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The human dimension of climate change research in Greenland: Towards a new form of knowledge generation

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In the field of climate change research, social sciences have lagged behind natural sciences and have not yet mustered enough recognition from the public. Studies on the human dimension of climate change commonly use the concepts of 'vulnerability' and 'resilience'. The 'resilience' approach investigates the capacity of a community that absorbs environmental disturbances, so as to retain essential social, cultural, and economic structures, while the 'vulnerability' approach seeks to identify factors that make the community in question vulnerable to ongoing or future climate change. The term 'resilience' tends to give an impression that a system may remain static, and because of this, I adopt the term 'vulnerability' in this essay. 'Vulnerability' does not mean that Arctic communities are always "vulnerable" to environmental changes but may be negatively impacted by the associated social and political changes. Accordingly, vulnerability means the social and political "characteristics" of the community that is experiencing the changes. This concept helps researchers direct their attention not only to environmental changes, but also to the societal situation of the community. In the second half of this essay, I exemplify how the vulnerability approach works, drawing data from my fieldwork conducted in Siorapaluk, in 2009. More local communities want scientific data in order to plan a course of action and to shape their political and economic policies in the rapidly changing environment. In future, it will be increasingly important for natural scientists to work closely with local communities, and this may lead to a new form of knowledge generation.

気候変動といえば自然科学の分野が先行し，社会科学的調査の認知度は低い．社会科学の分野には，「復元性（resilience）」と，「脆弱性（vulnerability）」に注目する手法がある．復元性とは，環境攪乱がおきても，社会，文化，経済構造を維持できる地域の包容力であり，脆弱性とは，調査地が現在または未来の気候変動に対して，脆弱になる可能性である．「復元性」という言葉は，社会が変わらないという印象を与えるため，筆者は，脆弱性に注目した手法を本稿で解説する．脆弱性という言葉は，北極圏に住んでいる人たちが，単に環境変化に「脆弱である」という意味ではなく，環境変化に伴っておきる社会的，経済的，政治的変化に対応できないために，脆弱になるということを意味している．つまり，「脆弱性」とは，変化にさらされている調査地の社会的，政治的「特徴」を表していると考えてよい．この概念は，環境変化だけでなく，調査地の社会状況をも考慮する必要性を喚起する．後半では，筆者が 2009 年に行ったシオガパルクでの現地調査を紹介し，気候変動の社会科学的な調査がどのように行われたか解説する．現在，多くの町や村では，将来の政治経済方針や事業方針を定めるのに有用な科学的データが必要とされている．今後，自然科学者はますます，調査地の社会と連携を図る必要性が出てくるであろう．そしてそれは，新しい知識の形成に繋がるのである．

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1. Introduction

The purpose of this essay is to introduce the study of the human dimension of climate change, along with commonly used 'vulnerability' and 'resilience' approaches in this field, to review the relevant existing literature, and to make suggestions to natural scientists working in Greenland on climate change research.

2. The social dimension in climate change research

2.1 Changing Arctic environment

When it comes to climate change in the Arctic, people's attention tends to be directed towards changes in the natural environment. For example, the summer of 2012 saw an extreme melt, in which almost the entire surface of the Greenland ice sheet started to melt, and this continued over four days. According to researchers, this phenomenon was a first in the past 120 years (Nghiem et al., 2012). The most striking feature of Greenland is snow and ice; these are dwindling. The Arctic environment is definitely changing at a much faster pace than was expected.

2.2 As climate changes, so does people's life: An example from Ilulissat

These changes matter for natural scientists, but for us who live a life on the planet of the Earth, the question to be asked is: "What is going to happen next, if snow and ice continue to melt?" Unless the change is not affecting our life, we do not necessarily care about that. For example, during my stay in Greenland in 2008, I heard that local fishers in Ilulissat were having trouble fishing halibut because hooks and baits were more often washed away by sediments discharged by the melting glaciers (see also Mølgaard, 2007). Scientific reports produced by glaciologists indicate that Jakobshavn Glacier is flowing faster and is calving more ice into the ocean (Holland et al., 2008). Putting together this kind of scientific reports with local stories, it clearly shows that as the environment changes, people's livelihoods are going to be significantly affected by them. This is more important to deal with, and this is the question that social scientists are tackling.

2.3 Physical environmental change ── ecological change ── human impacts

Internationally speaking, the human component in climate change studies lagged behind natural sciences such as climatology, glaciology, marine sciences, and geology. Much attention was, but still now is, paid to the impacts on the natural environments. In 1990, the Intergovernmental Panel on Climate Change (IPCC) produced one volume separately, as part of their first assessment report, on the social implications of climate change. It was around this period that the journal of *Global Environmental Change* was established, which covers wide ranging issues of social impacts of climate change. In the beginning of the 21st century, the human dimension of climate change began to draw more attention from the international arena. The Millennium Ecosystem Assessment (MEA), a project triggered by a speech given by then Secretary-General of the United Nations, Kofi Annan, in 2000, concluded in 2005 that the change in the ecosystem will very likely impact the livelihoods of Arctic communities (Chapin et al., 2005). Also, in a similar fashion, the Arctic Climate Impact Assessment (ACIA), carried out under the auspices of the Arctic Council and the International Arctic Science Committee (IASC), emphasized implications of climatic change on human society (Huntington et al., 2005; Nuttall et al., 2005). The latest version of knowledge synthesis on the human dimension of climate change can be available at the IPCC website. The Working Group II of the Fifth Assessment Report is specialized for the social implications of climatic and environmental changes (https://www.ipcc.ch/report/ar5/wg2/). In these reports, the mechanism of climate change impact was laid out that changes in the physical environment (such as the climatic system) will lead to ecosystem changes, and subsequently be translated into societal changes.

2.4 Adaptation in climate change studies

Although still being debated in a political arena, among natural scientists a consensus was already made that climate is changing (Oreskes, 2004). Furthermore, scientists have reached a common understanding that the Earth's climate has been affected by human activities and that the rate of change is unexpectedly faster. By 2006, in academia, whether climate was changing owing to human activities or a natural cycle was no longer a question. The focus in climate change studies had been shifted to a question of whether we can possibly adapt to the changing climate. The arising theme was "adaptation" to climate change, and "sustainable development" began to be discussed in the context of climate change.

2.5 Japanese research in the international arena in climate change studies

Japan has lagged behind the international arena. As late as 2015, as part of a new national-flagship ArCS (Arctic Challenge for Sustainability) project, one research project team (led by Dr. Sugiyama) included the social component in their research objectives to tackle with environment change problems along with this vein.

3. Research framework

3.1 Various impacts in different places

What we first keep in mind is that the impact of climate change varies from place to place. Accordingly, it is not prudent to make a sweeping generalization about influences of climate change. A certain impact in one place may be manifested differently in other areas. Greenland is the world's largest island, and the distance between the northern and the southern tips of Greenland is the same as the distance between Sapporo of Japan and Taipei of Taiwan. It is not reasonable to think of the weather of Taipei with reference to that of Sapporo. In North Greenland, the sea is covered by sea ice for extended winter months, and dogsleds are important for local people for hunting and transporting. Yet, in South Greenland, where the sea freezes, locals drive a car on the ice. (Actually, by law, one is not allowed to keep sled dogs south of Disko Bay.) As one passes down the Arctic Circle, bushes and trees start to appear. Willows and birches form bushes in the inner parts of the fjords in South Greenland. Some lands are arable; it is possible to grow crops such as potatoes and turnips; and there are about forty sheep farms along the shorelines of the inner fjords. Even plantation (mainly spruce trees transplanted from Alaska) has been promoted since the 1950s in South Greenland (Ødum, 1990; Hayashi, 2011).

Climate change has been manifesting differently, reflecting differences between these areas. In 2007, I heard that a hunter in Qeqertarsuaq, Disko Bay, sold off his sled dogs because as climate became warmer, the mushing season was becoming shorter. This means that he decided to stop hunting.

On the other hand, a warming temperature has made it possible for sheep farmers to grow more crops in South Greenland. The local agricultural advisory office indicates that sheep farmers in South Greenland produced over 100 tons of potatoes in 2012 and 2013 (Frederiksen, 2015). In the 1970s, it was not possible to grow potatoes in the region, but now vegetable growing is promising. The agricultural experimental station in Upernaviarsuk has been continuing experiments to grow lettuces, turnips, and even strawberries (KNR, 2011).

Another example for a positive impact of climate change may be fishing in South Greenland. Cod fishing collapsed in the 1970s due to a decline in the sea water temperature, but people are expecting that cod are coming back to the Greenland water due to the current warming trend. They began to see species that had never appeared in Greenland's coast such as mackerel (Tallaksen, 2014).

The media are usually quick to snatch these "hot spots" in climate change. *The New York Times* published an article with a headline "Climate Change Greens up Greenland" (Lyall, 2007). It described how sheep farmers might benefit by a warming trend because more hay could grow faster. The *National Geographic* featured Greenland in a similar vein in its volume of "Greenland: ground zero for global warming" (Folger, 2010). Yet, a closer look at the local community revealed that the impact of climate change was not so simple as generally thought (Hayashi, n.d.). My long-term fieldwork clarified that farmers are suffering from drier summers, being unable to produce enough winter fodder. In fact, a couple of sheep farmers closed their farms due to the changing climate conditions, economic

problems, or perhaps a change in their course of action.

3.2 Societal factors for the manifestation of climate change

As outlined above, the influence of climate change varies from place to place. Yet, it is not only physical and ecological conditions, but also societal factors that influence local manifestation of climate change. Sociocultural and political contexts are intertwined with natural phenomenon to create very complicated impacts on local communities. Here lies the difficulty of the study of the human dimension of climate change. For example, even though the same level of earthquakes hit two similar environments, people who live in the areas may not have the same impact. At one place, where buildings were designed to cope with quakes and residents were well trained to evacuate, residents are likely to be inflicted less than those in another area that are not like that. This is because social, cultural, political, technological conditions of a locality inform the degree of the impact of environmental change (Fisher and Feinman, 2005). In another words, societal characteristics of the place in question matter. Therefore, climate change is not just an environmental disaster, but also a human-caused disaster.

3.3 Theoretical framework in the human dimension of climate change

When looking into journals on the human dimension of climate change or natural disasters, such as *Global Environmental Change* and *Ecology and Society*, one soon runs into technical terms such as 'vulnerability' and 'resilience'. These two terms indicate the concepts that have often been used in this research field. The resilience approach looks into characteristics of the community that absorb disturbances, so as to retain essential social, cultural, and economic structures (Adger et al., 2005), while the vulnerability approach tries to identify factors that make the community in question vulnerable towards ongoing or future climate change (Kelly and Adger, 2000). Simply speaking, these concepts are used in the same context, and it is just that researchers are seeing communities from opposite directions. If increasing the resilience, it means that a community has reduced its vulnerability towards a harm, and by reducing vulnerability, it can build a resilient community in the course of climate change. Basically, these concepts are based on a systems thinking, and human society and the environment in which the society is located are viewed as systems, and these are interlocked. It is meaningless to determine which approach is better, but for the following reasons, I use the vulnerability concept in this essay. I hasten to add that I do not blindly support vulnerability approach.

Originally, the concept of resilience was brought from ecology, in which an ecological system tries to organize itself around a single equilibrial state. When receiving a disturbance such as a fire, an ecosystem like a boreal forest is supposed to bring itself back to the original state. The Canadian zoologist and ecologist C. S. Holling developed this idea and applied it to human society (Holling, 1986, 2001). According to his "panarchy" doctrine, there could be several equilibrial states, and an ecosystem at one stable point can jump to another stable point when recovering itself after a disturbance (Gunderson and Holling, 2002). So does a human society. When disturbed, a society may catastrophically collapse, but with resources that it can resort to (technology, knowledge, social institutions, or collective actions), a society can rebuild itself like the same way as they were or in a different way (Folk et al., 2003). As seen in the websites of the Resilience Alliance and the journal *Ecology and Society*, social scientists such as Fikret Berkes, Carl Folke, Elinor Ostrom and Brian Walker extended this ecological thinking to the study of environmental change. The concept as such is very informative and inspiring when seeing the interaction between humans and the environment in which they live and when thinking of environmental change from the wider perspective (Walker and Salt, 2006, 2012); however, I think that this term is prone to emphasize that a system tries to remain static. Arctic landscapes are always changing, and it is not comprehensible to think that a system, ecological or social, remains at a stable point. The vulnerability approach may give more practical insights when constructing a problem-solving approach towards climate change research.

The concept of vulnerability was developed in the fields of natural disaster studies, human geography, and sustainability science (Wisner et al., 2004). It is not

within the scope of this essay to review the development of the vulnerability concept. In 2003, Turner and his colleagues (2003) outlined the coupled human-environment systems model with a tangible diagram. This model facilitates the capture reciprocal interactions between humans and the environment and influences of the feedback from the environment on human society and vice versa. This model and the associated idea can be seen in the MEA (Kasperson et al., 2005) and the ACIA (McCarthy et al., 2005). Already, a forerunner of this model can be seen in the Third Assessment Report of IPCC (McCarthy et al., 2001). An extensive review on the development of the vulnerability conceptis done by W. Neil Adger (Adger, 2006), who is also one of the leading scholars in the field of *Global Environmental Change* and has been working in Southeast Asia.

At present, the Climate Change Adaptation research group at McGill University, led by James Ford (http://www.jamesford.ca/), is a leading research team in the vulnerability study, conducting extensive research in NWT and Nunavut (Ford et al., 2015).

What was new about the vulnerability approach was that it turned over the conventional notion of vulnerability. When it comes to the assessment of the vulnerability of a community towards the current and future climate change, it will often start with a projection of a future climate trend, move to the biophysical impacts studies, proceed to the identification potential adaptive options for the community, and will finally define any residual, adverse consequences as "social vulnerability" (Adger and Kelly, 1999; Kelly and Adger, 2000). In other words, natural scientists tend to place social vulnerability at the end point of their impact assessment.

Two points need to be made for this type of scientific assessment. First, this type of assessment is based on predicted future climate changes. The physical system of the Arctic region is dynamic, and even with advanced atmosphere-ocean general circulation models (AOGCMs), it is not possible to predict precisely the dynamics of the atmospheric and ocean currents that interact within and outside the region in a complex way. Therefore, this dynamism limits our understanding of the climate system. Now that it is widely regarded that the reduction of CO_2 emission from industrial activities prevents global warming, a primary driving force behind the work of the IPCC is to mobilize the broader community, and to put pressure on political arena. (This seems obvious when looking at summaries of its assessment reports, in which plain language, such as "very likely", are used.) Yet, because of a sense of uncertainty and doubt that reside in any well-crafted climate scenarios, it is hard to convince policymakers to take an appropriate action to combat anthropogenic change. Truly, there are a lot of possibilities that concrete numeric values derived from research, such as "+3℃" and "next 50 years", convince politicians; however, (natural) climate sciences have a limitation. Consequently, it is becoming more important to show local situations, where Arctic communities are actually being affected by climate change.

Second, as discussed above, since mitigation measures and coping options are selected based on predicted scientific scenarios, these do not always fit the actual situation of the community in question. Accordingly, mitigation and coping measures need to be determined by actually observing actual situations of Arctic communities.

Taking into account these two points, if we see a community actually being exposed to ongoing climate change, we can see that residents there are not just "passive actors" in the course of climate change, but that they are actively responding to unusual weather patterns and climate anomalies (Duerden, 2004). When exposed, individuals and groups in the affected community begin to cope with changes in a short term, by making use of a bundle of social resources, and their action will develop into the long-term adaptation to reduce vulnerability. Therefore, it appears that it is not appropriate to see vulnerability as a residue derived from the adaptation process. Accordingly, social scientists stopped placing "vulnerability" at the endpoint of the assessment, but began to view that vulnerability resides in a community before it goes through climate change (Kelly and Adger, 2000). In other words, vulnerability means the pre-existing constraints that limit the capacity to respond (the "adaptive capacity" often used in *Global Environmental Change*) to external environmental changes ("stress" and "stressor" often used in GEC). By defining vulnerability like this, we can start research by

actually observing the current (vulnerable) state of a community.

This conceptual shift has brought researchers' attention to actually observing a community. Here I organize terms that I have used above. 'Coping' is the action that takes place within existing structure (e.g., production systems), while 'adaptation' is changing the framework within which coping takes place (Adger and Kelly, 1999). Coping is rather a bundle of short-term responses to a situation that threatens livelihood systems, while coping may develop into long-term adaptation. Therefore, a short-term 'coping' and long-term 'adaptation' are processes that human-environment systems go through environmental changes, while 'resilience' and 'vulnerability' are associated with the capacity of systems in the course of the changes (Eriksen et al., 2005).

A community has resources (or assets) that can be used for coping with and adapting to environmental changes. Vulnerability is the potential to adversely affect a community's capacity to respond to the changes (Adger, 2000). As discussed above, resources include knowledge, techniques, technologies, local regulations and institutions, human networks, and infrastructure (Adger, 2003). Yet, there are resources that a community lacks, or factors that constrain local efforts from adapting to changes. A constellation of these resources and constraints is termed 'vulnerability', and what needs to be emphasized is that the constellation is conditioned by societal, political, and economic situations of the subject community. According to the vulnerability approach, in order to assess the impact of climate change, researchers only need to identify the above-mentioned resources and constraints (Pearce et al., 2010). In this respect, I have stated above that the vulnerability concept is more practical and more suitable for a problem-solving research. I suspect that by streamlining a research approach, other factors that inform local residents' responses, such as an historical context of a community, environmental and temporal perceptions of residents, may elude from the research framework. Yet, the vulnerability approach is significant in that it directs our attention to the current conditions of local communities. For example, livelihoods, food security, and social well-being are closely related to societal, political, and economic contexts of a community (Gerlach et al., 2011), and these are significantly affected by climate change. The vulnerability approach has brought these issues under the examination of climate change.

4. Observations at Siorapaluk

4.1 Siorapaluk

Drawing a concrete example, let me show how the study of the human dimension of climate change can be conducted with a vulnerability approach (Hayashi, 2015). I conducted my fieldwork in Siorapaluk in the spring of 2009. Siorapaluk is the northernmost village in Greenland, located north of Qaanaaq, North Greenland.

In this village, there were more dogs than residents in 2009 (some 70 residents to over 200 dogs). This fact shows how important dogsleds are for hunting and transportation. Hunting is deeply rooted in the culture of North Greenland. In other words, hunting is an integral part of local people's lives.

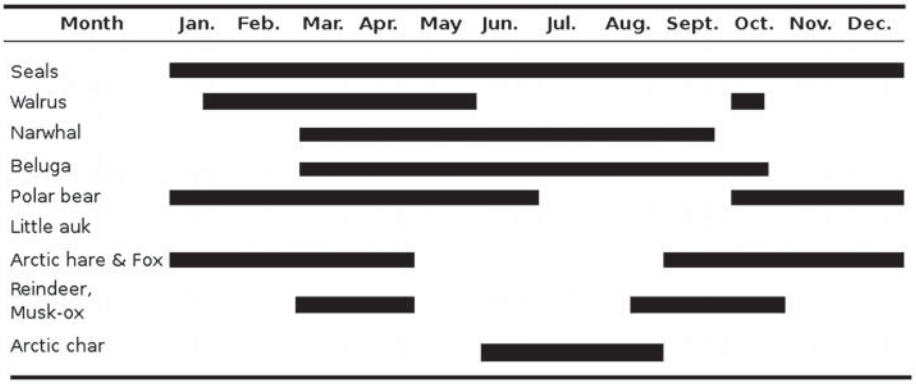
4.2 A rising trend in temperature

Recently in this village, dramatic changes are being observed in the climate and the ecosystem. First of all, the temperature has risen by 2–3℃ (Danmarks Meteorological Institut [DMI], n. d.). When I visited Siorapaluk on April 30, 2009, the sea north of the village was already open. When hunting, two hunters hauled a motorized vessel by their dogsled to the edge of the ice, and then they changed vehicles from dogsleds to the boat. After a couple of hours of sailing to the north, they shot two walruses basking in the sunlight on the ice floe from the boat. Here, I found a notable change in the way the local residents hunt walruses.

During the 1970s, the sea used to freeze in late October and the ice would continue to cover the sea until June and even July (Iwashita, 1977). This means that local hunters could use dogsleds for seven to eight months for hunting, until late spring.

Traditionally, walrus is an important animal in this village. A walrus which may weigh 1,200 kg when maturing is a very important source of food for humans and dogs (Born, 2005). When hunting walrus, a couple of hunters would be teamed up, travelling by dogsled to

Table 1：Hunting seasons for various animals in Siorapaluk, North Greenland



The table shows *potential* hunting seasons for several animals. Theoretically speaking, walrus can be hunt during winter months, but now hunters hunt only in spring. Therefore, the walrus hunting season was shortened from five months to one month. N. B. Compiled based on data obtained in 2015.

search for a breathing hole, wait for an animal to surface, and would harpoon it by the breathing hole (Iwashita, 1978; Ôshima, 1989). Yet, this is not the case any more. At present, the sea does not freeze until mid-December, while the sea ice starts to break up in late April. Unstable sea ice deters local hunters from mushing even during cold winter months. Consequently, nowadays, local hunters go hunting only in spring by boat. In other words, walrus is the one hunters kill on the sea, rather than on ice. Virtually, the hunting season for walrus was reduced from four months (February to May) to one month (May). Therefore, changing climate has changed the way local hunters procure animals.

As this shows, a temperature rise has significant implications for the environment —— namely, later freeze-up and early thaw. What is often reported is that these changes immediately make the winter hunting period shorter, make travel on ice dangerous, and make access to some living resources difficult. It can be said that local hunters are "victims" of climate change (Huntington et al., 2005). Let us look at closely this phenomenon. Table 1 shows hunting seasons for different animals in this village (Hayashi, n. d.). According to this table, it is clear that local hunters have a wide range of hunting options.

If it is difficult to hunt walruses, they can hunt seals because seals are accessible all year around. If hunting on ice is difficult, they can hunt reindeer and musk-ox on land. Other terrestrial animals such as fox and Arctic hare are still accessible. As for dragging a boat for walrus hunting, if viewed from a different angle, it can be thought that local hunters are flexible enough to change a means of transportation and travelling routes. Local hunters are vigilant and careful enough to avoid a dangerous situation, so that they hunt walrus only in spring these days. That said, I do not mean that climate change and the associated environmental changes are not significant. The point being here is local people's flexibility, adaptability, and ingenuity that take part in local climate change. Hunters are not just vulnerable to a changing environment. The coping strategy of hunters is mainly based on flexibility.

4.3 Traditional ecological knowledge (TEK)

What makes it possible for local hunters to exercise these abilities is their precise understanding of the local environment. Through a long-term observation of the landscape, local residents have accumulated a breadth of environmental knowledge (Freeman and Carbyn, 1988; Inglis, 1993). Some environmental knowledge are passed on from previous generations, and some kinds of knowledge are shared by fellow hunters. This is what is often called traditional environmental knowledge (TEK). The word "traditional" may be elusive and may make the readers misunderstand the scope of TEK. By actually engaging in their surroundings through hunting and everyday life, they have learnt how things work and how to live fully and effectively in their environment (Wenzel, 1999; Usher, 2000). Therefore, TEK is not about old knowledge, but TEK is one constantly being updated, modified, and readjusted, according to a changing environment (Stevenson, 1996). This knowl-

edge guides locals through their life and livelihood.

4.4 Other TEK examples

For example, in narwhal hunting, they decided not to use motorized vessels for hunting within the fjords of Qaanaaq in order to avoid scaring the narwhals and other animals (Lykke Thomsen, 1993). In addition, municipal bylaws require hunters to harpoon (with a rope at the other end) before shooting because the shot animals will sink immediately. A sunken animal will be wasted and is bad for the ecosystem. Like this, hunters have set up local regulations to keep a healthy animal stock. This is the case in dogsleding. As snowmobiles make a big noise to disturb animals, they have regulations prohibiting the use of snowmobiles for hunting (Born, 2008). These examples show that local hunters are knowledgeable about ecological processes and how they can maintain animal populations and the environment.

4.5 Assets and constraints: From a vulnerability point of view

These TEK and local environmental regulations based on TEK are good examples of resources and assets (social capital) that can be used for coping with climatic and environmental changes.

What the vulnerability approach tries is to find what constrains local effort to cope with and adapt to environmental changes. It has been a long time since the Greenland government introduced the quota system to hunting in the area. When I talked to local hunters, many complained about the introduction of this not because they are egoistic but because annual allowable hunts are not reasonably established.

The levels of allowable hunt are determined unilaterally by biologists' (i.e., natural scientists') recommendations, with little input from local residents. Consequently, the quota system is not so much useful for maintaining a balance between animal conservation and local households' economy. Here we can see a chasm between local hunters and natural sciences. I have stated above that the hunting season for walruses has been shortened from four months to one months. This is not just because of climate change. Since the walrus quota is so strict, hunters will max out their allowable hunt in a couple of hunting trips. Consequently, they do not need to take the risk of going out to unstable ice in the winter. They only need to go out to the sea by boat in spring (Hayashi, n.d.).

Another constraint is anti-sealskin campaigns in Europe (Wenzel, 1991). The harmed image of hunting seal has significantly affected the import of animal furs in European countries. Because of this, the Greenland national tannery could not clear the stockpile. When I was staying in 2009, the tannery stopped buying furs from hunters throughout Greenland for two months. Hunters earn money by selling sealskins to the tannery, and the two-month closure of the tannery was detrimental to many households in Greenland. Therefore, in order to facilitate hunters to cope with climate change, it is needed to provide a system or regulations to get rid of this kind of constraints. This kind of perspective cannot be drawn if only look at climate and environmental changes. As discussed above, constraints are conditioned by social, political, and cultural situations of a community. The vulnerability approach help understand the nature of constraints to local adaptation to climate change.

5. Concluding remarks

As demonstrated above, this essay has tried to clarify the importance of the observation of a local community that is actually experiencing climate change. In order to effectively combat a local manifestation of global climate change, it is necessary to see what climate change really means to local residents, and how it is intertwined to a local situation to create social, political, and economic problems for residents.

Recently, more communities are engaging in scientific research projects in the Arctic. This means that more communities want to participate in decision-making processes and two-way communications with authorities such as government. Also, they expect scientists to provide useful data and recommendations to mobilize authorities. This is why community-based research is becoming more important these days, and in near future (natural) scientists working in Greenland, such as researchers from the Institute of Low Temperature Science, will need to work more closely

with local residents in their research projects, and this may lead to a new form of knowledge generation.

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