RHYTHMS *of the* LAND

Indigenous Knowledge, Science, and Thriving Together in a Changing Climate

by Karim-Aly S. Kassam, Daler Kaziev, Leo Louis, Morgan Ruelle, and Anna Ullmann

In partnership with the communities of Sary Mogul (Kyrgyzstan), Savnob (Tajikistan), Roshorv (Tajikistan), Oneida Lake (USA), and Standing Rock Sioux Nation (USA)

Logo Credit: Natani Notah, Karim-Aly Kassam, Anna Ullmann

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Karim-Aly S. Kassam

Professor and Principal Investigator

Sary Mogul
Community Members

Kubanych
Aitmamatov

Mansur
Aliev

Ubaidylda
Jaanbaev

Mamatibraim Joldoshbaev &
Tajikbai Syiymkulov

Sajida
Joldoshova

Aidaraly
Joljakshiev

Kuduret Jorobekov

Babanazar
Karimov

Toktomamat
Kenjebaev

Kanataly
Kenjeev

Altynbek
Kharybekov

Rafshan
Korgonbaeva

Karybek Kulatov

Abdilashym
Kurbanov

Zulaika Kyiasova

Ainura Adaham
Kyzy

Abdusamad
Mamatazimov

Uulcha Najimidinova &
Murat Satybaldiev

Sary Mogul
Community Members (cont.)

Mamatumar
Narmamatov

Baktygul
Narmamatova

Abdulashim
Nishanov

Danyar
Nurmamatov

Kudayar
Nurmamatov

Kadyrali
Orozaliev

Kochkonbai
Orozaliev

Muratbek
Orozaliev

Tokur
Orozbaev

Adalat
Rahimberdieva

Berdikul
Saitov

Altynbek
Tabanov

Abdilla
Tashbekov

Adalat
Tashkulova

Taalaibek
Tashtanov

Buunisa
Termechkova

Myrzakarim
Tilemishov

Bashir
Toktobaev

Kokonbek
Tokurov

Sary Mogul
Community Members (cont.)

Sainazar
Turdiev

Mamatjuma
Uulu

Kharbek & Aynisa

Introduction

Why is Collaborative Research Important?

This is a narrative of collaboratively generated insights for the diverse communities where we undertook research. Therefore, the audience for this collection are these communities and those who seek to work with them. It shows the human-ecological relationships that underpin their food and livelihood systems. As a result of several decades of applied and participatory research, we have learned from many Indigenous and rural societies at high altitudes and latitudes that their food and livelihood systems are fundamentally dependent on their habitat. The relationships that arise from this connection to their respective environments inform their sense of self, cultural system, social structure, and even notions of the sacred. The ecosystem is the basis of these complex, sophisticated, and mutually beneficial interactions. Unlike the thinking that has informed the European Enlightenment and Industrial Culture, these societies do not perceive their existence outside their habitat. They live *within* the planet not just *on* it. Their sacred stories describe how they are *living through* the environment not *from* it. Although characterized by outsiders as remote locations, they see their habitat as a homeland in which to engage in the process of living. Indigenous and rural societies thrive in their habitats because of their connections with other living beings, human or otherwise. This dynamic and complex web of relations informs their identity and livelihoods and brings unity between their informational and physical environment. As such, there is no separation between mind and body because both exist because of and within an ecological space. Their homeland is not a frontier to be conquered and whose riches are to be extracted. This complex connectivity stands in stark contrast to the utilitarian or instrumental approach of industrial civilization, which views the land and waters teeming with life as *objects* for exploitation. Sadly, this dominant point of view has brought us to where we are today. The devastating impacts of anthropogenic climate change imperil the whole of humanity, including Indigenous and rural societies that have contributed least to its causes.

Over several years, as we have undertaken applied research in collaboration with Indigenous and rural societies, it has become clear that while their ecological professions may differ (such as hunters, fishers, farmers, herders, orchardists, and even tourism operators), the impacts of climate change bear similarly devastating effects on their overall food and livelihood systems. Whether it is late formation of sea-ice affecting hunting of marine mammals in the Arctic or unusual climatic variation impacting farming and herding communities of the Pamir Mountains, food security and livelihoods are increasingly being threatened.

The effects of anthropogenic climate change are causing debilitating anxieties because of the inability to anticipate so that communities can adapt. This anticipatory capacity to envision the next season or year and pragmatically consider future possibilities is essential for maintaining effective and sustainable food and livelihood systems. Furthermore, this instability will have immediate impacts on urban and sub-urban communities in the long-term owing to their dependency on the fruits of the lands and seas to sustain large

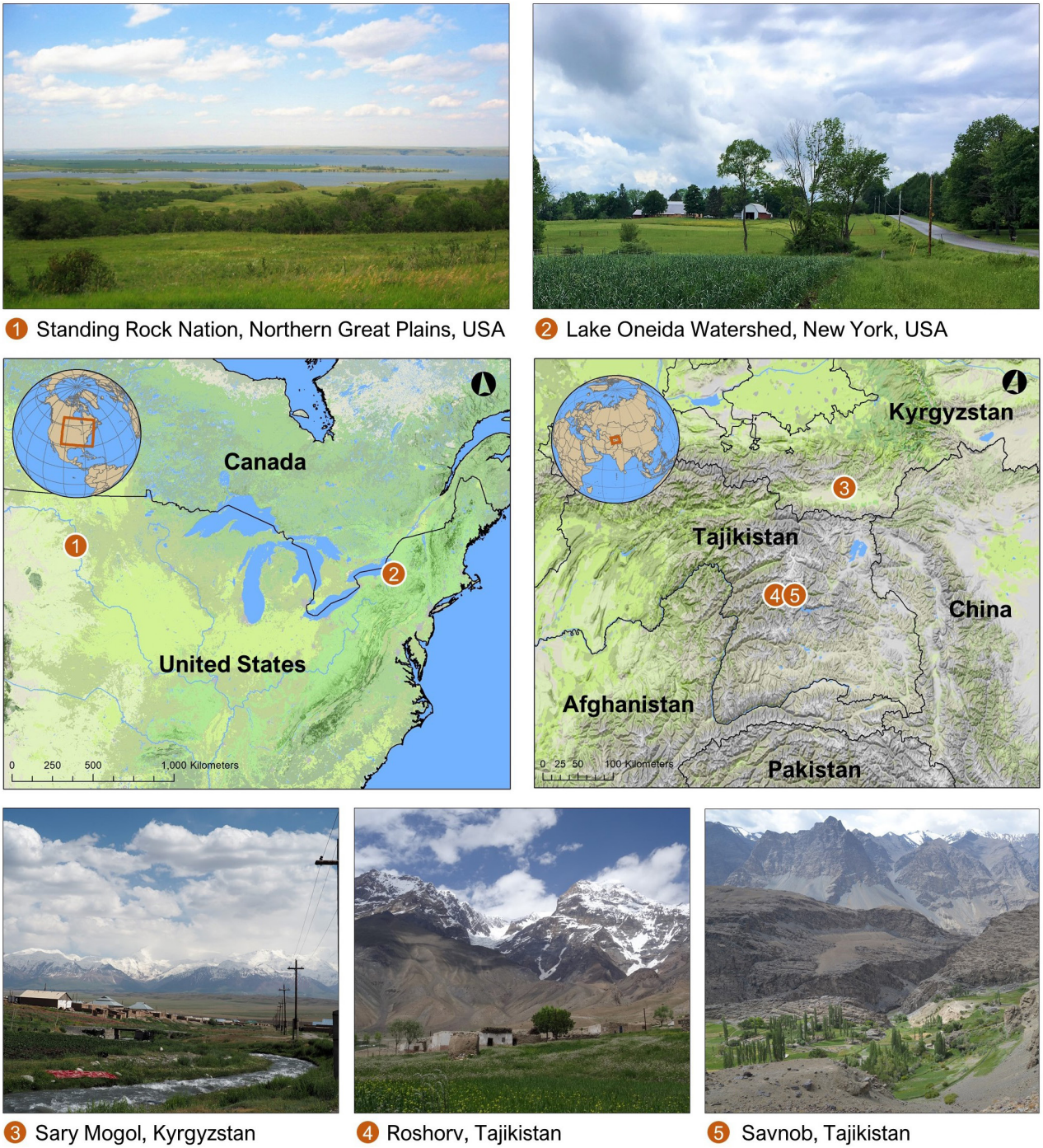


Figure 1.1: Research Context in Central Asia and North America

populations. Yet Indigenous and rural societies, which have faced the harmful impacts of colonization and now suffer the vagaries of global market and command economies, do not view themselves as mere victims. They recognize their own power and understand that while weakened by industrial domination of communist, socialist, or capitalist systems, their ecological knowledge and stewardship practices have enabled their survival for centuries if not millennia.

Rhythms of the Land Displayed Through Ecological Calendars

It is here that this work begins. It is grounded in the ecology and culture of the peoples with whom we are working. Historically, Indigenous and rural societies have developed and utilized *ecological calendars* to anticipate and then adapt to the changing rhythms of the seasons. Ecological calendars are knowledge systems to measure and give meaning to time based on close observations of one's habitat. They reveal seasonal indicators that integrate ecological phenomena (such as the first snowfall, the last frost, the flowering of a tree species, the sound of ice breaking, the appearance of an insect, or the arrival of a migratory bird) with cultural systems. Understanding these relationships has enabled Indigenous and rural societies to anticipate weather and other seasonal processes and thereby, adapt and coordinate their livelihood activities appropriately. These communities use ecological indicators to guide their actions to inform not only their food systems but also cultural events because these activities are fundamentally integrated into and are mutually reinforced through their daily lives.

We present our findings from five diverse geographical regions, ecological contexts, and cultural milieus (Figure 1.1) of Indigenous and rural societies in the Pamir Mountains of Kyrgyzstan and Tajikistan, as well as the Standing Rock Sioux Nation and Oneida Lake Watershed in the United States of America.

The communities that participated in this project have long-standing collaborative relations with researchers, which allowed for the mutual development of trust and understanding. This also enabled honesty during challenging moments. Given the geopolitical history where each of these communities is located, collective trust was fundamental to any research undertaken by us and key to addressing their priorities and concerns. In addition, these communities are at the forefront of anthropogenic climate change thus creating a sense of urgency for very practical and ethical reasons.

Our Collaborative Research Approach

The research problem guides the process of how we undertake research. In this case, we are seeking to build anticipatory and adaptive capacity to the effects of anthropogenic climate change at the level of specific communities. Therefore, an effective strategy must involve those affected by engaging their particular cultural and ecological systems and collaborating with their social institutions. In other words, the question of how to build anticipatory capacity and develop adaptive strategies drives the methodological approach. An adaptation strategy for any kind of change must be grounded within the local ecological and cultural contexts if it is to be effective in the long-term. An outside fix is neither relevant nor sustainable, and therefore, not appropriate.

Such an approach confounds single disciplinary expertise and demands collaboration among individuals with diverse expertise including the social, physical, and ecological sciences as well as the humanities. Collaboration is foundational because locally-grounded insights are achieved through participation of relevant professions such farming, fishing, gathering, herding, hunting, tending to orchards and so on.

To achieve this, we undertook a participatory research process that facilitated the cogeneration of insights. The first step was partnership formation through the use of local workshops (Figure 1.2). Except for the Oneida Lake Watershed, which encompasses rural Euro-American settler communities, we approached both the secular leadership (such as a tribal leader or village organization president) and spiritual leaders (such as Elders or *Khalifas*) to establish a partnership. Once there was an agreement to work together, we invited various participants who represented the different and wide-ranging knowledge found across the community based on advice of the leaders. However, partnerships with communities are not formed in a vacuum. Collaborative activities through workshops grounded in the reality of the community, anchor and cultivate this relationship. As a part of a community gathering involving a meal, our first collaborative research action was to develop a seasonal round. It forged our partnership.

Figure 1.2: Steps in the Iterative Research Process

Seasonal rounds are verbal articulations and visual representations of a community's sociocultural relations with their habitat. They express knowledge from engagement with spatial and temporal aspects of ecological cycles through the seasons. The spatial dimension speaks to the occupancy of landscapes used by the community. Movement across their habitat such as moving herds to summer pastures, ploughing farmland in the spring, or undertaking ice-fishing in the winter, convey the spatial dimension of the seasonal round. The temporal dimension is expressed through seasonal indicators that inform the timing of these activities, including herding, farming, or fishing. Articulation of a

seasonal round begins with broad questions such as 'How do you know that winter has ended and the next season has begun?', 'How many seasons are there?', and 'What are the names of those seasons?' As the discussion flows and deepens, the researcher serving as a facilitator gears their questions toward the specific ecological professions in the community, taking into account their distinct sociocultural and ecological contexts.

The process of articulation and physical representation of a seasonal round creates a common vocabulary and understanding among those participating in the research process. It builds mutual respect for different ways of knowing between those who are engaging in the inquiry and those who are engaging in the practice; namely, the researchers and the communities. In addition, it identifies specific avenues for further research and identifies topics to be explored through semi-structured interviews.

Finally, as seasonal variation is a reality upon which food and livelihood systems depend, this participatory process generates initial insights into: (1) a specific community's relationships with their habitat; (2) the divergent impacts of climate change upon them; and (3) locally appropriate adaptation strategies to respond to the emergent climate crisis.

After the seasonal rounds were developed, the research team lived within the communities to undertake semi-structured interviews and observe livelihood activities. This research on human ecological relations was undertaken through individual or group interviews as well as observation of livelihood activities in agricultural fields, pastures lands, fishing sites, and homes of community members.

Having compiled and analyzed the information gathered during workshops, interviews, and field observations the research team returned to each community to undertake validation of human ecological research findings at a second community workshop (Figure 1.2). Again, the secular and spiritual leadership were involved in gathering individuals to share a meal while discussing and developing a much more detailed and precise seasonal round. The researchers would ask general and specific questions to ensure an accurate understanding of the seasonal livelihood processes, examine the accuracy of the analysis, engender further discussion, add new insights, and as necessary, identify further research.

This iterative process tests the credibility of the cogenerated knowledge. It also sets the stage for identifying specific seasonal indicators for use in ecological calendars to anticipate climatic variation. Once this process was completed, the research team would analyze the information gathered for insights and indicators to be used to develop ecological calendars (Figure 1.3).

A final series of validation workshops to review each ecological calendar was planned as part of the iterative research process (Figure 1.2). However, due to the COVID-19 global pandemic these workshops were delayed. Nonetheless, under strict public health guidelines, a validation workshop was carried in July 2021 with community members in the Oneida Lake Watershed. Again, a meal was served while the draft ecological calendar was reviewed in detail and modifications made based on in-depth discussion.

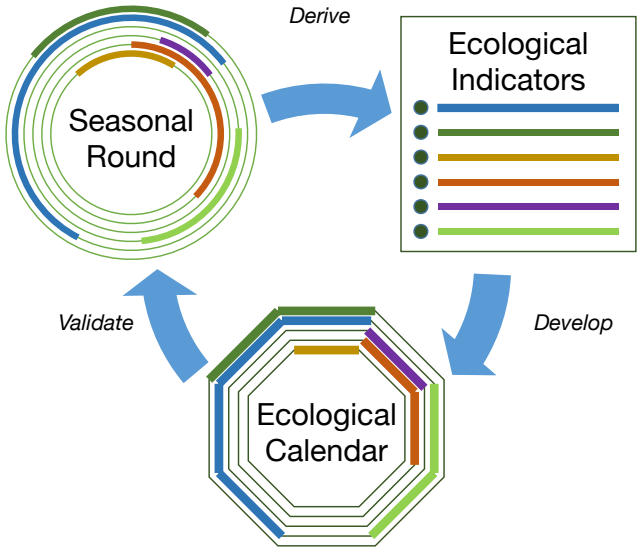


Figure 1.3: Collaborative Process of Developing Indicators for Ecological Calendars

This report is an organic outcome of the interaction between the research team and respective communities. Therefore, we have built-in flexibility – the electronic version of this report can be updated and changed after validation of the ecological calendars by the remaining communities and new insights may be added. Therefore, the long-term impacts of COVID-19 on our research process are mitigated by the strength of our collaborative relationship and the use of technology.

Diversity of Ecological Calendars

In the next sections, collaborative insights and ecological calendars are provided for the villages of Roshorv and Savnob in the Bartang Valley of Tajikistan; the village of Sary Mogul in the Alai Valley of Kyrgyzstan; the Oneida Lake Watershed in upstate New York, USA; and the communities of Bullhead, Cannon Ball, Fort Yates, Kenel, Little Eagle, Porcupine, and Wakpala in the Standing Rock Sioux Nation in North and South Dakota, USA.

The notion of an ecological calendar is universal and simultaneously particular. These calendars are diverse for obvious reasons. The first is tragic, reflecting the historical injustice of colonialism, war, and cultural genocide facilitated by dominant communist and capitalist colonial ventures that these various Indigenous and rural communities have experienced. In fact, anthropogenic climate change is, arguably, a result of instrumental industrialism across the entire planet and its peoples. In the Pamir Mountains as well as in the Standing Rock Sioux Nation, the impacts of the colonial legacy have been felt on the application, transmission, and utilization of Indigenous knowledge.

The second is that these calendars reflect the diversity of ecological professions, cultural systems, and ecological contexts. As described above, communities who see their habitat as a homeland in which to engage in the process of living share the notion of ecological calendars. However, the power and efficacy of these calendars are derived from their context-specificity because they facilitate anticipatory and adaptive capacity in a distinct sociocultural and ecological setting.

Even with its concomitant elements of historical colonial and environmental injustice, this diversity bears witness to Indigenous and local knowledge, and the agency of these respective communities in the third millennium to continue to demonstrate the relevance of their ontology or way of living. While reflecting the unique knowledge and strength of each community, this collection also puts into conversation the diversity of challenges these communities face. For instance, in the ethnic Bartangi villages of Roshorv and Savnob in the Pamir mountains of Tajikistan, where we first learned about the use of ecological calendars, the community engages in subsistence tilling of the land and orcharding at high altitudes and have some animals that they take to pastures. In contrast, the ethnic Kyrgyz village of Sary Mogul in the Pamir Mountains of Kyrgyzstan is primarily a herding culture with some cropping activities mainly potatoes for food and barley for fodder. At Oneida Lake, residents are settled in five counties within the Watershed pursuing a variety of livelihoods including farming and dairy production. In addition to their daily employment, many residents engage in fishing, gathering, hunting, orcharding, trapping and so on. However, these activities are not primarily subsistence activities as in the villages of the Pamir Mountains of Kyrgyzstan or Tajikistan. Finally, the Standing Rock Sioux Nation in North and South Dakota emerges from a painful history of cultural genocide and forced migration. The construction of the Oahe Dam destroyed the region's floodplain forests. The remaining lands in the Standing Rock encompass cultivated croplands, grasslands, hayfields, and pastures. As such, the differences among these communities are not a point of departure but rather a moment for mutual engagement to identify common options and to learn from each other.

Alai Valley, Kyrgyzstan

Sary Mogul

Figure 3.1: Sary Mogul in the Alai Valley

Sary Mogul
Alai Valley, Kyrgyzstan

Context

The village of Sary Mogul is in the Alai Valley of southern Kyrgyzstan at an elevation of around 3100 meters above sea level (Figure 3.1). The local livelihoods depend predominantly on herding and some farming practices. Community members engage in animal husbandry raising yaks, sheep, goats, and cows as well as grow crops like barley as fodder and potatoes for human consumption. Throughout the year, villagers are engaged in making livestock and crop related decisions. However, changes in the timing and severity of snow cover, and other shifts in seasonal weather patterns influence their livelihood activities.

It is commonly believed that Sary Mogul is a community of Kyrgyz from Tajikistan, who recently settled in the Alai Valley. However, the Alai Valley had been pastureland for several tribes before Soviet colonization of the region. Sary Mogul is not a homogenous village. Historically the village is formed of tribes from many ecological zones. For example, tribes arriving from lower part of Alai Valley, where barley and potatoes have long histories of cultivation, are experimenting with alternative crop cultivation in upper Alai. The inhabitants have various professions such as teachers, doctors, drivers, entrepreneurs, and veterinarians which supplement their income and support their activities on the land. Thus, Sary Mogul represents the ecological knowledge of those who arrived from surrounding areas and have adapted their knowledge to the climatic conditions in the Alai Valley.

Following the collapse of the Soviet Union, communities in the Pamirs of Central Asia faced food shortages. After the fall of the integrated Soviet planned system, which included state provisioned food systems, communities faced challenges in terms of self-reliant food production. Communities also faced uncertainties about decision making due to a shift from top-down decision-making systems in the Soviet times to bottom-up decision-making systems in the absence of governance structures and an emerging civil society. In the aftermath of the food crisis in the Alai Valley region (1998-2000), the Aga-Khan Development Network (AKDN) piloted several potato projects. Seed was brought from Chelpek Village farm, near Yssyk Kul Lake of Kyrgyzstan. Chelpek Village is located at a similar elevation, and it was hoped that these potatoes would grow in Sary Mogul. Some seed potatoes were brought from Jar-Bashy (at the western end of the Chon Alai Valley), Kyrgyzstan, and others from Suusamyr, a 3000-meter-high valley between Osh City and Bishkek City. Seeds were also brought from Ishakshim (Wakhan Valley) in Tajikistan and planted in Sary Mogul. Some of these potatoes mature in 60 days, others in 90 days. Successful potato growth depends on sunlight, soil quality, and use of livestock manure. These local experiments with seed potato varieties informed adaptation strategies for the community. The ecological calendars project seeks to build on these and other projects, by focusing on the development of anticipatory capacity, further supporting adaptation strategies.

Ecological Calendar for Sary Mogul

The Ecological Calendars and Climate Adaptation Project (ECCAP) to help build anticipatory capacity to climate change began in 2016 with the initialization workshop described in the Introduction (Figure 3.2).

Figure 3.2: Developing the Seasonal Round in Sary Mogul Village, 2016

The ecological calendar of Sary Mogul contains an enormous amount of local knowledge. This community report highlights two essential uses of ecological calendars: seasonal livestock management and crop harvest which will be discussed below. The ecological calendar supports seasonal livestock herding and crop related decisions by contextualizing the timing of livelihood activities within the local ecology and season. Changes in the timing of snow fall, and the duration of snow cover are critical for herding activities as it determines when to move livestock between grazing pastures. Due to changes in the timing and duration of winter weather, the availability of fodder in spring has become an issue. Herders rely on fodder to sustain livestock through the winter. For example, people reported that in some years the grass is not growing as high as it did in the past, especially during the summer rainy season. People associate the low productivity of grass with more snow in winter and lack of favorable weather conditions in summer. In addition, shifting times of snowmelt is creating pressure on the availability of fodder grass. If snowmelt occurs late, the community is at risk of running out of the stored fodder, especially during the lambing season. This was the case in 2016. Therefore, the ecological calendar may help to secure lambing in the spring. The revitalized ecological calendar aids in deciding when to plant potatoes and when to harvest them based on the local knowledge of appropriate biophysical conditions. The ecological calendar, thus, points out existing uncertainties and helps to anticipate changes related to crop harvesting. This community report includes a description of the

revitalized ecological calendar for Sary Mogul. It describes how the calendar can contribute to herders' decisions and seasonal mobility, which is dependent on the duration of snow cover in winter, snow melt in spring, snow free times in summer and accumulation of snow in autumn. Sary Mogul's ecological calendar is attached at the end of this chapter. Please read the subsequent sections along with the ecological calendar for Sary Mogul (Figure 3.10).

Seasonal Livestock Cycle

Keeping livestock is an essential livelihood represented in the calendar of Sary Mogul village. There are four distinct seasonal migration patterns such as *baarloo* spring, *jailoo* summer, autumn *kyzdoo,* and *kyshtoo* winter in the ecological calendar. Temperature related events such as snow cover change is a vital cue that informs seasonal rotation of livestock. For the herders, these migration patterns, and events such as snow accumulation (autumn), snow cover (winter), snowmelt (spring), and snow free (summer) are extremely important to anticipate when to move livestock between pastures.

Throughout the winter (November to April), herders keep their livestock (specifically cows, goats, female yaks, and sheep) in the village, which is known as *koldo-karoo.* During this period people hand-feed livestock because there is no access to grazing lands due to deep snow in the upper Alai Valley. The period of hand feeding livestock depends on the period of snow cover. In other words, this period is determined by when snow accumulates, how long it remains, and how long it takes to melt. All of this is anticipated through local observations. The arrival of snowfall is typically expected between late September to early November; however, this timing has been changing. As snow accumulates, it prevents animals from grazing in the vicinity of the village. Therefore, the animals are sheltered and hand-fed in the barns until the snow melt in April.

As the snow disappears in spring (depending on snowmelt period), livestock are herded near the open grass fields both around the village and further away (depending on snow-free area). That short period of livestock herding (April to May) is called *kezuu*, which means to graze the livestock around a stationary camp. During this period, herders pay careful attention to temperature related cues like *guur-tyshty* (ice melt along the rivers), *ala-telek* (appearance of white and black snow patterns in the fields), and *sary-kar* (the arrival of the last yellow snow). White and black snow patterns (created by bare patches of ground being revealed by melting snow) determine the departure of winter, and arrival of spring. These cues inform when to initiate activities like moving livestock into the fields. This period of herding livestock around the village does not last long depending on when winter ends and when spring begins.

Depending on the snowmelt, herders then take their livestock to the *jailoo* summer pastures. According to the ecological calendar, summer begins when *kok chykty* grass emerge. After which, *kok kubuu* livestock start grazing the newly emerged grass. Herders in Sary Mogul observe that livestock (cows, female yaks, goats, sheep) favor grazing upon fresh spring grasses as opposed to stored fodder. Herders then decide when to take their livestock to the summer pastures by observing snow melt in the pastures that are located at the southern Zaalai Range and the northern Alai Range (Figure 3.1). If herders remain in the village, managing livestock becomes impossible as new growth of barley will be in danger of being grazed by livestock. However, if it is too cold and snowy in the summer pasture valleys where they hope to graze livestock, then they must wait for the right time.

For herders, the summer is a time when more food is being produced. Throughout the warmest season (May to September), livestock produce dairy products. The period from April to October is known as *ak-chykty* (milk products). From March to October, food produced by livestock, especially dairy products (*syt* - milk, *ayran* – yogurt, *kaimak* - cream, *kurut* cheese, *saamal*- horse milk, *kymyz*- fermented horse milk, *karyn mai* - butter, *sary mai* yak butter, and *syzmo,* processed yogurt), are eaten, processed, and stored in

Figure 3.3: Women from Sary Mogul Processing Dairy Products in the Pastures for Use in the Autumn, Winter and Spring. Photo credit: Karim-Aly Kassam 2016.

cold places. Dairy products are processed and stored in summer for consumption through to the following spring, especially in April and May. This period is known as the long yellow *uzun sary* (starvation period). Thus, from April to September, it is crucial to take advantage of the short growing season.

In early September when the *jailoo* summer pasture season ends, herders return to the village with their flocks to continue *kezuu* from late August to mid-September. The arrival of autumn is associated with the changing behaviors of livestock. In late August, livestock stop grazing in the higher pasture lands, and they descend to lower elevation fields due to decreasing temperatures. With the cold the livestock start to leave higher pastures even if grass is still available. This livestock behavior is called *otko-kachat*. An unexpected sudden frost during this time can threaten the herd.

Another vital decision for herders during the autumn is livestock breeding. As the winter approaches in October and November, the herders time domestic sheep breeding to plan for *baargi tol kiret* (spring lambing) in March and April. Currently, October seems to be the best time to breed sheep, because herders must be certain that lambing in spring takes place when temperatures are warmer. There is no fixed time for breeding, but people must consider the temperature changes in spring when breeding in the fall. The villagers allow for 5.5 to 6 months when breeding sheep. For example, if they breed in August, the livestock will lamb in March. When the herders return from summer pastures, and the temperatures are dropping (October or November) they begin breeding sheep and goats (known as *kochkor koshylat*). Five months after breeding, *baargi tol kiret* (spring lambing) takes place in March or April. Although some herders undertake *kyshky tol* (winter lambing), during January and February, this is not commonly practiced. Cold temperatures during the winter, the fear of exhausting fodder reserves, and the uncertainty

of spring arrival, are the primary concerns. For example, if the winter temperature is too cold, the young lambs might not survive during January.

Another essential event in the autumn is the mating and calving season of yaks (*Bos grunniens*). According to herders, yaks are very clever and climate-sensitive animals. Their mating and calving seasons are monitored to understand the seasonal shifts. Herders pay careful attention to yak mating periods, which vary from July to November; giving birth about nine months later (specifically 256-7 days after mating). Like sheep lambing season, yak calving takes place in spring when the temperature is warmer. If yaks mate early, then it is an indicator that the spring will come early, and the year would be *jenil* – meaning not difficult. *Topoz tol* yak calving period may occur from May to mid-July, during the favorable summer season. On the other hand, if the yaks delayed their mating in fall, this is an indication of the *oor* – difficult year. Pastoralists in Sary Mogul suggested that the average yak mating time should be in early October. The Yak mating season varies year-to-year, and the late mating of yaks is not desirable in the Alai Valley-signifying shifting of seasons.

Barley and Fodder Grass

The Alai Valley is known for its rich grasslands. Villagers grow barley and *Espartset* (*Onobrychis sativa*, known as common sainfoin) in addition to fodder grasses (*Leymus secalinus, Aceae spp., and Atipa orientalis*). Barley, common sainfoin, and fodder grass are vital for several reasons. Collectively these plants are named *ot* – fodder grass. They ensure food security for livestock throughout the long winter and lambing season. Common sainfoin is a productive fodder grass that can provide 7-10 years of yield without re-planting. According to local people, barley is a top-quality fodder, followed by sainfoin, and other grasses harvested for livestock. Community members also rely on other fodder species such as *ak-bash godo* grass *(Stipa Orientalis), budai bashy* grass *(Poaceae spp.), kara-bash* grass *(Poaceae spp.),* and *kiyak* grass *(Leymus secalinus).* These are all widely grown in the Alai Valley.

Villagers follow sequences of planting and harvesting during the short growing season. As spring arrives, barley and common sainfoin are planted in late April. The right time to move livestock to summer pastures is a month after the barley was planted, when it develops *maiza* (spikelets) at the end of April to the end of May. *Maiza* or ripening time of barley is not the only cue used to determine the summer season. Barley and common sainfoin are planted in April, while potatoes are planted by mid-May. Planting cannot begin until the soil is thawed, as it is impossible to plant seeds into the frozen ground. Knowing when the ground will thaw in spring is vital for growing crops.

Throughout the summer, villagers depend on the climate for a good growing season (the taller the grass the better the yield). Depending on how much rain the area receives during the summer, barley will be irrigated 3-4 times during the growing season. The first irrigation occurs about 40 days after planting. Barley heads turning dark is a cue to irrigate. Rainy summers reduce the need for crop irrigation. However, too much rain also prevents successful crop growth. Ideally, there is a combination of enough sunlight and rain for a successful crop to grow.

As summer is coming to an end in early August, temperature related cues indicate the beginning of the harvesting season. When autumn arrives, days become colder, and a morning wind called *galdurgan shamal* occurs. People stated that this wind, in particular, indicates the beginning of autumn. The arrival of autumn is also informed by *ot-kaity* (color change in vegetation), particularly when the *ak-bash godo (Stipa orientalis)* and barley bends, stops growing, and changes color from green to yellow. Farmers also observe these changes in *ak-bash godo* grass *(Stipa orientalis), budai bashy* grass *(Poaceae spp.) kara-bash* grass *(Poaceae spp.), kiyak* grass *(Leymus secalinus),* and *at-kulak* common sorrel *(Rumex acetosa).* Quick changes of color in grasslands inform the seasonal transition from spring to autumn. Common sainfoin is harvested two times, in July and in September. Crops such as barley, common sainfoin, and natural hay

need to be collected during August to late September before livestock returns to the village. That is when grass dries, insects disappear, frosts begin, birds leave, and snow is expected. By the time snow arrives, it is crucial that people have stored fodder grass and are ready for the long winter.

Potatoes

Villagers have a small garden plot in front of their houses where they grow potatoes. Over the past two decades growing potatoes at elevations as high as 3000 meters has become possible. Although potatoes do not reach full size due to the short season, they are still cultivated, eaten, and stored for winter and spring. Some potatoes are sold in the market, and some are kept as seed for the next growing season.

The viability of growing potatoes locally, especially since 2000, is considered a positive change. However, many factors influence their successful yield. Local people have been experimenting with various potatoes varieties since 1990 and several local varieties exist: *Germansky. Picaso, Kardinal, Agava, Jele, Super Elita,* and *Chelpek.* Villagers have different perspectives on the successful adaption of these potato varieties. Villagers plant potatoes at different times in spring depending on their individual circumstances. In addition, some use fertilizers whereas others do not. The variability in growing seasons year-to-year also determines potato yields as factors such as the shifting times of spring snowmelt has created increasing uncertainty for the villagers. Further, potatoes are in the greatest danger during the harvest season, as an early frost in autumn may cause damage to the crop.

To address these challenges, we asked specific questions. How do you know when to harvest hay, barley, and potatoes? Focusing on the biophysical cues, villagers stated that they begin planting activities after the snow melts in spring, and then harvest crops before the arrival of snow in fall. However, snow melt and arrival depended on temperature changes, especially between April and May, and then August through October. For example, people start plowing and planting barley and common sainfoin when overall winter *tokson childe* ends, after snowmelt (*kar ketet*), when the earth becomes dark (*jerdin beti kararat*), and soil warms (*kerge tap kidi*) in April. Barley and common sainfoin are planted in late April, whereas potatoes are planted in early May. Changes in soil temperature varies slightly from year-to-year. The soil must become warm enough for potatoes to be planted, known as *jerge tap kirdi*. Generally, crops (barley, sainfoin, and potatoes) are planted in April through May, and are harvested in August through September.

Potatoes are also irrigated three to four times, the first occurring about 20-30 days after planting. Throughout the summer, villagers take turns irrigating plots. Each section of the village receives three-days of water flow, administrated by the village organization. Villagers also pay attention to the flowering time for different potato varieties compared to the previous year. Throughout the summer, they till the soil, creating extra space for crops to grow. They also remove extra grass that competes with the main crop.

Temperatures changing from warm to cold, play an essential role in harvesting crops, especially potatoes. Given the presence of multiple temperature indicators (e.g., insects, animals, and plants), observing co-occurring temperature-related events provides growers with valuable knowledge to make decisions. For example, potatoes are collected when frosts begin, their leaves start to drop and change color, pasturelands start to turn yellow, and when migratory birds begin to depart. Potatoes are important for the community because they provided food, income, and seed stock. Food sources such as processed or dried dairy products and especially potatoes, are stored in root cellars to be consumed during winter and spring. Most villagers harvest potatoes before the end of September. Other indicators, such as the departure of migratory birds or hibernation of marmots, may also be informative when deciding when to harvest potatoes.

Participants shared several ecological indicators, such as frost being related to the departure of migratory birds, or hibernation of marmots. The primary threat in autumn is *kyrgyek*, a sudden frost that could kill both young livestock as well as damage potatoes. The notion *kyrgyek* referred to sudden frost and the departure of the migratory birds in the Alai Valley. Early signs of frost are vital indicators for crop harvest. Participants reported a co-occurrence between bird migration and land-use activities, especially in the fall. People also stated that crops are planted only after the arrival of migratory birds, especially *torgoi* (skylarks) and another small green bird that we could not identify. The departure or return of migratory birds informs the community about temperature changes, in particular, the arrival of cold weather in the fall.

The community harvests crops relying on biophysical events in spring and autumn. Further, by observing ecological indicators of autumn, specifically observing early signs of frost (changes in the color of potato leaves and dropping of their leaves) when collecting potatoes. Villagers collect potatoes prior to arrival of cold, frozen ground, and arrival of snow, which is usually after the second week in September. Sudden temperature declines (frost and cold weather) prevent them from keeping potatoes in the soil until October. Hence, understanding ecological cues may further aid seasonal coping strategies. By observing ecological indicators that are triggered by temperature changes (e.g., cold days, frost, and drying plants), villagers may protect potatoes from sudden frosts in fall.

Working with the Ecological Calendar

The knowledge in the calendar was collected from villagers with diverse ecological professions. Therefore, it represents a variety of needs, priorities, and decisions that can be specific to individuals, but could also be common to many villagers. Some people raise horses and others are yak herders. Some people specialize in crops like barley and potatoes. Depending on the needs and priorities of decision-making in the cycle of the season, they could be looking at different cues for different purposes at different times. To demonstrate, let us situate ourselves in spring and autumn and take a few examples of how to use the knowledge in the ecological calendar.

Springs and summers are crucial seasons for livestock (sheep, horses, and yaks) breeding in the Alai Valley. For that to occur, herders consider temperature change driven cues in spring. The days must be warm enough when sheep lambing starts. Villagers also pay close attention when snow vanishes, and icicles melt. While yaks and horses mate with minimal human involvement, sheep breeding is very important for villagers in the autumn. As mentioned above, there are two practices of sheep breeding, winter, and spring. We have learned that villagers prefer to time sheep breeding for spring because they consider cues like warmer days, snow melt, and ice melt. In addition, they are concerned that sometimes fodder grass is not developed enough in the spring. Therefore, more fodder in fall might be useful to anticipate changes (shifting seasons) in spring (Figure 3.4).

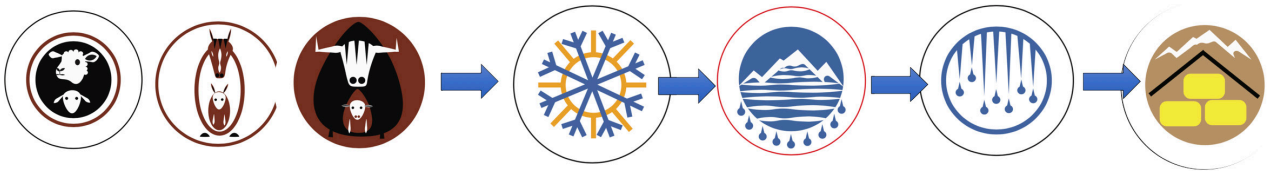


Figure 3.4: Sheep Lambing in Spring

As mentioned above and in the calendar, seasonal herding is vital to insure the wellbeing of livestock and community throughout the season. We have learned that herders pay attention to snow related changes as they move their livestock to different pastures. Snow melt in the spring informs herding livestock around the

village. As snow melts in the summer pastures, farmers take their livestock to the summer pasture during the snow free time. With temperature changes in fall and upon arrival of snow, farmers bring their livestock to the village. During the snow cover period, herders hand feed livestock in the village (Figure 3.5).

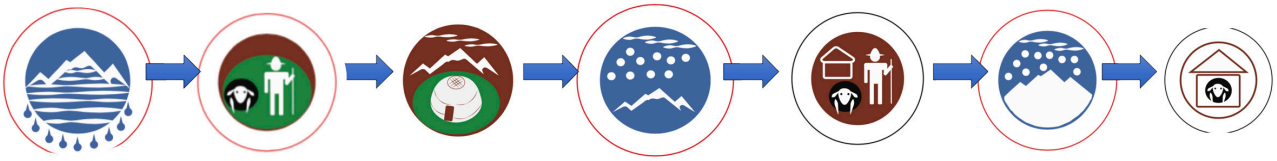


Figure 3.5: Seasonal Livestock Herding Cycle

During the short growing season, farmers do their best to grow barley, sainfoin and potatoes. Especially, potatoes are essential crops for the villagers. Farmers know the right time to plant crops by observing frosts. Then, farmers plant barley and sainfoin. With potatoes, farmers pay attention to the heat and steam coming out of soil. The soil must be right for potatoes to be planted (Figure 3.6).

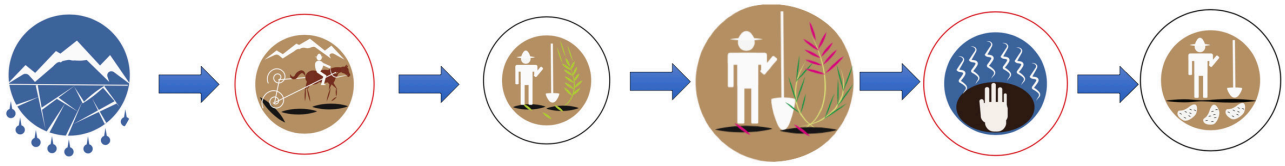


Figure 3.6: Harvesting Barley, Sainfoin and Potatoes in Spring

The use of ecological calendar in spring is not limited to one or two cues. When herders make decisions, they also consider other co-occurring biophysical events in spring. For example, warmers days (temperature change), ice-break-up in the river, emergence of flowers, waking of marmots from hibernation, surfacing of grass, appearance of insects, and arrival of migratory birds all inform of the onset of spring (Figure 3.7).

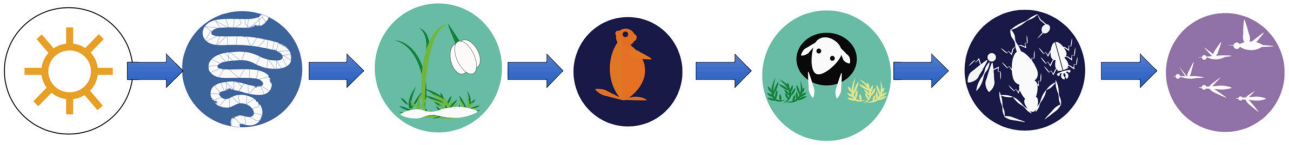


Figure 3.7: Co-Occurring Indicators in Spring

An important moment of decision making occurs with the arrival of autumn with temperature changes. People prepare to harvest hay, barley, sainfoin, and potatoes. An important indicator of autumn begins with temperature changes that drive many other changes and seasonally related human decisions. As for the fodder, villagers consider color changes in the north and south facing hills and mountain valleys. As the growing season ends, rich grass fields bend and dry. That is when farmers undertake harvesting fodder grass (Figure 3.8).

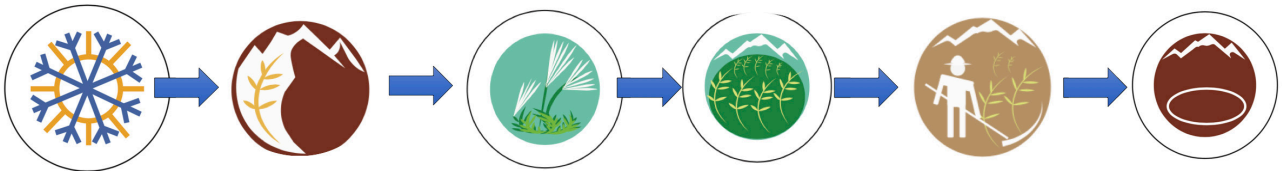


Figure 3.8: Fodder Harvest

During the harvesting season, herders do their best to store enough fodder as livestock return to the village. Farmers continue harvesting sainfoin, barley, and potatoes. One of the important weather events affecting the harvesting of potatoes is an unexpected frost. By observing early sings of frost on the grass and drying and dying potatoes leaves, farmers gather their crops. Early signs of temperature changes in the autumn are vital for a successful harvest. If not collected, frost might destroy the potatoes. By the time of ground freeze, farmers must collect potatoes and all crops (Figure 3.9).

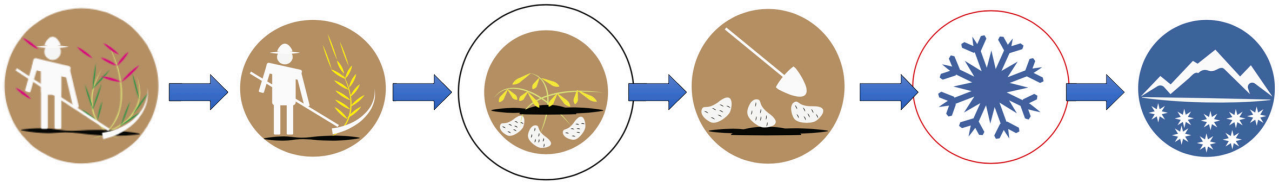


Figure 3.9: Sainfoin, Barley and Potatoes

Similarly, there are co-occurring events that are anticipated during the seasonal decision making, especially in the autumn. Villagers pay attention to the arrival of wind, departure of birds, disappearance of insects, hibernation of marmots, arrival of snow and freezing water in the rivers and streams (Figure 3.10).

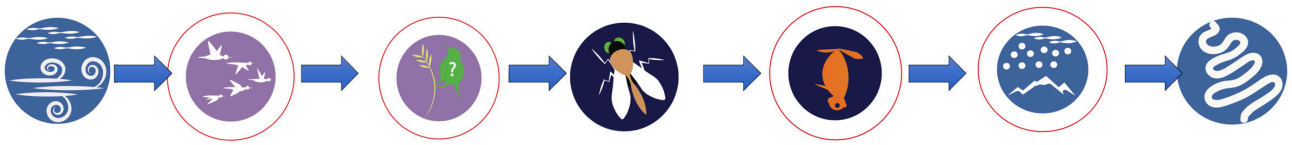


Figure 3.9: Co-Occurring Indicators in the Autumn

As a result of five years of collaboration with the farmers and herders, we have documented and revitalized a rich local knowledge of the ecological calendar in response to specific community needs and climate change. Changes related to snow cover during winter, snowmelt in spring, snow free in summer, and snow accumulation in autumn are key for the seasonal rotation of livestock. Hence, an ecological calendar offers practical benefit for livestock related seasonal decisions. Such a calendar may help time sheep breeding to ensure that the lambs are born in warmer spring. However, lately herders are facing shortage of fodder because of shifting spring seasons. Herders could store more fodder to prepare for increasingly variable times of snowmelt in the spring. As for the cropping and agriculture, our research with the community revealed that potatoes were essential for the villagers' food system. Although yet to be validated by the community, this draft ecological calendar reveals essential knowledge about the timing of crops, growing season, and harvesting period. Despite the challenge of frost damaging potatoes, early indicators of autumn could help villagers to harvest potatoes on time. Furthermore, given the importance of herding and animal husbandry in Sary Mogul, better understanding of timing of seasons through the ecological calendar for fodder production is fundamentally linked to livestock management and survival.

The Seasonal Calendar of Life: Sary Mogul, Alai valley, Kyrgyzstan

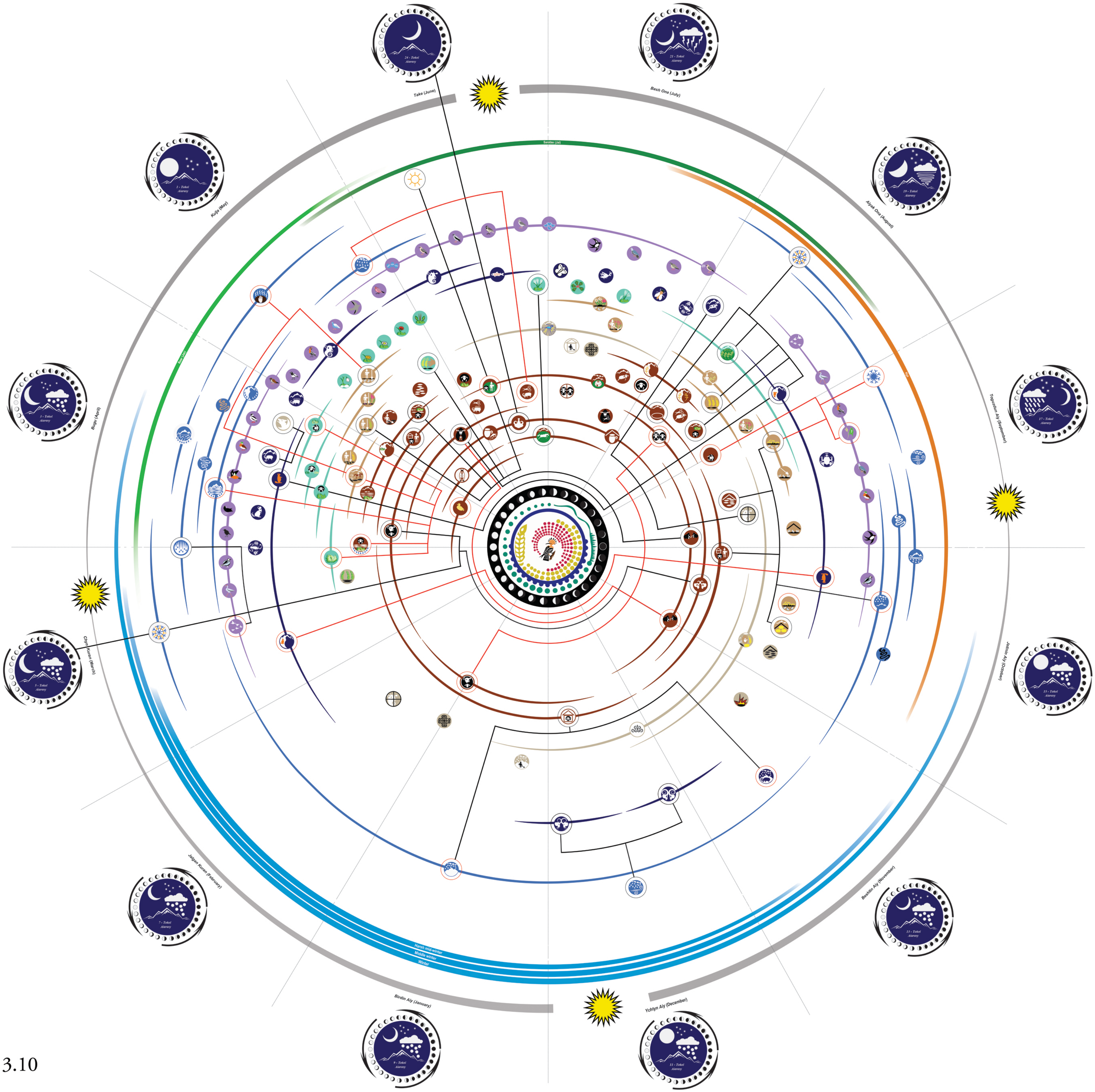
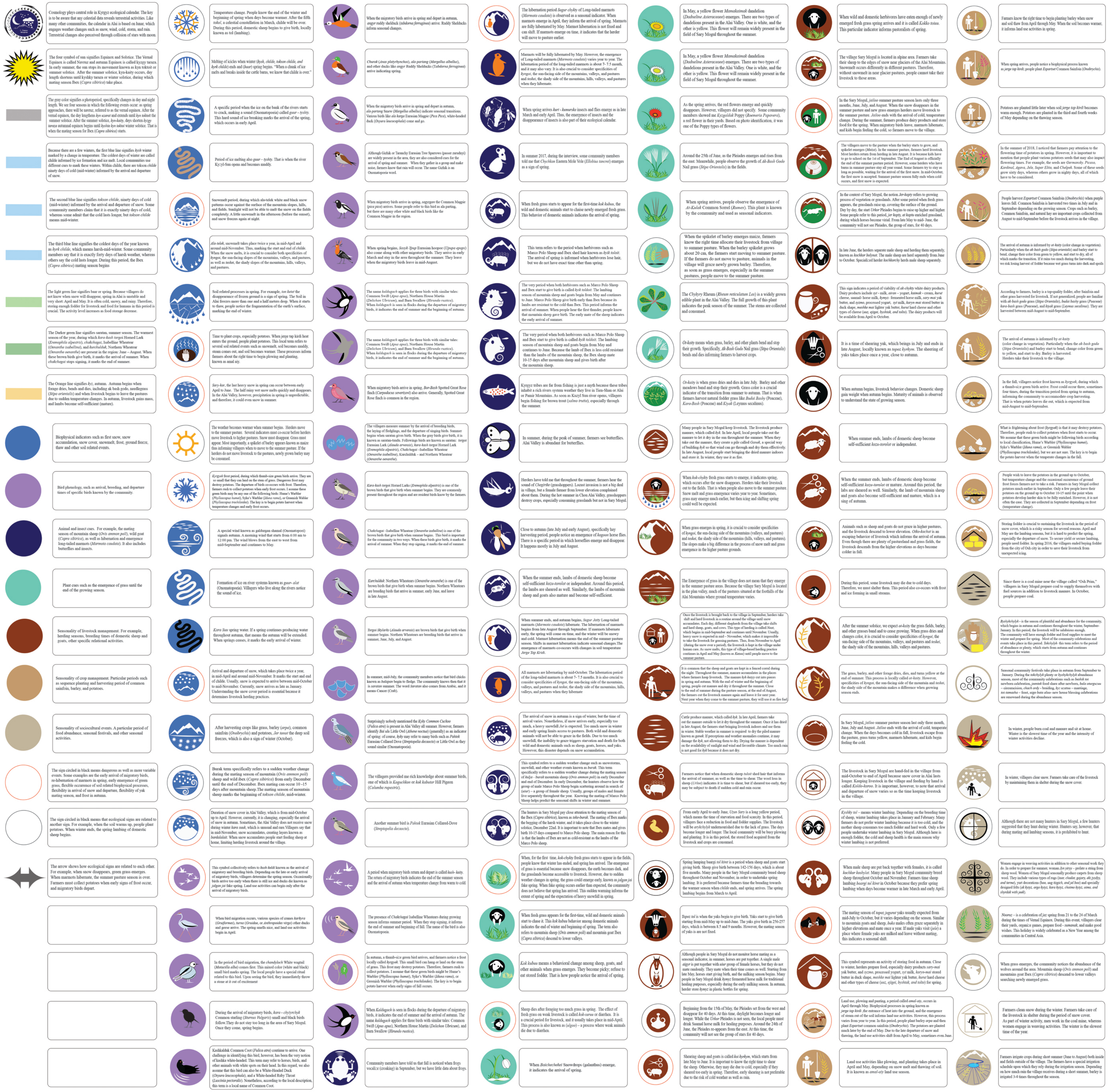


Figure 3.10

Legends


Cosmology plays central role in Kyrgyz ecological calendar. The key is to be aware that any celestial data reveals terrestrial activities. Like many other communities, the calendar in Alai is based on lunar, which engages weather changes such as snow, wind, cold, storm, and rain. Terrestrial changes also perceived through collision of stars with moon.
The four symbol of sun signifies Equinox and Solstice. The Vernal Equinox is called Navruz and autumn Equinox is called kyzgy taraza. In early summer, the sun stops its movement known as kyn toktoit or summer solstice. After the summer solstice, kyn-kaity occurs, day length shortens until kyshky taraza or winter solstice, during which mating season Ibex (Capra sibirica) take place.
The gray color signifies a photoperiod, specifically changes in day and night length. We see four seasons in which the following events occur: as spring approaches, there will be navruz, referred to as the vernal equinox. After the vernal equinox, the day lengthens kyn uzarat and extends until kyn toktoit the summer solstice. After the summer solstice, kyn-kaity, days shorten kyzgy taraza autumnal equinox begins until kyshta kyn toktoi winter solstice. That is when the mating season for Ibex (Capra sibirica) starts.
Because there are a few winters, the first blue line signifies kysh winter marked by a change in temperature. The coldest days of winter are called childe informed by ice formation and ice melt. Local communities use different cues to mark these winters. Within childe, there are tokson childe ninety days of cold (mid-winter) informed by the arrival and departure of snow.
The second blue line signifies tokson childe, ninety days of cold (mid-winter) informed by the arrival and departure of snow. Some community members claim that it is exactly ninety days of cold, whereas some admit that the cold lasts longer, but tokson childe means mid-winter.
The third blue line signifies the coldest days of the year known as kyrk childe, which means harsh-mid-winter. Some community members say that it is exactly forty days of harsh weather, whereas others say the cold lasts longer. During this period, the Ibex (Capra sibirica) mating season begins
The light green line signifies baar or spring. Because villagers do not know when snow will disappear, spring in Alai is unstable and very short: April and May. It is often cold, snowy, and rainy. Therefore, storing enough fodder for livestock and food for humans in this period is crucial. The activity level increases as food storage decrease.
The Darker green line signifies saratan, summer season. The warmest season of the year, during which kara-kash torgoi Horned Lark (Eremophila alpestris), chakchagai, Isabelline Wheatear (Oenanthe isabellina), and kurchulduk, Northern Wheatear (Oenanthe oenanthe) are present in the region: June – August. When these brown birds give birth, it marks the arrival of summer. When chakchagai stops signing, it marks the end of summer.
The Orange line signifies kyz, autumn. Autumn begins when forage dries, bends and dies, including ak bash godo, needlegrass (Stipa orientalis) and when livestock begins to leave the pastures due to sudden temperature changes. In autumn, livestock gains mass, and lambs become self-sufficient (mature).
Biophysical indicators such as first snow, snow accumulation, snow cover, snowmelt, frost, ground freeze, thaw and other soil related events.
Bird phenology, such as arrival, breeding, and departure times of specific birds known by the community.
Animal and insect cues. For example, the mating season of mountain sheep (Ovis ammon poli), wild goat (Capra sibirica), as well as hibernation and emergence long-tailed marmots (Marmota caudata). It also includes butterflies and insects.
Plant cues such as the emergence of grass until the end of the growing season.
Seasonality of livestock management. For example, herding seasons, breeding times of domestic sheep and goats, other specific relational activities.
Seasonality of crop management. Particular periods such as sequence planting and harvesting period of common sainfoin, barley, and potatoes.
Seasonality of sociocultural events. A particular period of food abundance, seasonal festivals, and other seasonal activities.
The sign circled in black means dangerous as well as more variable events. Some examples are the early arrival of migratory birds, re-hibernation of marmots in spring, early emergence of green grass, flexible occurrence of soil related biophysical processes, flexibility in arrival of snow and departure, flexibility of yak mating season, and frost in autumn.
The sign circled in black means that ecological signs are related to another sign. For example, when the soil warms up, people plant potatoes. When winter ends, the spring lambing of domestic sheep begins.
The arrow shows how ecological signs are related to each other. For example, when snow disappears, green grass emerges. When marmots hibernate, the summer pasture season is over. Farmers must collect potatoes when early signs of frost occur, and migratory birds depart.

Future Directions

As we have demonstrated, the potential to develop ecological calendars exists across differing ecological and cultural contexts. The diversity of breadth and depth in these community reports is not a point of departure, but a moment of learning. The idea of ecological calendars is simultaneously universal and particular. Because of the connectivity that Indigenous and rural people have to their homeland, ecological calendars are inherently particular as they reflect the specific knowledge of a particular habitat. That connectivity also makes it universal because communities in different places and in other moments of time can develop such calendars precisely because of their linkage to their habitat. This is what gives the ecological calendar its anticipatory and adaptive potential. Where local knowledge has been diminished by a history of colonialism and injustice as well as the continuing global trend of unchecked industrialization, there is potential of rebuilding and revitalizing it through collaborative research.

It is our hope that through this report, other communities are inspired to develop their own ecological calendars. There is a demonstration effect resulting from this project, namely that other Indigenous and non-indigenous communities may also have or are now considering developing their own ecological calendars. At a dismal moment in human history, where industrial civilization irrespective of its ideological roots in capitalism, communism, or socialism has undermined the linkage individuals and societies have with their habitat, the collaborative act of developing such calendars is empowering on several fronts. First, it creates a heightened awareness of one's own habitat whether it is urban or rural or some space in between. This heightened sense, brings forth an understanding of relationships inherent in that ecological space. Therefore, both the individual and community become conscious of the *rhythms* of their lands and cognizant of the consequences of their actions. Second, this exercise of awareness and understanding is the first step to co-creating an ecological calendar that suits a particular community and their cultural and ecological context. Third, with such an outlook, human-induced climate change ceases to be simply an overwhelming global phenomenon, it becomes particular because understanding these changes, anticipating their impacts, and developing adaptive capacity can be empowering when arising from uniquely place-based knowledge. Yet a response to climate change demands global commitment and action. That commitment cannot take place in a vacuum, it must be grounded in the knowledge and reality that is locally informed.

The process that we have described in these reports has been iterative and organic. It is an engagement that co-created insights through deliberative discussions even while a global pandemic ravaged the planet and, in some instances, armed conflicts destroyed the lives of people where we work. The very fact of the commitment of these diverse communities and our research team speaks to the necessity of this work and its capacity to build a meticulous methodology of hope. Therefore, several more tasks remain.

First, the ecological calendars for the communities in the Pamir Mountains and the Standing Rock Sioux Nation need to be validated. Given this publication and the intent of having it available electronically

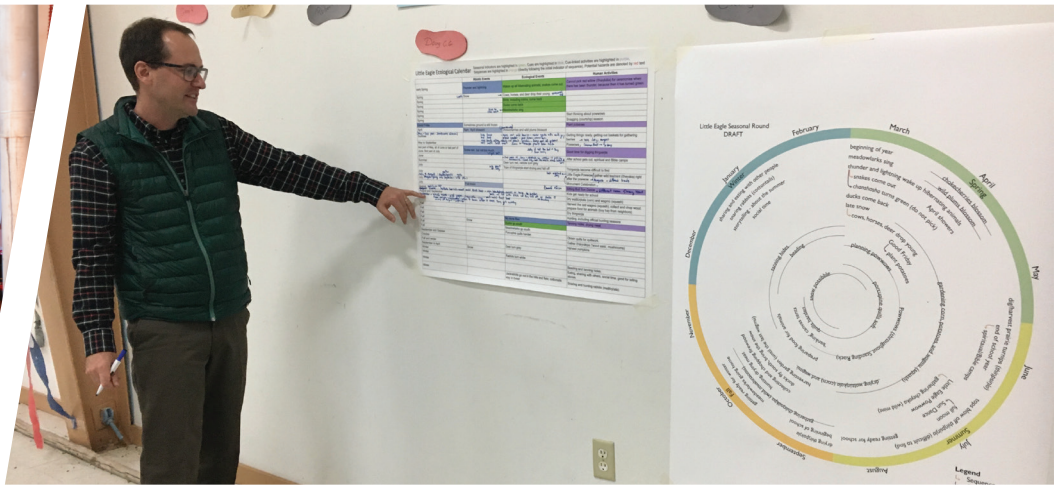
on the web, means the validation can be achieved more easily. In addition, new insights and ecological relationships can easily be added.

Second an international conference that brings together scientific, local community, civil society, and governmental institutions will help strategies for future action, research, and policy formulation. Such a conference entitled *Rhythms of the Land: Indigenous Knowledge, Science, and Thriving Together in a Changing Climate* has been organized for October 2021 at Cornell University.

Third, an effort must be made that the Indigenous and local knowledge that is contained in ecological calendars is not only communicated but is also revised and revitalized by future generations in their respective communities. This is most easily achieved through environmental education and curriculum development not only in the social sciences and humanities but concomitantly in the biophysical sciences. Climate change knows no disciplinary, geopolitical, or cultural boundaries. Similarly, the response to understanding and adapting to its impacts must reflect that consciousness.

Fourth, policy in terms of hunting, fishing, farming, herding, or broadly land stewardship must reflect the insights that communities and researchers are collaboratively reporting through their ecological awareness and insights. This will have direct impact on regulations for hunting and fishing seasons. In addition, land use plans, policies, and practices will need to be examined in the context of the changing climate and in light of specific insights arising from these localized ecological calendars.

Finally, when communities described their ecological relationships, their knowledge, although fractured by the impact of industrialization and a colonial legacy, was intimate. Descriptions of their habitats did not separate their presence on the land from other living beings. They were cognizant that they are *living through* the environment not *from* it. There was no separation between mind and body because both exist because of and within an ecological space. This perspective should give us hope and inspire us to explore it in our own lives.

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