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Evaluating the Socioeconomic Factors on Deforestation in Northern Pakistan: A Study on Existing Economic Incentive Tools for Reducing Deforestation

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Abstract: Deforestation is a common threat to the environment that has a substantial impact on the forest's distribution across territorial boundaries. It is simply defined as the loss of forest cover, which most commonly occurs as a result of deforestation for various reasons. Pakistan is among those countries which have a very high deforestation rate. This paper analyzes the various socioeconomic factors which cause deforestation in northern Pakistan and the existing economic incentive tools for reducing deforestation. Data collected from 602 respondents were analyzed using descriptive statistics and a logistic regression model, while the Likert scale was used to determine the mean socioeconomic factor score encouraging deforestation and the economic incentives used to reduce deforestation. Gender distributions showed that the majority (65.9%) of the respondents were male while 34.1% were female. On family size, the majority of the respondents (66.8%) had a family size of 5–8. On age, between 21–25 years (46.0%) recorded the highest number. The average age of the respondents was 24 years. Educationally, 13.8% had a master's education, 11.1% a bachelor's education, 4.3% no formal education, 5.6% a higher education level, meaning master's or PhD students, 56.1% had a primary education, and 9.0% had a secondary education. On occupation, the majority (50.4%) of the respondents were involved in farming as their main occupation. On income, the major income recorded a mean of 25,000 net, while the minor income recorded a mean of 15,500 net. Setting the forest ablaze, increasing farming activities, low level of literacy, increasing timber mafia, growing population, and poverty were the socioeconomic factors found. The economic incentives listed were for forest crop subsidies, an enhanced system of taxes on exploited forest products, the acquisition of well-monitored hunting licenses, alternative job opportunities, credit provision, and a limited ban on round log exports. The results of the logit regression established that rewarding socioeconomic factors were statistically significant variables at ($p < 0.05$). Conclusively, if adequately controlled and applied, economic incentives can be an important instrument for reducing deforestation. Therefore, deforestation activities cannot be entirely eradicated but they can be reduced to the barest minimum by properly enforcing forest policies in terms of efficient forest policing. The goals of this study are to help with the implementation of appropriate policies and decision-making in forest management, as well as to provide a foundation for future scenario analysis of deforestation potential or to investigate potential environmental and human implications.

Keywords: economic incentives; tool; deforestation; socioeconomic factors; forest degradation

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1. Introduction

According to the Pakistan Forest Institute (PFI 2003) and the Government of Pakistan (1992), Pakistan is a forest-poor country with only 5.2% forest cover (4.72 million hectares). In Pakistan, the per capita forest area is 0.0333 hectares, whereas the global average is one hectare. The primary reason is that 70 to 80% of Pakistan's land area is in arid or semi-arid

zones with insufficient precipitation to support tree growth. Every year, different areas are replanted and revitalized. Policies and programs are being developed to increase the forest area to meet national requirements, but there has been no significant increase in area, rather rapid deforestation. The use and depletion of these resources is heavily influenced by forest communities [1]. In the last 20 years, a total of 1707 km^2 forest land has been lost, which is 8% of the total forest area, meaning 3.8% of the area per year. Government authorities are making efforts and strategies to control this continuous and rapid loss of the forest area in the northern part of the country. Gilgit-Baltistan (GB) is primarily a source of concern as the forest in these regions is consistently badly maintained, and the area's primary problem is deforestation and degradation [2–5]. Especially during the winter, when the weather is cold and demand for fuelwood is high. Illegal forest harvesting and cutting occurred due to a shortage of renewable energy options (timber mafia is the main body behind this") [2,6]. Deodar, fir, spruce, and juniper forest cover is quickly vanishing due to extensive logging. This has a direct impact on the climatic and economic conditions in the area. Within these protected areas, mining activities are reduced due to this continuous deforestation and degradation [7–10]. Due to even minor rain events, forest loss poses a risk of erosion and this especially applies to soil on steep slopes, as does the precipitous mountainous terrain in GB province, Pakistan [11,12].

Many international organizations, including the United Nations and the World Bank, have begun to develop deforestation-reduction programs, primarily through reducing emissions from deforestation and forest degradation (REDD), which uses direct monetary or other incentives to encourage developing countries to limit and/or reverse deforestation. Significant work is being undertaken on tools for monitoring developing countries' adherence to agreed-upon REDD targets [13].

Pakistan has initiated a REDD program and joined numerous international initiatives to improve its institutional structure and enhance its capacity for the implementation of the REDD program [14–16]. The UNFCCC wants REDD countries to take major steps to set a national forest reference level (FRL) which is a tool to progress the REDD activities within a country. As a result, in Pakistan's northern areas, accurate scientific knowledge and information are required to create a valid and comprehensive forest inventory. The climate change ministry recently produced an action plan to implement Pakistan's national forest monitoring system (NFMS) [17]. By planning and implementing REDD, the inventory would eventually contribute to the NFMS.

Without a doubt, population growth is one of the most important socioeconomic factors that could alter the pattern of forest resource use. Globally, the recent trend of accelerated environmental degradation has been primarily driven by changes in land use as a result of frontier expansion and population growth [18,19]. Land use practices and land use have a significant impact on natural forests, the environment, and the entire biosphere. Social, economic, and political factors have created incentives for rapid forest exploitation, putting additional strain on the remaining tropical forests and arid woodlands [20–22]. Africa's forests are the most depleted of any tropical region, with only 30% of historical stands remaining [23]. Socioeconomic factors are altering or depleting forest cover, affecting forest structure and species composition [24]. The intensity of disturbances varies within a given landscape depending on land use, accessibility, topography, and vegetation type. Because of anthropogenic pressures, the increased dominance of small woody trees in harvested GB woodlands suggests that the woodlands may degrade to shrub lands [25,26].

The main issues are considered to be the participation of local communities, encouragement of private sector investment, illegal harvesting, and the local need for fuelwood and construction timber [25,27]. Such studies show that there is a disparity in understanding of the anthropogenic factors that cause deforestation in the forests. This paper analyzes the factors influencing deforestation in the Gilgit Forest. For scientists and decision-makers concerned with a sustainable environment and forest management, the information provided in this paper is especially significant. Several international organizations have begun implementing strategies to control deforestation and degradation to stop carbon emission

(REDD) by providing incentives and good monitoring to promote sustainable forest management and reduce forest deforestation in developing countries. Significant research has been conducted on the tools for tracking developing countries' adherence to their negotiated REDD goals [15,28]. The lack of valuable knowledge about timber production and forest preservation for the long-term use of these forest resources according to fundamental needs is the most serious danger to sustainable forest management. In a study conducted by FAO, it was reported that 89% of forests in developed countries were managed in some way, but only about 6% were in developing countries. Not only could 20 percent of timber demand be met sustainably, but buffer zones could be established to consolidate protected areas. This would result in one of the world's largest and most important conservation estates (FAO, 2001, Anon, 2001a) [29,30].

Deforestation brings many social and environmental problems with it, which can make human life intolerable [31]. Deforestation is a global issue that threatens environmental sustainability, with a greater impact on Nigeria due to its high rate. Deforestation has a negative impact on the entire environment, the economy, and the citizens. Tree cutting contributes to global warming and climate change [32,33]. Deforestation has detrimental environmental, economic, and citizen impacts. In Pakistan, there is a significant disparity between demand and output. Wood use in 2018 was 52.6 million cubic meters, compared to 29.5 cubic meters in 1993, indicating a significant difference over 25 years. Pakistan now produces 14 million cubic meters of wood, with a requirement of 52 million cubic meters in 2020. As a result, wood consumption is a major contributor to deforestation [34]. Government also bans the cutting of trees, but these rules are just for some people, and corrupt timber mafia and government officials do not follow the government policy regarding the control of deforestation. Political influence in these matters is also a reason to implement restrictions on smuggling wood and timber trading [35]. The forest department is also involved in the selling of trees to only the rich and big mafia in the market. They cannot bring these people to justice because of their share in this business with mafias [36]. The government failed to provide them with an alternative resource to fuelwood and economic incentives to the community.

In addition, strategies and laws for forest management are in favor of income generation and do not recognize the social and economic circumstances of the populations. The Khyber Pakhtunkhwa (KPK) link between integrated family health and forestry systems indicates that a lack of resources in the area is one of the main causes of deforestation [7,34]. In these forest areas, the tree is used as the ultimate source of livelihood because they have no basic facilities in these harsh mountainous regions such as gas, electricity, and availability of renewable energy sources. Therefore, the forest and trees are the only sources of energy in these hilly areas [37]. Deforestation and poverty are directly related to each other due to uncertain property rights and duration, leading to poor forest management and deforestation. This evidence is obtained from Balakot in the Mansehra district of the Khyber Pakhtunkhwa province. In these areas, more than 80% of people live below the poverty line. A lack of basic facilities such as transport and education is causing some serious issues regarding forest management. People find it difficult to understand the importance of the forest and the benefits they can obtain from sustainable forest management and development [7,34].

The natural factors affecting forests include an arid climate, heavy dependence on irrigation water, long forestry gestation periods, and fragile watersheds and rangelands. Other factors include burgeoning population pressure resulting in unsustainable removals, the reliance of 90 percent of rural households and 60 percent of urban households on fuelwood as the primary source of energy, the suspension of forest management in natural forests, the unscientific pasture beyond capacity-bearing, and the lack of adequate and sustained financial inputs for the natural regeneration and sustainable growth of fragile ecosystems (e.g., mountain, riparian, desert, mangrove). Moreover, floods, fire storms, pests, diseases, and developmental pressure, i.e., construction of roads, buildings, and

water reservoirs, that threaten riparian and mangrove habitats have led to widespread deforestation in Pakistan [2].

The belief that economic opportunities will inspire governments to invest in biodiversity seems to be currently driving most of the action under the aegis of the United Nations' REDD program. REDD may still be the only multilateral instrument working to tackle climate change following the failure to achieve a binding successor agreement to the Kyoto Protocol at the Copenhagen climate summit in 2009. Though it has a relatively limited program compared to Kyoto, it is nothing to sneeze at. REDD had raised over $4 bn and expected to raise at least $100 bn by 2020 [38].

Deforestation is the conversion of forest land to a non-forested permanent land use such as agriculture, grazing, or urban development and deforestation is also defined as the process by which land is cleared of forests or trees. Deforestation, also known as "timber extraction" in some circles, occurs throughout the developed and developing worlds and can be viewed as a byproduct of the industrialization and development processes. Forests cover nearly one-third of the Earth's land surface and provide numerous environmental benefits such as a significant role in the hydrologic cycle, soil conservation, climate change prevention, and biodiversity preservation [39]. Rural households not only use forest resources to meet their subsistence needs, but they also create significant monetary income by trading forest goods [40,41]. This connection between forest dependency and biodiversity preservation shows how important it is for academics and researchers to comprehend the factors that affect household reliance on forest resources in order to ensure the long-term sustainability of forest resource management and biodiversity preservation. Furthermore, forest revenue contributes roughly 10–20% of the average Asian household's income [42]. These studies attested to the fact that forest resources have a sizable impact on household income. Some families rely only on forest resources to survive. Despite the importance of trees in human lifestyles, human dependency on forest resources is a different story. Forest resources are an important source of income, although their importance varies around the world and among different socioeconomic classes [43]. For example, in India's Himalayan area, agriculture and agricultural-related activities support about 80% of rural communities. As a result, the forest plays an important role in agricultural activities by indirectly and, in some cases, directly contributing to household livelihoods [44,45].

The accelerating nature of deforestation also endangers the forest's raw materials' sustained resource base and causes various economic and environmental hazards. Economic incentives are specific inducements designed and implemented to persuade government bodies, businesses, non-governmental organizations, or local people to conserve, utilize, and manage environmental resources in a sustainable and responsible manner [46]. This underlines the value of this study with the following objectives: to define the respondents' socioeconomic profiles, to identify the socioeconomic factors that encourage deforestation, to evaluate the impact of the incentives of socioeconomic factors, and to identify the economic incentives used to reduce deforestation. Overall, these studies show that forest cover changes dramatically, with accessibility and human pressure being some of the most prominent causes of deforestation. This preliminary study aimed to evaluate socioeconomic factors and the forest situation in Gilgit-Baltistan. Although it was a questionnaire, it was critical to learn about the knowledge of deforestation in Pakistan and economic incentives, if properly monitored and implemented, can be an effective tool for reducing deforestation because they are likely to be the most effective measures for converting the overexploitation of biological resources to sustainable use. Thus, while deforestation cannot be completely eliminated due to the daily increase in human population, the adequate implementation of forest policy in terms of effective forest policing can reduce it to the bare minimum.

2. Conceptual Framework

Step one: Many governments have nominal control over forests but are unable to effectively regulate their use. This can result in a tragedy of the commons in which forest resources are depleted. Deforestation is a common practice and legalized method of

claiming land and securing tenure in frontier areas [47]. However, there is strong evidence that rapid population growth is a major indirect and systemic cause of deforestation. More people necessitate more food and space, which necessitates more land for agriculture and human habitation. Managing human life support systems is arguably the most difficult challenge of all, and controlling population growth is perhaps the best single thing that can be undertaken to promote sustainability [48]. Fuelwood gathering was thought to be the primary cause of deforestation and forest degradation in the tropics' drier areas. Fuelwood gathering can be a major cause of deforestation and degradation. Forest resources and agricultural products are the primary sources of income for the local people in the study area, but these resources appear to be deteriorating on a daily basis. Conservation of such areas is impossible without the participation of local communities who rely on these resources for their daily needs. The level of education in rural communities can influence households' reliance on forest products. An examination of educational levels in the study sites revealed that a significant proportion of household members only completed primary and junior secondary school. As a result, the areas have a high level of undereducation. This may highlight the local communities' reliance on forest products for a living due to a limited capacity to seek employment in the formal sector. Higher education levels are associated with a lower reliance on forests for subsistence, owing to the fact that education provides a broader range of employment opportunities in other sectors of the economy [49,50].

Step two: These findings have numerous policy implications. Most importantly, deforestation can be viewed as an endogenous economic process fueled by rational economic decisions made by local agents. As a result, the focus of new policies should be on changing the economic incentive structure that agents face by changing the expected profits of various land use methods (sustainable versus unsustainable). One more specific implication is that commodity prices, as well as commodity future prices, should be taken into account in policy design, deforestation forecasting, and policy evaluation [51].

In this study, the conceptual framework adopted in order to evaluate socioeconomic factors that cause deforestation and degradation problems is shown in Figure 1. These studied socioeconomic factors are linked with livelihood activities, population growth, and energy requirements. The economic activities that can reduce/control the deforestation activities and preserve forest ecology are listed in Figure 1.

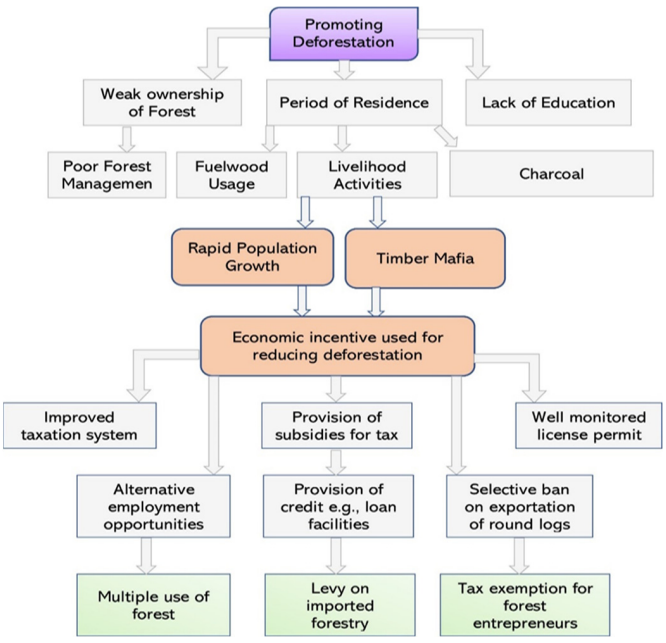


Figure 1. Socioeconomic factors promoting deforestation and economic incentives to control deforestation in GB, Pakistan.

3. Study Area

Gilgit-Baltistan is an administrative region in the extreme northern part of Pakistan (split into seven districts: Gilgit, Diamer, Hunza-Nagar, Ghizer, Ghanche, Astor, and Skardu) (Figure 2). This northern area has 72,971 km^2 of cover [52]. There are 1582 km^2 of land forest [1] and the Karakorum, Himalayas, Hindu Kush, and Pamir ranges. The majority of the terrain is at least 4500 m above sea level. The world's three most powerful mountain ranges, the Karakoram, Hindukush, and NW Himalaya, meet near Bunji at the confluence of the Gilgit and Indus rivers. The Indus River flows from here and is fed by the Gilgit, Hunza, and Shyoke rivers. The longest glaciers outside of the polar regions can be found here. Climate change and its negative consequences are becoming more visible in the ecosystems of Gilgit-Baltistan. Pristine valleys are home to a diverse range of wildlife. Outside of the polar regions, Gilgit-Baltistan has the most widespread perpetual ice (22,000 km^2). The height range in this region is enormous, ranging from 8611 m at K-2 peak to a little more than 569 m in the lowlands. In the valley, the low temperatures range from 40 °C extremes in summer to 10 °C in winter [7,11,52].

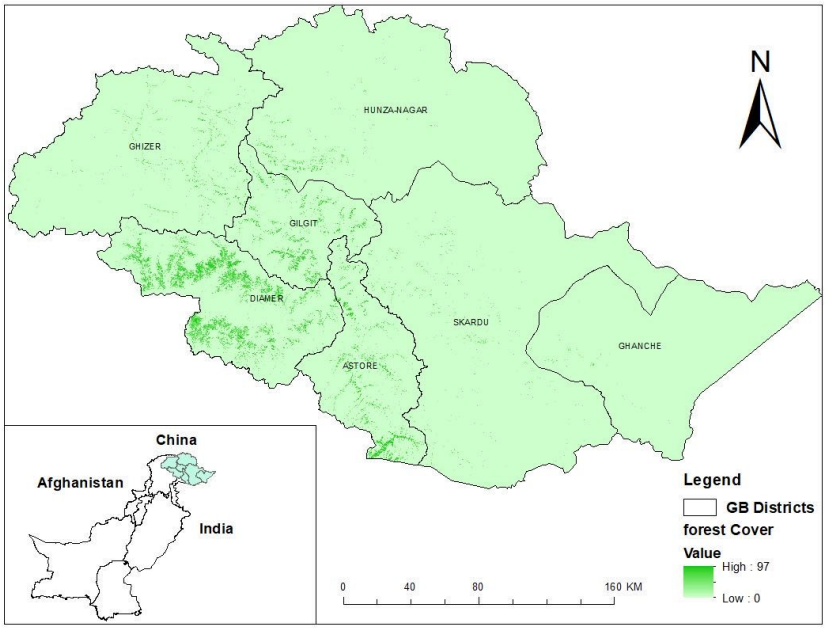


Figure 2. Gilgit-Baltistan district displaying the Pakistani study area.

Gilgit-Baltistan is one of the most endangered places on the planet, with unchecked tree cutting resulting in rapid deforestation. With one of the world's highest rates of deforestation, Gilgit-Baltistan forests are in desperate need of protection and conservation. Mismanagement and unsustainable cutting for living purposes and timber products pose the greatest threat to these forests. Proper management practices are desperately needed to halt deforestation [53,54].

The area's importance is evident from its geographic location, as it is the juncture among Central Asia, China, and South Asia. This important region, however, remained cut off from the rest of the country (Pakistan) until the Karakoram Highway (KKH) was established in 1978. The literacy ratio grew steadily from 14.7 percent in 1981 to 37.8 percent in 1998 and grew further to 52.0 percent in 2012. Nonetheless, women's education reported a 12-fold rise from 1981 (3 percent) to 2012 (36 percent). Nevertheless, the literacy level for women in the Diamer and Astore districts is still very small. This is the same as in Gilgit-Baltistan [55]. According to Burki, 2015 [56], Gilgit-Baltistan's population census was at 216,760 people [57] and the annual population growth rate in northern areas of Pakistan has been 4.85 percent. Data were collected through questionnaires, interviews, consultations with focus groups, and evaluation of the participants. In each village, two focus group

discussions were conducted to help determine the accuracy of the data obtained through the questionnaires and interviews.

4. Materials and Methods

4.1. Data Sources

This study used both primary and secondary data sources. Primary data were the collected research from the respondents who completed the questionnaire survey and interviews with local indigenous people about the uses of timber products, and the study took the answers of the respondents and then quantified them with statistical modeling to solve the collected data. Data were compared with previously published articles, newspapers, and net sources data for assigning as secondary data and it was useful in discussions and model selection for primary data, then for the assessment and interpretations of the results on the basis of both the primary and secondary data.

4.2. Field Survey

(i) Semi-Structured Interviewing

The primary goal of the household survey was to determine the relative importance of household demographic, socioeconomic, and land use characteristics in forest clearing decision-making and area cleared. In each interview, the primary respondent was the head of the household. The household survey was a semi-structured interview that included two major surveys. The survey focused on recording household assets such as human, social, natural, physical, and financial capital.

Key informants were interviewed using semi-structured interviews (forest development corporation). Different interview guides were used for different informants, but the content essentially covered the research questions' demands. Though respondents were given the same context of questioning (including both closed and open-ended questions) so that responses could be aggregated, semi-structured interviews are mostly flexible by nature, giving interviewees a great deal of leeway in how to respond. It also gave the interviewer the opportunity to delve deeper and clarify issues relevant to the study.

(ii) Self-Administered Questionnaire

The study also employed a self-administered questionnaire to elicit the individual perspectives of household heads on the research questions. A questionnaire is a type of research instrument that is commonly used in the design of social surveys. It consists of a series of usually closed-ended questions that are completed by the respondents themselves. Under the supervision of the researcher, respondents were given an equal number of questions to answer. Because the questions had to be interpreted to respondents (due to their inability to effectively read and/or write) and the responses aggregated by the researcher, the "self-administered questionnaire" was renamed self-completion questionnaire. The various responses could then be compared and contrasted to establish a thought pattern.

(iii) Participant Observation

Another major data collection method used to produce qualitative data was participant observation or ethnography. First-hand knowledge was collected by this approach in relation to the different facets of the study issues.

4.3. Data Collection

A semi-structured questionnaire served as the data gathering tool. The respondents were given the questionnaire along with an interview guide. For the survey in Gilgit-Baltistan, a non-probability quota sampling process was utilized as an optimum sample strategy. A predetermined sampling frame of 602 respondents was selected across 14 villages' local governments in the zone. Moreover, the rural and urban areas are very closely attached and it is extremely difficult to define a clear-cut boundary and distinguish a village from an urban territory. Therefore, based on inquiry from the concerned municipal office and respondents' report, we have specifically categorized the rural villages and urban villages and used the same categorization in our analysis. Furthermore, we have

highlighted the rural villages and urban villages in Table 1 and with a footnote under Table 1 as well. Some of the photographs from the field survey are given below as Figure 3.

Table 1. Sampling plan of the study area, GB, in Pakistan.

No	Province	Village	No of Respondents
1	Gilgit-Baltistan	Damas *	43
2		Sandi **	43
3		Asqurda *	43
4		Shayar **	43
5		Chalt **	43
6		Dadimal **	43
7		Bunji *	43
8		Astore *	43
9		Ganish **	43
10		Aliabad *	43
11		Kasrot *	43
12		Jutial **	43
13		Haiderabad *	43
14		Dassu **	43
		Total	602

Note: * rural villages, ** urban villages.

Figure 3. Some photographs from the field survey in Gilgit-Baltistan Pakistan.

The quota sampling technique was used to select 602 respondents across 14 local villages in the zone; and in each local community, 43 respondents were selected. The questionnaire comprises 7 sections in total and each section is consisted of 3 to 9 main questions along with

sub-questions (detailed questionnaire is attached as Supplementary Materials). The aforesaid seven sections are (1) extent and causes of deforestation, (2) initiatives for curbing deforestation, (3) community-based economic incentives, (4) value functions and physical pattern of forests, (5) physical pattern of forests and anthropogenic activities, (6) economic incentives and their impact on physical pattern and value-function dynamics, and (7) REDD + i.e., reduced emissions from deforestation and degradation of forests and the role of conservation of forest carbon stocks, sustainable forest management, and enhancement of forest carbon stocks. The distribution of the respondents is presented in Table 1. The data were collected from the start of November to the middle of December in 2021 and in January 2022.

The variables successively identified in the forest were entered into the logistic regression model to estimate the chance that socioeconomic factors affected human disturbances. The logistic regression model was used again to assess the importance of socioeconomic factors that contributed to human disturbances in the forest [58–60].

The model's fitness was found to match well with this study's results (84.9%) (Table 2). A chi-square value of 297.501 with a degree of freedom of 6 was very important at a likelihood level of 5 percent (p = 0.000), which means that the independent variables (socioeconomic factors) influenced the dependent variable very well. Similarly, the log probability (−2LL) value of 453.216 showed that the model matched the data well. Table 2 shows that the Wald statistics were non-zero values, indicating that the dependent and independent variables interacted. According to Norušis, 1990 [61] and Powers and Xie and Spradling, 2000 [62], the Wald statistical values that are not zero reveal the link between the dependent and explanatory variables. As a result of the outcomes of this research, the null hypothesis was rejected in favor of the alternative hypothesis that socioeconomic factors had a substantial influence on deforestation at a forest level of 5%.

Table 2. Socioeconomic factors influencing and promoting the deforestation of GB in Pakistan.

Variable	B	S. E	Wald	df	Sig.	Exp(B)
Weak ownership of forest by the community	0.524	0.263	3.974	1	0.046	1.689
Period of residence close to forest	0.842	0.260	10.461	1	0.001	2.321
Inadequate education	1.110	0.284	15.268	1	0.000	3.035
Poorly managed forests	0.749	0.289	6.726	1	0.010	2.115
Using wood as fuel	0.641	0.284	5.095	1	0.024	1.898
Livelihood activities	1.090	0.277	15.458	1	0.000	2.976
Rapid population growth	0.687	0.271	6.439	1	0.011	1.988
Distance	0.102	0.132	0.601	1	0.438	1.108
Household size	0.104	0.074	1.967	1	0.161	1.110
Constant	−3.756	0.673	31.136	1	0.000	0.023

4.4. Data Analysis

The Statistical Package for the Social Sciences (SPSS version 25.0) was also utilized to arrange and code the data for the quantitative data analysis. The socioeconomic profiles of the respondents, socioeconomic factors encouraging deforestation, and economic opportunities used to decrease deforestation were analyzed. For the evaluation of the influence of the socioeconomic variables on the incentives, the logit regression model was used. We used descriptive and inferential statistical methodologies to analyze the quantitative data. To define and emphasize the socioeconomic characteristics of peripheral groups in the forest community, descriptive statistics such as frequency and percentage counts were employed. For the examination of the dependent variable, logistic regression was used to analyze inferential statistics. The dependent variable in this study was 'deforestation in the forest', which was assigned a value of '1' if deforestation occurs in the forest and '0' if it does not. The independent variables were weak ownership of the forest by the community, period of

residence close to the forest, lack of education, poor forest management, fuelwood usage, livelihood activities, rapid population growth, years of residence, distance, and household size. These were the independent variables of deforestation influenced by socioeconomic reasons. In the equation, the logistic regression model is shown.

$$p = E(Y) = \frac{\exp(\beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 \ldots + \beta 9nXn)}{1 + \exp(\beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 \ldots + \beta nXn)} \quad (1)$$

Equation (1) is then transformed as follows:

$$logit(p) = \log e(\frac{p}{1-p}) \quad (2)$$

The result of the transformation of Equation (2) becomes as follows:

$$logit\ (p) = \beta_0 + \beta_{1 \times 1} + \beta_{2 \times 2} + \beta_{3 \times 3} + \beta_{4 \times 4} + \beta_{nXn} \quad (3)$$

A probability score (p) for each cell is the end result.

It denotes that the logit conversion of the dichotomous data confirms that the regression's dependent variable is continuous, and the new dependent variable (logit transformation of the probability) is infinite. Finally, it confirms that the predicted probability will be continuous between 0 and 1. The best-fitted predictor set's regression equation and the probability of forest change were generated. The goodness of fit is an alternative to model X2 for evaluating the significance of a logistic regression model. It is calculated by subtracting the predicted and observed values of the dependent variable.

Y = socioeconomic factors promoting deforestation, $\beta_1 \times 1$ = weak ownership of forest by the community, $\beta_2 \times 2$ = period of residence close to forest, $\beta_3 \times 3$ = lack of education, $\beta_4 \times 4$ = poor forest management, $\beta_5 \times 5$ = fuelwood usage, $\beta_6 \times 6$ = livelihood activities, $\beta 7 \times 7$ = rapid population growth, $\beta_8 \times 8$ = years of residence distance, $\beta_9 \times 9$ = household size, ε = error term, β_0 = intercept, and β_1 = regression where p is the probability that the cell's forest would be lost, E(Y) is the dependent variable's anticipated value Y, β_0 is a constant to be estimated, and $\beta_1 \ldots$ βn are coefficients to be estimated for each independent variable ($X_1 \ldots X_n$). This logistic function (Equation (1)) can be transformed (Equation (2)) into a linear function (Equation (3)) which is called a logit or logistic transformation [63–67].

5. Results and Discussion

The total number of respondents was 602, and we used the regression model as shown in Table 2. The results are based on the chi-square model = 297.501 (p = 0.000), −2 log livelihood = 453.216, overall percentage = 84.9%, Exp (b) = an odds ratio (probability of failure/probability of success), SE = estimate of the standard error, = statistically non-significant at a 0.05 level of significance, Sig = significance, b = regression coefficients which stand for the odds ratio of probability of success to the probability of failure, Wald statistics = b/(SE)2, and df = degree of freedom. *Statistically significant at 0.05 level of significance, ns [64,66–69].

The rate of deforestation is considerably and negatively influenced, according to the results of the logistic regression. Though all the factors such as the weak ownership of the forest by the community (Wald = 3.974, Exp(B) = 1.689 df = 1), period of residence close to the forest (Wald = 10.461 Exp(B) = 2.321 df = 1), lack of education (Wald = 15.268 Exp(B) = 3.035 df = 1), poor forest management (Wald = 6.726 Exp(B) = 2.115 df = 1), fuelwood usage (Wald = 5.095 Exp(B) = 1.898 df = 1), livelihood activities (Wald = 15.458 Exp(B) = 2.976 df = 1), rapid population growth (Wald = 6.439 Exp(B) = 1.988 df = 1), household size (Wald = 1.967 Exp(B) = 1.110 df = 1), and distance (Wald = 601 Exp(B) = 1.108 df = 1) play a main role in the deforestation rate, (Table 2) shows that the effects of socioeconomic factors promoting the deforestation in the Gilgit-Baltistan, Pakistan woodlands were statistically significant at a 5% level of significance.

The forest deforestation research by M. Appiah, 2009 and Babulo, 2009 [49,70] suggested that subsistence practices, such as holding livestock and extracting coal, had a

major effect on tree abundance and diversity. The results of the present study show that weak ownership of the forest by the community, period of residence close to the forest, lack of education, poor forest management, fuelwood usage, livelihood activities, rapid population growth, years of residence, distance, and household size are among the leading factors influencing deforestation in the northern area of Pakistan (Table 1). These results are consistent with the Pakistan Forest Deforestation Survey by Mitinje et al., 2007 [71], who argued that household size, schooling, and the size of farmland significantly leads to the depletion of forest resources.

Table 3 shows the socioeconomic characteristics of the respondents. The gender distributions showed that the majority (65.9%) of the respondents were male while 34.1% were female. On family size, the majority of the respondents (66.8%) had a family size of 5–8. On age, 21–25 years (46.0%) recorded the highest. The mean age of the respondents was 24 years. Educationally, 13.8% had a master's education, 11.1% a bachelor's education, 4.3% no formal education, 5.6% a higher education level, meaning master's or PhD students, 56.1% had a primary education, and 9.0% had a secondary education. On occupation, the majority (50.4%) of the respondents were involved in farming as their main occupation. On income, the major income recorded a mean of 25,000 net, while the minor income recorded a mean of 15,500 net [59].

Table 3. Socioeconomic characteristics of the respondents.

Variable	Frequency	Percentage	Mean/Mode
Age 18	34	5.6	
21–25	277	46.0	24 years
26–30	207	34.4	
35	84	14.0	
Total	602	100.0	
Gender			
Male	397	65.9	Male
Female	205	34.1	
Total	602	100.0	
Level of education			
Primary education	338	56.1	Primary education
Secondary	54	9.0	
Bachelor	67	11.1	
MSc	83	13.8	
Higher Edu-Level	34	5.6	
No formal education	26	4.3	
Total	602	100.0	
Household size			
1–4	200	33.2	
5–8	402	66.8	5
Total	602	100.0	
Number of children			
1–3	374	62.1	3
4–5	228	37.9	
Total	602	100.0	

Table 3. *Cont.*

Variable	Frequency	Percentage	Mean/Mode
Job holder			
10.000–20.000	148	24.6	15.500
20.000–30.000	304	50.4	25.000
30.000–40.00	112	18.6	
50.000 and above	38	6.3	
Total	602	100.0	

5.1. Weak Ownership of the Forest by the Community

Weak ownership of the forest by the community had a positive regression coefficient (b) of 0.524 with an odds ratio (Exp b) of 1.689 that was statistically significant at a probability level of 5% ($p = 0.046$) (Table 2). In other words, an increase in one unit of weak ownership of the forest by the community size decreased by a factor of 1.689 of the probability of human activities in the forest, and vice versa. As a result, if a family has a large plot of land to grow on, it can produce more and eventually become self-sufficient in terms of both food security and income. However, in this area, most of the households had a very small piece of land and they just struggled gradually and often looked for work to have a good life, but they could not because there was no economic incentive. Therefore, small land households need the government to provide some economic incentives so they can then care about the forests. Consequently, the pressure on deforestation will be reduced in the forest area of GB.

Figure 4 shows that most of the households own small pieces of forested land. Primary data were collected from the study area using a questionnaire. Thus, the occupants are mainly dependent on the forest wood for their livelihoods because they live on the mountain adjacent to the forest. The private forest covers 29.9% and government forest covers 34.1%. While 36.0% of the households do not have any land and solely depend on the government forest directly and indirectly for their means of survival [72].

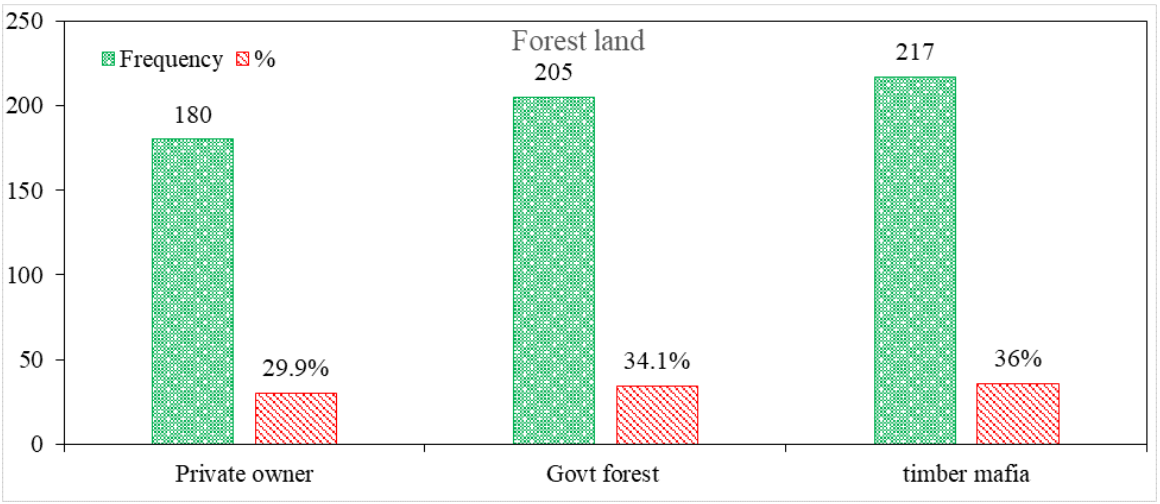


Figure 4. Government and private forest ownership (forest area) and timber mafia in GB forest, Pakistan ($n = 602$).

5.2. Period of Residence Close to the Forest

Residence period in the region had a positive regression coefficient (b) of 0.842 with an odds ratio (Exp b) of 2321 that was statistically significant at a likelihood level of 5 percent ($p = 0.001$) (Table 2). This means that the risk of human disturbances in regard to forest deforestation increased by a factor of 2.321 per unit change in this calculation. In other words, the number of years of family residence in the villages adjacent to the forest

deforestation areas raised the likelihood of the perception of forest disturbance. The more people who live in a given place, the greater the size of their families. Therefore, more forest products are needed from the forest, and more land is needed to meet the increasing population's demands.

In addition, the results indicate that approximately 64.3% of the respondents lived in the rural area side and 35.7% in the urban area side (Table 4). The fact that most of the respondents spent many years in the village means that they were fully aware of the trends in deforestation activities and related problems in their respective villages. People remaining in a particular location for a longer period of time gain experience of the various disturbance-related problems as well as the need to restore the forest from the conditions of deforestation and degradation. The observations made were similar to those recorded by G. Furo, 2022 [73] and G Köhlin [74], which showed that people who lived in a region for longer periods were likely to have more accurate historical data.

Table 4. Distributions of the respondents by the residence period.

Year of Residence	**Numeral**	**%**
5–10 years	33	5.5
11–20 years	86	14.3
21–30 years	151	25.1
Above 30	332	55.1
Total	602	100.0
Close to forest	**Frequency**	**Percentage**
Rural	387	64.3
Urban	215	35.7
Total	602	100.0

5.3. Inadequate Education

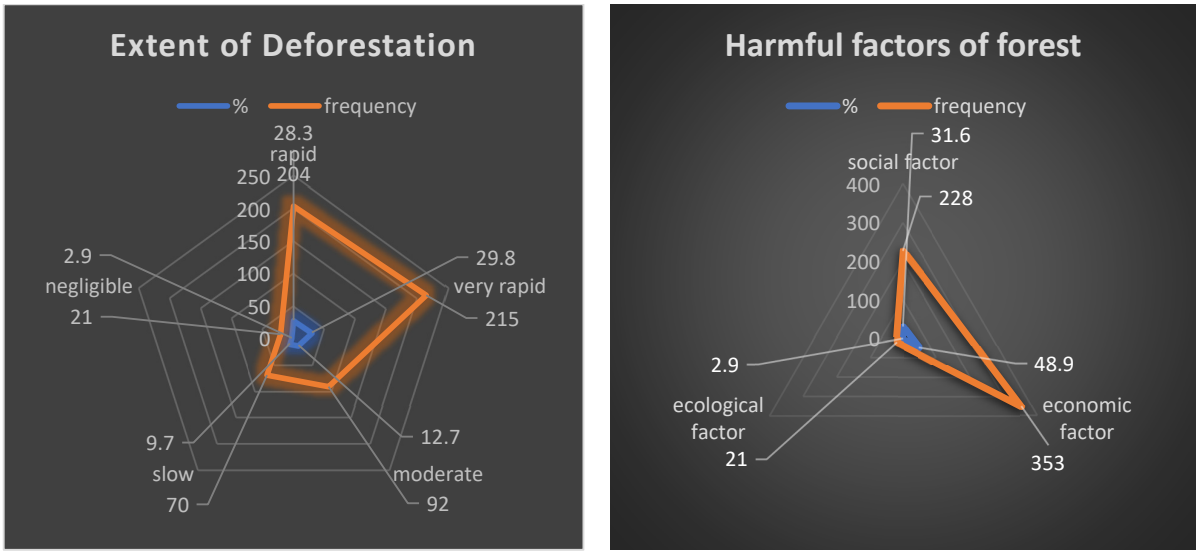
The odds ratio (Exp b) for education was 3.035 with a positive regression coefficient (b) of 1.110. This implies that a statistically significant (p = 0.000) increase in education reduced human disturbances caused by deforestation by a factor of 3.035. To put it another way, farmers who can read and write may cause less forest disturbance than farmers who have not attended school. Education is a critical aspect in developing living strategies since it determines the kind of livelihood activities that a family engages in. In the study field, 56.1 percent of those who responded had at least a primary education. Many of the residents were former agricultural workers who relied primarily on agriculture for their livelihood (Table 2). Education was, therefore, an enabling factor that affected the involvement of the households within the research area in various life-sustaining activities. There had been explicit claims made by Giliba, 2011 [59] in the GB area of Pakistan. He emphasized that the level of education has a considerable impact on the long-term management of natural resources. Nonetheless, while education had no statistically significant influence on the livelihood of human agitation (Table 2), it is critical when it comes to trying to improve living conditions. It has been widely recognized that education is viewed as one of the factors affecting the perception of disturbance by a person. According to Mitinje et al., 2007 [71], education is usually seen as the gateway to better opportunities for information and service creation and accessibility.

5.4. Poorly Managed Forests

Weak forest management had a positive regression coefficient (b) of 0.749 with an odds ratio (Exp b) of 2.115 (Table 2). This means that each unit change in this variable raised the sense of forest disturbance by a factor of 2.115. In other words, forest management

considered to be effective was statistically important (p = 0.010); it was discovered that nearby populations' perceptions of forest disturbances are diminishing.

Figure 5a shows that the key informants expressed concern about grazing, very rapid 29.8%, rapid 28.3%, moderate 12.7%, slow 9.7%, and negligible 2.9%. Figure 5b shows that the harmful factors for the forest include economic factors 48.9%, social factors 31.6%, and ecological factors 2.9%. The main concern of all these factors has led to the growing disturbances in the forest. Proper forest management will help raise concerns about deforestation and the burden of human activities in the forest region [59].



(**a**) (**b**)

Figure 5. The level of deforestation in GB, Pakistan comprises (**a**) extent of deforestation and (**b**) socioeconomic and ecological factors affecting forest.

5.5. Using Wood as Fuel

Furthermore, the results in Table 2 indicated that the use of fuelwood was the main concept behind the use of deforestation fuelwood, which had a positive regression coefficient (b) of 0.641 with an odds ratio (Exp b) of 1.898. That was statistically important at a 5 percent chance (p = 0.024). This implies that an increase in forest boundary awareness indicated that human forest activities had decreased by a factor of 1.898. Most of the rural households used firewood rather than coal and these sources of energy were used for cooking, illumination, heating water, and household heating activities [6]. The growth in energy sources has provided users with certain challenges. Cooking has emerged as the key practice reported by the interviewees in rural GB. The main use of firewood and charcoal was as a source of energy for cooking, since it could either be easily acquired as a free resource or, once acquired, user fees and a high cooking rate are associated [75].

Figure 6 shows that, of all the 602 inhabitants who were interviewed and had data collected by the questioner, 65.9% were males and 34.1% were females. In total, 36.4% of the respondents reported they constantly used wood for their households, 24.9% occasionally used it, 20.6% said not at all, and 18.1% of the local community used forest wood once in a while according to their needs. In this study, we have described the socioeconomic factors promoting deforestation [2].

5.6. Livelihood Activities

Household livelihood activities had a positive regression coefficient (b) of 1.090 with an odds ratio (Exp b) of 2.976, implying that a unit increase in livelihood operation increased the likelihood of forest deforestation by a factor of 2.976, and vice versa (Table 2). Figure 7 depicted the behaviors known as livelihood activities in the study area. Cooking was (41.9%) the most

performed of the livelihood activities performed in the study region, as it is in many rural areas, while ironing (15.3%), heating water (5.1%), lighting (22.7%), warming the house (6.0%), and entertainment (9.0%) were the other livelihood activities that depended entirely on Pakistan's forest resources. According to the findings, subsistence habits in the Gilgit-Baltistan Forests are damaging. The consequences of forest livelihood activities were statistically significant at the 5% likelihood level, according to Table 2 ($p = 0.000$) [76,77].

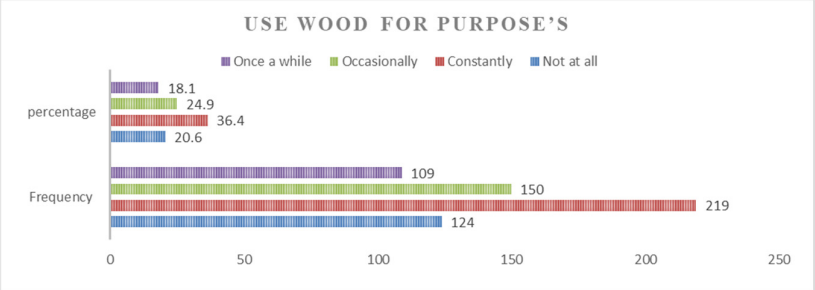


Figure 6. In rural areas, how often people use wood for purposes in GB, Pakistan.

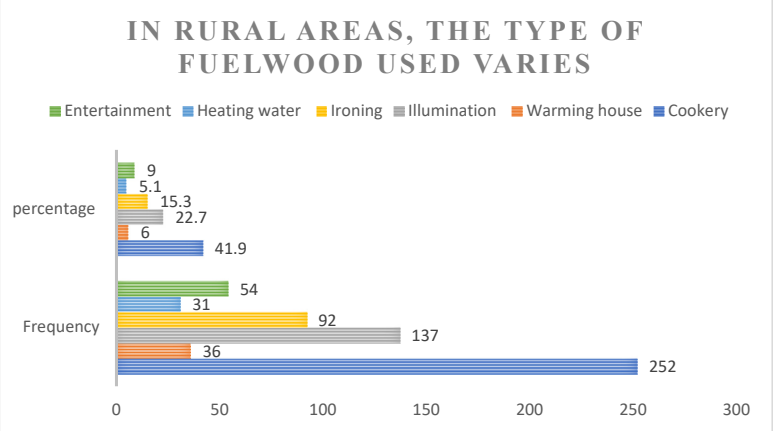


Figure 7. In rural areas, the type of fuelwood used varies in GB, Pakistan.

Figure 7 shows that most rely on fuelwood for cooking, entertainment, water heating, home warming, illumination, and ironing. The significant variables which explained the use of firewood were the employment status, income, and use of liquefied petroleum gas (LPG) by the respondents. All of these factors affected firewood use negatively. Therefore, as income rises, the probability of using firewood in rural households decreases. However, some households report that the cost of purchasing gas was prohibitively expensive due to the distance to the filling station and the price of the gas. Most households in the GB communities do not have access to cleaner energy, such as LPG. As noted earlier, household heads who work are less likely to use firewood as they are likely to make more money than their counterparts who are unemployed [78] and thus can afford alternative energy sources, and this result collaborates with that finding [79]. A higher average household income is likely to reduce firewood usage because it may be regarded as an inferior type of good and from the economic theory, demand for such goods falls as income rises. This also confirms the earlier findings of [80] in their Nigerian study, and [81] who suggested the fact that if a household uses LPG, it is likely to reduce firewood usage, which may be due to its convenient nature [2,75].

5.7. Rapid Population Growth

Pakistan's RPG had a positive regression coefficient (b) of 0.687 with an odds ratio (Exp b) of 1.988, which was statistically significant at a likelihood level of 5% ($p = 0.011$)

(Table 2). Put in other words, there was a 2.03 percent annual population growth in Pakistan [82]. These analyses allow us to estimate the magnitude of the population–deforestation relationship, and to identify the factors that are responsible for the correlation between them [83]. The ratio of humans to forest size shows that, with the degree of human pressure on the forests as the rural population grows rapidly, direct forest dependence will decrease and forests could be preserved for ecological functions, such as soil conservation, carbon sequestration, and recreational uses. The population of the Asia-Pacific region is growing and will continue to grow. In the last 25 years, the population had increased by 1718 million, from 2446 million in 1980 to 3604 million in 2005. A figure of 560 million people was expected to increase the population to 4164 million by 2020. The increase is not only large in absolute numbers but is also unevenly distributed across sub-regions and groups. By 2020, South Asia will have the highest population (East Asia had the highest population in 2005). This increase is very notable because the populations in India, Pakistan, and Bangladesh have been having strong annual growth levels. For developed countries, the bulk of the population growth will be in developing countries. The population of developing countries will grow from 3389.8 million in 2005 to 3946.1 million in 2020, while the population of small island countries will increase to 2.9 million by sometime in 2020 from 2.4 million in 2005 [84]. As a result, deforestation activities cannot be entirely eradicated due to a constant rise in the human population; however, the appropriate implementation of forest policies in terms of effective forest management will lower this to the minimum [85].

5.8. Distance

Distance from the home to the forest had a negative regression coefficient (b) of 0.102 with an odds ratio of 1.108 (Exp b). This implies that a rise in distance between the household and the forest would minimize the risk of disturbance by a factor of 1.108, and vice versa (Table 2). The factor was statistically important at a 5 percent (p = 0.438) likelihood level. The distance between Gilgit-Baltistan's homestead and the forest reserve was between 0.3 and 3 km with an average of 1.7 km [86]. It was recorded that a rise in the distance between the homestead and the forest limited the contribution of the woodland to the local communities' livelihoods. Likewise, [87] recorded the spatial effects of the use of forest resources in Pakistan and showed that increasing the distance from the homestead to the forest increased the cost of collecting resources, and vice versa [88]. One Pakistan study also argued that increasing the scarcity of forest resources led to an increase in the distance from forest food resources.

5.9. Household Size

The size of the household determines the selection and use of forest products per capita, and thus affects human disorder. Household size had a positive regression coefficient (b) of 0.104 and odds ratio (Exp b) of 1.110 (Table 2). It means that a rise in the size of the household, which was statistically negligible at a likelihood of 5 percent (p = 0.161), raised by a factor of 1.110 awareness of human disturbances in the reserve. This suggests that the household size in the study region would encourage the contribution of forests to local communities' livelihoods. In other words, considering that the majority of the household members in the study region were in the working class (30–35 years old), the larger the size of the household, the greater the chances of the members being involved in different livelihood strategies depending on the forest resources. However, the effect of the household size on the forest contribution odds was not statistically significant (Table 2), but the variable is very important from the standard of living context. The average household size was five. A larger household would likely overexploit the reserve's resources to meet subsistence needs. Those consequences were verified by Nduwamungu, 2001 [89] and Madulu, 1996 [90]. They reported clear relationships between the household size and degradation of the environment.

Table 5 shows the economic opportunities that can be used in the study area to reduce deforestation. Subsidies for forest products, an improved tax system on exploited forest items, the acquisition of well-monitored hunting licenses, alternative work prospects, credit, and a restricted prohibition on round log exports are among the listed economic incentives. Economic incentives, if properly monitored and implemented, can be an effective tool for reducing deforestation because they are likely to be the most effective measures for converting the overexploitation of biological resources to sustainable use. Thus, while deforestation cannot be completely eliminated due to the daily increase in human population, the adequate implementation of forest policy in terms of effective forest policing can reduce it to the bare minimum [9,29,85].

Table 5. Mean estimation: n = 602 economic incentives used for reducing deforestation in the districts of Gilgit-Baltistan, Pakistan.

Variables	SD	MEAN	[95%Conf.Interval]	Inference
Improved taxation system on exploited logs from the forest will reduce deforestation.	0.0224376	1.878738	1.834672, 1.922803	Strongly agree
Provision of subsidies for forest crops will reduce deforestation.	0.0212254	1.858804	1.817119, 1.900489	Strongly agree
Well-monitored license permits before the exploitation of trees will reduce deforestation.	0.0190396	1.910299	1.872907, 1.947691	Strongly agree
Alternative employment opportunities will reduce deforestation.	0.0200453	1.828904	1.789536, 1.868271	Strongly agree
Provision of credit such as loan facilities for forest entrepreneurs will reduce deforestation.	0.0194093	1.946844	1.908725, 1.984962	Strongly agree
Selective ban on exportation of round logs will reduce deforestation.	0.0229173	1.900332	1.855324, 1.94534	Strongly agree
Multiple use of forest land will reduce deforestation.	0.0236501	1.770764	1.724317, 1.817211	Strongly agree
A reduced levy on imported forestry machinery will reduce deforestation.	0.0316149	1.538206	1.476117, 1.600295	Undecided
Tax exemption for forest entrepreneurs will reduce deforestation.	0.0356566	1.717608	1.647581, 1.787635	Disagreed

Figure 8 shows the economic incentives given to the local population in order to reduce deforestation activities in the study area, GB, in Pakistan. The economic incentives evaluated by the locals in the study area included community-based economic incentives from the government and their nature, and local and international NGO community-based economic incentives and their nature. The data showed only 32.1% of the population was given economic benefits from local government and 9.8% from local and international NGOs.

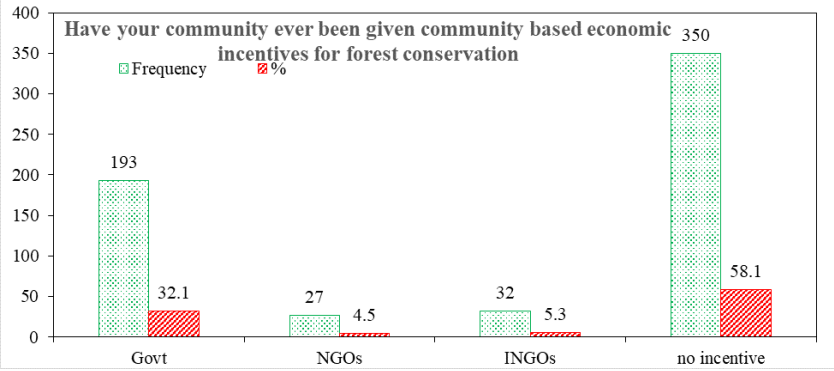


Figure 8. Economic incentives given to the local community for forest deforestation in GB, Pakistan.

6. Conclusions

Deforestation is currently a dominant issue in Pakistan and around the world. In this paper, we looked at some of the elements that are closely associated with deforestation, using certain relevant parameters and a logistic regression model. This analysis, as expected, indicates that regional deforestation is influenced by local altitude, geographical changes in forest cover, and accessibility in the area. The research demonstrates the impact of socioeconomic factors on deforestation. Economic incentives could be used as a source for deforestation reduction in the northern area of Pakistan. Weak ownership of the forest by the community, residence close to the forest, forest management being poor due to a lack of education, usage of fuelwood, livelihood activities, population growth, duration of residence, distance, and household size were found to be the factors influencing deforestation in the northern area of Pakistan. The dependency of local communities on the forest was higher in number and socioeconomic factors were the ones which affect the forest's quality. Instead of having a thorough understanding of the consequences of the degradation of forest resources, these factors are deeply ingrained in the communities' daily demands for forest products in order to accommodate a growing population. When combined with our regular activities at work, domestically, industrially, and even in agriculture, human activities endanger the climate's stability and ecological balance. In accordance with the above logic, the authorities of Gilgit-Baltistan are the primary perpetrators of deforestation since they have failed to provide for the citizens via the abundant natural resources that God has bestowed. Economic incentives, if adequately controlled and enforced, can be an important tool for reducing deforestation, since they are likely to be the most effective steps to turn overexploitation into the sustainable use of biological resources. Finally, because the fundamental proximal and underlying deforestation reasons were identified at a local level, the current study contributed to the development of mitigation methods for deforestation and forest degradation. Decision-makers might designate governmental goals using the proposed methodology, which would then allow the tracking of and reduction in specific activities that cause changes in forest cover over time. The results can be used as a basis for future scenario analysis, where current explanatory factors can be combined with other explanatory drivers to adapt to changes in the biophysical or socioeconomic environment in the GB, Pakistan context, to enable more precise and realistic modelling of deforestation risk.

7. Recommendations

There should be prosecution of corrupt government officials in charge of the forestry laws and policies along with illegal loggers. Population growth must be reduced in order to reduce deforestation in developing countries. As a result of reduced population, per capita income will rise as a result of higher incomes and literacy rates, reducing pressure on remaining forests for new human settlement and land use change. Increasing the area of forest plantations by using fallow or unused lands and marginal lands, especially along the roadsides, along railway tracts, on contours, avenues, boundaries, and on land not suited for agricultural production should have a net positive impact. Planting trees outside of forest areas relieves forest pressures for timber, fodder, and fuelwood. Furthermore, deforested areas must be reforested. Investment in research, education, and extension is immensely needed. Stakeholders' education and training helps people understand how to prevent and reduce the negative environmental effects of deforestation and forestry activities, and to take appropriate action when possible. The aforesaid is supported by research, which aids in understanding the problem, its causes, and possible solutions. This arena lags behind due to a lack of funds and investments, which encourages this arena. The general public lacks knowledge and information about forests and forestry. Forest managers and policy makers must be well educated and understand the complexities of the interacting ecological, economic, social, cultural, and political factors.

The government should put more effort into eradicating poverty, and educated jobless kids should be given job opportunities. A skills training system for rural women and

the illiterate young should be organized to slow the rate of deforestation. In conclusion, therefore, it is necessary to recognize and introduce successful ways for addressing the daily needs of the communities. Alternative energy sources, sustainable farming methods, diversifying revenue sources, and promoting rural development for young people and disadvantaged community members must all be prioritized. Forestry education and extension should be focused toward institutional strengthening at the local level in order to empower people to participate actively in decision-making processes aimed at protecting the forest and improving rural communities' livelihoods.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15075894/s1, Questionnaire.

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