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Livelihood Security and Ecosystem Services Nexus in the Beas Basin: Challenges and Opportunities

by **Anju Singh**, Associate Professor,

Department of Geography,

Aditi Mahavidyalaya, University of Delhi - 110039, India

Email: anjusingh.geog@gmail.com

Ranjeet Kumar, Research Scholar,

Department of Geography,

Delhi School of Economics, University of Delhi - 110007, India

Email: ranjeet.dse09@gmail.com

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Abstract :

The Beas Basin, nestled within the Himalayan region of Himachal Pradesh, is facing multifaceted challenges to livelihood security and ecosystem services due to changing environmental conditions. This paper explores the intricate nexus between livelihood security and ecosystem services in the Beas Basin, with a specific focus on the declining trend in apple productivity and its implications for local communities. Through interviews with farmers and experts, climate variability and change emerge as primary factors contributing to the decline in apple production, attributed to increased temperatures, erratic rainfall patterns, and heightened occurrences of frost and storms. Consequently, farmers are adapting by shifting towards alternative crops like vegetables and

hard fruits, while facing constraints such as restricted access to forest-based provisioning services and reduced livestock productivity due to invasive weed species and climate-induced pest infestations. Concurrently, the burgeoning tourism industry presents opportunities for livelihood diversification but poses risks to the region's ecological integrity. The paper underscores the urgent need for comprehensive planning and grassroots-level execution to mitigate the impacts of changing environmental drivers and sustain ecosystem productivity, ensuring the long-term livelihood security and well-being of communities in the Beas Basin.

Introduction:

Livelihoods are conceptualized as integrated systems involving assets, capabilities, and activities that enable individuals to secure a means of living (Chambers and Conway, 1992). Within households, diverse combinations of capacities and activities give rise to various livelihood strategies that extend beyond income generation, encompassing social assets and other components (Ellis, 2000). In their work, Hahn, Riederer, and Foster (2009) integrate the livelihoods approach (Chambers and Conway, 1992; Scoones, 1998) with the vulnerability framework proposed by the IPCC. The sustainability of livelihoods is contingent upon their ability to withstand and recover from shocks and stresses while preserving or augmenting their assets and capabilities, all without compromising the natural resource base (Carney, 1998).

Ecosystem services play a vital role in sustaining life and livelihoods. As stated by Daily (1998), ecosystem services encompass the conditions and processes that support and fulfill human life, representing the natural components that are both enjoyed and utilized for sustainable livelihoods. Ecosystems themselves are valuable assets that offer a multitude of services. These services not only sustain life and livelihoods but also contribute to economic growth, mitigate floods and diseases, and provide recreational opportunities (MA, 2005). However, the escalating demand for these services in recent years has exerted pressure on natural resources and diminished the capacity of ecosystems (MA, 2005). Additionally, it is worth noting that ecosystem productivity is relatively lower in plains compared to mountain regions (Zobel et al., 2001), although there is still limited knowledge regarding the management of ecosystem services (Kremen, 2005).

The Himalayan ecosystem especially Himachal Himalaya ecosystem which incorporates Beas Basin is known for its remarkable diversity, housing the highest variety of flora and fauna. It serves as a crucial provider of ecosystem services to approximately one-fourth of the world's population (Chaudhary et al., 2017; Sharma, 2020).

However, this region exhibits significant variations in temperature and moisture levels, resulting in a high degree of heterogeneity (Ring et al., 2010; Sati, 2014). These factors, combined with the region's susceptibility to natural disasters such as landslides, flash floods, and the impacts of climate change, have substantial effects on the ecosystem services available. Therefore, it is crucial to evaluate the immediate ecosystem services that directly impact the livelihood security of local individuals, particularly those belonging to impoverished and marginalized groups.

Study Area :

The Beas Basin, situated in the northern Indian state of Himachal Pradesh, spans latitudes between $31^{\circ}25'N$ to $32^{\circ}45'N$ and longitudes between $75^{\circ}35'E$ to $77^{\circ}50'E$, encompassing approximately 24.5 per cent of Himachal Pradesh's total catchment area. With a catchment area of about 13,390 square kilometers, the River Beas traverses approximately 245 kilometers from Kullu to Dehragopipur. Along its course, the river flows through four districts of Himachal Pradesh: Kullu, Mandi, Hamirpur, and Kangra.

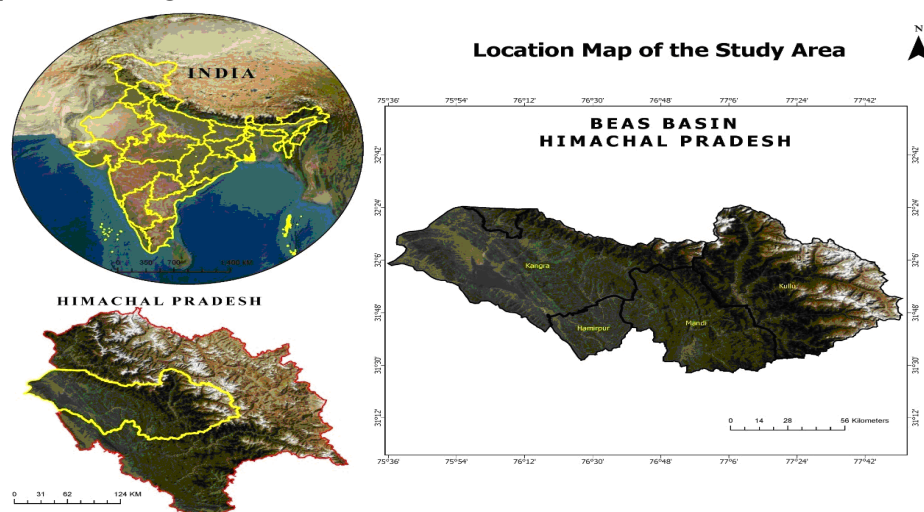


Fig. 1: Location Map of Study Area

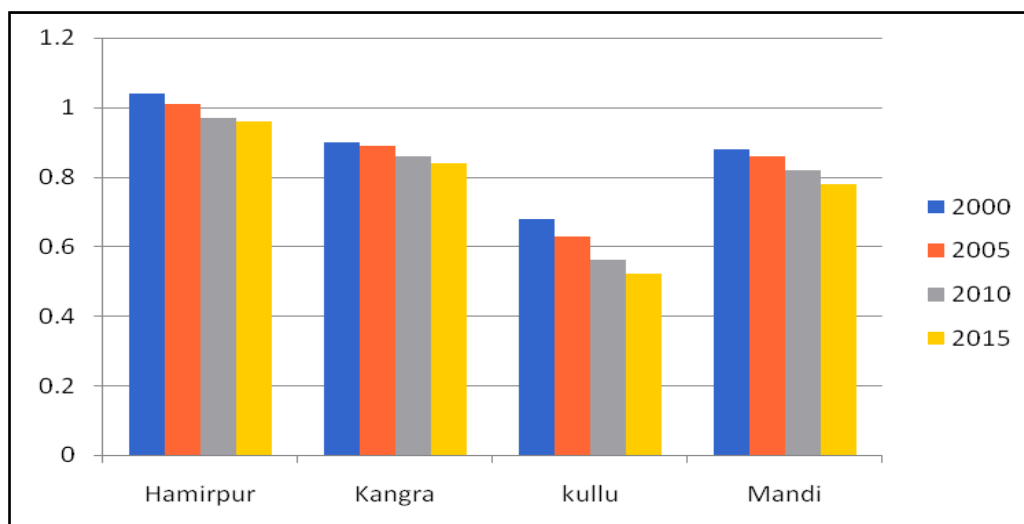
Data Base and Methodology :

The research draws upon a comprehensive range of primary and secondary data sources to investigate the nexus between livelihood security and ecosystem services in the Beas Basin. Primary data collection methods include household surveys to gather quantitative insights into livelihood security indicators, interviews with local community members, experts, and stakeholders to capture diverse perspectives regarding changing ecosystem services and consequent livelihood security. Additionally, secondary data from District Statistical Handbook have been used to collect data regarding farm and forest production. Apart from this tourism related data have taken from Himachal Pradesh Tourism Development Corporation (HPTDC). Quantitative analysis of Primary and secondary data enables the assessment of livelihood security indicators, while qualitative analysis of interview and focus group data allows for the exploration of perceptions, attitudes, and experiences related to ecosystem services.

Result and Discussion :**Diminishing land Resource and consequent Ecosystem Services :**

In the Beas Basin, land is the primary natural asset upon which the livelihoods of the majority of the local population depend. More than 60 percent of the population is engaged in agriculture, which is ultimately contingent upon the size of land holdings. Across all districts in the study area, the size of land holdings has gradually decreased during the period from 2000 to 2015, as evidenced by Fig. 2. Furthermore, the number of land holdings has increased between 2000 and 2015 in every district of the study area. This increasing pressure on each unit of land is attributable to the growing population and the consequent fragmentation of land holdings.

The more fragmented the land becomes, the more intensive its use becomes. The consequence of this fragmentation and intensification is the over-exploitation of land resources, a decrease in land productivity, and an increased reliance on chemical fertilizers and pesticides, leading to an expansion of wastelands. This scenario poses significant challenges to the livelihood security of the local population, whose sustenance is heavily dependent on the ecosystem services provided by the land resources in the Beas Basin.



Source: District statistical Abstract

Fig. 2: Decreasing Land holding Size

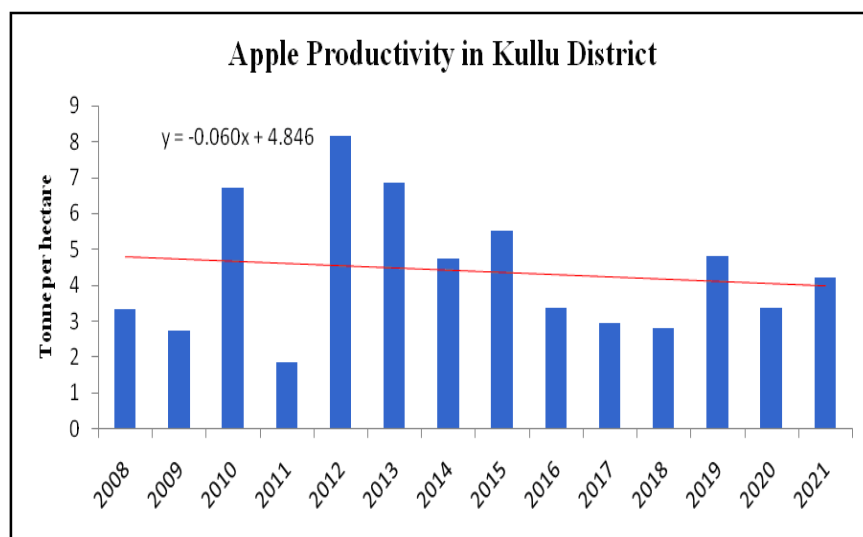
The diminishing size of land holdings, coupled with the increasing fragmentation and unsustainable agricultural practices, jeopardizes the ability of the ecosystem to provide essential services, such as food production, water regulation, and soil conservation. Addressing these challenges is crucial for ensuring the long-term livelihood security of the local communities and maintaining the delicate balance between ecosystem services and human well-being in the Beas Basin.

Fluctuating Agro- ecosystem Services :

Horticulture, especially apple cultivation, underpins the livelihood security of communities in the Beas Basin. Introduced by the British, large-scale apple farming commenced in the early 1950s. Apples contribute over 60% of total fruit production and 40% of farmers' income. However, climate change has disrupted this vital ecosystem service over the last three decades, with certain areas witnessing an increase while others face a decline in apple cultivation.

Secondary data revealed fluctuating apple production trends, with a marked decline from 2008 onwards (Fig. 3). Interviews with local farmers and experts highlighted climate variability as a major factor. Over 90% of respondents in lower Kullu confirmed rising temperatures, erratic rainfall, increased frost, storms, and

sudden low temperatures during flowering as detrimental to apple production. Consequently, aridity has risen, and rainfall has declined, affecting quantity and quality. Apple tree heights have reduced from 30 feet to 15 feet, and hailstorms have damaged crops, lowering market value.



Source: District Statistical Abstract

Fig. 3 : Decreasing Apple Productivity

The changing climate has impacted apple shape, size, color, and productivity, which has plummeted from 4,000 boxes per hectare to 500 in three decades. Apples fail to attain desired color and size, and trees struggle to bear flowers, leading to the disappearance of high-demand varieties, significantly reducing profitability.

Climate change has exacerbated natural calamities, disrupting ecosystem services and livelihoods. Data reveals the impact of climatic anomalies like prolonged droughts, hailstorms, and temperature variations, causing a significant loss of production during last decades. Rising temperatures have also increased plant diseases and pests, further reducing productivity. Sustainable adaptation measures are crucial to restoring the balance between ecosystem services and livelihood security in the Beas Basin.

Forest Based Ecological Services :

The forest ecosystem in the Beas Basin provides a wide range of provisioning services that support the livelihoods and well-being of local communities. These services include timber, fuel wood, fodder, non-timber forest products (NTFPs), medicinal plants, honey, and water. The value of construction wood obtained from forests in different districts of the Beas Basin has fluctuated, with the total value increasing from Rs. 15,588.85 crore in 2019 to Rs. 21,429.47 crore in 2020, and then declining to Rs. 11,888.08 crore in 2021 (Table 1).

Table 1 : Value of Construction Wood Extracted from Beas Basin (Rs. '000)

Years	MANDI	KULLU	HAMIRPUR	KANGRA	Total Value (Rs.)
2019	3,243.81	17,848.75	2,21,22,528	155,867,430	155,888,522.56
2020	5,446.64	15,275.68	1,74,30,000	214,273,983	214,294,705.32
2021	3,048.98	1,36,829.827	1,96,68,458	1,188,805,873	1,188,808,921.98

Source: District statistical Abstract

Similarly, the total value of fuel wood obtained from forests in the Beas Basin increased by about 160% from Rs. 466.50 crore in 2019 to Rs. 1,211.90 crore in 2020 (Table 2). The value of NTFPs also saw a significant increase from Rs. 12.20 crore in 2019 to Rs. 292.49 crore in 2020, before decreasing slightly to Rs. 34.76 crore in 2021.

Table 2 : Value of Fuel Wood Extracted from Beas Basin (Rs '000)

Years	KULLU	HAMIRPUR	KANGRA	Total Value (Rs.)
2019	3,500	4,77,149	4,661,529	4,665,029
2020	18,287	6,27,000	12,101,088	12,119,375
2021	3,72,499	1,62,608	16,517,841	16517841

Source: District statistical Abstract

Despite the increasing forest cover at an average rate of 2.0% per year, local communities face restricted access to these new resources due to strict regulations on extraction from community forests. Additionally, the spread of invasive weed species like Lantana Camara and Eupatorium hinders natural regeneration of local species, posing a threat to forest health.

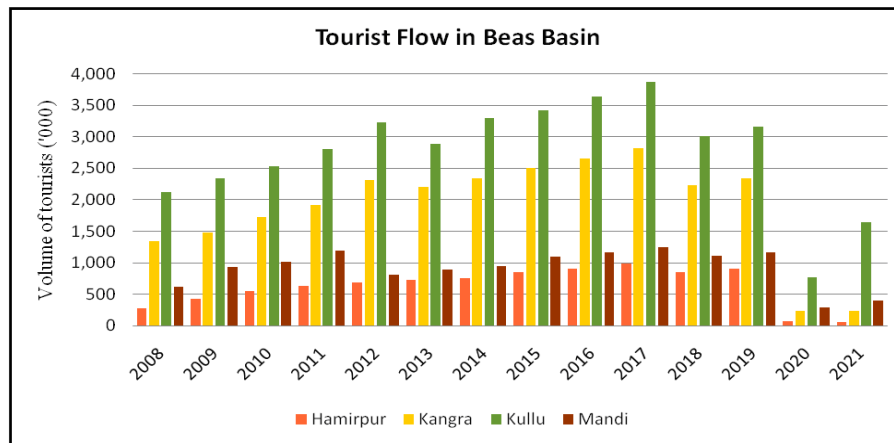
Local communities have observed changes in the ecosystem, attributing the decrease in snowfall and increase in temperature to the rise in pests and diseases, such as root rot, which has reduced the productivity of forest crops. Furthermore, the flowering patterns of certain plants like Guras (*Rhododendron* species) and Painyu (*Prunus ceracoides*) have changed, and species like dudhilo (*Ficus nemoralis*) and bhimsenpate (*Buddleja asiatica*), previously found at lower altitudes, are now present at higher elevations.

Primary surveys have revealed an increased vulnerability of ecosystem services due to faulty plantation practices. During the late 19th and early 20th centuries, the British replaced deodar with Chir trees, which have had significant repercussions on ecosystem stability. Chir trees absorb more moisture and release more evapotranspiration, reducing soil moisture content. Additionally, they have low soil-holding capacity, increasing the susceptibility of the region to slope instability and landslides in areas where they dominate.

Booming Tourism and Hospitality Services :

The Beas Basin, known for its scenic beauty, cultural diversity, and adventure activities, is a popular tourist destination in Himachal Pradesh. The region offers a range of attractions, including hill stations, temples, museums, wildlife sanctuaries, skiing, trekking, and paragliding. The districts of Kullu, Kangra, Mandi, and Hamirpur have witnessed significant growth in tourist arrivals, with Kullu consistently receiving the highest number of visitors (Fig. 4).

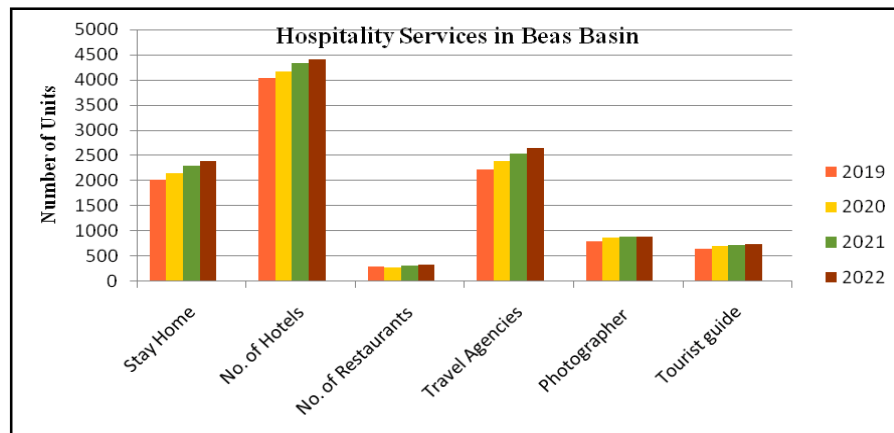
The booming tourism industry has led to a steady increase in hospitality services, such as hotels, restaurants, travel agencies, photographers, and tourist guides, catering to the diverse needs and preferences of tourists. This growth in tourism activities has created economic opportunities for locals, enhancing livelihood security in the region.



Source: HPTDC

Fig. 4: Tourist Flow in Beas Basin

While the COVID-19 pandemic severely impacted tourism in 2020, the region has shown a remarkable rebound in tourist arrivals post-pandemic. The development of infrastructure and facilities, as well as the promotion of year-round attractions, has contributed to the growth of tourism in districts like Kangra and Hamirpur.



Source: HPTDC

Fig. 5 : Availability of tourism related services

The hospitality sector in the Beas Basin has flourished to meet the increasing demand from tourists, offering a wide range of services and experiences (Fig. 5).

This thriving industry has not only boosted the local economy but also provided employment opportunities and enhanced the overall livelihood security of the communities in the region.

Conclusion :

The Beas Basin is facing a complex nexus between livelihood security and ecosystem services, with significant challenges threatening the delicate balance. The fragmentation of land resources has led to over-exploitation, decreased productivity, and increased reliance on chemical inputs, jeopardizing the livelihood security of the local population dependent on agriculture. Climate change has disrupted vital agro-ecosystem services, such as apple cultivation, a crucial source of income, with rising temperatures, erratic rainfall patterns, and natural calamities adversely impacting production and profitability. While the forest ecosystem provides essential provisioning services, access restrictions, invasive species, pests, and faulty plantation practices pose threats to its sustainability. However, the booming tourism and hospitality sector, driven by the region's natural beauty and cultural diversity, has emerged as an opportunity, creating economic avenues and enhancing livelihood security, although initially impacted by the COVID-19 pandemic. Addressing these multifaceted challenges through sustainable practices is crucial for maintaining the intricate nexus between ecosystem services and human well-being, ensuring long-term livelihood security for the local communities in the Beas Basin.

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