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Research Article

Mapping the spatial distribution of endangered and key species of Khunjerab National park through remote sensing techniques

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Abstract

Mapping of the key species of Khunjerab national park is carried out through remote sensing techniques. The methods adopted to carry out this study were Georeferencing, digitization, unsupervised classification for LULC (Land use Land cover), change detection and clipping of heads of key faunal species of Khunjerab National Park. In this study ISO cluster unsupervised classification was used in which four classes (snow, Bare Rocks/Bare Soil, Shadowed Rocks and mixed grasses/pastures) were set to determine the (LULC) of khunjerab national park and the accuracy assessment came out to be 80% which is quite satisfactory. Future perspectives of this study may include the following: Conservation Efforts, Monitoring and Management and Scientific Knowledge. The study contributes to the scientific community's understanding of the biodiversity and ecological dynamics within Khunjerab National Park. It provides valuable data on the distribution and status of key mammalian species, as well as insights into the impact of environmental changes on the park's ecosystem. This study also recommends different conservative approaches to protect the key and endangered mammalian species of Khunjerab national park.

Keywords: Geo-spatial; Large mammals; Mammalian fauna; Snow leopards

Introduction

Protected area can be defined as "an area of land or ocean that is specifically dedicated to the preservation and protection of biodiversity and related natural resources and is regulated by legal or other effective ways." Protected areas represent various, aquatic and terrestrial ecosystems that are essential for the ecological, economic and social services. Geographically Khunjerab national park is located in Pakistan's extreme northeastern region, in the north part of the old Hunza State named as Gojal, between 74° 55' East to 75° 57' East and 36° 01' North to 37° 02' North that covers a large area of 6,150 km2 **[1]**. The study area map is shown in (Fig. 1).

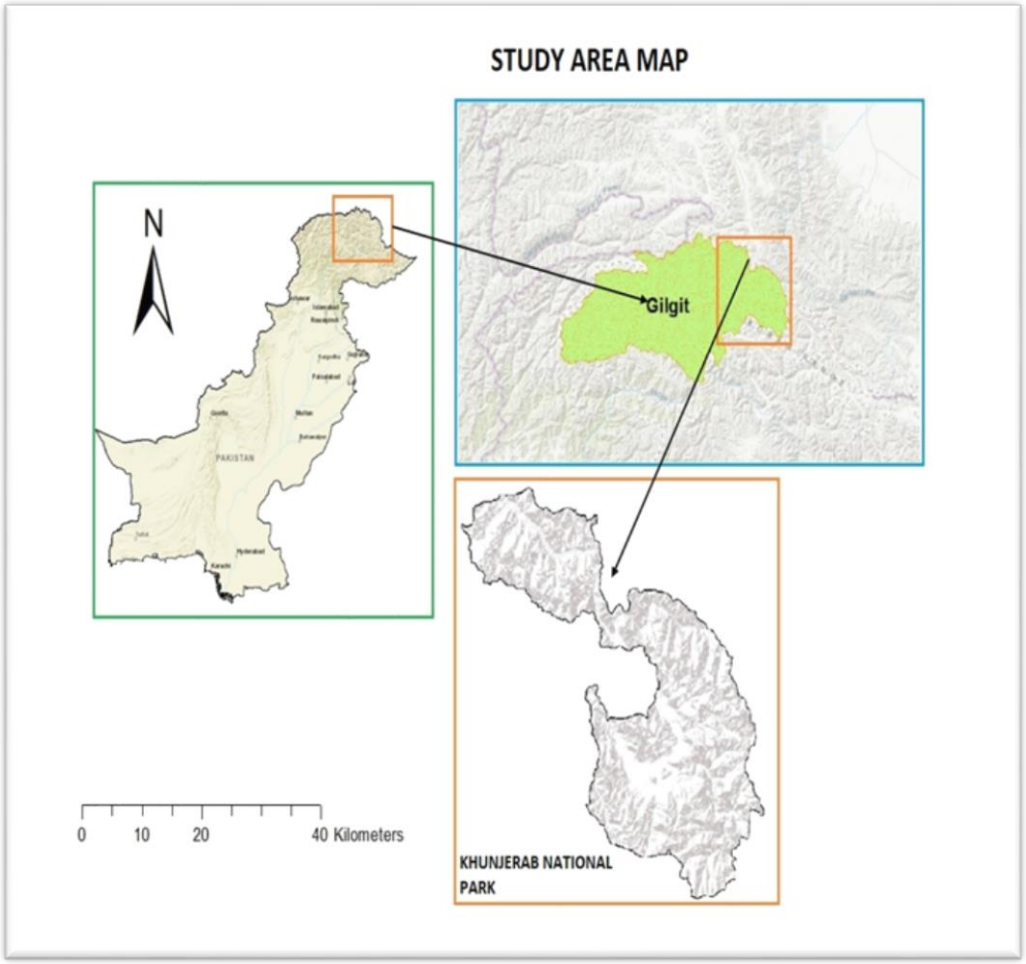

Figure 1: Study area map of Khunjerab National Park

The area under the present Khunjerab National Park (KNP) is famous for being the main habitat of many large mammals. *Panthera uncia* (Snow leopard), *Ovis ammon polii* (Marco Polo sheep) *Equus kiang* (Tibetan wild ass), *Pseudois nayaur*(Blue sheep), *Ursus arctos* (Brown bear) *Lupus pallipes* (Indian wolf), *Canis Capra sibirica* (Himalayan Ibex). However, this was mainly because of the drastic reduction in the number of Marco Polo sheep in the early 1970s, which led to the establishment of Khunjerab National Park in 1975, the main motive was to conserve the key habitat of Marco Polo sheep *(Ovis ammon polii)* **[1].** Khunjerab is literally the combination of two words "Khoon" and "Jerab". The words "Khoon" and "Jerab" is implied to "blood" and "river," according to Wakhi language respectively.

Materials and Methods

The following methods were adopted to carry out this study:

Georeferencing

The scanned map of Khunjerab national park used in this study was taken from Google images which was further rectified and georeferenced through the software ArcMap10.8.

The X and Y coordinates had been added through the software. The coordinate system used was WGS 1984. The final rectified image has been exported to KML format to be opened in Google Earth explorer.

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Digitization

For the digitization of Khunjerab national park's boundary the polygon feature was used. The final digitized boundary is shown in (Fig. 2).

Unsupervised classification for LULC (Land use Land cover)

In this study ISO cluster unsupervised classification was used in which four classes were set to determine the Land use land cover (LULC) of khunjerab national park. Accuracy assessment was done through high resolution satellite images (Fig. 3).

Clipping of heads of Key faunal species of Khunjerab National Park

Inventories of key faunal species of Khunjerab National Park has been gathered from published sources (research papers). Clipping of heads of key species had been done for the development of maps showing the final distribution of species.

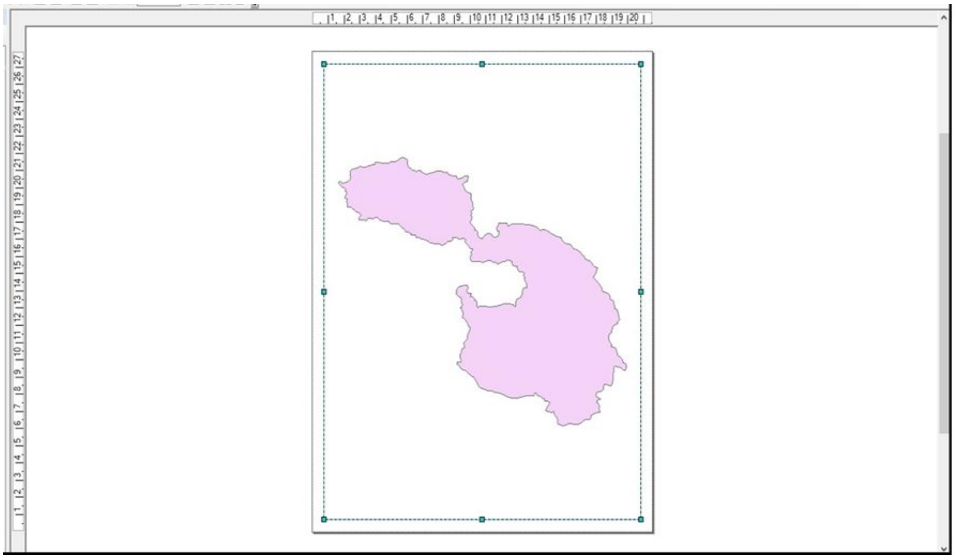

Figure 2: The final digitized boundary of Khunjerab National Park

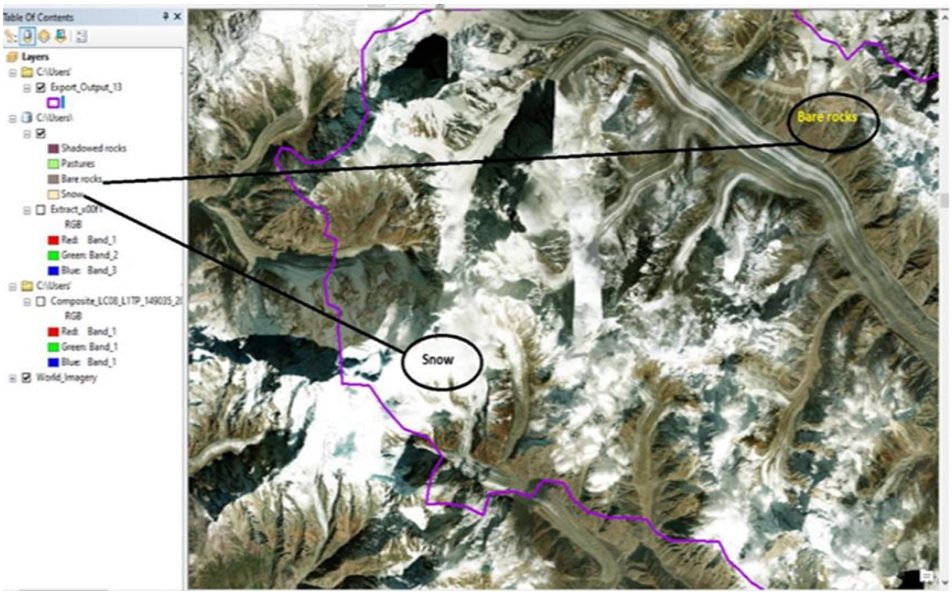

Figure 3: Accuracy assessment of defined classes through satellite images

Results and Discussion

Unsupervised classification

For the determination of Land use/ land cover (LULC) of Khunjerab national park four classes (snow, bare rocks, shadowed rocks and Pastures) are identified.

Khunjerab national park is largely made up of glaciers and is located at altitudes ranging from 3,200 to 7,700 m (ICIMOD). The extent of snow cover, on the other hand, is dependent on the season at the time satellite imagery was acquired. According to a report of WWF "boundary delineation of Khunjerab National Park" terrain is made up of large, bare rocks. The area contains a diverse range of sedimentary, metamorphic, and igneous rocks. Certain steep portions of the valley have no reflectance so the class (shadowed rocks) was created. The high rocky hills' northern and northwestern sides are dominated by shadowed rocks. The communities graze their livestock on pastures. These pastures are fully covered by snow in the winter, but in the summer, they transform into lush green biomass spots. The (Fig. 4a) shows all these classes. The Change Detection of Khunjerab National Park over the last decade had been done through NDVI (Normalized difference vegetation Index). The Landsat images were downloaded from (United States geological survey) USGS Earth explorer with minimum cloud cover. It is used as an input in the Minus raster function. Once the differencing of index is done, the image values helped to identify the areas of change. Both the images are processed and the earlier year image is differenced from the latest. The high values are indicating positive changes in (Fig. 4b).

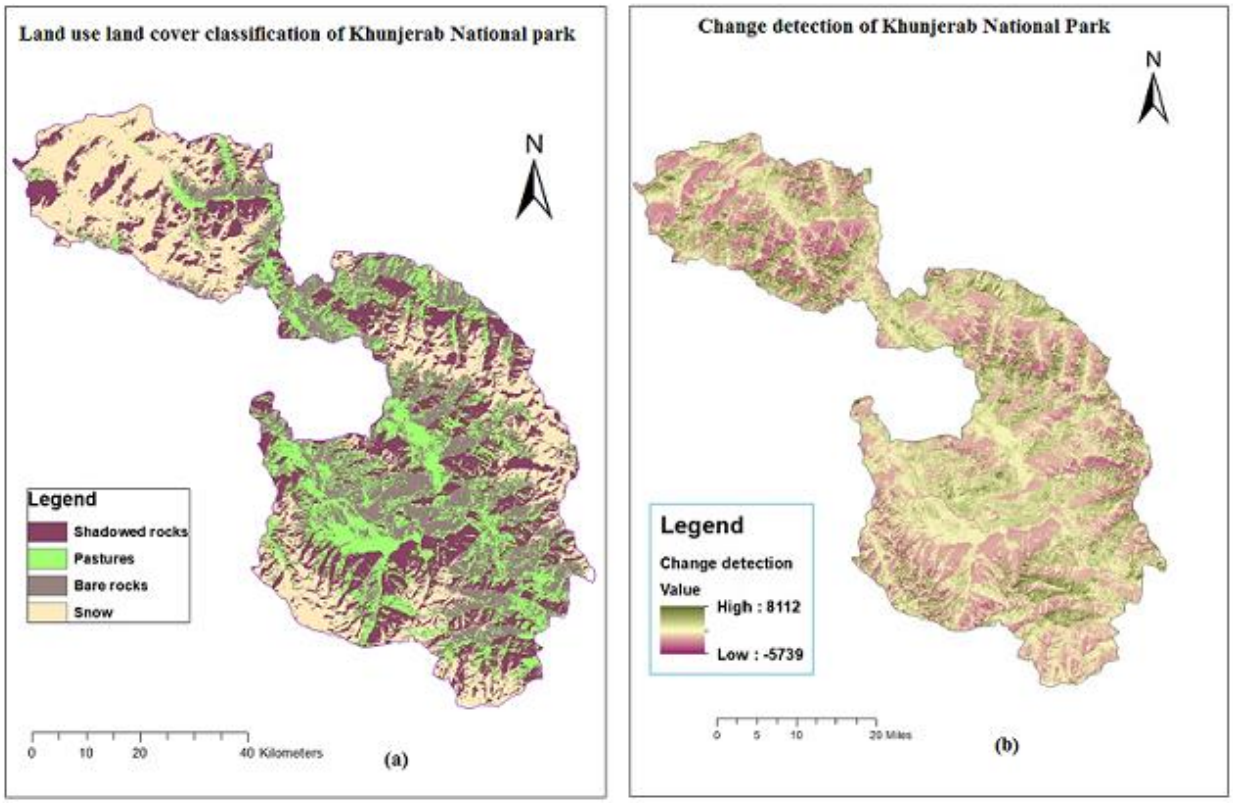

Figure 4 (a): Land use land cover classification of Khunjerab National park. (b) Change detection of Khunjerab National Park over the decade

Over all accuracy of unsupervised classification

The overall user accuracy was calculated. For calculating over all accuracy user accuracy (software) and producer accuracy (high resolution satellite images) was first determined as given in (Table 1).

Table 1: Overall accuracy of unsupervised classification

	Snow	Bare Rocks	Shadowed rocks	Pastures	Total (user)
Snow	6	0	0	0	6
Bare Rocks	0	5	1	0	6
Shadowed rocks	0	0	8	0	8
Pastures	5	0	0	5	10
Total (producer)	11	5	9	5	30

Overall accuracy=Total number of correctly classified pixels (Diagonal) / Total number of referenced pixels * 100
= 24/30 *100
= 80%
Overall accuracy is 80%

Fauna

Khunjerab National Park was primary established for the conservation of *Panthera uncia* (Snow Leopard). ***Canis himalayensis*** (Tibetan wolf), *Ursus arctos* (Brown Bear), Tibetan fox, *Pseudois nayaur* (Blue sheep), *Capra falconeri* (Markhor), *Marmota flaviventris* (Golden marmot) and *Capra sibirica* (Himalayan ibex). *Capra sibirica* (Himalayan Ibex), *Lynx,* Ermine, Tibetan Wild Donkey, Alpine Weasel, Stone Martin, *Marmota flaviventris* (Golden Marmot), Cape Hare, *Ochotona macrotis* (Large-eared Pika) along with many other small mammals are also present in the park **[2]**. The snow leopard, *Panthera uncia*, has achieved worldwide fame and is considered the standard bearer of the greater Himalayan ecosystem **[3]**. It is found in the Altai, Hindu Kush, Xi'an, Karakoram, Tian Shan, Pamir, Kanlon, and Outer Himalayan ranges, as well as small isolated mountains in the Gobi region **[4, 5]**. The size of the global range is estimated at over 1,200,00 to three million km per square, and its entire range is extremely threatened. A latest study roughly calculates its range in 12 countries overall 2.8 million km per square **[6]**; Uzbekistan, China, Afghanistan, Pakistan, India, Mongolia, Kazakhstan, Bhutan, Nepal, Kyrgyzstan, Tajikistan and Russia **[7]**. According to **[8]**, the total population of snow leopards in Pakistan is estimated to be about 80,000 km per square, and about half of them are considered to be the main habitat. Accurate modeling of the geographical distribution of species is essential for various applications in the environment and conservation.

Mapping of the key and endangered species of Khunjerab national park are shown in (Fig. 5). All the maps were drawn with the help of ArcMap 10.8. The heads of species were clipped to maps to enhance the distribution patterns.

Threats to mammals

The CPEC (China Pakistan economic corridor) poses a serious threat to Pakistan's biodiversity in Northern Pakistan. The biodiversity has been likely to be high because this region is difficult for humans to explore; however, some threatened and endangered species may occupy this area for other reasons. The Himalayan brown bear, Indian wolf, Snow leopard, Markhor, and other rare and threatened mammals can be found in this area **[9]**. In Pakistan, the Marco Polo argali population and migration trends

are well-known. In Pakistan, the areas where it occurs fall within the Khunjerab National Park Protected Area, which prohibits both illegal hunting and grazing. Competition for resources among wild herbivores in sharable habitats is threatening the population of ungulates [10]. Trophy hunting involving wild large mammals in such a given area at an unsustainable level may endanger their long-term survival. Mass tourism has serious negative environmental consequences and poses a threat to local biodiversity, potentially degrading the ecosystem [11].

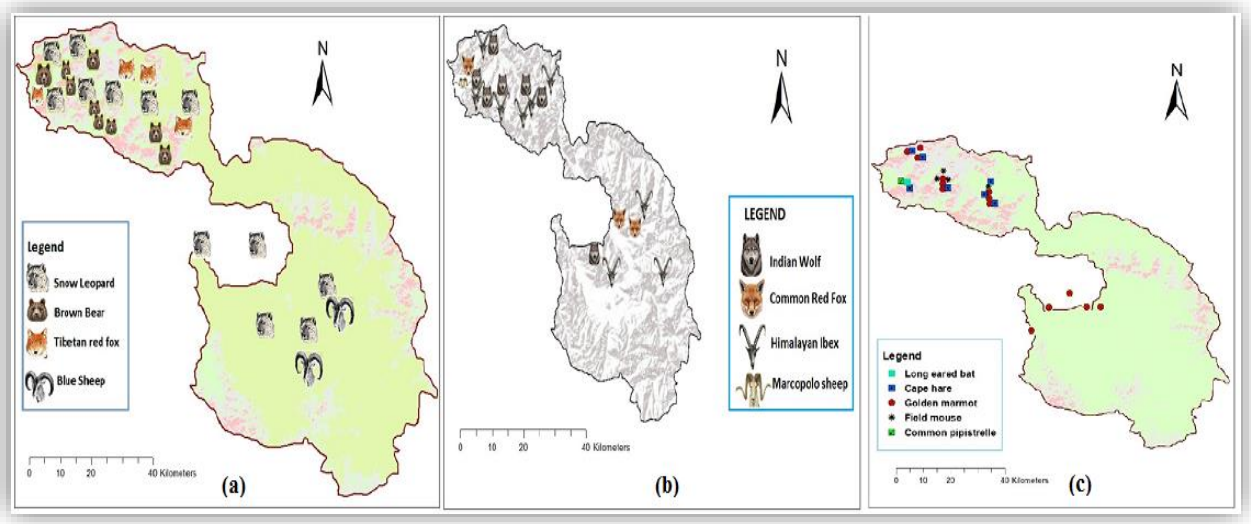

Figure 5: (a), (b) The distribution map of large mammals of khunjerab national park. (c) The distribution map of small mammals of khunjerab national park

Conclusion and Recommendations

It is important to reduce mammalian persecution and for this purpose training of local staff is necessary. If farmers believe their own livestock is in danger, they may kill carnivores. It may be difficult to enforce national laws or rules created to protect wild mammal on a local level. Local staff, including farmers, may be able to gain more respect and work very closely with farming families to find a way of reducing predator losses without resorting to lethal control methods. It is important to ensure anti-poaching efforts patrolling of rangers could be conducted where poaching represents a threat to mammals as a deterrent as well as to apprehend poachers. When people from the local community participate in the involvement of urban property resources, they may have a greater stake in the management's long-term viability. A decreasing trend in mammal persecution is one possible outcome.

Authors' contributions

Conceived and designed the experiments: A Sikandar, Performed the experiments: A Sikandar, R Bibi, M Noreen, R Ullah, A Naveed & S Riasat, Analysed the data: A Sikandar, R Ullah & A Naveed, Contributed reagents/ materials/ analysis tools: A Sikandar, R Bibi & R Ullah, Wrote the paper: A Sikandar, S Riasat, R Ullah, A Naveed, R Bibi & M Noreen.

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