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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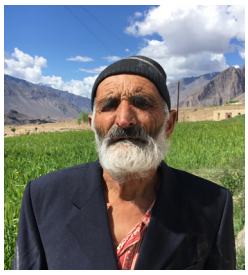
As I express my gratitude to the communities, our research team, and particularly our students; it should be noted that any shortcomings in this organically developed work are entirely my responsibility.

Karim-Aly S. Kassam

Professor and Principal Investigator

Roshorv
Community Members

Shozodalal
Ayomovich



Saidbek
Baktaolatov

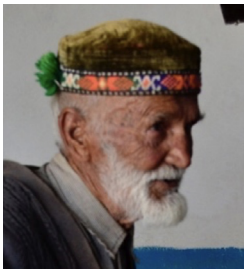
Cholok Charorov

Sadonsho
Daoletmirov

Mobegim
Doutovna

Shomunir
Jamalov

Khudobek
Kazelov

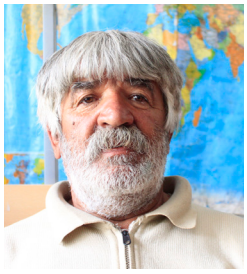


Passor Kazelov

Zubujin
Kholmamadov

Komilsho
Khujanazarov

Zarinatsho
Khujanazarov



Madimar
Madimarov

Vatansho
Mirzoev

Bedillokhon
Mulloboboev

Karamsho
Mushkiev

Jamal
Nazarmamadova

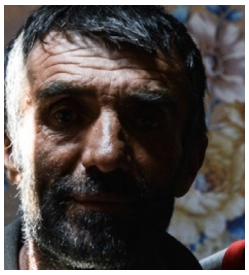
Porshambey
Orshormamadov

Chinikhon Qizilov

Abdulrasul
Qurbonovich

Abdumamad
Sabzikov

Roshorv Community Members (cont.)



Lalbek Sabzikov

Sultonmamad Sainiev

Janob Sangilichov

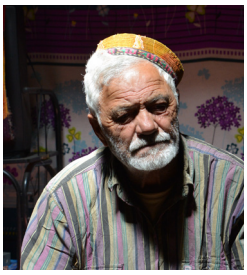
Navruzkhatun Shaikhova

Khujanazar Shugonovich

Saradbek Tohirbekov

Savnob Community Members

Mulkabek Alifbekov



Mulomalek Alifbekov

Munavvar Ayubov

Odilkhon Ayubov

Riswonova Bakor

Topchibek Bekov

Bakhtibek Boshaev

Ekbolsho Dustambuev

Gulzorkhon Egamov

Ayubov Gulayoz

Savnob
Community Members (cont.)

Otambek
Guldastashoev

Mamadsho
Guliev

Darwozi
Gulzarkhonov

Soatnazar
Gulzorkhonov

Kholmirozo
Jafarkuliev

Guldasteshoev
Kosembek

Marvori
Mamadbekova

Qandak
Mirshaibov

Zarbonu
Noyozova

Chilla
Nurmamadova

Sarkori
Rahmatbekov

Shahlo
Saradbekova

Aslibegum
Sarkorieva

Schokoman
Schobozev

Qurbon
Shoguniev

Morodbegim
Solaymoshoeva

Mastale
Toshbekov

Olomali
Yormonov

Not Pictured: Gulbahor Ilchibekova

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

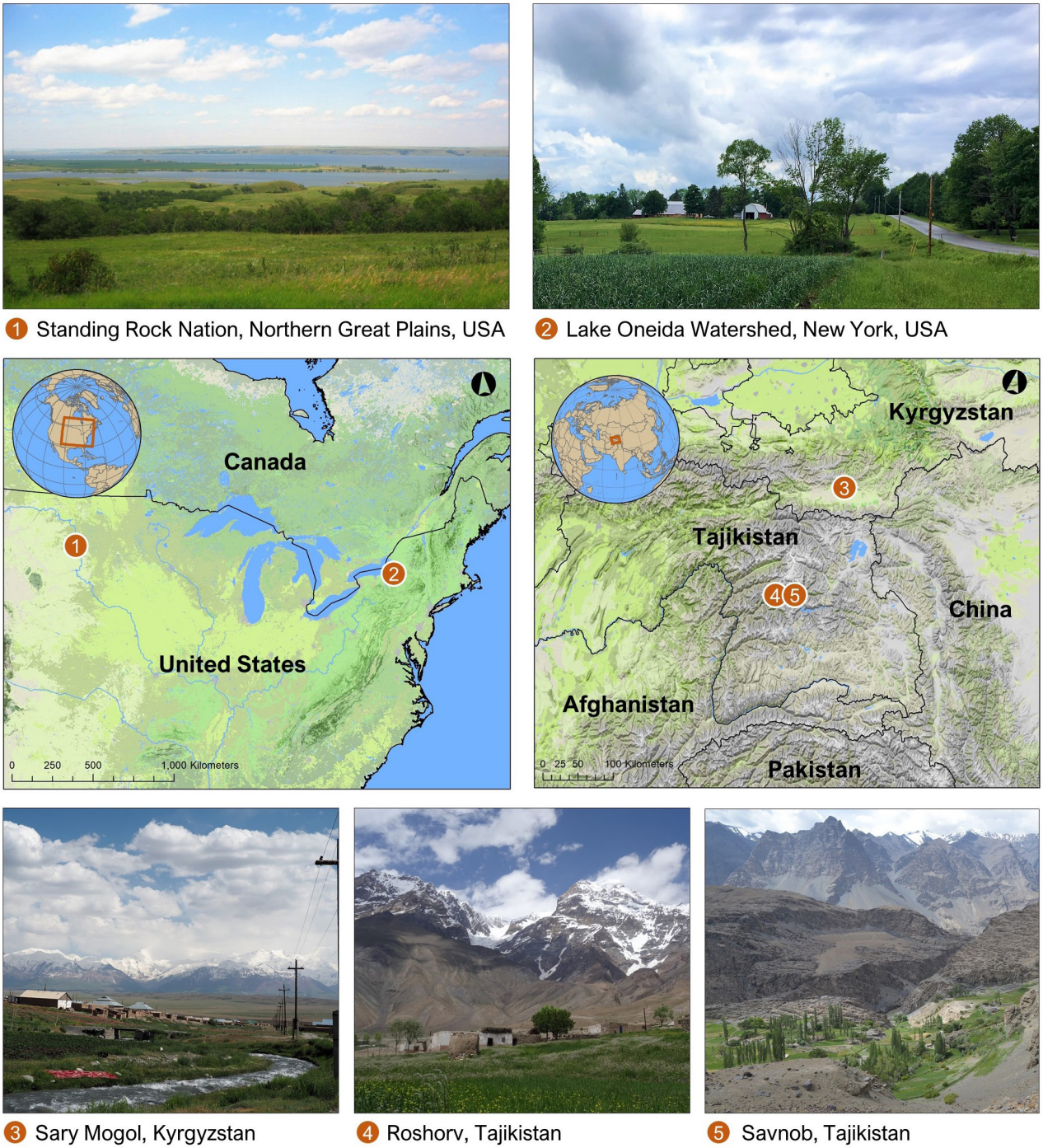


Figure 1.1: Research Context in Central Asia and North America

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.

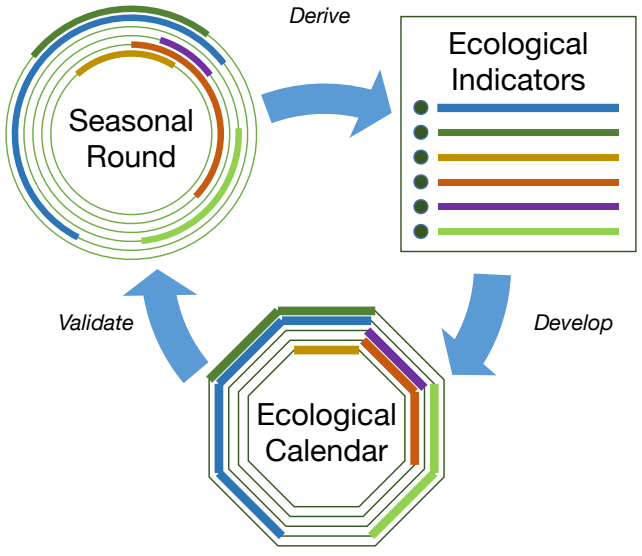


Figure 1.3: Collaborative Process of Developing Indicators for Ecological Calendars

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.

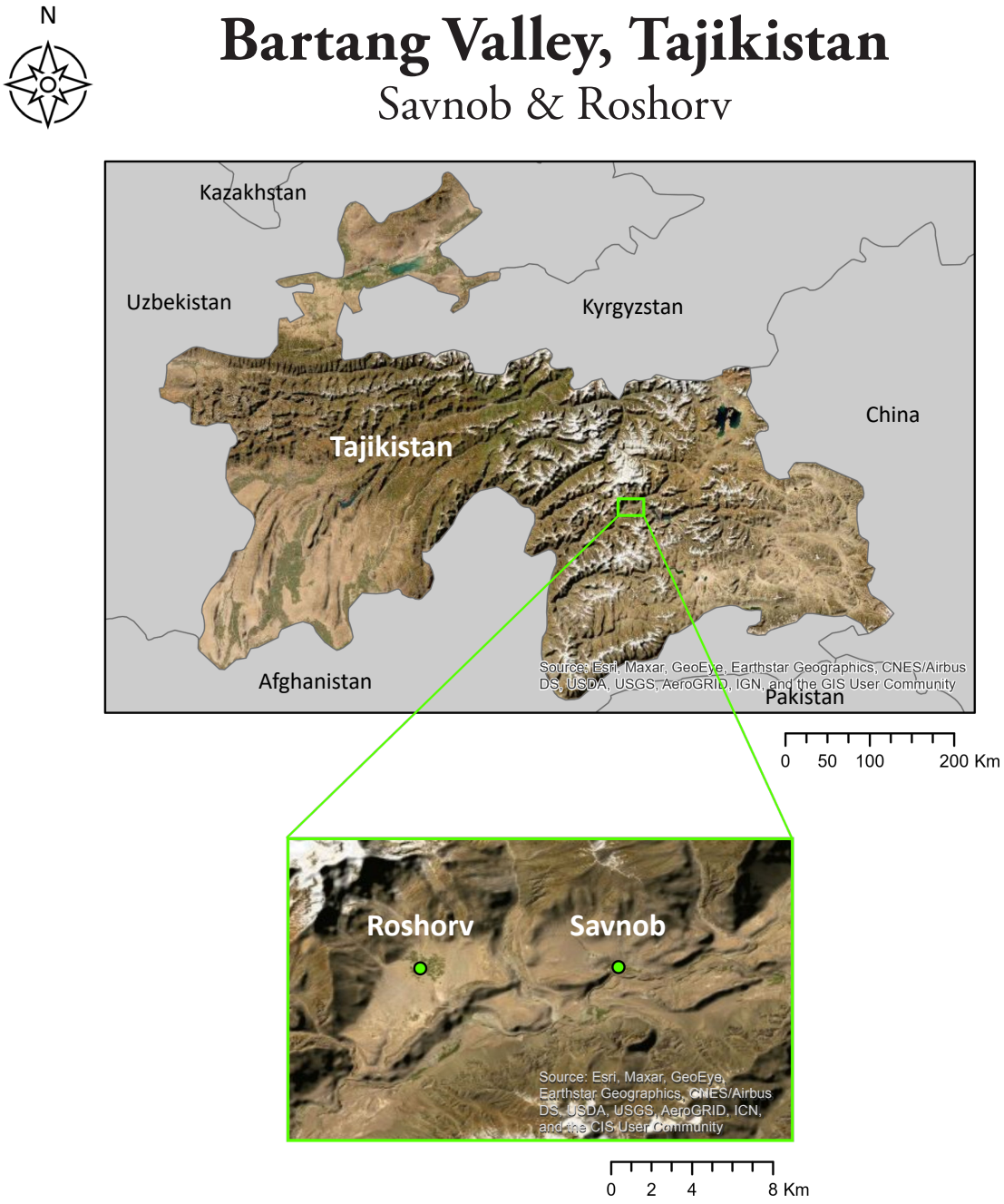


Figure 2.1: Maps and Images of the Two Villages in the Bartang Valley of Tajikistan, Roshorv and Savnob.

Roshorv & Savnob
Bartang Valley, Tajikistan

Context

The impetus for research on ecological calendars was inspired by insights and information provided by the villagers of the Bartang Valley in the Pamir Mountains of Tajikistan during fieldwork by the lead Principal Investigator of the *Ecological Calendars and Climate Adaptation Project* (ECCAP), Professor Karim-Aly Kassam, in 2006. Gorno-Badakhshan Autonomous Oblast (GBAO), the name of the mountainous region of Tajikistan where the Bartang Valley is situated, is a remnant of Soviet colonial rule in the region. According to villagers, during Soviet presence in the region, cultivation and herding practices were altered from sustainable self-sufficiency to production at an industrial scale through forced migration and collectivization, mechanization of agriculture, and sedentarization of peoples of the Bartang Valley to the lowlands to produce cotton. The impact was devastating on the communities of the valley as many died of malaria and starvation. This also resulted in loss of knowledge concerning how to cultivate local seed varieties of grains and fruits in their own homelands. Thus, diminishing food sovereignty and security. Indigenous knowledge, like the know-how for use of ecological calendars, was actively suppressed and denigrated under Soviet industrial development. Eventually some community members returned to their homelands but not after significant disruption to their cultural and social systems as Soviet style rule was established.

From 2006 to 2010, communities in the Bartang Valley reported the following impacts of climatic variation (Kassam, 2009; Kassam, Bulbulshoev, & Ruelle, 2011: 148):

- Increasing water levels in rivers and lakes due to more rapid snow and glacial melt;
- Villages at lower elevations report the loss of valuable agricultural land to higher water levels and changing river-ways;
- Villages at higher elevations report increasing size of glacier-fed lakes;
- Increased intensity of rainfall in the spring, which is now concentrated within a few days rather than spread over a longer period, is affecting the physical integrity of structures;
- Villagers also identified growing problems with avalanches and rockslides due to rains;
- In some villages, ploughing and sowing begins 15 to 30 days earlier than a decade ago, and harvesting also takes place 15 to 30 days earlier;
- It became possible to grow regular crops of wheat without the risk of frost damage in villages at higher elevations;
- Villagers at lower elevations report change in the quality of, or inability to grow certain fruits because they require cold days in spring to produce fruit in the summer (i.e. vernalization); and
- Nomadic communities report that the spring season seems like a continuation of winter and in the summer, fodder in high altitude pastures is "burnt," resulting in animals not gaining the necessary weight to sustain them through the winter.

Unusual weather events are a key feature of the anxiety caused by the impacts of anthropogenic climate change. Therefore, when the ECCAP research team undertook interviews in 2017, their results were different from their findings between 2006-2010. The unusual weather patterns of 2017 were evident in community members' comments as they described abnormal weather such as increased snow levels. However, the research team returned the following year and undertook validation of the 2017 observations. The information collected in 2017 was relayed back to the community members of Roshorv and Savnob to ensure accuracy, make adjustments, update observations where relevant, and add new insights. In contrast to 2017, 2018 was more characteristic of the impacts described earlier (2006-2010), illustrating the variable effects of annual weather patterns associated with climate change. As illustrated below, findings by the climate science members of our research team for the winter snow period reinforced observations from individuals living in both communities (Haag et al., 2021).

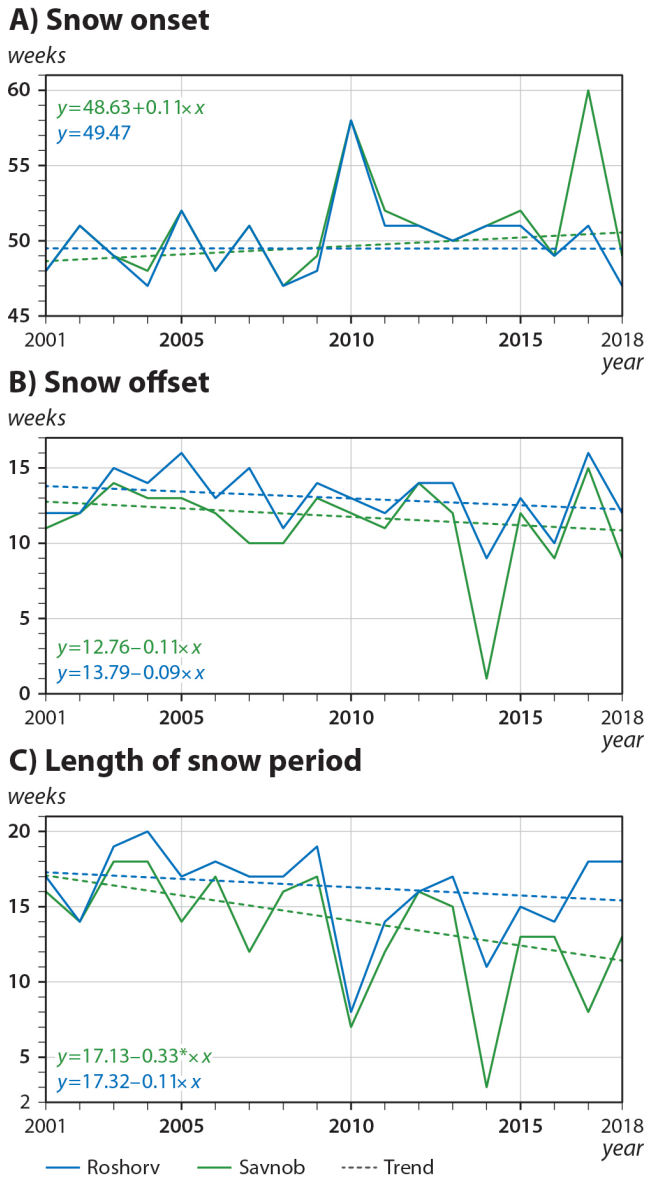


Figure 1: Changes in the timing of snow onset, snow offset, and in the duration of the snow period in weeks for the villages Savnob and Roshorv (Haag et al., 2021).

Climate Data from 2001-2018

Figure 2.2 illustrates the change in snow cover in Roshorv and Savnob over time. Data were collected on snow onset (A), snow offset (B), and length of the snow period (C). Snow onset is defined as the first week where the number of days with snow cover is above 50%, while snow offset refers to the first week where the number of days with snow cover is below 50%. From 2001 to 2018, results showed a shortening of the season due to the onset occurring later as well as the snow offset occurring earlier. This was particularly evident in Savnob where the snow period decreased by 5.4 weeks.

In conjunction with the climate data, interviews were also collected to consider community observations. Based on these observations, a moderate level of consent was reached in Savnob for declining snow levels. In comparison, community members in Roshorv were strongly in consensus about the decreasing levels of snow over time.

Voices of the People
Village of Roshorv

Calendar of the Human Body

- How do we know it is time for *Boj Ayom*?

  "*We use the varmoi to count where the sun is in the body: three days in the nail, three days in the knee, and so on, until it meets the head*" (Mushkiev Karamsho Qurbonovich, 2017 Workshop).

Irregular/extreme weather events

- In the past ten years, have you noticed that hazards are more frequent than before? Are there any new climate events that you have not seen before?

  "*This year there was much snow, and as a result, many avalanches and rockfalls. They destroyed some homes here. This is the first time an avalanche came to this place in ten years. On November 20th, there was a strong and terrible wind that blew for a day and night and destroyed the roof of the first aid station/doctor's office. There was also an earthquake in December 2015. No one died, but they had to close the road*" (Vatansho Mirzoev, Charorov Cholok Sufovich, and Shozodalal Ayomovich 2017 project initialization workshop while developing seasonal round).

- Impact of receding glacier:

  "According to my experience, the weather is becoming warmer. In the past, we would harvest wheat and barley in October, and some people couldn't harvest before it began to snow. Now we harvest in August. Also, the Fedchenko glacier is becoming smaller" (Porshambey Orshormamadov, 2017).

- Changes in weather:

  "I remember that last year (2016) on November 25, we had a very heavy wind. It picked up the clay from the land... it only happened last year. These heavy winds are unusual. We always have a light wind in March and April, but this is the first wind like this that I have ever seen" (Mushkiev Karamsho Qurbonovich, 2017).

- Changes in wildlife behavior:

  "After tsatsao, when the land becomes all green in the village, the babůb (Eurasian hoopoe, *Upupa epops*) *appears, which is another sign of spring. The babůb comes after ploughing. Nowadays, they come near the beginning of June. When I was younger, the babůb would come at the same time. When the wheat and barley become green from the land, at that time the babůb comes"* (Barotov Abdulrasul Qurbonovich, 2017).

Context Specificity

- "*If you planted 10 hectares of land here and 10 hectares in Savnob, the harvest in Savnob would be more than in Roshorv. This is because the water in Savnob is warmer water (spring water)*" (Sabzikov Lalbek Shakarshoevich, 2017).

Village of Savnob

Calendar of the Human Body

- Do you think that this calendar could be useful today for timing events?

  "It is useful, but we didn't pay attention to it. Our grandparents started their work with this calendar" (Aslibegum Sarkorieva, 2017).

Irregular/extreme weather events

- What unusual weather have you noticed in your lifetime?

  "1995 was a dry year with no snow. This year 2016-2017 there was too much snow. If I'm not mistaken, in 2010 it was about minus 40-50 in winter in Aktash" (Qandak Mirshaibov Yusefshuevich, 2017).

- Can you remember when you saw this steam coming from the ground this year?

  "It usually comes on the 21st of March, when the day and night become equal. But this year, it did not happen until April 10th when the snow melted" (Riswonova Bakor, 2017).

- Changing climate impacting crop yields:

  "It has a lot of influence. When we sleep inside, we make a tent inside of the home because of the bugs. It also influences the crops. Now there are more insects that destroy onions and other vegetables. The cold has not been killing the insects" (Odilkhon Ayubov, 2017).

  "The rust appears when it is warmer. The warm weather causes the water to become warmer and hurts the plants. The plants don't grow well then. When we gather hay, there is also not as much" (Mulomalek Alifbekov, 2017).

- Impact of receding glacier:

  "Now the summers are warmer than when I was young. When I was younger, in the nearby valley called Ruj Dara, there was a glacier. When we used to go when I was young, one pasture was a glacier. Nowadays, a few years ago I went, and the glacier has melted back 1-2 kilometers" (Guldasteshoev Kosembek, 2017).

  "When we used to take oxen to Ruj in past years, we would go over the glacier. But now the glacier is retreating, and we do not cross over it. Usually there is no snow in the mountains when we take our animals to pasture, but this year there was snow. In August the snow melts and more grass grows. When there is more snow in the autumn, we cannot feed our animals on the mountain" (Odilkhon Ayubov, 2017).

Context Specificity

- Between Roshorv and Savnob:[1]

  What makes the agriculture of Savnob unique?

  "Every family tries to plant wheat first because wheat is the most important. In Savnob and other poytakht villages, we can grow apples and apricots" (Ekbolsho *Dustambuev*, 2017).

  What makes Savnob *poytakht*?

  "Poytakht villages are warmer than other villages. The snow melts very early here, right after Navruz. We plow 20 to 25 days earlier than other villages like Roshorv. It is possible to grow cucumbers and tomatoes here. The sarad villages are very high above sea level. For example, Savnob is only 2,500 m above sea level, while sarad villages are 3,000 m above sea level. The elevation is what makes Savnob poytakht" (Ekbolsho Dustambuev, 2017).

1 Villages are categorized as either *sarad* or *poytakht* according to their geographic location and climatic conditions. Sarad villages are located at higher altitude and therefore commonly have colder temperatures and lower land productivity than *poytakht* villages. *Poytakht*, being the center or capital, and *sarad*, translated to border or periphery, describe locations comparatively. This relationship is conditional as the village of Savnob could be considered *sarad* relative to villages at lower elevations (Bulbulshoev, 2021).

- Within Savnob[2]

  "In some place, the land is called wombi zamin (downstream), and the other is called sai zamin (dry soil). People in sai zamin plant and harvest earlier than wombi zamin (around 4-5 days). Wombi zamin has a better harvest than sai zamin" (Ilchibekova Gulbahor, 2017).

Working with the Ecological Calendar

Introduction

Ecological calendars capture key events across space and time. Individually tailored to the communities of Roshorv and Savnob, their calendars are an illustration of important events that were discussed during interviews with the *Ecological Calendars and Climate Adaptation in the Pamirs* research team in 2017 and 2018. Roshorv's and Savnob's ecological calendars are attached of the end of this chapter. Please read the subsequent sections along with the ecological calendars for Roshorv and Savnob (Figures 2.10 and 2.11). Both of their calendars engage all the senses as they highlight the villagers' agropastoral relationship with their habitat, speaking to their farming and herding practices. They feature weather phenomena, movement of local animal and plant life, spiritual aspects, and cultural festivities (Figure 2.3). The diversity of perspectives among individuals as well as the nuances in their approaches have added to the complexity of their ecological calendars. Therefore, these calendars have the ability to speak to every individual in the Bartang Valley.

Image A: Roshorv
Apricot Harvest

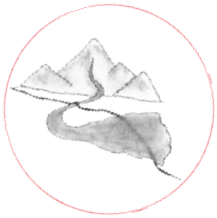


Image B: Savnob
Flooding Road

Image C: Bartang
Ibex Kidding

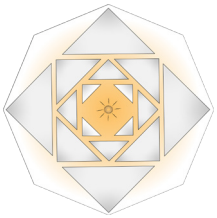


Image D: Bartang
Pamiri Ceiling

Figure 2.3: Images A-D are icons present in both Roshorv's and Savnob's ecological calendars representing agropastoral activities (e.g., Image A of apricot harvest), abiotic and weather events (e.g., Image B of the river flooding), local animal and plant life (e.g., Image C of ibex kidding), and reference to their spirituality (e.g., Image D depicting a Pamiri ceiling).

Calendar Description & Symbolism

Inspired by the villagers' cultural spirituality, both Rohorv's and Savnob's Ecological Calendars incorporate vast amounts of symbolism (Figure 2.4). Their octagonal shape considers the community's complexity and the interconnectivity woven throughout their activities and the land with which they engage. The octagon represents the material, cyclical, and spiritual nature of the communities' relationship with their habitat. It references their cosmology and architectural style. Furthermore, the octagonal shape can assist in visualizing changes occurring overtime. As the calendar is divided into four seasons, green for spring, yellow for summer, red for fall, and blue for winter, alterations in the climate could be revealed through the fluctuating length of seasons. For example, if the cold winter

2 *Wombi zamin* and *sai zamin* can be geographic descriptions relating to water sources such as rivers, channels, and streams. Upstream, or the top half, is referred to *sai/say zamin* while downstream is identified by *ghumbi/wombi zamin*. However, *sai/say zamin* not only describes land lacking water supply upstream, but this term is also used to describe unfertile land irrespective of its location. Similarly, *wambi/ghumbi zamin* primarily indicates productive soils (Bulbulshoev, 2021).

months are prolonged, this would clearly be displayed in the area dedicated to the color blue (Image A in Figure 2.4). Given villagers of the Bartang Valley incorporate multiple calendars into their everyday life, one of which being the Gregorian solar calendar, the names of months are fixed within the calendar's octagon outline as another point of reference. Similar to the octagon, the months provide orientation to illuminate variation in shifting events that occur overtime.

This ecological calendar also refers to the historical use of the calendar of the human body. This calendar was first revealed to the ECCAP research team in Savnob. Although the use of the calendar of the human body is no longer ubiquitous, it remains linguistically active and resonant (Image B in Figure 2.4). Comparable to the internal separation of a traditional Pamiri house, with a feminine and masculine side, a man and women dressed in traditional Pamiri clothing are placed with their heads aligning at the summer *chilla* and feet at the winter *chilla*. Despite the division, they remain united and equal. The *chillas* refer to periods when community members can regain energy and reflect. These *chillas* are therefore built into the calendar of the human body as well as into the ecological calendars of Roshorv and Savnob.

The centers of the Bartang Valley ecological calendars hold a depiction of the sun entering through the skylight of a traditional Pamiri home (Image D in Figure 2.3). As the sun shines through, its rays mark the passing of time through their movement around the inside of the house. The year begins with *Navruz*, the vernal equinox, occurring nine days before the sun rises over the *varmoi*, a marker or sign made of rocks in the mountains visible from the village (Image C in Figure 2.4). Although there are multiple calendars and cultural qualities at play, the sun ties each of these elements together. Its movement through the human body, appearance across the mountain tops of the Bartang Valley, and entrance through the skylight into one's household are simultaneously linked to the sun's travel through their ecological calendar. The sun is an essential element of culture and necessary for survival.

Each event or activity is represented by an icon situated on a tapered brown line within the ecological calendar. This line symbolizes the span of time over which the event occurs. For example, in Savnob, the line associated with yaks calving extends from April to July and has its respective icon resting in the middle. This relays that yaks generally calve from April to July in Savnob. Similarly, the line associated with cows calving in Roshorv extends from December to February, has its respective icon resting in the middle, and conveys calving from December to February. Some Roshorv villagers have additional land in Yapshorv therefore dividing their labor between these two villages. Events in these locations inform each other, influencing the sequence of livelihood activities. To distinguish events that occur in Yapshorv, Roshorv's ecological calendar employs two shades of brown. Dark brown denotes Yapshorv while the light brown represents Roshorv. When events take place in both locations, such as the river flooding in July, the line is evenly divided into both colors.

Every icon in the calendar represents a unique event, such as the celebration of a festival, the arrival of a migratory bird, or snowfall. These encompass everything occurring in the surrounding environment as well as human activities. Therefore, the categories of icons include references to livestock management, agricultural practices, crops, crop pests, birds, amphibians, undomesticated animals, hunting, gathering, abiotic events, celebrations, and potentially threatening events.

The representations of these icons act in accordance with particular themes. Icons that symbolize the planting of crops are expressed through an illustration of their life stages (Image D in Figure 2.4). Similarly, hands holding a crop always depict the action of harvesting (Image A in Figure 2.3). Any incidents that may pose a threat to the community and their sustenance are highlighted with a red circle around the icon. Identified by the community, these include natural disasters, extreme temperatures, or possible predation and conflict with undomesticated species (Image B in Figure 2.3). Additionally, key species that inform livelihood activities, indicator species, are also emphasized in the ecological calendars. Each indicator species icon is placed into a light-green filled circle (Image C in Figure 2.3).

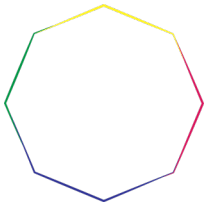


Image A: Bartang
Ecological Calendar Octagon

Image B: Savnob
Calendar of the Human Body

Image C: Savnob
Varmoi in the Mountains

Image D: Bartang
Planting Potatoes

Figure 2.4: Images representative of Savnob's and Roshorv's ecological calendars. Image A and D correspond to both ecological calendars while Image B and C pertains to the village of Savnob. Image A presents the octoganal shape and seeasonal colors of the ecological calendars, Image B appears in Savnob's calendar with reference to the calendar of the human body, Image C represents Savnob's varmoi in the moutains, and Image D symbolizes the planting of potatoes.

Engaging these calendars requires noticing how each of the icons are interacting, both in terms of the events that occur together in time as well as those dispersed. As organisms are connected to each other and the local environment, their behaviors influence the livelihood activities of villagers. This is a matter of survival. Therefore, it is these complex relations that provide the foundation of the ecological calendar and life in the Bartang Valley.

Each ecological calendar is accompanied by an icon legend which contains descriptions of icons and their respective relations. This document is intended to be referenced by the local *Hisobdon*, an individual devoted to monitoring seasonal events. As the 'keeper of time', they are responsible for overseeing the passing of time (Kassam et al., 2011; 2018). The top left corner of the legend addresses consistent elements found within their calendars such as how seasons, timeframes, indicators, and dangerous events are represented. All the content populating the ecological calendar and icon legend are derived from the 2017 interviews and 2018 validation with the research team. This ensures precise portrayal of every event, and therefore, includes the diversity of perspectives found amongst individuals of the community.

Sequences

The Bartang Valley ecological calendars are designed to show sequences, the order in which events occur across time. From left to right, the first icon on the left of a line represents the initial event that arises. For example, in Roshorv, the order in which specific crops are planted begins with wheat and is followed by chickpeas, barley, potatoes, and then other vegetables (see Image A in Figure 2.5). In other scenarios, the first icon may initiate a sequence such as the appearance of dandelions. In this sequence of events at the end of March and beginning of April, snowmelt always initiates the arrival of dandelions. This also applies to Savnob as the temperatures dropping in November influence migratory birds leaving for the winter.

Image A: Roshorv
Planting of Wheat, Chickpeas, Barley, and Potatoes

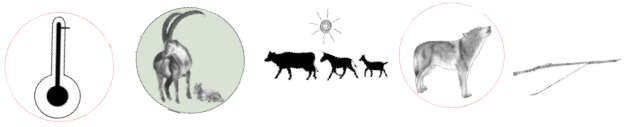


Image B: Savnob
Warming Temperatures, Ibexes Kidding, Herding in Summer, Wolves, and Hunting

Figure 2.5: Illustrations of sequences in the Bartang Valley's ecological calendars. Image A depicts the order of planting in Roshorv regarding three crops from April to May. Wheat is planted first, followed by chickpeas, barley and then potatoes. Image B includes five icons, the longest sequence in Savnob's ecological calendar. When weather warms in the beginning of June the ibexes begin kidding. These events are related to herding activities, wolf behavior, and prevalence of hunting.

The majority of the Bartang Valley's ecological calendars are composed of clearly depicted sequences. Despite initial appearance, the standalone icons are also connected to other elements of the calendar. This holds true for situations such as the birthing of livestock as this is a result of mating earlier in the year. It is important to keep in mind that other external factors such as weather, availability of fodder, or absence of disease each influence the success of such events and tie biophysical and physical processes to human livelihoods.

The longest sequence in Roshorv's ecological calendar includes six icons, occurring throughout September. The first cue to initiate the sequence is a change in temperature. At the beginning of September, the temperature drops causing streams to freeze. The grasses turn yellow as a sign that autumn has arrived and meanwhile, the marmots begin to disappear. In turn, this causes the wolves to apply more pressure on the livestock in pasture. These five events are an indication for herders to bring their livestock back to lower pastures and the village.

Juxtaposed to Roshorv's calendar, the longest sequence in Savnob's ecological calendar includes five icons, occurring throughout June. The first cue, which initiates the sequence, is a change in temperature. At the beginning of June, when the weather warms, the ibexes begin kidding. This corresponds to the herders moving to higher pastures in *Aqtash* as the wolves are increasingly threatening the livestock as well as greener pastures are available at higher elevations. These events initiate hunting (Image B in Figure 2.5).

Cues

Cues are signals that notify the community of upcoming events. They encompass celestial, physical, and biophysical events (Figure 2.6). Cues can exist in the beginning of a sequence as well as within a sequence. For instance, in Roshorv, the temperature of the soil at a depth of 10 cm is a cue to plant vegetables in mid-April. If the soil is warm to the touch, then planting can occur (Image A in Figure 2.6). The avalanches in July are also a cue. They inform the community to harvest apricots in Yapshorv.

Image A: Roshorv
Soil Temperature at 10 cm

Image B: Roshorv
Spring Rain

Image C: Savnob
Flowing Water

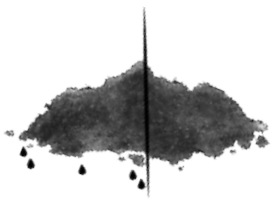


Image D: Savnob
Partially Dry Soil

Figure 2.6: Examples of cues in the Bartang Valley's ecological calendars. Cues notify the villagers of approaching events. These icons include, but are not limited to, soil characteristics (Image A and D), weather events (Image B), and flowing water (Image C).

Concerning Savnob, steam rising from the ground is a cue for some villagers to spread sand on the snow encouraging it to melt faster. Similarly, partially dry soils (Image D in Figure 2.6) are a cue to begin plowing in April. It is common for cues to be followed by indicator species before the livelihood activities take place. This is evident in two sequences in Roshorv relating to plowing time in April as well as a sequence in September regarding livestock herding. In Savnob, this is also apparent in multiple sequences throughout June regarding hunting as well as harvesting of wild and cultivated plants.

Indicator Species

Indicator species, a form of cue, are a crucial aspect of the ecological calendars as their behaviors inform livelihood activities. As previously mentioned, their icons are distinguished in the calendar by a light-green background (Figure 2.7). Each time an indicator species appears in the calendar it is highlighted, irrespective if it is performing as an indicator in that instance. This is intended to emphasize the importance of their life stages and relevant behaviors.

Image A: Roshorv *Wurj* | Image B: Roshorv *Zarez* | Image C: Savnob *Akhar* | Image D: Savnob *Kharbirj*

Figure 2.7: A sample of two indicator species from each village, Roshorv and Savnob, in the Bartang Valley of Tajikistan. Indicator species are highlighted in the ecological calendars with a green circle and inform community members when to carry out livelihood activities. They include mammals, birds, plants, and amphibians. Further information on the 11 indicator species is detailed in Tables 2.1 and 2.2.

Roshorv Indicator Species

The village of Roshorv has a total of eight indicator species consisting of four birds, three mammals, and one plant family. These include the *mandozak* (barn swallow, *Hirundo rastica), torwathich* (brown dipper, *cinclus pallasii), tsatsao (*Himalayan snowcock, *Tetraogallus himalayensis), zarez (*chukar, *Alectoris chukar), wurj* (grey wolf, *Canis lupus*), *khuchirf* (long-tailed marmot, *Marmota caudata*), *nakhcheer* (Siberian ibex, *Capra sibirica*) and *wokh* (term for grasses in the Monocotyledons class). As previously mentioned, these indicators are completely unique to Roshorv, aside from the Siberian ibex. See Table 2.1 for their respective icons, associated sequences, and seasons in which they appear in Roshorv's ecological calendar.

The grasses are a very important indicator species, appearing in the ecological calendar a total of four times, more than any other icon. At the end of March and beginning of April the temperatures warm and the grass begins to turn green. Although it is not performing as an indicator in this instance, the grass icon reappears in the beginning of May because the greening color is inviting the ibexes to move to lower pastures. Once the ibexes have arrived at lower elevations, they become easier to hunt. In June, grass is the first icon of a sequence as it is an important food source for the ibex who are kidding. This time period also coincides with the hatching of the chukar, another indicator species, as it is followed by the blossoming and harvest of alfalfa. Both the ibexes' behavior and the greening of grass in higher pastures initiate hunting in June. Arguably, the best time to hunt is not until autumn when the wildlife is well satiated from their summer diets. Commonly hunted animals include ibex, Marco Polo sheep, marmots, Himalayan snowcock, and chukar.

The Himalayan snowcock is an indicator that generally arrives after the appearance of grass in the beginning of spring. This takes place following the melting of snow and first rain. The call of the Himalayan snowcock is important because it initiates plowing. The arrival of barn swallows and brown dippers, two other indicator species, arrive in mid-April following the Himalayan snowcock. These birds are indicators for the second and third plowing sessions, corresponding to the thawing of the land. This time of year, a stone can be dropped as a cue to determine if the land has softened. If this stone does not bounce once it hits the ground, then the soil has thawed enough to plow. The barn swallows reappear in the ecological calendar towards the end of September. Their arrival in autumn is an indication for herders to bring their livestock back from pasture.

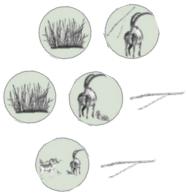
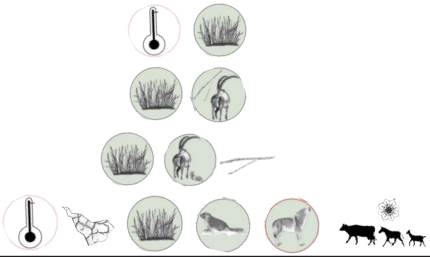
Icon	Indicator Species	Respective Sequence	Months
	***Mandozak*** Barn Swallow *Hirundo rastica*		April (Spring – Green) September (Autumn – Red)
	***Torwathich*** Brown Dipper *Cinclus pallasii*		April (Spring – Green)
	***Tsatsao*** Himalayan Snowcock *Tetraogallus himalayensis*		April (Spring – Green)
	***Zarez*** Chukar *Alectoris chukar*		June (Summer – Yellow)
	***Wurj*** Grey Wolf *Canis lupus*		September (Autumn – Red)
	***Khuchirf*** Long-tailed Marmot *Marmota caudata*		September (Autumn – Red)
	***Nakhcheer*** Siberian Ibex *Capra sibirica*		May (Spring – Green) June & August (Summer – Yellow)
	***Wokh*** Grasses		April & May (Spring – Green) June (Summer – Yellow) September (Autumn – Red)

Table 2.1: Table of Roshorv's indicator species including the (1) icon illustrations, (2) species according to the Bartangi, English, and scientific name, (3) depiction of the respective sequences in which the indicator appears in the ecological calendar, as well as (4) the time of year the indicator species emerge and how it is represented in the ecological calendar. These species include *mandozak*, *torwathich*, *tsatsao*, *zarez*, *wurj*, *khuchirf*, *nakhcheer*, and *wokh*.

Savnob Indicator Species

The village of Savnob has a total of four indicator species consisting of a plant, bird, mammal, and amphibian. These include the *akhar (*dog rose*, Rosa canina), qargha* (Red- and Yellow-billed Chough*, Pyrrhocorax pyrrhocorax and Pyrrhocorax graculus* respectively), *nakhcheer* (Siberian Ibex*, Capra sibirica*), and *kharbirj* (referring to the frogs and toads of the region). Relative to Roshorv, and aside from the Siberian Ibex, these indicators are completely unique to Savnob. See Table 2.2 below for their respective icons, associated sequences, and seasons in which they appear in Savnob's ecological calendar.

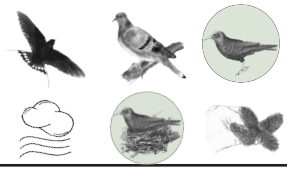
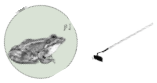
Icon	Indicator Species	Respective Sequence	Months
	***Akhar*** Dog rose *Rosa canina*		June (Summer – Yellow)
	***Qargha*** Red/Yellow- billed Chough *Pyrrhocorax pyrrhocorax/graculus*		March (Spring – Green) June (Summer – Yellow)
	***Nakhcheer*** Siberian Ibex *Capra sibirica*		June (Summer – Yellow)
	***Kharbirj*** Frog The order Anura		February (Winter – Blue)

Table 2.2: Table of Savnob's indicator species including the (1) icon illustrations, (2) species according to the Bartangi, English, and scientific name, (3) depiction of the respective sequences in which the indicator appears in the ecological calendar, as well as (4) the time of year the indicator species emerge and how it is represented in the ecological calendar. These species include *akhar, qargha, nakhcheer*, and *kharbirj*.

The croaking of frogs, likely the lake frog (*Rana ridibunda)* and green toad (*Bufo viridis),* are the first sign winter is coming to an end. Their calls are an indicator initiating the celebration of *Boj Ayom* in February. This event is a chance for villagers visit each other's homes to wish *Shogun Bahor* (a happy new year and happy spring). Many prepare *kochi* during this time. *Kochi* is a dish similar to porridge made from red wheat flour, milk, and water. After the croaking of frogs, the subsequent indicator species in Savnob's ecological calendar is the chough. The chough arrives with other migratory birds around *Navruz*, the vernal equinox. Although not an indicator in this first scenario, the chough reappears in the calendar around *Joth*, the summer solstice. Through the dusty weather, the chough's calls can be heard coming from their nests during their mating season. This is an indicator to collect mint.

June holds the most indicator species. Generally appearing slightly earlier than the chough indicator, when the weather has warmed, the ibexes are kidding. This informs herders to move their livestock to their highest pastures. This time period also corresponds to wolves threatening the livestock, which initiates hunting. But come mid-summer, the wolves shift to feeding on the abundant marmots. The final indicator, appearing at

the end of June, is the dog rose. This species simultaneously flowers when water flows into the Ruj pastures. The flowering of dog rose indicates turnips are ready to be harvested and planted for the second time.

Livelihood Activities

The narratives in the Bartang Valley ecological calendars are guided by multiple practices such as that of the farmer, herder, hunter, and gatherer. The calendar therefore provides adaptive capacity outlining what agropastoralists, among others, may experience throughout the year. Activities include, but are not limited to, the planting of chickpeas and the hunting of ibex in Roshorv as well as mating of goats and harvesting apples in Savnob (Figure 2.8).

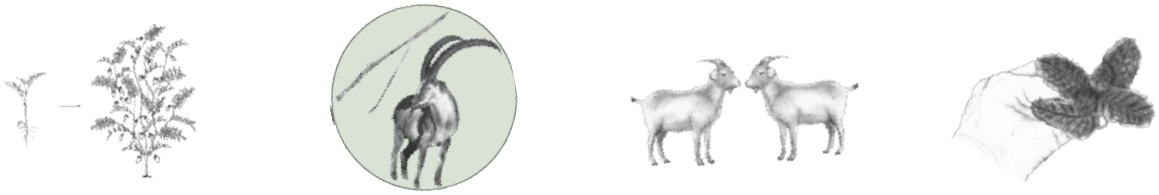


Image A: Roshorv Planting Chickpeas | Image B: Roshorv Ibex Hunting | Image C: Savnob Goats Mating | Image D: Savnob Apple Harvest

Figure 2.8: Icons of livelihood activities in the Bartang Valley. Images A and B, planting chickpeas and ibex hunting respectively, are icons present in Roshorv's ecological calendar. Images C and D, goats mating and apple harvest, appear in Savnob's ecological calendar.

Focusing on the herder's experience in Roshorv, livestock generally give birth throughout winter as a result of mating during the warmer season. Specifically, livestock keepers are focused on sheep, cows, and goats delivering young between December and February. Come February, some oxen need to be taken down to Yapshorv. This is necessary for their land to be plowed. Throughout March and April, the yaks require extra attention while they are calving. Additionally, plowing begins in April once the *zamin* (the land) becomes alive. In May, after planting is complete, sheep need to be sheared before they leave Roshorv for pasture. It takes from the end of May until early June to drive the livestock to Aqtash[3] and Gudhara pastures. Between July and August, it is common for cows to calve in the summer pastures before the temperatures drop. In response to cues and indicators in September, the shepherds bring their livestock back to the village. Community members will ensure the crops are harvested before the livestock return and then will assist in the herding process. Once again, as the sheep have returned to Roshorv, shearing occurs. It is only the cold and windy month of November, while winter is arriving, where the herders are not occupied with tasks noted on the ecological calendar. However, their livestock still need tending and it is time to settle in for another cold winter before the cycle continues.

In contrast, focusing on the herder's experience in Savnob, they are occupied with their goats kidding from March into May. After plowing the land in March and April, the yaks and cattle also need to be taken to the forest. This is generally only necessary if the snow has melted but there is not enough grass. However, if a fence is available, some livestock can be kept away from the crops until the middle of May. Furthermore, the beginning of May entails the oxen and donkeys need to be taken to pasture in Ruj. Once planting is completed around the end of May, livestock are moved to an Aqtash pasture, which is also used by yaks.

2 Aqtash pasture, also referred to as Aktash, is commonly used by various herders. Similar to other pastures, they are identified by several names (Kaziev, 2021).

Similarly, the goats and sheep are brought to pasture before the arrival of insects in Savnob. In June, when the weather is warm and the ibexes are kidding, herders move their livestock to Aqtash's top pastures.

Throughout this process, additional attention needs to be given to the cows, yaks, chickens, and sheep in Savnob. Overlapping with the goats, the cows are calving between April and May, the chickens from May to June, and the yaks from April through July. Additionally, it is common for sheep mating to occur in the summer, generally through June and July. The mating of goats, yaks, and cows typically begins at the end of August and lasts into October. The declining temperatures in September and October are a cue for herders to move their livestock to lower pastures. Rather than bringing them back to the village right away, they remain is this location until Savnob's harvests are complete. However, if their herds are under pressure from wolves, or the conditions are too wet, then this exception would encourage the herders to bring their livestock back earlier. When available, fences are used for the animals coming back from pasture, especially if harvest is not complete.

The winter months in Savnob, from the end of November into March, are spent tending to the livestock as it is time to settle in for another cold winter before the cycle continues. They are fed fodder collected over the summer months. During the coldest winter days, the animals are either fed three times a day or taken to winter pastures. However, pastures are only accessible if there is not too much snow, preventing some villagers from being able to feed their livestock if the roads are blocked. This is less of an issue for yaks that feed well during the summer (they eat about 60-70 kg of grass per day) as they will be able to keep on their weight during the winter.

Similar to the herder, this extrapolation can also be conducted for the farmer or hunter. The Bartang Valley's ecological calendars include the relative timing of seeding, tending, and harvesting crops as well as why those actions take place at their respective times. Furthermore, the calendar captures intricacies that indicate specifics such as when the evenings are warm enough for hunters to spend the night outdoors or when it is the best time to hunt. As displayed above, although these professions are discussed separately, there is incredible overlap and interconnectivity between these livelihood activities and the local habitat in which they reside. Each experience may be different, yet success is achieved through direct and indirect collaboration.

Potentially Threatening Events

In addition to sequences, cues, indicator species, and livelihoods events, the Bartang Valley ecological calendars include periods of recurring hardships relating to crops, temperature, livestock, and natural disasters. Emphasized by a red circle, these icons provide warnings of potentially dangerous or threatening events to the villagers and their livelihoods (Figure 2.9).

Image A: Roshorv Floods

Image B: Roshorv Crops Covered by Clay

Image C: Savnob Frost

Image D: Savnob Avalanche

Figure 2.9: Icons of potentially threatening events in Roshorv and Savnob, highlighted by a red circle in their ecological calendars. Images A-D depict floods, damage to crops, frost, and avalanches respectively.

Recent history shows spring to be the most troubling season in the Bartang Valley. The winter food storage runs low affecting both the villagers and their livestock. Illness is simultaneously becoming more prevalent with increasing temperatures and anxiety is growing. Preparation for the new season needs to occur however crop production will not begin until summer. Nonetheless, according to both Roshorv's and Savnob's ecological calendars, summer has the highest frequency of threatening events relative to the other seasons.

In Roshorv, crop related concerns begin in June as it is common for rust to affect the wheat yield. Across June and July, a variety of pests appear consuming crops. For example, it is common for caterpillars to arrive and feed on sorrel, apple, and apricot leaves. The month of July also commonly entails avalanches and floods (Image A in Figure 2.9) while August tends to have exceptionally high temperatures. These heat waves can harm the wheat and barley crops while causing glaciers to melt rapidly. The resulting increase in runoff sequentially covers the crops down river with clay (image B in Figure 2.9). Cherry trees also ripen in Yapshorv in August, enticing the Eurasian tree sparrows to their red fruits. In September, during the harvest season, the crimson winged finch arrives for the wheat and barley grains. September is also the month when wolves begin to threaten the livestock. This is due to the declining autumn temperatures, as marmots move into hibernation leaving the wolves with less food supply. Come winter, the end of November occasionally has very strong winds capable of picking up clay from the land. When transitioning into the coldest time of year, December, it is important that ample firewood was collected in October before the temperatures dramatically drop and snow appears. Although the snow begins to melt during the daytime in February, it ultimately covers the ground until the end of April.

In contrast to Roshorv, the first reasons for concern arrive in June as wolves begin threatening Savnob's livestock and strong winds blow through the village. Although these winds are occasional, they can damage roofs, cause injuries, and knock down large trees, including fruit trees. July commonly presents floods and the highest level of crop pests. It is specifically during *Nosh boz*, in Mid-July, when the rivers begin to flood and wash out the roads. Among many other pests, the caterpillar arrives in dry, warm years. Other common pests include mosquitoes, grubs, aphids, and grasshoppers.

In August, when harvesting occurs, migratory birds return to eat the ripe grains and fruit. Generally, these species include the hill pigeon, crimson winged finch, spotted great rosefinch, and the barn swallow. September corresponds to the first frosts, *khitsoom* (Image C in Figure 2.9). This frost arrives during the autumnal equinox, when the length of the day and night become equal. In order to protect their vegetables, it is important for Savnob villagers to harvest before *khitsoom*. Although the temperatures decline in September; they drop dramatically between October and November. The end of November also corresponds to the period of *Bolo Gordon*. This represents the return of bad tidings (i.e., weather events) such as avalanches, blocked roads, and other dangers (Image D in Figure 2.9). To avoid these hazards, the villages are precisely located outside of areas where avalanches occur. A tradition that predates Islam includes burning *strakhm* (immortelle, *Anaphalis virgata*), a medicinal plant, to ward off evil. Others choose to recite "balo-rad-sa, balo-rad-sa" and sacrifice an animal as a cleansing ritual. The coldest time of year arises between mid-December and mid-February. The migratory birds have already departed in November to avoid these temperatures and they will not return until the land begins to thaw at the end of March.

Updating the Ecological Calendar

The Bartang Valley's ecological calendars were designed to be organic and dynamic as an evolving and updateable record. The calendar's flexible design is easily adaptable, responding to fluctuations as it captures the nuances of varying experiential knowledge. However, as larger changes occur overtime, especially under conditions of climate change, the intention is for the community members to update their ecological calendar as was historically done with the calendar of the human body.

Once an understanding of the calendar's organization and contents have been achieved, observations of changes in the local environment, as well as impacts on the community members, can be introduced into the calendar. This is envisioned to provide anticipatory capacity; and therefore, assist in informing future decisions. However, this cycle of updating the calendar is continuous. The outcomes of actions, those which were influenced by the calendar, are also a form of necessary feedback with which to revise the calendar. Not only does this ensure Savnob's and Roshorv's ecological calendars remain effective with current conditions, but it also becomes a record of the local transformations taking place. Like the historical calendar of the human body, these ecological calendars are therefore evidence of the communities' adaptive capacity as it demonstrates human response to changes occurring in the environment.

Planning and Risk Management

Considering the circumstances of climate change, it would be beneficial to determine the vulnerability of Savnob's and Roshorv's key indicator and livelihood species to climate change. Such an assessment predicts how threatened a species is by the changing environment based on significant characteristics. This meaningful evaluation not only sheds light on whether the species is particularly sensitive to the varying environment, but it also would highlight cascading effects on the community.

Simply making this distinction by defining an indicator as vulnerable does not capture the level of detail needed for this to be a useful assessment. For example, a vulnerable species could be beneficial to the community if its behaviors are noticeably influenced by the local environment. The act of being responsive to external stimuli would be revealing for agropastoralists as indicator species dictate the timing of their activities. As this affects the probability of a successful harvest, it is a matter of livelihoods. However, an extremely sensitive species may no longer be able to survive under the new conditions. Irrespective of whether the species is capable of relocating, members of the Bartang Valley would be warned of the demise of this indicator in their village. This allows them to have more time to adapt to the new circumstances. Alternatively, if the vulnerability assessment determined the indicator to be incredibly insensitive, this species would not be in tune to subtle changes in the environment. Although the species will likely remain in the village, these sensitive characteristics are precisely what is needed to be an effective indicator. It is therefore the detail and precision of a vulnerability assessment that is essential to providing meaningful results.

Data from the International Union for Conservation of Nature (IUCN), thus far, recognizes two of Savnob's indicator species to have stable global populations. These include dog rose and the red- and yellow-billed chough. As for Roshorv, the grey wolf, long-tailed marmot, chukar, brown dipper, barn swallow and Himalayan snowcock have also been acknowledged to have stable global populations by the IUCN. However, specifics about the subspecies, when relevant, to Savnob and Roshorv are needed for an accurate vulnerability assessment. This is particularly critical for the Siberian ibex, although it has a stable population in the region, as their global population is threatened. Similarly, although the red-billed chough is currently not listed as a species of concern, their global population is declining. Climatic impacts are difficult to predict in mountainous ranges, therefore data collected in the village would be the most reliable. If such an assessment is of interest to the villagers in Savnob and Roshorv, thorough studies of these species specific to the Bartang Valley would be needed.

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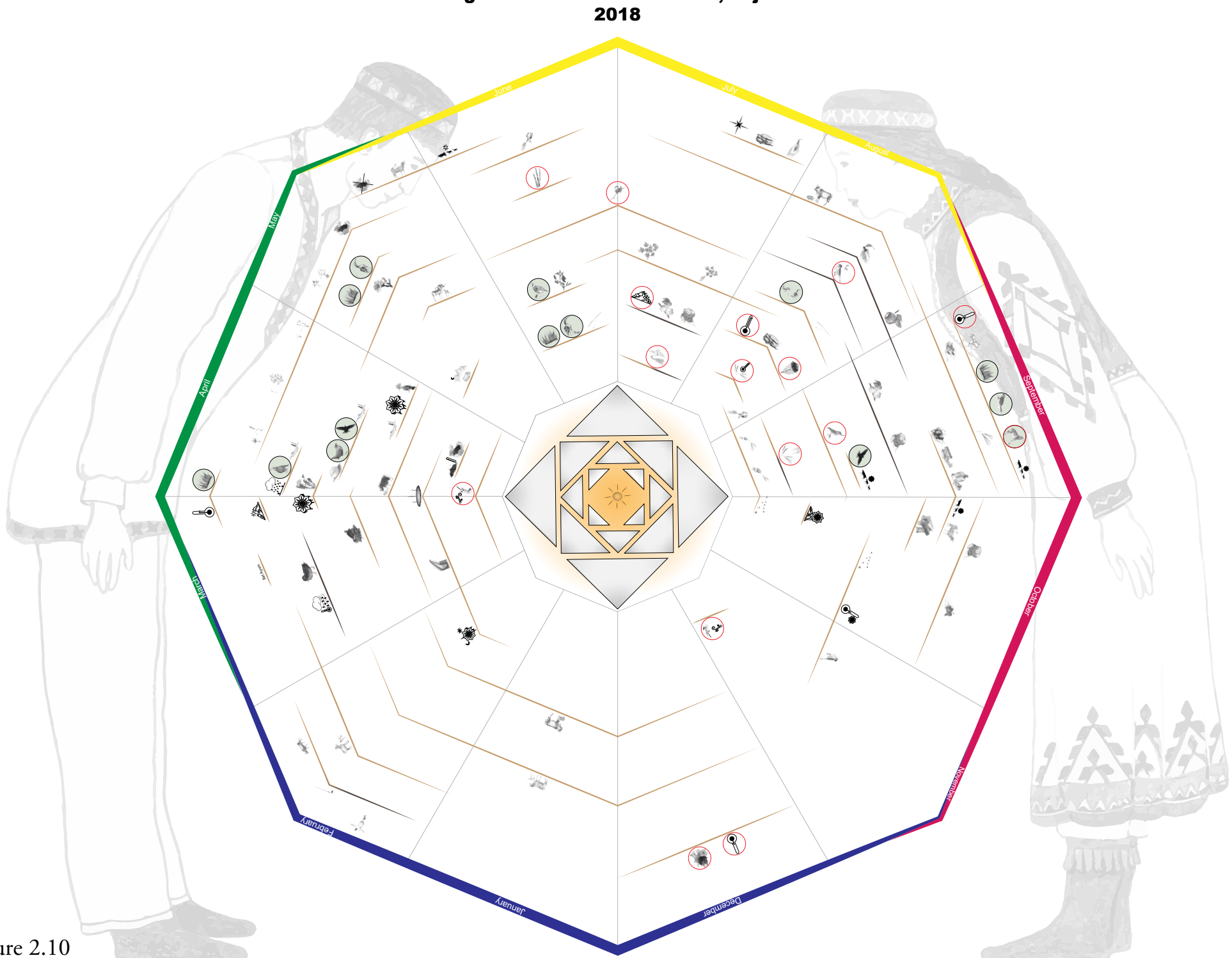
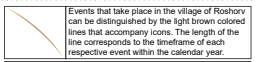
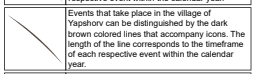
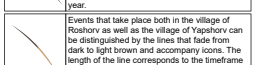

Ecological Calendar for Roshorv, Tajikistan
2018
June
July
August
May
April
September
March
October
February
November
January
December

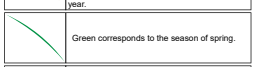
Figure 2.10

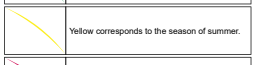
Legend for Ecological Calendar
Roshorv, 2018

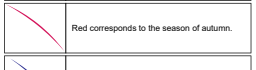

Events that take place in the village of Roshorv can be distinguished by the light brown colored lines that accompany icons. The length of the line corresponds to the timeframe of each respective event within the calendar year.

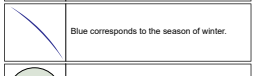

Events that take place in the village of Yapshorv can be distinguished by the dark brown colored lines that accompany icons. The length of the line corresponds to the timeframe of each respective event within the calendar year.

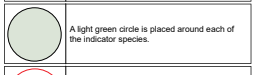

Events that take place both in the village of Roshorv as well as the village of Yapshorv can be distinguished by the lines that fade from dark to light brown and accompany icons. The length of the line corresponds to the timeframe of each respective event within the calendar year.

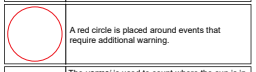

Green corresponds to the season of spring.

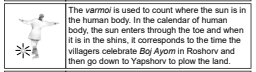

Yellow corresponds to the season of summer.

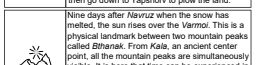

Red corresponds to the season of autumn.

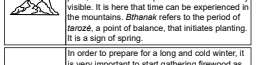

Blue corresponds to the season of winter.

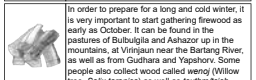

A light green circle is placed around each of the indicator species.

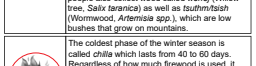

A red circle is placed around events that require additional warning.

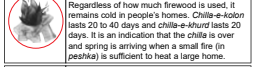

The *varmoi* is used to count where the sun is in the human body. In the calendar of human body, the sun enters through the toe and when it is in the shins, it corresponds to the time the villagers celebrate *Boj Ayom* in Roshorv and then go down to Yapshorv to plow the land.


Nine days after *Navruz* when the snow has melted, the sun rises over the *Varmoi*. This is a physical landmark between two mountain peaks called *Bthanak*. From *Kala*, an ancient center point, all the mountain peaks are simultaneously visible. It is here that time can be experienced in the mountains. *Bthanak* refers to the period of *tarozé*, a point of balance, that initiates planting. It is a sign of spring.

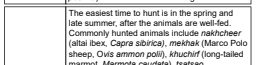

In order to prepare for a long and cold winter, it is very important to start gathering firewood as early as October. It can be found in the pastures of Bulbulgila and Ashazor up in the mountains, at Virinjaun near the Bartang River, as well as from Gudhara and Yapshorv. Some people also collect wood called *wenoj* (Willow tree, *Salix taranica*) as well as *tsuhm/tsish* (Wormwood, *Artemisia spp.*), which are low bushes that grow on mountains.

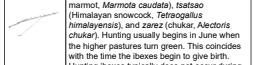

The coldest phase of the winter season is called *chilla* which lasts from 40 to 60 days. Regardless of how much firewood is used, it remains cold in people's homes. *Chilla-e-kolon* lasts 20 to 40 days and *chilla-e-kurd* lasts 20 days. It is an indication that the *chilla* is over and spring is arriving when a small fire (in *peshka*) is sufficient to heat a large home.

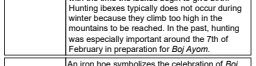

The easiest time to hunt is in the spring and late summer, after the animals are well-fed. Commonly hunted animals include *nakhcheer* (altai ibex, *Capra sibirica*), *mekhak* (Marco Polo sheep, *Ovis ammon polii*), *khuchirf* (long-tailed marmot, *Marmota caudata*), *tsatsao* (Himalayan snowcock, *Tetraogallus himalyensis*), and *zarez* (chukar, *Alectoris chukar*). Hunting usually begins in June when the higher pastures turn green. This coincides with the time the ibexes begin to give birth. Hunting ibexes typically does not occur during winter because they climb too high in the mountains to be reached. In the past, hunting was especially important around the 7th of February in preparation for *Boj Ayom*.

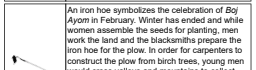

An iron hoe symbolizes the celebration of *Boj Ayom* in February. Winter has ended and while women assemble the seeds for planting, men work the land and the blacksmiths prepare the iron hoe for the plow. In order for carpenters to construct the plow from birch trees, young men would cross valleys and mountains to collect the wood. In the calendar of human body, this phase is symbolized by the sun entering through the toes and into the shins. The villagers celebrate *Boj Ayom* in Roshorv and then descend to Yapshorv to plow the land.

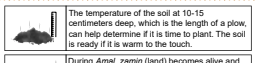
Bat Ayom — *Bat Ayom* is celebrated about a week before *Navruz* which occurs on March 21st.

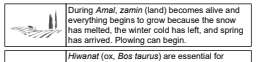

This icon represents the harvesting of crops. Vegetables are generally harvested before the end of September as this is before the livestock return. The most common vegetables grown in Roshorv include carrots, onions, beets, cabbage, garlic, tomatoes, cucumbers and *revand* (chickpea, *Cicer arietinum*). Generally, *chush* (barley, *Hordeum vulgare*) is harvested first, then chickpeas, *kilak Bartangi* (wheat, *Triticum aestivum*) and finally the other vegetables.

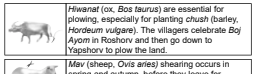

When the weather becomes cold, all the crops have to be harvested because the livestock are returning from their summer pastures.

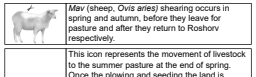

If a stone hits the ground and stops, rather than bounces, the land is no longer frozen and it is time to plow for the second and third time. This corresponds to the arrival of the *mandozak* (barn swallow, *Hirundo rastica*) and *torwathich* (brown dipper, *cinclus pallasii*).

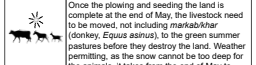

When steam rises from the ground, people sometimes decide to plow, but there is occasionally a late frost afterwards.

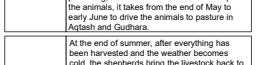

The temperature of the soil at 10-15 centimeters deep, which is the length of a plow, can help determine if it is time to plant. The soil is ready if it is warm to the touch.

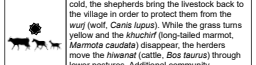

During *Amal*, *zamin* (land) becomes alive and everything begins to grow because the snow has melted, the winter cold has left, and spring has arrived. Plowing can begin.

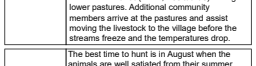

Hiwanat (ox, *Bos taurus*) are essential for plowing, especially for planting *chush* (barley, *Hordeum vulgare*). The villagers celebrate *Boj Ayom* in Roshorv and then go down to Yapshorv to plow the land.

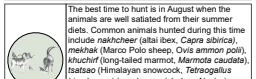

Mav (sheep, *Ovis aries)* shearing occurs in spring and autumn, before they leave for pasture and after they return to Roshorv respectively.

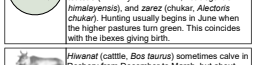

This icon represents the movement of livestock to the summer pasture at the end of spring. Once the plowing and seeding the land is complete at the end of May, the livestock need to be moved, not including *markab/khar* (donkey, *Equus asinus*), to the green summer pastures before they destroy the land. Weather permitting, as the snow cannot be too deep for the animals, it takes from the end of May to early June to drive the animals to pasture in Aqtash and Gudhara.

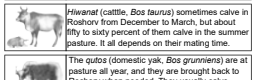

At the end of summer, after everything has been harvested and the weather becomes cold, the shepherds bring the livestock back to the village in order to protect them from the *wurj* (wolf, *Canis lupus*). While the grass turns yellow and the *khuchirf* (long-tailed marmot, *Marmota caudata*) disappear, the herders move the *hiwanat* (cattle, *Bos taurus*) through lower pastures. Additional community members arrive at the pastures and assist moving the livestock to the village before the streams freeze and the temperatures drop.

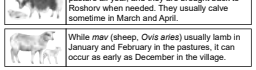

The best time to hunt is in August when the animals are well satiated from their summer diets. Common animals hunted during this time include *nakhcheer* (altai ibex, *Capra sibirica*), *mekhak* (Marco Polo sheep, *Ovis ammon polii*), *khuchirf* (long-tailed marmot, *Marmota caudata*), *tsatsao* (Himalayan snowcock, *Tetraogallus himalayensis*), and *zarez* (chukar, *Alectoris chukar*). Hunting usually begins in June when the higher pastures turn green. This coincides with the ibexes giving birth.

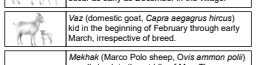

Hiwanat (cattle, *Bos taurus*) sometimes calve in Roshorv from December to March, but about fifty to sixty percent of them calve in the summer pasture. It all depends on their mating time.

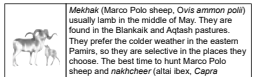

The *qutos* (domestic yak, *Bos grunniens*) are at pasture all year, and they are brought back to Roshorv when needed. They usually calve sometime in March and April.

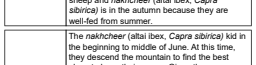

While *mav* (sheep, *Ovis aries*) usually lamb in January and February in the pastures, it can occur as early as December in the village.

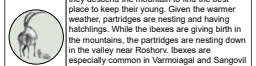

Vaz (domestic goat, *Capra aegagrus hircus*) kid in the beginning of February through early March, irrespective of breed.

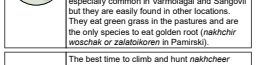

Mekhak (Marco Polo sheep, *Ovis ammon polii*) usually lamb in the middle of May. They are found in the Blankaik and Aqtash pastures. They prefer the colder weather in the eastern Pamirs, so they are selective in the places they choose. The best time to hunt Marco Polo sheep and *nakhcheer* (altai ibex, *Capra sibirica*) is in the autumn because they are well-fed from summer.

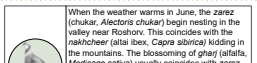

The *nakhcheer* (altai ibex, *Capra sibirica*) kid in the beginning to middle of June. At this time, they descend the mountain to find the best place to keep their young. Given the warmer weather, partridges are nesting and having hatchlings. While the ibexes are giving birth in the mountains, the partridges are nesting down in the valley near Roshorv. Ibexes are especially common in Varmoiagal and Sangovil but they are easily found in other locations. They eat green grass in the pastures and are the only species to eat golden root (*nakhchir woschak or zalatoikoren* in Pamirski).

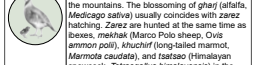

The best time to climb and hunt *nakhcheer* (altai ibex, *Capra sibirica)* is in autumn, if the weather is not too cloudy. Climbing begins in June when the pastures are green because the ibexes are at the top of the mountain and are well-fed from summer. Generally, only the largest ibexes are hunted, and the smaller ones are left for the upcoming years. Although spring is not the best time, the ibexes are easiest to hunt in spring because they are in the green pastures.

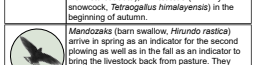

In the early spring, when shepherds arrive in the pastures, the *wurj* (wolf, *Canis lupus*) are exclusively hunting *khuchirf* (long-tailed marmot, *Marmota caudata*) and are therefore not a threat to livestock. But this changes in September when the marmots begin to hibernate. As a result, someone has to drive the *vaz* (domestic goat, *Capra aegagrus hircus*) to protect them. There has recently been an arrival of a new wolf. It is not afraid of humans and attacks more animals during the day. Comparatively, the local wolf used to only hunt at night, and it kept its distance from people. The new, larger wolf which shows up every day, is able to remove stones and clay from animal pens leaving the *mav* (sheep, *Ovis aries)* extremely vulnerable.

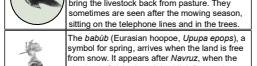

August is the best time to hunt *khuchirf* (long-tailed marmot, *Marmota caudata*) because they are well satiated from the summer. When shepherds arrive in the pastures the *wurj* (wolf, *Canis lupus*) are hunting marmots, but in September the marmots begin to hibernate and therefore the wolves become a major threat to the livestock. Marmots are also used as a source of medicine. People extract their oil for use and for sale. The oil warms the body.


This icon represents the migration of birds. The birds in Roshorv leave once the *kilak Bartangi* (wheat, *Triticum aestivum*) harvest is over. These include the: *kurak* (common Teal, *Anas crecca*), *mosY(kh)* and *kabitsor* (mallard, *Anas platyrhynchos*) as well as the *torwathich* (brown dipper, *cinclus pallasii*), *babùb* (Eurasian hoopoe, *Upupa epops*) and *mekhnul* (crimson winged finch, *Rhodopechys sanguineus*).


When the weather warms in June, the *zarez* (chukar, *Alectoris chukar*) begin nesting in the valley near Roshorv. This coincides with the *nakhcheer* (altai ibex, *Capra sibirica)* kidding in the mountains. The blossoming of *gharj* (alfalfa, *Medicago sativa*) usually coincides with *zarez* hatching. *Zarez* are hunted at the same time as ibexes, *mekhak* (Marco Polo sheep, *Ovis ammon polii*), *khuchirf* (long-tailed marmot, *Marmota caudata*), and *tsatsao* (Himalayan snowcock, *Tetraogallus himalayensis*) in the beginning of autumn.


Mandozakѕ (barn swallow, *Hirundo rastica*) arrive in spring as an indicator for the second plowing as well as in the fall as an indicator to bring the livestock back from pasture. They sometimes are seen after the mowing season, sitting on the telephone lines and in the trees.


The *babùb* (Eurasian hoopoe, *Upupa epops*), a symbol for spring, arrives when the land is free from snow. It appears after *Navruz*, when the plowing is finished, and the *kilak Bartangi* (wheat, *Triticum aestivum)* and *chush* (barley, *Hordeum vulgare*) are turning green. It stays until the end of summer, sometimes in trees.


The eagles stay in Roshorv all year including throughout the winter and make their nests in early spring when the *karshops* (magpies) are nesting. In the spring it is impossible to see the eagle nests because they are at the top of the mountains. Other birds that stay in Roshorv throughout the year are the *qargha* (red-billed chough and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *Pyrhocorax graculus* respectively) as well as the raven, and crow.

The *torwathich* (brown dipper, *cinclus pallasii*) is a small, dark colord bird that comes to Roshorv in the spring as an indicator for the second plowing. They stay in Roshorv during the summer and leave at the end of September.

The arrival and call of the *tsatsao* (Himalayan snowcock, *Tetraogallus himalayensis*) indicates that it is time to begin plowing as spring has arrived. *Tsatsao* arrive with the first spring rains once the snow has melted, a period described as *khushka sol*. In the winter, the *tsatsao* finds food in the pastures, where the *nakhcheer* (altai ibex, *Capra sibirica*) dig for grass.

When the temperature rises with light rain and fog at the end of March, the *kurak* (common teal, *Anas crecca*) appears on the river in Yapshorv. This is around the time of the *Navruz* celebration. The *mosY(kh)* and *kabitsor* (mallard, *Anas platyrhynchos*) are not long to follow. They generally go up to Lake Sarez to avoid being hunted in Yapshorv.

The *mekhnul* (crimson winged finch, *Rhodopechys sanguineus*) first flies to Yapshorv village and other *paytakht* villages while they are harvesting. Afterwards, it returns to Roshorv when the seeds are ripe. The *mekhnul* arrives at the same time every year in order to eat the ripe *kilak Bartangi* (wheat, *Triticum aestivum)* and *chush* (barley, *Hordeum vulgare*). Once the wheat and barley harvest is over the *mekhnul* disappears from the village.

The *charthoch* (Eurasian tree sparrow, *Passer montanus*) stays in Roshorv all year. They are known for eating the nearly ripened *gilas* (cherry, *Prunus avium*) in Yapshorv. Cherries generally ripen two weeks faster than *nosh* (apricot, *Prunus armeniaca*).

In August, *gilas* (cherry, *Prunus avium*) are harvested in Yapshorv. The *mun* (apple, *Malus spp.*) varieties also start to ripen in the middle of August.

On July 21st the Cold Star appears in the night sky. During this time the glacier freezes at the night and melts throughout the day. A couple days later the *tuth* (white mulberry, *Morus alba*) become ready for harvest in Yapshorv.

The Khorog *mun* (apple, *Malus spp.*) variety is not harvested until October. Apple and *nosh* (apricot, *Prunus armeniaca*) trees are the most common fruit trees because of Roshorv's elevation and having 8-14 hours of sun exposure, depending on the time of year. The apples tend to ripen just after the *gilas* (cherry, *Prunus avium*).

Mun (apple, *Malus spp.*) and *nosh* (apricot, *Prunus armeniaca*) trees are the most common fruit trees because of Roshorv's elevation and having 8-14 hours of sun exposure, depending on the time of year. The apples tend to ripen just after the *gilas* (cherry, *Prunus avium*).

Nosh (apricot, *Prunus armeniaca*) are usually ripe and ready to be harvested at the end of August to the beginning of September, but this varies with the variety. For example, the Yems variety is not ready until October when *kilak Bartangi* (wheat, *Triticum aestivum*) is being mowed.

Nosh (apricot, *Prunus armeniaca*) are usually ripe and ready to be harvested at the end of August to the beginning of September, but this varies with the variety. For example, the Yems variety is not ready until October when *kilak Bartangi* (wheat, *Triticum aestivum*) is being mowed. *Mun* (apple, *Malus spp.*) and apricot trees are the most common fruit trees because of Roshorv's elevation and 8-14 hours of sun exposure, depending on the time of year. The apricots tend to ripen two weeks after the *gilas* (cherry, *Prunus avium*) in Yapshorv.

Nosh (apricot, *Prunus armeniaca*) trees typically begin blossoming around the end of May.

Kilak Bartangi (wheat, *Triticum aestivum*) is ready to harvest when the spike bends down and the seed is too hard to bite. The wheat at higher elevations is ready to be harvested about ten days earlier than wheat at lower elevations. Although *turki* is occasionally planted, *rushtak (*red wheat, *Triticum spp.)* and *safedak* (white wheat, *Triticum spp.)* are the most common varieties. *Safedak* harvest occurs before *rushtak* and is followed by *turki*. There is generally a good wheat harvest when the weather is warmer throughout the spring, summer, and autumn. Wheat growth is only hindered if the spring is cold. These cold springs cause the respective wheat harvest to occur later in the year. In terms of sequence, wheat is generally harvested after *chush* (barley, *Hordeum vulgare*) but prior to kartoshka (potato, Solanum tuberosum). Birds start leaving once the wheat harvest is over.

Planting *kilak Bartangi* (wheat, *Triticum aestivum*) occurs when the weather becomes warm. *Rushtak* (red wheat, *Triticum spp.*) is planted ten days before *safedak* (white wheat, *Triticum spp.*) and it prefers warmer growing conditions. Wheat is generally planted before *revand* (chickpea, *Cicer arietinum*), followed by *chush* (barley, *Hordeum vulgare*), kartoshka (potato, Solanum tuberosum) , and other vegetables.

Common varieties of *kartoshka* (potato, *Solanum tuberosum*) include *kardinal* (red), *joidori* (a local variety), and *Jirgatol* (a larger variety brought from Jirgatol, in northern Tajikistan). All of these varieties grow well, but the *kardinal* variety is ready to harvest in July while *joidori* and *jirgatol* are ready in September. The harvesting of potatoes occurs after *kilak Bartangi* (wheat, *Triticum aestivum)* but before the livestock return from pasture.

Common varieties of *kartoshka* (potato, *Solanum tuberosum*) include *kardinal* (red), *joidori* (a local variety), and *Jirgatol* (a larger variety brought from *jirgatol*, in northern Tajikistan). All of these varieties grow well and there is no difference between growing them. They are all planted at the same time before the beginning of June. The potatoes require planting conditions of 8°C at a soil depth of 12 centimeters. Once the potatoes are planted, it is time to plant other vegetables.

Chush (barley, *Hordeum vulgare*) is mowed when the spike turns white and the seeds become too hard to bite. Typically, barley is harvested after *revand* (chickpea, *Cicer arietinum*) but before *kilak Bartangi* (wheat, *Triticum aestivum*).

Chush (barley, *Hordeum vulgare*) is ripe when the spike turns white and the seeds become too hard to bite.

Chush (barley, *Hordeum vulgare*) is often planted with *revand* (chickpea, *Cicer arietinum*) following the seeding of *kilak Bartangi* (wheat, *Triticum aestivum*). Planting barley requires *hiwanat* (catttle, *Bos taurus*) to plow the land. This is not the case for wheat and if barley is planted in the previous year, then the land does not need plowing the following year.

Revand (chickpea, *Cicer arietinum*) are ready to be harvested once the plant turns from green to yellow. After peas are harvested it is time to harvest *chush* (barley, *Hordeum vulgare*).

Revand (chickpea, *Cicer arietinum*) and *chush* (barley, *Hordeum vulgare*) are planted at the same time between the end of April to early May.

The icon depicting the gathering of *zira* (black cumin, *Bunium persicum*) is used to represent the collection of wild and medicinal plants. Generally, the best time to gather the flowering plants is in June and July of every year.

The icon depicting *zira* (black cumin, *Bunium persicum*) is used to represent the flowering of wild and medicinal plants. Generally, the best time to gather the flowering plants is in June and July of every year.

There are two varieties of *gharj* (alfalfa, *Medicago sativa*), a Russian variety which remains standing and a local variety which lies on the ground when it is mature. The livestock depend on both, so the alfalfa is mowed every year, but the local variety takes a little more effort to cut. There is also a field farther away from the village that does not require any care. This crop is mowed twice a year, in mid-June and at the end of August or beginning of September. Overall, there are three harvests, but in some cases, the third harvest does not occur because farmers are busy harvesting *kilak Bartangi* (wheat, *Triticum aestivum)*.

About fifty percent of the poor fields are used for grass and *gharj* (alfalfa, *Medicago sativa*). There are two varieties of alfalfa, a Russian variety which remains standing and a local variety which lies on the ground when it is mature. The livestock depend on both.

Assuming the *hiwanat* (ox, *Bos taurus*) are available, planting occurs after the snow has melted. Some people wait nine days after *Navruz* for the sun to travel between peaks at the *Bthanak* *Varmoi*. Others wait for the *schop*, soft and wet soil, to dry. That said, everyone plants during *broth* (May 8th - 9th) for a good harvest. However, only the land farther away from the water is planted. Ge

Once planting is complete, livestock are taken to the green summer pastures before they destroy the land.

The *zerd gulak/shirgulak* (dandelion, *Taraxacum officinale*) is a symbol of spring because they appear when the snow melts. Villagers prepare *zerd gulak* in a variety of ways. For example, the flower needs to be picked in the early morning and then put into a pot with sugar to create a substance similar to honey. After giving it 20 days to sit in a dark, cold place covered by a cloth, the sugar melts to create the desired sweetness. The roots can also be used for making coffee.

When there is warm weather at the end of March and early April the *wokh* (various grass and sedge species) turns green around the water spring. In May, the *nakhcheer* (altai ibex, *Capra sibirica*) move to the lower pastures that are beginning to turn green. Once the grass turns yellow autumn is arriving. At this point, the *khuchirf* (long-tailed marmot, *Marmota caudata*) disappear from the pastures causing *wurj* (wolf, *Canis lupus*) to threaten the livestock. In order to protect them, the herders move their livestock to lower pastures.

Rust affects *kilak Bartangi* (wheat, *Triticum aestivum)* in mid-June.

Mur caterpillars will eat seeds from seedpods, leaves of sorrel (horse cabbage/shoruha), as well as *nosh* (apricot, *Prunus armeniaca*) and *mun* (apple, *Malus spp.*) leaves until the trees become dry. Other common pests include *zadetch/chidishk* (grasshopper, *Caelifera spp.*), *chirum* (grey grub), and *shakorak* (green aphids, *Sappaphis pirі).*

Every two to three years, there are about ten days in August when rapid warming causes the glacier to melt quickly and push clay down the river. If the clay is not carried down the river, then the black clay runoff covers the farmland like plastic. This prevents the water from permeating, thereby affecting the crop yields. During these years, it is important to water the land early in the morning, before the clay enters the water.

There can be a cold spell in September called *Xitscewn*. Although *Xitscewn* is rare, the frost lasts for three days and it can harm the *kilak Bartangi* (wheat, *Triticum aestivum)* and *chush* (barley, *Hordeum vulgare*) crop. This is more common in Yapshorv.

Occasional very hot weather in August impacts the crops for a couple of days. The *kilak Bartangi* (wheat, *Triticum aestivum)* begins to wilt, turn yellow and fall over. The heat also misleadingly whitens the wheat as if it is ripe. Although this is unusual, it causes a very poor harvest because it dries the crop.

In October and November, the cold temperatures and snow begin to stay for the winter. At this point the migratory birds have left but a few species remain in Roshorv including the *charthoch* (Eurasian tree sparrow, *Passer montanus*).

The temperatures begin to drop in September. The pastures become covered by snow and the streams freeze. This is an indication that it is time to bring the livestock from summer pasture. By the time the cold temperatures and snow stay for the winter, the migratory birds have left.

After winter the warmer temperatures are an indication that it is time to plow and plant crops.

Every two to three years in August there is rapid warming. This causes the glacier to melt quickly and push clay down the river. The black clay runoff can cover the farmland like plastic.

The streams freezing is an indication that the temperatures are dropping and that it is time to bring the livestock back from the summer pastures to the village.

The wind in March and April is usually light, but by the end of November strong gusts occasionally arrive that pick up the clay from the land.

Fjenko, Grumgujumailo, and Lapnazar glaciers affect the land around Roshorv. Given that the glaciers are very close to the village, sunny days allow for the cold water to reach the crops. How close one lives to the glacier influences when people begin to plow and plant their crops. In August, there are about ten days when the water from the glacier is mixed with clay. This occurs every two to three years during rapid warming. It is important to water the land early in the morning, before the clay gets into the water. If the weather slowly warms, then the glacier will also slowly melt, not causing any problems.

On July 21st the Cold Star appears in the night sky. The glacier freezes during the night and melts during the day. A couple days later the *tuth* (white mulberry, *Morus alba*) are ready for harvest in Yapshorv.

In the spring, the snow freezes overnight. People can walk on it without it cracking but during the day the snow becomes soft in the sun. This period of *tafi-zamin* is a sign that winter is ending. *Tafi-zamin* occurs during *tarozé* (a point of balance) when the sun rises between two points in the mountain peaks called *Bthanak*.

Snow arrives In Roshorv once autumn is over. Often the first snow in the mountains occurs in early October.

During winter the snow is typically dry, but the snow becomes wet when winter ends. During this transition the snow melts enough to form a crust. *Bijens* is the process of putting clay on the snow to expedite melting. If there is still snow after April 1st then it is common for *bijens* to be used. Once the snow is completely melted in the village and the soil feels warm to the touch, it is time to begin plowing and planting.

In Thew Dara (Devil's Valley) there are three land/mud slides in mid-July. The first landslide is a sign of the ripening of the *nosh* (apricot, *Prunus armeniaca*) in Yapshorv. The occurrence of avalanches and rockfalls are unusual. They are more common in years with a lot of snow and it can be detrimental to homes.

Fog is common in the spring accompanied by warm temperatures and rain. Sometimes when it is raining in Yapshorv it would be snowing in Roshorv.

It is very common for there to be rain in the spring around May, but there is less rain during the summer. Sometimes when it is raining in Yapshorv it would be snowing in Roshorv.

Obdow refers to the days when there is rapid warming which means swift water in the irrigation channels. This occurs before *Navruz* and lasts until steam comes from ground (*tafi-zamin*). The timing of *obdow* changes depending on the weather. If the spring is warmer, then *obdow* is earlier, but if there is more snow then it might not occur until mid-April. It is not possible to plow during *obdow* as there is still snow and the land is frozen. Once *obdow* is over and the snow is melted then it is possible to plow.

In July, due to rapid melting, both the stream and the river flood in Roshorv and Yapshorv. When this occurs, it becomes sandy and it is difficult to irrigate the lands with water.

Once it is warm enough for the hunters to spend the night in pastures, it is a sign for the arrival of spring. This suggests that it is time to plow and seed the land.

Ecological Calendar for Savnob, Tajikistan
2018

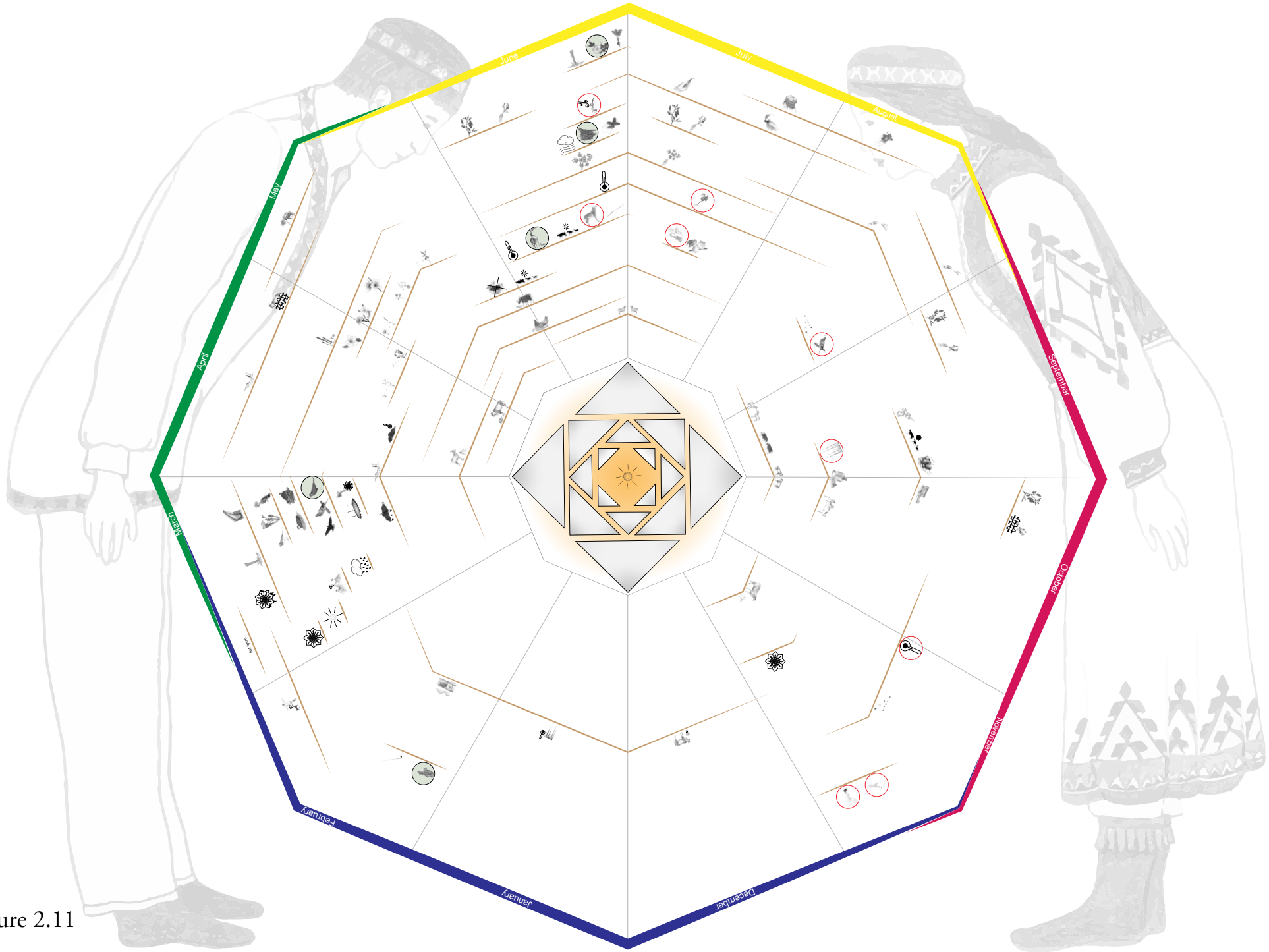


Figure 2.11

Legend for Ecological Calendar
Savnob, 2018

Events that take place in the village of Savnob can be distinguished by the light brown colored lines that accompany icons. The length of the line corresponds to the timeframe of each respective event within the calendar year.

Green corresponds to the season of spring.

Yellow corresponds to the season of summer.

Red corresponds to the season of autumn.

Blue corresponds to the season of winter.

A light green circle is placed around each of the indicator species.

A red circle is placed around events that require additional warning.

When the sun reaches the *varmoi*, it indicates the start of spring and harvesting time for various species of plants in the fall.

After the sun enters the female dog (*oftob ba Kid*), it then goes through the human body (*oftob ba mard/xhūr ba mard*) around February when the land becomes alive.

In winter the primary tasks are housework and feeding the livestock. Common housework includes cooking, cleaning, and removing snow that has collected on the roof.

The irrigation channels are cleaned, repaired and opened for the first time in March. This is celebrated by sacrificing an animal and performing a *Khudo* where blessings are given, and food is shared.

The period of *Bolo Gordon* represents the return of bad things such as avalanches, blocked roads and other dangers. A tradition that predates Islam includes burning straxhm (immortelle, *Anaphalis virgata*) to ward off evil. Others choose to recite "balo-rad-sa, balo-rad-sa" and sacrifice an animal as a cleansing ritual.

In June, when the weather begins to warm, the *nakhcheer* (altai ibex, *Capra sibirica*) give birth and the herders move to high pastures in Aqtash. When *wurj* (grey wolf, *Canis lupus*) start attacking the livestock, hunting begins.

Boj Ayom marks the period of preparations from the 8th to 12th of February. It is the beginning of a small *Navruz*. People bring the farmer's tools to their homes and use them in the fields. This is a sign that spring work has begun.

Bat Ayom

Bat Ayom is similar to *Boj Ayom* but it occurs one month later from the 8th to 12th of March. People visit each other's homes to wish them *Shogun Bahor* (a happy new year and happy spring). Many cook *kochi* during this time which is similar to a porridge made from *rushtak* (red wheat, *Triticum spp.)* flour, milk and water.

The celebration of *Sol Pokhta* marks the completion of the harvest season in Savnob, often accompanied by a frost that lasts two to four days at low elevations. This thanksgiving festival is celebrated by beating sickles together (*thos-vithd*) while singing, "We will bear seed next year." This is accompanied by games, music, and *Kikhtov*, the sacrifice of an animal for the celebration.

Harvesting marks the season of autumn. Everyone tries to harvest their crops before the frost and avoid days with rain. The birds join in and eat the *kilak Bartangi* (wheat, *Triticum aestivum*). The sequence in which crops are harvested begins with *chush* (barley, *Hordeum vulgare*) and is followed by *safedak* (white wheat, *Triticum spp.*), *rushtak* (red wheat, *Triticum spp.*), *kartoshka* (potato, *Solanum tuberosum*), and other vegetables. This must occur before the animals return from their summer pasture. If the livestock are fenced in, they do not pose a threat to the crops and harvesting can occur later.

All the crops have to be harvested before the livestock return from summer pasture. The celebration of *Sol Pokhta* marks the completion of the harvest season. There is often a frost that occurs at the same time in Savnob lasting two to four days at low elevations.

From mid-March until mid-April the soil is partially dry referring to *sah-e-zamin* (the land above the canal). Plowing begins around April first.

At the end of March, the weather is warming, the snow is melting, and steam is rising from the ground. This is the period of *tafi-zamin*, at the end of *tarozé*, where the length of the day and night are becoming equal and the snow is melting on both the earth and in the sky. When the steam is visible, plowing begins on higher ground because the snow melts at a faster rate and therefore the land is drier at higher elevations. The melting of snow influences when the soil can be seeded.

If the soil is above ten degrees Celsius, planting can occur. The soil is warm to its touch.

Navruz represents the vernal equinox on March 21st. Afterwards, the oxen come out for plowing from April to May while various bird species arrive. The snow must be melted, and the land has to begin to dry. Any precipitation will delay this process. The livestock are kept in a fenced area, so they are not able to disturb the land. Once the plowing is finished, the oxen and *markab/khar* (donkey, *Equus asinus*) are taken to pasture in Ruj.

If there is less snow, livestock can be taken to pasture which is used by some *qutos* (domestic yak, *Bos grunniens*) all year. Other yaks may return to Savnob if needed. These larger animals as well as cows are first taken to the forest (*voyd-boeth* or *kanabin*) when the snow has melted in April before they are taken to the Aqtash pasture in May. Once plowing is finished, the oxen and *markab/khar* (donkey, *Equus asinus*) are taken to pasture in Ruj. The smaller animals such as *vaz* (domestic goat, *Capra aegagrus hircus*) and *mav* (sheep, *Ovis aries*) are taken to pasture when there is less snow and before the arrival of the insects in Savnob. Moving the livestock to Aqtash indicates summer. In June, when the weather warms and *nakhcheer* (altai ibex, *Capra sibirica*) give birth, the herders move the livestock to its top pastures.

In late September to early October the temperatures begin to drop, streams freeze, and ice forms in the water buckets. The livestock are now moved to lower pastures and *chush* (barley, *Hordeum vulgare*) and *kartoshka* (potato, *Solanum tuberosum*) crops are harvested. Winter is about to arrive. The livestock do not come back to Savnob before harvest unless the climate is too wet or *wurj* (grey wolf, *Canis lupus*) are threatening their survival.

Once plowing is finished, the oxen and *markab/khar* (donkey, *Equus asinus*), are taken to pasture in Ruj.

Although *chakh* (chicken, *Gallus gallus domesticus*) are rare in Savnob, chicks hatch between May and June, especially if they are kept in a well-attended chicken coop protected from foxes.

The larger animals such as *quotos* (domestic yak, *Bos grunniens*) and *hiwanat* (cattle, *Bos taurus*) are first taken to the forest (*voyd-boeth* or *kanabin*) when the snow has melted in April. They are later brought to the pasture at Aqtash in May. Moving the animals from temporary pastures to Aqtash is referred to as *kuch tayd*. The livestock are only taken to the forest if there is not enough grass, before the insects arrive.

If a fence is available, the livestock are kept away from the plowing or the blossoming of fruit trees. Fences are often used once the animals come back from pasture. If there is no space, harvesting must occur before the livestock return to avoid damage to the crops.

One of the main tasks during winter is to feed hay to the livestock. Preparation for this begins in the summer as watering the land and gathering grass is necessary to have enough fodder. During the coldest winter days, the animals are fed three times a day, but when the snow is not much more, they can be taken to the winter pastures. Some villagers are not able to feed their livestock, if the roads are blocked by snow and there is no access to grass. If the *quotos* (domesti yak, *Bos grunniens*) feed well during the summer (they eat about 60-70kg of grass per day), they will be able to keep on their weight during the winter.

Mav (sheep, *Ovis aries*) mate in June and July in the summer pastures.

Mav (sheep, *Ovis aries*) lamb in November.

Hiwanat (cattle, *Bos taurus*), *quotos* (domestic yak, *Bos grunniens*), and *vaz* (domestic goat, *Capra aegagrus hircus*) mate in the Aqtash pasture between August and October.

Hiwanat (cows, *Bos taurus*) can mate and calve at any time during the year, but many are born between March and May.

Vaz (domestic goat, *Capra aegagrus hircus*), *quotos* (domestic yak, *Bos grunniens*), and *hiwanat* (cows, *Bos taurus*) mate from late August to the beginning of October in the Aqtash pasture.

Vaz (domestic goat, *Capra aegagrus hircus*) are born between March and May.

Quotos (domestic yak, *Bos grunniens*) mate between August and September because the males and females are generally kept separate. The herder goes to the mountain to count and check on them, but the male yaks do not come back to the camp.

Quotos (domestic yak, *Bos grunniens*) calve from April to July. Once the calves are born, they are taken from their mothers and kept at camp. The females are free to roam during the day and then come back to their calves at night. The yaks prefer not to stay in Savnob because they are sensitive to *tevd* (mosquito, *Culicidae spp.*). Generally, yaks are only brought back to Savnob to be slaughtered.

Wurj (grey wolf, *Canis lupus*) are a threat to livestock. In June, during warmer temperatures, they threaten *quotos* (domestic yak, *Bos grunniens*), *hiwanat* (ox, *Bos taurus*), *mav* (sheep, *Ovis aries*), and *markab/khar* (donkey, Equus asinus). The *nakhcheer* (altai ibex, *Capra sibirica*) are giving birth while the herders move their livestock to the top pastures of Aqtash. In midsummer the wolves feed on the abundant *khuchirf* (long-tailed marmot, *Marmota caudata*). In autumn, the wolves arrive in Savnob when the shepherds are coming back from pasture.

Nakhcheer (altai ibex, *Capra sibirica*) kid when the weather warms and the herders move to the top of the pastures in Aqtash.

The croaking of *kharbirj* (lake frog, *Rana ridibunda* and green toad, *Bufo viridis*) is the first indication that winter is over, initiating the celebration of *Boj Ayom* in February.

The beginning of spring is marked by the *zhon* (golden eagle, *Aquila chrysaetos*) nesting and calling from the tops of the mountains. It occurs around *Navruz*, the vernal equinox, and corresponds to the time of plowing.

Around *Joth*, summer solstice, you can hear the *qargha* (red-billed and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *graculus* respectively) calling in their nests during their mating season. Mint is also being collected, but during this time of year, the weather is dusty, and trees should not be planted (*afghanka*).

The *qargha* (red-billed and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *graculus* respectively) arrive in Savnob around *Navruz* with the *khofta* (hill pigeon, *Columba rupestris*) and *mandozak* (barn swallow, *Hirundo rastica*).

The *mandozaks* (barn swallow, *Hirundo rastica*) are a small black bird with a forked tail. They arrive around the same time as the *khofta* (hill pigeon, *Columba rupestris*) and *qargha* (red-billed and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *graculus* respectively), usually during plowing, and return in August at the time of harvest. Some use the *mandozacks* nest for medicine.

The arrival of ducks from the south marks the end of winter. The *churpai (Eurasian coot, Fulica atra), sholtarkal/kabitsor* (mallard, *Anas platyrhynchos*) frequent the river. While the *churpai* is completely black, the *sholtarkal* is brown with a rest crest, and the *kabitsor* is a red-brown. They nest in Savnob and leave in autumn depending on the weather. These birds used to be hunted as a source of food.

The *khofta* (hill pigeon, *Columba rupestris*) appears in Savnob around *Navruz* accompanied by the *mandozak* (barn swallow, *Hirundo rastica*) and *qargha* (red-billed and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *graculus* respectively). The *khofta* is sometimes hunted for food.

When harvesting occurs, the migratory birds return to eat the ripe grain. These include the *khofta* (hill pigeon, *Columba rupestris*), *mekhnul* (crimson winged finch, *Rhodopechys sanguineus*), *rashslt/khinsit* (spotted great rosefinch, *Carpodacus severtzovi*), and *mandozak* (barn swallow, *Hirundo rastica*). They sometimes also eat *noxh* (apricot, *Prunus armeniaca*) that ripen later in the year.

The *ghil ghilok* (white wagtail, *Motacilla alba*) is the first bird to arrive in March once winter has ended. This small bird has black on top and is white underneath. Its arrival in Savnob, which is weather dependent, marks the season of plowing and planting. During colder temperatures it will appear later.

The *babüb* (Eurasian hoopoe, *Upupa epops*) is one of the first birds to appear in spring. It arrives around the same time as the *ghil ghilok* (white wagtail, *Motacilla alba*), once the plowing is over. They don't eat the harvest and leave before winter.

The arrival of ducks from the south is an indication that winter has ended. Many other migratory bird species arrive after the ducks including the *ghil ghilok* (white wagtail, *Motacilla alba*), *qargha* (red-billed and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *graculus* respectively), *mandozak* (barn swallow, *Hirundo rastica*), *khofta* (hill pigeon, *Columba rupestris*) and *babüb* (Eurasian hoopoe, *Upupa epops*). In autumn, the migratory birds, *mekhnul* (crimson winged finch, *Rhodopechys sanguineus*), *rashslt/khinsit* (spotted great rosefinch, *Carpodacus severtzovi*), *mandozak*, and *khofta*, return to eat the ripe grain. The *charthoch* (Eurasian tree sparrow, *Passer montanus*) and *karshops* (magpies) stay in the village all year.

Gilas (cherry, *Prunus avium*) blossom in April before becoming ripe and ready to harvest in late June through early August. The *tuth* (white mulberry, *Morus alba*) ripen at the same time as cherries in July.

The *tuth* (white mulberry, *Morus alba*) ripen and are harvested at the same time as *gilas* (cherry, *Prunus avium*) in July.

Mun (apple, *Malus spp.*) become ripe and ready to harvest in late July through August. They blossom in late April to early May, but if there is a lot of snow, they begin later.

Nosh (apricot, *Prunus armeniaca*) trees blossom in late April and then ripen for harvest between July and August.

The first *nosh* (apricot, *Prunus armeniaca*) become ripe during *Nosh boz* in mid-July. This is the same time the rivers begin to flood and wash out the roads.

The *nosh* (apricot, *Prunus armeniaca*) and *mun* (apple, *Malus spp.*) trees blossom in late April and early May, producing fruit in July and August. If there is a lot of snow, they begin to blossom later, however if the weather is dry, it occurs earlier. They generally blossom just after the *gilas* (cherry, *Prunus avium*) trees and before the *tuth* (white mulberry, *Morus alba*).

Gilas (cherry, *Prunus avium*) trees blossom in late April and are ready to be harvested in July to early August. They usually blossom just before *mun* (apple, *Malus spp.*), *nosh* (apricot, *Prunus armeniaca*), and *tuth* (white mulberry, *Morus alba*).

Chelgi/shaftalu (peach, *Prunus persica*) blossom in late April to early May and are ready to be harvested in July to early August. If there is a lot of snow, they blossom later. Although peaches can be grown in Savnob, they usually come from Rushan or Khorog.

Kilak Bartangi (wheat, *Triticum aestivum*) harvest occurs from August to September. *Safedak* (white wheat, *Triticum spp.*) is harvested at the same time as *kilak* (soft wheat), which is about ten days before *rushtak* (red wheat, *Triticum spp.*), but *rushtak* is less common because it struggles with the warmer water and disease. The wheat is used for human consumption, often to make bread, yet the sparrows also enjoy eating both varieties.

Kilak Bartangi (wheat, *Triticum aestivum*) is planted between April and May. People look for steam coming from the ground as a sign for planting. *Rushtak* (red wheat, *Triticum spp.*) is usually planted before *safedak* (white wheat, *Triticum spp.*). Generally, *chush* (barley, *Hordeum vulgare*) and *ghaj* (alfalfa, *Medicago sativa*) are planted first, followed by wheat, *kartoshka* (potato, *Solanum tuberosum*), and other vegetables such as onions, carrots, cabbage, and *rediska* (turnip, *Brassica rapa rapa*).

Chush (barley, *Hordeum vulgare*) is harvested in July to early September. It is cut with *hiwanat* (ox, *Bos taurus*) and then allowed to dry. It is primarily used as fodder today, but historically it was a staple food made into bread.

Chush (barley, *Hordeum vulgare*) is planted around April. If there is a lot of snow, then planting will occur later. Some also look for the steam coming from the ground (*tafi-zamin*) to indicate that it is time to plant.

The time to plant *joidore* potatoes (*Solanum tuberosum*) is between April and the beginning of May after *chush* (barley, *Hordeum vulgare*), *ghaj* (alfalfa, *Medicago sativa*) and *kilak Bartangi* (wheat, *Triticum aestivum*), but before other vegetables such as onions, carrots, cabbage, and *rediska* (turnip, *Brassica rapa rapa*).

Kartoshka (potato, *Solanum tuberosum*) are harvested between the end of September and the beginning of October because, shortly after, the *hiwanat* (cattle, *Bos taurus*) come back from summer pasture. The timing usually coincides with the movement of livestock to the lower pastures. The temperatures begin to drop during this time, forming ice in streams and buckets.

The harvest and planting of *rediska* (turnip, *Brassica rapa rapa*) for the second time in late June coincides with the flowering of *akhar* (dogrose, *Rosa canina*) in the village. At the same time, water flows into the pastures in Ruj.

Rediska (turnip, *Brassica rapa rapa*) are planted after *chush* (barley, *Hordeum vulgare*). They prefer cool weather, so this crop occasionally struggles in Savnob due to the warmer temperature and insect pests.

In Savnob, there are four *ghaj* (alfalfa, *Medicago sativa*) harvests. The first harvest is in the beginning of June, the second in mid-July, the third at the beginning of September, and the fourth at the beginning of October. *Ghaj* has to be fenced during the fourth harvest to protect it from livestock.

There are four *ghaj* (alfalfa, *Medicago sativa*) harvests in Savnob, but the fourth harvest can only occur if the *ghaj* is fenced. It would take place in the beginning of October when the livestock have returned from their summer pastures.

In Savnob are four *ghaj* (alfalfa, *Medicago sativa*) harvests. Once the alfalfa begins to flower from 30 to 70 percent, it is time to harvest.

Ghaj (alfalfa, *Medicago sativa*) is planted as fodder for livestock at the same time as *chush* (barley, *Hordeum vulgare*) and it thrives when the soil is saturated.

The icon depicting the gathering of the *zira* (black cumin, *Benium persicum*) plant represents the collection of wild and medicinal plants that usually takes place during June and July. Common plants collected include *zira*, which is used for blood pressure regulation, *chaber* (capper, *Capparis spinosa*) for tuberculosis, *rag-vohkak* (broadleaf plantain, *Plantago major*) for stomach problems, *yob/strakhm* (imortelle, *Anaphalis virgata*) a diuretic, *withn/virn* (wild mint, *Mentha asiatica*) as a tea, *khichiftkhorth/qaysarqula* (catnip, *Nepeta glutinosa*) applied to areas with injured bones, and *tsakh* (wild onion, *Allium spp.*) used as food.

The icon of *zira* (black cumin, *Bunium persicum*) represents the flowering of wild and medicinal plants. Usually the flowering and gathering of wild plants is best in June and July. Its root can be made into tea and its seeds can be added to foods like *pilau*. It has a pleasant smell and is effective against headaches.

Withn/virn (wild mint, *Mentha asiatica*) is harvested during *Joth*, summer solstice. It has a green flower and is used in tea, soup, and for animal fodder. It is believed to be good for all ailments including the stomach.

When akhar (dogrose, *Rosa canina*) begins to flower in the village, water simultaneously comes to the pastures in Ruj. This is similar in timing to the harvest and planting of *rediska* (turnip, *Brassica rapa rapa*) for the second time around late June.

Zerd gulak/shirgulak (dandelion, *Taraxacum officinale*) blossoms first in spring, coinciding with the first appearance of ducks. If there is a lot of snow, its arrival can be delayed. *Zerd gulak* can be used as stomach medicine.

The *mur (caterpillar, Pieris brassicae)* icon is a placeholder for all common insect pests in Savnob, as there are *tevd* (mosquito, *Culicidae spp.*), *chirum* (grey grub), *shakarak* (green aphids, *Sappaphis piri*), and *zadetsh/zhidishk* (grasshopper, *Caeliifera spp.*). The *mur* does not appear every year but prefers warm and dry weather.

Vegetables are planted in spring after steam comes from the ground (*tafi-zamin*) and the land is warm. After *chush* (barley, *Hordeum vulgare*), *kilak Bartangi* (wheat, *Triticum aestivum*), *ghaj* (alfalfa, *Medicago sativa*), and *kartoshka* (potato, *Solanum tuberosum*) are planted, then it becomes time to seed the remaining crops.

Planting is finished in late May when the *mav* (sheep, *Ovis aries*) and *vaz* (domestic goat, *Capra aegagrus hircus*) are taken to the summer pasture.

Khitsoom, frost, occurs when the days become equally long during the autumnal equinox. In order to protect all vegetables, they need to be harvested before *khitsoom*.

The darkest and coldest time of year is when the land is frozen. The days are shorter than the nights during the *chilla-e-kalon* in early December. This lasts for approximately 40 days. The *chilla-e-khurd* follows for another 20 days. As the days are slowly lengthening, quid arrives and everything becomes alive again after having died during winter.

The coldest time of year is between mid-December and mid-February. The migratory birds have left before winter when the temperature begins to drop.

Avalanches are common during *Bolo Gordon*, the return of bad tidings. Often roads and pathways between villages become blocked and hazardous. To avoid danger, the villages are located outside of these areas. This is similar to a *Khudo* where blessings are given, and food is shared.

Freezing streams in the Aqtash pasture is an indication to move the livestock to lower grounds. Aqtash is at a higher elevation than Savnob so if herders wake up in the morning to ice in water buckets, they know it is time to return. This cold weather arrives in late September and early October.

During *tafi-zamin*, at the end of March, the weather is warming, the snow is melting, and steam can be seen coming from the ground. Some villagers choose to spread sand on the snow to help it melt faster.

Snowfall indicates the arrival of winter. It provides needed moisture to the crops and wild plants. If there is too much snow, the land remains wet and cold in the spring. This can be very dangerous for the livestock in April. The animals quickly lose weight and they have to travel far to find food. Planting will have to occur later, likely resulting in a poor harvest. Additionally, a winter with heavy snow can cause the *wurj* (grey wolf, *Canis lupus*), *nakhcheer* (altai ibex, *Capra sibirica*), foxes, and leopards to come down from the mountain to the village. Alternatively, in a dry year with little snow, the plants fade early in the spring which also has an impact on the animals.

Winter has ended when the warm sun is shining brightly, and the snow is melting. The snowflakes are filled with water, called *palak*, and the land is in *namnok*, meaning it has wet soil. When the snow melts in the gorge, water begins to run making streams. It is possible to see the steam coming (*tafi-zamin*) out of the land indicating that the soil is drying and now ready to plow and plant. This is an indication of spring.

When the first rain appears, it means winter has ended. Most of the rainfall occurs in spring, yet heavy rain in July and the beginning of August can damage *kilak Bartangi* (wheat, *Triticum aestivum*) and *chush* (barley, *Hordeum vulgare*).

Dust is very common around *Joth*, the summer solstice. This weather is also called *afghanka* and occurs when the *qargha* (red-billed and yellow-billed chough, *Pyrhocorax pyrrhocorax* and *graculus* respectively) are calling in their nests and mint is being gathered. It is advised not to plant trees during *afghanka*.

The sun shining brightly indicates heat.

Warm temperatures in Savnob occur between June and August. In June, the *nakhcheer* (altai ibex, *Capra sibirica*) give birth, herders move to the highest of the pastures in Aqtash, *wurj* (grey wolf, *Canis lupus*) attack the animals, and hunting takes place. It is also common for pests to appear during this warm period between June to July.

Water runs into the pastures in Ruj at the same time the *akhar* (dogrose, *Rosa canina*) begins to flower. This also occurs during the second harvest and planting of *rediska* (turnip, *Brassica rapa rapa*). The source of water in Savnob comes from glaciers and snow. It is available in both the dry and in the wet years. With rising temperatures in the summer, the glacier melts more rapidly. In July and August, the water from the spring is too warm and can kill the crops. Cooler weather and cooler water are needed for agriculture.

During *Nosh boz*, in Mid-July, the rivers begin to flood and wash out the roads at the same time the first *nosh* (apricot, *Prunus armeniaca*) ripen.

There are occasional strong winds in late June which can damage roofs, cause injuries and knock down large trees, including fruit trees.

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

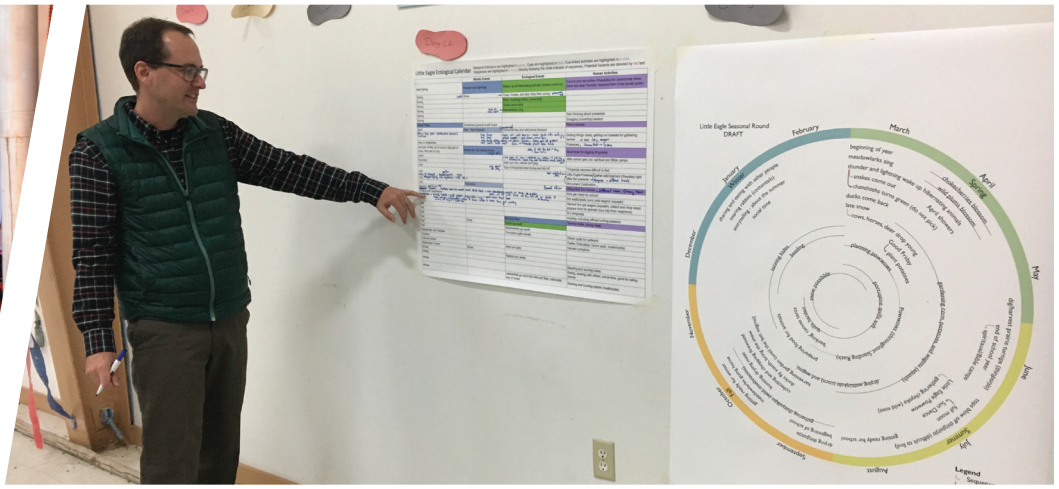
on the web, means the validation can be achieved more easily. In addition, new insights and ecological relationships can easily be added.

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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