



Climate change vulnerability assessment of six flagship mammal species in Central Asia



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Acronyms and Abbreviations

CAMCA – Central Asian Mammals and Climate Adaptation project

CBD – Convention on Biological Diversity

CMIP6 – Coupled Model Intercomparison Project

CMS – Convention on the Conservation of Migratory Species of Wild Animals

CRU – Climate Research Unit

IPCC – Intergovernmental Panel on Climate Change

NDC – Nationally Determined Contribution

R95pTOT – 95th percentile of wet-day precipitation amounts, indexed for a chosen reference period

RCP – Representative Concentration Pathway

SSP – Shared Socioeconomic Pathways

SVA – Species Vulnerability Assessment

UNEP – United Nations Environment Programme

UNCCD – United Nations Convention to Combat Desertification

UNFCCC – United Nations Framework Convention on Climate Change

WWF – World Wide Fund for Nature (World Wildlife Fund)



Introduction

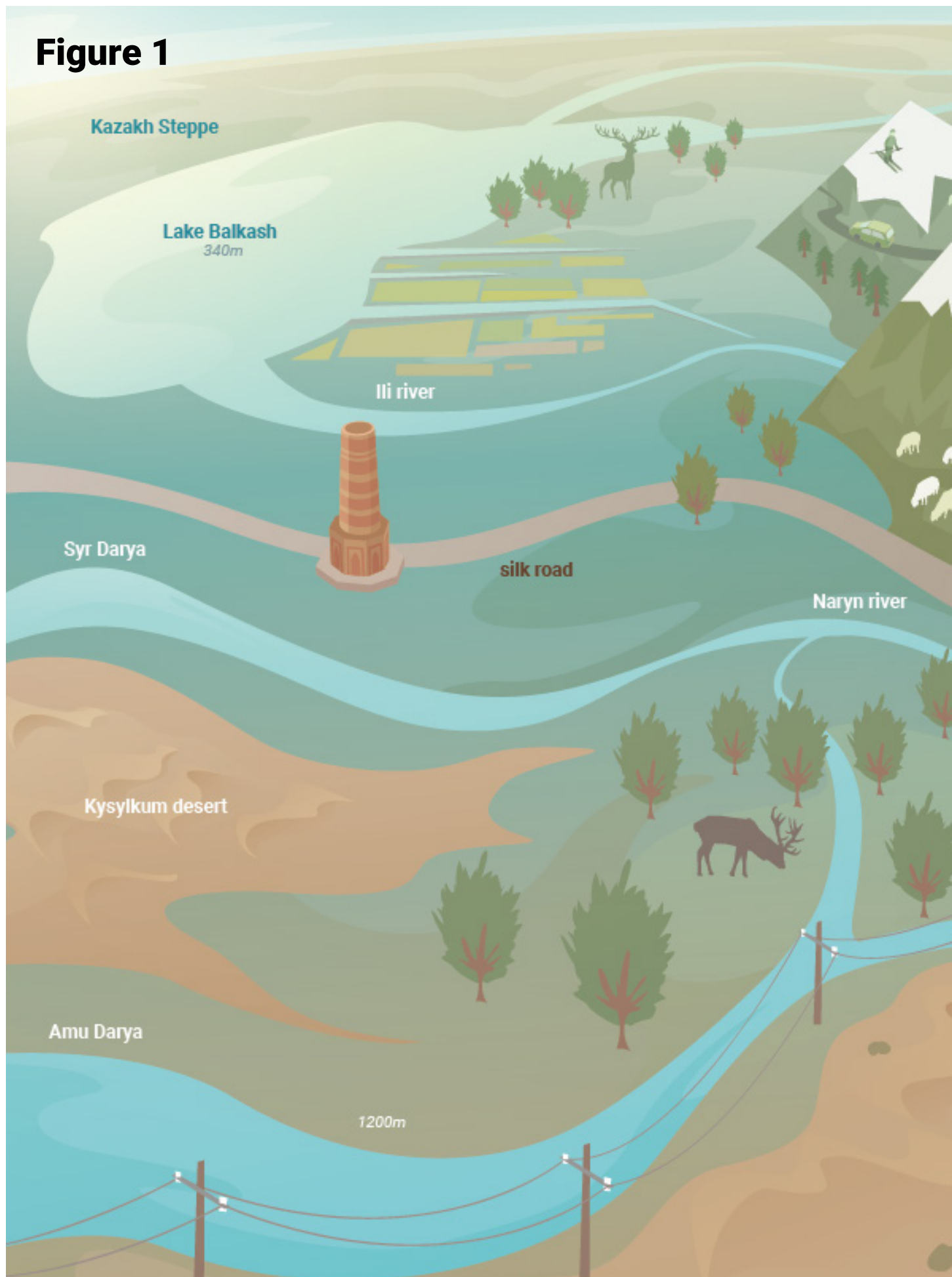
Central Asia is a vast region of contrasting landscapes that stretches from the barren Ustyurt Plateau in the west to the Tien-Shan mountain range in the east, covering five countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. The great differences in altitude of individual parts of this territory – from areas lying below sea level to the highest mountain peaks – create an extraordinary variation in geomorphology, climate, and ecosystems (Fig. 1).

Central Asia's mountains hold immense ecological, cultural, and economic significance. They are not only home to numerous enigmatic species but also serve as critical sources of fresh water, food, and livelihoods for millions of people. In the mountainous landscapes of the Pamirs and the Tien-Shan, foothills are generally characterized by semi-deserts, which are replaced by steppe and forest-steppe landscapes at higher altitudes, followed by subalpine and alpine meadows. At altitudes above 3,500 m, permanent snow, rock, and glaciers dominate the landscape. The total glaciated area in Central Asia covers more than 17,000 km². Glaciers feed a well-developed network of rivers that flow down from the mountains to form lakes such as Ysyk-Köl in Kyrgyzstan, and Balkhash in Kazakhstan. These river valleys and deltas with fertile soils provide

favourable conditions for both wildlife (such as Bukhara deer) and communities living in otherwise arid, nutrient-poor saline steppes, semi-deserts, and deserts adjacent to the mountains. Climate change, combined with heavy regulation of water along some rivers (i.e., dams and irrigation) in Central Asia, threatens these riparian ecosystems and the species inhabiting them.

The mountains of Central Asia are a recognized global biodiversity hotspot and home to many endemic and endangered species. Central Asian countries deserve recognition for making great strides towards conserving and restoring these wildlife populations and ecosystem services. However, despite these efforts, mountain and associated downstream wetland ecosystems remain under pressure throughout the region from land degradation and human-wildlife conflict, among other threats. In addition, according to the IPCC Sixth Assessment Report (AR6), the biodiversity of mountain ecosystems is especially vulnerable to the negative effects of climate change. Climate change exacerbates existing anthropogenic pressures, further threatening mountain species, reducing water storage capacity, and disrupting other ecosystem services that people have relied on for thousands of years.

Figure 1





Migratory species might adapt to climate change by altering their movement patterns and habitat use, which may expose populations to increased human-wildlife conflict and other threats. Fences and roads pose barriers to the movement of flagship species in search of suitable habitat and food, decreasing their resilience. Livestock grazing in the region has generally increased in both intensity and duration, and shifted to higher elevations due to climate change, leading to human-wildlife conflict, poaching, and encroachment on species' habitats. The general public and the conservation sector have low awareness about the impacts of climate change on biodiversity and associated ecosystem services, resulting in inaction and a lack of proactive policies. For example, integration of climate change considerations into biodiversity and ecosystem management, in particular in the management of protected areas, is not yet sufficiently applied, and is lacking in decision-making across many sectors that rely on ecosystem services provided by the Central Asian mountains.

The United Nations Environment Programme (UNEP) has teamed up with several international and local partners in the Central Asian Mammals and Climate Adaptation (CAMCA) project, funded by the International Climate Initiative of the German government. The project works with communities and governments to increase the resilience of flagship mammal species and associated mountain ecosystems to climate change and related threats. Simultaneously, it supports communities to diversify into biodiversity-positive alternative livelihoods to increase their resilience and reduce their impacts on the ecosystem. Under the CAMCA project, these flagship species are:



Snow Leopard (Panthera uncia), the smallest of the world's large cats



Argali (Ovis ammon), a wild sheep species



Asiatic ibex (Capra sibirica), a wild goat species



Tien-Shan maral (Cervus canadensis songoricus), a wapiti subspecies



Bukhara deer (Cervus hanglu bactrianus), a subspecies of Tarim red deer, recently recognized as a distinct deer species



Tien-Shan brown bear (Ursus arctos isabellinus), a brown bear subspecies.

The project benefits both wildlife, protected areas, and local communities in six pilot sites in Kazakhstan, Kyrgyzstan, and Tajikistan by supporting climate change-informed, community-based wildlife management inside and outside of protected areas, and reducing human-wildlife conflict and other pressures on wildlife and ecosystems. Within the framework of the CAMCA project, partners completed an assessment of the vulnerability of each of these flagship species to climate change.

This report provides an overview of the observed and projected climate change-induced impacts on the six project species, their ecosystems, and interactions with people based on recent scientific studies, publications, experts' field observations, and focus group interviews. The report evaluates their vulnerability to climate change via a qualitative scale, identifies knowledge gaps, and provides recommendations for possible adaptation measures relevant for species conservation, the management of protected areas, and community livelihoods.

These findings can inform strategy and planning documents (e.g., on protected areas, pasture, water, infrastructure, and energy management planning) on how to consider the climate vulnerability of the species, their habitats, and associated ecosystem services.





Climate change trends in Central Asia

Central Asia, particularly the mountainous regions of Kyrgyzstan, Tajikistan, and eastern Kazakhstan, is experiencing climate change impacts at a rate significantly exceeding the global average. The observed mean surface temperature increase in the region is clearly beyond the range of internal variability compared with 1850–1900. For instance, the average annual temperature in Kyrgyzstan increased by 1.2 °C between 1960 and 2023, which is double the global average of 0.6 °C, and this rise is expected to accelerate in the coming decades.

Tajikistan is also projected to experience temperature increases significantly above the global average, with potential annual mean temperature increases of up to 6.3 °C by 2080. Concurrently, heat extremes have increased while cold extremes have decreased, a trend that is expected to persist. Tajikistan, for example, is projected to experience 12.5 more heat days (above 40 °C) by 2080, with tropical nights (temperatures not falling below 20 °C) reaching almost 10 nights per year by the same year. While average and heavy precipitation are projected to increase over much of Asia, there is considerable uncertainty in predictions. Central Asia is no exception, and

regional studies indicate a shift towards decreasing precipitation in summer and autumn and increased precipitation in winter. Under a 1.5 °C warming scenario, mean annual total precipitation could increase by 7.7% and heavy precipitation by 26.6%. It is generally accepted that an increase in precipitation intensity is likely. In Tajikistan, a total of 3.5 heavy precipitation days is expected by 2080 under Representative Concentration Pathway (RCP)8.5.

The accelerated warming and changing precipitation patterns mean that the region will reach critical thresholds rapidly, leading to more immediate and pronounced climate impacts than in many other parts of the world. One critical consequence is glacial retreat and permafrost thaw across the region. Glaciers in the Tien-Shan and Pamir mountain ranges, which are vital “water towers” for Central Asia, have melted by 14% to 30% over the last 60 years, with the rate intensifying. Kyrgyzstan and Tajikistan are the primary water providers for the region. In Kyrgyzstan, glacier area has already decreased by 20%, with concerns that most glaciers could disappear by 2100.



Seasonal snow duration, glacial mass, and permafrost area are projected to decline further by mid-century. While glacier run-off in the Asian high mountains may initially increase up to mid-century, it is projected to decrease subsequently due to the loss of glacier storage. This will increase variability in river discharge and fluctuations in water availability and quality, while warmer temperatures will increase water demand. Furthermore, receding glaciers have created new hazards, as meltwater forms new lakes that can cause dangerous torrents downstream. Thawing permafrost, combined with excess water, can destabilize the ground, leading to landslides and mudflows, rockfalls, and avalanches.

The combination of increased temperature with more-or-less stable precipitation amounts and increasing precipitation intensity leads to predictions of significant drought conditions in most of Central Asia (more than 60%). A global overview of the changes in probability of meteorological drought conditions under different warming scenarios suggests the Central Asian region will be among the most affected. What would previously have been a 1 in 100-year drought event is projected to occur around once every 15 years under 2 °C of global warming, a threshold likely to be surpassed under both RCP6.0 and RCP8.5. These climate shifts translate into significant sectoral vulnerabilities, particularly for agriculture, energy, infrastructure, and the environment. Agriculture across Central Asia is

highly susceptible to climate extremes, directly impacting food production and security. While general temperature increases may extend the growing season and expand suitable croplands, and increased precipitation could benefit grasslands, warming will also exacerbate water deficits and increase the risk of droughts and extreme heat events. In Central Asia, agriculture relies heavily on irrigation. An increase in warm days, changes in overall precipitation amounts and patterns, and an increase in consecutive dry days will exacerbate drought conditions and elevate demand for irrigation.

Availability of irrigation water is adversely affected by the decline of water volume stored in snowfields and glacier ice, which act as seasonal and inter-annual buffers. Crop yields in Tajikistan are projected to drop by 5% to 30% by 2050. Fodder grasslands in these areas will also be adversely affected, impacting livestock husbandry. Moreover, extreme weather events and natural hazards such as droughts, floods, mudslides, landslides, avalanches, rockfalls, windstorms, and forest fires regularly destroy land, crops, infrastructure, and livelihoods across the region.

Beyond direct economic and infrastructure damage, climate change is intensifying existing anthropogenic impacts on ecosystems, again with dire social consequences. It is fundamentally restructuring mountain ecosystems by forcing biological zones to shift in elevation, and altering

the delicate balance between wildlife and human livelihoods. Unsustainable land-use practices, such as high livestock density and inadequate pasture management, have led to soil erosion and degradation. Desertification is a substantial threat, with over 1.7 million hectares of pasture rated as highly degraded in Kyrgyzstan and subject to desertification.

As temperatures rise and water availability at lower altitudes changes, mountain forests and pastures are moving to higher elevations and decreasing in total area. High-altitude species, such as the snow leopard and its primary prey, the ibex, and argali, are expected to see their habitats shrink and may have to relocate as they are pushed into smaller, more fragmented pockets of rugged terrain.

The upward shift of mountain pastures is bringing pastoralist communities into closer contact with wildlife. In mountain regions such as the Tien-Shan and Pamir, Asiatic ibex and argali sheep are increasingly forced to compete for forage with domestic livestock and are displaced from prime habitat due to disturbance by herders and their dogs. Climate-driven pasture degradation accelerates this competition, as herders maintain livestock in high summer pastures for longer periods. As wild prey populations decline or shift, snow leopards may turn to domestic livestock for food. In Tajikistan, spatial overlap between

snow leopards and pastoralists is projected to increase by 4% to 17%, leading to higher rates of livestock depredation and subsequent retaliatory killings by herders. In addition, climate change and the resulting modified patterns of land use and wildlife ranges can increase the transmission risk of zoonotic diseases between livestock, domestic dogs, and wildlife. High mortality among mountain ungulates (wild goats and sheep) not only disrupts the ecological balance but also impacts the livelihoods of communities that depend on these ecosystems for both grazing and emerging ecotourism sectors.

The following chapters will detail climate impacts on wildlife species and their interaction with human adaptation strategies in the CAMCA project focal areas. Nevertheless, it is noted that environmental and socioeconomic impacts are not isolated but compound each other, creating a complex web of vulnerabilities. This leads to significant economic multipliers, where climate-change impacts and environmental degradation directly translate into substantial gross domestic product losses and increased poverty, creating a feedback loop that hinders sustainable development and nature restoration.





Project Focal Areas

This chapter provides a brief description of the CAMCA project focal areas in Kazakhstan, Kyrgyzstan, and Tajikistan, focusing on climate change impacts on ecosystems and flagship species.

Kazakhstan

The climate of Kazakhstan is distinctly continental due to its distance from the ocean, with prolonged hot summers and cold winters with sharp daily and annual fluctuations in air temperature. Maximum average precipitation occurs from April to July, while the minimum occurs from August to September. According to the 8th National Communication and the 5th Biennial Report of the Republic of Kazakhstan to the United Nations Framework Convention on Climate Change (UNFCCC), a comparison of long-term average ambient temperature values for two consecutive periods (1961–1990 and 1991–2020) indicates that the country's average annual temperature has increased by 0.9 °C. February and March warmed most significantly – by 2.0 °C and 1.7 °C, respectively. July and December temperatures have changed little. The territory's average annual

precipitation has not changed significantly. Nonetheless, some months show an increase, with the highest documented for February (+15.6%), while precipitation values in September and October decreased (-10.8% and -14.8%, respectively). An analysis of trends in extremes of surface air temperature and precipitation, based on meteorological station data for the period from 1961 to 2021, shows the following:

- a steady increase in the number of days with temperatures above 30 °C to 35 °C, particularly noticeable in the south, south-west, and west of the republic
- a countrywide increase in the total duration of heat waves and a reduction in the total duration of cold waves
- a countrywide steady increase in the duration of the vegetation season (with an average daily temperature above 5 °C) and the sum of positive temperatures for the vegetation season
- in many regions, an appreciable reduction in the number of days with frost and severe frost, defined as a daily minimum air temperature of below 0 °C and -20 °C, respectively

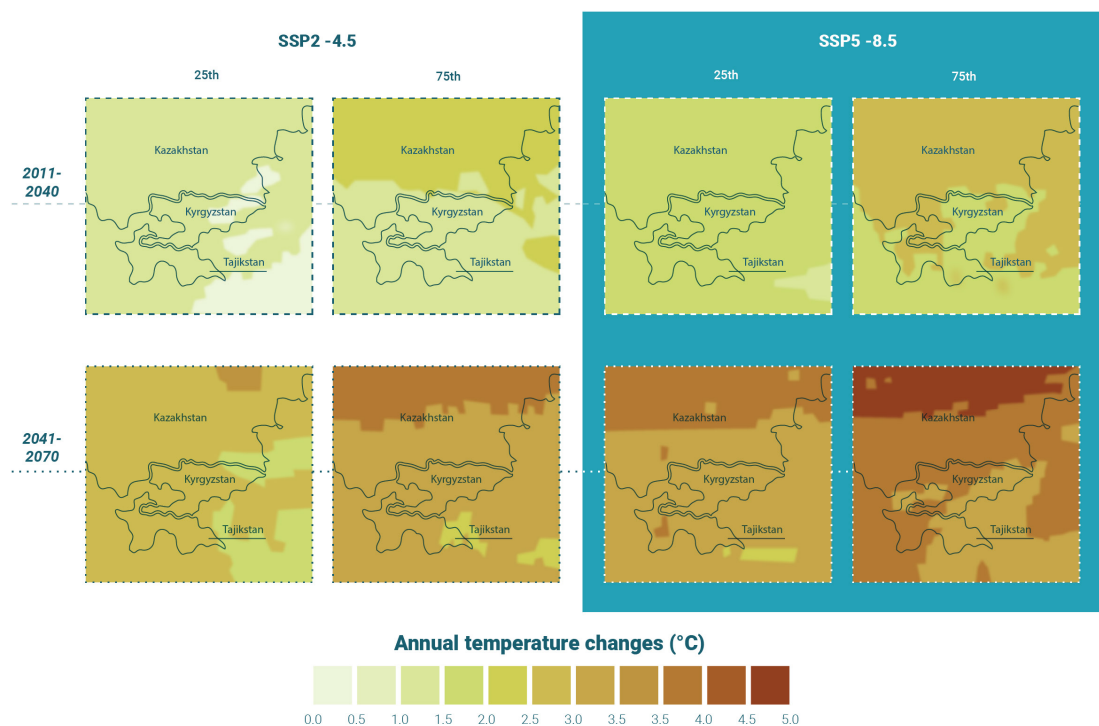


Fig. 2: Projected changes in annual mean temperature under scenarios SSP2–4.5 (left) and SSP5–8.5 (right) for 1981–2010. The 25th and 75th percentiles of the model ensemble are reported for each scenario and future period. Protected areas are shown in purple. (Source: Crespi et al., 2023)

The projected changes with respect to the baseline in annual mean temperature are also spatially homogeneous over the entire area under Shared Socioeconomic Pathways (SSP)2–4.5 and SSP5–8.5, with more pronounced increases in the northern part of the CAMCA focal area, in the south-east of Kazakhstan (Fig. 2). Similar temperature changes are projected by 2040, but discrepancies between the two scenarios gradually increase over the second half of the century, for example, in the Khan Tengiri area, in the high mountains of Kyrgyzstan near the border with Kazakhstan (Fig. 3). Projected changes in annual temperatures suggest that the south-east of

Kazakhstan, including the Ili River Delta and Lake Balkhash, will experience an even higher increase in average annual temperatures by 2040 (1.3 °C under SSP2-4.5; 1.5 °C under SSP5-8.5) and 2070 (2.6 °C and 3.4 °C, respectively) than the adjacent mountains of the Tien-Shan. In the nearby Dzungar-Alatau, projected temperature increase is slightly less pronounced (2040: 1.4 °C and 2.4 °C; 2070: 1.4 °C and 3.3 °C) than in the Ile-Balkhash region. These temperature increases are projected to be combined with moderately increased precipitation. In the Ile-Balkhash region, however, the aridity of the climate will remain or increase.

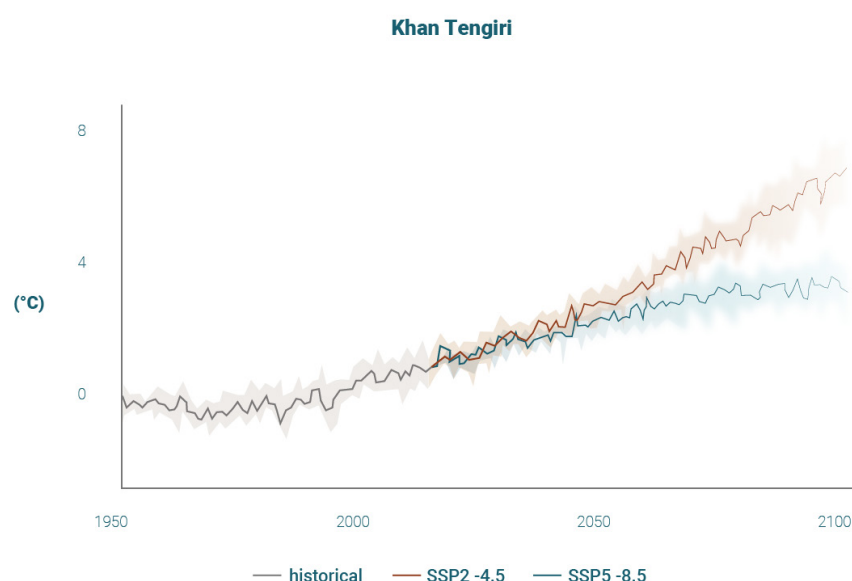


Fig. 3: Projected mean annual temperature changes for Khan Tengiri (Kyrgyzstan) under SSP2–4.5 and SSP5–8.5. The solid line is the ensemble median, while the dashed areas are the interquartile range (25th–75th percentiles). (Source: Crespi et al., 2023)

In mountain regions, increasing temperatures are expected to reduce the proportion of snow in precipitation totals, leading to reduced water storage and higher inter-seasonal and inter-annual fluctuations in river flow. The **Ile-Balkhash Reserve** project site (Fig. 4) is in the south-east of the country in the Almaty region. The 1,439 km Ili River flows from the snow and glacial Tien-Shan Mountains in China, with tributaries originating in Kazakhstan and Kyrgyzstan, into Lake Balkhash in Kazakhstan.

Due to the aridity of the lower parts of the river's catchment, most of its flow originates from the high mountain areas, which receive more precipitation than the lowlands. The Ili River enters the lake through an 8,000 km² wetland delta of meadows, reeds, and tugai, a characteristic mixed riparian community of trees and shrubs. The delta contains the Ile-Balkhash Reserve, the Pribalkhashskiy Nature Sanctuary, and the Karaoisky Nature Sanctuary, all Ramsar sites and under protection by the government of Kazakhstan. Climate change impacts on the Ili River ecosystem begin with changes in precipitation and glacial melt from the upstream Tian-Shan mountains. The glaciers that feed water to the river are retreating, creating serious water shortages in areas where water demand is expected to grow.

In the intermontane valley, uncharacteristic rising temperatures and rainfall are leading to more flooding in the winter and drier summers, causing droughts and dust storms. The shifting climate conditions in these interdependent ecosystems connected by the Ili River are creating complex food and energy challenges in the region. Traditional "grey" infrastructure, diverting water from the river for irrigated croplands upstream within and outside Kazakhstan, seriously threatens the lake and delta. Changes in water supply to the delta have also led to a decline in tree cover. *Tugai* riparian ecosystems are crucial habitats for the Bukhara deer population. In addition to natural shelters, especially during the breeding season and hot seasons, tugai forests provide food for deer.

Tugai forests act as a water regime controller in the area, since the moisture retained by the leaf litter and topsoil layer allows for grassland growth in summer. Another project site is **Dzungar-Alatau National Park** (Fig. 4), in the Dzungarian Alatau mountain system (part of the Tien-Shan mountains), stretching almost 450 km from the west-south-west to the east-north-east along the border of Kazakhstan and China. The Dzungarian Alatau mountain system consists of several – but mainly two – parallel, high mountain ranges, of which only the northern and north-western parts lie within the borders of Kazakhstan.

Dzungar-Alatau is projected to become drier (via evapotranspiration from temperature increase), exceeding any projected precipitation increase, and resulting in a higher probability of drought occurrence. The projected increase in heavy rainfall events would reduce the water retention of vegetation, soil, and groundwater, and cause a higher frequency of floods and more intensive erosion. Dzungar-Alatau is inhabited by the following CAMCA flagship species: Asiatic ibex, Tien-Shan maral, Tien-Shan brown bear, argali sheep, and snow leopard.







Kyrgyzstan

Kyrgyzstan is a landlocked, lower-middle-income country in the centre of the Eurasian continent, with nearly 94% of the country's territory over 1,000 m above sea level and 40% over 3,000 m above sea level. The climate in Kyrgyzstan is as complex as the country's topography and orography, and can be classified into four major zones:

- the valley-submountain zone (between 900 and 1,200 m) experiences hot summers, snowless and temperate winters, and almost zero precipitation
- the mountain zone, medium altitude belt (between 1,200 and 2,200 m), is characterized by a temperate climate, with warm summers and cold, snowy winters
- the high mountain zone (between 2,200 and 3,500 m) is cooler in the summer and has relatively cold, snowless winters, with temperatures ranging from well below zero to 16 °C
- the nival belt zone (3,500 m and higher) has a polar climate and is covered by numerous snowfields and glaciers

These climatic conditions make Kyrgyzstan highly vulnerable to stresses associated with climate change, which include both rapid events (landslides, mudslides and mudflows) and slow processes (glacial melting). Recent international

studies of six glaciers in Kyrgyzstan (in the Ysyk-Köl, Naryn, Osh, and Chuy regions) documented that glaciers retreated on average by ~15–20 m per year between 2018 and 2021, a shrinking rate of approximately 0.2% to 0.4% of the total glacier area per year.

According to the vulnerability and risk assessment described in the updated Nationally Determined Contribution (NDC) for Kyrgyzstan, vulnerability to climate change-related hazards and negative impacts increases from the eastern to the western parts of the country. Observed mean annual air temperature in Kyrgyzstan rose by approximately 1.25 °C between 1981 and 2021, and the observed maximum annual temperature increased from 5.21 °C to 6.84 °C during the same period. The rate of warming accelerated notably between 1990 and 2010. Warming trends were reported across all regions and at all altitudes. The total annual precipitation in the country shows a slight increase of 4.6 mm per decade during 1991–2020 compared with 1961–1990.

Skrimizea et al. (2022) show a growing number of heatwave days and heat extremes, particularly in lower-lying and intermontane areas (Figure 5). While total annual precipitation shows a slight increase, precipitation is characterized by strong seasonal variability, with wetter springs

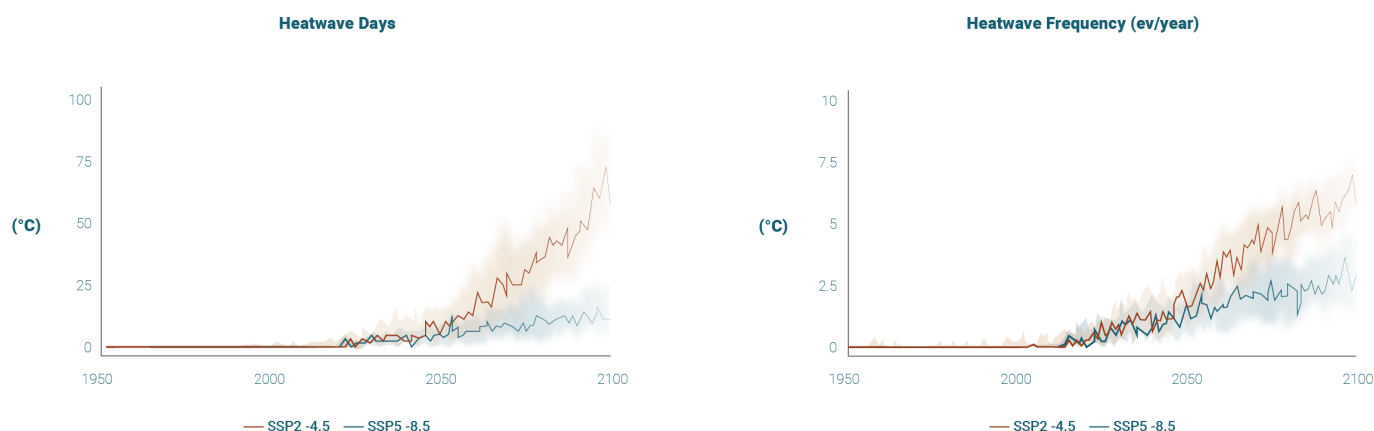


Fig. 5: Annual regional time series of a) heat wave days and b) heat wave events in Kyrgyzstan based on Coupled Model Intercomparison Project (CMIP)6 ensemble projections under SSP2–4.5 (blue) and SSP5–8.5 (red). The solid line represents the ensemble median while the shaded area extends from the 25th to the 75th percentile of the ensemble.

and increasingly dry summers, alongside higher precipitation intensity. Despite modest precipitation gains, drought frequency and duration have increased, as rising temperatures and evapotranspiration intensify water stress, making drought and heat among the most significant climate risks in the Kyrgyz Republic. Future predictions promise continuation of these trends.

The project sites in Kyrgyzstan are located in the east of the country, in the high mountain ecosystems of western and inner Tien-Shan (Fig 6). The project sites are connected by a new ecological corridor (Ak-Ilbirs). : Fig. 6). At the western end of the corridor is Naryn State Reserve, located in the Naryn and At-Bashi districts of the Naryn region and covering a hillside forest of the Nary-Too mountain range. The total reserve area is approximately 37,000 ha, with the purpose of preserving coniferous forests and alpine meadows.

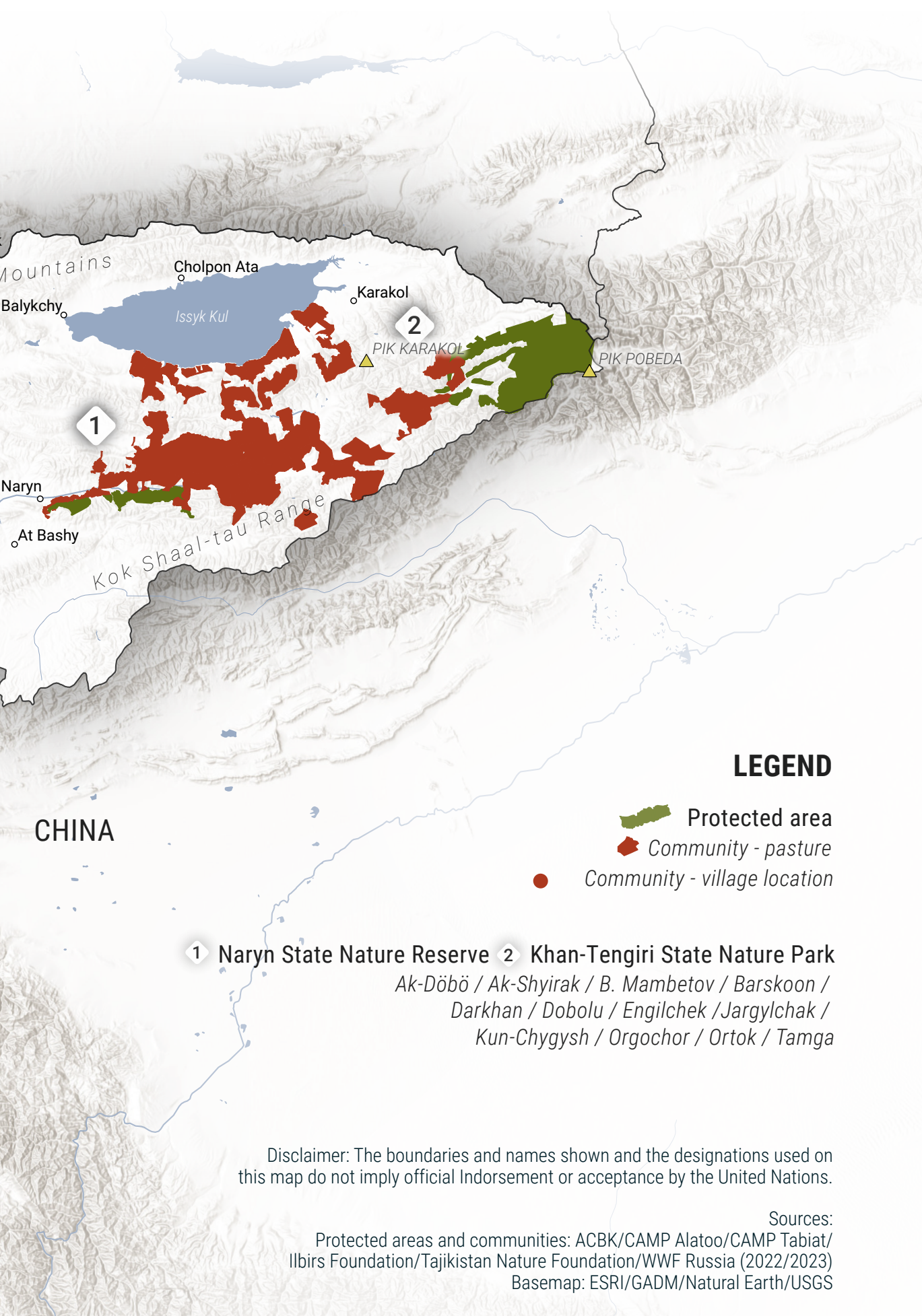
Naryn State Reserve hosts the currently most important population of Tien-Shan maral in Kyrgyzstan, along with Tien-Shan brown bear, Asiatic ibex, and snow leopard (flagship species of the CAMCA project). At the other end of the corridor is Khan-Tengri Nature Park, located in the easternmost part of the country between the Terskey Ala-Too and Kakshaal-Too mountain ranges. Khan-Tengri Natural Park and its surroundings, as well as the ecological corridor connecting it with the state reserves Sarychat-Ertash and Naryn, are important areas for the project's flagship species argali, Asiatic ibex, snow leopard, and Tien-Shan brown bear.

Overall, protected areas cover 7.37% of the country's territory, and total protected area coverage increased from 5.38% in 2015 to 7.37% in 2022, as part of the country's commitment to Target 3 of the Kunming-Montreal Global Biodiversity Framework of the Convention on Biological Diversity (CBD). Nonetheless, the increase in the number and area of protected areas will lead to improved conservation outcomes only if climate change informs their establishment and management.

The project sites in Kyrgyzstan are subject to climate change-related drought, melting glaciers, various climate-related emergencies (mudflows, floods, landslides, avalanches, flooding, wind, hail, snow, and rain), resulting in economic insecurity for people, and degraded pastures for grazing ungulates (both wild and domestic livestock).

It is predicted that due to climate change in Kyrgyzstan, the surface area of high-altitude pastures may increase, however the productivity of pasture vegetation may decrease. Together with a projected loss of spring-autumn ephemeral pastures, this may negatively impact the seasonal availability of grazing opportunities. The reduction in productivity of pastures and the expected altitudinal shift of grazing resources (and hence livestock activity) is expected to lead to the displacement of wildlife due to persecution by herders and dogs and related disturbance, and to increasing competition between livestock and wild animals for grazing, as well as within rural communities for the use of pasture lands.







Tajikistan

Tajikistan is a landlocked mountainous country located in the south-eastern part of Central Asia. The relief of most of its territory is characterized by mountain ranges interspersed with numerous glaciers and intermountain depressions, with deep valleys in the floodplains. Mountains make up 93% of the country's territory. The country's elevations range from 300 m to 7,495 m above sea level. The climate of Tajikistan is extremely continental, with sharp fluctuations of daily and seasonal temperatures, highly intensive solar radiation, aridity, and uneven distribution of seasonal precipitation.

The territory of Tajikistan is located at the junction of several powerful atmospheric circulation processes. One of them is the Siberian anticyclone in winter. Cold waves from the Arctic reach all the way to south-western Tajikistan and the mountains bordering the country from the north and east favour the retention of cold air masses. The influx of warm air in winter, as a rule, occurs when tropical air masses penetrate. Another important atmospheric process – thermal depression – prevails in summer. Its formation is facilitated by the proximity of deserts and high mountains, and it is characterized by clear, dry, and hot weather. Heavy precipitation is often brought by western cyclones in the winter–spring transition period. At national level, a statistically significant increase

was observed for temperature values from the Climate Research Unit (CRU) data set from 1951 to 2010 at both the annual and seasonal scales. According to the Fourth National Communication of the Republic of Tajikistan to the UNFCCC, between 1940 and 2020, Tajikistan experienced a temperature increase of 0.1 °C to 0.2 °C for each decade of that period. Further warming is expected under both the SSP2–4.5 and SSP5–8.5 scenarios, especially in summer and autumn. The number of days with temperatures of 40 °C and above is increasing. This increase in heatwave days and events is expected to accelerate in the short and medium term as shown in Fig. 7. Mountainous areas experienced an increase of 0.3 °C to 0.5 °C, while the alpine zones experienced an increase of 0.2 °C to 0.4 °C. Temperatures were 0.1 °C to 1.1 °C higher on average in winter and 0.1 °C to 1.3 °C higher in spring. Autumn temperatures in all mountainous areas exceeded the average by 0.6 °C to 1.1 °C.

Trends in precipitation at the country level are difficult to assess due to the high inter-annual variability and spatial heterogeneity of precipitation, especially in mountainous areas. The time series of annual precipitation shows a great inter-annual variability and no significant trend, and a non-significant tendency towards higher

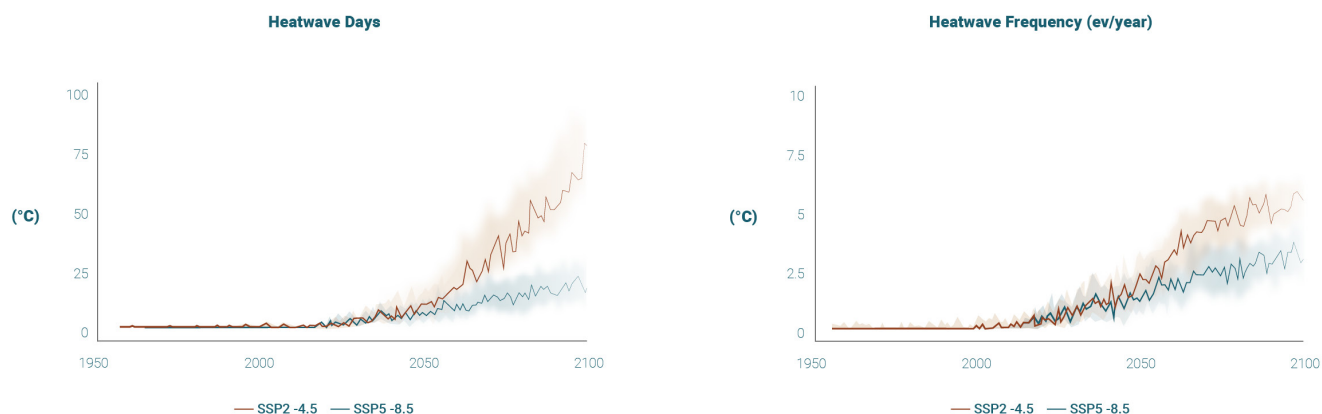


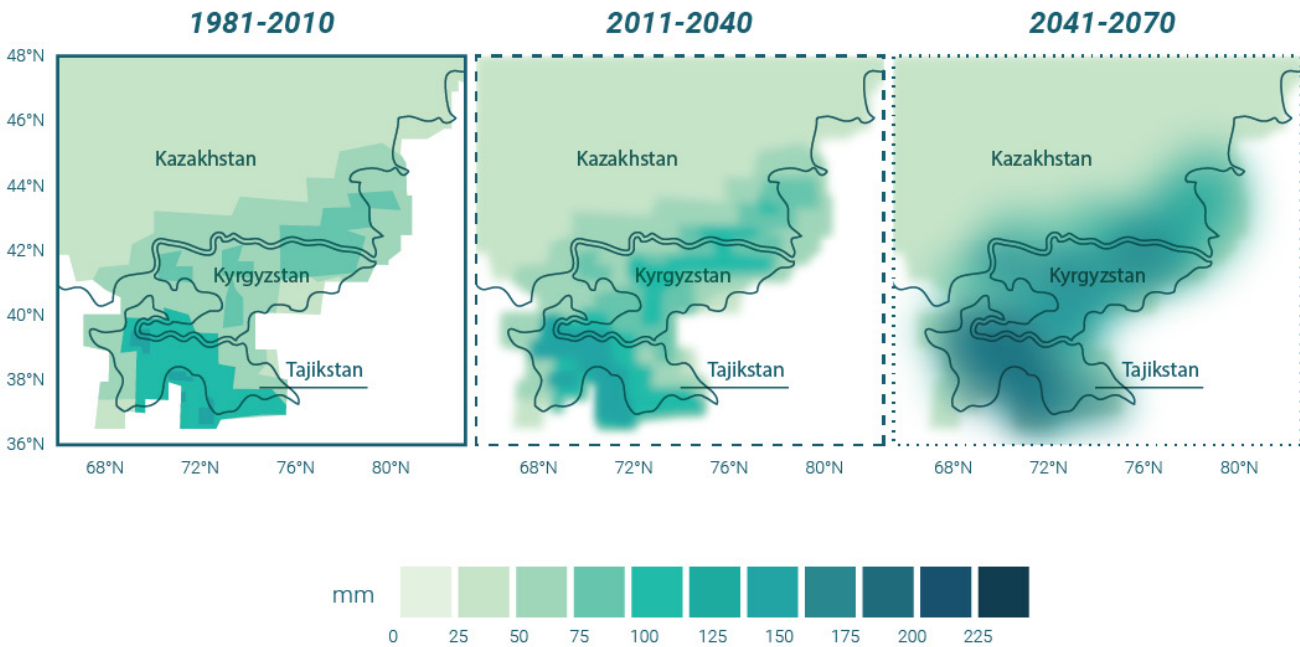
Fig. 7: Annual regional time series of a) heat wave days and b) heat wave events in Tajikistan based on CMIP6 ensemble projections under SSP2–4.5 (blue) and SSP5–8.5 (red). The solid line represents the ensemble median while the shaded area extends from the 25th to the 75th percentile of the ensemble. (Skrimizea et al., 2022)

annual totals. While no well-defined trend emerges for seasonal amounts, the data indicate a non-significant drying in spring and non-significant increases in the other seasons. Projected changes of precipitation show high variability and range from modest decreases to modest increases (Skrimizea et al., 2022). An increase in heavy rainfall events is projected and particularly pronounced in northern-central Tajikistan, where the project site, Yaghnob Valley, is located (Fig. 8).

Tajikistan is prone to natural disasters such as floods, avalanches, landslides, extreme temperatures, and droughts, which are exacerbated by climate change, especially by the observed increase in heatwaves, intensive rainfall, and overall increasing aridity. Such events damage and

destroy land, crops, and infrastructure, reducing sources of income and affecting the livelihoods of people, especially those living in rural areas, but also have a profound adverse impact on ecosystems and their biodiversity. The project sites are located in the west of the country. The Beshai Palangon (Tigrovaya Balka) Nature Reserve is situated in south-western Tajikistan (Fig. 9). It includes part of the Vakhsh valley north from the junction of the Vakhsh and Panj rivers, and is a large flat area with three river terraces. The climate of the reserve is sharply continental and dry. Its ecosystems and the agricultural activities in its vicinity are therefore entirely dependent on the water flow from the upper reaches of the Vaksh river basin, and to a much lesser extent, the Panj river.

Fig. 8: Mean values of the R95pTOT index in the reference period (1981-2010) and in the near and middle future under the SSP5–8.5 scenario. The median of the model ensemble is reported. Protected areas are shown in purple. (Skrimizea et al., 2022)



During the winter, air masses from temperate latitudes prevail replaced by tropical influences in summer. The 460 km² reserve is home to riparian tugai, wetland, and semi-desert ecosystems, and one of the largest Bukhara deer populations.

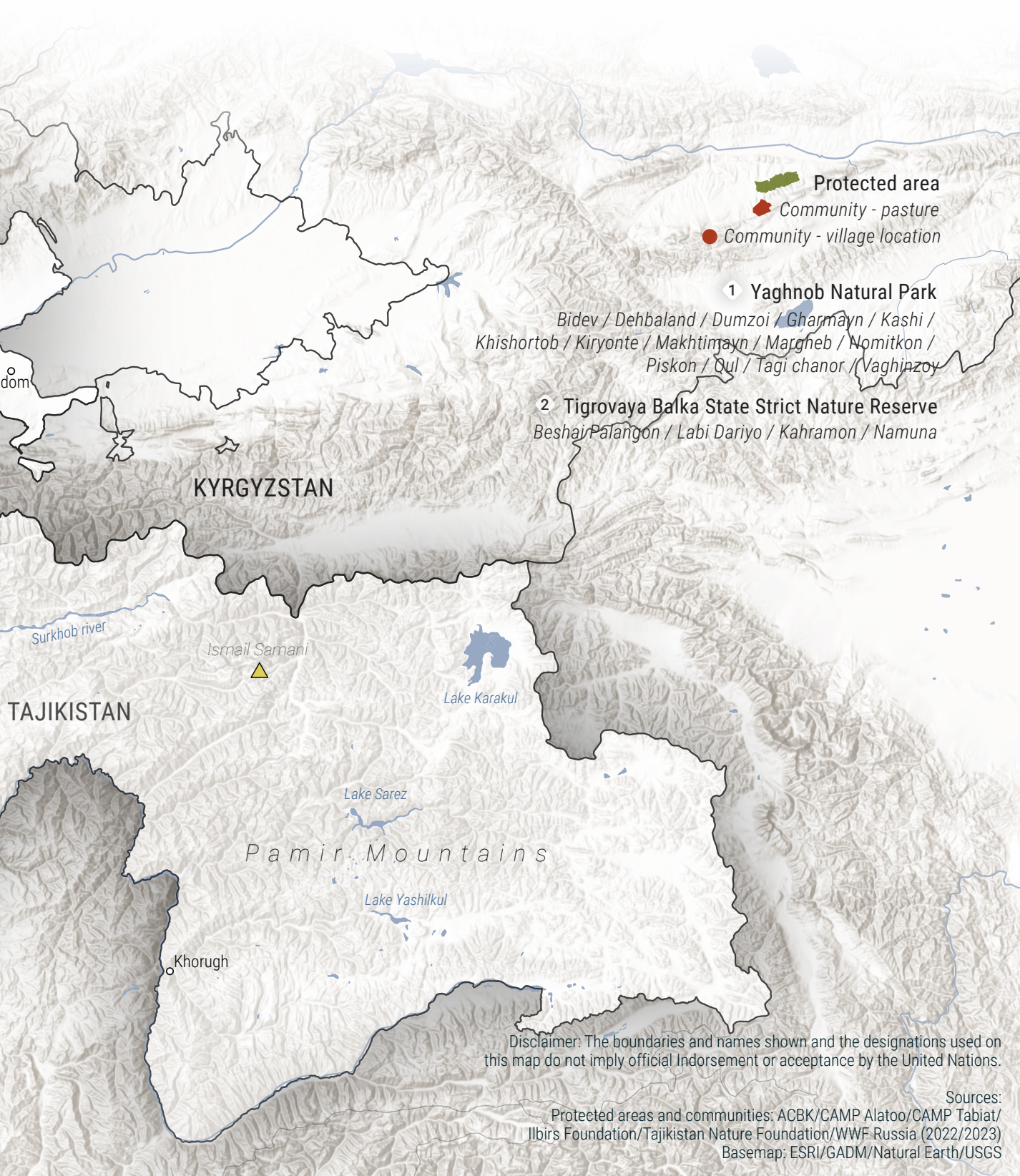
Climate change in this area is projected to lead to further increases in average annual temperatures by 1.2 °C to 1.3 °C and 2.4 °C to 3.2 °C in the near- and mid-term (scenarios SSP2–4.5 and SSP5–8.5, respectively), with the most pronounced increases during the summer and autumn under the mid-term scenario. The number of heat wave days and heat wave events is expected to increase by more than two weeks under this scenario by 2070. The already high aridity of the area will further increase as precipitation is not projected to increase proportionally with the temperature rise. The water supply of the riparian areas of Beshai Palangon depends on upstream water management, which will have to cope with the various impacts of climate change, such as higher demand for water for irrigation under hotter conditions, the growing needs of electric energy from hydropower, and increasing fluctuations in river flow due to the future decline of the inter-seasonal and inter-annual balancing effects from disappearing snowfields and glaciers.

Yaghnob Valley is located in north-west Tajikistan, between the southern slope of the Zarafshan range and the northern slope of the Hisor range (Fig. 9). This remote valley is a biologically and culturally significant region. Its isolation, high altitude (2,500 to 3,000 m above sea level), and harsh winters helped preserve a unique Yaghnobi culture and language until the forced resettlement of the entire population to the lowlands in 1970. In later decades, people returned and revived parts of their villages.

Climate change is affecting the valley and temperatures have been steadily increasing, with a notable rise in mean annual temperatures, especially in winter. Near- and mid-term projections predict annual average temperature increases of 1.3 °C by 2040, up to 3.1 °C by 2070, and similar increases during the winter season. This warming trend is directly linked to the rapid retreat of glaciers. While overall precipitation patterns are highly variable, a general trend is observed and reported by local people towards drier winters and potentially wetter, more intense summers, leading to a higher risk of both droughts and floods. Projected increases in annual precipitation of 5% to 7% under SSP2–4.5 and 3% to 6.5% under SSP5–8.5 would not compensate for the increased potential evapotranspiration caused by warming, especially under the second scenario.

This will lead to increased aridity and therefore lower productivity of the vegetation in the valley. From a conservation perspective, the Yaghnob Valley is particularly important as it provides habitat for a variety of rare and endangered species, including the snow leopard, Asiatic ibex, and a host of bird species, such as the Egyptian vulture. The establishment of Yaghnob National Park in 2019 marks a significant step towards formally protecting this rich ecosystem and its inhabitants.







Climate change vulnerability assessments

An existing species vulnerability assessment (SVA) approach developed by the World Wildlife Fund (WWF) was used to evaluate the vulnerability of the project's flagship species to climate change. The SVA approach is designed to systematically evaluate the susceptibility of species to climate change, based on their characteristics and specific biological, ecological, and anthropogenic factors that might affect vulnerability to climate change. By considering elements such as exposure to climate stressors, sensitivity to these changes, and adaptive capacity, the approach provides a more nuanced understanding of how climate change might affect species populations and distributions, and can inform more actionable management recommendations.

In addition to climate-specific factors, the approach also integrates "other threats" into the vulnerability assessment. This is because the impacts of climate change can exacerbate existing anthropogenic stressors, such as habitat loss and degradation, poaching, human-wildlife conflict, and other human responses to climate change. Based on the climate change impacts described in Chapters 2 and 3 of this report, it was assumed that the EXPOSURE level for the CAMCA

project flagship species is HIGH due to predicted increased risk of droughts, reduced water flow in rivers and streams, floods, landslides, and avalanches, as well as the expected phenological mismatches between different parts of the ecosystem. The primary goal of this updated SVA is to inform conservation strategies and prioritize interventions by highlighting which species are most at risk and why. It helps conservation practitioners identify critical vulnerabilities, such as limited dispersal abilities, reliance on specific habitats, low genetic diversity, or the presence of significant "other threats," which can then be addressed through targeted conservation actions. It also identifies areas of resilience for each species. This proactive and evidence-based approach is crucial for effective climate change adaptation planning.

The SVA approach was adapted for the CAMCA project to focus on the Central Asian context and, where possible, the local context of the project focal areas, allowing for specific recommendations. Any site-specific observations or recommendations are indicated as such in the individual species' assessments.



Snow Leopard *Panthera uncia*

The snow leopard (*Panthera uncia*) is the smallest of the so-called big cats of the genus *Panthera*, adapted to mountain habitats in Central Asia, where it preys on mountain ungulates, marmots, and birds. Snow leopards inhabit cold, arid environments and have evolved a suite of adaptations suited to low temperatures and hunting on steep slopes at high altitude to survive in harsh, rugged mountainous environments. For example, they can withstand a wide range of temperatures, have low freshwater requirements, and have the capability for both nimble and long-distance movements. The species thus seems to be resilient to the direct impacts of climate change.

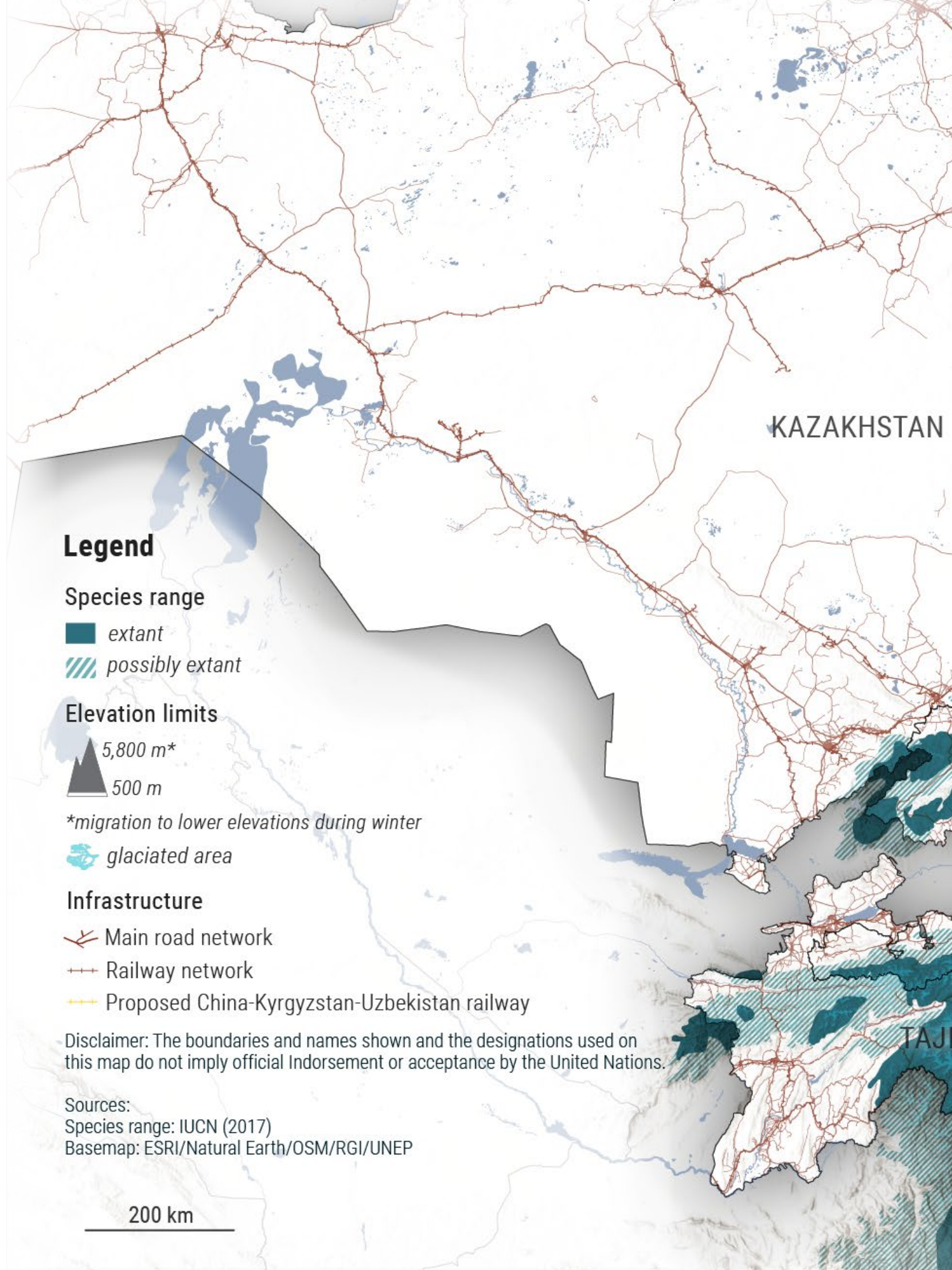
Climate change is projected to increase the total available snow leopard habitat in all three countries, with a +66% change in Kazakhstan, +9% change in Kyrgyzstan, and a +5% change in Tajikistan, while simultaneously contributing to its increased fragmentation, because of an upward shift in the tree line and concurrent loss of the alpine zone. This could potentially result in loss of genetic connectivity. Climate change also leads to a spatial shift of ungulate habitat and a decrease in its quality, consequently increasing competition with livestock and affecting the distribution of important snow leopard prey, with potential negative effects for snow leopards.

Key threats include habitat fragmentation, poaching of the prey base, degradation of prey-base habitat from overgrazing by livestock and linear infrastructure (roads, fences, etc.), intentional and incidental trapping, and killing of snow leopards for their skins and other parts as economic situations worsen in some mountain communities. Poor pasture management degrades snow leopard prey habitat and decreases forage quality. This further reduces wild prey availability and puts the prey base in competition with livestock.

The increasing presence of livestock in snow leopard habitat, due to the loss of the alpine zone and increasing drought conditions in lower elevation areas, can bring livestock in closer contact with snow leopards. Snow leopards can also kill livestock, putting them in direct conflict with herders. Although there are occasional retaliatory killings, this is rare, especially in Kyrgyzstan and Kazakhstan. Mining and energy development are also a potential threat, since they contribute to the loss of habitat and genetic connectivity due to fragmentation created by linear infrastructure. Border fences also contribute to habitat fragmentation, restricting snow leopards' movement. Movement routes are anticipated to be further impacted by climate change.

Snow leopard (*Panthera uncia*) range in Kazakhstan, Kyrgyzstan

Central Asian Mammals and Climate Adaptation (CAMCA) project



h & Tajikistan



Altai

Tien Shan

KYRGYZSTAN

KISTAN

Pamirs

Hindu Kush

Karakoram



H High

M Medium

L Low

U Unknown

Climate Vulnerability of the Snow leopard (*Panthera uncia*)

Sensitivity

M	IUCN Red List Status: <u>Vulnerable</u>	The snow leopard is assessed as Vulnerable due to a small population size and a projected decline of at least 10% over 22.62 years (three generations).
M	Geographic range: <u>Medium</u>	The estimated global distribution is approximately 1,800,000 km², within an altitude range of 900–5,400 m (900–2,500m at the northern range limit). At the regional level, the total range area of snow leopards in Tajikistan (74,500 km²), Kyrgyzstan (65,900 km²), and Kazakhstan (43,600 km²) is 184,000 km².
H	Population size: <u>Small</u>	Population size estimates vary both on the global and regional level. An estimated 3,500–7,500 snow leopards live throughout the species' range. In Kazakhstan, there are an estimated 145–190 snow leopards, with 246 –366 in Kyrgyzstan, and 500 in Tajikistan, including individuals shared with the population in Kyrgyzstan.
L	Temperature tolerance: <u>High</u>	The snow leopard tolerates a wide temperature range, perhaps as wide as -40 °C to +40 °C.
U	Does the species rely on environmental cues for reproduction? <u>Unknown</u>	The breeding season is between January and mid-March, however, it is unknown if and which environmental cues, such as daylight length or temperature, are determinants for reproduction.
L	Does the species rely on environmental cues for migration? <u>No</u>	Snow leopards do not migrate, but they might expand their home ranges if prey availability is not sufficient.
L	Does the species rely on environmental cues for hibernation? <u>No</u>	Snow leopards do not hibernate.
L	Does the species have any strong or symbiotic relationships with other species? <u>No</u>	Snow leopards compete with wolves for prey resources.
L	Diet: <u>Generalist</u>	Snow leopards are carnivorous, feeding mainly on mountain ungulates (argali, markhor, and ibex). During the summer, marmots provide an important staple along with pika, snowcock, and chukar partridge. Occasionally, snow leopards take livestock, but the proportion of livestock in their diet is small. Domestic prey is taken under specific conditions (encroachment, habitat fragmentation or insufficient number of wild prey). Snow leopards require 3.2 kg of meat per day.
H	Abundance of food source: <u>Low</u>	The snow leopard is heavily dependent on access to mountain ungulate prey. Generally, low densities of ungulates correlate with low numbers of snow leopards.

L	Freshwater requirements: <u>Low</u>	Snow leopards can draw water from the food they eat.
M	Habitat specialization: <u>Specialist</u>	Snow leopards inhabit the high mountains of Central Asia, with a large portion of their range predominantly treeless due to either alpine or desert conditions. Vegetation in snow leopard range varies from treeless alpine zones in most mountain systems, to dense forest–alpine ecotones, to open forests and woodland habitats in relatively dry parts of many mountain systems, and to scrubland and desert mountain habitats.
M	Susceptibility to disease: <u>Medium</u>	Snow leopards inhabit cold, arid environments. Because microbial abundance in soil correlates negatively with precipitation, it is predicted that they encounter lower microbial abundance than their counterparts in more mesic, temperate, or tropical environments, and may have evolved correspondingly lower immune indices. This circumstance is of concern as it may render these species particularly vulnerable to the emergence of pathogens disseminated by fast-spreading populations of domestic species such as herding dogs, and to changes in pathogen distribution resulting from climatic changes. Diseases are also a potential area of concern; limited knowledge of the true incidence of viral infections in wild snow leopards exists due to a lack of surveillance in the remote areas they occupy. Snow leopards are likely to be susceptible to a range of pathogens found in other free-ranging felids. Climate change could potentially lead to wider or more widespread hotspots of pathogens, such as canine distemper, increasing the threat to snow leopards.
Adaptive capacity		
L	Dispersal ability: <u>High</u>	Home range size varies from as small as 12 km² to possibly 1,000 km². Male and female snow leopards can disperse great distances. Subadult males cover greater distances to search for areas that are not occupied by more dominant males. Females tend to stay close to the home ranges of their mothers. Snow leopards have a mean daily journey length of 1 km, with observations as high as 28 km. Information from a long-term study in South Gobi shows that snow leopards can disperse across the open plains and steppe landscape between mountain ranges, which are otherwise considered unsuitable habitat. Fencing along international borders may restrict snow leopards' movement.
M	Generation time: <u>Medium</u>	Once snow leopards reach the age of 3 years, they typically breed every other year.

M	Reproductive rate: <u>Medium</u>	In the wild and in captivity, snow leopards breed during late winter (January to March) with 2 to 3 (rarely 1 or 4 to 5) cubs born in April to June, following a 90–105-day gestation period.
H	Genetic variation: <u>Low</u>	Snow leopards have the lowest genetic diversity of any big cat species, likely due to a persistently small population size throughout their evolutionary history, rather than recent inbreeding. Genetic variation in snow leopards has not yet been studied in Tajikistan, Kazakhstan, or Kyrgyzstan. It is assumed to be of limited concern due to existing habitat connectivity, but it could become an issue if habitats are fragmented. Without a large population size or ample standing genetic variation to help buffer challenge from climate change or other anthropogenic threats, snow leopard persistence may be more tenuous than currently appreciated.
Other Threats		
H	Other threats: <u>High</u>	Non-climate-driven threats continue to affect snow leopard populations, and these might be exacerbated by climate change: • Human-wildlife conflict with herders and retaliatory killing • Illegal wildlife trade for snow leopard parts as economic situations worsen in some mountain communities • Poaching of prey species, degradation of prey habitat from poor pasture management, and competition between prey and livestock for forage, resulting in less prey for snow leopards • Habitat loss and fragmentation caused by land development and encroachment (i.e., around alpine resort areas in Kazakhstan), alpine pasture use, and habitat damage caused by extractive industries • Disease • Linear infrastructure, including roads, railways, fences, and transmission lines that form barriers either by directly blocking movement or by producing traffic, noise, and light pollution that wildlife avoid Threats identified from Climate Crowd surveys: • The reduction of glaciers, which are a major source of fresh water • Climate change affecting species' ranges, especially that of snow leopards • An increase in diseases among the region's biodiversity, including wildlife and plants • Significant mortality of species due to severe cold and snow, specifically ungulates • In Kyrgyzstan, community members reported an increase in human-wildlife conflict as encounters occur more often

Regional recommendations

General sustainable land use, improved connectivity, and improved environmental management are necessary across the species' range. This includes better pasture management supporting biodiversity conservation and reduction of anthropogenic pressure on mountain ungulates (argali and ibex), which serve as the main prey species for snow leopards. Climate change might exacerbate other threats. The following measures are recommended to address human-wildlife conflict, fragmentation, and pressure on prey species:

1. Promote the coexistence of snow leopards with human land-use, especially for livestock. Coexistence can be stimulated by:

- Reducing the risk of retaliatory killings through predator-proof corrals, insurance and incentive schemes, revolving community funds, and other community benefits
- Ensuring prey base stability by:
 - I. Improving the implementation of pasture management and land-use planning by regulating grazing times and locations to limit competition with livestock and avoid pasture degradation.
 - II. Ensuring that livestock numbers align with the pasture carrying capacity, taking into consideration the forage needs of argali and other wild ungulates that serve as snow leopard prey.
 - III. Encouraging nature-friendly alternative livelihoods, such as beekeeping and sustainable tourism, which reduce community dependence on livestock and lower livestock numbers.

IV. Regulating the number and movements of herding dogs.

V. Enacting veterinary surveillance and vaccination of both livestock and dogs in and close to habitats of the snow leopard and their prey.

2. Enforce existing measures and enact additional ones to improve protection from poaching and the illegal wildlife trade. This can be achieved by enhancing legislation, intensifying law enforcement, improving prosecution, addressing drivers, and improving data collection, analysis, and information sharing, in compliance with and cooperation with the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Examples include:

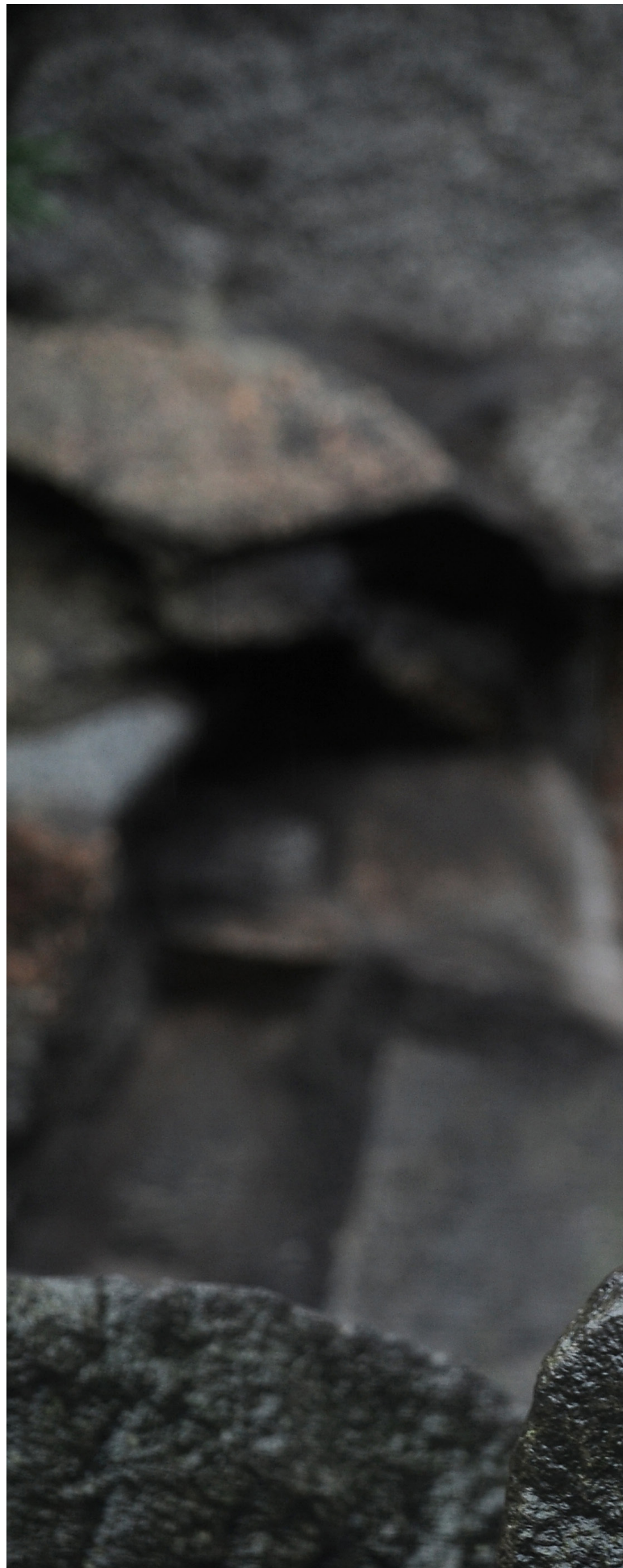
- Mitigating the effects of poaching and associated disturbances by supporting effective law enforcement against poaching and illegal trade, including training for law enforcement officers, border staff, and community members.
- Establishing partnerships across different ministries (such as Security and Customs) to track and combat the illegal trade of snow leopards and their parts.
- Develop and support community-based wildlife conservation and management programmes that provide economic benefits to local people, ensuring they have a vested interest in protecting the species.



3. Actions to reduce habitat fragmentation include:

- Taking stock of animal movement routes and delineating ecological corridors that connect core protected areas in snow leopard habitats.
- Completing a thorough assessment of all development activities (infrastructure, mining and tourism), and prioritizing planning that avoids harm to snow leopard populations and habitats, and mitigates unavoidable negative impacts.
- Removing or making permeable linear infrastructure (e.g., border fences) that impedes movement.
- Mandating infrastructure projects to include wildlife movements and other wildlife needs in their Environmental Impact Assessments, avoiding adverse impacts and mitigating any unavoidable negative impacts.
- Strengthening transboundary collaboration with neighbouring countries to facilitate snow leopard movement and ecosystem connectivity, improving protection, and coordinating species monitoring.

In general, protected areas with snow leopards require additional assistance to include these considerations effectively in management plans. This includes increased funding and technical assistance, particularly for staff, as well as equipment (such as patrol vehicles) and training. Community-based conservation areas and conservation-minded private hunting concessions should also be supported, and ecological corridors recognized.









Bukhara deer *Cervus hanglu* *bactrianus*

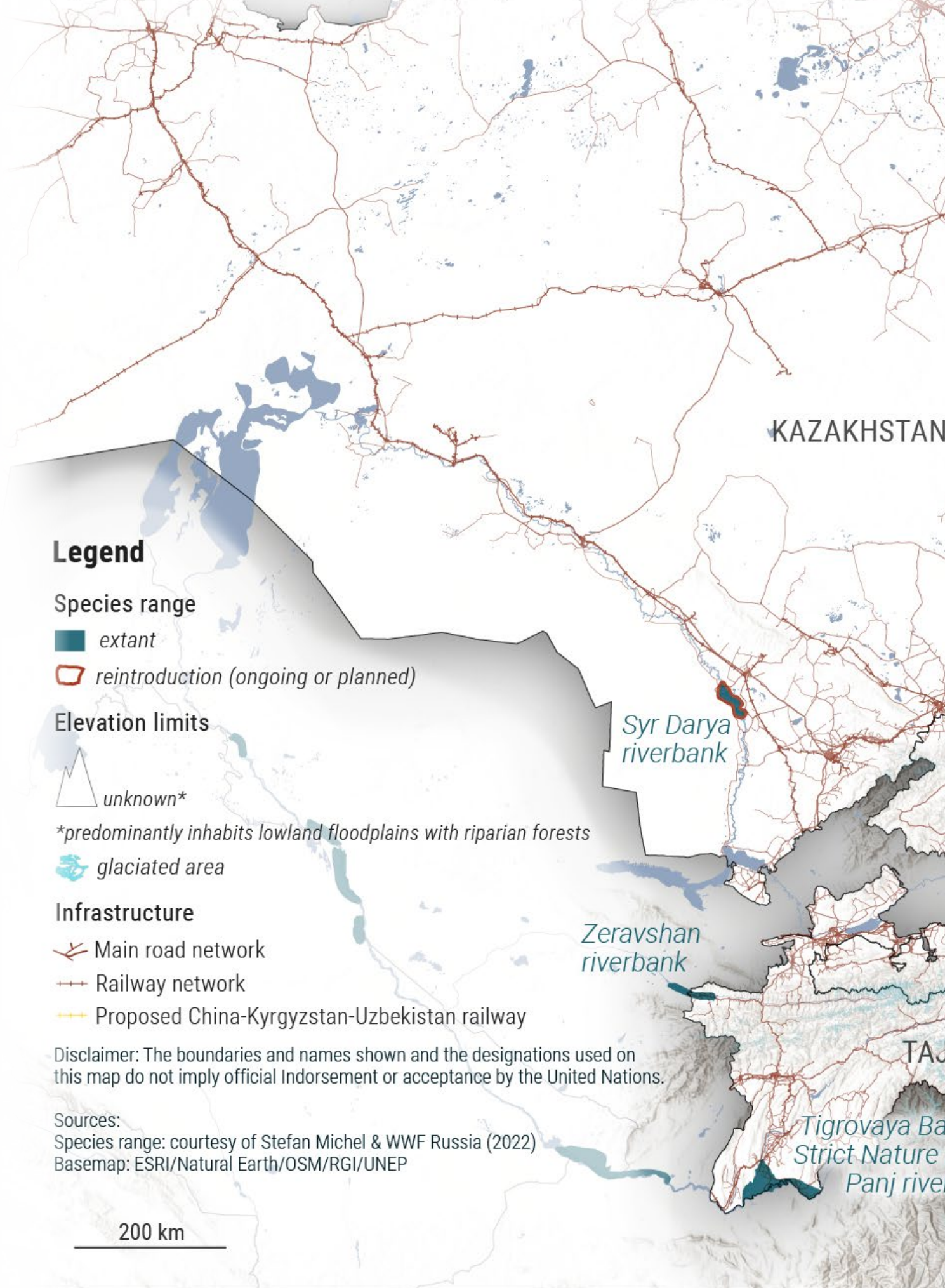
Bukhara deer occur in riparian lowlands and adjacent desert and agricultural areas with highly variable temperatures – hot in summer and freezing in winter. Climate change may cause additional heat stress in summer and during the rut in autumn. They have high freshwater requirements due to the dependence of their riparian habitats on water flow dynamics, which might be adversely affected by climate change, in particular by reduced snow cover and shrinking glaciers in mountain regions upstream of their habitats.

The more significant impact caused by climate change on Bukhara deer will be through the modification of their habitat and, indirectly, their forage base. Bukhara deer use riparian tugai forests as cover and feeding habitat. These forests currently occur in small fragments of former belts along larger rivers. Their restoration is already affected by various non-climate change-related factors and this habitat may even vanish entirely when flow patterns are disrupted. The availability and quality of fodder plants are also likely affected due to changing riparian flow dynamics, dropping groundwater tables, and the increasing aridity of riparian habitats and adjacent areas.

Human activities – particularly destruction, modification, and degradation of riparian habitats by conversion into agricultural lands, modification of riparian morphology and flow dynamics, and livestock grazing, overuse of water sources, illegal logging, infrastructure, and urban development – affect Bukhara deer. In some areas, poaching is an additional threat, while locally well-protected deer populations are growing to an extent exceeding the carrying capacity of their habitat. Small, fragmented populations, unable to move between suitable habitats, cannot recover or recolonize lost range areas.

Climate-informed conservation of Bukhara deer should improve the connectivity of populations and habitats, and reduce direct mortality and disturbance, ensuring access to forage, water, and shelter. An important issue is the preservation and maintenance of riparian morphological and flow dynamics, and consideration of the needs of Bukhara deer and the entire riparian tugai ecosystem in the context of any measures directly or indirectly impacting the riparian areas.

Bukhara deer (*Cervus hanglu bactrianus*) range in Kazakhstan & Central Asian Mammals and Climate Adaptation (CAMCA) project



& Tajikistan



Ili River
floodplains

Karachingil
hunting concession

KYRGYZSTAN

IKISTAN

Alka State
Reserve &
rbank



H High

M Medium

L Low

U Unknown

Climate Vulnerability of the Bukhara Deer (*Cervus hanglu bactrianus*)

Sensitivity

L	IUCN Red List Status: <u>Least Concern (Nationally Vulnerable)</u>	In 2017, Bukhara deer were assessed as Least Concern. In Kazakhstan and Tajikistan, Bukhara deer are included in the respective national Red Books. Applying the IUCN criteria at a national level, Bukhara deer are Vulnerable (VU) in Kazakhstan as well as Tajikistan due to the low number of mature individuals (below 1,000) in these countries.
H	Geographic range: <u>Small</u>	Bukhara deer occur in fragmented and typically small areas across multiple countries (Afghanistan, Kazakhstan, Uzbekistan, Tajikistan, and Turkmenistan). Historically, they inhabited all the river valleys of Amu Darya and Syr Darya, as well as the Murgab and Tedjen to the west and Zarafshan and Ily to the east, but their range was significantly reduced in the 1960s. Conservation activities have restored the deer to a number of areas. However, there are only seven major populations and their local range areas are small and unconnected. The species was extirpated from Kazakhstan in the 1960s and reintroduced to the Karachingil hunting concession, the Altyn-Emel National Park, Turkestan (Syr Darya valley), and most recently into the Ile-Balkhash Reserve. In Tajikistan, Bukhara deer occur in the riparian areas of the Panj river and Vakhsh river in the region of their confluence (Strict Nature Reserve Tigrovaya Balka) and in small numbers further upstream along the Panj river, which is partly transboundary with Afghanistan. A reintroduced population exists in the Zarafshan river valley, which is transboundary with Uzbekistan. An introduced population outside of the natural habitat in the Romit Strict Nature Reserve was extirpated in the 1990s, but a new introduction in this area is reportedly planned or ongoing.
H	Population size: <u>Small</u>	The total population size according to the latest Bukhara Deer Overview Report (CMS 2024) is 4,320 to 4,600 and considered growing. Numbers for the range countries are as follows: • Afghanistan: Unknown, partly transboundary • Kazakhstan: 1,100, increasing • Tajikistan: 520–650, stable • Turkmenistan: 180–230, stable • Uzbekistan: 2,500–2,700, increasing, with an overpopulation in Baday-Tugai causing degradation of the ecosystem and the population itself. The high level of habitat fragmentation prevents the deer from naturally expanding their range and limits population numbers.

M	Temperature tolerance: <u>Medium</u>	The Bukhara deer lives in riparian lowlands with tugai forests and adjacent deserts, and agricultural areas with summer temperatures of up to 40 °C and above and winter temperatures as low as -40 °C. This wide temperature range suggests a high tolerance to both high and low temperatures. However, as large-bodied animals with limited options for thermal regulation, they are likely affected by increasingly high summer temperatures.
M	Does the species rely on environmental cues for reproduction? <u>Yes</u>	The mating period may change depending on weather and the shifting of environmental cues due to climate change. Weather conditions can affect fecundity and their ability to carry to term.
M	Does the species rely on environmental cues for migration? <u>Yes</u>	Bukhara deer move seasonally in search of food, staying close to water sources in summer and moving off to the desert in the spring to feed on desert ephemerals. This depends on weather, which influences when and where ephemerals vegetate.
L	Does the species rely on environmental cues for hibernation? <u>No</u>	Bukhara deer do not hibernate.
L	Does the species have any strong or symbiotic relationships with other species? <u>No</u>	No symbiotic or other strong relationships exist except for the physiologically essential flora of the gastro-intestinal tract.
L	Diet: <u>Generalist</u>	The diet of Cervus hanglu bactrianus includes grasses, sedges, shrubs, and tree branches (willow, poplar, some other riparian forest species, and saxaul).
M	Abundance of food source: <u>Medium</u>	The Bukhara deer's habitat is increasingly fragmented, but forage remains available. In some parts of the range, high population densities of Bukhara deer combined with fragmented habitat cause shortages and ecosystem degradation. Locally, competition with livestock and habitat disturbance may affect the abundance of forage, as well as the accessibility for Bukhara deer.
H	Freshwater requirements: <u>High</u>	Cervus hanglu bactrianus needs regular access to drinking water and is dependent on fresh water supplied by the rivers and lakes that gives rise to the riparian habitats known as tugai forests.
H	Habitat specialization: <u>Specialist</u>	Bukhara deer inhabit riparian forested corridors surrounded by desert environments, often adjacent to irrigated farmlands and tree plantations. The predominant species composition of tugai forests is typically a mix of poplar, willow, oleaster, tamarix and other shrubs. Sometimes, the deer inhabit the reed thickets growing on riverbanks. During the spring season, Bukhara deer move into the deserts adjacent to the tugai for grazing.

L	Susceptibility to disease: <u>Low</u>	Disease is currently not a major threat to Bukhara deer. Like other wild ungulates, Bukhara deer might be susceptible to disease transmission from domestic livestock and could also serve as vectors of livestock diseases, such as brucellosis.
Adaptive capacity		
M	Dispersal ability: <u>Medium</u>	If appropriate habitat conditions are available, the species can disperse well. In human-modified landscapes with high urban density and intensively used agricultural areas and linear infrastructure, dispersal is significantly hampered, although they are known to jump over fences. The fragmentation effect is exacerbated by the impacts of poaching, causing high mortality of dispersing deer as well as avoidance of humans and their structures, thus reducing dispersal.
M	Generation time: <u>Medium</u>	Females reach sexual maturity at 1.5 years of age and fertility increases with age. Males usually mate successfully much later, at the age of 5 or 6. In natural conditions, Bukhara deer can live up to 12–14 years; in captivity they can live up to 25–30 years. The generation time is eight years.
M	Reproductive rate: <u>Medium</u>	Females give birth to one, occasionally two, offspring per year.
U	Genetic Variation: <u>Unknown</u>	The species went through multiple known historic bottlenecks, but populations are apparently healthy.



Other Threats

H

Other threats: High

Bukhara deer are affected by habitat loss and fragmentation caused by various anthropogenic pressures, including desertification, leading to the loss of riparian tugai ecosystems. Immediate habitat loss and fragmentation occur from the transformation of riparian areas into arable lands, livestock pastures, and urban areas, as well as indirect effects of river course modification (e.g., through dams, dykes, and water withdrawal structures).

Locally, habitat degradation is driven by an overpopulation of Bukhara deer and/or livestock grazing and illegal logging. The major factor affecting the functioning and dynamics—particularly the regeneration—of riparian habitats is the anthropogenic alterations to hydrology. This is driven by upstream reservoirs regulated to supply irrigation and/or generate electricity, which reduces inter-seasonal and inter-annual flow dynamics and withdraws large quantities of river water for irrigation.

Poaching is a threat, but mainly in protected areas. While positive population trends in some areas indicate an absence or low levels of poaching, in other areas nocturnal behaviour, avoidance of open habitats, and a lack of migratory or dispersal movements indicate persecution by humans.

Further threats include fires, especially human-induced fires in reed bushes and forests (fire is used as a “pasture management” tool or for clearing border areas for better control); linear infrastructure, including border fences; and potentially environmental pollution caused by agrochemicals, industries, and disposal of garbage in riparian areas.



Recommendations

The resilience of the species would be best improved through addressing non-climate change-related threats, specifically by i) preventing immediate habitat loss from conversion into agricultural lands and modification of river courses and riverbanks; ii) reducing habitat degradation caused by livestock, illegal logging, and/or local overpopulation of the deer themselves; iii) making habitat accessible through mitigation of conflict between farmers' interests and deer as well as reducing poaching and associated disturbances; and iv) fostering connectivity and exchange between fragmented populations and recolonizing previous range areas through preservation of potential horizontal and vertical migration routes.

1. **The needs of Bukhara deer and the entire riparian tugai ecosystem should be considered in legislation, development, community land management, landscape-level watershed management, and infrastructure planning that affect riparian areas. Potential activities include:**

- Assessing the current and projected hydrological situation and riparian dynamics in Bukhara deer habitats in the context of direct and indirect climate change impacts.
- Studying and assessing options for preserving, rehabilitating, or imitating natural riparian dynamics.
- Including the preservation and maintenance of tugai forests and flow dynamics in protected area management, landscape management, water resource management, and infrastructure development plans.
- Making habitats other than riparian forests available for Bukhara deer to prevent them from impacting riparian forest regeneration.
- Incorporating the needs of protected areas and tugai forest ecosystems into international water-use policies, agreements, and water management plans.
- Placing a moratorium on any extractive activities, agriculture, or land development in remaining riparian ecosystems.
- Improving awareness of the effects of fire on riparian ecosystems.

2. The reduction of poaching and associated disturbances and the coexistence of Bukhara deer with human land use (such as livestock, arable farming, and tree plantations) could be stimulated by sustainable livelihood options.

- Promoting nature-positive alternative livelihoods, such as nature-based tourism, sustainable hunting, beekeeping, and sustainable agroforestry.
- Evaluating the possibility of incentive-based conservation through sustainable hunting in assigned wildlife management areas, predicated on clear rights and responsibilities for well-defined user groups and preferably based on local communities and land users. This can create incentives to prevent poaching and enable the coexistence of local communities and Bukhara deer outside of protected areas.

3. Enhance ecological connectivity and range expansion by:

- Ensuring population and habitat connectivity by designating ecological corridors and including these in land management policies and in development and infrastructure plans. This would enable adaptation through range shifts, changes in seasonal habitat use, increased genetic diversity to enhance resilience against climate change, and recolonization of range areas where the species are locally extinct.

Country-level considerations

In Kazakhstan, Bukhara deer populations all originate from reintroductions and may benefit from increased genetic diversity by adding animals from genetically different populations, if available and if transport is feasible. This concerns the small population in the Ile-Balkhash nature reserve, which is a project site.

In the Syr Darya river valley, additional reintroduction sites should be assessed, and options for enhancing connectivity between the existing reintroduction site and the potential additional core habitats should be studied and, if feasible, further developed. The fenced population in the privately managed Karachingil game management area could potentially pilot sustainable hunting options for the generation of material benefits, stimulating the acceptance of Bukhara deer in the context of hunting management, and potentially keeping the population in the fenced areas within the ecosystem's carrying capacity.

In Tajikistan, the focus should be on enhancing the opportunities for Bukhara deer to expand their range within the Zarafshan, Panj, and Vakhsh river valleys. In Zarafshan, transboundary collaboration with Uzbekistan in the protection, management, and monitoring of Bukhara deer and its habitat has large potential.

Introductions outside the natural riparian habitats, or in areas with very little available habitat, such as the Romit Biosphere Reserve and Dashtijum Reserve, should be critically assessed to avoid damage to native ecosystems from potentially unsustainable introduced Bukhara deer populations.







Argali Sheep *Ovis ammon*

Argali occur in hilly areas of lowlands and higher mountainous regions with highly varying temperatures. Climate change may cause heat stress in summer and during the rut in autumn, however, reduced snow cover in winter may have an immediate positive impact on their survival. They have moderate freshwater requirements, which might be affected during periods of extended drought.

A significant impact caused by climate change will be through the modification of the species' habitat and forage base. Argali occur mainly in areas with high variability of forage and access to it, depending on variations in seasonal weather conditions. Climate change may affect the availability and quality of fodder plants due to increasing aridity and shifting phenology,

as well as increasing frequency of atypical seasonal conditions such as snowless winters, summer droughts, or extreme rainfall. Human activities, in particular poaching, livestock grazing, infrastructure and industrial (mining) development, and border fences, also affect argali. Small, fragmented populations, hindered by these factors, cannot recolonize lost range areas.

Climate-informed conservation of argali should maintain or improve the connectivity of populations and habitats, reduce direct mortality and disturbance, and ensure access to forage and other key habitat elements.

Argali sheep (*Ovis ammon*) range in Kazakhstan, Kyrgyzstan & Central Asian Mammals and Climate Adaptation (CAMCA) project

Legend

Species range

- extant
- possibly extant

Elevation limits

- 5,500 m*
- 400 m

*migration to lower elevations during winter

- glaciated area

Infrastructure

- Main road network
- Railway network
- Proposed China-Kyrgyzstan-Uzbekistan railway

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official Indorsement or acceptance by the United Nations.

Sources:

Species range: IUCN (2020)

Basemap: ESRI/Natural Earth/OSM/RGI/UNEP

200 km

Tajikistan



Kazakh
Uplands

Altai

Tien Shan

KYRGYZSTAN

UZBEKISTAN

Pamirs





H High
M Medium
L Low
U Unknown

Climate Vulnerability of the Argali sheep (*Ovis ammon*)

Sensitivity

M	IUCN Red List Status: <u>Near Threatened</u>	The argali is listed as Near Threatened. The subspecies <i>Ovis ammon nigrimontana</i>, occurring only in the Syr Darya Karatau mountains of Kazakhstan, was assessed as Endangered, occurring in only one location that has less than 250 mature individuals and occupying an area less than 5,000 km². Other subspecies occurring in the project region have not been assessed separately in the IUCN Red List. In Kazakhstan, Kyrgyzstan, and Tajikistan, the argali is included in the national Red Books. In Kazakhstan, category II (Vulnerable) is assigned to the species.
M	Geographic range: <u>Medium</u>	In Kazakhstan, argali are present in the central Kazakhstan Low Hills (Melkosopochnik) and in the Tarbagatay and Saur in the north-eastern part of the country (on the Chinese border). Smaller populations also exist in the Karatau mountains and in the ranges of the western and northern Tien-Shan. A few individuals may be found in the Altai mountains. In Kyrgyzstan, argali are present in the south-eastern and eastern quarter of the country from the border with Kazakhstan in the north to Tajikistan in the south, as well as along portions of the western Tien-Shan towards the Uzbek border and the northern Tien-Shan along the border with Kazakhstan. In the south-west of the country, on the northern slope of the Turkestan Range of the Pamir Alay System, distinct Severtzov's argali occur in small numbers. Argali are present in most of the eastern third of Tajikistan, where they are called Marco Polo sheep. The distinct Severtzov's argali is extremely rare in the north-west of the country but may still occur on the southern slopes of the western Turkestan range near the border with Uzbekistan, and in the upper Zarafshon Valley in both the Turkestan and Zarafshon ranges. Beyond the project countries, argali are distributed across mountainous regions in Afghanistan, China, Mongolia, the Russian Federation, Uzbekistan, India, Nepal, and Pakistan.
M	Population size: <u>Medium</u>	16,705 (Kazakhstan, 2024), 21,300 (Kyrgyzstan, 2024), and 29,121 (Tajikistan, 2024). The overall population in these countries would probably be around 65,000 individuals.

M	Temperature tolerance: <u>Medium</u>	The various subspecies of argali occur in steppe hills, rocky outcrops, and mountain habitats at various altitudes from about 500 m up to 5,000 m. This tolerance for a variety of altitudes, and the variation between hot summers with daytime temperatures of 30 °C and above, and extremely cold winters with temperatures reaching -40 °C and below, suggests a high temperature tolerance as well. As large-bodied animals with limited thermal regulation, argali are likely affected by particularly high summer temperatures, and move vertically to avoid these extremes and associated parasitic insects in their mountainous habitat. The largest argali subspecies inhabits the coldest regions and may thus be particularly affected by rising temperatures during specific seasons.
L	Does the species rely on environmental cues for reproduction? <u>No</u>	There is no indication of environmental cues for reproduction. However, as the rut takes place during the cooler autumn season and the activities of the rams defending harems against their competitors are physically demanding and could cause overheating, hot temperatures may stagger the rut and thus impact reproduction.
M	Does the species rely on environmental cues for migration? <u>Yes</u>	Argali migrate between summer and winter habitats, covering distances of several tens of kilometres. This migration is mainly triggered by forage availability and temperature. In some regions, summer habitats with nutritious forage are covered by deep snow in winter, causing migrations to areas with reduced snow cover due to wind exposure or local climatic conditions. In the Altai, it has been reported that livestock movements following the same patterns as argali have caused displacement of the latter and resulted in reverse migration patterns. Alternatively, livestock and human presence may cause movements to higher altitudes and steeper slopes. Such situations exist in areas with high levels of livestock grazing, and associated poaching and other disturbances prevent the argali from using optimal seasonal habitats.
L	Does the species rely on environmental cues for hibernation? <u>No</u>	Argali do not hibernate.
L	Does the species have any strong or symbiotic relationships with other species? <u>No</u>	No symbiotic or other strong relationships exist except for the physiologically essential flora of the gastro-intestinal tract. Argali are an important element of the ecosystem and serve as major prey for both wolves and snow leopards.

L	Diet: <u>Generalist</u>	Argali are intermediate herbivores, between typical grazers such as cattle and browsers such as goats. They eat various species of grasses, forbs, and where available, buds and leaves of shrubs with specific and seasonally varying preferences. During the short vegetation period, they require sufficient nutritious forage, such as leguminous forbs and freshly grown grasses. In winter they rely on subshrubs, especially teresken (<i>Krascheninnikovia ceratoides</i>) in the Pamirs. Although they consume a broad range of plants, argali are potentially vulnerable to changes in forage availability and access. Poaching and land-use pressure force argali into rocky and high-altitude areas with little nutritious forage. Overgrazing by livestock causes degradation of pasture vegetation, and climate change modifies the phenology of plants, potentially affecting the seasonal availability of nutritious forage.
H	Abundance of food source: <u>Low</u>	Domestic livestock largely use the same forage plants as argali and consequently compete for forage. Competition with livestock and habitat disturbance affects the abundance of forage, as well as the accessibility for argali in all range countries. In the short term, livestock causes displacement by associated disturbance. Argali in areas without poaching can coexist well and share pastures with livestock. In the medium and long term, overly intensive livestock grazing causes degradation of vegetation. In parts of the range area, especially in the Pamirs of Tajikistan, the collection of subshrubs for fuel (mainly teresken) reduces available winter forage and causes degradation.
M	Freshwater requirements: <u>Medium</u>	Argali need regular access to drinking water. In winter, snow is also consumed to fulfil their water needs. Climate change impacts may cause a reduction of water availability (due to a shorter season of water flow in small streams, and the disappearance of springs and streams) in certain seasonal habitats, making these less suitable for argali, although occurrence in arid areas with limited fresh water suggests that argali can survive with very little water.
H	Habitat specialization: <u>Specialist</u>	Argali inhabit mountains, steppe valleys, and rocky outcrops. They also occur in open desert habitats at the south-eastern end of its range (Mongolia), mostly preferring rolling slopes to steeper areas. Argali are sensitive to deep snow, particularly if forage is limited. Most argali live on alpine grasslands between 3,000 and 5,500 m, often descending lower in winter (particularly if snow accumulates to more than a few cm). In some areas, they live in lower-elevation, semi-arid areas. They generally avoid forested areas.

M	<u>Susceptibility to disease:</u> <u>Medium</u>	Argali can be affected by various diseases, including foot-and-mouth disease, peste de petits ruminants (PPR), ecrobacillosis, pasteurellosis, and pyroplasmosis. Argali host various ectoparasites and endoparasites. Movements to higher mountain belts and exposed ridges reduces interaction with certain gadflies and other insects. Cases of scabies (sarcoptic mange) have been reported in animals weakened by snowy winters. Argali might be susceptible to disease transmission from domestic livestock, in particular foot-and-mouth disease, PPR, and sarcoptic mange.
Adaptive capacity		
L	<u>Dispersal ability:</u> <u>High</u>	Natural dispersal ability might be high, as argali are able to cover large distances. In human-modified landscapes with linear infrastructure, dispersal is significantly hampered. This effect is exacerbated by the impacts of poaching, causing high mortality of dispersing argali as well as avoidance of humans and their structures, thus further reducing dispersal.
M	<u>Generation time:</u> <u>Medium</u>	Females reach sexual maturity at 2 years and give birth to their first lamb at 3 years. Males usually mate successfully from the ages of 5 or 6, but intensive poaching and overhunting may favour mating by younger males. The maximum lifespan is 10–13 years. The generation time is eight years.
M	<u>Reproductive rate:</u> <u>Medium</u>	Females have one lamb, with twins occurring rarely. In some areas in Kazakhstan, regular occurrence of twins has been reported. Fecundity rates may be above 70%, but are difficult to determine due to early lamb mortality, and typical lamb per female ratios are much lower. Recruitment is mainly determined by lamb mortality during the first year, especially during winter, and can be as low as 20%.
U	<u>Genetic variation:</u> <u>Unknown</u>	Genetic variation within populations has not been well studied. Data from the Pamirs of Afghanistan, China, and Tajikistan showed high genetic variation as well as the isolating impact of a border fence, reducing genetic exchange. Genetic variation within smaller and isolated populations might be low due to previous genetic bottlenecks, small founder groups (in cases of natural recolonizations), and resulting genetic drift.

Other Threats

H

Other threats: High

The main threat to argali is poaching, causing direct mortality. Associated human disturbance makes large sections of otherwise suitable habitat inaccessible and drives argali into suboptimal habitats.

Increasing livestock numbers and reclamation of mountain pastures leads to forage competition, reduces available habitat, and causes habitat degradation. Herding practices that use motorbikes may increase the level of disturbance, especially if they are also used for poaching. Herding dogs can be a significant cause of mortality for lambs. Livestock may also be a vector of diseases.

Fragmentation of populations and habitats due to poaching, development of infrastructure in mountainous regions, displacement by livestock, and disturbance by herding dogs causes a loss of genetic diversity within small populations and increases the likelihood of local extinctions.

Locally, in the Pamirs of Tajikistan, the collection of the slow-growing subshrub teresken for heating causes shortage of winter forage, also indirectly due to the need to move livestock deeper into argali habitat, and lasting habitat degradation.

Recommendations

The resilience of argali to climate change would be best improved by i) making habitat accessible through reduction of poaching and associated disturbance; ii) reducing negative impacts of livestock and other human activities on the quality and quantity of available habitat; iii) fostering connectivity and exchange between fragmented populations as well as the recolonization of previous range area through preservation of (potential) routes of horizontal and vertical migrations.

1. Improve enforcement of existing anti-poaching measures and enact additional measures:

- Reduce poaching and associated disturbance via fines, patrolling, capacity-building for rangers, and community-level enforcement.
- Reduction of poaching and associated disturbance could be stimulated by sustainable use options – both non-extractive (nature tourism) and extractive (regulated hunting opportunities), predicated on clear rights and responsibilities for well-defined user groups and based on local communities and land users.

2. Enact sustainable land-use policies that promote human-argali coexistence, particularly in the context of competition with livestock grazing. This could include:

- Integrating argali needs into pasture management plans, community development plans, and other relevant frameworks, including raising local awareness.
- Ensuring that livestock numbers align with carrying capacity, considering the forage needs of argali and other wild ungulates, limiting forage competition/disturbance, and avoiding pasture degradation caused by out-of-season grazing or overstocking.
- Limiting the impact of herding dogs on wildlife through improved training, controlling their movements, or limiting their numbers.
- Enabling improved veterinary management of livestock via mandatory vaccinations, veterinary inspections, and other health measures to reduce risks of livestock-borne disease transmission. This includes training and equipping local veterinarians with the specialized skills and knowledge needed for the safe and effective handling of sick wild animals, as well as the proper collection and storage of samples for disease testing.

- Regulating and monitoring the collection of firewood (teresken) from mountain pastures and assist local people in identifying and using alternative energy sources, as well as increasing energy efficiency in their homes.
- Stimulating alternative livelihoods that reduce grazing pressure, such as nature-based tourism, beekeeping, and regulated hunting opportunities, based on clear rights and responsibilities for well-defined user groups, preferably local communities and land users.
- Optimizing incentive-based conservation (sustainable hunting) in designated wildlife management areas. For example, the establishment of community-based wildlife management areas outside protected areas, where a large share of accrued revenue is allocated to local communities, may act as an incentive to reduce poaching pressure as well as grazing pressure.
- Considering the development of other effective conservation measures in actual and potential argali habitats outside of or adjacent to the state-protected areas.

3. Mainstream the conservation of argali and their habitat into linear infrastructure and industrial development planning, applying the mitigation hierarchy where necessary. This could include:

- Conducting a review to identify existing barriers to migration, such as linear infrastructure (including border fences), and identifying measures to either remove barriers or make them more permeable.
- Carrying out a thorough assessment of various development activities (e.g., infrastructure, mining and tourism), prioritizing planning that avoids harm to argali populations and habitats, and mitigating any unavoidable negative impacts.
- Integrating wildlife migration into Environmental Impact Assessments for future infrastructure projects, including measures to avoid adverse impacts and mitigate any unavoidable negative effects.
- Establishing ecological corridors to enhance resilience against climate change impacts by enabling range shifts, changes in seasonal habitat use, and increased genetic diversity.

4. **Improve funding and enhance technical assistance – including expert support and capacity-building – for protected areas to improve monitoring, enforcement of regulations, and anti-poaching efforts, while specifically addressing argali conservation in protected area management plans.**
5. **Study current habitat use, seasonal habitat preferences, and movements, as well as factors influencing these. Targeted research is recommended on the impacts of climate change on argali range, population size, migratory movements, and other behaviour.**

Country-level considerations

For Kazakhstan and the Dzungar-Alatau pilot site, a more detailed assessment of issues, threats, and limitations, as well as potential, is required for developing specific recommendations. This concerns the Dzungar-Alatau National Park, as well as private hunting and game management areas.

For Kyrgyzstan, the hunting sector, including community-based wildlife management areas, should further be involved in the conservation of argali and the restoration of their area and population by preventing poaching and supporting the coexistence of argali in a multi-use context.

For Tajikistan, the system of commercial hunting concessions could be complemented by community-based conservancies or game management areas. Such community-based conservation and hunting management has already proven effective and is contributing to the restoration of argali populations in areas intensively used for livestock grazing and other land use.

For Yaghnob, no occurrence of argali has been documented thus far, but special attention should be paid during wildlife surveys to detect occasional or seasonal occurrence of Severtzov's argali, and conservation measures should be planned and initiated if presence is confirmed.









Asiatic Ibex

Capra sibirica

The Asiatic ibex occurs in mountainous areas with sufficient rugged escape terrain and suitable pockets of grazing habitat, but it is absent in the wide mountain valleys and plateaus used intensively for livestock grazing.

It appears to be a relatively resilient species to the direct impacts of climate change in the short term: it can tolerate a wide range of temperatures, has minimal freshwater requirements, and can disperse quite well. However, in the long term, a significant decrease of the species' range might result from climate change, especially due to drought, low pasture quality, and water shortages compounded by increased competition with livestock.

Other anthropogenic pressures, such as poaching and poorly controlled legal hunting for both meat and sport, could contribute to a population decrease and local extinctions.

Recommendations include increasing the focus on effective protection of those areas that would serve as a natural refugium for ibex, protecting rangelands and pastures used by the species, and improving grazing management by adjusting livestock numbers and grazing approaches, including the use of guard/herding dogs, which may disturb ibex during the birthing season or kill other wildlife, such as marmots.

Due to the general proximity of Asiatic ibex habitat to the glacial edge, the monitoring of postglacial ecosystems (arising where glaciers retreat) and protection of glaciers would indirectly benefit Asiatic ibex, since those areas would provide cooler refuges during periods of heat extremes or drought.

Asiatic ibex (*Capra sibirica*) range in Kazakhstan, Kyrgyzstan & Central Asian Mammals and Climate Adaptation (CAMCA) project

Legend

Species range

 extant

Elevation limits

 5,500 m*

 500 m

*migration to lower elevations during winter

 glaciated area

Infrastructure

 Main road network

 Railway network

 Proposed China-Kyrgyzstan-Uzbekistan railway

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official Indorsement or acceptance by the United Nations.

Sources:

Species range: IUCN (2020)

Basemap: ESRI/Natural Earth/OSM/RGI/UNEP

200 km

KAZAKHSTAN

Alay

TAJIKISTAN

Tajikistan



Altai

Tien Shan

KYRGYZSTAN

IKISTAN

Pamirs

Hindu Kush

Karakoram



H High

M Medium

L Low

U Unknown

Climate Vulnerability of the Asiatic Ibex (*Capra sibirica*)

Sensitivity

M	IUCN Red List Status: <u>Near Threatened</u>	At the global level, this species is listed as Near Threatened. The Asiatic ibex is not listed in the national Red Books of Kazakhstan, Kyrgyzstan, or Tajikistan. In Tajikistan, it is believed that after past declines in most parts of its range, the population is stable. In Kyrgyzstan, while it is not included in the Red Book, it is included in the list of endangered species, although their numbers have been increasing in recent times, according to the data from the National Statistical Committee of Kyrgyzstan.
M	Geographic range: <u>Medium</u>	In Kazakhstan, the Asiatic ibex lives across a wide altitudinal range of 500 to 5,000 m, inhabiting all mountain ranges in the south and east of the country, from the Western Tien-Shan to the Altai. In Kyrgyzstan, the Asiatic ibex occurs throughout most mountainous territories. In Tajikistan, the Asiatic ibex is present across the whole His or-Alay mountain system and the Pamir region. There are no isolated or fragmented populations. The highest density of Asiatic ibex is directly linked to the areas with low human presence/livestock density and higher elevation.
M	Population size: <u>Medium</u>	In Kazakhstan, the official numbers reported by the Provincial Territorial Inspection Services for Forestry and Wildlife of the Ministry of Agriculture during the period 2014–2018 varied between 16,582 and 22,700. The latest official figure is 20,500 (2024). These variations may reflect differences in reporting or methods, rather than actual fluctuations in population size. In Kyrgyzstan, the most recent official figure was 54,542 individuals in 2024, but abundance varies across the landscape. There are hunting concessions with little livestock grazing and few protected areas (e.g., Ala-Archa National Park and Sarychat-Ertash Strictly Protected Area) with high numbers and densities. In the overall mountain landscape, which is intensively used for livestock grazing and where poaching is widespread, numbers are very low. In Tajikistan, the officially reported population was between 25,000 and 40,000 individuals in 2024. The uncertainty is due to large areas not being surveyed.
M	Temperature tolerance: <u>Medium</u>	There are no studies on this topic in the region at the time of writing, but studies on Alpine ibex in Europe show that temperatures above 15°C to 20°C can result in heat discomfort in large male Alpine ibex, who spend less time feeding during daylight compared with younger and smaller ibex. Rutting can also be affected if the temperature stays warm in November. Warm temperatures also produce more insect pests (e.g., gadflies), which force animals to climb to higher elevations.

M	Does the species rely on environmental cues for reproduction? <u>Medium</u>	The species relies to some degree on environmental factors, such as temperature, humidity, water availability, and pasture quality and quantity for reproduction. Females require nutritious food to support gestation, nursing, and parental care. If that changes, it may not affect reproduction per se, but it would impact the survival rate of kids. A study on Alpine ibex showed that females with insufficient reserves may allocate energy to their own survival at the cost of reproduction.
U	Does the species rely on environmental cues for migration? <u>Medium</u>	Migrations are altitudinal and are mostly triggered by forage availability and temperature. In the summer, ibex move to higher elevation habitats, while in the fall, with the onset of snow, they move to lower areas and/or southern exposed slopes. Poaching pressure and disturbance (including from livestock and herding/guard dogs) can also force ibex to shift to higher, more inaccessible habitats.
L	Does the species rely on environmental cues for hibernation? <u>No</u>	Asiatic ibex do not hibernate
L	Does the species have any strong or symbiotic relationships with other species? <u>No</u>	No symbiotic or other strong relationships exist
L	Diet: <u>Generalist</u>	Asiatic ibex feed on 140 different species of plants, which include grasses, mosses, sedges, feather grasses, and thorns.
H	Abundance of food source: <u>Low</u>	Competition with livestock and disturbance affect the abundance of forage as well as access. In areas with high livestock presence, Asiatic ibex tend to be pushed into higher elevation areas. Winter pastures are also compromised due to being overgrazed by livestock in the summer and autumn.
M	Freshwater requirements <u>Medium</u>	Asiatic ibex can go without water for several days as they draw moisture from grasses and plants. However, in all three countries, climate change is impacting water availability, especially during the summer for kids and lactating females. Small springs and snow have been disappearing due to hot temperatures, so forage quality and moisture levels could be impacted, generating greater surface water needs.
H	Habitat specialization: <u>Specialist</u>	Asiatic ibex prefer alpine and subalpine belts, which are characterized by rugged relief with steep slopes and deep gorges and associated grasslands and herbal vegetation. The optimal habitats of the Asiatic ibex are located at an altitude of 2,200 to 3,900 m but they are also able to use lower elevations if relief and vegetation are suitable. However, they are specialists due to their preference for rocky slopes and cliff terrains.

M	Susceptibility to disease: <u>Medium</u>	Several infectious diseases have been identified in the Asiatic ibex, such as pasteurellosis, pleuropneumonia, necrobacillosis, foot-and-mouth disease, and scabies (sarcoptic mange). In high mountain areas, it is heavily infested by <i>V. alacurt</i> fleas from September to May. In the Eastern Pamirs in Tajikistan, the nasal gadfly <i>Oestrus caucasicus guozdeui</i> was found. Of the ectoparasites in Asiatic ibex, there are ticks from the genus <i>Dermacentor</i>, in particular <i>D. pavlowskii</i>. In Kyrgyzstan, pruritic scabies, along with sheep ked <i>Melophagus ovinus</i>, causes high mortality among Asiatic ibex.
Adaptive Capacity		
M	Dispersal ability: <u>Medium</u>	Asiatic ibex tend to have small home ranges on lower, south-facing slopes, expanding to larger ranges in summer and autumn. As the population grows, it tends to incrementally increase habitat use, absent of any constraints or barriers. Poaching, linear infrastructure, habitat degradation by livestock, and livestock presence generally can displace ibex and change habitat use patterns. The development of linear infrastructure such as power lines, roads, and railways through mountainous regions already hampers dispersal and causes fragmentation of populations. Ongoing and planned infrastructure projects will exacerbate this effect.
M	Generation time: <u>Medium</u>	Females are sexually mature at 2 years, and males at 3 years. The maximum lifespan is 10–15 years.
M	Reproductive rate: <u>Medium</u>	Gestation is about 160–170 days, and females give birth to 1–2 offspring. Females separate from the herd to give birth and remain alone with the offspring for several days.
U	Genetic variation: <u>Unknown</u>	No studies have been done on the genetics of Asiatic ibex.

Other Threats

H

Other threats:
High

Other threats include poaching for meat, competition with livestock for habitat and pasture, attacks on Asiatic ibex kids by herding dogs, mineral resource extraction such as mining, and linear infrastructure, including power lines and roads, which cause habitat destruction, degradation, and fragmentation.

The Asiatic ibex is a popular species for trophy hunting and often inadequately managed due to unsustainable quotas and hunting practices that target animals that are important for the viability of the population.



Recommendations

The vulnerability of Asiatic ibex to climate change is best reduced by keeping population sizes high through i) habitat protection to reduce poaching pressure; ii) reducing the negative impacts of livestock on the quality and quantity of available habitat; and iii) ensuring connectivity and exchange between fragmented populations, as well as recolonization of previous range areas by addressing barriers (linear infrastructure; degradation of pastures and livestock presence).

1. Reduce habitat disturbance and competition with livestock for Asiatic ibex by:

- Increasing effective protection of areas that serve as natural refugia (e.g., areas rich in glaciers) for Asiatic ibex and protecting rangelands and pastures used by the species.
- Improving grazing management by adjusting livestock numbers and grazing management approaches to reduce competition.
- Limiting the use of guard/herding dogs, which may disturb ibex during the birthing season or kill other wildlife, such as marmots.
- Establishing disease surveillance mechanisms and fully vaccinating livestock against diseases that are transmissible to wildlife.
- Implementing incentives that encourage voluntary measures to reduce pressures on Asiatic ibex and their habitat such as:
 - I. Promoting nature-positive alternative livelihoods, such as nature-based tourism, sustainable hunting, beekeeping, gardening, and sustainable agroforestry.*
 - II. Optimizing sustainable use for domestic hunting and hunting tourism, e.g., through community-based wildlife conservation and management areas.*
 - II. Supporting communities in reducing human-wildlife conflict.*

2. Enforce existing measures and enact additional measures to improve protection from poaching and associated disturbances via fines, patrolling, training for rangers, and community-level enforcement.

3. Invest in the establishment and fund the operation of community-based conservation areas, national parks, and other wildlife conservation areas.

4. Remove or make permeable linear infrastructure (e.g., border fences) that impedes migration.







Tien-Shan Maral (*Cervus canadensis* *songoricus*)

The Tien-Shan maral occurs in mountainous regions with moderate but highly variable temperatures. Climate change may cause heat stress in the summer and during the rut in autumn, but reduced snow cover in winter may have an immediate positive impact on their survival. They have moderate freshwater requirements but could be vulnerable during extended droughts.

The most significant impact caused by climate change on Tien-Shan maral will be through the modification of their habitat and forage base. Tien-Shan maral use coniferous forests as cover. These forests currently occur in a narrow belt with a suitable combination of temperature and precipitation. The availability and quality of fodder plants will be affected due to likely increasing aridity and shifting phenology.

Human activities, in particular poaching, livestock grazing, and infrastructure and urban development, directly affect Tien-Shan maral and reduce their adaptive capacity. Small, fragmented populations, hindered by these factors and unable to move between suitable habitats, are prone to the negative impact of climate change and cannot recover or recolonize lost range areas.

Climate-informed conservation of Tien-Shan maral should improve the connectivity of populations and habitats and improve the fitness of the animals by i) reducing direct mortality and disturbance and ii) ensuring access to forage, water, and shelter. Incentive-based conservation through sustainable hunting in assigned wildlife management areas could complement protected areas and support the coexistence of Tien-Shan maral and land use.

Tian Shan maral (*Cervus canadensis songoricus*) range in Kazakhstan

Central Asian Mammals and Climate Adaptation (CAMCA) project

Legend

Species range

■ extant

Elevation limits

▲ unknown

■ glaciated area

Infrastructure

— Main road network

— Railway network

— Proposed China-Kyrgyzstan-Uzbekistan railway

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official Indorsement or acceptance by the United Nations.

Sources:

Species range: courtesy of Ilbirs Foundation, Stefan Michel & CAMP Alatau (2022)

Basemap: ESRI/Natural Earth/OSM/RGI/UNEP

200 km

KAZAKHSTAN

Sary-Chelek State
Biosphere Nature Reserve

TAD

Uzbekistan & Tajikistan



Zhonggar Alatau State
National Natural Park

Chong Kemin
National Park

Northern Tien Shan

KYRGYZSTAN

Naryn State
Nature Reserve

TAJIKISTAN



Climate Vulnerability of the Tien-Shan Maral (*Cervus canadensis songoricus*)

Sensitivity

L	IUCN Red List Status: <u>Least Concern</u>	The species <i>Cervus canadensis</i> is assessed as Least Concern with an increasing trend. There have been range contractions and presumably population declines in some parts of the species' range in both Asia and North America. The Tien-Shan maral is not listed in the Red Book in Kazakhstan, but it is included in Kyrgyzstan.
M	Geographic range: <u>Medium</u>	In the past, the Tien-Shan maral range included the Dzungarian Alatau, the entire Tien-Shan mountain system in the south, the northern fringes of the Fergana basin and the north-eastern spurs of the Alay range in the west, to the western Tien-Shan, possibly even including the Syrdarya Karatau range. The current range area is only a small portion of the historic range and includes several isolated sections of the Tien-Shan in Kyrgyzstan and Kazakhstan, as well as the Dzungarian Alatau. Maral occurring further to the north in Kazakhstan are Siberian or Altai maral, and may potentially represent a separate subspecies. In Kyrgyzstan, the species had vanished from most of its former range, except the eastern part of the Naryn-Too range and the Chon-Kemi valley, by 1980. In Kemin Valley and in the eastern Ysyk-Köl region, maral had been considered extinct in the past, but the species has recolonized these areas from Kazakhstan by establishing transboundary populations since 2010. In the Jalal-Abad region, non-native maral from the Altai region have been introduced.

H	Population size: <u>Small</u>	Most literature, including the IUCN Red List assessment, considers Tien-Shan maral (<i>C. c. songoricus</i>) as part of <i>C. c. sibiricus</i>. Since 2010, the population of <i>C. c. sibiricus</i> in Russia has remained stable at 33,000 to 39,000 individuals and in the late 1990s, there were 8,000 to 10,000 deer in Mongolia. Populations in Kazakhstan and Kyrgyzstan are, in comparison, rather small. However, both countries, combined with the adjacent Chinese section of the Tien-Shan, hold the entire population of Tien-Shan maral. No numbers are available for the Kazakhstan section of the Tien-Shan maral range area. According to data from the Committee for Forestry and Wildlife, the number of maral in Dzungar-Alatau National Park in 2021 was around 1,700 individuals. Maral occur outside this national park in privately held hunting and game management areas. The population in the northern Tien-Shan sections of Kazakhstan is likely substantially smaller. In Kyrgyzstan, the largest population of maral is in Naryn Strict Nature Reserve, numbered at 130 individuals in 1983, 150 individuals in 1985, and about 280 individuals in 2003. In 2023, the Ministry of Natural Resources, Environment, and Technical Supervision of Kyrgyzstan reported 689 maral in the Naryn, Chui, Ysyk-Köl, and Jalal-Abad regions of Kyrgyzstan, with the overwhelming majority in Naryn Strict Nature Reserve. In 2021, 143 maral were recorded in Kemin Valley and 76 in the eastern Ysyk-Köl region, with an increasing trend in both areas; in the early 2000s, the species was absent and recolonization occurred from Kazakhstan.
M	Temperature tolerance: <u>Medium</u>	The maral and its close relatives live in habitats from the Central Asian riparian lowlands and adjacent deserts with summer temperatures up to 40 °C and above, to southern Siberian continental mountains with winter temperatures falling to -40 °C. This wide temperature range suggests a high temperature tolerance. However, local populations might prefer more moderate temperatures. As large-bodied animals with limited options for thermal regulation, they are likely affected by particularly high summer temperatures and avoid these (and associated parasitic insects) by vertical movements in their mountainous habitat.
U	Does the species rely on environmental cues for reproduction? <u>Unknown</u>	There is no indication of environmental cues for reproduction. However, as the rut takes place during the cooler autumn season and the activities of the stags for defending territories and harems against their competitors are physically demanding and could cause overheating, hot temperatures may stagger the rut and thus impact reproduction.

M	Does the species rely on environmental cues for migration? <u>Yes</u>	Migrations of Tien-Shan maral between their summer and winter habitats, covering distances of up to 150 km, are mainly triggered by forage availability and temperature. In the summer, maral use semi-open forest and forest-steppe habitat of the montane belt and subalpine grasslands (syrtes). In winter, maral naturally use areas with limited or no snow cover, determined by aspect, wind, and altitude. Typical winter habitats are southern exposed slopes with steppe and semi-desert vegetation, as well as riparian areas. Seasonal movements are known in Kyrgyzstan and in the northern Tien-Shan, with migrations occurring between Kyrgyzstan and Kazakhstan in the Terskei Ala-Too and Kungei Ala-Too ranges.
L	Does the species rely on environmental cues for hibernation? <u>No</u>	Tien-Shan maral do not hibernate.
L	Does the species have any strong or symbiotic relationships with other species? <u>No</u>	No symbiotic or other strong relationships exist except for the physiologically essential flora of the gastro-intestinal tract.
M	Diet: <u>Generalist</u>	Maral are intermediate herbivores, between typical grazers such as cattle, and browsers such as goats. They eat various species of grasses, forbs, buds and leaves of shrubs and trees, and the shoots of willows and other shrubs, with specific and seasonally varying preferences. In times of forage shortage or reduced access, mainly in winter, they are known to debark trees. While a generalist, the Tien-Shan maral is potentially vulnerable to changes in forage availability and accessibility. Poaching and land-use pressure can force maral into forests with little nutritious forage. Overgrazing by livestock causes degradation of pasture vegetation.
M	Abundance of food source: <u>Low</u>	Competition with livestock and disturbance affect forage quantity and accessibility for maral. In Kazakhstan, acute shortage of forage is, thus far, not considered as serious a threat as intensive grazing and resulting competition with livestock. In Kyrgyzstan, available forage within the species' range is limited in most areas due to overgrazing by livestock. Grazing and occupation of lands by settlements may have affected the accessibility of the natural winter range of maral.
M	Freshwater requirements: <u>Medium</u>	Maral need regular access to drinking water. In winter, snow is also consumed to serve their water needs. Currently, in the range areas in Kazakhstan and Kyrgyzstan, sufficient streams and rivers are available. Climate change impacts may cause a reduction of water availability (due to a shorter season of water flow in small streams, and the disappearance of springs and streams) in certain seasonal habitats, making these less suitable for maral.

M	Habitat specialization: <i>Specialist</i>	The maral is a mountain animal, using forested, semi-open, and open terrain. Naturally, maral would likely use more open subalpine and open habitats of forest steppe (in summer and spring), as well as semi-desert and riparian areas (in winter). The apparent preference for forested areas is mostly an effect of long-lasting anthropogenic pressure, particularly poaching pressure and disturbance by livestock herders and their dogs. While forests provide shelter in times of unfavourable weather conditions, their suitability as a foraging habitat is very limited, especially in the dark coniferous (spruce) forests. Altered habitat use patterns and migration of Tien-Shan maral for many decades have potentially negatively affected both the animals and the forest ecosystems. In Kazakhstan, the preferred habitats of maral vary. In the Western Tien-Shan (Talas Alatau), maral live in juniper forests and in the valleys of mountain rivers. In the rest of the Tien-Shan, they live in spruce forests and in the Dzungarian Alatau, they live in spruce and spruce–fir forests, as well as in birch forests. Marals make vertical movements, descending to lower elevations in winter and rising to the upper border of the forest or to the alpine belt in the early summer. In the Dzungarian Alatau, some maral go deep into the mountains for the winter where there is less snow, and in the spring, they return to ridges where it is warmer, and greenery appears earlier. In Kyrgyzstan, maral populate forest and shrubby landscapes in mid-montane elevations and migrate in the summer to subalpine meadows at 2,000–2,900 m.
M	Susceptibility to disease: <i>Medium</i>	Little specific information is available on diseases of Tien-Shan maral. From maral farms in other areas, mass death caused by anthrax, as well as other diseases, including cattle plague, pasteurellosis, tuberculosis, necrobacillosis, and brucellosis, have been reported. Maral host various ectoparasites and endoparasites. Movements to higher elevations and exposed ridges helps them avoid gadflies and other insects. Maral might be susceptible to disease transmission from domestic livestock and could also serve as vectors of livestock diseases, such as brucellosis.

Adaptive capacity

M	Dispersal ability: <u>Medium</u>	Natural dispersal ability might be high, as maral are able to cover large distances. In human-modified landscapes with high urban densities, intensively used agricultural areas, and linear infrastructure, dispersal is significantly hampered. This effect is exacerbated by the impacts of poaching, which cause high mortality of dispersing maral, as well as avoidance of humans and their structures, further reducing dispersal. This is evidenced by the lack of recolonization of former habitat by maral from the Naryn Strict Nature Reserve in Kyrgyzstan, despite decades of legal protection and a growing population. Known recolonization is only observed from areas bordering existing maral range areas and areas with recently improved protection due to the establishment of community-based conservation.
M	Generation time: <u>Medium</u>	Females reach sexual maturity in their second year of life, but most reproduce only from the third year onwards. Males usually mate successfully only from the ages of five or six. In natural conditions, maral can live for up to 12–14 years and in captivity, they can live for up to 25–30 years. The generation time is eight years.
M	Reproductive rate: <u>Medium</u>	Females have one, or rarely two, fawns annually, but may not give birth every year.
U	Genetic variation: <u>Unknown</u>	Given the lack of genetic analysis, morphological differences and the biogeographic situation suggest limited genetic exchange between maral from the Altai and maral from the Tien-Shan and Dzungarian Alatau. The Tien-Shan maral should be treated as a separate conservation unit, and therefore no maral from other areas should be introduced to the range of Tien-Shan maral or its captive population. Genetic variation within smaller and isolated populations of Tien-Shan maral might be low due to previous genetic bottlenecks, small founder groups (in cases of natural recolonizations), and resulting genetic drift.

Other threats

H

Other threats: High

The main threat to maral in Kazakhstan and Kyrgyzstan is poaching. Poaching affects maral in several ways. It causes direct mortality, reducing population size, and (due to the resulting behavioural responses to human disturbance) it makes large sections of otherwise suitable habitat inaccessible, hindering connectivity between populations and the species' potential for recolonization.

Increasing livestock numbers and reclamation of mountain pastures lead to forage competition and further reduce available habitat. Livestock may also be a vector of diseases. In potential and actual winter range areas, urban and agricultural development and intensive livestock grazing affect the availability and quality of habitat.

Fragmentation of populations and habitats due to poaching, development of infrastructure in mountainous regions, displacement by livestock, and disturbance by herding dogs increases the likelihood of local extinctions.

Local and human-modified habitat selection, particularly in winter, may increase susceptibility of predation by wolves in locations with deep snow.

Genetic pollution and hybridizing have been caused by the release of maral originating from the Siberian Altai. Potential hybridization with other deer species, such as the spotted deer *Cervus nippon* and European red deer *Cervus elaphus*, may be a risk if these species are kept together in deer farms or are released for hunting purposes into natural habitats.

Recommendations

The Tien-Shan maral appears understudied in terms of its ecology, including climate change sensitivity. Targeted research is recommended, including examining how range shifts, changes in population size, and changes in behaviour might correlate with changes in weather and climate.

The resilience of Tien-Shan maral would be best improved by i) making habitat accessible through the reduction of poaching and associated disturbance; ii) reducing the negative impact of livestock on the quality and quantity of available habitat; and iii) fostering connectivity and exchange between fragmented populations, as well as recolonization of previous range areas through preservation of (potential) routes of horizontal and vertical migrations.

1. Improve environmental management across the species' range area, ensuring access to forage, water, and shelter.

- Minimizing habitat loss and fragmentation caused by intensive grazing, deforestation, and infrastructure construction.
- Making habitat outside of forests available for maral might also be of importance to prevent any excessive impact of maral on forest regeneration and to ensure that forests are resilient against climate change-related and other stressors.

2. Research population ecology – including climate change-induced range shifts, changes in population size, changes in behaviour, and the relationship of these to changes in weather and climate – as Tien-Shan maral appear understudied.

3. Establish a long-term population monitoring programme around protected and wildlife management areas, providing adequate data for guiding conservation targets and sustainable hunting thresholds.

4. Actions to reduce anthropogenic pressure on maral include:

- Enforcing existing measures and enacting additional measures to improve protection from poaching and associated disturbances through fines, patrolling, ranger training, and community-level enforcement.
- Strengthening the work of protected areas and conducting training for staff on the conservation of Tien-Shan maral.

- Improving funding and enhancing material assistance to protected areas.
- Enacting policies that promote the coexistence of maral with human land use and incorporating wildlife and protected area/corridor considerations in pasture management practices.
- Promoting nature-positive alternative livelihoods, such as nature-based tourism, sustainable hunting, beekeeping, and sustainable agroforestry.
- Evaluating the possibility of incentive-based conservation, such as sustainable hunting in assigned wildlife management areas. This should be based on clear rights and responsibilities for well-defined user groups, such as local communities and land users.
- Improving veterinary management of livestock through mandatory vaccinations, veterinary inspections, and other health measures to reduce the risk of livestock-borne disease transmission.

5. Improving connectivity would allow maral to adapt to climate change by shifting range areas and seasonal habitat use, promote exchange between fragmented populations, and facilitate recolonization of historic range areas through the preservation of potential routes of both horizontal and vertical migrations. Supporting activities include:

- Designating ecological corridors and including these in land management policies and in development and infrastructure plans.
- Removing or making permeable linear infrastructure (e.g., border fences) that impedes animal movement.
- Assessing development activities (infrastructure, mining and tourism) and prioritizing avoidance of adverse impact before mitigating unavoidable negative impacts.

Country-level considerations

For Kazakhstan and the Dzungarian Alatau project site, a more detailed assessment of issues, threats, limitations (as well as potential) is required for developing specific recommendations. This concerns the Dzungar-Alatau National Park, as well as private hunting and game management areas.

For Kyrgyzstan, the issuance of a limited quota for legal hunting outside strictly protected areas could be considered to stimulate the involvement of the hunting sector in the restoration and conservation of the maral range area and population by preventing poaching and supporting the coexistence of maral and multiple land uses.

The adaptive capacity of maral in Kyrgyzstan and reduction of other threats should be further fostered by:

- Conducting broad consultations with hunters/hunting companies, the Academy of Sciences, the Pasture Department and Biodiversity Conservation Department, local decision makers, local institutions (pasture committees), tour operators, and other stakeholders to identify the main threats and to make joint decisions on the conservation of Tien-Shan maral populations
- Establishing functional connectivity between the maral population of the Naryn Strict Nature Reserve and other actual areas of maral occurrence, such as Khan-Tengri National Park and the Ysyk-Köl region, and identifying potential areas of natural recovery

For the Naryn Strict Nature Reserve specifically, it is recommended to study current habitat use, seasonal habitat preferences, and movements, as well as factors influencing these. Available knowledge suggests that improved protection from poaching is needed to allow for an intensified use of open and semi-open habitats by maral. This particularly concerns their winter habitats. Maral could potentially use south-facing slopes with less snow during winter, but these are located outside of the protected area. The establishment of – preferably community-based – wildlife management areas may foster support of anti-poaching and coexistence with livestock grazing if sustainable use options are foreseeable.

Further recommendations for the Naryn Strict Nature Reserve include:

- Adapting the management and zoning of the reserve and its buffer zone
- Considering the development of wildlife management areas in actual and potential maral habitat outside of the strictly protected area, and integrating livestock grazing and sustainable use of maral there







Tien-Shan Brown Bear (*Ursus arctos isabellinus*)

The Tien-Shan brown bear (*Ursus arctos isabellinus*) is a subspecies of the widely distributed brown bear, which occupies a variety of habitats. In Tajikistan, Kyrgyzstan, and Kazakhstan, it inhabits mountain highlands as well as temperate forests. It forages on a variety of grasses, herbs, roots, berries, and nuts, as well as animal matter such as insects, mammals, and fish when available.

Lower densities (5 to 15 bears per 1,000 km²) are found in dry, desert-like areas, alpine and subalpine areas, as well as areas where habitat availability and numbers have been reduced by high human and domestic livestock densities. Kantarbayev et al. (2024) found that bear activity and density were influenced by the level of anthropogenic activity in and around protected areas.

Conflict with livestock herders and predation of livestock is an issue due to an overlap of grazing areas with bear habitats. Beekeeping in bear habitats without protective measures can trigger conflict. Furthermore, increased tourism activity in mountainous areas and the probable associated increase in unregulated waste disposal is also expected to lead to conflict.

Climate change impacts on the behaviour of brown bears and the availability of different food sources have not been adequately assessed. However, forage plants and shrubs (including fruit and nut trees) and prey species may be vulnerable to climate change, and it is suspected that these changes could increase the risk of conflict with humans.

Tian Shan brown bear (*Ursus arctos isabellinus*) range in Kazakhstan

Central Asian Mammals and Climate Adaptation (CAMCA) project

Legend

Species range



extant



possibly extant

Elevation limits



5,000 m

1,000 m*

*due to anthropogenic landscape transformation at lower elevations



glaciated area

Infrastructure



Main road network



Railway network



Proposed China-Kyrgyzstan-Uzbekistan railway

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official Indorsement or acceptance by the United Nations.

Sources:

Species range: courtesy of the IUCN Bear Specialist Group & Ibirs foundation (2022)

Basemap: ESRI/Natural Earth/OSM/RGI/UNEP

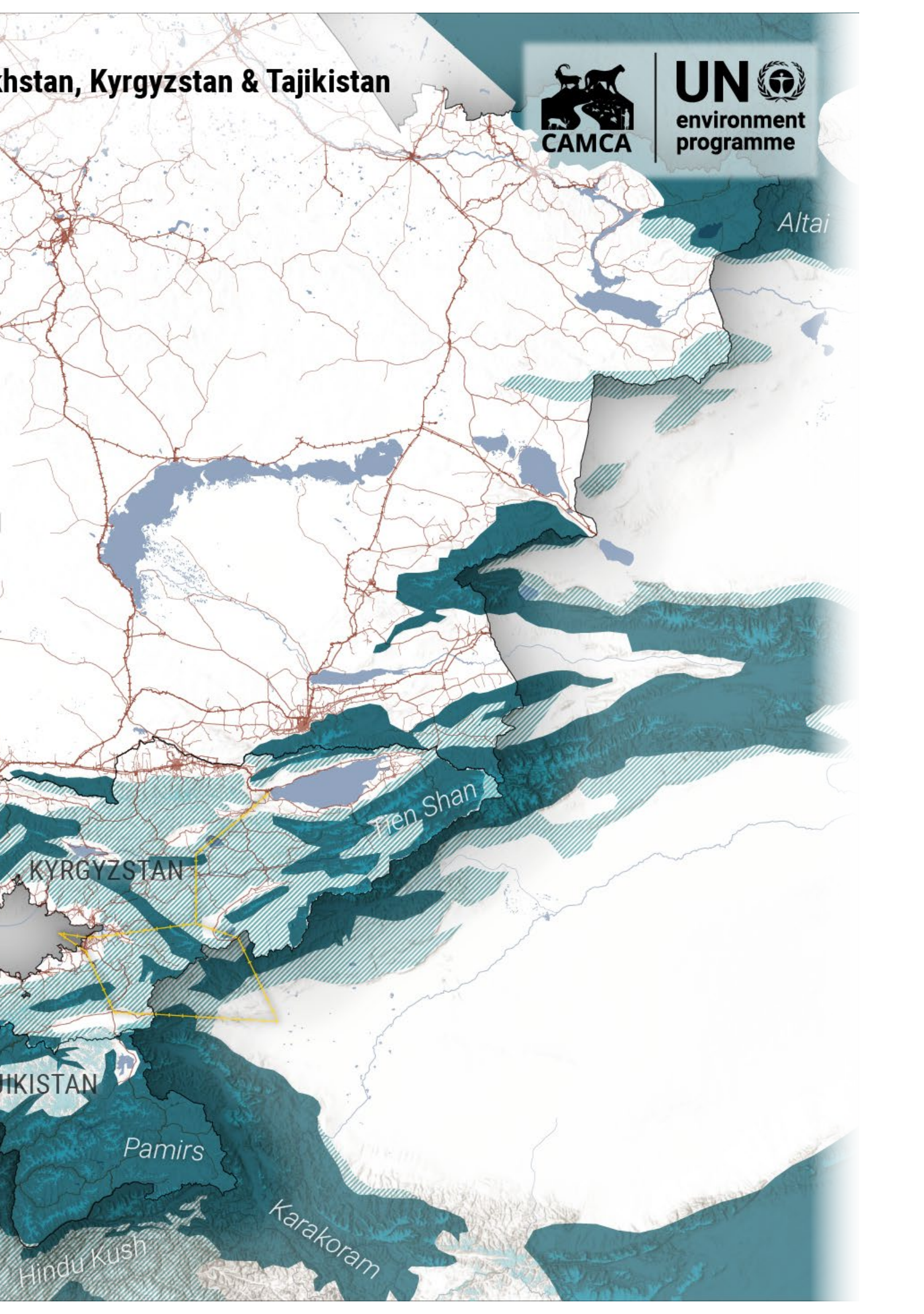
200 km

KAZAKHSTAN

Alay

TAJIKISTAN

Uzbekistan, Kyrgyzstan & Tajikistan





H High
M Medium
L Low
U Unknown

Climate Vulnerability of the Tien-Shan Brown Bear (*Ursus arctos isabellinus*)

Sensitivity

M	IUCN Red List Status: <u>Vulnerable</u>	The species <i>Ursus arctos</i> is listed by IUCN as Least Concern, but the main populations of the Tien-Shan subspecies <i>Ursus arctos isabellinus</i> are listed as Vulnerable, and one population as Endangered. In Kazakhstan, Kyrgyzstan, and Tajikistan, the Tien-Shan brown bear is included in the national Red Books.
L	Geographic range: <u>Large</u>	Within Kazakhstan, the Tien-Shan brown bear inhabits the western and northern Tien-Shan (Ugamsky, Karzhantau, Talassky, Kirghizsky, Zailisky, Ketmen, Kungei Alatau and Terskey Alatau ridges), as well as Zhongar Alatau, with spurs of Toksanbai, Koyandytau, and Altyn-Emel. In Kyrgyzstan, bears are found in the Terskei and Kungei Ala-Too, Naryn, At-Bashy, Kyrgyz, Talas, Chatkal, Fergana, Alai, and Zaalay ranges. Bears have been observed repeatedly along the entire syrt zone, from Khan-Tengri Peak in the east to the Fergana range in the west, with its constituent Ak-Sai and Arpa valleys, as well as in the Alai valley. There are also bears in the mountains surrounding Son-Köl Lake and the Suusamyr Valley. In Tajikistan, the bears are found in the north – in the Kurama, Turkestan and Zerafshon ranges, along the Hissar-Alai mountains and in the Pamirs and its western spurs (Darvaz, Hazratishoh, Baljuvan, Tavildara and others). They are rare in the eastern Pamirs.
M	Population size: <u>Medium</u>	In Kazakhstan, a rough estimate in 2012 by Loginov found between 195 and 255 bears in the Kazakhstan portion of the Tien-Shan. However, this number is based on expert assessment and fragmentary observations (Kantarbaev, personal communication, 2025). No numbers are available for Zhongar Alatau, but Zhiryakov and Grachev (1993) stated that one of the densest bear populations was on its northern slope. In Kyrgyzstan, there are 612 bears (official figure 2024). In Tajikistan, there are no reliable data on the number of bears. Few studies have been carried out to determine density, which shows the different densities of this species in different parts of the country. It is estimated that there are 550 to 600 bears (2024) in total in the territory of Tajikistan.
M	Temperature tolerance: <u>Medium</u>	Brown bears naturally occur in habitats with a broad range of temperatures from -40 °C and below, when brown bears normally hibernate, to more than 30 °C, although at such high temperatures brown bears typically rest during daytime and are active only in cooler evening, night, and morning hours.

M	Does the species rely on environmental cues for reproduction? <u>Medium</u>	A cue for reproduction is the sufficient availability of food resources before hibernation.
L	Does the species rely on environmental cues for migration? <u>No</u>	Bears do not migrate, but they may cover long distances in search of specific food sources.
M	Does the species rely on environmental cues for hibernation? <u>Yes</u>	Lower temperatures, dwindling food resources, and shorter days are cues for bears to start hibernation. When in the year these conditions are met depends on the latitude, altitude, and ecosystem. In the north of Kyrgyzstan and in the highlands, the bear hibernates in November and in the south in December. Hibernation lasts until February or March, averaging 120 to 130 days. The duration of hibernation is correlated to fat deposits. It is not uncommon for a bear to hibernate before the appearance of stable snow cover. It also varies based on the elevation gradient. In Tajikistan, for example, bears will hibernate at 3,000-4,000m in the eastern Pamirs from October to April, while in Darvaz, they will hibernate at 1,000 m from November to February. A change in climate may cause a later onset and earlier end of hibernation, leading to changing energy requirements and different foraging patterns, potentially increasing human-bear conflicts.
L	Does the species have any strong or symbiotic relationships with other species? <u>No</u>	Bears may compete with wolves and snow leopards for the same prey. However, there could be beneficial relationships as well. Foraging behaviour does not occur in a vacuum but is impacted by other apex predators in the landscape. While snow leopard attacks on bears were not observed in Tajikistan, they might kill more prey when sharing the landscape with bears, as the latter could drive snow leopards from their kill sites, increasing their kill rates.
L	Diet: <u>Generalist</u>	Diet varies by region and can be dominated by fish, ungulates, rodents, ants, roots, shoots, or fruits. Brown bears are omnivorous, and their diet varies with the season, from grass and shoots in the spring to berries and apples in the summer, and nuts and plums in the autumn. All year round they eat roots, insects, mammals and reptiles.

L	<u>Abundance of food source:</u> <u>High</u>	The brown bear occupies a diversity of habitats, greater than any other species of bear, and also exploits a large variety of food items. As omnivorous species they are not highly dependent on specific food sources, however, specific highly nutritious food might be insufficient during critical periods. In Tajikistan and Kyrgyzstan, marmots are a key food source for bears.
L	<u>Freshwater requirements</u> <u>Low</u>	Dependence on water is not very high, and they may draw water from grasses, fruit, and meat from their kills.
L	<u>Habitat specialization: Generalist</u>	The main bear habitats are located in the upper forest belt, subalpine and alpine belt (where they can be seen at the foot of glaciers), high-altitude steppes, and nut-bearing forests. They are also common at medium elevations on the slopes of gorges covered by bushes, tall grassy vegetation and, sometimes, by rather sparse vegetation. Rocks and upper belts of forests are favourite bear habitats. Although quite widespread, the species is difficult to observe due to low numbers and extremely cautious behaviour. Bears are generalists and can be very adaptive. However, they will not thrive in human-dominated landscapes, where they can be killed or trapped. In the eastern Pamirs, bears are very much dependent on marmots, which explains their willingness to balance a poor vegetation diversity with high quality animal fat and protein to survive long and cold periods.
L	<u>Susceptibility to disease:</u> <u>Low</u>	Fleas (<i>Arctopsylla tuberculaticeps</i>) and mites (<i>Ixodes persulcatus</i>) are found in bears. Two helminthiasis species: nematode (<i>Toxascaris transfuga</i> ; 63 specimens) and cestode (<i>Mesocostoides lineatus</i> ; over 1,000 specimens).
Adaptive Capacity		
M	<u>Dispersal ability: Medium</u>	Dispersal is sex-biased, with males dispersing more frequently and farther than females. Females tend to be philopatric; males less so. However, females can also show dispersal behaviour to evade competition, infanticide, and inbreeding. Long-distance dispersal of bears can also be indicative of a spatially expanding population. Connectivity might be poor in some areas due to persecution related to intensive land use.
M	<u>Generation time: Medium</u>	Brown bears reproduce slowly, with females having their first litters at 4 to 12 years old and litters every 2–3 years thereafter, but in some populations this interval stretches to 4–6 years.

M	<u>Reproductive rate: Medium</u>	Breeding occurs from April to July, but implantation of the blastocyst is delayed until late autumn. Cubs, usually in litters of 1 to 3 (rarely 4 or 5), are born in January or early February when the mother is hibernating. Brown bears mate from May to July; mating is followed by a gestation period of 180 to 266 days, with births occurring from January to March, usually while the female is still in hibernation.
L	<u>Genetic variation: High</u>	In Tajikistan, Kazakhstan, and Kyrgyzstan, lack of genetic variation may not yet be of concern, given the population size and nearly contiguous range area.
Other threats		
M	<u>Other threats: Medium</u>	- Frequent contact with humans (human-wildlife conflict): while attacks on humans are very rare, bears are attracted to livestock, orchards, beehives, and rubbish, which brings them into contact with people. Bears can either be killed in retaliation for killing livestock or raiding orchards and beehives, but in rare circumstances, because of their habituation to rubbish and its association with humans, they can exhibit aggressive behaviour and attack humans, and are killed as a result. - Poaching: bears are often killed in retaliation for livestock depredation or raiding orchards and (to a lesser degree) beehives. Bears are also sought for fat and parts used for traditional medicinal purposes, as bear meat and paws are served in restaurants and are considered a culinary delicacy. Bears are also hunted for hobby sport and once the mothers are killed, cubs are kept as pets in homes and restaurants. - Poor management practices: poor husbandry practices and lack of use of measures to prevent conflict.

Recommendations

1. Human-wildlife conflict reduction can be achieved by implementing measures that have proven successful in deterring conflict. These include:

- Establishing electric fencing around beehives and orchards.
- Using livestock guard dogs.
- Using visual and audio devices (such as fox lights and transmitters that emit loud noises) to scare bears away.
- Bear-proofing waste disposal bins in communal areas to avoid habituation to humans.
- Keeping tourist areas clean and food-free to deter human-bear encounters.
- Education and awareness-raising campaigns to promote appropriate and safe behaviour when encountering bears.

2. Strengthen policies to protect and increase the resilience of bears, their habitat, and their food sources.

- Establishing conservation incentives (such as nature tourism, sustainable use, and reducing human-wildlife conflict) to encourage voluntary measures that reduce pressures on bears and their habitat.
- Expanding existing reserves and national parks and creating new protected areas and ecological corridors.
- Improving funding and material assistance to protected areas, including staff capacity to manage bears.
- Including specific bear management measures in protected area management plans.
- Mandating that infrastructure projects incorporate wildlife movements and other wildlife needs in their Environmental Impact Assessments, prioritizing the avoidance of adverse impacts and the mitigation of any unavoidable negative impacts.

3. Enforce existing measures and enact additional measures to support effective law enforcement against poaching and illegal trade, including training for law enforcement officers and border staff.

4. Research population ecology and the level of community acceptance of bears, as well as the impacts of climate change on food availability and behaviour.

5. Conduct environmental awareness campaigns focused on the ecological importance of bears.





Conclusion

Central Asia is warming at a rate significantly exceeding the global average, which, combined with melting glaciers and shifting precipitation patterns, is fundamentally altering mountain ecosystems. The vulnerability assessment of the six flagship mammal species under the CAMCA project – the snow leopard, argali, Asiatic ibex, Tien-Shan maral, Bukhara deer, and Tien-Shan brown bear – acknowledges high climate risks for the continued survival of these species and the ecosystems they are associated with across Kazakhstan, Kyrgyzstan, and Tajikistan.

Across all three countries, species are adapting by altering their movement patterns and shifting their ranges to higher elevations or new habitats. This migration often brings wildlife into closer proximity with human activities. A primary issue is the exacerbation of existing anthropogenic pressures: livestock grazing is shifting to higher altitudes due to climate change and grazing seasons in high mountains are expanding, leading to heightened human-wildlife conflict, increasing disturbance of wild ungulates such as argali and Asiatic ibex, and competition for forage with them. Furthermore, linear infrastructure, such as border fences and roads, continues to act as a significant barrier, reducing the resilience of these species by preventing them from reaching suitable climate refugia or food sources.

Several key recommendations are prioritized at both the regional and national levels to address these challenges. The recommended strategies are designed to build the resilience of mountain ecosystems, their biodiversity, and their communities.

Climate-informed research and monitoring:

Targeted research and monitoring of range shifts, population size changes, and behavioural correlations with weather are needed for understudied species such as the Asiatic ibex and Tien-Shan maral.

Increase adaptive capacity: By improving habitat connectivity and reducing barriers, species are granted the “room to move,” allowing them to seek out new habitats as their current ranges become unsuitable due to warming or drought. Larger, connected (and therefore genetically more diverse) populations have a higher adaptive potential compared with small, isolated, and genetically impoverished ones. This includes mitigating the impact of linear infrastructure, particularly border fences and roads, and maintaining suitable habitats for contiguous populations through ecological corridors or “stepping stones”, which are essential to allow for the movement of natural species across landscapes.

Strengthen community resilience: Supporting biodiversity-positive alternative livelihoods and incentives through non-extractive and extractive uses, e.g., in the context of community-based wildlife management, reduces local dependence on climate-vulnerable livestock grazing and motivates tolerance towards wildlife and its active protection, thereby decreasing the intensity of land-use pressure on mountain ecosystems.

Reduce non-climate pressures: Addressing non-climate stressors such as poaching, displacement from good habitat, land degradation, and disease reduces overall pressure on a species, helping to maintain or increase its population size, which in turn makes the populations better equipped to survive extreme climate events such as heatwaves or severe winter storms.

- Strengthening anti-poaching enforcement and addressing human-wildlife conflict through measures such as corral improvements, electric fencing of beehives, and visual deterrents are critical to increasing the survival capacity of vulnerable populations. Implementing improved pasture management is necessary to reduce competition between livestock and wild mountain ungulates, which also serves to protect the prey base for the snow leopard. The displacement of wild ungulates caused by herders and dog presence should be reduced to maintain sufficient available habitat for thriving populations and movements of wildlife across the changing landscape.

Transboundary collaboration is a central pillar for these recommendations. Because the ranges of flagship species such as the snow leopard and argali span national borders, conservation efforts must be harmonized across the region to be effective. Collaboration is specifically needed to manage transboundary ecological corridors that connect habitats and populations, align protection policies, and address shared climate-driven water and land-use challenges.

The conservation of these flagship species is not merely a biodiversity concern but a vital component of cross-sectoral ecosystem-based climate adaptation for Central Asia, securing essential ecosystem services such as:

- **Water security:** Mountains serve as “water towers” for millions of people; conserving the ecosystems inhabited by these species helps protect the headwaters and glacier-fed rivers that are critical for regional agriculture and energy sectors.
- **Disaster risk reduction:** Healthy mountain ecosystems with intact vegetation cover and stable permafrost help mitigate the risk of landslides and flash floods, which are projected to increase with extreme precipitation events.
- **Sustainable development:** Integrating wildlife considerations into sectors such as infrastructure, energy, and livestock management ensures that regional development is “climate change-proofed” and does not inadvertently increase the vulnerability of the very ecosystems upon which human livelihoods depend.





The results of the species vulnerability assessments and the resulting recommendations provide a robust source of information to inform the implementation of several key national, regional, and international policy instruments frameworks:

Convention on the Conservation of Migratory Species of Wild Animals (CMS): The CAMCA project directly informs the update and implementation of species-specific international frameworks, including the Work Programme for the Bukhara Deer (2025–2032) and the Action Plan for the Conservation of the Argali (2024–2032). Furthermore, these findings are mainstreamed into the Work Programme for the Central Asian Mammals Initiative 2026–2032, providing a strategic opportunity for adoption at the CMS COP15 in March 2026. The project also supports the CMS mandate on climate change (Resolution 12.21) and the management of pastoralism in relation to migratory species.

Convention on Biological Diversity (CBD): The assessments offer critical data for the revision of National Biodiversity Strategies and Action Plans in Kazakhstan, Kyrgyzstan, and Tajikistan. Specifically, the focus on ecological corridors and transboundary connectivity directly contributes to achieving Target 3 of the Kunming-Montreal Global Biodiversity Framework, which aims to protect and effectively manage at least 30% of terrestrial areas.

United Nations Framework Convention on Climate Change (UNFCCC): By demonstrating how wildlife conservation acts as an ecosystem-based

adaptation, the project findings can strengthen the biodiversity and adaptation components of NDCs and National Adaptation Plans. They also align with the Regional Climate Change Adaptation Strategy for Central Asia, where natural ecosystems are identified as a top priority.

United Nations Convention to Combat Desertification (UNCCD): Recommendations for sustainable pasture management and the reduction of habitat degradation support Land Degradation Neutrality targets. Additionally, the project’s practical measures, such as setting up watering points for wildlife, align with the Regional Strategy for Drought Risk Management and Mitigation in Central Asia (2021–2030).

Regional and global platforms: The vulnerability assessments are highly relevant to the Global Snow Leopard and Ecosystem Protection Program, as snow leopard ranges are particularly sensitive to climate shifts. Synergies also exist with regional initiatives such as RESILAND CA, One Health in Nature Conservation (International Union for Conservation of Nature), and the UNEP Vanishing Treasures project, all of which prioritize climate resilience and landscape-level community-based sustainable land-use management.

Ultimately, protecting these flagship species serves as a catalyst for maintaining the ecological integrity of the mountains of Central Asia, which is fundamental to the long-term climate resilience of the entire region.



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