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CLIMATE CHANGE AND LIVELIHOOD SUSTAINABILITY IN KISHTWAR, JAMMU AND KASHMIR

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ABSTRACT

The Himalayas are rich in cultural and biological diversity and generate different ecosystem services. The Himalayas act as water towers and food sources but suffer from poverty, risks, and vulnerability. Climate change is the biggest threat to living organisms and negatively impacts rural livelihoods in such areas. Warming has accelerated and surpassed the global average over the past century. Receding glaciers have led to water scarcity not only for drinking but also for agricultural activities. The erratic rainfall results in flash floods and landslides, causing massive damage to infrastructure, life, and property. This study identifies and analyses the impact of climate change on livelihood sustainability and associated challenges. A household survey using purposive sampling was conducted in the Gandhari valley of Kishtwar district, Jammu and Kashmir, in 2021-2022. It was concluded that climate change has brought multiple changes to the valley and affected livelihoods. Most males migrate to cities in winter because of unemployment, whereas the rural poor are the worst hit because they are economically backward and vulnerable to these changes. The valley should adapt to climate change, traditional practices, and knowledge to help locals become resilient.
KEYWORDS Livelihood, Ecosystem, Sustainability, Diversity, Traditional Practices.

RESUMEN *Cambio climático y sostenibilidad de los recursos en Kishtwar, Jammu y Cachemira*

El Himalaya alberga grande diversidad cultural y biológica, a más de proporcionar diversos servicios ecosistémicos. Sin embargo, esta región, considerada una fuente vital de agua y alimentos para muchas comunidades, también enfrenta grandes retos como la pobreza, vulnerabilidad, y riesgos. Entre ellos, el cambio climático representa la mayor amenaza, afectado gravemente la vida de los organismos y poniendo en riesgo la sobrevivencia de las poblaciones rurales de la zona. Durante el último siglo, el calentamiento global se ha intensificado, superando la media mundial. El retroceso de los glaciares ha provocado una escasez de agua potable y para la agricultura, mientras que las lluvias irregulares han aumentado las incidencias de inundaciones y derrumbes, causando daños en la infraestructura, la vida, y las propiedades. Este estudio examina el impacto del cambio climático en la sostenibilidad de los medios de vida en la región y las dificultades que esto implica. En 2022, se realizó una encuesta en hogares del valle de Gandhari, en el distrito de Jammu y Kishtwar utilizando sus muestras. Los

resultados mostraron que el cambio climático ha causado grandes cambios en la zona y ha afectado a sus habitantes. Ante la falta de empleo, muchos hombres migran a las ciudades durante el invierno, y los sectores más pobres de la población han sido los más afectados por estos cambios, ya que cuentan con menos recursos para adaptarse. Para afrontar este desafío, es necesario que la comunidad implemente estrategias para adaptarse e incorpore su conocimiento para fortalecer la resistencia de los habitantes.
PALABRAS CLAVE: Recursos de vida ecosistema, sostenibilidad, diversidad, prácticas tradicionales

Introduction

Climate change has become a significant cause of concern for livelihoods in the Himalayas (UNEP, 2021; Jamal et al., 2022). Global warming and climate change have resulted in the upward shifting of snowlines, glacial retreats, and declines in the availability of water sources (Kumar & Sharma, 2014; Hazarika et al., 2022). Climate change has disturbed the natural cycles of summer, spring, and winter (Tiwari & Joshi, 2015). Continuous human intervention in the fragile Himalayas has caused massive damage to the natural landscape and existing livelihood sources (Jamal et al., 2021). The Himalayas have the least cultivable land, the lowest potential for agriculture-related activities, and limited employment opportunities, forcing locals to move to plain areas (Singh et al., 2021). During spring, unseasonable snowfall and sudden torrential rainfall damage crops, harm cattle, and restrict vegetation to specific regions (World Bank Group, 2021).

Nomadic communities like the Bakarwals and the Gujjars migrate with sheep and goats to the Gandhari valley in search of fortified grazing grounds for animals during June and July (Suri, 2014). Vast meadows are found on the foothills of Himadri at the end of Tun village, the last village in the valley. Generally, nomads prepare bridges of stones, thatches, and timber to cross water bodies due to the lack of permanent infrastructure (Allen et al., 2020). The valley receives heavy snowfall for almost six months, disrupting the lives of everyone, including humans and animals (Naik, 2020). During these six months, people migrate to lower regions for livelihoods (Singh, 2019). Himalayan people store fodder in caves to feed cattle during emergencies, but caves are insufficient when the situation gets out of control (Sharma & Raina, 2021). Unpredictable weather conditions lead to fodder shortages in cattle, which cover long distances in search of fodder (Yadav et al., 2017). Hence, they feed willow tree branches and leaves to cattle during spring (Tashi et al., 2022). The non-availability of sufficient fodder and its quality affect animals' health yearly (World Meteorological Organization, 2021). There is a decline in animal products like milk and milk products, including butter, curd, dry lassi, and cheese, due to the intake of non-fortified fodder (Sudesh, 2014). The valley has potential for tourism, but anthropogenic activities often pollute local water bodies like springs, thereby impacting the water supply and irrigation system (Raj, 2020).

Study Area

Rajput and Buddhist communities dominate the Gandhari valley. Rajputs mostly live in lower regions, whereas Buddhists live in upper areas (District Survey Report, 2019). The valley lies at the foothills of the Himadri, and is known as the Greater or Inner Himalayas (Government of Jammu & Kashmir, 2022). Gandhari is a sub-valley in the Padder valley or the Padder tehsil of the Kishtwar district, within the union territory of Jammu and Kashmir (Fig. 1). The locals celebrate the annual mountain festival, locally known as Nagoohi, where the entire mountain community participates with immense enthusiasm and fervour (Bala, 2020). The important temples of the valley include the Shiv temple, Nag temple, Chandi Mata temple at Chandi Paddar, and the Buddhist monastery called Gompa monastery (Thakur, 2017). The natural beauty of the Gandhari valley is unparalleled in India (Romshoo et al., 2020). Recreational activities like rafting, trekking, and traditional medicinal practices attract people from across the globe (Gupta et al., 2013). Gandhari is located at 33°11'28.9"N to 33°19'13.5"N latitude and 76°22'02.5"E to 76°36'73.6"E longitude. The Gandhari valley borders the Zaskar Range and Himachal Pradesh from the south, the union territory of Ladakh from the east, and is 9500 feet above mean sea level (Central Ground Water Board, 2016–17). This region consists of several villages, including Muthal, Chug, and Batwas, which are Rajput villages, while Tun and Aliah Khijroni are Buddhist villages. The Gandhari valley is located in the southernmost part of Jammu and Kashmir, and from there onwards begins Himachal Pradesh (District Census Handbook, 2011).

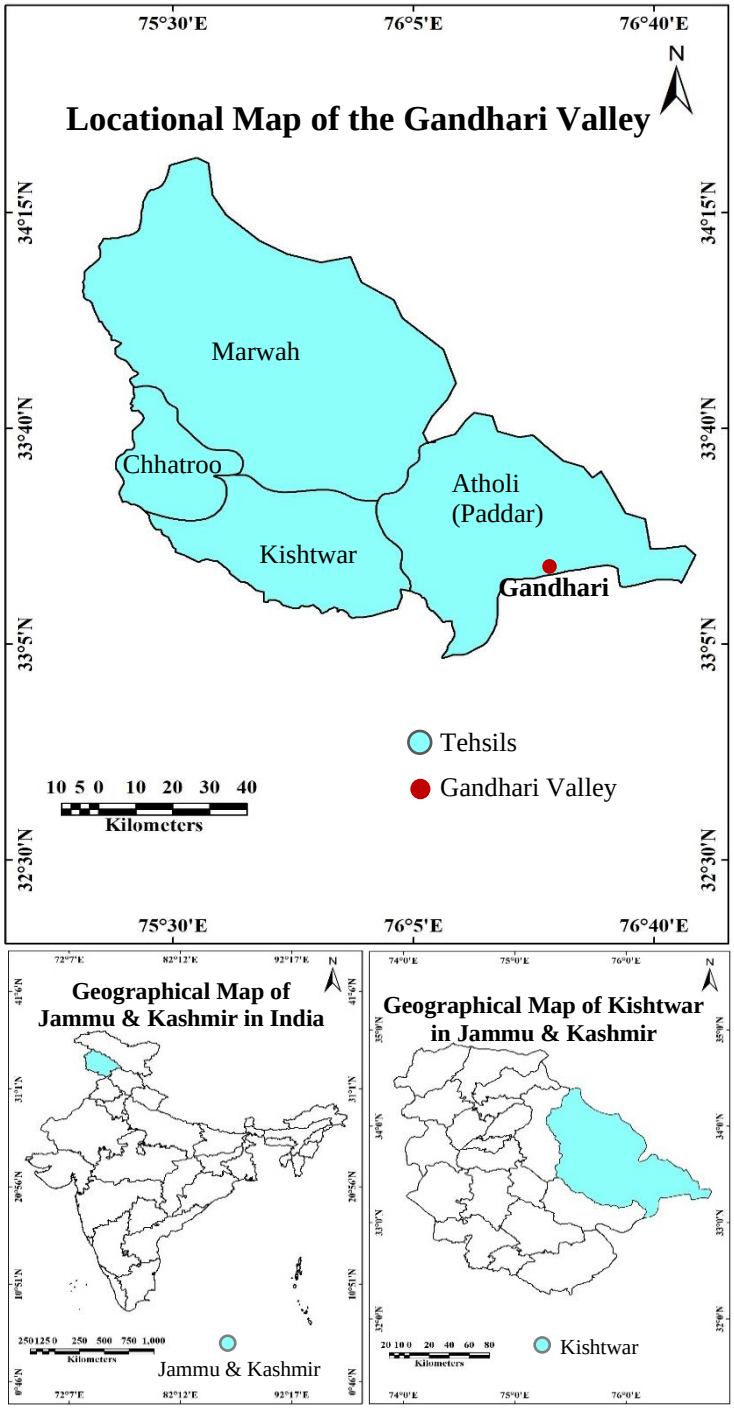

Fig. 1 Prepared by Authors, 2023

Table 1 Socio-economic Elements of the Gandhari Valley

Elements	**Numbers**
Name of community: Buddhist and Rajput	2
Primary religion: Hindu and Buddhist	2
Language: Boti, Pangwal, Pahari.	3
Distance of block headquarters: Around 30 km by road and 10 km by trek	40 km
Type of road: Initially metalled road and 10-15 km trekking and pony road	02
Banking institution	00

School: Primary	02
Self-help group (SHG) Functioning in the Village	00
Number of health centres	01
Major land use types: agriculture, forest land, and meadows	03
Major crops: barley, buckwheat, wheat, rye, maize, etc.	05+
Major rivers: Gandhari Nala, a tributary of Chenab River, connects to Sansari valley	01

Source Field Survey, 2022

The valley was chosen primarily because of its ecological vulnerability, aesthetic glory, and current threats and secondly, to understand the impacts of climate change, the climate crisis, threats to rural livelihoods, and the role of locals with the support of the district administration to conserve the valley. There is a gap in the living standards of the Gandhari valley people compared to other Himalayan regions. A difference was noticed in lifestyle when we moved southward from Tun village into the lesser Himalayan region of Himachal Pradesh. The population in the valley has increased, but the flow of springs and rivulets has decreased. This leads to people becoming more dependent on the same natural resources to meet their daily drinking water and other needs (Fig. 2). Anthropogenic activities like diverting the natural channels in springs and rivulets shrink their flow.

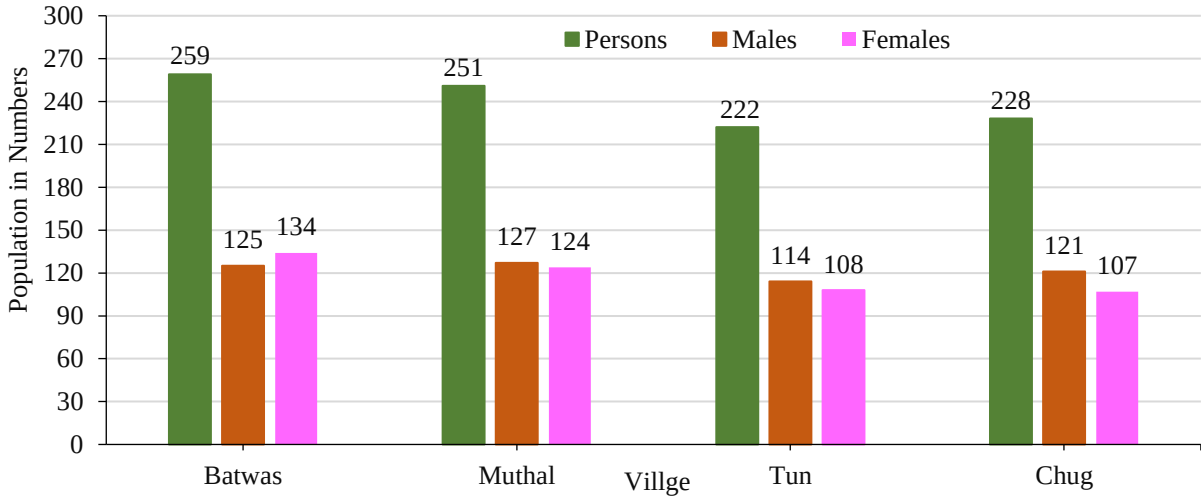

Fig. 2 Population in Villages of the Gandhari Valley (Compiled from District Census Handbook, 2011 and Prepared by Authors, 2023)

The Gandhari communities construct households with locally available building materials such as timber, thatch, mud, lime, stone, and gravel. The buildings have single floors, with entry doors and small windows to minimise the inflow of cold waves (Fig. 3). They reside on the first floor of their homes and keep domestic animals, such as goats, sheep, fodder, food grains, and firewood on the ground.

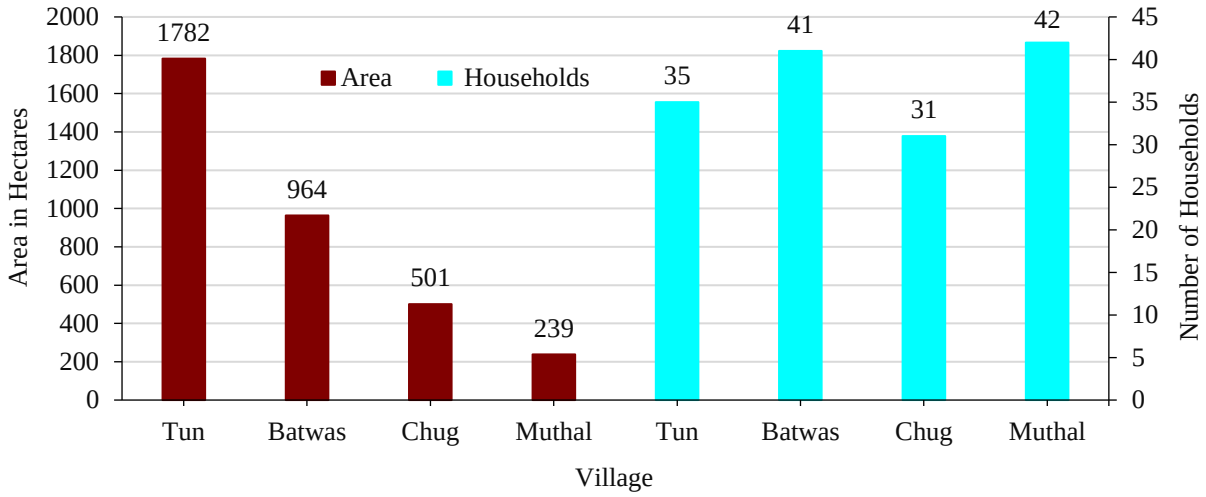

Fig. 3 Households and Areas in the Gandhari Valley (Compiled from District Census Handbook, 2011 and Prepared by Authors, 2023)

The valley is composed only of rural settlements. The housing structure is divided into three categories: permanent, semi-permanent, and temporary (Table 2). The semi-permanent housing structure has the highest structure share, followed by the permanent and temporary housing structures. Wooden doors and windows are used because of their insulating properties (Fig. 4). However, they have a good stock of firewood because they go to the jungle daily for firewood collection. The extra stock is used to ensure a daily supply of cooking fuel and for bonfires during winter.

Fig. 4 Household Morphology

Table 2 Housing Structure in the Valley

Structure	Total	Rural	Urban
Permanent	6.14%	6.14%	0%
Semi-permanent	92.21%	92.21%	0%
Temporary	1.39%	1.39%	0%

Source District Census Handbook, 2011

Database and Research Methodology

a. Sampling Procedure

A preliminary assessment focused on household and personal interviews was conducted in the Gandhari valley of Kishtwar district, Jammu and Kashmir, in 2021-2022. Two of six villages, Batwas and Tun, were selected for the household survey. Respondents from each village belonging to different groups (above 30 years and from Rajput and Buddhist communities) were interviewed using purposive random

sampling because they have a broader understanding of climate change and its impact on livelihoods. Local guides were used during the survey to remove language and communication barriers.

b. Data Collection

A set of questionnaires was used to conduct the household survey and interviews, which included questions on climate change and rural livelihood sustainability. In-depth interviews, focused group discussions, and participant observations were conducted to obtain a comprehensive understanding of indigenous challenges. Regarding secondary data, District Census Handbook, reports from the Indian Meteorological Department, Inter-governmental Panel on Climate Change, World Bank Group, United Nations Environment Programme, Climate Change-related Risks and Management were synthesized and later interpreted. In addition, several newspapers, magazines, government websites, journals, and research articles were consulted to obtain the desired outcome of this study.

c. Data Analysis

Data collected during the household survey were assembled, analysed for climate change and rural livelihood sustainability, and computed using several statistical tools. These included bar diagrams, pie diagrams, stack diagrams, and trend lines before the final evaluation. QGIS software was used to prepare a map of the study area. Essential explanations regarding the purpose of the assessment were briefed to all respondents. Initially, each respondent was asked to give a score on the list of components of climate change and rural livelihood sustainability. The economic gains and utility of each component were considered for ranking. A total of 11 components were analysed using a grading scale, such as very high (+2), high (+1), neutral (0), low (–1), and very low (–2). The grading scale was calculated using the scores given by the respondents during the discussion (Appendix I). The descriptive method, qualitative, and quantitative techniques were used for the analysis.

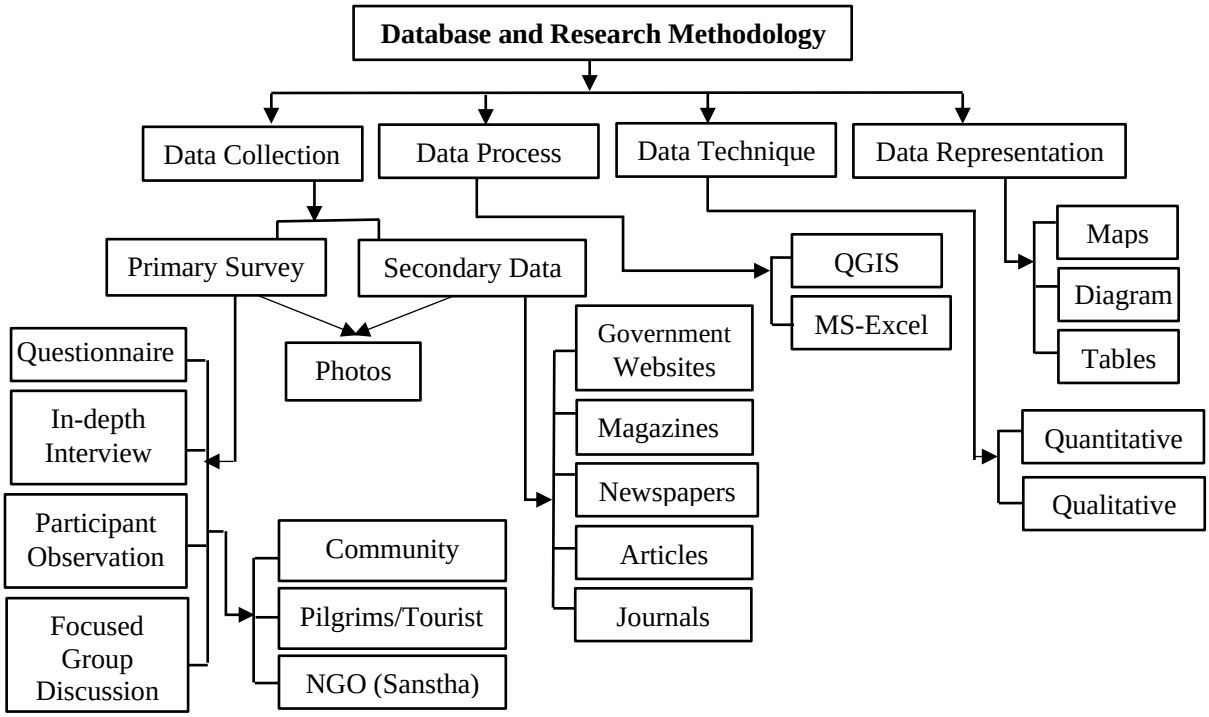

Fig. 5 Diagrammatic Representation of Database and Research Methodology (Prepared by Authors, 2023)

Results

a. *Retreating Glacier*

The Himalayas are renowned as the third pole after the north and south poles, and they encompass ice water storage areas outside the poles. Glaciers are retreating rapidly in the upper Himalayas due to increased temperature, causing unstable mountain slopes, flooding, frequent landslides, and avalanches (Fig. 6). Constant and high vulnerability to flash floods has damaged several life-supporting infrastructures and households and jeopardized poor, marginalized, downtrodden, and voiceless families. This includes road blockades, disruption of communication, electricity, and tree uprooting, putting the entire valley under threat. Around 50% of households and crops are damaged by flash floods and unseasonal snowfall. The hospital facility is located approximately 100 km from the valley, and reaching there during emergencies is another big challenge. In several cases, people lost their lives, and pregnant women lost their babies because they could not reach the hospital due to the inundation of roads or landslides on the way to the hospital. The lack of infrastructure and logistic support is one thing, but in the Himalayas, people do not have access to these infrastructures when needed due to weak political will.

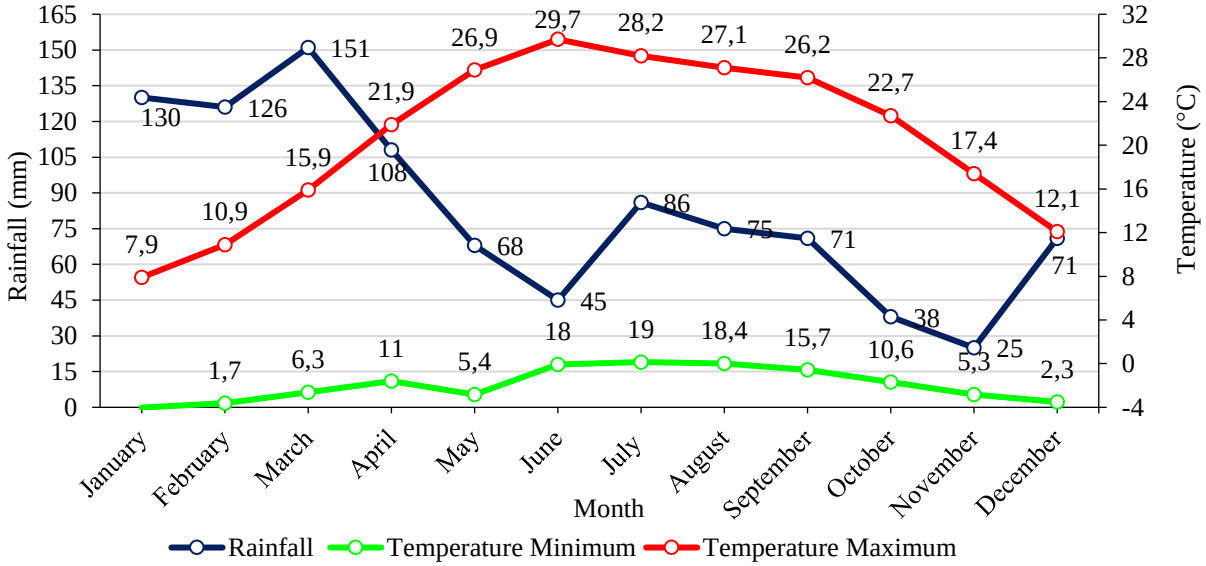

Fig. 6 Monthly Average Rainfall and Temperature Distribution in Kishtwar (Adopted from Central Ground Water Board, 2016–17 and Prepared by Authors, 2023)

Sapphire is found in the mountains of the Gandhari valley and is a rare earth mineral with considerable market value worldwide. Rock testing to construct hydropower projects and sapphire mining has triggered the frequency of landslides and avalanches in the valley. When engineers blast a targeted spot in the Himalayas as a routine activity, it causes earthquake-like events throughout the valley. This disturbs their sleep because the trigger is not powerful during the day, but its intensity and frequency are very dangerous during the night. The entire valley is bearing the psychological trauma from the blast, despite regular complaints to the concerned authorities. However, blasting happens several kilometres from the valley, and the trigger is felt in their households. The terrain is entirely virgin and not feasible for large or small hydropower projects because the ecology is highly fragile, and blasting will further damage the ecosystem.

b. Loss of Livelihood

The condition of infrastructure, particularly transportation facilities like roads, has been dilapidated in the Gandhari. The Gandhari valley has poor connectivity due to extreme weather conditions, where the construction of all-weather roads is not feasible. The frequent occurrence of snowfall in spring results in widespread damage to standing crops. Most people migrate to support their livelihoods. The loss of livelihood due to unseasonal rainfall affects marginalised sections the most because they do not have insurance for damaged crops (Fig. 7). Recent developmental activities are boosted in the valley, such as constructions, and local resources are exploited to construct check dams on the Chenab River. Firewood plays a vital role in daily life, such as cooking food, bonfires, and heating water. Firewood collection from the nearby forest is a hectic and time-consuming task that the community performs as a routine activity. Both male and female members of the Gandhari valley participate equally in firewood

collection. Previously, they travelled a short distance to collect firewood, but now they must travel longer distances to obtain better-quality firewood.

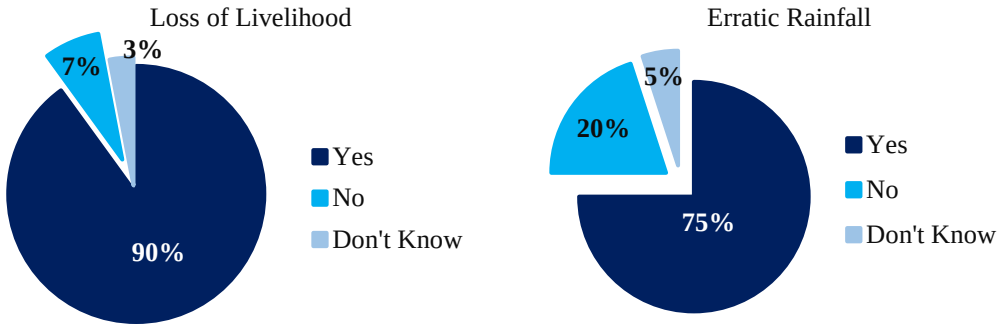

Fig. 7 The Community Faced Challenges in the Gandhari Valley (Field Survey, 2022)

The increased temperature causes the unnatural death of livestock because they are not adaptable to bear such an increased temperature. Almost 90% of households lost either one or two livestock due to the adverse impact of climate change. The livestock, including sheep, goats, dzo, and dzomo (hybrid yak; dzo is male, dzomo is female), are everything to them, and their loss puts their livelihoods under threat. In addition, fodder shortage during winter has become a major challenge. There were several incidences where their livestock died due to rainfall and cold because they kept their livestock in meadows. The comprehensive provision of on-time and in-situ veterinary services for cattle and an alternative source of fodder during winter is a cause for concern.

The communities living in the Gandhari valley have used watermills to grind grains for generations. The functioning of watermills depends on the flow of spring water, which is managed through naturally constructed check dams. Further, tapped water is diverted to watermills through canals of approximately 1–2 km. Earlier, these canals were made of mud and stone, but now they are made of concrete. The drying of springs has adversely affected the operation of watermills due to the non-availability of alternative water sources to ensure an uninterrupted water supply. The flow of springs is sufficient in early summer but becomes a water deficit in July due to intense heat. The operation of watermills becomes impossible in peak summer due to water scarcity. This leads to water crises in the valley, as everything is connected and plays an important role in maintaining sustainability.

c. Climate Change and its Impact

Approximately 30 years ago, the average snowfall in February and March was 3-4 feet, but now the snowfall has been reduced. It is evident that Aliah village barely receives one foot of snow, which has rarely happened before. Reduced snowfall means less water availability in water bodies, mostly tributaries (Fig. 8). The nallahs of the Sansari River were prominent and joined the Chandrabhaga River. The reduction in snowfall has consequences like low harvest for local produce, including potatoes and peas, which depend on good water availability and seasonal rains. There is a decrease in the number of

natural herbs and medicinal plants " jhaddi bhuti"[1], which the environment produces annually. Animals like snow leopards and Himalayan ibexes have been pushed away from their natural habitats due to disturbances in low-lying areas. Wildlife and plants must co-exist for a sustainable environment to flourish. The symbiotic relationship between flora and fauna in the valley has been disturbed by climate change. The rising mercury had dried a spring flowing between Batwas and Akhri Mod (last turn) earlier in the valley.

Fig. 8 Springs as a Source of Drinking Water (Field Survey, 2022)

The erratic rainfall, landslides, and avalanches led to the widespread death of animals. Spring flows have declined due to increased burdens and high mass consumption over the past few years (Fig. 8). Approximately 40% of the total springs have dried up in the past decade. The natural course of springs is changing due to artificial diversion in several places to meet water demands in the Himalayas. This has resulted in acute drinking water shortages in the recipient villages. Water disputes between villages have intensified as each village wants a good drinking water supply for its people, which is impossible with very limited leftover springs.

d. Mass Migration

The Gandhari valley lacks quality services such as multi-specialty hospitals, modern educational institutions, roads, sports grounds, markets, and mandis[2]. There is always a shortage of employment opportunities, and the valley is covered with snow during winter. The Gandhari valley has become a ghost valley because of migration from November to March, but which remains normal from April to October. Tough physiography compelled people to migrate to other regions for better economic opportunities. Small landholdings, low productivity, and limited crop sowing seasons are not sufficient to sustain quality life for extended families and better education for children. The migration was mainly

[1] Medicinal herbs and plants found in India

[2] Local markets

male-oriented, as male family members did not engage in any work during winter. Almost 80% of households migrate to cities, and the rest of the families stay in the valley during winter.

Fig. 9 Migrated Families from the Gandhari Valley (Field Survey, 2022)

The valley's demographic dividend is becoming a demographic disaster as it becomes a ghost valley during winter. The elderly population moves to cities for regular health check-ups, purchase of medicines, and better weather. Seasonal migration is prevalent because of harsh climatic conditions during winter (Fig. 9). They get jobs in cities where they work as street vendors, construction workers, and in temporary and portable shops to support their livelihoods. They sell shawls, woollen socks, gowns, saffron, zeera[3], heeng[4], and ornaments. They also sell milk and milk products extract from sheep and goat. They sell sheep and goats, to traders during festive seasons.

e. Loophole in the System

The Ujjwala Yojana is a watershed step to protect women's lungs from smoke because they were involved in cooking with fuelwood. The Ujjwala yojana controls deforestation by using an alternative source of liquified petroleum gas (LPG) for cooking. Regular use of LPG cylinders will keep them healthy and eliminate several respiratory diseases because during the conventional cooking method, they used to inhale harmful smoke. These LPG cylinders are given in plain regions, and carrying 14–16 kg LPG cylinders to the valley is beyond their capacity. There is no better mode of transportation except ponies. Ponies take around three hours to reach the valley. They follow a narrow path, and ponies cannot carry a heavy cylinder. The valley is located in a remote corner of the Kishtwar district, where ensuring the regular supply of one cylinder to each household every month is another challenge for the concerned authority. There is no particular distribution point for LPG cylinders. Most households use firewood, whereas a few families use LPG for cooking. Conventional firewood is a better option for cooking because its smoke plays a vital role in keeping the house worm-free. These worms die from suffocation when the smoke from the fire is emitted.

[3] Cumin seeds
[4] Asafoetida

f. Political Ecology

Political ecology focuses on how local politics shape environmental problems. Political ecology studies how a shift in one community from their native place affects their livelihoods. In this research, there is a mass migration of the local communities due to the lack of livelihood options in the Gandhari valley. One principle of political ecology that examines human cultural behaviours is an adaptation to the environment where they have lived for generations. This means that people who are not aboriginals may have sophisticated means of managing and interacting with the environment. Adaptations of human beings that do not synchronise with the environment cannot be sustained for a long time. Another principle examines the degradation of the local environment, for example, frequent landslides, erratic rainfall, and unseasonal snowfall, which destroy the naturally available resources and human infrastructures. Political ecologists point out that unscientific decisions taken by political economic forces are responsible for the degradation of the local environment. They highlight the sustainable use of local resources and landscapes at the local, regional, national, and international scales. Another principle of political ecologists describes the power; and how differences in power shape different aspects of peoples' relationships with the indigenous environment. It is about how the benefits and costs of environmental relationships are distributed among all who have control over certain resources and landscapes, and who suffer the adverse consequences of particular actions. It also explains who has the power to control the environmental vision.

Political ecologists often argue that respondents in human affairs are not merely human. Human beings always contend with the flora and fauna and the biophysical mechanisms. Hence, studying political ecology means much more than understanding how human beings struggle for limited resources and cultural hegemony (Robbins, 2012). These clarify how a wide variety of flora and fauna interact to shape the environment in a certain way. However, there is no common political ideology among ecologists who tend to search for greater social equity and to observe social equity as a vital factor in achieving environmental sustainability. It depends on individual perceptions of whether the social changes occurring in the environment are good or bad.

Discussions

i. Local Practices

The locals go to the hills daily to collect herbs, medicinal plants, and other materials for their basic needs. Gram, barley, and maize are mainly used to prepare sattu (black gram powder) and liquor. They prepare liquor during winter to keep their bodies warm. They harvest beans, peas, wheat, and maize during the harvesting season. Rivulets and springs play a vital role in their routine lives, such as in agriculture, water mills, and irrigation purposes (Table 3). All households have solar panels to meet the

electricity demand due to the non-availability of installed electric poles across villages. Solar panels are placed on terraces or windows to absorb maximum sunlight throughout the day. Electric poles have been installed in some places in the valley since 2018, but there is no electricity. The wires of these poles are used to dry clothes and for other purposes. People are happy but hopeless because they do not have job opportunities to feed their families, except for minimal farming.

Agriculture is the main occupation in the valley, where rice is the staple crop, and maize is the second most important crop. The small size of fertile landholdings results in the subsistence production of crops in which mechanization is impossible. Good quality saffron is cultivated during June-September, wherein saffron plants require dry, hot summers and extreme cold during winters. Saffron cultivation provides a good source of income for the community involved, and they sell cultivated saffron in the market. However, the valley allows for growing limited crops in one season due to the shortage of high-yielding variety (HYV) seeds and modern machines like tractors, harvesters, and others.

Table 3 Rivulets and Springs

Rivulets	**Location**	**Natural Springs**	**Locations**
Tun Tollum	Between Tun and Aliah	Alia	Below Rabtans House
Aler Tollum	Close to Aliah	Sinot	Sinot Thang
Mulchae	Between Aliah and Khijroni (bigger)	Khijroni	Between Mulchong and Khijroni
Mulchong	Between Aliah and Khijroni (smaller)	Batwas	Between Batwas and Akhri Mod
Anad Nena	Between Muthal and Chug		
Chaal Longma	Between Batwas and Chug		

Source Primary Survey, 2022

The sources of water and electricity in the valley are limited. The community is forced to drink tap water from an untreated source, which constitutes 75% of the total drinking water supply in the valley (Table 4). The proportion of tap water from treated sources accounted for less than 1% of the available drinking water. Springwater accounts for 10% of the drinking water supply, and its percentage is declining rapidly due to overconsumption and overexploitation.

Table 4 Source of Drinking Water in Atholi (Paddar)

Paddar	**Tap water from Treated Source**	**Tap water from Untreated Source**	**Tubewell/Borewell**	**Spring**	**River/ Canal**	**Other Sources**
Total	0.95%	75.01%)	1.65%	9.46%	2.76%	10.17%
Rural	0.95%	75.01%)	1.65%	9.46%	2.76%	10.17%
Urban	0%	0%	0%	0%	0%	0%
Source of Lighting in Atholi (Paddar)						
Paddar	**Electricity**	**Kerosene**	**Solar**	**No Lighting**	**Others**	
Total	29.12%	31.56%	25.89%	1.7%	11.73%	
Rural	29.12%	31.56%	25.89%	1.7%	11.73%	
Urban	0%	0%	0%	0%	0%	

Source District Census Handbook, 2011

Kerosene oil accounts for the highest proportion of lighting sources in the Gandhari valley. No regular kerosene supply is ensured due to landslides or rainfall, which blocks roads. Solar sources of lighting account for ¼th of the total lighting sources (Table 4). Some villages do not have access to any lighting source, but their percentage is less than 2%. Local governments are concerned about providing lighting sources to these left-out villages.

ii. Alternate Opportunities

Climate change has some positive impacts, such as creating new avenues for livelihoods in cash crop plantations such as apples and walnuts. Earlier, these crops were not ripening within a certain period, but are now ripening within a certain period due to changes in the climatic conditions of the valley. The increased temperature supports cash crops that are growing on a large scale. Initially, wheat production was not good, but now it has become better, and the community has started growing maize in their fields. The yields and productivity of these cash and food crops have increased because of climate change, with longer summers than ever before. Locally manufactured handicraft products in cottage industries provide better livelihood opportunities, and mass-scale migration has bridged the income gap. Before this, people used to migrate, resulting in broader income inequality, whereas increased awareness, people-to-people linkages, improved educational standards, and know-how about new avenues have played a vital role (Fig. 10). The disparity has shrunk because everyone migrates to surrounding cities, such as Shimla and Dharmshala, from November to March. The standard of living in all communities has improved with the opening of new employment opportunities.

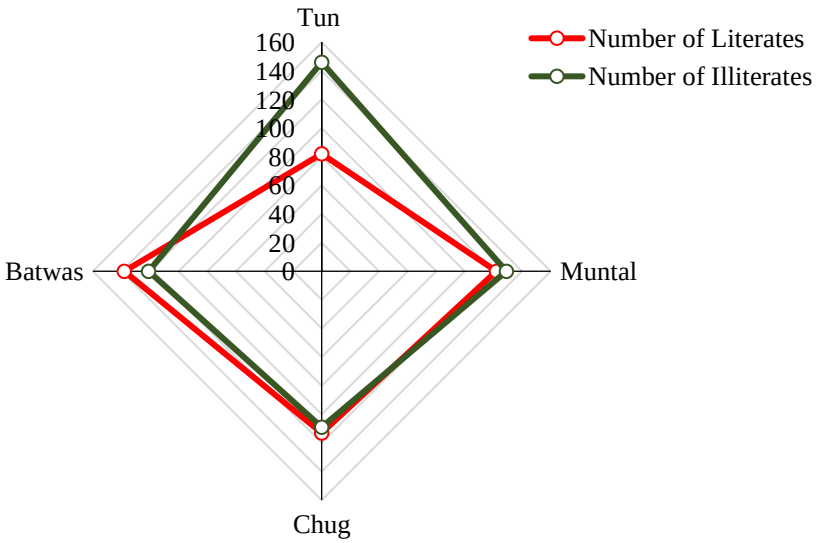

Fig. 10 Number of Literates and Illiterates in the Gandhari Village (Adopted from District Census Handbook, 2011 and Prepared by Authors, 2023)

iii. Medical Tourism

The Gandhari valley is centred around several herbs that are very helpful in treating different acute and chronic diseases such as cough and diabetes. Tourists and patients are keen to take decoction (kaadha)

from the valley as it maintains the metabolism and keeps their bodies healthy. The traditional medical system of the valley is world-famous, and every tourist wants to experience it at least once. This is also a popular form of Sowa-Rigpa, a living medical tradition that has been practiced since ancient times. The treatment cures tourists and patients with skin diseases, hypertension, and arthritis. Patients are receiving treatment in the valley at a marginal rate. Indigenous plant species, mineral stones, medicinal plants, and foliage can provide long-lasting relief from multiple diseases.

Ayurvedic products such as different juices, immunity boosters, and skincare supplements are popular among tourists. The demand for Ayurvedic products by tourists has increased over the past two decades. Yoga and meditation have attracted people from every corner of the world to the Gandhari. Tourists from all walks of life visit the valley with great enthusiasm and fervour. This generates a source of income for the natives because these tourists hire locals as tourist guides, and ponies carry tourists' luggage, including tents and food items. They enjoy trekking, but trekking with heavy luggage is very difficult and requires the help of ponies. They charge a reasonable rate per pony to make everyone happy. They follow pony paths for trekking, and it would be unsafe to go anywhere without taking precautions and putting their lives in danger. Tourists enjoy indigenous culture, food, routine activities, and scenic beauty throughout the excursion. The hospitality of the locals is overwhelming, and tourists, cum trekkers, are invited from every household for drinks and tea.

iv. Role of Women

The role of women is highly appreciable in the Gandhari, where both young and elderly women are involved in the collection of materials needed daily from forests, including fodder and firewood. They go to the forests in a group to avoid problems like human-animal conflict. Many of them sell the excess firewood collected in the local market to sustain their livelihoods. They travel several kilometres for water collection as nearby springs have dried up because of climate change and anthropogenic activities. The difficulties associated with carrying water from long distances to their homes are very challenging. Women represent around 50% of the total population, whereas their representation in terms of total workers is relatively less in the Gandhari (Fig. 11). The actual number of female workers in the industrial category is greater than the given figure because they are often registered with government authorities. Female workers are often given daily wage work that is not recorded in the formal dataset. Maintaining the sustainability of rural areas in the valley is the future and not the past.

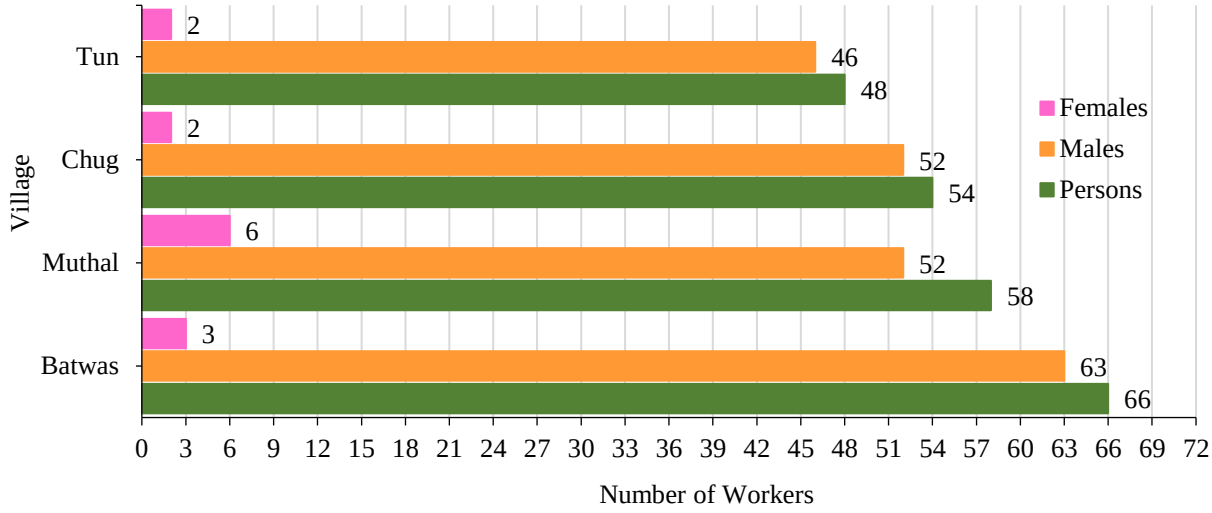

Fig. 11 Industrial Category of Total Workers in the Gandhari (Compiled from Adopted from District Census Handbook, 2011 and Prepared by Authors, 2023)

Conclusion

The incredible beauty of the Gandhari valley will inspire years and decades of collective partnership and ownership. The community has rich traditional knowledge that should be documented, conserved, and harnessed for sustainable rural livelihoods. New and attractive employment opportunities should be explored to prevent migration from the Gandhari valley. For this purpose, a galaxy of stakeholders, including geographers, scientists, planners, environmentalists, engineers, and the masses, is desired to come forward and suggest future plans. There is an urgent need for more efficient canals, locally called Yura to stop water loss during summer. In addition, sustainable mini-hydropower projects, rooftop solar panels, and solar plants should be developed to generate and provide electricity for all. Logistical and financial assistance must be extended under several government schemes to improve biodiversity conservation and ecosystem welfare. The awareness programmes and community sensitisation must be conducted to protect the natural environment.

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APPENDIX

Appendix I Grading of 11 components by 50 Respondents to Derive the Priority Order with Grading Scale, such as very high (+2), high (+1), neutral (0), low (–1) and very low (–2)

Components	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
Drying of rivulets	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+1	+1	+1
Drying of springs	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Availability of fodder	0	0	0	0	0	0	+1	+1	+1	+1	+1	+1	+1
Erratic snowfall	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Migration	+1	+1	+1	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Loss of livelihoods	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2

Rise in temperature	+2	+1	+1	+1	+1	+1	+2	+1	+1	+2	+1	+1	+2
Firewood collection	–1	–1	–1	0	–1	–1	–1	–1	–1	0	–1	–1	–1
Agriculture	–1	–2	–1	–1	–1	–1	–1	–1	–2	–1	–1	–1	–1
Threat to species	+1	+1	+2	+2	+2	+2	+2	+1	+2	+2	+1	+1	+2
Deficit rainfall	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1

Components	**R14**	**R15**	**R16**	**R17**	**R18**	**R19**	**R20**	**R21**	**R22**	**R23**	**R24**	**R25**	**R26**
Drying of rivulets	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Drying of springs	+1	+1	+1	+1	+1	+1	+1	+1	+1	+2	+2	+2	+2
Availability of fodder	0	0	0	0	0	0	0	+1	+1	+1	+1	+1	+1
Erratic snowfall	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Migration	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Loss of livelihoods	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Rise in temperature	+2	+1	+1	+1	+1	+1	+2	+1	+1	+2	+1	+1	+2
Firewood collection	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
Agriculture	–2	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–2
Threat to species	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+2
Deficit rainfall	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2

Components	**R27**	**R28**	**R29**	**R30**	**R31**	**R32**	**R33**	**R34**	**R35**	**R36**	**R37**	**R38**	**R39**
Drying of rivulets	+1	+1	+1	+1	+1	+1	+1	+2	+2	+2	+2	+2	+2
Drying of springs	+2	+2	+2	+2	+2	+2	+2	+1	+2	+1	+2	+1	+2
Availability of fodder	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
Erratic snowfall	+1	+1	+1	+1	+1	+1	+1	+1	+2	+2	+2	+2	+2
Migration	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Loss of livelihoods	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
Rise in temperature	+1	+1	+1	+2	+1	+1	+2	+1	+1	+2	+1	+1	+1
Firewood collection	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	0	0
Agriculture	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
Threat to species	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+2	+2
Deficit rainfall	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2

Components	**R40**	**R41**	**R42**	**R43**	**R44**	**R45**	**R46**	**R47**	**R48**	**R49**	**R50**	**Total**
Drying of rivulets	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	97

Drying of springs	+1	+1	+1	+1	+1	+1	+1	+1	+2	+1	+2	73
Availability of fodder	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	30
Erratic snowfall	+2	+2	+2	+1	+1	+1	+1	+1	+2	+2	+2	95
Migration	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	97
Loss of livelihoods	+1	+1	+1	+2	+1	+2	+1	+1	+1	+2	+1	92
Rise in temperature	+1	+2	+1	+1	+2	+1	+2	+1	+1	+1	+2	66
Firewood collection	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0
Agriculture	–1	–1	–1	–2	–1	–1	–2	–1	–1	–1	–2	0
Threat to species	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	71
Deficit rainfall	*+2*	*+2*	*+2*	*+2*	*+2*	*+2*	*+2*	*+2*	*+2*	*+2*	*+2*	*87*