human dimension" to promote its inter-disciplinary nature and new inclusiveness in polar research (Allison et al. 2007: 11). Such intellectual format *a priori* favored the "integration" of indigenous peoples' knowledge into the hard-core science structure and datasets in scholarly assessment of environmental dynamics in the polar regions. Several major surveys of the era, such as the *Arctic Climate Impact Assessment* (ACIA 2005), *Snow, Water, Ice, Permafrost in the Arctic* (SWIPA 2011) embraced similar templates, also championed by the two most recent IPCC Assessment Reports of 2007 and 2014.

Russian SIKU, like its parent international SIKU project, advocated a different approach based on several earlier collaborative studies of indigenous knowledge of climate change (i.e., Krupnik and Jolly 2002; Fox 2003; Ozeeva et al. 2004; Huntington and Fox 2005; Gearheard et al. 2006; Laidler 2006; 2008, etc.). It was participatory, multi-focused, and built on data collected primarily by indigenous researchers and monitors with deep roots in their home communities. Russian SIKU also relied on established partnerships forged during prior years of collaboration among Chukotka hunters, knowledge experts, biologists, conservationists, and anthropologists (Ainana et al. 1997; Bogoslovskaya et al. 1982; Bogoslovskaya 2003). Thanks to its strong local connections, Russian SIKU team was able to implement several tasks.

Local observations of ice and weather

Prior to IPY 2007–2008, polar physical scientists paid little attention to Arctic peoples' practices in observing the environment, and systematic records of indigenous ice and weather monitoring existed for no longer than a few-month period (cf. Oozeva et al. 2004).

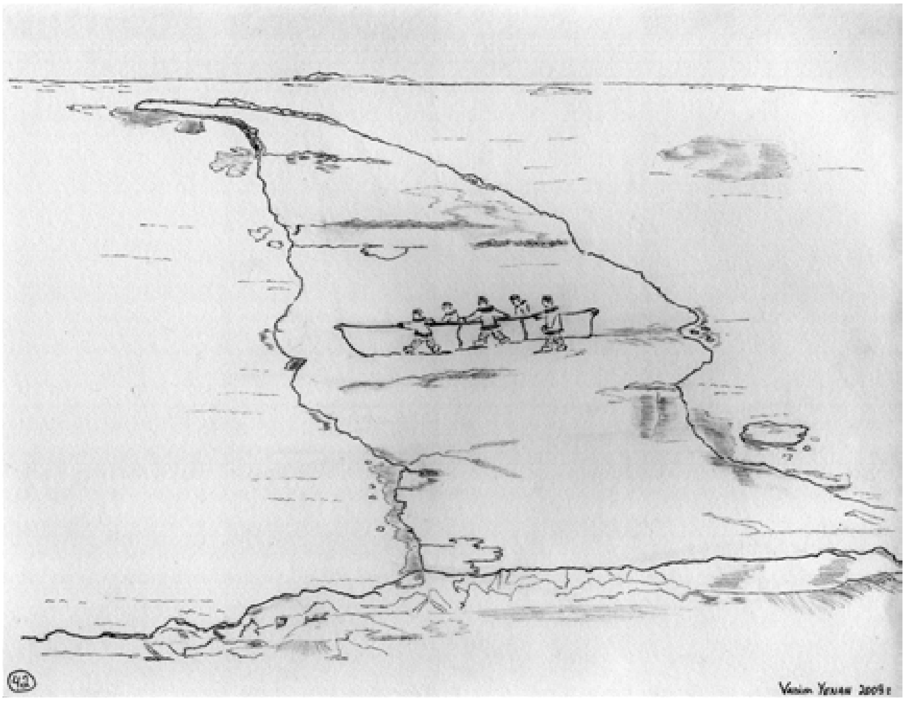

Fig. 3 *Tekeghin* – ice "point" stretching out into the sea. Good for moving to the ice edge while pulling a boat; dangerous to walk on, as it may crush or break off and float away. Sample entry from the Sirenikski Yupik sea ice "dictionary" by Aron Nutawyi, with pencil drawing by Vadim Yenan, 2008–2009 (OISW 2013: 81).

Observations for the Russian SIKU project started in the fall of 2006. It eventually included five monitors working in their home communities of Uelen (Roman Armaergen, November 2006–June 2009), New Chaplino (Aleksandr Borovik, November 2007–June 2009), Yanrakinnot (Arthur Apalu, November 2007–June 2009), Sireniki (Oleg Raghtilkun, January 2008–May 2009), and Vaegi (Nikolai Nuvano, October–November 2006). Observers' logs covered daily temperature, wind, weather, ice conditions, information on local wildlife and community activities. Entries varied from a few lines and up to 150–200 words per day. The Russian SIKU team also included two experienced non-Native ice monitors in Uelen, on the Chukchi Sea coast (Victor Struzhikov) and in Provideniya Bay (Igor Zagrebin—OISW 2013: 300–307, 309–322). Such combination of indigenous and non-indigenous monitors provided critical insight into the nature of ice and weather watch based on observer's background (see below).

Indigenous ice, snow, and wind terminologies

SIKU was the first scientific program in the Arctic that systematically collected indigenous nomenclatures for ice, snow, and weather phenomena in local languages and dialects. Altogether, the international SIKU team recorded over 30 nomenclatures from today's elders or compiled words for ice from dictionaries and early literary sources in the area from Bering Strait to Labrador and East Greenland (Krupnik 2011: 60–62). The Russian SIKU team produced five dictionaries of indigenous ice nomenclatures in three local languages, one list of snow terms, and several shorter lists of local names for winds, currents, and weather phenomena:

- *Siberian / Chaplinsky Yupik ice terminology* formerly in use in the community of Sireniki—over 60 terms with explanations in Yupik and Russian (OISW 2013: 72–82; see Fig. 3);
- *Siberian / Chaplinsky Yupik ice terminology* used in the former community of Ungaziq (Old Chaplino)—almost 80 terms arranged by major types of ice and ice processes (OISW 2013: 97–99);
- *Siberian / Naukansky Yupik ice terminology* used in the former community of Naukan / Nevuqaq—90 alphabetically arranged terms (OISW 2013: 149–153);
- *Northeastern Chukchi ice terminology* used in the community of Uelen—over 200 terms and expressions (OISW 2013: 172–193; see Fig. 5);
- *Eastern Chukchi ice terminology* used in the community of Yanrakynnot—52 terms (OISW 2013: 125–137);
- *Southern Chukchi snow terminology* used in the community of Vaegi—over 100 terms and expressions (OISW 2013: 197–205).

Documentation of indigenous safety rules, navigation and forecasting practices

Recent climate warming, thinning of ice, and weather instability have increased the risk to people, who travel on ice, snow-covered tundra or ice-chocked waters. It exposes them to new dangers even in their familiar habitat. Several stories collected from local elders on their personal experience were compiled in the Russian volume, with the illustrations by pencil drawings and hunting scenes engraved on walrus tusks (OISW 2013: 216–238).

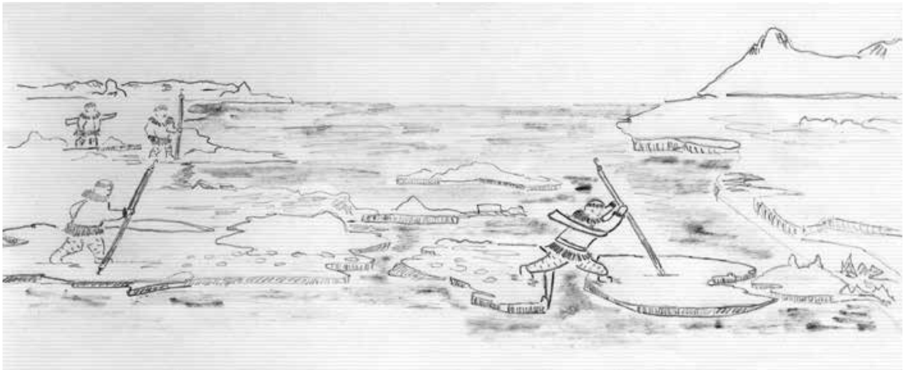

Fig. 4 Vadim Yenan's pencil drawing to the Elders' stories about traditional ways of traveling on drifting ice (OISW 2013: 219).

Fig. 5 Victoria Golbtseva (right) and Roman Armaergen document Uelen Chukchi terms and expressions for various types of sea ice and ice processes (OISW 2013: 236).

Survey of historical ice and climate records

The Russian SIKU team collected historical data on weather and ice conditions in Chukotka and the nearby seas, including early instrumental weather records, ice charts, published ice and climate overviews, photographs, and ship logs. In Chukotka, such early records have been available since the mid-1800s (in Provideniya Bay—Krupnik 2013c) and, more systematically, since the late 1800s (Mahoney et al. 2011). Instrumental weather observations became common in the 1920s and 1930s (Vdovin, Evstifeyev 2008; OISW 2013: 279–280), and data on ice conditions in the coastal areas of the Bering, Chukchi, and East Siberian Seas have been available since the 1930s (OISW 2013: 287–299).

Public activities

Russian participants used various venues to inform local residents about their activities, climate change, indigenous knowledge and heritage documentation. They organized training workshops for local monitors, elders, and students in participating communities, as well as in the area hubs of Provideniya, Lavrentiya, and Anadyr. The results of the Russian SIKU activities were presented at several *Beringia Days* conferences in Anadyr (in 2006, 2010, and 2013), Fairbanks (2008), and Nome (2011). Several local public and media sessions featured the publication of the Russian SIKU book in 2013. It was the first scientific program in Chukotka that systematically reached out to local audiences via a variety of means.

Russian SIKU Transitions: From Knowledge Integration to Cultural Ice Scapes

As the records generated by the Russian SIKU team kept growing, it expanded beyond the project's original goal to strengthen the scientific documentation of local ice and weather change. The wealth of information covered various aspects of community life, subsistence, use of local languages, and ecological knowledge. Many local partners—experienced hunters, observers, and naturalists—built personal photo archives and carefully recorded seasonal ice formation, animal and bird behavior, and community life. This vast visual archive became another product of the Russian SIKU team; only a small portion of it has been published so far.

With the limitations of the "knowledge integration" paradigm mounting, we were pushed to revisit the template of the data presentation in the Russian SIKU book. Instead of individual chapters structured by geographic areas, types of ice or other environmental components, we eventually arranged our material in seven blocks by participating communities (Sireniki, New Chaplino, Old Chaplino, Yanrakinnot, Naukan, Uelen, and Vaegi). Such structure better reflects how local residents view environmental change: not by natural elements but holistically, by their familiar home habitats.

Next, the very term "integration" was quietly retired, as our local partners expressed little enthusiasm about integrating their observations into the existing scholarly models. We started looking for other terms, such as "knowledge interaction," "matching" (Callaghan et al. 2004) "complement" (Laidler 2006), "combining," etc. Between 2010 and 2012, the overall structure of the Russian SIKU book was reorganized. Initially, it envisioned a large opening synopsis of the scientific data on climate and ice change in Chukotka and the Eastern Russian Arctic to be followed by local observations as supporting and comparative material. In the 2013 volume, that order is reversed: all "scientific" (instrumental) records are summarized in its *last* chapter as a backdrop and large-scale view of the data collected in local communities (OISW 2013: 276–300).

Another critical milestone was a new concept of "cultural ice-scape" (Krupnik 2012; OISW 2013: 10–23) to account for the growing volume of project's cultural data. It introduced a vision of the sea ice as a *cultural environment*, a *cultural space* (or, rather many local spaces) used by individual communities, often for many generations. Such spaces on ice bear several features typical of the land-based "ethnographic scapes," like historical place names, established routes, navigation markers, other physical modifications, safety rules, stories, and myths (Krupnik et al. 2004). Such imprints of human presence and associated knowledge transform the sea ice, a physical body, into a component of human culture, local identity, and heritage.

Created by the forces of Nature, a cultural scape on sea ice is a product of delicate and fluid agents—human memory, people's presence on the ice, and continued transmission of cultural knowledge. Unlike culturally modified spaces on land, human "ice-scapes" are *seasonal* phenomena. They evolve during the wintertime, from the fall freeze-up till spring break-up, and then vanish each year with the summer melt. They leave no physical traces, no archaeological remains, and no records, except in the human mind. Absent in the summer, cultural ice-scapes are restored in the fall by the sheer power of human use and knowledge. If the traditions associated with local ice-scapes cease to be passed or people move elsewhere, the ice once again transforms into a cultural "desert," the endless mass of cracks, hummocks and ridges, a barren frozen sea, the *ultima Thule* of ancient cartographers and early explorers. Yet today's survival of cultural ice-scapes is also threatened by rapid climate change.

It is obvious that the concept of cultural ice scape is a product of social sciences rather than of indigenous knowledge systems that lack such terminology. Nonetheless, "cultural ice scape," an invisible reality sustained by human memory, has many close paradigms in indigenous epistemologies, like "spiritual scapes" (Basso 1996; Fair 2004), "memoryscapes" (Nuttal 1991), "fishermen's scapes" (Maurstad 2004), or "aboriginal dreamlands" (Smith and Burke 2004).

Local people may not call their ice a "cultural scape"; but their known representations of it as a familiar cultural habitat, a space both revered for its power and feared for its danger are intimately tied to this paradigm. It is materialized in Native maps, drawings, and graphic art. People follow established routes across the barren ice by using familiar place names, navigation marks, and age-old stories. They also view the ice as a teaching, training, and spiritual ground, where humans have to co-exist with dangerous creatures, like dwarfs, giant worms, monster polar bears, sea woman, etc. (Heyes 2011; Fienup-Riordan and Rearden 2012; Wisniewsky 2010). The concept of "cultural ice scape" became a valuable tool to encourage the flow of information of importance to local partners and transformed the SIKU data collection into a two-way process driven increasingly by local interests and needs.

Discussion: Insights into Knowledge Co-production from the Russian SIKU

Since the key outcomes of the Russian SIKU have been presented elsewhere (Bogoslovskaya et al. 2008; Krupnik 2009; Krupnik et al. 2014; OISW 2013: 328–339), the section below introduces its contributions related specifically to the knowledge co-production process.

1. Co-Production in Scale and Resolution. Modern scholarly studies of Arctic change increasingly focus on modeling and projections of the polar processes. The goal here is to produce reliable scenarios and forecasts at regional and eventually global scale, and with the ever-advanced precision. Local knowledge has an entirely different purpose: it serves people's practical needs for successful and long-term use of particular habitats. It has the strongest observational and explanatory power at *local scale*, that is, at the level of individual or community knowledge of a certain portion of land, ocean or sea ice. Here, people's intimate connection to the same ecosystems, often for several generations, makes it possible to register even a minute signal of change and at a remarkable speed.

From the diaries of SIKU observers, we learned that they commonly monitor many species of animals, birds, and plants as indicators of natural and man-created shifts; even more so, they usually focus on *combinations* of multiple indicators. People constantly scan the environment for many signals, including wind direction, persistence, and strength; cloud and weather patterns; ice movement; current and tidal cycles; status of the tidal area and of the tundra surface; timing of animal, bird, and fish migration and reproduction, plants' and animal seasonal status, and many more. The most experienced monitors track key sites for certain features year after year to assess the condition of each individual season, as quoted below:

> I took my grandchildren down to school about 9 a.m. and I looked for water and ice near the school side of the shore—whether there is any open water out there (far at sea—IK). I could tell it because there was some dark(ness) in the sky far over there; that dark sky is over open water. I stayed at the store

> for some time to get information from other people, who were there earlier in the morning. We always have a few people of my age gathering at the store, the side that faces the water and the beach—they just stay there for some time, watch the weather and ice, and talk (Chester Noongwook, February 2001—Krupnik 2002: 173).

The strength of indigenous monitoring is also rooted in the large number of seasoned observers, who constantly network in tracking and analyzing any signals of change. Judging from the SIKU monitors' diaries, they always cross-check the information they report against other people's observations and they commonly practice what is called "cross-fertilization," that is, they use indicators from different, often unrelated fields. Here, the lesson for knowledge co-production is that indigenous observations should be treated as reliable and verifiable in their own sense, even if not accompanied by instrumental records. They are highly valuable to our understanding of environmental processes, particularly at local and regional scale.

2. Climate Warming and Observation at Local Scale. Russian SIKU records generally concur with the diverse and quite detailed body of Arctic peoples' observations that points definitively toward the present-day *warming* of the northern circumpolar zone (Hovelsrud et al., 2011; Huntington, Fox 2005; Krupnik, Jolly, 2002; Krupnik et al., 2010). In Chukotka, the diaries of local monitors tracked many signs of recent warming in the area's land-, sea-, and ice scapes; in weather, snow, and ice regime; increase in storm frequency; rapid coastal erosion and degradation of the permafrost layer; shifts in local biota and seasonal cycles of many marine and terrestrial species (OISW 2013: 239–245). Yet this general warming trend is neither a linear nor a uniform phenomenon.

Arctic ecosystems are remarkably diverse. They often have individual microclimates and ice regimes, comprise highly distinct sets of plant and animal species, and display a variety of physical and topographic features. Local people accumulate the knowledge of such local diversity for practical use; scientists just started grasping how to incorporate it in their models.

Indigenous peoples' monitoring of their home habitats is a long-term occupation. It covers myriad sites around northern villages, family cabins and fishing camps, and long transects along hunters and herders' seasonal routes, often for hundreds of miles. Each local community serves as an informational hub, where many knowledgeable observers share and discuss any unusual signals of change. Expanses of ice, land, and sea that are being carefully watched to produce overlapping continuums of individual and community scapes, often for major sections of the seashore or entire river systems. The obvious advantage of knowledge co-production is that it brings many qualified observers and at more sites than scientific programs and government weather services can afford.

3. Co-Production of Visions. The combination of indigenous and non-indigenous observers, often at the same sites, pioneered in the Russian SIKU project revealed significant *cultural* differences in environmental monitoring. For the first time, we may assess how people rooted in local cultural traditions view change in their home habitats compared to outsiders, even skilled monitors. Non-native observers, particularly those working for scientific programs and weather services, follow standardized protocols and concentrate largely on a defined set of environmental features. They have articulated historical approach and eagerly mark individual years along few selected parameters. Yet their focused and number-driven vision is also fragmented. It may track minute changes in ice, clouds and temperature, but it leaves out winds, tides or currents that are integral to indigenous sea and weather watch.

Non-native climate change monitoring is also thin on biological indicators. In Native observers' logs, numerous life forms—birds, beach invertebrates, marine and terrestrial animals, even sled dogs—make a constant presence as important signal of any pending shifts. Yet the most remarkable feature of non-native monitoring is an absence of people and a lack of interest in people's daily activities. An outsider monitor usually stands as a lonely person tasked to document an assigned segment of the environment. Indigenous entries, to the contrary, brim with people's names, remarks, and shared data, as if the observer is always surrounded by fellow villagers, elders, relatives, visitors, even strangers on the road. Such openness to other people's input makes local observers natural partners in knowledge co-production and willing players in any teamwork. To them, co-production is primarily about personal interaction, and is always a learning experience and fun.

4. Indigenous Environmental Terminologies. It is a common saying that the Inuit (Eskimo) have "200 words for snow." It may be an old joke and the number is inflated, but the richness of indigenous terminologies is undisputed. In many Inuit communities, the number of actively used ice and ice-related terms is close to 50–80, and some experts can name up to 100–120 terms and expressions in their native language or dialect (Krupnik 2011: 60–62).

Local terms often carry more information compared to their analogs in the scientific ice, snow, and weather nomenclatures, which is critical to knowledge co-production. Internationally accepted sea ice terminologies are aimed at observers at coastal stations, ship's bridge or a flying aircraft and they commonly refer to all polar seas, both in the Arctic and Antarctic. Indigenous ice terms, to the contrary, were coined by people moving on the ice and they identify ice features according to their safety, age, and formation history (Krupnik 2002; Norton 2002). For example, international ice classification defines *rotten ice* as one of the forms of melting spring ice 'which has become honeycombed and is in an advanced stage of disintegration' (http://www.aari.ru/gdsidb/glossary/p1.htm). A Chukotka Native definition of the similar ice called *aghulleq* in Yupik is 'the old ice thinned by spring warming; extremely dangerous for walking, pulling boats or any work, even dog-driving. While walking on this ice, one always has to use a special ice-stick (*tuvek*) with a sharp iron or bone edge and continuously check the ice thickness and sturdiness for safety' (OISW 2013: 73). The informational and safety message of indigenous definition is obvious, as well as its practical value to anyone moving on the ice.

5. Indigenous Knowledge and Biodiversity. Indigenous knowledge systems with their multiple indicators and detailed terminologies are tuned to accumulate data on the status and trends in local diversity, both environmental and cultural. Overall, people tend to be more caring and thoughtful of Nature within certain set of traditional norms. In spite of decades of predatory harvesting and economic mismanagement by commercial fisheries, whaling and sealing industries, Arctic indigenous users generally sustain a high level of biological productivity in their home habitats. Small communities whose livelihood depended on local "scapes" were naturally concerned about sustainable, long-term use of biological resources.

We may say it otherwise: "the Nature is best secured by Tradition and not by people" (Koulemzine 1999: 450). By preserving their cultural rules, indigenous people acted historically as stewards of their home ecosystems, on which their livelihood and identity was built. To the contrary, the risk of major biodiversity losses increases, deliberately or accidentally, when indigenous knowledge is ignored and people themselves are moved off their home landscape. Another lesson in knowledge co-production is that without indigenous people and their knowledge, the Arctic will quickly transform into an area for resource extraction built on a mixture of modern extractive technologies (cf. Bogoslovskaya 2014). In that case, damage to our common knowledge and to the regional (global?) sustainability would be irreparable.

6. Resilience of Cultural Ice-Scapes. The Russian SIKU project produced a pool of benchmark data to assess the status of local ice scapes and associated cultural knowledge in Chukotkan communities in the early years of the 21st century. It underscored both the resilience and vulnerability of aboriginal ice-scapes in Chukotka of the modern era. Many hunters and Elders still possess the rich body of practical knowledge, are fluent in traditional ice and weather nomenclatures, and abide to traditional safety rules. Even in those communities, where people have mostly switched to Russian as their daily language, certain traditional practices of ice scape use are sustained (OISW 2013: 105–108, 121–123, 170–171). New ice-related activities are sometimes added, like dog-races or winter catch of marine invertebrates through ice holes and cracks (OISW 2013: 109–113). They help support people's use and knowledge of ice, and thus preserve a living ice scape.

7. Knowledge Losses and its Consequences. Yet cultural ice scapes can hardly be immune from the general culture trends. As people switch from their indigenous languages to Russian, traditional nomenclatures for ice, snow, winds, and animals fall out of use. Younger generations operate with "creolized" Russian equivalents for

a few basic terms that fit poorly to the variety of local conditions. Indigenous place names disappear or are replaced by Russianized forms from contemporary maps and everyday vernacular. As Elders and senior hunters continue to use traditional terms not known by the youth, generational cultural gaps, "cracks in the knowledge" (Heyes 2011) expand. Even middle-aged hunters in Chukotka use but a handful of indigenous ice terms and scores of borrowed Russian words for local ice conditions, compared to some 100 traditional terms their grandparents applied to the same ice-scape.

The fading of the old cultural ice scapes and the 'thinning' of the current ones illustrate the vulnerability of cultural knowledge. Here, the value of co-production is critical, as without a sustained effort to strengthen community-based knowledge transmission, we are certain to see a rapid transformation of local cultural ice scapes in Chukotka and its conversion into the Russian language domain by the middle of this century. As this process advances, many components of today's practical knowledge and use of sea ice may be lost.

Conclusion

During its seven-year teamwork, the Russian SIKU partnership has moved from a concept of "integration" of the scientific and indigenous knowledge to "interaction" and, eventually, to "co-production." It adopted a different template for the organization and presentation of project data aimed at new audiences. We eventually opted for a popular and less technical heritage publication called "Our Ice, Snow, and Winds,"[3] one organized in community-based chapters and illustrated not by charts and graphs but by photographs and drawings made by local participants. Textual descriptions were shortened and scientific interpretations of today's ice and climate trends were placed at the very end of the book. In this transition, our trajectory was similar to that of other co-production publications of the post-IPY era (Gearheard et al., 2013; Fienup-Riordan and Rearden 2012; Salamon et al. 2011).

Even more notable was the *intellectual* shift from the "integration" to "co-production" paradigm in course of the project years. It required a new framework, such as the concept of cultural ice-scape, to document the rich information on individual communities' vision of their home ice-scapes. It encompasses patterns of local ice use, the cycle of ice-related activities, ways of observation; specific ice, snow, and weather nomenclatures in local languages; knowledge sharing via people's memories and stories. By viewing local ice through the lenses of cultural scape, we moved it from the

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3 In Russian, the words *ice* and *snow* have plural forms; so, the authentic translation of the Russian book's title is "Our Ices, Snows, and Winds," which underlines the diversity of indigenous people's visions of local environments.

realm of climate change assessment to the domain of culture, language, and community lifeways, where it belongs.

In the aftermath of this transformative experience, we view the "integration" and "knowledge documentation" paradigms as almost two opposing ends in the spectrum of participatory LTK/TEK studies. Whereas the former aims at using ("integrating") indigenous data in scientific models and monitoring practices, the latter focuses on recording indigenous knowledge *per se,* albeit with the use of certain scholarly means, such as published books, charts, computer datasets, reports, and others.

We should also emphasize that the terms "knowledge documentation" and "knowledge co-production" are by no means synonymous. It is appealing to view co-production as something "in the middle" of the integration-documentation continuum that strives to incorporate (blend?) multiple perspectives. Even more tempting is to argue that co-production produces *new shared knowledge* (Hegger et al. 2011; Pohl et al. 2011; Stegmaier 2009). We found it difficult to prove. Co-production does generate new paradigms; but they have clear birthmarks of their parental knowledge systems, like the concept of "cultural ice scape" that does not exist in Native epistemologies. An illustrated bilingual lexicon (dictionary) of local ice terms is another example, as it had no place in indigenous culture, yet it appeals to today's hunters, elders, youth, teachers, ice scholars, linguists, and heritage specialists. Rather, *in spite* of different origins, the outcomes of knowledge co-production have value to multiple audiences, as is the very process of collaboration, from which such products originate.

We tend to view knowledge co-production as a dynamic and fluid space, a continuum with the boundaries defined on a case-by-case basis, by intuition rather than by default. Each team in this emerging space may experiment with its own template to achieve a balance based on its goals, composition, and project arrangements. Such legacy of seeking a *balance through respectful coexistence* of various types of knowledge is the most valuable lesson of the Russian SIKU project. It may be of particular importance to those who strive to "integrate" the wealth of indigenous knowledge into scientists' models, charts, and table spreadsheets.

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