

# Coupled socio-cultural and ecological systems at the margins: Arctic and alpine cases

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**Abstract** There is agreement that the most effective response to the unprecedented confluence of issues that face humanity at the dawn of the third millennium, namely, climate change, economic crisis, and growing energy demand is 1) applied interdisciplinary research involving coupled socio-cultural and ecological systems and 2) practical application of knowledge generated by the sciences. Meaningful examination and understanding of coupled-systems emerges from direct engagement with communities that have faced and adapted to dramatic changes. Drawing from a high latitude (Arctic) case and a high altitude (Alpine case), this paper illustrates that the interplay of cultural values, social structures, and ecosystems services facilitate adaptation.

**Keywords** adaptation, climate change, socio-cultural change, human ecology, interdisciplinary, indigenous knowledge

## 1 Introduction

An unprecedented confluence of issues faces humanity at the dawn of the third millennium. While tenuously grappling with dramatic climate change and its socio-cultural and ecological consequences, we simultaneously need to address a structural economic crisis resulting in a global recession and growing demand for alternative energy sources to sustain food and livelihood security. Despite the fact that these three issues are intimately related, there is no historical model from which to articulate an effective response to the convergence of climate change, economic crisis, and growing energy demands. Policy makers and applied researchers are turning to coupled ecological and socio-cultural systems as a foundation from which to formulate adaptation

strategies. There is an emerging consensus that resilience of ecological and socio-cultural systems depends on conservation of biological and cultural diversity (Holling, 2001; Maffi, 2001, 2002; Harmon, 2002; Berkes et al., 2003; Turner et al., 2003; Chapin et al., 2004; Adger et al., 2005; Maffi, 2005; Folke, 2006; Harmon, 2007; Kassam, 2009a).

The Editors of *Conservation Biology*, while commenting on the-state-of-the science as they marked the 20th anniversary of their journal, acknowledged that an interdisciplinary perspective was essential.

*The most repetitive message coming out of “these retrospective papers” is the great need for interdisciplinarity and inclusion of the various social sciences. This is an obvious imperative; we have to learn how to transform our scientific knowledge into practice. We are facing a fundamental problem relative to human behavior, and the solution ultimately will need to take human behavior into account. This is the great challenge that confronts us in the next decades. Those who still think that biology and ecology alone are sufficient for our task—that good science by itself will save the day—are as much in denial as those who say there is no environmental crisis* (Meffe et al., 2006).

The key messages are, first, sensitivity to coupled socio-cultural and ecological systems so as to understand human behavior and, second, keen attention to practical application of knowledge generated by the sciences.

This paper draws freely from research on the Alaskan Arctic (Kassam, 2009a) and the Pamir mountains of Afghanistan (Kassam, 2009b,c), which are high latitude and high altitude environments that bear the brunt of climate change, threat to food security, and economic uncertainty; although, indigenous people from these regions contributed little if anything to the current global crisis. The aims of this paper are to 1) illustrate that an interdisciplinary perspective necessarily embraces the physical, biological, and social sciences, as well humanities; 2) show that the notion of “interdisciplinarity” extends to indigenous knowledge holders; and 3) demonstrate that

adaptation to change is a product of the interplay of complex socio-cultural and ecological systems.

## 2 Context for case studies

The inner workings of systems are revealed under conditions of change (Greenwood and Levin, 1998). Specific cases from the Circumpolar Arctic and the Pamir Mountains of Central Asia will illustrate how coupled systems work under conditions of stress. Meaningful examination and understanding of coupled-systems emerges from direct engagement with communities that have faced and adapted to dramatic changes. Change is context specific within the complex connectivity of cultural, social, and ecological relations. Similarly, coupled systems are functional and grounded in concrete localized experience. A coupled human-ecological perspective describes the relationships between people and their environment—including relations between humans themselves and relations of human to other animals, plants, and their habitat. It is a narrative of human beings' developing a socio-cultural system on the foundation of nature.

### 2.1 Case 1: Iñupiat experience of climate change in the arctic

#### 2.1.1 Context and method

Subsistence hunting and gathering lifestyle inherently connects people to their environment, allowing them to

observe discernible change. Therefore, indigenous knowledge about sea-ice, which is so important to livelihoods, has the potential to enrich and expand our collective understanding of climate change in the Arctic. Recent studies using documented personal observations based on indigenous knowledge indicate climatic variations on a regional basis (Magnuson, 2000; Reidlinger and Berkes, 2001; Krupnik and Jolly, 2002; Nichols et al., 2004). In the context of Wainwright, Alaska, indigenous knowledge about sea-ice gained through direct participation in Iñupiat subsistence activities is relatively well documented (Nelson, 1969, 1982).

This case study documents observations about sea-ice by community members from Wainwright and is drawn and abridged from Kassam (2009a). Wainwright, Alaska, is an Iñupiat community located 136 km<sup>2</sup> southwest of Barrow on the Chukchi Sea (Fig. 1). The community is 480 km<sup>2</sup> north of the Arctic Circle. Because of its unique location, ice movement in the Wainwright area is affected equally by both the wind and ocean current relative to other coastal communities on the North Slope. Therefore, community-held knowledge of sea-ice movement for the purposes of subsistence hunting is distinct to Wainwright's coastal geography and gained through direct experience. With ice movement and because of it, there is an abundance of marine resources for harvest in the North Slope of Alaska. The residents of Wainwright are significantly dependent upon the fruits of sea for their food needs (Nelson 1969, 1982; Luton, 1986; Ivie and Schneider, 1988; Braund, 1993; Fuller and George, 1999; Kassam and the Wainwright Traditional Council, 2001).



Fig. 1 Map of Wainwright

Along with relying upon the richness of the sea come special problems of safety and travel on open water and sea-ice. As a result, the Iñupiat have over successive generations developed detailed knowledge of the sea-ice environment and methods for safely interacting with it (Nelson, 1969, 1982).

This case study flows from action research on human ecology, which examined the relationships between Iñupiat of Wainwright and their environment. A total of 50 interviews were conducted in 1999. There were 22 female and 28 male participants. Their ages ranged from the early 20s to the late 90s. All participants except one, a young female, were currently or had been in the past hunters, fishers, and/or trappers. There were 38 currently active hunters, fishers, or trappers among the participants. Approximately half of the participants were over the age of 60 and were considered 'elders,' wherein all of them had engaged or continue to engage in a subsistence lifestyle. In the summer of 2000, when the results of the research were being presented to the Wainwright Traditional Council for validation, observations on climate variations, taken from interviews, were noted (Kassam and the Wainwright Traditional Council, 2001). The leadership of the community requested that additional research be undertaken to explore Iñupiat knowledge of climate change to confirm the earlier research because of its importance to their subsistence activities. A total of 14 new interviews were conducted with captains of traditional whaling crews and subsistence hunters who have an immediate and intimate empirical understanding of sea-ice conditions.

### 2.1.2 Findings

In order to understand whether climate change is taking place, we must ask *how* the performances of tasks on sea-ice by the Iñupiat of Wainwright are being affected. The talent the Iñupiat display in hunting marine birds and mammals is fundamentally linked to their knowledge of sea-ice. Once the shore-fast ice has formed, the seasonal cycle of hunting may begin. Figure 2 illustrates the seasonal nature of harvesting ecological resources. Furthermore, it indicates periods in which sea-ice may affect harvesting of specific resources. While the figure does not show the presence of pans and floes of ice in late June through to September, such features are essential for the harvesting of walrus and bearded seals.

Summarized below are four observations made by hunters, fishers, and trappers in the community related to ecological changes and their impact on the Iñupiat.

First, over the last 25 years, many community members noted that ice formation has moved later into the fall. Freeze-up has shifted from mid or late September to late November or December. In 2001, freeze-up (formation of shore-fast ice) did not occur until January 16th. It is noteworthy that most hunting activities are not conducted in large groups with the exception of subsistence whaling,

which takes place with a crew of 10 to 20 people. Therefore, the observations of these hunters reflect their individual experiences and as part of different subsistence whaling crews. In addition to the research conducted with participants in the community of Wainwright, additional assistance was available from the North Slope Borough's Geographic Information Systems divisions, which helped to access and interpret satellite imagery. Synthetic Aperture Radar (SAR) images were used to complement information collected. For each year from 1996 to 2000, a total of five years, one image per month was collected from April to December for a total of nine months of the year. Keeping in mind the expenses associated with accessing each of these images, nine months out of the yearly seasonal calendar of subsistence activities seemed reasonable. Depending upon the availability of the SAR images, the pictures were taken roughly a month apart. While these images are only two-dimensional and do not portray the dynamic quality of the knowledge the Iñupiat have of sea-ice conditions, collectively, they suggest trends. Even though the SAR images do not provide information on the quality of pack-ice or the robustness of shore-fast ice and its relationship to ridges, they indicated that the heavy pack ice formed with shore-fast ice by mid-December. Until November, the area around Wainwright is characterized by offshore pack ice and young ice forming along the coast. The only exception is the image for December 2000 in which pack ice is still offshore, there is open water and shore-fast ice did not form until January 2001. Images for spring for the five years indicated smaller open leads in April in front of the village of Wainwright. By June, large leads extending as far northeast as Point Belcher or the Village and widening beyond Icy Cape to the southwest. As the leads progress to the southwest of Wainwright they tended to get larger. This corroborates what the Iñupiat have already stated: that in the spring and early summer the current flows from the south, moving the pack ice from the southwest to the northeast. By July, the SAR images indicated the presence of open water around the coastal area of Wainwright. The SAR images show that, indeed, ice formation along the coast of Wainwright is now delayed as community members maintain. Furthermore, the images suggest that there is swift decay of shore-fast ice as the Iñupiat hunters contend.

Second, climatic changes make subsistence harvesting activities potentially dangerous and have a direct impact on the ability of the hunter to harvest food. Hunters observed that in the past, ice was rough, thick, and robust; whereas, currently, ice tends to be thinner, less likely to anchor to the shore and tends to "rot" (i.e., thaw) more rapidly in the spring. Findings indicate that the ice seems to be a lot more "damp" (wet), and it does not get very thick. They estimated that it does not get thicker than four feet. Thin and poorly developed ice makes subsistence activities more difficult. Strong and stable ice conditions are required for marine mammal harvesting. Specifically, the people of

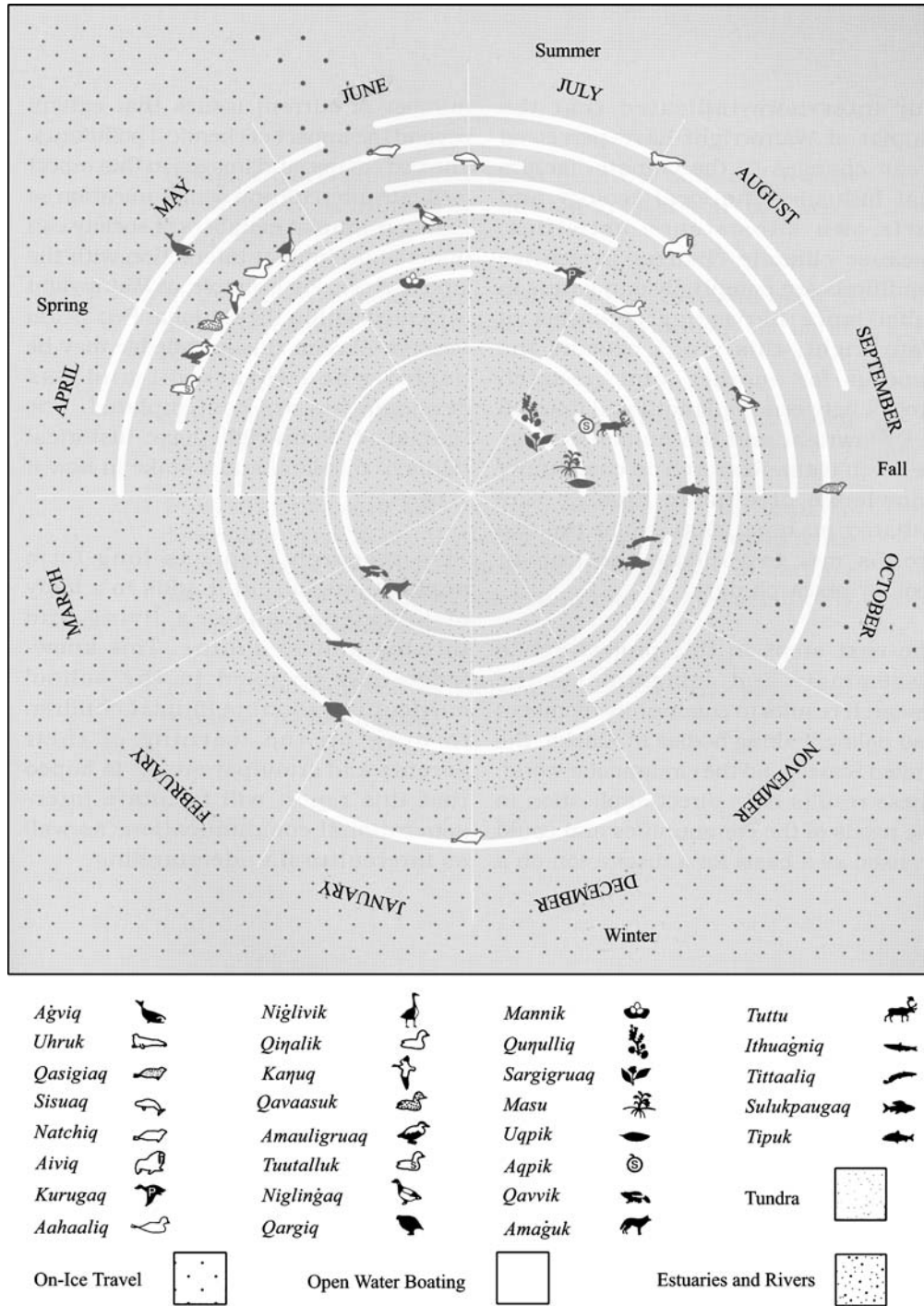


Fig. 2 Seasonal profile of key plant and animal species harvested near Wainwright

Wainwright continue to harvest a number of marine mammals: bowhead and beluga whales, bearded and ringed seals, and walrus. Tasks such as hauling a whale out of a lead up onto the ice have become burdensome and dangerous to whaling crews. The bowhead harvesting season is from mid-April to early-June. Safe harvesting of the bowhead whale requires calm weather and strong ice. Similarly, hunters prefer to harpoon walruses, on drifting

floes and pans of ice after the break up. Due to their size, they are usually immediately butchered out on the ice anytime after mid-June through November. Although seals are not as heavy as walrus, the hunters also butcher *Ugruk* (bearded seal) directly on the sea-ice after the hunt. Hunters take home only the usable portions of the *Ugruk* leaving the remainder. This is a relatively more efficient method of butchering than taking the large seal back to the

home of the hunter, provided that the sea-ice is solid and stable.

Third, as early as the 1980s, weather changes were perceptible to hunters, which were manifested in changing waterfowl behavior in terms of feeding and landing locations (Nelson, 1982). It is not surprising that, given the intimate knowledge the Iñupiat have of their local ecosystems, Wainwright community members revealed perceptions of broad changes in the climate and, as a consequence, in animals. Local observation indicated clear biological impacts on organisms arising from climatic change. A warmer and longer fall season affects the fur quality of animals, such as wolves, wolverines, and foxes. The guard hairs, which are the longer and more wiry strands, are not as long as they were ten or fifteen years ago. Winter conditions do not dramatically affect the fur quality, even if the winter is cold. The quality of fur is said to be directly affected by warmer autumn months.

Fourth, late freeze-up also has an impact on the polar bear population, which is trapped on the land and appears to be starving. Community members are often forced to kill these bears when they come to the town seeking food as they pose a danger to the community. Several years back, a resident from the neighboring village of Point Lay (to the West) was killed by a starving polar bear. In the summer of 2000 while undertaking research on indigenous knowledge of climate change, there were several sightings of polar bears stranded on land, and one had to be killed because it ventured into the community. Examination of the bear indicated that it was starving.

### 2.1.3 Discussion: Socio-cultural and ecological implications

Climatic change in the region of Wainwright reveals three interconnected impacts on the human ecology of the area: 1) concern for the safety of hunters resulting from erratic weather conditions; 2) its implications for subsistence activities; and 3) the bearing these changes will have on the cultural system and social structure of the community.

The most immediate impact of climatic change in Wainwright is safety for subsistence hunters. The loss of ability to hunt marine mammals safely may not only result in increasing accidents and loss of life on sea-ice but may put greater pressure on harvesting of terrestrial mammals to compensate for food sources by the community. Furthermore, there may be increased pressure on other animal species that marine mammals feed upon as populations increase. Finally, marine mammal calving and migration patterns may be dramatically affected.

The people of Wainwright have clearly indicated their concern for this erratic weather. It is a source of stress because it creates a disjunction, a fissure in the direct relationship between the Iñupiat and their habitat as they have known it. The implications of this type of instability

and consequential anxiety in a subsistence hunting culture are difficult to assess beyond initial concerns of safety and travel on sea-ice (Turner et al., 2008). The loss of the power to predict climatic behavior by the Iñupiat may lead to a debilitating anxiety that has profound effects on subsistence hunting practices, nutrition, and socio-cultural institutions. This case suggests that a study needs to be undertaken to assess the impact and implications of stress experienced by subsistence communities like Wainwright as a result of climate change. An examination of coping practices and adaptation may not only contribute to general knowledge of human dimensions of climate change but, more importantly, be useful to northern communities and their survival.

The third potential impact of climatic change in the region is that the combined effects of loss of safety on sea-ice and disturbance in subsistence hunting of marine mammals and birds may contribute to conflict between the cultural system and social structure of the community. Human-ecological relations are dependent on a cultural system of symbols, values, and beliefs. For instance, the food and nutritional contribution that the bowhead whale makes to the Iñupiat is not divorced from its cultural and spiritual significance. The whale is simultaneously food as well as creature of great beauty and intelligence. Whaling and other subsistence activities reinforce values, such as sharing, concern for the common good, leadership, discipline of behavior, a sense of deep respect for nature, the symbiotic relationship between man and woman, and a deep connection between the Iñupiat and the community of wildlife that surrounds them (Freeman et al., 1998). The relationship between man and wife also includes the bowhead whale. How a man behaves with his wife impacts the whale hunt because the whale does not give itself to the man but the woman. Therefore, while the men on the boat who make up the whaling crew hunt, it is to the women waiting on sea-ice nearby, to whom the whale gives itself as food (Bodenhorn, 1990). Sharing, manifested, for instance, in the social context of the *Nalukataq* festival after a successful whale hunt where the food is shared with the entire community, is a fundamental value. *Nalukataq* is a community event, held shortly after a successful hunt. People gather not only to share from the harvest but also to give thanks to both the whale and the whaling crew. Social bonds among community members and in turn with bowhead whales are renewed and reinforced at the *Nalukataq*. In an Iñupiat community like Wainwright, Alaska, whaling is more than just a major food source; it defines the cultural life of the community (Nelson, 1982; Freeman et al., 1998; Kassam, 2009a). The majority of community members do not participate in the hunt but benefit from the efforts of a few hunters. If sea-ice conditions continue to deteriorate to the point where subsistence activities can no longer be carried out in the way they have been; socio-cultural impact may be devastating to the fabric of the community.

Historical evidence clearly indicates that the value of sharing has a deep resonance with, and a common thread linking the subsistence cultural system to, its social structure. The value of sharing has sustained human ecological relations of the Iñupiat of Wainwright in periods of dramatic socio-cultural upheaval. These upheavals have included colonial contact, Christianization, the influenza epidemic, the rise and fall of industrial whaling, the rise and fall of the fur trade, and other vagaries of the global market economy. About 40 years ago, Richard K. Nelson characterized whale hunting in the community of Wainwright as a “lost art” and predicted its demise (1969). Some 20 years later Nelson had to revise his predictions of not only the demise of whale hunting but the subsistence economy as a whole. He admitted his error with honesty worthy of a true scholar:

*“When I lived in Wainwright during the 1960’s, I believed that growing contact with the outside world would soon eliminate subsistence as the basis of village economy and culture. ... It is so instructive to look at these predictions now, almost 20 years later: the material aspects of life in Wainwright have undergone a steady and progressive change, resulting in far greater modernity than I could have foreseen. Wainwright’s recent history shows that change is not a constant, universal, or one-directional process. Nor can it be accurately predicted. Subsistence has persisted here for a number of reasons, most of them related to its prominent position in Iñupiat culture, social organization, and value system.”* (Nelson, 1982)

Subsistence hunting continues to thrive in Wainwright, Alaska, as the Iñupiat navigate their cultural and ecological heritage in the 21st century. However, climatic variation may diminish the capacity of communities to be resilient. Human agency also has upper limits defined by its physical, cultural, and biological factors. In short, one needs *all* the parts in order to tinker. Is the current climatic variation a challenge to sharing that can be overcome or will it result in a deterioration or modification of this fundamental value? A coupled socio-cultural and ecological systems perspective would be the beginning for undertaking an analysis and developing a response to the severity of this challenge.

## 2.2 Case 2: Human ecology of the Kyrgyz and Wakhi

### 2.2.1 Context and method

This case study is adapted and abridged from Kassam (2009c). The Wakhi and Kyrgyz live in the Wakhan corridor bordering China to the east, Tajikistan to the north, and Pakistan to the south (Fig. 3). In 2006, interviews were conducted in small groups with the Kyrgyz at their Summer camp of Tashbulaq (approx. 4000 meters above sea level) and Wakhi in the villages of Sahrad-i-Brogil (approx. 3297 meters above sea level) and Wuzd (approx. 2901 meters above sea level), Afghanistan. In total, 21 individuals (all male) were interviewed as part of this preliminary research initiative. In the course of these interviews survival based

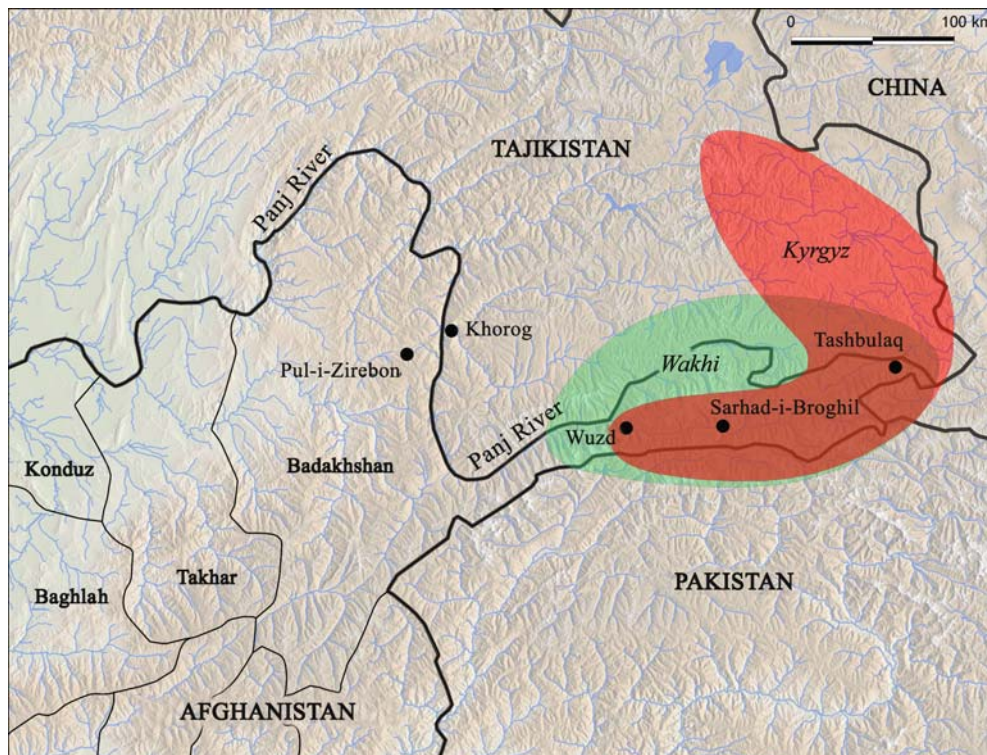


Fig. 3 Map of Kyrgyz and Wakhi

in mutual support between ethnic groups in response to the uncertainties of war and socio-cultural and environmental change became apparent. In 2008, follow-up interviews were undertaken in each of these villages to validate the information from 2006 and pursue the linkage between coupled socio-cultural and ecological systems. This time interviews were conducted with 47 individuals including both men and women. The iterative nature of the interviews enabled examination of the interconnections between socio-cultural and ecological systems. This research also draws upon previous work undertaken by Shahrani (1978, 1979), Kreutzmann (2003), and Felmy and Kreutzmann (2004).

While the Wakhi consist of sedentary farmers who keep some animals, the Kyrgyz are nomadic and utilize large pastures for grazing their animals. The Wakhi, a distinctive ethnic group, undertake irrigated crop farming in valleys between 2500 and 3500 meters above sea-level growing wheat, barley, millet, peas, and potatoes. Potato harvest is not reliable in villages at higher elevations, such as Sarhad-i-Brogil. Often many of the poorer households who do not have sufficient grain for the entire year have to decide between using up the store of grain for seeding in the next season or for food to meet their immediate needs. The Kyrgyz, another ethnic group, are largely nomadic pastoralists located in high pastures valued for spring and summer grazing of their animals that comprise mostly of sheep and goats (because they are highly marketable), yaks (for local consumption and transport), and horses, donkeys, and camels (for transport of supplies). The mobility of the Kyrgyz optimizes the ecosystem services they draw upon. A combination of relatively longer periods of high-altitude grazing in the spring and summer with shorter time for grazing in low-lying areas in the winter enables utilization of natural resources in dispersed locations. Whereas, the Wakhi, whose mixed farming and mountain agriculture provides an advantage in fodder production for their animal herds in the winter, utilizes high Mountain plateaus as pastures in the summer. Proximity of pasture lands and overlap of land-use in the spring and summer requires an understanding between the two communities for sharing common resources. In short, the two communities occupy a distinct ecological niche that overlaps seasonally.

### 2.2.2 Findings

The connectivity between the Kyrgyz and Wakhi is facilitated by the diversity of socio-cultural and ecological relations. Diversity, therefore, is complex; it exists not only at the level of ecological habitat in terms of livelihood and ethnicity but also in language and religion. Linguistically, Wakhi belongs to the Pamirian language group related to Indo-Iranian family of languages, whereas Kyrgyz belongs to the Altaic group related to Turkic family of languages.

The Kyrgyz are Sunni Muslims, and the Wakhis are Shia Ismaili Muslims. Kyrgyz and Wakhi habitation in the Wakhan corridor of the Pamir was not a free choice but a historical process of various groups competing for strategic control of resources. Overtime, the Wakhi, who adhere to a Shia Ismaili interpretation of Islam faced persecution at the hands of various Sunni groups invading and occupying the region. Similarly, the Kyrgyz have undergone a process of marginalization at the hands of the Mongols, in the past, and the nation state, more recently. According to Shahrani (1979), the Kyrgyz historically have experimented by moving from nomadism to sedentary agriculture back to nomadism as they sought to adapt to changing political authority. The “Great Game” resulting first from the colonial aspirations of Britain and Russia and then the imperial machinations of the West and the Soviet Block gave impetus to “closed frontiers”, thereby limiting movement and trade along the Silk Road. Given the context of long-term warfare, hegemony of a narrow interpretation of Sunni Islam under the Taliban, limited arable land in mountainous regions, and religious and ethnic differences, one would expect that this part of the Pamir would be ripe for conflict. However, it is precisely this diversity that enables these two communities to engage in close socio-cultural and ecological relations that ensure each other’s survival (see Table 1).

The Wakhi grow wheat and barley that they trade with the Kyrgyz. They also mill the grain into flour for the Kyrgyz. The Kyrgyz for their part respect the pasture lands of the Wakhi and trade animals with them in return for food. The Kyrgyz also trade rope, hide, and other items manufactured from their herds. The Wakhi also obtain tea, salt, oil and other items from the south and occasionally act as middlemen for the Kyrgyz. The Kyrgyz employ poorer members of Wakhi households to tend to their livestock and give remittances in the form of animals. This generates strong relations between neighbors. By using specialization of ecological niches, these two different Muslim cultures ensure resilience and the common good. When they are in each other’s territory, hospitality is extended, and they live at each other’s homes while securing supplies and engaging in trade. The plurality of difference in terms of religious, cultural, and ecological niche is respected and seen as an asset. These groups also share religious shrines drawing inspiration and comfort from their own interpretation of Islam. These groups have used their ecological context, as well as religious and cultural diversity, to resist the homogenizing tendencies of narrower interpretations of Islam.

### 2.2.3 Discussion: Socio-cultural and ecological implications

Adaptation to change takes place with multiple systems interacting, thus illustrating the interplay between the interdependence of the socio-cultural and ecological systems.

**Table 1** Comparative summary of Kyrgyz and Wakhi

	Kyrgyz	Wakhi	comparison
religion	Sunni	Shia Ismaili	religious distinctiveness
language	Kyrgyz	Wakhi	cultural distinctiveness
profession	nomadic pastoralists	sedentary farmers with livestock	Kyrgyz are pastoralists and Wakhi are sedentary farmers who keep animals
trade Items	goats, sheep, yaks, and other livestock; and manufactured items such as rope and hide produced from their herds	wheat, occasionally items from southern markets such as salt, tea, and oil	the Kyrgyz and Wakhi have items from southern markets to trade
employment	employer	employee	the pastoralists are employers
habitat (location)	highlands: nomadic use of seasonal high-elevation mountain pastures and valleys	highlands: valleys and villages of Sarhad-i-Brogil and Wuzd with and seasonal use of high mountain pastures	seasonal overlap in niche occurs between the Kyrgyz and Wakhi
elevation	3500–4000 m	2500–3500 m	the pastoralists are at higher elevations but not always

When cultural values of a group or community are retained and practiced, they manifest themselves through individual action in a social context (Sorokin, 1962; Geertz, 2000). If there is synthesis between the cultural system and social structure, conflict is avoided. The case of the Kyrgyz and Wakhi is informative because their milieu is rife with conflict yet their approach is pragmatic as they negotiate human ecological relations with a practical wisdom that helps secure their livelihoods. The interdependence between the Kyrgyz and Wakhi is not limited to economic self interest. This interdependence is not only an outcome of a materially determined calculus but an organic engagement of diverse cultural systems and social structures in the context of varied but overlapping ecological zones. Trust and confidence sustain this interdependence (Smith, 1976). It is noteworthy that the notions of “diversity” and “pluralism” are part of the lexicon among the ethnically varied Muslims in the Pamir Mountains of Central Asia. A geological cross-section of religious history in the Pamir Mountains reveals the presence and ongoing influence of indigenous beliefs, Zoroastrianism, Buddhism, and multiple interpretations of Islam. Instead of weakening the foundation of social life, a lack of homogeneity in the religious sediments of the people of the Pamirs contributes to a pluralistic cultural fabric that enables resilience and facilitates survival. For instance, the ethnically diverse Shia Ismaili Muslims, which include the Wakhi as well as several other groups in both Afghanistan and Tajikistan, have specific words for cultural diversity and pluralism. Co-emergent with the waning of Soviet power, strengthening of Taliban power, and increased outside contact in the 1990s, they use the words *chandandeshi* (meaning “several opinions”) to refer to diversity and *gunoguni* (meaning “varieties”) to refer to pluralism. In addition, a long and sustained history of the Silk Road in this region speaks to development of institutions that facilitated difference and negotiated conflicts. Despite, the interruption of “closed frontier,”

this history is part of the consciousness of the inhabitants of the Pamirs. Furthermore, the continuing practice of sharing sacred sites (mazars) between the religiously and ethnically different and ecologically varied professions of the Kyrgyz as herders and Wakhi as farmers speaks to the historic nature of its roots. The practice of pluralism in the context of the Pamir refers not only to economic need but a socio-cultural awareness that extends to ecological niche.

### 3 Conclusions

Indigenous communities in the Circumpolar Arctic and the Pamir Mountains of Afghanistan and Tajikistan have been subjected to dramatic change. Within a span of just a century, only two-to-three generations, these regions have directly experienced colonization; resultant epidemics; cultural and socio-economic dislocation because of their strategic location in the Cold War; penetration of the market system; famine; natural resource extraction; and, presently, they are at the vanguard of climatic change and the so called “clash of civilizations” (Huntington, 1996). Their survival and continued existence under these conditions speak to their agency and the resilience of their socio-cultural and ecological systems. The communities in the Circumpolar Arctic and Pamir Mountains of Central Asia are both replicates and contrasts. They are replicates because of the nature of the change these regions have faced over a period of 100 years and the current challenges related to climatic variation, natural resource development, and food sovereignty. These cases provide opportunities for contrast because of the cultural and ecological diversity of the regions. The cultural background of indigenous peoples in the Arctic is largely hunting and gathering, whereas in the Pamir Mountains, it is mostly pastoral and agricultural. The replicate nature of the case studies provides the basis for identification of linked socio-cultural relations, and the contrast allows for



robust understanding of these relations in day-to-day life of communities under strain.

The case of the Iñupiat illustrates how the depth of knowledge of sea-ice contributes to food security. Similarly, the example of the Kyrgyz and Wakhi shows how ecological roles of each community combine with social interactions to enable food security. Ecology is at the foundation of survival. However, the way in which in these specific processes of survival are achieved requires the inclusion of a socio-cultural understanding. Both case studies illustrate that cultural values inform ecological interactions, and in turn, ecological interactions reinforce cultural values and social relations. For the Iñupiat, this is related to sharing the fruits of the bowhead whale hunt with the entire community. Among the Kyrgyz and Wakhi, this is related to trade. To divide the socio-cultural from the ecological, that is, the Iñupiat from sea-ice or the Kyrgyz and Wakhi from their respective eco-zones, leads to a myopic perspective and the inability to respond effectively to relevant and pressing issues, such as habitat conservation, food security, and climate change.

The overarching argument of this paper is that understanding of critical environmental issues necessitates integration of the cultural and social with the ecological. Resolution to practical issues of concern, which may be as diverse but fundamentally related as climate change and food security, demands sensitivity to interdisciplinarity, where local as well as institutional banks of knowledge are valued and utilized. As these two case studies illustrate, adaptation to change is an outcome involving complex socio-cultural and ecological systems. Cultural values, social structures, and ecosystems services facilitate adaptation. In short, conservation requires an interdisciplinary perspective and socio-cultural factors are a fundamental part of ecology.

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