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REPORT

Communal visual histories to detect environmental change in northern areas: Examples of emerging North American and Eurasian practices

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Abstract This article explores the pioneering potential of communal visual-optic histories which are recorded, painted, documented, or otherwise expressed. These materials provide collective meanings of an image or visual material within a specific cultural group. They potentially provide a new method for monitoring and documenting changes to ecosystem health and species distribution, which can effectively inform society and decision makers of Arctic change. These visual histories can be positioned in a continuum that extends from rock art to digital photography. They find their expressions in forms ranging from images to the oral recording of knowledge and operate on a given cultural context. For monitoring efforts in the changing boreal zone and Arctic, a respectful engagement with visual histories can reveal emerging aspects of change. The examples from North America and case studies from Eurasia in this article include Inuit sea ice observations, Yu'pik visual traditions of masks, fish die-offs in a sub-boreal catchment area, permafrost melt in the Siberian tundra and early, first detection of a *scarabaeid beetle* outbreak, a Southern species in the Skolt Sámi area. The pros and cons of using these histories and their reliability are reviewed.

Keywords Visual observation · Optic history · Traditional knowledge · Photography · Rock art

INTRODUCTION

Human beings perceive their environment with multiple senses (Sawatzky 2013; Pulsifier et al. 2014). The role of visual perception and its varied expression is an age-old method of observing changes, events, and characteristics of the living conditions and ecosystems with which we interact (Agrawal 2002; Nadasdy 2003; Sheridan and Longboat 2006; Survo 2008; Eicken et al. 2014; Fidel et al. 2014). Northern Indigenous and local communities have recorded these communal *visual*, some times known as *optic* (Survo 2008; Mustonen 2014; Bennett and Lantz 2014), *histories* in a number of ways from prehistoric times (Autio 1981; Macdonald 2000; Kii7iljuus and Harris 2005; Bird and Hallam 2006) by using petroglyphs and rock art, painting, and various uses of cultural symbols, and, more recently, painting, print-making, carving, and most importantly for this inquiry, photographic materials of the twenty-first century. Pulsifier et al. (2014) emphasize that these local observations have author merit on their own (Eicken et al. 2014; Fidel et al. 2014) instead of being only 'data.'

The concept of visual-optic history or, in short, *visual history* (Bennett and Lantz 2014) and its role in monitoring, detecting, and informing societies about northern environmental change can illustrate the role and relevance that such communal observation efforts have in the North. Globally, authors such as Wehi et al. (2009) and Dick et al. (2012) support this approach, pointing to needs of exploring links between biological and cultural diversities in long-term, holistic, and cumulative monitoring efforts.

This paper explores visual histories as a mechanism to document environmental change. They may provide a dialogue between Indigenous and traditional knowledge (Berkes 1999; Agrawal 2002) practitioners and researchers investigating ecosystem and climate change in the Arctic (Kumpula et al. 2006, 2010). As this is an emerging field of linking different knowledge traditions, regional examples are used to illustrate variation and commonality using carefully selected cases.

Methodologically central to these communal recordings is the notion of *event* (Mustonen and Feodoroff 2013; Eicken et al. 2014) as a part of the engagement with local

places (Sawatzky 2013). Therefore, the approach to communal visual-optic histories operates inside culturally relevant, particular sets of meanings, interpretations of time and space, and aesthetics (Valkeapää 1991; Murtomäki 2008). Communal visual-optic histories refer in this paper to recorded, painted, documented, or otherwise expressed materials that provide collective meanings of an image or visual material within a specific cultural group. While they may be recorded initially by single individuals, meaning and interpretative power of an image, especially when shared 'outside' a culture or community in joint, collective decision to do so, produces the communal aspect of a communal visual history. Communal digital databases of visual histories are emerging as collective methods of storing and keeping such materials (Mustonen and Feodoroff 2013).

This means that recorded data and these long continuums of communal observations can be reviewed as a part of the specific culture and the visual tradition that produces it (Agrawal 2002; Nadasdy 2003; Huntington et al. 2013). A dialogue with available sets of long-term linear data used in science becomes possible from this positioning. Pulsifier et al. (2014) stress the new realization of acknowledging the authors of local community observations and their cultures instead of treating 'observations' only as a pure data flow for environmental monitoring.

In English, "optic" frequently refers to the use of an instrument in the visual observation of things or aiding sight (Dictionary.com 2015). Typologically, here optic refers to a broader understanding of visual observations, old or new, which are then recorded in different mediums ranging from cultural stories to digital photography in order to monitor changes.

Community-based monitoring and observations both globally and in the Arctic have received much attention in the last 20 years, including a varied range of discussions on scales, scope, and methodologies (Cruikshank et al. 1997, 2005; Macdonald 2000; Nadasdy 2003; Kumpula et al. 2010; Arnold et al. 2011; Arctic Council 2013; Fox-Gearheard et al. 2013; Eicken et al. 2014; Fidel et al. 2014; Pulsifier et al. 2014). Community-based monitoring is seen, at its best, to complement and expand the observations of ecological and climate change (Fox-Gearheard et al. 2013), beyond remote sensing and site-specific expeditions (Kumpula et al. 2006, 2010). Yet, regional differences of methods are quite pronounced. This paper focuses on examples of how *visual histories* of the North American (Bennett and Lantz 2014; Fidel et al. 2014) and Eurasian North, as a method (Pulsifier et al. 2014), can be used in such communal observation efforts. The drivers of and context from Alaskan and Canadian cases are assessed together with three cases from the Finnish and Russian North. By reviewing geopolitically differing regions, practices, and cases, a more systematic view of the role, relevance, and contextual differences of *visual history* emerges.

The Arctic and the sub-Arctic are shifting to a 'new normal,' where uncertainty and unexpected constitute the norm (Jeffries et al. 2013). This has profound consequences for the climate (Shaktova et al. 2010), flora, fauna, and human societies of the region (Kumpula et al. 2010; Arctic Council 2013; Fidel et al. 2014). Coinciding with this realization are the various efforts across multiple academic disciplines, cultures, languages, and sectoral approaches in the North to address and understand the new conditions of the Arctic—much of the region is still underexplored, and simultaneously the current change underway affects and produces new contexts and conditions. Therefore, cross-disciplinary, innovative efforts are needed (Pretty 2011).

While there are long-standing monitoring efforts in some parts of the Arctic, some of which include the role of Indigenous knowledge (Kumpula et al. 2006, 2010; Arnold et al. 2011; Arctic Council 2013; Fidel et al. 2014), northern regions of the planet are assessed and observed using remote sensing data or site- and time- specific expeditions in addition to field-based monitoring (Kumpula et al. 2006, 2010).

The socioecological change (Pretty 2011) underway requires new thinking, new methods, and an interdisciplinary application across scales, ecosystems, and paradigms (Pretty 2011).

Kumpula et al. (2006, 2010) outline methodologies where natural sciences, including remote sensing methods, have been combined with Indigenous and local knowledge. They (Kumpula et al. 2006) call for a "holistic" approach, including land use studies, to assess environmental changes resulting in wide cross-disciplinary results of a studied event, or topic. Remote sensing according to Kumpula et al. (2006) has limitations—specific areas of impact need to be verified using field visits and engagement with local and traditional knowledge (Fienup-Riordan 2014). Nadasdy (2003) reminds us of the cultural distinctiveness and specificity of traditional knowledge.

Engagement and dialogue with communal northern visual-optic histories has the potential to provide mechanisms for detection and assessment of ecosystem change, which is relevant for local communities and Indigenous peoples as well as science. Pulsifier et al. (2014) stress the need to include local stakeholders as interpreters of the materials to move methodologically forward: "interactions among practitioners from observers to compilers to interpreters are essential to developing a better collective understanding of what works in various circumstances and how awareness, acceptance and use of local observations can be raised in scientific and policy circles" (Pulsifier et al. 2014: 3). In this paper, this dialogue across knowledge systems, in its purest form, is a symmetric

engagement between community stakeholders sharing their visual histories with practitioners of science who can review the material using multidisciplinary inquiries.

Communal visual-optic histories can be defined as processes, descriptions, cultural texts, photos, and other means of communication that refer to *events* (Cruikshank 2005; Mustonen and Feodoroff 2013; Lehtinen and Mustonen 2013; Bennett and Lantz 2014; Fienup-Riordan 2014) observed by residents of an ecosystem that position, frame, and interpret them, sometimes using endemic cultural concepts. Berkes (1999, see also Posey 1999) stresses that Indigenous cultures and their traditional knowledge operate on a matrix that includes the aspects of 'sacredness' within the relationship with nature. Visual materials authored within such cultures may operate, therefore, on a carefully developed set of socioecological contexts (Agrawal 2002; Nadasdy 2003).

Such visual observations are built on *records* observed in the communities (Mustonen and Feodoroff 2013; Bennett and Lantz 2014; Fienup-Riordan 2014). *Visual/optic histories* are formed when these culturally relevant, particular records form a continuum of particular diachronic sequences and perspectives relevant for the community (Autio 1981; Bennett and Lantz 2014). As Sheridan and Longboat (2006) remind us, the Indigenous observations, including visual-optic histories, contain intergenerational, sometimes "deep" knowledge, scales, and interpretations not easily conveyed outside the specific cultural matrix and co-learning (Agrawal 2002; Nadasdy 2003; Cruikshank 2005; Lehtinen and Mustonen 2013; Fienup-Riordan 2014).

MATERIALS AND METHODS

Examples of North American uses of communal visual histories using carefully selected cases (Eicken et al. 2014), juxtaposed with three examples from the Eurasian North, provide a frame to illustrate how local monitoring and observation efforts conform to, and on the other hand, differ in various northern contexts.

By examining these cases from the recent research literature, it is possible to illustrate the capacity and potential of engaging communal visual histories more precisely. The cases have been chosen to represent specific inquiries where visual observation and history were positioned to be relevant by the local/indigenous peoples and their cultures. Cruikshank et al. (1997), working with the Northwestern First Nations in Canada, stress the need to position contemporary documentations of Indigenous societies in nuanced cultural continuums. Agrawal (2002) and Nadasdy (2003) emphasize the particularity of Indigenous knowledge and its specific characteristics. The purpose of these examples is to illustrate the methodological innovation in the engagement of visual optic-histories in their cultural context as the focus.

In the North American Arctic, Pitseolak (Eber 1975) provides a cultural use of visual histories for the Baffin Island Inuit, while the Inuit woman artist Kalvak does the same for the Inuvialuit people of the Western Arctic (Umholtz 1987) in Canada. In Greenland, Norrman (1949) recorded some of the very first artwork by the Polar Inuits. Fox-Gearheard et al. (2013) render the communal paintings, memories, trips, and photographs into a holistic, co-authored review of a meaning of ice to the Inuit people from Nunavut.

Bennett and Lantz (2014) developed an extensive monitoring program to record Inuvialuk visual histories over several years. The locations of observations were recounted using oral histories and marked with a GPS. Their research is the most applied form of visual history work from North America to date. Bennett and Lantz (2014) stressed that such work needs to be effective, compatible with the contemporary Indigenous culture, and should facilitate knowledge transfer within the particular local/Indigenous community. They do not position their own works in the historical visual tradition of the Inuvialuit peoples (Umholtz 1987), rather emphasizing the relevance to present day communities.

For Alaska, Fienup-Riordan (1996) illustrates the case of the long-lasting Yu'pik tradition of recording events, histories, and knowledge in highly visual masks. She stresses the spiritual–ecological dimensions and communal practices of access and avoidance in using these histories. As Kay Hendrickson (Fienup-Riordan 2014) states: "These masks didn't belong to just ordinary people. They come from the *angalkut* [shaman]. They belong to the *angalkut*…the *angalkut* would have the carvers make masks they would use when the invited guests came." More recent work (Fienup-Riordan 2014) stresses the role of the Yu'pik community as an actor in the visual history and traditional knowledge work.

Krupnik and Weyapuk (2012; see also Eicken et al. 2014) demonstrate how ecosystem change can be monitored using Indigenous languages in combination with old and contemporary photographic materials to produce an interpretation based on both science and traditional knowledge. Eicken et al. (2014) illustrate the use of a database to record visual histories in sea ice observation from the coast of Alaska. They stress the need for a continuous presence, in addition to remote sensing and archiving, as keys to success in communal visual records.

In the North America context, the majority of cases addressing visual histories builds on the long-established mechanisms of community monitoring efforts (Pulsifier et al. 2014) and they are seen, for the most part, as a

mechanism to convey data about changes and conditions. This results from the history of settled land claims and rights, which has, for the most part, solidified the concept of 'communities' (Fidel et al. 2014) as a basic operational unit to collaborate within monitoring efforts.

Out of the Alaskan and Canadian examples here, Bennett and Lantz (2014) stress the specific relevance of visual history documentation to the communities themselves. On the other hand, only AQFienup-Riordan (1996, 2014) positions the changes and observations of today within a long, unbroken cultural continuum which includes the specific visual traditions of the given local context.

Turning to the Eurasian Arctic, a few examples illustrate how visual histories manifest in their multiplicities across different cultural groups. Key notions here are the attachments of a visual history to and by a specific culture group and the positions and authorships of images from within/outside a group/culture (Cruikshank 2005). The rock art and pictographs (Autio 1981) of Eurasian northern societies are most likely some of the oldest forms of human visual expression, along with rock paintings from Europe, and can be interpreted as visual histories. Using this as a basis, experienced northern photographers, like Finnish author Murtomäki (2008: 91), have written about the concept of new visual methods, such as "circular photography", rooted in Sámi tradition which stresses round and circle-based forms in its symbolism, viewpoints, and crafts in its choices of an image.

Luhta (2009) positions the images of northern lights as a key factor in a long continuum of boreal cultural traditions. In modern times, Indigenous authors such as Sámi Nils-Aslak Valkeapää (1991) have combined art, historical photographs, poetry, and cultural rock art motifs from within the culture to provide visual histories for a people, which at the same time offer a culturally relevant positioning of change, wildlife, and northern nature. Other Sámi artists, such as Marja Helander, Iver Jåks, Carl-Johan Utsi (Mustonen and Syrjämäki 2013), Rose-Marie Huuva, and Britta Marakatt-Labba, have followed, and carried on the Sámi visual histories in their work (Lehtola 1997).

Similarly, contemporary Siberian Indigenous visual artists such as Nikolai Kurilov (Timofeyeva 2011) offer a view of an unbroken visual communal record using distinct cultural forms. Valkeapää (1991) and Kurilov (Timofeyeva 2011) have explicitly referred to specific northern Indigenous culture-relevant visual tradition as an expression of the particular relationship with nature. Using such approach as a guiding idea, data here stress that contemporary photographic materials can be positioned as parts of their unique cultural continuums.

Outsiders, such as Vuorelainen (1990) and Puranen (1999) have, in their turn provided visual materials which have had a role in forming the visual-optic history of the Sámi, a Eurasian Indigenous community. Jochelson (1926/1975) provided crucial visual and photographic materials from the Kolyma River in Siberia at the beginning of the twentieth century. More recently Mustonen and Feodoroff (2013) utilized documented photographs from the 1880s and 2000s to compare ecosystem change in the Eastern Sámi community of Chalme-Varre along the Ponoi River, in the Murmansk Region of Russia. Classical ethnographic photography, where Indigenous and local peoples and their landscapes are the targets of visual documentation, is therefore shifting toward a re-assessment and use of old photographs to provide new interpretations of 'classical' (/colonial) materials (Kendall et al. 1997; Savard 2010).

Finally, communal visual history can be used to come to terms with large-scale hydropower projects, which flood areas of age-old human occupation, as in the southern boreal village of Paihola, North Karelia, Finland (Molen 2003; Mustonen and Mustonen 2013; Dora 2013), or to provide histories of the shift from nomadic life to settlements in the Arctic and sub-Arctic (Simon 1982). Visual-optic histories can also be gendered as has been demonstrated by the Finnish photographer Rita Lukkarinen (2007).

For the purposes of this inquiry, three relevant northern Eurasian cases of visual history can be contextualized using both the actual events of environmental change as well as the visual cultural tradition of a particular culture. Methodologically, the first case, Jukajoki, was explored using oral history and visual documentation using field trips (Mustonen 2013) as well as a literature review of the region and ecosystem. Second case relied on co-production of knowledge (Lehtinen and Mustonen 2013) where the Skolt Sámi were provided with digital cameras to record observations. Then oral histories related to the photographic materials were documented, workshops organized in the community of Sevettijärvi (Mustonen and Feodoroff 2013), and the materials, once approved and validated by the Skolts, compared with science database of insect ranges in Finland (Hyönteistietokanta 2013). Third case from Siberia used a combination of long-term community oral history documentation (Wehi et al. 2009, Fienup-Riordan 2014), equipping the herders with digital cameras (Mustonen 2009, 2012) and comparative literature review between 2004 and 2014. All cases and materials were analyzed by the author positioning the communities and recording individuals as co-producers of knowledge (Lehtinen and Mustonen 2013), emphasizing the communal role of sharing visual histories.

RESULTS

In the first case, in the southern boreal watershed of the Jukajoki River in North Karelia, Finland, local subsistence

fishermen noticed severe damage to the waterway and the occurrence of two instances of fish die-offs (Mustonen 2013) (Fig. 1).

The Finnish–Karelian cultural zone is renowned for its long-lasting visual arts tradition (Survo 2008), combining nature, culture, and communal relevance. Visual histories have an age-old role in the life of the local villages. Heikki Roivas, who lives and fishes on the Jukajoki River, observed a large pack of sea gulls flying up and down the river in July 2010. This led him to go down to the river where he saw scores of dead fish floating downstream.

He proceeded to describe his *visual history* to the researchers dispatched to the site using oral history (Macdonald 2000). Roivas observed the fish deaths, which resulted from extremely acidic discharges from a local industrial peat production site. They had gone undetected by the state environmental agencies and the VAPO Company (Mustonen 2013), which is the owner of the site and the responsible body along the watershed. VAPO is a government-owned power company whose environmental record has been contested both in science and in policy (Mustonen 2013). The oral histories of Roivas were documented using digital recorders and semi-directive interviews (Bennett and Lantz 2014).

The events were repeated in June 2011 when Roivas visually detected a second wave of fish deaths caused by a repeated discharge, again unmonitored by the state or the corporate agents. Mustonen (2013) reviewed materials from 2000 to 2012 regarding the quality and means of monitoring that the company and authorities conducted. The review points to a case where the overall context of the conditions for fish deaths were known to these actors, but the actual *events* went unnoticed by them for months.

Later the communal visual histories were collected from a number of fishermen along the watershed (Mustonen 2014) using both semi-directive interviews and photography from their private archives. The history observation made by Roivas challenges the established consensus and follows a similar path as the one made by Inupiaq Elder Charles O. Degnan regarding individual Pacific salmon that return to the sea after spawning in Unalakleet, Alaska, USA (Mustonen and Mustonen 2009: 35). In short, these histories conveyed by Roivas detected a significant alteration in a watershed's condition in the Jukajoki River,

Fig. 1 Healthy part of the river Jukajoki, a site of repeated fish deaths, North Karelia, Finland. The catchment area is a key hunting and fishing area of the local residents of the village of Selkie. Photo: Matti Pihlatie, used with permission

North Karelia, Finland that would not have been observed using only scientific means. Second, they position themselves in a long cultural continuum of visual histories of the Finnish–Karelian zone (Survo 2008).

As a second empirical case, Skolt Sámi fishermen and reindeer herders have participated in the first collaborative management (Carlsson and Berkes 2005) initiative in Finland. They provide observations, participate in design of ecological restoration activities and discuss quotas and management options for the watershed (Mustonen and Feodoroff 2013). Its focus rests on Skolt traditional knowledge, Atlantic salmon, and the Näätämö watershed in sub-Arctic Finland (Mustonen and Feodoroff 2013). During the initial field season's co-management activities, the herders and fishermen were equipped with high-quality digital cameras, in the hope that they would record observations and events which they found meaningful from their own cultural viewpoint in the catchment area. As an experimental method, the fishermen were guided to photograph issues, events, and sites that would be unrestricted, and relevant for them.

One of the results was the documentation of the northernmost record of the *Potosia cuprea* scarabaeid beetle in the Nordic countries (Mustonen and Feodoroff 2013: 88) (Fig. 2). The observation was confirmed using scientific records from the Finnish entomological database (Hyönteistietokanta 2013), which confirmed the observation. Furthermore, the observations documented during the season included fluctuations and outbreaks of *Aphidoidea* aphids and the *Epirrita autumnata* defoliating looper moth larvae, which are thought to benefit from warming temperatures in the Näätämö watershed.

The appearance of *Aphidoidea* aphids in the fishing areas of the Näätämö river watershed was seen as a new *event* (Mustonen and Feodoroff 2013: 88) by the Skolt Sámi fishermen. On the other hand, the presence of *Epirrita autumnata* defoliating looper moth larvae has been detected both by science and the Sámi in the catchment area since 1960s (Hyönteistietokanta 2013; Mustonen and Feodoroff 2013). The Sámi involved in the study interpreted the presence of the lost birch forest areas caused by these larvae as an indicator of warming temperatures (Mustonen and Feodoroff 2013: 88). This interpretation most likely includes a mix of Indigenous and public knowledge as this particular species has been discussed in the media for decades, including causes and reasons of its presence in Sámi areas (Arctic Council 2013; Mustonen and Feodoroff 2013).

In third case, Chukchi reindeer herders living in Lower Kolyma, Republic of Sakha-Yakutia, Russia, documented sites of melting permafrost along the catchment area of the Kolyma, a large Siberian river (Mustonen 2009) (Fig. 3). Nomadic societies cross wide ranges of territory during their annual migrations. These mobile societies also travel across varied ecosystems, from the tree line in winter to the tundra coasts of the Arctic Ocean in spring and summer (Mustonen 2009, 478, 2012). From their viewpoint, the emptying and disappearance of lakes as a result of the melting permafrost and the increased and varied meandering of the Kolyma River were worth documenting using digital cameras and marking on maps. The region is home to unbroken Indigenous art traditions of the Yukaghirs and Chukchi (Timofeyeva 2011), providing a view that visual histories are a natural method of conveying tradition, change, and meaning.

Fig. 2 Skolt Sámi documented the northernmost appearance of the *scarabaeid* beetle in the Näätämö river watershed, Finland in the summer 2012. Photo: Skolt Sámi Optic History Archive, used with permission

The region contains some of the last nomadic Arctic societies (Mustonen 2009, 2012; Lehtinen and Mustonen 2013), which are living traditional lifestyles. The sites of melting permafrost recorded by the herders have been instrumental in widening the scope and extent of the phenomena and its study. Melting permafrost, with its methane releases, both on land (Walter et al. 2006) and on the continental shelf (Shaktova et al. 2010) of northeastern Siberia, constitute a process, which has global significance, too, due to the amounts of greenhouse gases being released. Scientists have not yet recorded all of the sites of change and here the efforts of the herders can assist them with the detection of terrestrial change.

Those sites which the herders themselves have marked on maps and documented using their visual histories are

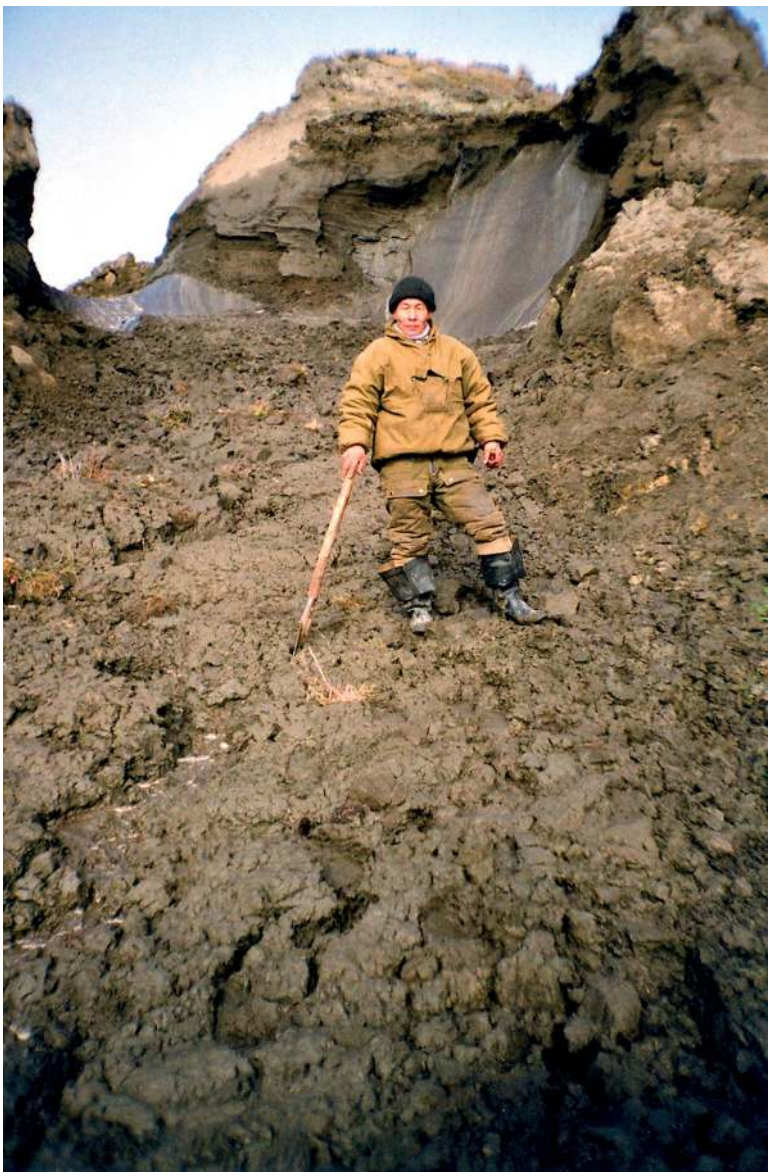

Fig. 3 Reindeer herder Pyotr Kaurgin, Chukchi member of the Turvaurgin nomadic community, has documented sites of melting permafrost in Lower Kolyma, Republic of Sakha-Yakutia, Russia. Photo: Pyotr Kaurgin, used with permission

also crucial from the viewpoint that they stand out in the local context—many of the knowledge holders living in the Indigenous communities of Kolyma do not recall such events or precedents in the rate and speed of this change. Consequently, documentation efforts can play a key role in monitoring how and to what extent permafrost is being affected in the Eurasian Arctic.

DISCUSSION

From the methodological viewpoint of applying visual-optic histories as a new, experimental method to convey messages and cultural relevance of environmental change, three cases presented here proved to be successful in all of the regions involved. In Eurasia, first, the results regarding the fish deaths along the Jukajoki River watershed in North Karelia, Finland (Mustonen 2013) triggered the local fishermen to recount their visual observations to scientists, authorities, and media. This persuaded the local villages (Mustonen 2014) to start the largest catchment-wide restoration project, employing both local knowledge and science, in Eastern Finland. Peat production was suspended on the problematic VAPO site, and it was eventually shut down. Here the observation and change detected by the fishermen led to watershed-wide restoration activities.

Second, the Näätämö River observations by the Sámi of the arrival of new species, like the *Potosia cuprea*

scarabaeid beetle (Mustonen and Feodoroff 2013), confirmed that the environment is changing in profound ways. In addition, when the results were compared with scientific records of the species (Hyönteistietokanta 2013), the communal visual-optic history of the beetle was confirmed to be the northernmost occurrence of the species recorded so far. The observation of a new southern species in the catchment area, from both Sámi and scientific viewpoints, contributed to a process during which the first collaborative management project in Finland (Mustonen and Feodoroff 2013) was initiated after these observations.

The project has, among other issues, the specific focus of addressing salmon survival amid weather changes by restoring lost spawning sites. The Sámi involved in the communal visual-optic history documentation felt for the first time that their knowledge was taken seriously in the dialogue with scientists involved in the work, thereby contributing to the well-being of the Skolt Sámi in a number of ways, including the artistic renderings of nature, as with reindeer herder Illep Jefremoff's portfolio (Mustonen and Feodoroff 2013).

In Lower Kolyma, Siberia (Mustonen 2009), the melting permafrost is a significant *event* (Lehtinen and Mustonen 2013) in their world. It was documented using cameras and on maps, as well as discussed in a communal process with the local Elders to position the change under way into a historical context (Mustonen 2009, 2012). While the process of permafrost melt itself has received much attention in science, the local actions and interpretations of communal visual-optic observations are worth investigating by exploring the communal responses and documentation of these events. The Chukchi of Turvaurgin nomadic community, from where the observations presented in this paper have come, decided to respond in a number of ways.

Overall, as Mustonen (2009) reports, they decided that a deepening engagement with their traditional livelihoods would be the answer. Nomadic reindeer routes were shifted. In addition, the Chukchi decided to share their observations with the scientists to make larger audiences aware of the process underway (Mustonen 2012; Arctic Council 2013). Locally, they wish to establish nomadic schools (Mustonen 2012) as a mechanism to encourage young people to continue traditional occupations and lifestyles. Lastly, in an act that has both social symbolic and technical relevances, the Turvaurgin nomadic community decided to respond to the changes by installing pilot-style solar panel units in their fish bases and nomadic brigades, a unit of nomadic reindeer herding in Kolyma (Madine 2012). This has reduced the dependency on fossil fuels by up to 60% in these camps, and has also had a great impact as a communal effort to address climate change (Madine 2012).

North American cases here (Weyapuk and Kruonik 2012; Bennett and Lantz 2014; Eicken et al. 2014; Fidel et al. 2014; Fienup-Riordan 2014) in the context of visual histories focus on the ongoing monitoring efforts of environmental and weather changes. This can be positioned into the established and evolving role of community-based monitoring characteristic of Canadian and Alaskan Arctic (Pulsifier et al. 2014). Visual histories form a quite recent methodological engagement in the region with a strong emphasis on "data." Bennett and Lantz (2014) frame the relevance of the visual histories for the contemporary Inuvialuit to be strong but do not refer to long visual traditions of the place (Eber 1975; Umholtz 1987, Arnold et al. 2011). Fienup-Riordan, both in previous works (1996) and in the new inquiry (2014), stresses the role and relevance of the tradition. This is similar to other visual history documentations from the region from the previous decades (Eber 1975; Simon 1982).

The northern Eurasian visual histories, in the absence of often formalized land claims and legally defined communities, tend to manifest and be read as expressions of cultural continuums (Lehtola 1997; Survo 2008; Timofeyeva 2011) rather than sources of data as is the case with some of the North American processes (Bennett and Lantz 2014). Eurasian visual histories seem to be closer to the observations made by Fienup-Riordan (1996, 2014) and Eber (1975), which stress communal decision-making and the cultural context of releasing, using, and sharing specific visual histories.

This article has emphasized the role and relevance of communal visual-optic histories to detect environmental change in the North (Fienup-Riordan 2014). As the dominant contemporary source of these histories, the photographic evidence of ecosystem event(s) can be contested from various viewpoints when taken and analyzed as scientific evidence or data (Agrawal 2002; Nadasdy 2003; Fienup-Riordan 2014). An observation of change needs to be verified for authenticity or it may lose much of its credibility if the exact location of the site cannot be recorded from the scientific date viewpoint. Advancements in digital camera technology may assist in this process as they record the GPS coordinates of the photo that has been taken (Bennett and Lantz 2014). Visual history is communally validated, when it is shared to 'outside'—a marker method that can strengthen the credibility of materials within the given culture (Eber 1975; Timofeyeva 2011).

The digital photography of contemporary society also allows specific photographic files to be edited, manipulated, or distorted in a number of ways. To address this issue, the file dates and versions need to be reviewed regarding observations. However, technical inaccuracies may be kept to a minimum by establishing the context of a visual

history through the mapping of sites and an appropriate engagement with science and the traditional knowledge holders (Bennett and Lantz 2014).

Another, less-obvious context and challenge rests with the Indigenous and local societies themselves. Indigenous interpretations and cosmologies of change, as demonstrated by Valkeapää (1991), Agrawal (2002), Nadasdy (2003), Lehtinen and Mustonen (2013), Fienup-Riordan (1996, 2014), Bennett and Lantz (2014), and Pulsifier et al. (2014), can vary greatly from the ecological monitoring aims of visual history use. These societies have their own scales of interpretation, time, and space, which may differ from linear worldviews and demarcations of scientists (Agrawal 2002; Couzin 2007; Huntington et al. 2013; Mustonen 2014; Pulsifier et al. 2014; Bennett and Lantz 2014; Fienup-Riordan 2014). Therefore, an integrated approach to convey a visual observation and history with oral passing of knowledge (Macdonald 2000) may strengthen the cultural context of a case (Agrawal 2002).

If we position visual-optic histories within the broader cultural continuum which originates with prehistoric rock art (Autio 1981) and spans to contemporary communal photography, we can agree with Murtomäki (2008) that the northern societies, each on their own terms, portray culturally specific and unique visual arts and interpretations. This seems to be the case with materials recorded by Illep Jefremoff, one of the Skolt Sámi herders equipped with the cameras in the Näätämö River catchment area in Finland to document his observations (Mustonen and Feodoroff 2013). In addition to documenting changes in the ecosystems and salmon population sizes and health of the Näätämö River, he also produced a large portfolio of artistic renditions using his visual histories, which has emerged to be of significance to the other Sámi in the community he lived in (Mustonen and Feodoroff 2013).

Finally, the notion of community ownership (Fienup-Riordan 1996, 2014; Macdonald 2000) of visual histories and materials is on the rise. This means that some aspects of cultural, communal visual histories may be off-limits for those actors, such as researchers, who come from outside a specific community (Bennett and Lantz 2014; Fienup-Riordan 2014). This can be the result of previous colonial experiences where photographic materials were used for an inaccurate portrayal of a culture or way of life (Francis 1996; Savard 2010). It may also occur where customary or traditional ownership and laws guard against the use and portrayal of certain sites, events, photos, and images (Sheridan and Longboat 2006; Eicken et al. 2014).

This poses a challenge to the operational principles of science, which is based on the understanding that all data can and should be shared. One mechanism to solve such quandaries of ethical and moral differences may be found in community-based and -maintained oral and visual archives (Macdonald 2000; Mustonen 2014; Eicken et al. 2014; Fienup-Riordan 2014) which operate on principles guided by the peoples themselves, thus allowing culturally appropriate guidance of how specific materials and histories may be shared. Fienup-Riordan (2014) confirms specific, direct moral instructions shared by Yu'pik knowledge holders of Alaska as a basis of any such traditional knowledge work.

Remote sensing and GIS surveys also provide visual data (Kumpula et al. 2010). The main difference with the northern communal materials rests on the authorship of why, where, and to what extent the particular visual materials are produced. The northern tradition of visually recording *events* (Autio 1981; Mustonen and Feodoroff 2013; Fienup-Riordan 2014) places great significance on the specific image(s), as opposed to general-generic image production associated with remote sensing efforts (Kumpula et al. 2006). This difference in meaning may potentially result in a clash of cosmologies and worldviews as Sheridan and Longboat (2006) remind us.

Visual-optic histories have the pioneering potential to address innovations in environmental monitoring in the North (Bennett and Lantz 2014). The arctic and sub-arctic, including the boreal zone, are undergoing a historical regime shift to unpredictable context (Arctic Council 2013; Jeffries et al. 2013). Ecosystems, human societies, weather patterns, wildlife, and entire landscapes are changing. These events are often monitored using remote sensing and site-specific scientific expeditions and observations (Kumpula et al. 2006, 2010). Such methods, while effective, frequently convey only a portion of the events under way. At the same time, there are many local and Indigenous societies in these territories who continue to dwell in and occupy remote, peripheral sites, and areas outside current scientific monitoring efforts (Arctic Council 2013).

Northern communal visual-optic histories may provide crucial new evidence of species (Mustonen and Feodoroff 2013) and landscape (Mustonen 2009; Mustonen and Mustonen 2011, pp. 42–43) changes, including the unexpected deterioration of ecosystem health (Mustonen 2013) (Fig. 4a, b). Especially the Indigenous societies of the North possess their own cosmologies, context of interpretation, and time-spaces (Mustonen and Feodoroff 2013). Therefore, such visual histories are not only sources of data, but can be positioned in a long continuum of using visual means (Autio 1981) to tell about the places, nature, and human societies of the northern part of the planet. The cases here also mark distinct differences in approach to the visual histories in the North American and Eurasian North, respectively.

For the general monitoring efforts underway in the northern regions, respectful engagement of these visual histories may yield crucial information of how and to what extent things are changing in this "new normal" (Jeffries et al. 2013; Eicken et al. 2014; Pulsifier et al. 2014).

Kumpula et al. (2010) provide a model of scaling of environmental change and observations combining sociocultural surveys, ground-thinking, and remote sensing. They (2010: 175) agree that: "Local and Indigenous peoples' assessments add a different level of interpretation to changes in tundra."

Following the advice from Kumpula et al. (2010), we should approach this "embedded" engagement with communal histories as a form of dialogue (Pulsifier et al. 2014; Eicken et al. 2014). Integration can happen if the local meaning, *the event* (Mustonen and Feodoroff 2013; Fienup-Riordan 2014), of a particular observation is appreciated by science. Such special events, recorded by the local and Indigenous communities, mark specificity and particularity, and also potentially mark systematic shifts (Pulsifier et al. 2014; Fidel et al. 2014). Otherwise, this can be a challenge to scientists looking for general data, and the fear of ignoring relevant materials emerges.

By exploring the materials and various observations about events and then combining them with science-based sensing and research, new realizations may emerge. Bennett and Lantz (2014), after having applied the method in the Inuvialuit areas, conclude that it is an effective method to document, contextualize and share traditional knowledge.

Such new knowledge needs then to be conveyed to decision makers, scientists, and authorities, and further disseminated as the efforts from North Karelia (Mustonen 2013) and Näätämö (Mustonen and Feodoroff 2013) illustrated. Correspondingly, Fox-Gearheard et al. (2013) demonstrate for the North American and Greenlandic Arctic how such efforts can be significant, scaling up from the community level to international efforts.

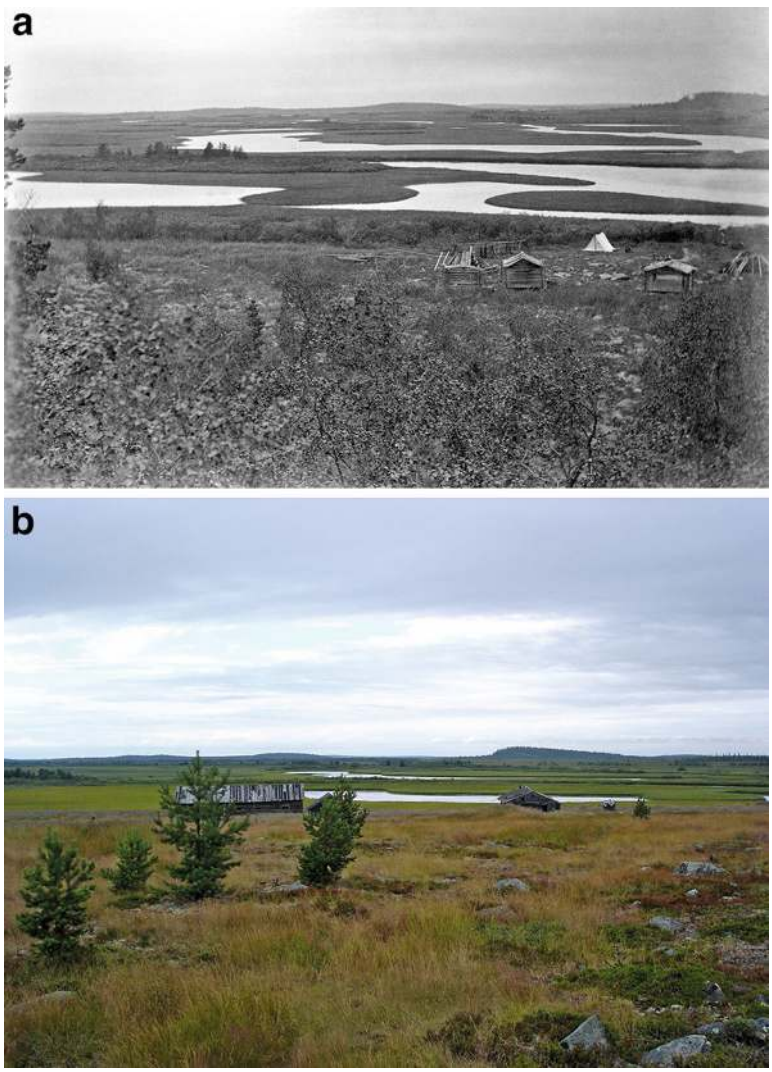

Fig. 4 Community of Chalme-Varre, located on the Ponoi river, Eastern Sámi area, Murmansk, Russia in 1880s (**a**) and in 2006 (**b**). Use of archival photos may provide visual guidance of how landscapes and ecosystems change, or in this case, retain most of their characteristics. Photo: Mustonen and Mustonen (2011)

Thus, visual histories provide direct paths of engagement for local and Indigenous societies, allowing them to become actors within the changes underway (Mustonen 2012; Fienup-Riordan 2014) rather than being seen and felt as victims of our times. As the late Caleb Pungowiyi, a Yupik knowledge holder from the St. Lawrence Island in Alaska, has said, engagement with Indigenous and local knowledge puts a human face to these changes underway (Couzin 2007).

CONCLUSION

Observation of an *event* (Huntington et al. 2013; Mustonen and Feodoroff 2013; Fienup-Riordan 2014) can have greatly varied meanings (Sheridan and Longboat 2006; Pulsifier et al. 2014) for different actors in northern areas. The communal visual histories, as demonstrated in this paper, can yield crucial new data of how things are changing in the north. They can also become locally relevant mechanisms to address the issues involved (Mustonen 2012, 2014).

As Kumpula et al. (2006, 2010) state, a dialogue between remote sensing and science-driven observations with ground- and culture-based approaches is relevant to assess changes under way in the North. As a pioneering method, communal visual histories and their dialogue with science are well suited for partnerships with fisheries, hunting, and reindeer-herding communities. Given more empirical tests, both in taiga and tundra ecosystems and applied cases, communal visual histories may potentially develop into a robust new concept that can be confidently applied to monitoring efforts.

The pilot cases explored here both from North America and Eurasia indicate that communal visual histories of change confirm that rather than becoming only conveyors of new data and observations for science, affected communities have the potential to lead adaptation and corrective measures, such as the establishment of catchment area-restoration actions (Mustonen 2014), reforms in nomadic education (Mustonen 2012), and installation of renewable energy production systems (Madine 2012) to culturally and practically address the issues. Cultural differences, relationship with tradition, and contexts vary between different parts of the North, but such partnerships with interdisciplinary teams of scientists can result in significant new data and research.

Perhaps most importantly, as Fox-Gearheard et al. (2013) demonstrate for the North American and Greenlandic North, we should not dismiss the capacity and innovative approaches present in the northern communities, each on their own terms (Fienup-Riordan 1996, 2014; Sheridan and Longboat 2006), to address the new normal (Jeffries et al. 2013) in which we currently find ourselves.

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