Pol. J. Environ. Stud. Vol. XX, No. X (XXXX), 1–14
DOI:*10.15244/pjoes/188236* ONLINE PUBLICATION DATE:

Original Research

Local Perceptions of Ecosystem Services and Anthropogenic Disturbances on Endangered *Taxus Wallichiana*: Implications for Conservation and Sustainable Management

Syed Waseem Gillani[1], Mushtaq Ahmad[1*], Muhammad Manzoor[1], Muhammad Zafar[1], Hamayun Shaheen[2], Javeed Hussain[3], Dunia A Al Farraj[4], Mohamed S Elshikh[4], Naveed Abbas[5]**

[1]Department of Plant Sciences, Quaid-i-Azam University, Islamabad 45320, Pakistan
[2]Department of Botany, University of Azad Jammu & Kashmir
[3]Department of Botany, University of Kotli Azad Jammu and Kashmir
[4]Department of Botany and Microbiology, College of Science, King Saud University, P.O. 2455, Riyadh 11451, Saudi Arabia
[5]Department of Genetics, Plant Breeding and Seed Science, University of Agriculture in Krakow, Poland

Received: 04 February 2024
Accepted: 27 April 2024

Abstract

The current study provides insightful information on the ecosystem services and anthropogenic disturbances that affect the endangered *Taxus wallichiana* forest. *T. wallichiana* has enormous ecological and societal significance, as evidenced by a diverse range of ecosystem services and products in the Kashmir western Himalayan region. The demographic features of participants and ecological services of the *T. wallichiana* were documented during group discussions and personal interviews. The interviews included 106 informants, of whom 19 were women and 87 were men. The majority of informants (82.07%) were male due to restrictions on women's interactions with strangers in the study area. Based on visual assessment at each sampling site, anthropogenic disturbance levels were assessed on a four-point scale (1 = low, 2 = moderate, and 3 = high). The bark is used as a substitute for tea during the winter to feel warm. Tea from *Taxus* bark is also believed to increase vitality and cure other health-related problems. The bark is also considered an anti-cancerous agent among the locals. The highest value of daily fuel wood consumption per capita was 5.25 kg at Kala Ban, whereas the lowest value of daily fuel wood consumption per capita was 1.36 kg at Japsar. Rural communities mostly rely on *T. wallichiana* wood as a source of fuelwood for cooking and heating their homes because upper temperate zones are dominated by mostly coniferous trees like *T. wallichiana* forests and other tree species

*e-mail: mushtaq@qau.edu.pk
**e-mail: mmanzoor@bs.qau.edu.pk

like *Pinus wallichiana*, *Picea smithiana*, and *Abies pindrow*. The species faces severe risks, such as exploitation for fuel, construction, fencing, agricultural expansion, climate change, and other dangers, putting pressure on its native ecosystem. Endangered *T. wallichiana* populations require immediate attention from forest management and policymakers to ensure the survival of this highly medicinal anti-cancerous plant species.

Keywords: Climate change, Endangered, Ethnobotany, Fuel wood, Population pressure.

Introduction

Himalayan forests are among the most depleted in the world [1–6], and overgrazing, tree harvesting, and nomadic lifestyles constitute the root cause of this degradation [7–10]. The Himalayan yew (*Taxus wallichiana*), a valuable medicinal plant found in these forests, is becoming threatened [11]. *Taxus wallichiana* is known as Barmi in Urdu, Hindko, and Hindi, and common yew or Himalayan yew in English [12]. Although *Taxus* species are distributed in a broad range of altitudes [13], they are most frequently found in the 1800–3300 m range [11, 14]. However, *Taxus* has only recently gained significant conservation attention. Though the plant has long been used by the locals of the Himalayan region, its therapeutic value was only discovered a few decades ago [15, 16].

Taxus wallichiana has enormous ecological and societal significance, as evidenced by a diverse range of ecosystem services and products [11, 12, 17, 18]. Yew's bark and leaves produce taxol, a molecule that has been shown to be effective against breast and ovarian cancer. *Taxus wallichiana* populations provide long-term habitats for the Kashmir region's indigenous flora and fauna, as this species matures in 70 years and has a life expectancy of more than 1000 years [19]. This species provides a wide range of ecological services. It yields strong, decay-resistant hardwood, which is highly valued for lumber and furniture. *Taxus wallichiana* is used for a variety of home applications, including medicine, fuel, and timber [20, 21]. The phytochemical study has shown that this plant has high anti-cancer action due to the presence of paclitaxel (taxol), which is widely used for cancer chemotherapy treatment around the world [22]. *Taxus wallichiana* populations are overexploited by locals throughout the Himalayan range [23]. IUCN classified it as a rare species in 2006 [24], and it is also included in Appendix II of CITES [22]. The International Union for Conservation of Nature has designated this species as endangered (EN). It has considerable conservation value as well as significant economic values, such as timber and medicine [25, 26].

Ecosystems can influence the quality of life and well-being in positive or negative ways, based on the cultural and socioeconomic setting [27, 28]. The idea of ecosystem services (ESs) has recently emerged to represent the numerous values as well as benefits that ecosystems deliver to people [29, 30]. One of the many issues that ES research encounters is the variety of interpretations of their present classification methods, as well as inconsistencies among ideas and terminologies [31]. However, relatively few studies have focused only on comparing different interpretations of the term [32], and classified ESs depending on their benefits. However, Mea [33] classified ESs into four distinct categories: provisioning (those services that are obtained directly from ecosystems, e.g., food, materials, water, etc.), controlling (those advantages that originate from regulating the functioning of ecosystem processes, e.g., flood control, water regulation, climate regulation, purification, etc.), and sustaining (those methods that must take place for the generation of all other ES, e.g., nutrient cycling, primary production, soil formation, etc.). These various types of ESs operate to benefit mankind by providing livelihoods, managing ecological systems, and promoting overall life and well-being [34, 35]. The interconnections and interdependence of human livelihoods and ecosystems determine the ESs required for human survival [36, 37]. It is thus impossible to separate the human advantages from ESs [38].

Anthropogenic disturbances are leading to increased extinction rates and the loss of biological diversity at all levels, including species, ecosystems, and genetics. Human demands are rapidly increasing, resulting in an unparalleled loss of genes, species, and the environment. Conservation biologists are increasingly concerned with the conservation of wild species. Biologically, conserving and managing endemic, endangered, rare, and threatened species is a top priority[24]. In recent decades, ecologists and environmentalists have made significant studies focused on evaluating the co-dominance of plant species and their relationship with both abiotic and biotic variables under growing natural and anthropogenic pressures [39, 40]. Population growth has led to the exploitation of natural habitats, resulting in continued loss of biodiversity [41–43]. The global vegetation composition has been adversely impacted by a variety of anthropogenic activities, including livestock grazing, tourism, agricultural expansion, and so forth. These activities have also led to the introduction or spread of invasive species [44–46].

Meanwhile, with the loss and deterioration of ecosystem services, there is growing interest in exploring ecosystem-based methods that might contribute to the shared benefits of adaptation and mitigation of climate change [47]. The idea of ecosystem services can be used to more efficiently integrate the numerous parts of natural and social systems, as it represents the relationship between humans

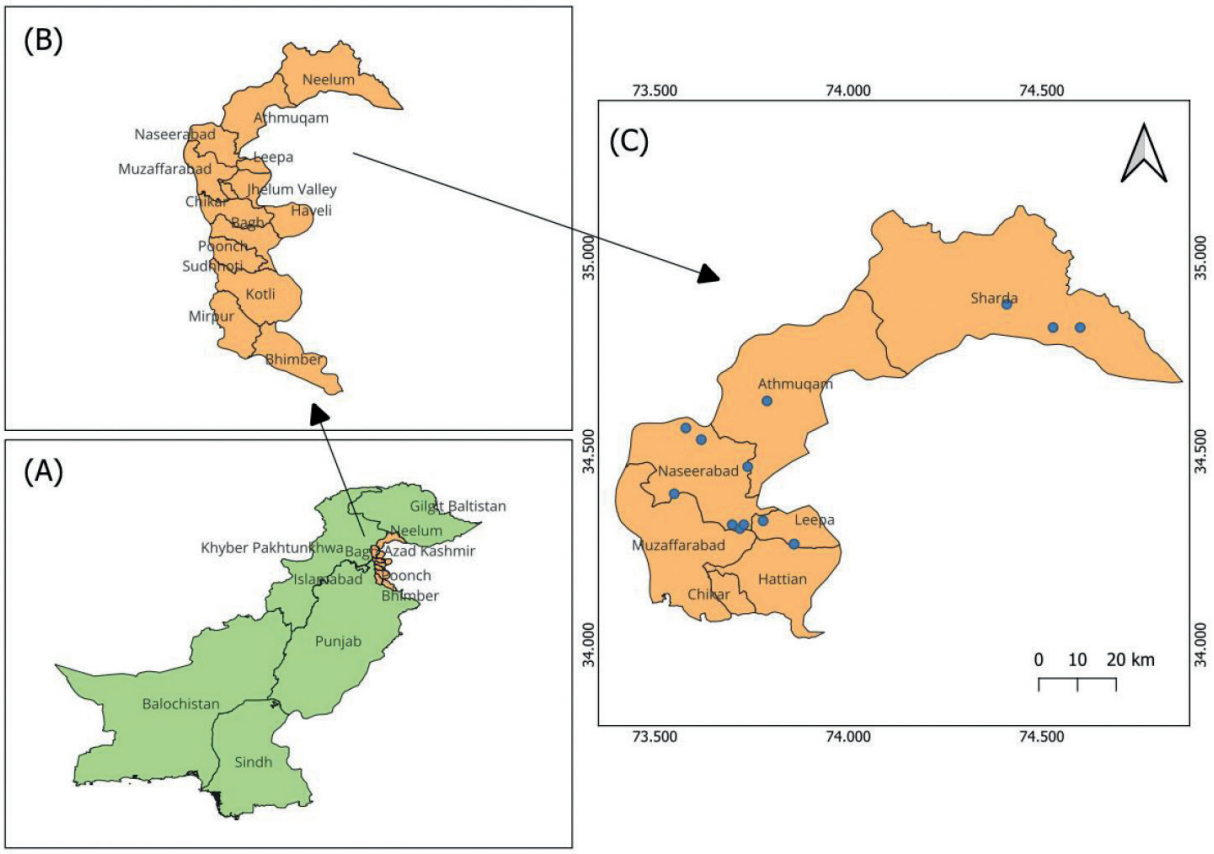

Fig. 1. Study area map: A represents Pakistan, B represents AJK, and C represents Division Muzaffarabad.

and nature. Several ecosystem service frameworks are currently available for evaluating vulnerability; these frameworks primarily analyze ecosystem service elements and processes that are associated with social outcomes directly, such as GDP outputs [48–51]. Globally, 2.8 billion people, the world's poorest and most marginalized rural populations, use biomass to cover their daily home energy needs [52]. Biomass extraction may additionally threaten forests' potential to provide a healthy environment for people by contributing to global forest deforestation, degradation, and climate change [53, 54]. The Western Himalayan region has high fuelwood demand, which has resulted in the significant degradation of forest resources near settlements [55]. Fuel, forage, lumber, and other natural resources are becoming increasingly scarce in the region as the population grows [56]. In order to meet future demand, fuelwood production and sustainable use have drawn a lot of attention. For fuelwood utilization to be sustainable, it is critical to comprehend the factors influencing the patterns of fuelwood consumption. Due to regional geographical and metrological peculiarities as well as socioeconomic household variables like size and wealth, data on fuelwood consumption is insufficient [57]. Fuelwood collection, especially in western Himalayas in an unsustainable manner, has drastically reduced the population of woody species and prevented the production of biomass for bioenergy in a sustainable manner [58].

Many studies have already been done on the Himalayan Yew in terms of diversity, distribution, associated flora, habitat geography, and GIS-based investigations, but there is a lack of study on the ecosystem services of *Taxus wallichiana* from the Kashmir Himalayas [11, 19, 59–62]. To fill this gap, this is the first attempt to thoroughly investigate the ecological services and anthropogenic pressure on endangered populations of *Taxus wallichiana* from the Himalayan Region of Kashmir. The primary objective of the current study is to investigate ecosystem services, anthropogenic pressure on endangered populations of *Taxus wallichiana* among rural communities in Kashmir, and implications for sustainable management.

Materials and Methods

Study Area

The study area is located in the western Himalayan region of Kashmir, spread between longitudes 73° and 74° north and 33° and 36° east (Fig. 1). The landscape of the study area is hilly and rugged, with deep valleys carved out

by numerous streams and rivers and mountainous slopes covered with forests. Kashmir is a hotspot for regional biodiversity that supports a wide range of climatic conditions and ecosystems because of its enamored elevation gradient [8, 16, 63, 64].

Data Collection

Site Selection and Description

14 sites were chosen based on the accessibility and residents' willingness to participate in interviews (Table. 1). Earlier discussions with our local representation team members were made to ensure an appropriate representation of the ecological services. All fieldwork was taken out between June and September 2023. The interviews were primarily above the age of 35 and comprised both male and female household members. The survey and participatory rural appraisal were used to collect data on the social structure and the use of wood for fuel and construction. We also documented community members' perspectives on key risks, anthropogenic pressure, and their implications. Plant specimens were collected, identified, and preserved in the Herbarium of Pakistan Quaid-i-Azam University, Islamabad with Voucher number ISL-133809.

Focus Group Discussion

One focus group discussion was held in each of the six communities to identify how ESs are used at the level of households in the study area. Following a description of the study's theme and objectives, participants were asked to list the ESs in the study region. The questions and responses were given verbally, with facilitators utilizing local vernacular to the greatest extent possible to ensure everyone involved understood what was stated. Each focused group discussion lasted no longer than two hours and was handled by a study member of the team, who was from the area and proficient in the local language. The facilitator of the group made sure that all participants participated in the conversation to support the group's perspective [65].

Ecosystem Services Assessment

Fuelwood collection and consumption patterns are influenced by the climatic conditions, availability of resources, and cooking techniques and are thus likely to differ among valleys. A total of 14 sites were selected from 3 districts for the assessment of taxus forest ecosystem services (Table 1). Each household's head member was chosen for an interview, during which they were questioned about the size of the family, the resources available for fuelwood, how fuelwood is collected and used, and other pertinent topics by following the method of Rawat et al. [66]. In accordance with Negi and Maikhuri [67], data on fuelwood consumption and collection were gathered based on family size and subsequently converted into per capita fuelwood usage. A well-designed questionnaire was used for individual interviews regarding fuelwood collection and consumption patterns. A weight survey approach was used to measure the amount of fuelwood consumed during a 24-hour period [68]. The ethnobotanical data of *T. wallichiana* was collected using the questionnaire method. A semi-structured questionnaire was used to collect the data from the rural communities of Kashmir by following the method of Gillani et al. [8].

Disturbance Indicators

Anthropogenic perturbations to the forest structure and *T. wallichiana* populations were explored. The number of yew stumps at each sampling site was used to quantify the degree of deforestation. Grazing intensity was measured using visible indications, such as trampling, hoof markings, and trails [1]. Additionally, a semi-quantitative scale was used to assess the level of anthropogenic disturbance (grazing intensity, and fire) at each sampling site (Table 1). Based on visual assessment at each sampling site, anthropogenic disturbance levels were assessed on a four-point scale (1 = low, 2 = moderate, and 3 = high).

Results

Forest ecosystems are the main source of sustenance for the local population's agricultural and fundamental needs. Cattle, goats, and sheep all enjoy consuming the Himalayan yew tree leaves. Furthermore, Himalayan yew wood is noted for its resilience and attractive color, making it a popular choice for architectural components such as eaves, roofing, and furniture. This application substantially covers the minimum requirement for firewood, which is used for both heating and cooking. However, the frequent harvesting of Himalayan yew bark by local residents for its therapeutic properties has resulted in an enormous decline in its population and viability.

Demography of the Informants

The demographic features of participants were documented during group discussions and personal interviews. The interviews included 106 informants, of whom 19 women and 87 men took part (Fig. 2). The majority of informants (82.07%) were male due to restrictions on women's interactions with strangers in the study area. Women are often restricted from attending markets, cities, or ceremonial sites, resulting in a lower level of female involvement in the current study. According to this current study, those who are older have a better understanding of the ecological services of plants. Those with excellent educational backgrounds are generally

Table 1. Study sites, fuelwood consumption (Kg/capita/day), deforestation, grazing intensity, and Agricultural Expansion in *Taxus* forests.

Site Name	Altitude (m)	Latitude	Longitude	Stay Duration	Number of households	Population	Family size	Fuelwood consumption	Grazing	Deforestation	Extraction of NTFPs	Fire	Agricultural Expansion
Peerchenasi	2626	34°23’27.15”N	73°33’13.79”E	4.5	21	146	6.95	1.58	2	84	2	3	2
Japsar	2445	34°33’51.29”N	73°34’48.29”E	4	13	86	6.62	1.36	2	61	2	2	2
Panjor Gali	2580	34°31’53.47”N	73°37’24.40”E	12	30	216	7.20	1.67	2	72	2	2	2
Boojni Wala	2495	34°17’44.90”N	73°43’7.47”E	5	4	17	4.25	3.76	3	95	2	2	1
Nogazian	2186	34°18’32.05”N	73°42’8.14”E	5	35	240	6.86	2.04	1	46	1	1	2
Khoajy Tarar	2412	34°18’19.86”N	73°43’46.55”E	5.5	31	290	9.35	2.89	3	164	3	2	3
Gydran Behk	2403	34°19’9.45”N	73°46’31.91”E	4.5	9	52	5.78	2.94	2	131	2	1	2
Brithwar 1	2574	34°15’45.47”N	73°51’26.83”E	4	16	73	4.56	3.51	2	115	3	1	1
Brithwar 2	2693	34°15’22.17”N	73°51’41.07”E	4.5	27	225	8.33	2.52	3	146	2	2	2
Leswa	2576	34°27’35.51”N	73°44’34.59”E	12	36	304	8.44	1.78	3	87	2	1	3
Kutton Naar	2717	34°37’46.87”N	73°47’17.39”E	5	18	103	5.72	2.97	2	124	2	1	2
Kala Ban	2863	34°49’6.72”N	74°36’14.95”E	5	21	88	4.19	5.25	3	143	3	1	2
Shounthar	2762	34°52’33.51”N	74°24’23.79”E	12	42	337	8.02	1.99	2	84	2	1	3
Janwai	2879	34°48’55.58”N	74°31’44.22”E	4.5	15	69	4.60	4.35	2	114	2	1	2

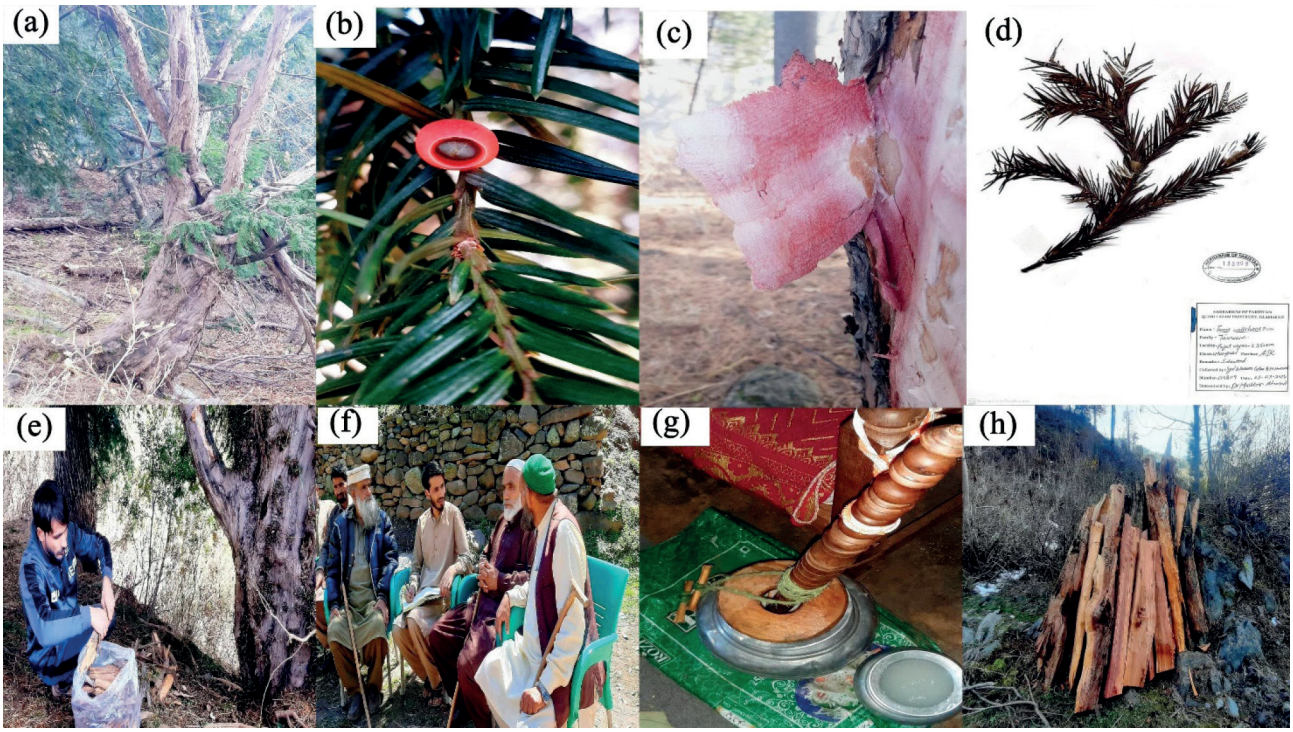

Fig. 2. (a) *T. wallichiana* in natural habitat; (b) Fruit; (c) Bark; (d) Herbarium specimen; (e) Principal author: Syed Waseem Gillani is collecting the bark for herbal tea; (f) Interactions with local inhabitants; (g) Homogenizer made from the wood of *T. wallichiana*; and (h) Deforestation in the study area.

unaware of the cultural norms and local ecological services provided by plants (Table 2.).

Medicinal

The bark is used as a substitute for tea during the winter to feel warm. Tea from *Taxus* bark is also believed to increase vitality and cure other health-related problems. The bark is also considered an anti-cancerous agent among the locals.

Herbal Tea

The bark of the *T. wallichiana* is used to make herbal tea. Indigenous people take the bark from this tree and boil it in water for 20–30 minutes before adding sugar and milk and boiling for another 5–10 minutes to make herbal tea.

Cultural Uses

The bark of *T. wallichiana* is used for the preparation of homogenizers among the local inhabitants of the Himalayan region of Kashmir. This has been a cultural practice among the locals for decades, but over time, the trend of this practice is declining day by day because of the low interest of younger generations in such practices (Fig. 2).

Fuelwood Consumption

The highest value of daily fuel wood consumption per capita was 5.25 kg at Kala Ban, whereas the lowest value of daily fuel wood consumption per capita was 1.36 kg at Japsar (Table 1). Rural communities mostly rely on *T. wallichiana* wood as a source of fuelwood for cooking and heating their homes because upper temperate zones are dominated by mostly coniferous trees like *T. wallichiana* forests and other tree species like *Pinus wallichiana*, *Picea smithiana*, and *Abies pindrow*. Some other trees and shrubs are also used as fuel, like *Juglans regia*, *Aesculus indica, Quercus semecarpifolia, Viburnum grandiflorum,* and *Paratiopsis Jacquemontii.* The linear correlation analysis revealed that fuelwood consumption values increase along the altitude of the study area (Fig. 3). This relationship showed the dependency level of the rural population on *T. wallichiana* as fuelwood due to harsh environmental conditions. As the altitude increased, the rural population used more fuelwood for heating to sustain their lives in harsh environmental conditions (Fig. 3, 4). One of the important points in terms of fuelwood consumption of *T. wallichiana* is that the wood of this species takes more time to burn, so a small quantity of wood of this species produces more heat and is longer lasting as compared to some other species. The local inhabitants of the study area like to burn the wood of *T. wallichiana and Quercus* species as compared to other species. So there's huge anthropogenic pressure on the endangered populations of *T. wallichiana.*

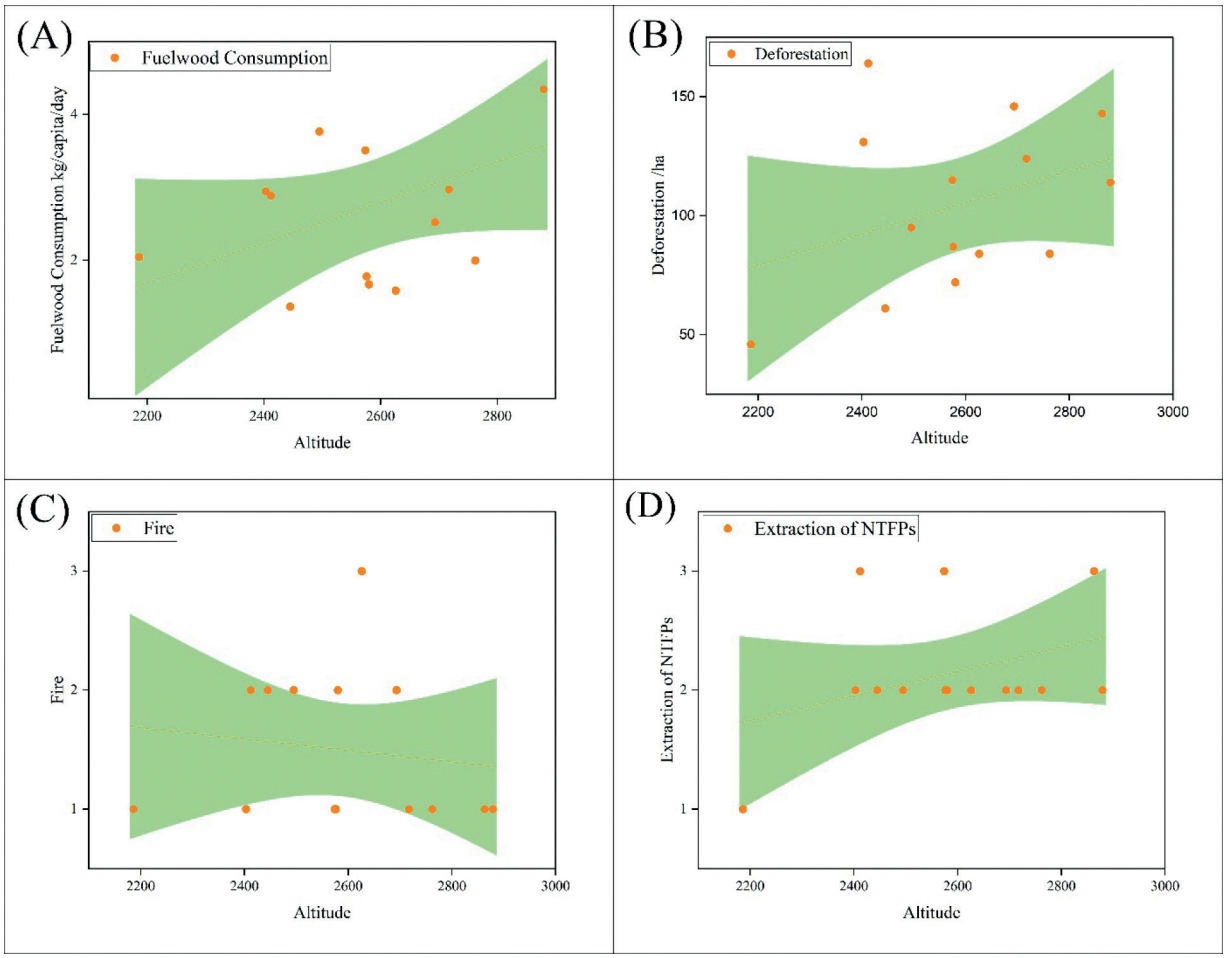

Fig. 3. Linear regression analysis between altitude and different aspects.

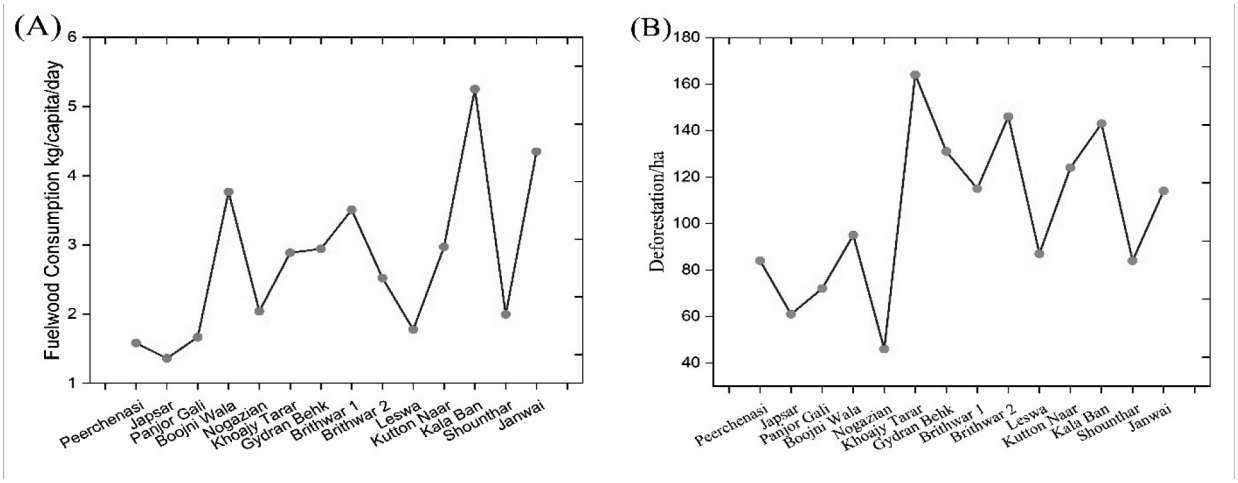

Fig. 4. Graph representing the fuelwood consumption and deforestation patterns in the studied sites.

Bedding

Branches are used as bedding for humans as well as for animals in mountainous areas and summer pastures among the indigenous communities of Kashmir Himalaya. Leaves and branches are also used to make soft beds (locally known as Danga).

Household Tools

Wood is used to make wooden utensils and wooden tubs, used as troughs for pet animals.

Table 2. Demographic information of the local inhabitants.

Demographic Features	Number of Interviewed Persons	Percentage
Gender		
Male	87	82.07
Female	19	17.92
Informant category		
Indigenous people	98	92.45
Hakims	08	7.54
Age of informants		
20–35 years	11	10.37
36–50 years	29	27.35
51–65 years	43	40.56
66 and above	23	21.69
Educational background		
Illiterate	56	52.83
Elementary school level	25	23.58
Secondary school level	12	11.32
High school level	08	7.54
Higher education	05	4.71

Fodder

Young branches are used for fodder, and yew leaves are supposed to benefit the local animals' health.

Timber

Particularly in temperate-alpine regions, pillars, and beams are the most often used as yew wood for building homes.

Some Major Threats

A major threat to our forest resources is being created by human interference, which is causing habitat loss and a decrease in biodiversity in the studied area. It is happening at a rate never seen before as a result of the growing demand for natural resources brought on by human needs.

The primary source of the extreme pressure on *T. wallichiana*'s habitat is human activity, and overexploitation of the plant's parts is causing the species' natural numbers to decline. The increasing number of people and their need for local farming, coupled with the expansion of animal husbandry practices, unsustainable commercial extraction, development projects, and other factors, have all contributed to the stress on the habitat and regeneration of this economically significant plant species. However, indigenous tribes' frequent collection of Himalayan yew bark for medicinal purposes has significantly reduced the species' growth and survival rates. The bark is traditionally utilized in local remedies to treat a range of health issues, putting further strain on the species' survival. As a result, the natural population of this species has decreased and faces a serious threat of extinction. *T. wallichiana*, known for its cancer-fighting properties, has been listed as endangered due to over-harvesting of its leaves, bark, and whole trees. The species faces severe risks since its wood is also exploited for fuel, construction, fencing, agricultural expansion, climate change, and other uses, putting pressure on its native ecosystem. The decreasing population of *T. wallichiana* is a major problem caused by the overuse for timber, and medicinal, furniture, and cultural purposes by the local inhabitants of the rural areas of the Kashmir Himalayas (Table. 1).

Discussion

The Himalayan ecosystems' forests are thought to be the reservoir of biodiversity. In addition, they serve as carbon sinks and offer protection against flooding and soil erosion in low-lying areas [8, 69, 70]. However, the ecosystems of forests are declining [71]. According to the United Nations Environment Program's Millennium Ecosystem Assessment Report, almost 60% of ecosystem services that sustain life are being degraded or used up more

quickly than they can be regenerated [72]. The ecosystem of the Himalayan Forest is particularly vulnerable to human activities, such as urbanization, industrialization, and so forth. These activities can have serious repercussions, such as the degradation of forest land, changes in climate, and the loss of forest cover. Eventually, these problems can lead to major problems like soil erosion, a reduction in soil fertility, slope failures, a decrease in fuelwood and fodder, a decrease in groundwater recharge, increased overland flows, and siltation of riverbeds in the lowland areas [58, 73–77]. Deforestation, degraded soil, and habitat fragmentation induced by anthropogenic disturbances in the Himalayan Forest ecosystem have resulted in uncontrollable weed flora proliferation in this region [1, 74]. Another issue with the lack of manure and animal bedding is forest fires in the Himalayan biodiversity. The quality of maintaining land has decreased as a result of disintegration and lack of consideration for the common people [5, 78–80]. In order to prevent environmental degradation in favor of economic expansion and development, common policies and legislation for the preservation of natural resources such as forests, biodiversity, water, organic food, and ecotourism should be promoted.

The severe impact on the quantity of seedlings may be explained by the intense anthropogenic and grazing load in the study area [81]. *P. wallichiana* needs a lot of sunlight to flourish, as supported by previous studies [11, 25]. The highest value of daily fuel wood consumption per capita was 5.25 kg, whereas the lowest value of daily fuel wood consumption per capita was 1.36 kg. One of the important points in terms of fuelwood consumption of *T. wallichiana* is that the wood of this species takes more time to consume itself, so a small quantity of wood of this species produces more heat and is longer lasting as compared to some other species. Our current results are comparable with previous studies [55, 82]. The amount of firewood consumed varies with family size; larger households use more firewood. So, the highest fuel wood consumption was observed among the larger family households as compared to the families with a smaller number of people. This phenomenon is also noted by Shaheen et al. [55]. The bark of the *T. Wallichiana* is used to make herbal tea among the indigenous communities of the Kashmir Himalayas. *T. wallichiana*, known for its cancer-fighting properties, has been listed as endangered because of over-harvesting of its leaves, bark, and whole trees. The current study findings are supported by some other studies in the same area by some other researchers as well [8, 11, 16, 63]. *T. wallichiana* grows relatively slowly, and its low seed yield and production rate are the main causes of its poor natural regeneration. The species' relative intolerance of fire contributes to the effects of exploitation and habitat deterioration.

T. wallichiana habitat decline is caused by home encroachment on forest areas for agricultural production, such as tea and pepper cultivation. Sanctions to combat unlawful extraction are inadequate to protect this endangered, valuable, and rare plant species from habitat loss. There is an increasing demand for wood, fuel, and medicinal purposes; illegal cutting and smuggling of trees, as well as conversion of forests for farmland, lead to habitat loss and environmental degradation [9, 11, 23, 56, 60, 83, 84]. Yousaf et al. [85] also stated that habitat degradation caused by human activities reduced the occurrence of *T. wallichiana* and hampered species restoration. Other risks include medical exploitation, such as taxol extraction, fuelwood harvesting, timber for roofing materials, and climate change. The main cause of poor regeneration, especially at lower elevations, is herbivores trampling on the bark and leaves of trees that the locals excessively exploit for medicinal purposes. Apart from human causes, natural forces also exert a considerable influence on the growth and development of regenerated plants. Therefore, it is crucial to develop and implement laws, regulations, and appropriate management in order to safeguard and enhance this plant species [26, 61, 62, 85]. *T. wallichiana* populations' habitats will alter dramatically in the future as a result of human activity and climate change. As a result, this species has difficulty spreading and regenerating organically. It has been categorized as an endangered species due to trade, habitat loss, and degradation [11, 81, 86–89]. The *T. wallichiana* population declined mostly as a result of unsustainable extraction, illegal harvesting, cutting, and seedlings being exposed to direct sunlight, which negatively impacts their ability to grow and survive, as well as a lack of awareness and understanding of sustainable management techniques. The Himalayan yew tree produces durable, gorgeously colored wood. It is therefore frequently used as a building material for furniture, roofing, and eaves. The study's interview subjects likewise believed that this use played a significant role in the species' rapid decline and was also inconsistent with the previous finding [13]. The results of this study showed that agricultural land expansion from upper temperate to alpine regions, particularly in the summer pastures, is a major contributing factor to the reduction of Himalayan yew. The slow-growing seeds cannot naturally flourish in regions cleared for agriculture when people produce crops and build homes in areas of the forests that once supported them. The main issues facing this species have been determined to be its poor regeneration and the decline of older populations in its native habitat. Numerous studies have determined that one of the primary causes of this species' extinction is the expansion of agricultural land inside forests [90–100].

The habitat of the Himalayan yew has been degrading at an alarming rate due to overexploitation, which has resulted from the plant's many beneficial uses. Effective conservation and effective management techniques have not yet been the subject of any ecological research on *T. wallichiana* in the Kashmir Himalayan region. Proper conservation measures, such as in-depth research, species-specific initiatives, site- and habitat-based actions, policymaking, communication, and education, can limit the loss of a species. The main objectives of any conservation effort should be to identify, record, and explore the species' ecological significance. Protected area networks can be used to restore habitats and ecosystems in situ or ex situ while including the local population. By creating parks, reserve

forests, sanctuaries, and other areas, in situ conservation can be practiced for the conservation of *T. wallichiana* in their natural habitats. Only with strong habitat protection and well-supported species conservation efforts will these species be able to survive climate change.

Conclusions

Taxus wallichiana has enormous ecological and societal significance, as evidenced by a diverse range of ecosystem services and products in the Kashmir western Himalayan region. The current study provides insightful information on the ecosystem services and anthropogenic disturbances that affect the *T. wallichiana* forest. Ethnobotanically, *T. wallichiana* is an important species. The bark is used as a substitute for tea during the winter to feel warm. The bark is also considered an anti-cancerous agent among the locals. The highest value of daily fuelwood consumption per capita was 5.25 kg at Kala Ban, whereas the lowest value of daily fuelwood consumption per capita was 1.36 kg at Japsar. The species faces severe risks since its wood is also exploited for fuel, construction, fencing, agricultural expansion, climate change, and other uses, putting pressure on its native ecosystem. The decreasing population of *T. wallichiana* is a major problem due to overuse for timber, medicinal, furniture, and cultural purposes by the local inhabitants of the rural areas of the Kashmir Himalayas. Ecosystem services should therefore be protected and conserved by implementing important integrated management and conservation techniques that incorporate the concepts of value addition, evaluation, and compensation for ESs. Understanding the value and interactions between forest ecosystem services on a regional, national, and international scale is always crucial. We suggest proper conservation measures, such as in-depth research, species-specific initiatives, site- and habitat-based actions, policymaking, communication, and education, which can limit the loss of *T. wallichiana* forest.

Acknowledgments

The authors extend their appreciation to the Researchers supporting project number (RSP2024R190), King Saud University, Riyadh, Saudi Arabia.

Funding

The authors extend their warm appreciation to the Researchers Supporting Project Number (RSP2024R190), King Saud University, Riyadh, Saudi Arabia.

Ethical Approval and Consent To Participate

All the experiments were performed in accordance with relevant guidelines and regulations.

Author Contributions

Syed Waseem Gillani: Field Collection, Writing-Original draft preparation, Mushtaq Ahmad, Muhammad Zafar: Supervision and Review Editing, Muhammad Manzoor: Statistical analysis, Syed Waseem Gillani: Field Collection, Methodology and Data analysis, Investigation, Hamayun Shaheen, Muhammad Manzoor, Naveed Abbas: Interpretation of Results, Dunia A Al Farraj, Mohamed S Elshikh: Funding acquisition & data curation.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

All the data has been presented in this article.

References

1. ALAM N.M., SHAHEEN H., MANZOOR M., TINGHONG T., ARFAN M., IDREES M. Spatial Distribution and Population Structure of Himalayan Fir (*Abies pindrow* (Royle ex D. Don) Royle) in Moist Temperate Forests of the Kashmir Region, Forests, **14** (3), 482, **2023**.
2. DHYANI S. Are Himalayan ecosystems facing hidden collapse? Assessing the drivers and impacts of change to aid conservation, restoration and conflict resolution challenges, Biodiversity and Conservation, **32** (12), 3731, **2023**.
3. TIWARI O.P., SHARMA C.M. Anthropogenic disturbance impact on forest composition and dominance-diversity: A case of an ecosensitive region of Garhwal Himalaya, India, Acta Ecologica Sinica, **43** (4), 662, **2023**.
4. LI J., HUANG L., CAO W., ZHAO J., XU X. Ecosystems face the risk of ecological deficits in the southern foothills of the Himalayas, Ecological Indicators, **158**, 111267, **2024**.
5. SATI V.P. Forest fires in the Indian Central Himalaya: major drivers, implications, and mitigation measures, Environmental Hazards, 1, **2024**.
6. NAYAK R., VERMA A.K., MANIKA N., CHAUDHARY L.B., BEHERA S.K., BARGALI K., PANDEY V.N. Distribution pattern and management of invasive alien plant species in Sikkim Himalaya, India, Plant Science Today, **11**, 2, **2024.**
7. AHMAD S.S., ABBASI Q., JABEEN R., SHAH M.T. Decline of conifer forest cover in Pakistan: a GIS approach, Pakistan Journal of Botany, **44** (2), 511, **2012**.
8. GILLANI S.W., AHMAD M., ZAFAR M., HAQ S.M., WAHEED M., MANZOOR M., SHAHEEN H., SULTANA S., REHMAN F.U., MAKHKAMOV T. An Insight into Indigenous Ethnobotanical Knowledge of Medicinal and Aromatic Plants from Kashmir Himalayan Region, Ethnobotany Research and Applications, **28**, 1, **2024**.
9. HAQ S.M., RASHID I., KHUROO A.A., MALIK Z.A., MALIK A.H. Anthropogenic disturbances alter

community structure in the forests of Kashmir Himalaya, Tropical Ecology, **60**, 6, **2019**.
10. SAJJAD H., RAHAMAN M.H., MASROOR M., SHARMA Y., SHARMA A., SAHA T.K. Vulnerability assessment of forest ecosystem based on exposure, sensitivity and adaptive capacity in the Valmiki Tiger Reserve, India: A geospatial analysis, Ecological Informatics, **80**, 102494, **2024**.
11. SHAHEEN H., ATTIQUE A., RIAZ M.T., MANZOOR M., KHAN R.W.A., RIAZ M.T. From biodiversity hotspot to conservation hotspot: assessing distribution, population structure, associated flora and habitat geography of threatened Himalayan Yew in temperate forest ecosystems of Kashmir, Biodiversity and Conservation, 1, **2024**.
12. MULLIKEN T., CROFTON P. Review of the status, harvest, trade and management of seven Asian CITES-listed medicinal and aromatic plant species: results of the R+ D Project FKZ 80486003, **2008**.
13. IQBAL J., MEILAN R., KHAN B. Assessment of risk, extinction, and threats to Himalayan yew in Pakistan, Saudi Journal of Biological Sciences, **27** (2), 762, **2020**.
14. XU J., GRUMBINE R.E., SHRESTHA A., ERIKSSON M., YANG X., WANG Y., WILKES A. The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods, Conservation Biology, **23** (3), 520, **2009**.
15. NICOLAOU K., GUY R.K., POTIER P. Taxoids: new weapons against cancer, Scientific American, **274** (6), 94, **1996**.
16. MANZOOR M., AHMAD M., ZAFAR M., GILLANI S.W., SHAHEEN H., PIERONI A., AL-GHAMDI A.A., ELSHIKH M.S., SAQIB S., MAKHKAMOV T. The local medicinal plant knowledge in Kashmir Western Himalaya: a way to foster ecological transition via community-centred health seeking strategies, Journal of Ethnobiology and Ethnomedicine, **19** (1), 56, **2023**.
17. THAKUR U., BISHT N.S., KUMAR M., KUMAR A. Influence of altitude on diversity and distribution pattern of trees in Himalayan temperate forests of Churdhar Wildlife Sanctuary, India, Water, Air, & Soil Pollution, **232** (5), 205, **2021**.
18. ADHIKARI P., PANDEY A. Phytochemicals, and antioxidants and antibacterial activities of Taxus wallichiana Zucc. root associated endophytic fungi, Biologia, 1, **2024**.
19. SAQIB Z., MALIK R.N., HUSAIN S.Z. Modeling potential distribution of *Taxus wallichiana* in Palas Valley, Pakistan, Pakistan Journal of Botany, **38** (3), 539, **2006**.
20. SAEED M.K., DENG Y., DAI R., LI W., YU Y., IQBAL Z. Appraisal of antinociceptive and anti-inflammatory potential of extract and fractions from the leaves of Torreya grandis Fort Ex. Lindl, Journal of Ethnopharmacology, **127** (2), 414, **2010**.
21. GAO X., ZHANG N., XIE W. Advancements in the Cultivation, Active Components, and Pharmacological Activities of *Taxus mairei*, Molecules, **29** (5), 1128, **2024**.
22. UNIYAL S.K. Bark removal and population structure of *Taxus wallichiana* Zucc. in a temperate mixed conifer forest of western Himalaya, Environmental monitoring and assessment, **185**, 2921, **2013**.
23. BISHT M., CHANDRA SEKAR K., MUKHERJEE S., THAPLIYAL N., BAHUKHANDI A., SINGH D., BHOJAK P., MEHTA P., UPADHYAY S., DEY D. Influence of anthropogenic pressure on the plant species richness and diversity along the elevation gradients of Indian Himalayan high-altitude protected areas, Frontiers in Ecology and Evolution, **10**, 751989, **2022**.
24. PAUL A., BHARALI S., KHAN M.L., TRIPATHI O.P. Anthropogenic disturbances led to risk of extinction of *Taxus wallichiana* Zuccarini, an endangered medicinal tree in Arunachal Himalaya, Natural areas journal, **33** (4), 447, **2013**.
25. GAJUREL J.P., WERTH S., SHRESTHA K.K., SCHEIDEGGER C. Species distribution modeling of *Taxus wallichiana* (Himalayan yew) in Nepal Himalaya, Asian Journal of Conservation Biology, **3** (2), 127, **2014**.
26. BHARDWAJ V. *Taxus wallichiana* Zucc.(Himalayan Yew): A Medicinal Plant Exhibiting Antibacterial Properties. Springer; 2023.
27. BRILL G., ANDERSON P., O'FARRELL P. Methodological and empirical considerations when assessing freshwater ecosystem service provision in a developing city context: Making the best of what we have, Ecological Indicators, **76**, 256, **2017**.
28. DÍAZ S., PASCUAL U., STENSEKE M., MARTÍN-LÓPEZ B., WATSON R.T., MOLNÁR Z., HILL R., CHAN K.M., BASTE I.A., BRAUMAN K.A. Assessing nature's contributions to people, Science, **359** (6373), 270, **2018**.
29. BENNETT E.M., PETERSON G.D., GORDON L.J. Understanding relationships among multiple ecosystem services, Ecology letters, **12** (12), 1394, **2009**.
30. FISHER B., TURNER R.K., MORLING P. Defining and classifying ecosystem services for decision making, Ecological economics, **68** (3), 643, **2009**.
31. LA NOTTE A., D'AMATO D., MÄKINEN H., PARACCHINI M.L., LIQUETE C., EGOH B., GENELETTI D., CROSSMAN N.D. Ecosystem services classification: A systems ecology perspective of the cascade framework, Ecological indicators, **74**, 392, **2017**.
32. DANLEY B., WIDMARK C. Evaluating conceptual definitions of ecosystem services and their implications, Ecological Economics, **126**, 132, **2016**.
33. ASSESSMENT M.E. Ecosystems and human well-being: Island Press, Washington, DC, **2005**.
34. BENNETT E.M., CRAMER W., BEGOSSI A., CUNDILL G., DÍAZ S., EGOH B.N., GEIJZENDORFFER I.R., KRUG C.B., LAVOREL S., LAZOS E. Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability, Current opinion in environmental sustainability, **14**, 76, **2015**.
35. FISCHER A., EASTWOOD A. Coproduction of ecosystem services as human – nature interactions – An analytical framework, Land use policy, **52**, 41, **2016**.
36. HEIN L., VAN KOPPEN K., DE GROOT R.S., VAN IERLAND E.C. Spatial scales, stakeholders and the valuation of ecosystem services, Ecological economics, **57** (2), 209, **2006**.
37. SILOKO B.E. Human security, sustainable livelihoods and development: the case of the Niger Delta region in Nigeria, Global Discourse, 1, **2024**.
38. CIMON-MORIN J., DARVEAU M., POULIN M. Fostering synergies between ecosystem services and biodiversity in conservation planning: a review, Biological conservation, **166**, 144, **2013**.
39. YAO Z., ZHAO C., YANG K., LIU W., LI Y., YOU J., XIAO J. Alpine grassland degradation in the Qilian Mountains, China — A case study in Damaying Grassland, Catena, **137**, 494, **2016**.
40. BHATT D., SEKAR K.C., RAWAL R. Tree diversity, congruence and endemism: Himalaya 'The land

of diversity', Biodiversity and Conservation, **30** (10), 2633, **2021**.
41. PANDEY A., CHANDRA SEKAR K., JOSHI B., RAWAL R. Threat assessment of high-value medicinal plants of cold desert areas in Johar valley, Kailash Sacred Landscape, India, Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology, **153** (1), 39, **2019**.
42. YIRGA F., MARIE M., KASSA S., HAILE M. Impact of altitude and anthropogenic disturbance on plant species composition, diversity, and structure at the Wof-Washa highlands of Ethiopia, Heliyon, **5** (8), **2019**.
43. MEHTA P., SEKAR K.C., BHATT D., TEWARI A., BISHT K., UPADHYAY S., NEGI V.S., SORAGI B. Conservation and prioritization of threatened plants in Indian Himalayan Region, Biodiversity and Conservation, **29**, 1723, **2020**.
44. TANG L., DONG S., SHERMAN R., LIU S., LIU Q., WANG X., SU X., ZHANG Y., LI Y., WU Y. Changes in vegetation composition and plant diversity with rangeland degradation in the alpine region of Qinghai-Tibet Plateau, The Rangeland Journal, **37** (1), 107, **2014**.
45. KACHENA L., SHACKLETON R.T. The impact of the invasive alien plant Vernonanthura polyanthes on conservation and livelihoods in the Chimanimani uplands of Zimbabwe, Biological Invasions, 1, **2024**.
46. GOSWAMI P., RAJPUT P. Navigating climate risk through loss and damage: implications for Bakarwal nomads in the Pir Panjal Range, India, GeoJournal, **89** (2), 1, **2024**.
47. TRAN L., BROWN K. The importance of ecosystem services to smallholder farmers in climate change adaptation: Learning from an ecosystem-based adaptation pilot in Vietnam, Agroforestry Systems, **93** (5), 1949, **2019**.
48. BERROUET L.M., MACHADO J., VILLEGAS-PALACIO C. Vulnerability of socio — Ecological systems: A conceptual Framework, Ecological Indicators, **84**, 632, **2018**.
49. REYERS B., BIGGS R., CUMMING G.S., ELMQVIST T., HEJNOWICZ A.P., POLASKY S. Getting the measure of ecosystem services: a social–ecological approach, Frontiers in Ecology and the Environment, **11** (5), 268, **2013**.
50. MONONEN L., AUVINEN A.-P., AHOKUMPU A.-L., RÖNKÄ M., AARRAS N., TOLVANEN H., KAMPPINEN M., VIIRRET E., KUMPULA T., VIHERVAARA P. National ecosystem service indicators: Measures of social–ecological sustainability, Ecological Indicators, **61**, 27, **2016**.
51. QIU B., LI H., ZHOU M., ZHANG L. Vulnerability of ecosystem services provisioning to urbanization: A case of China, Ecological Indicators, **57**, 505, **2015**.
52. BONJOUR S., ADAIR-ROHANI H., WOLF J., BRUCE N.G., MEHTA S., PRÜSS-USTÜN A., LAHIFF M., REHFUESS E.A., MISHRA V., SMITH K.R. Solid fuel use for household cooking: country and regional estimates for 1980–2010, Environ Health Perspect, **121** (7), 784, **2013**.
53. BAILIS R., WANG Y., DRIGO R., GHILARDI A., MASERA O. Getting the numbers right: revisiting woodfuel sustainability in the developing world, Environmental Research Letters, **12** (11), 115002, **2017**.
54. BAILIS R., DRIGO R., GHILARDI A., MASERA O. The carbon footprint of traditional woodfuels, Nature Climate Change, **5** (3), 266, **2015**.
55. SHAHEEN H., AZAD B., MUSHTAQ A., KHAN R.W.A. Fuelwood consumption pattern and its impact on forest structure in Kashmir Himalayas, Bosque, **37** (2), 419, **2016**.
56. KUMAR B., SINGH K., SHARMA J., GAIROLA S. A comprehensive review of fuelwood resources and their use pattern in rural villages of Western Himalaya, India, Plant Archives, **20** (2), 1949, **2020**.
57. HUSSAIN A., NEGI A., SINGH R.K., AZIEM S., IQBAL K., PALA N.A. Comparative study of fuelwood consumption by semi-nomadic pastoral community and adjacent villagers around Corbett Tiger Reserve, India, Indian Forester, **142** (6), 574, **2016**.
58. BHAT J.A., HUSSAIN A., MALIK Z.A., TODARIA N. Fuelwood consumption of dhabas (temporary hotels) along an altitudinal gradient in a pilgrim and tourist affected protected area of western Himalaya, Journal of Sustainable Forestry, **35** (2), 133, **2016**.
59. SHAHEEN H., SARWAR R., FIRDOUS S.S., DAR M., ULLAH Z., KHAN S.M. Distribution and structure of conifers with special emphasis on *Taxus Baccata* in moist temperate forests of Kashmir Himalayas, Pakistan Journal of Botany, **47**, 71, **2015**.
60. SHAHEEN H., QURESHI R.A., ULLAH Z., AHMAD T. Anthropogenic pressure on the western Himalayan moist temperate forests of Bagh, Azad Jammu & Kashmir, Pakistan Journal of Botany, **43** (1), 695, **2011**.
61. SHARMA H., GARG M. A review of traditional use, phytoconstituents and biological activities of Himalayan yew, *Taxus wallichiana,* Journal of integrative medicine, **13** (2), 80, **2015**.
62. LANKER U., MALIK A., GUPTA N., BUTOLA J.S. Natural regeneration status of the endangered medicinal plant, *Taxus baccata* Hook. F. syn. T. wallichiana, in northwest Himalaya, International Journal of Biodiversity Science, Ecosystem Services & Management, **6** (1–2), 20, **2010**.
63. MIRZAMAN Z., KAYANI S., MANZOOR M., JAMEEL M.A., WAHEED M., GILLANI S.W., BABAR C.M., BUSSMANN R.W. Ethnobotanical study of Makra Hills district Muzaffarabad, Azad Jammu and Kashmir, Pakistan, Ethnobotany Research and Applications, **26**, 1, **2023**.
64. MANZOOR M., AHMAD M., ZAFAR M., HAQ S.M., SHAHEEN H., WAHEED M., GILLANI S.W., SULTANA S., MAKHKAMOV T. Unveiling the Indigenous Ethnomedicinal knowledge of Genus *Nepeta* from Division Muzaffarabad, Azad Jammu & Kashmir, Pakistan, Ethnobotany Research and Applications, **26**, 1, **2023**.
65. SAEED U., ARSHAD M., HAYAT S., MORELLI T.L., NAWAZ M.A. Analysis of provisioning ecosystem services and perceptions of climate change for indigenous communities in the Western Himalayan Gurez Valley, Pakistan, Ecosystem Services, **56**, 101453, **2022**.
66. RAWAT Y.S., VISHVAKARMA S.C., TODARIA N. Fuel wood consumption pattern of tribal communities in cold desert of the Lahaul valley, North-Western Himalaya, India, Biomass and Bioenergy, **33** (11), 1547, **2009**.
67. NEGI V.S., MAIKHURI R. Forest resources consumption pattern in Govind wildlife sanctuary, western Himalaya, India, Journal of Environmental planning and management, **60** (7), 1235, **2017**.
68. SHAHEEN H., AZIZ S., DAR M. Ecosystem services and structure of western Himalayan temperate forests stands in Neelum valley, Pakistan, Pakistan Journal of Botany, **49** (2), 707, **2017**.
69. GIRI A., PANT D. CO2 management using carbonic anhydrase producing microbes from western Indian Himalaya, Bioresource technology reports, **8**, 100320, **2019**.

70. SINGH C., CHAUHAN N., UPADHYAY S.K., SINGH R., RANI A. The Himalayan natural resources: Challenges and conservation for sustainable development, Journal of Pharmacognosy and Phytochemistry, **10** (1), 1643, **2021**.
71. SHAHEEN H., AZIZ S., NASAR S., WAHEED M., MANZOOR M., SIDDIQUI M.H., ALAMRI S., HAQ S.M., BUSSMANN R.W. Distribution patterns of alpine flora for long-term monitoring of global change along a wide elevational gradient in the Western Himalayas, Global Ecology and Conservation, **48**, e02702, **2023**.
72. ASSESSMENT M.E. Chapter 9: Changes in ecosystem services and their drivers across the scenarios, Ecosystems and human well-being: scenarios, **2**, **2005**.
73. PANT G., MANSOTRA D.K., SHARMA S., GOSWAMI M., JOSHI P. Role of Species Distribution Models in Biodiversity Conservation, Current Status of Researches in Biosciences, 507, **2020**.
74. JOSHI V.C., BISHT D., SUNDRIYAL R., PANT H. Species richness, diversity, structure, and distribution patterns across dominating forest communities of low and mid-hills in the Central Himalaya, Geology, Ecology, and Landscapes, 1, **2022**.
75. AHMAD M., UNIYAL S.K., BATISH D.R., SINGH H.P., JARYAN V., RATHEE S., SHARMA P., KOHLI R.K. Patterns of plant communities along vertical gradient in Dhauladhar Mountains in Lesser Himalayas in North-Western India, Science of The Total Environment, **716**, 136919, **2020**.
76. AHMED M.J., MURTAZA G., SHAHEEN H., HABIB T. Distribution pattern and associated flora of Jurinea dolomiaea in the western Himalayan highlands of Kashmir: an indicator endemic plant of alpine phytodiversity, Ecological Indicators, **116**, 106461, **2020**.
77. DAR J.A., SUNDARAPANDIAN S. Patterns of plant diversity in seven temperate forest types of Western Himalaya, India, Journal of Asia-Pacific Biodiversity, **9** (3), 280–92, **2016**.
78. BARGALI H., CALDERON L.P.P., SUNDRIYAL R., BHATT D. Impact of forest fire frequency on floristic diversity in the forests of Uttarakhand, western Himalaya, Trees, Forests and People, **9**, 100300, **2022**.
79. KAUSHAL S., SIWACH A., BAISHYA R. Diversity, regeneration, and anthropogenic disturbance in major Indian Central Himalayan forest types: implications for conservation, Biodiversity and Conservation, **30** (8), 2451, **2021**.
80. HUSSAIN S., SHARMA S., BHATTI R.C., SINGH A.N. Sustainability in the Indian Himalayan Region: Understandings the Ecosystem Services, Climate Change Impacts, Land Use Shifts and Their Threats. The Himalayas in the Anthropocene: Environment and Development, 33, **2024.**
81. SHRESTHA D. Population Structure and Microhabitat Preferences of the Himalayan Yew (*Taxus wallichian*a Zucc.) in Panchase Protected Forest in Central Nepal: Amrit Campus, **2023.**
82. SHARMA A., UNIYAL S.K., BATISH D.R., SINGH H.P. Utilization of fuelwood species by the Bhangalis community of western Himalaya, India, Environment, Development and Sustainability, **25** (4), 3577, **2023**.
83. HAQ S.M., CALIXTO E.S., RASHID I., KHUROO A.A. Human-driven disturbances change the vegetation characteristics of temperate forest stands: A case study from Pir Panchal mountain range in Kashmir Himalaya, Trees, Forests and People, **6**, 100134, **2021**.
84. HAQ S.M., KHAN I., MALIK Z.A., SINGH B. Plant diversity and species distribution pattern across the Pir Panjal Mountain forest range in the Western Himalayas. Biodiversity, Conservation and Sustainability in Asia: Volume 2: Prospects and Challenges in South and Middle Asia: Springer, p. 67–84, **2022.**
85. YOUSAF A., HADI R., KHAN N., IBRAHIM F., MOIN H., RAHIM S., HUSSAIN M. Identification of suitable habitat for Taxus wallichiana and Abies pindrow in moist temperate forest using maxent modelling technique, Saudi Journal of Biological Sciences, **29** (12), 103459, **2022**.
86. GOWTHAMI R., SHARMA N., PANDEY R., AGRAWAL A. Status and consolidated list of threatened medicinal plants of India, Genetic Resources and Crop Evolution, **68** (6), 2235, **2021**.
87. THAKUR A., KANWAL K.S. Assessing the Global Distribution and Conservation Status of the *Taxus* Genus: An Overview, Trees, Forests and People, 100501, **2024**.
88. GUL N., BAIG S., AHMED R., SHAHZADI I., ZAMAN I., SHAH M.M., BAIG A. Conservation of an endangered medicinal tree species Taxus wallichian through callus induction and shoot regeneration, Plant Tissue Culture and Biotechnology, **30** (1), 161, **2020**.
89. CHAKRABORTY D., MONDAL K.C., MUKHOPADHYAY S. Period wise future distribution and range-shift estimation using shared socioeconomic pathways on *Taxus wallichiana* medicinal plant, **2023**.
90. LEVERS C., ROMERO-MUÑOZ A., BAUMANN M., DE MARZO T., FERNÁNDEZ P.D., GASPARRI N.I., GAVIER-PIZARRO G.I., WAROUX Y.L.P.D., PIQUER-RODRÍGUEZ M., SEMPER-PASCUAL A. Agricultural expansion and the ecological marginalization of forest-dependent people, Proceedings of the National Academy of Sciences, **118** (44), e2100436118, **2021**.
91. RAIHAN A., BEGUM R.A., NIZAM M., SAID M., PEREIRA J.J. Dynamic impacts of energy use, agricultural land expansion, and deforestation on CO2 emissions in Malaysia, Environmental and Ecological Statistics, **29** (3), 477, **2022**.
92. BILLAH M.M., RAHMAN M.M., ABEDIN J., AKTER H. Land cover change and its impact on human–elephant conflict: a case from Fashiakhali forest reserve in Bangladesh, SN Applied Sciences, **3** (6), 649, **2021**.
93. AKINDE B.P., OLAKAYODE A.O., OYEDELE D.J., TIJANI F.O. Selected physical and chemical properties of soil under different agricultural land-use types in Ile-Ife, Nigeria, Heliyon, **6** (9), **2020**.
94. RAHMAN M.U., DEY T., BISWAS J. Land-use change and forest cover depletion in Bhawal National Park, Gazipur, Bangladesh from 2005 to 2020, Environmental Monitoring and Assessment, **195** (1), 201, **2023**.
95. PETERS F., LIPPE M., EGUIGUREN P., GÜNTER S. Forest ecosystem services at landscape level–Why forest transition matters?, Forest Ecology and Management, **534**, 120782, **2023**.
96. EDOSA B.T., NAGASA M.D. Spatiotemporal assessment of land use land cover change, driving forces, and consequences using geospatial techniques: The case of Naqamte city and hinterland, western Ethiopia, Environmental Challenges, **14**, 100830, **2024**.
97. ERAZO-MERA E., YOUNES N., HORWOOD P.F., PARIS D., PARIS M., MURRAY N. Forest loss during 2000–2019 in pygmy hippopotamus (Choeropsis liberiensis) habitats was driven by shifting agriculture, Environmental Conservation, **51** (1), 55, **2024**.

98. YADAV S.P.S., MEHATA D.K., POKHREL S., GHIMIRE N.P., GYAWALI P., KATEL S., TIMSINA U. A comprehensive study of banmara (invasive alien plant species): Understanding the invasive potential and ecological consequences for biodiversity conservation, and management strategies, Journal of Agriculture and Food Research, 101031, **2024**.
99. GILLANI, S.W., AHMAD, M., ZAFAR, M., MANZOOR, M., SHAH, G.M., SHAHEEN, H., ZAMAN, W., SULTANA, S., SADIA, B., KHISHLATOVNA, K.K. Ethnobotanical Exploration of Traditional Medicinal Plants Among the Rural Inhabitants of District Muzaffarabad, Kashmir Himalayan Region. Plant Science Today, **11** (sp1), **2024**.
100. MANZOOR, M., AHMAD, M., ZAFAR, M., GILLANI, S. W., SHAH, G. M., SHAHEEN, H., ZAMAN, W., SULTANA, S., JABEEN, S., KHISHLATOVNA, K. K. Exploration of Traditional Ethno-gynaecological Knowledge: Advances to Ethnobotanical Studies from Indigenous Communities of Neelum Valley in the Himalayan region Plant Science Today, **11** (sp1), **2024**.