Deforestation in Pakistan: efficiency of forestry policies and measures for sustainable forest management.

Metsa raadamine Pakistanis: metsapoliitka tõhusus ja meetmed jätkusuutlikumaks majandamiseks.

MASTER THESIS

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Tallinn 2021

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THESIS TASK

Student: Muhammad Bilal (194395EABM)

Study programme, Master's Degree

Main speciality: Environmental Engineering & Management

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Thesis topic:

(In English) Deforestation in Pakistan: efficiency of forestry policies and measures for sustainable forest management.

(In Estonian) Metsa raadamine Pakistanis: metsapoliitka tõhusus ja meetmed jätkusuutlikumaks majandamiseks.

Thesis main objectives:

1. Compiling data and literature review on forestry activities and its environmental impacts in Pakistan.

2. Assessing the efficiency of forestry activities and policies in region through public opinion.

4. Based on survey results proposing policy recommendations for sustainable forest management in Pakistan.

Thesis tasks and time schedule:

No	Task description	Deadline
1.	Literature review of deforestation practices in Pakistan	02.2021
2.	Developing of survey questionnaire	03.2021
3.	Analysis of survey results	05.2021

Language: ………… **Deadline for submission of thesis:**"……."………20….a

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1. INTRODUCTION

Forests are critical to the livelihoods of billions of people all over the world[1], supplying wood fuel as a source of energy for regular cooking and heating, Providing a variety of wildlife environments, as well as preserving biodiversity[2]. and ensuring that ecosystem services perform their full range of functions. Unfortunately, significant forest loss has occurred from depletion and clearing of forest resources to meet the basic needs of a rising population and stimulate economic growth, Especially the tropics, where more than two-thirds of the world's biodiversity is present. [3].

Forest clearance and destruction result in major habitat loss, Furthermore it is responsible for producing 10% and 25% of carbon dioxide emissions worldwide[4]. The world lost approximately 26 million hectares (ha) of forest every year between 2014 and 2018, with the tropics accounting for nearly all of it[5]. At whatever scale, it is imperative that we take bold steps to prevent or even reverse the trend of forest cover loss to prevent the future damages. Carbon storage, oxygen production, soil protection, and water cycle control are just some of the benefits trees provide to our planet, they sustain natural and human food systems and provide habitats for countless species, including humans[6]. Trees and forests are our best air cleaners, and due to their critical position in the terrestrial environment, it is harder to envision many species, including ours, surviving on Earth without them.

Pakistan is a developing country with a forest-covered area of 4.3478 million ha, which is 5.1% of the territory[7]. Of that 3.44 million hectares is governed by the Forest department management, while privately own area is 0.781 million hectares[7]. The forest area is gradually decreasing in the various region of Pakistan[7]. The annual rate of reduction of 270 km^2 is observed for the total covered area, there are estimations that the rate of deforestation is up to 1.5% of the forest land annually which is a big sign of worry and quite an alarming situation[7]. Furthermore, The Estimation of the international union for conservation of nature (IUCN) is that if the population of Pakistan continues to grow at the current pace with ever-increasing wood demand with no alternate sources of wood, there would be a 3% increase in the demand for wood every year[7].

Different approaches for determining the causes of deforestation and forest degradation D & D on a global scale have been employed up till now. To assess the drivers of deforestation, Curtis et al. [8] utilized satellite images and a forest loss categorization framework. The key factor was forest clearing for commodity production (27 percent), followed by logging activities (i.e., forestry, 26 percent), shifting agriculture (24 percent), and wildfire (23 percent). A research conducted by Skutsch and Turnhout [9]

demonstrated that Local agents were responsible for more than 70% of the driver of D & D in 12 tropical nations. This demonstrated that, before implementing any policy measures for effective implementation, direct interviews and field observations are necessary to classify the drivers and their agents at the local level. Therefore, through an overview of local perceptions in Pakistan, this study aims to classify the drivers of deforestation and forest destruction, the agents of these drivers, and the necessary activities for reducing these drivers, efficiency of the current forest management system, and monitoring approach of ongoing reforestation project in Pakistan i.e., Billion tree Tsunami project. In general, the scope of the study includes: 1) Compiling data and literature review on forestry activities and its environmental impacts in Pakistan, 2) Assessing the efficiency of forestry policies in region, 3) Proposing policy recommendations for more sustainable forest management in Pakistan.

2. LITERATURE REVIEW

2.1. Area of Study

Pakistan's Islamic Republic lies between 24° and 37° North latitudes and 61° and 76° East longitudes[10]. Pakistan is bordered on the east by India, with whom it shares a 2,192 km boundary, and on the west by Iran and Afghanistan, with whom it shares 909 km and 2,430 km of shared border, respectively. It extends north to the great Karakoram and Hindukush Mountain ranges, with peaks as high as the K2 (8,611 meters) and the Nanga Parbat (8,126 meters). It borders the Arabian Sea in the south, with a coastline of 1,046 km. In the north, it shares a 523 kilometers boundary with China as shown in Figure 1[11].

The total area of Pakistan is 88.430 million hectares, while the total population is more than 207 774 million. Baluchistan, Khyber Pakhtunkhwa (KP), Punjab, Gilgit, and Sindh are the five provinces that constitute Pakistan. The Federally Administered Tribal Area (FATA), and Islamabad Capital Territory (ICT) are the special areas of Pakistan[10]. In general, the terrain of Pakistan is mountainous, also the elevation from the sea can go up to 8611 meters in different places. Almost 65% of land consists of mountain ranges. In Pakistan, 49 percent of the country is arid, receiving less than 250 millimetres of rain per year, while 35 percent is semi-arid, receiving 250-500 millimetres per year. [10] However, the remaining 16 percent is known as the sub-humid zone mostly situated in the northern mountainous area and contain forest in great numbers[10]. The below figure 1 shows geographical information in the region and province-wise distribution of Pakistan. However, figure 2 shows the forest cover map of Pakistan[7].

Figure 1 Geographical map of Pakistan[12].
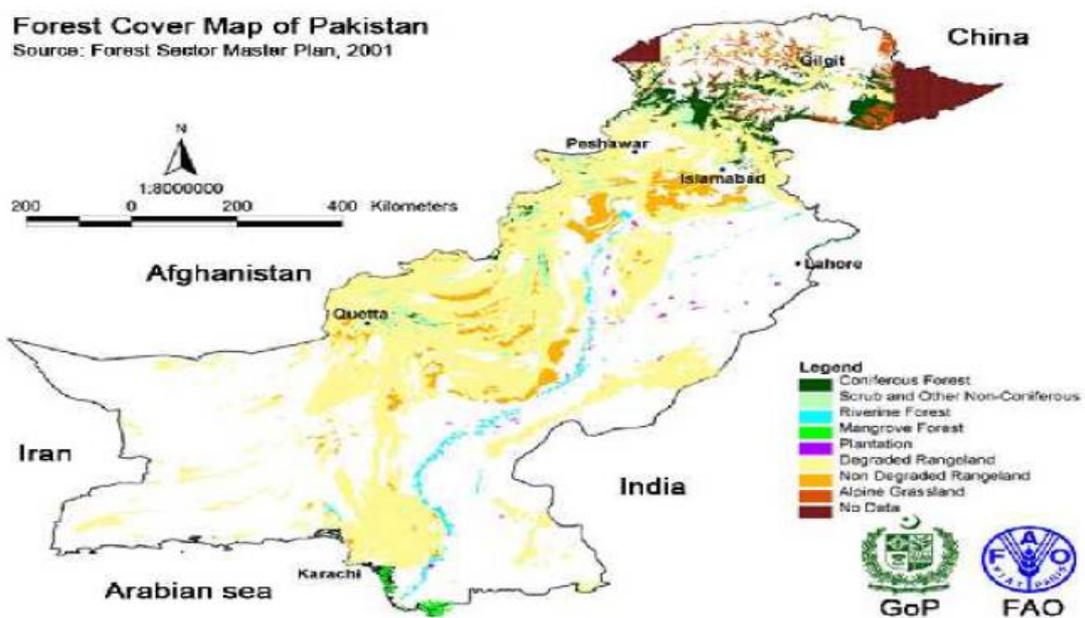
Figure 2 Forest Cover Map of Pakistan[12].

2.2. Deforestation

Deforestation is the destruction of forests, which results in land degradation and contributes to the release of greenhouse gases that harm the climate, will lead to a loss of biodiversity, disruption of water cycles, increased soil erosion, floods and slides, and human-animal conflicts[13]. According to FAO (Food and Agriculture Organization of United States), Although the rate of deforestation has decreased during the last three decades, Since 1990, it has been projected that 420 million hectares of forest have been destroyed due to conversion to other land uses.[14]. Deforestation was observed as 10 million hectares per year between 2015 and 2020, down from 16 million hectares per year in the 1990s. The world's primary forest has reduced by almost 80 million hectares since 1990. [14].

According to data released by Global Forest Watch, Pakistan lost 9.68 Kha of tree cover between 2001 and 2020, which is equal to 0.99 percent of tree cover lost between 2000 and 2020. Tree cover loss is shown in Figure 3[15].
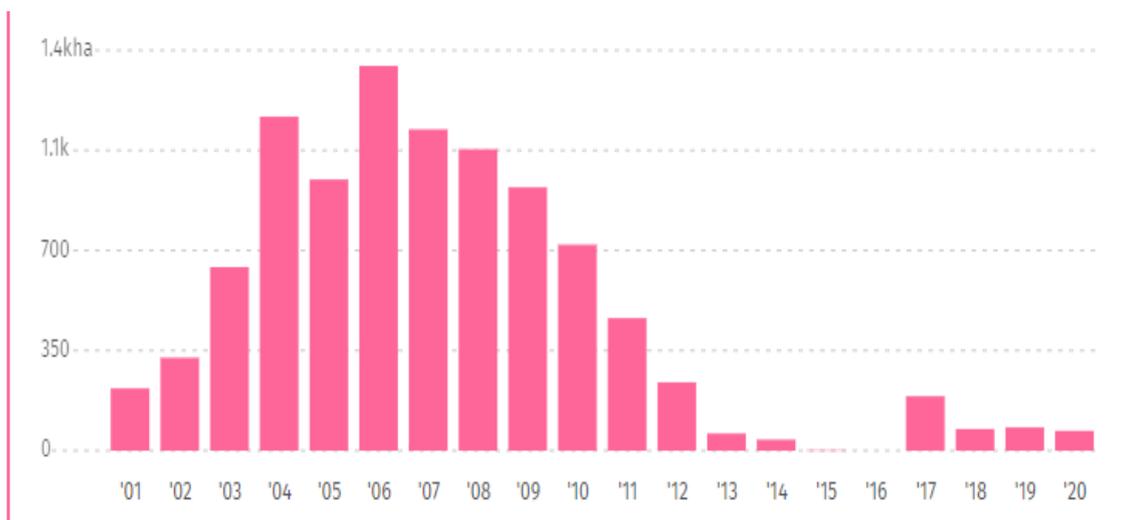
Figure 3 Pakistan tree cover loss from the year 2000 to 2020[15].

Figure 3 shows that the forest area has been steadily decreasing. In 2006, 1.35 hectares of tree cover were lost. Compared to past years, there has been a significant reduction in tree cover. However, as shown in figure 3, there is a decreasing trend in tree cover loss from 2007 to 2015. While, in 2015 and 2016, there has been a slowdown in tree cover loss. Moreover, there has been no notable rise or decrease in forest cover loss between 2018 and 2020.

2.3. Causes of Deforestation

To determine the drivers of deforestation and forest degradation, many methodologies were utilized until recently. Curtis et al [16] utilized satellite photos and a forest loss categorization technique, to understand the causes of D & D on a global scale. They identified that logging activities were the leading cause (27 percent), followed by removing forests for commodity production (i.e., forestry, 26 percent), altering agricultural practices (11 percent), and wildfire (23 percent). Jayathilake et al. [17] identified some of the primary drivers of D & D in the investigated regions by collecting data from landscape managers who oversee 28 tropical landscapes in the tropics via a questionnaire survey Commercial and subsistence agriculture, followed by settlement expansion and infrastructure development, were the main drivers of deforestation, according to their findings. In these iconic conservation settings, land was specifically cleared for rice, rubber, cassava, and maize agriculture. By conducting and evaluating data from scientific publications, national and international publications, and other sources, Urban growth, infrastructure, mining, agriculture for local sustenance, and agriculture for commercial purposes were recognized as the five main drivers of deforestation on all tropical continents by Green et al. [18]. Furthermore, Forest livestock grazing, uncontrolled fires, fuelwood charcoal, and timber logging were also highlighted as four other drivers of forest degradation.

Although previous research into the causes of tropical deforestation has provided useful insights, it has failed to focus on the variables that are genuinely thought to be critical for the survival of local people, especially those whose livelihoods have long relied on forest ecosystem services for subsistence. Van Khuc et al. [15] in Vietnam indicated that before initiating any interventions to reduce D & D, it is necessary to identify the factors at the local level. Because the drivers involve so many agents, any policy interventions that do not target the individual agents of the drivers are guaranteed to fail [19]. The causes are explained in the following chapter.

Skutsch and Turnhout [19] also investigated the drivers of D & D in 12 tropical countries and discovered that indigenous agents were responsible for more than 70% of D & D[9].

2.3.1. Commercial Agriculture

Agricultural expansion (especially commercial agriculture) is the single most important cause of tropical deforestation[20]. Forests are considered to have covered around 40% of the world's geographical area, or around 6000 million ha before agriculture began roughly 8000 years ago. The expansion of agriculture around the globe rise until AD 1500

led to the clearing of many forests, particularly those on the most accessible and fertile ground[21]. Small-scale farming and changing cultivation have long been responsible for deforestation in the tropics, but this is no longer the case. Many studies have shown that commercial agriculture and other factors, not only the small farmers or moving growers, are the primary causes of deforestation in the tropics, in which the mass of deforestation occurring[22], [23].

Regarding Pakistan, a study conducted by Manan and others [24] in Pakistan, conducted a case study and examined the use of land-use/land-cover changes in monitoring and projecting forest biomass carbon loss. During the study period, forest land decreased from 40936.77 ha to 36709.23 ha, agricultural land increased from 4220.46 to 10374.64 ha, and built-up area increased from 1497.60 to 5395.12 ha. The average annual biomass and carbon losses were 50.34 Gg ha-^{1}yr^{-1} and 31.33 ha-^{1}yr^{-1}, respectively. Furthermore, the study also illustrated Temporal statistics of LULCC (Land-use and land cover change) and it can be observed from table 1 that land-use area for agriculture is expanding and forest land area is shrinking. Furthermore, future predictions show the same trend. However, Table 2 presents the percent change of land use classes. The table (1 & 2) below illustrates the results in detail.

Table 1. Temporal statistics of LULCC (Land-use and land cover change)[24].

Land use	1998 (ha)	2008 (ha)	2018 (ha)	2018 projected (ha)	2028 projected (ha)
Forest Land	40,936.77	40,545.63	39,231.90	40549.30	36709.23
Barren Mountains	14,407.29	12,758.76	10,819.17	12730.21	9456.56
Agricultural Land	4220.46	4705.65	7908.21	4700.33	10374.64
Built-up Area	1497.60	3400.05	3966.39	3906.23	5395.12
Water Body	1112.76	764.04	249.48	255.23	252.12

Table 2. % Change of Land use Classes[24].

	1998−2008		2008−2018		2018−2028		Average Annual Change (%)(1998−2008)
	(%)Change per decade	(%)Annual Change	(%)Change per decade	(%)Annual Change	(%) Change per decade	(%)Annual Change	
Forest Land	−0.95	−0.09	−3.24	−0.32	−6.43	−0.64	−0.35
Barren Mountains	−11.44	−1.14	−15.20	−1.52	−12.59	−1.25	−1.30
Agricultural Land	11.49	1.14	68.05	6.80	31.18	3.11	3.69
Built up Area	127.03	1.27	16.65	1.66	36.01	3.60	2.17
Water Body	−31.30	−3.13	−67.34	−6.73	1.01	0.10	−3.25

2.3.2.   Cattle Ranching

The use of cattle to provide food for people is fundamentally big-scale, implying that a huge quantity of land is required to produce a small amount of food[25]. As a result, pasture accounts for almost 70% of all agricultural land worldwide (3.4 billion hectares

out of 4.9 billion)[26]. However, Humans, on the other hand, consume just around 33% of their protein and 17% of their calories from animals[27]. In southern Brazil, where cattle pasture had historically required minimal fresh forest clearing as it extended into savannas, temperate grasslands, or long-deforested areas, the forest was in the way in the Amazon. As a result, the northward expansion resulted in widespread deforestation[25]. Furthermore, data from 2010-2014 is presented in below figure, it can be observed that cattle ranching accounts for highest percent (40.7%).
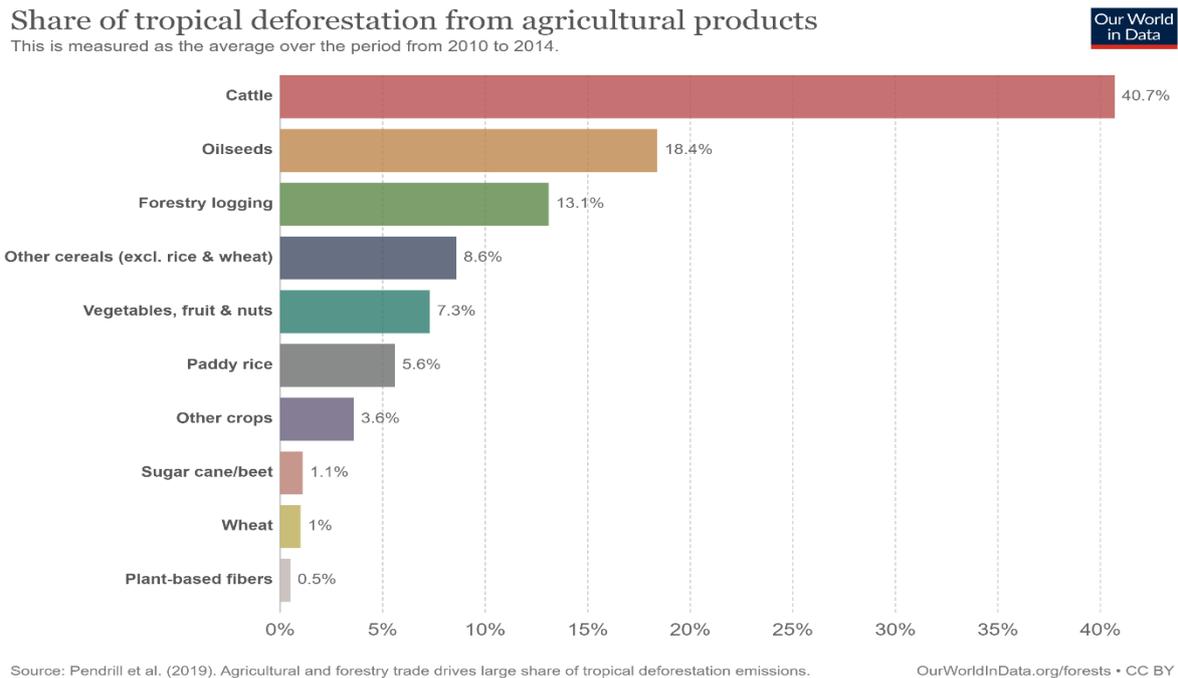
Figure 4 Share of tropical deforestation from agricultural products[28].

Northern Pakistan's grasslands and rangelands are more productive than those in the country's central and western regions. Rangeland production has suffered because of mismanagement and centuries of overgrazing. As a result, the rangelands are not producing to their full capacity[10].

A survey of 120 persons was done figure 5 to find out how the indigenous people in Dir Kohistan (Northern Area of Province Khyber Pakhtunkhwa) use the woodlands. Fuelwood, animal grazing, and infrastructure are the three main primary drivers of deforestation recognized. These woodlands are utilized for fuelwood by 120 of the 120 respondents (100 percent). It is used by 84 respondents (70%) for livestock grazing, 40 respondents (33%) for infrastructure, and 64 respondents (53%) for black marketing[29].
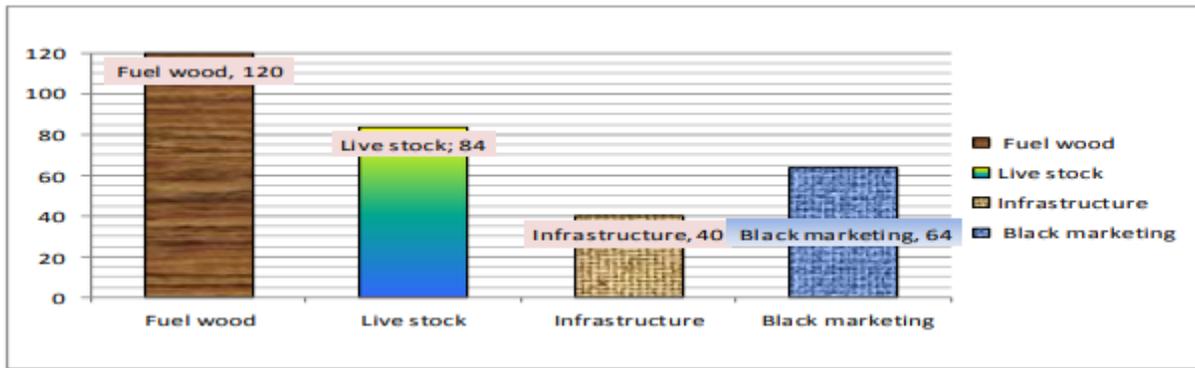
Figure 5 Direct causes of deforestation in Dir Kohistan (Province Khyber-Pakhtunkhwa)[29].

Pakistan's cattle population is projected to be 176.659 million (Economic Survey of Pakistan and Livestock sector, 2013). Table 3 shows estimated livestock figures for 2004-05 and 2013-14. As a result, the livestock population has grown at 2.6 percent annually[10].

Table 3. Pakistan estimated livestock figures (Million) for 2004-05 and 2013-14[10].

PERIOD	CATTLE	BUFFALOES	SHEEP	GOATS	CAMELS	ASSES	HORSES	MULES	TOTAL
2004-05	24.218	26.295	24.923	56.665	0.736	4.199	0.313	0.251	137.600
2012-13	39.743	34.702	29.096	66.615	1.021	4.942	0.361	0.179	176.659

2.3.3.   Firewood Collection

Wood has been the principal fuel for a fire since it was first discovered. Although most of the developed world today uses fossil fuels such as coal and petroleum for cooking and heating, wood fuels are still a key source of energy for people in poor countries[25]. Here, wood fuels account for between 50 and 90 percent of the fuel used[30]. Every year, around 1.4 billion cubic meters of firewood are consumed in the tropics, and around 40 million metric tons of charcoal are created[25]. The energy usage of the CFUG understudy is comparable to that of other emerging countries. Biomass (fuelwood) is used by the majority of homes for energy. However, energy dependence varies with time and with socioeconomic situations, with high-income households dependent on alternative energy sources such as LPG and the poor continuing to rely on wood fuel[31]. The household survey 2016-2018 revealed that low-income households have more wood fuel

consumption and emit nearly two-fold CO2 compared to affluent ones (Figure 6). Furthermore, future predictions for firewood consumption in developing countries are illustrated in the below figure. The provided data shows that in developing countries firewood collection for fuel is more.

Economic Class	Fuelwood Use (kg per Year)	CO_2 (Tons per Year)
Low income	2392.0	4.12
Medium	1526.5	2.63
Affluent	1248.0	2.15

Figure 6 Firewood consumption based on economic class[31].
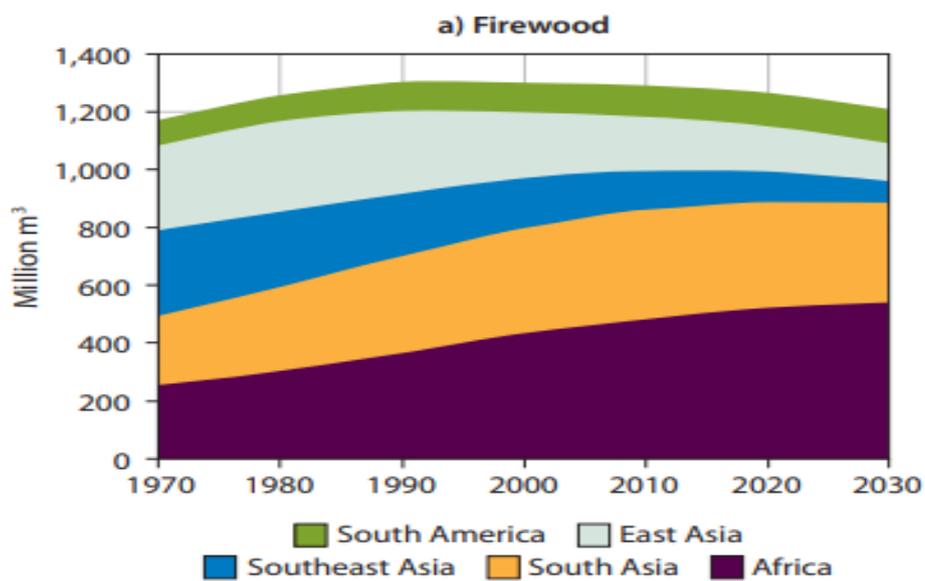
Figure 7 Future projection of firewood consumption in developing countries[25].

In the Regional Wood Development Programme (RWEDP), wood energy accounts for roughly 30% of total energy consumption in Asian member countries, including Pakistan. Even though wood's share of national energy consumption is declining in these countries, its consumption is still rising in absolute terms (Figure 7). Nearly every single country in South and Southeast Asia is a major user and producer of wood fuel. The FAO (2009a) estimated that 72 percent of all wood used in Pakistan is consumed as fuelwood[32].
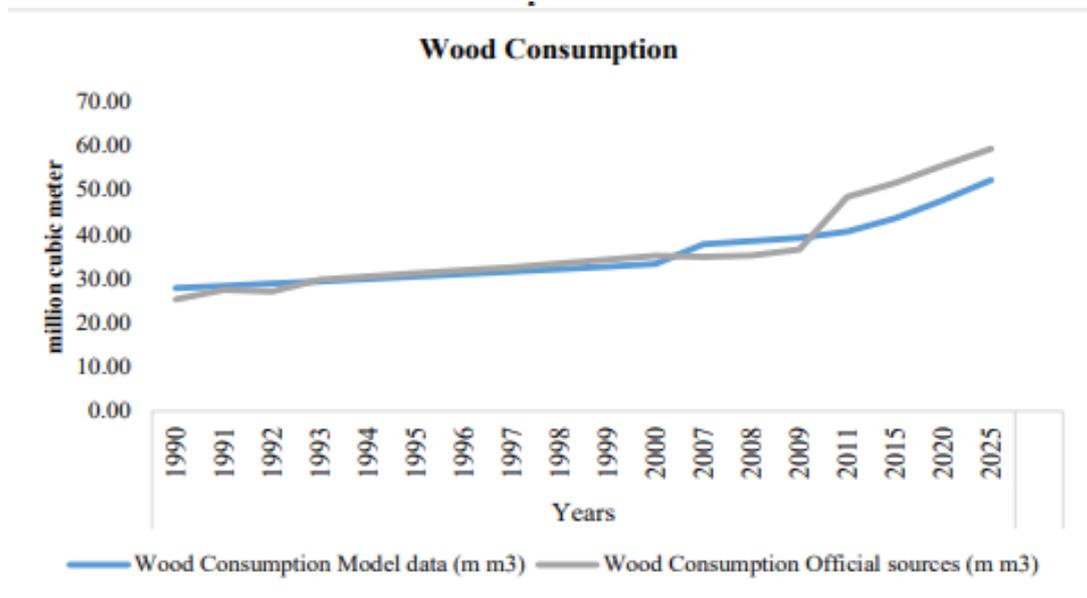
Figure 8 historic trends and projections for wood consumption in Pakistan[32].

2.3.4. Illegal wood logging

Illegal logging refers to the practice of collecting timber in contravention of local laws and regulations. Illegal logging is a global concern with significant economic, environmental, and repercussions[33]. According to U.S. Agency for International Development (USAID), The unregulated wood business, which is worth an estimated $51–$152 billion each year, endangers the world's forests while also depriving local communities who rely on forests for food, health, and wealth. Corruption tied to illegal logging weakens the rule of law and perpetuates the global criminal cycle[34]. According to the United Nations Environment Programme and the international law enforcement agency Interpol, illegally processed timber accounts for 15-30% of all timber traded globally. Southeast Asia has some of the world's highest deforestation rates. Forest degradation is also exacerbated by unsustainable demand for high-value hardwoods[35].

In countries like Pakistan, loggers cut down countless trees each year, some of them illegally. They create roads to access more and more isolated forests to gain more economic benefits, causing increased destruction[7]. However, all logging, whether illicit or legal, results in deforestation[7]. Illegal loggers have been chopping down trees in Gilgit-Baltistan, Pakistan, for decades with little ramifications[36].

On a global basis, $1.81 trillion is used in the underground market sector, including $7 billion for illicit logging. Pakistan contributes $6.53 billion to the underground market sector, with $782 million going to illegal forestry. These figures are from annual estimates of illegal wood harvesting Nazir et[32].

2.3.5. Forest Fires

Despite the fact that wildfires is a natural phenomenon in some forest ecosystems, Even in tropical rain forests, where wildfires are unusual and exceptionally devastating, fire seasons are becoming more intense and broad. More frequent, larger, and more intense wildfires are becoming more common as a result of climate change-induced hotter, drier weather combined with inadequate land management[37]. Forest fires are projected to play a critical part in the loss of forest biomass as extreme drought events become more common in the future[38].

The peak fire season in Pakistan usually starts in mid-January and lasts for around 18 weeks. Between the 25th of May 2020 and the 17th of May 2021, there were 1,129 VIIRS (Visible Infrared Imaging Radiometer Suite) fire alarms reported, based solely on high confidence alerts. When compared to past years, dating back to 2012, this is normal[15]. The below figure presented by Global Forest watch presents the graphical illustration.
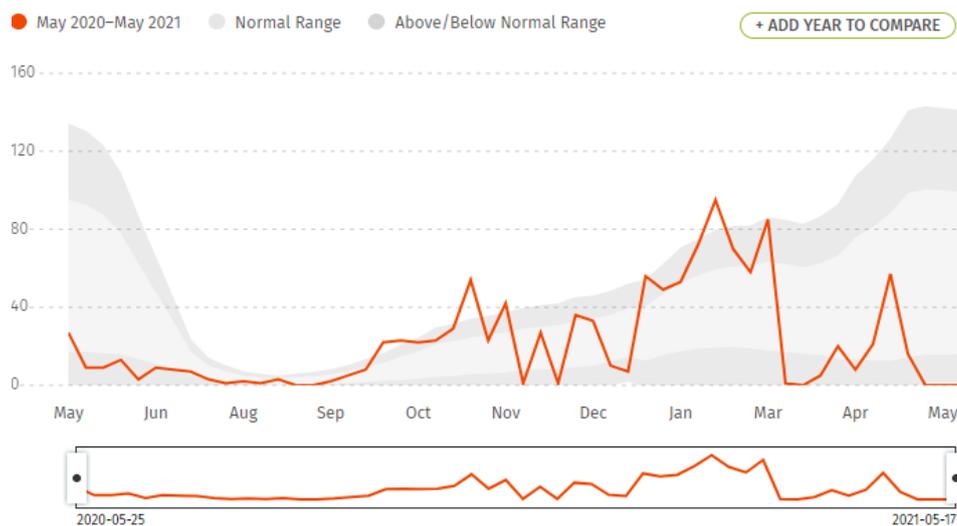
Figure 9 Forest fires in Pakistan from May 2020- May 2021[15].

2.3.6. Infrastructure building

In the tropical region, urbanization has been identified as one of the primary sources of deforestation and land degradation[39]. Urbanization and population growth increase the demand for new infrastructure. In addition, Infrastructure development is considered to have both beneficial and bad consequences in terms of deforestation[40]. Fewer lands may need to be deforested as countries modernize and develop their infrastructure, as demand for infrastructure may be met without the development of additional roads, railroads, and other infrastructure[40]. However, developing countries may be forced to extend rather than modernize their existing infrastructure. Deforestation is expected to be harmed as a result of such an expansion[40].

China, India, Indonesia, Pakistan, and Bangladesh are among Asia's most populous countries. The urban areas of the world are home to half of the world's inhabitants. According to the UN, 64 percent of people in developing nations will be urbanized by 2050[41]. However, Shah and others conducted a case study regarding four decadal urban land degradation in Pakistan. In the study, Landsat satellite imageries were used to classify the LULC change in class transition. The below figures (10 & 11) show that build up land in the capital territory(Islamabad) increased in the last two decades[42].
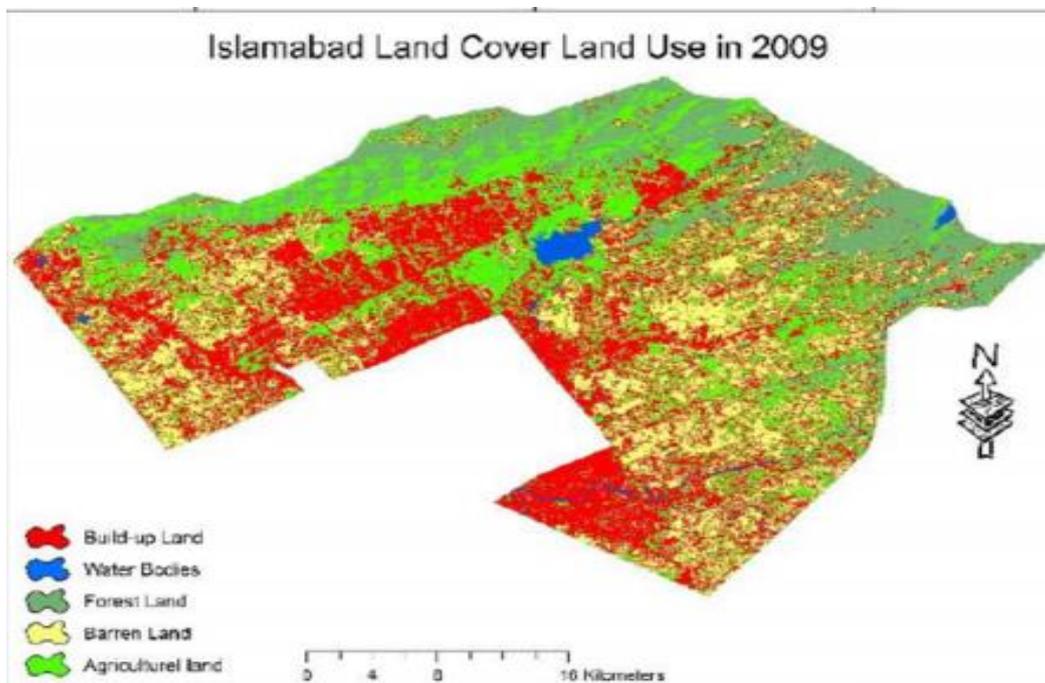
Figure 10 Islamabad Land Cover Land Use in 2009[42]*.*
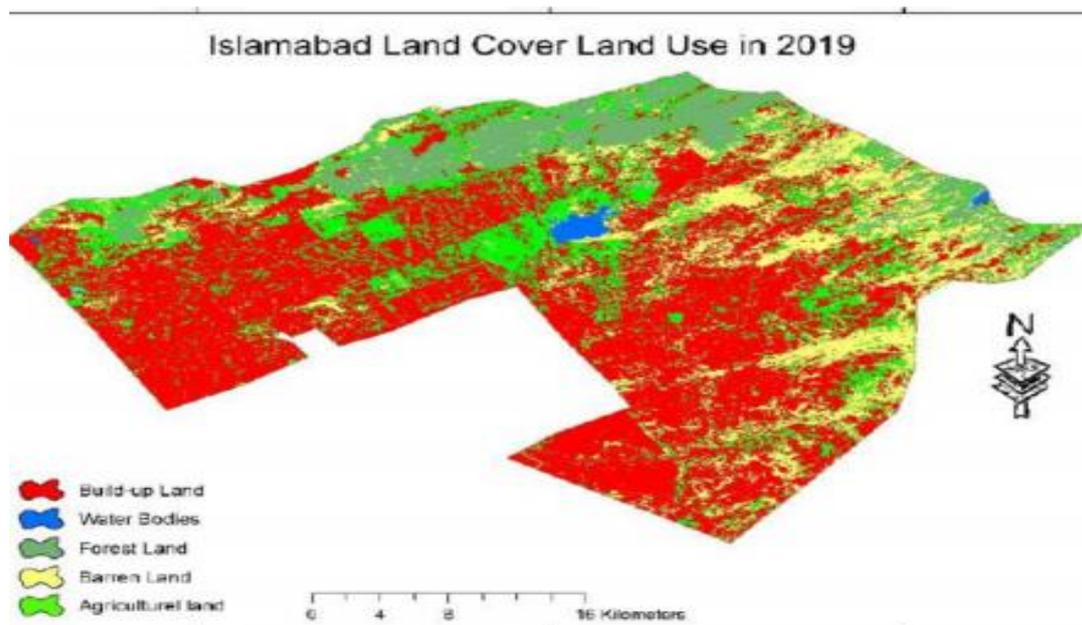
Figure 11 Islamabad land cover land use in 2019[42].

The below table 4 presented by the same study presents the landscape pattern change from 1979 to 2019 in the Capital territory of Pakistan. It can be seen from the below table 4 that in 2019 built-up land is increased by 52.4% in 2019, while on the other side forest land is decreased from 19.3% (1979) to 10.3% in 2019[42] and is decreased by 9%.

Table 4. Landscape pattern change from 1979 to 2019[42].

Land use/cover categories	1979		1989		1999		2009		2019	
	km²%		km²	%	km²	%	km²	%	km²	%
Built-up land	97.2	10.7	135.2	14.9	159.2	17.6	312.2	34.4	474.8	52.4
Agriculture land	130.0	14.3	150.4	16.6	162.3	17.9	193.4	21.3	177.0	19.5
Forest land	174.7	19.3	139.2	15.4	134.8	14.9	122.7	13.5	93.4	10.3
Water bodies	15.6	1.7	14.5	1.6	13.3	1.5	11.4	1.3	6.0	0.7
Barren land	489.1	53.9	467.3	51.5	437.0	48.2	267.0	29.4	155.4	17.1

2.4. EFFECTS OF DEFORESTATION

According to the World Wildlife Fund [43], 12 to 15 million hectares of forest are lost every year, which is the equivalent of 36 football fields per minute. When forest cover is destroyed, it not only causes massive soil erosion and landslides but also deprives species of habitat, making them vulnerable to be hunted. Erosion can also create stagnant water pools, which are ideal breeding grounds for mosquitos, which are well-known carriers of malaria, yellow fever, and the Nipah virus, along with many other diseases[44] Given that tropical forests are home to 80% of the world's known species, deforestation puts a large portion of the planet's biodiversity at risk. Deforestation is also responsible for 15% of global greenhouse gas emissions [43]

Deforestation and the human population are directly proportionate to one another. With each passing day, the human population grows, necessitating greater industrialization and infrastructural standards, which leads to the exploitation of forestry resources to meet varied needs such as housing, agricultural land, furniture, paper, instruments, and charcoal. Sadly, wildlife species are the first to be impacted by deforestation[45]. Furthermore, according to Robert[46], the following are some of the environmental consequences of excessive forest degradation.

I.   It causes modifications in the natural plant cover's composition and structure. Furthermore, results in the loss of valuable flora and fauna resources.

II.   Wildlife migration results in mass destruction or relocation, resulting in a decline in the source of animal protein.

III.   Desertification and the development of semi-arid areas are also the consequences.

IV.   Deforestation has an impact on the water cycle as well. When forests are indiscriminately exploited, trees can no longer collect groundwater and release it into the atmosphere, resulting in drier weather. The amount of water in the soil and the amount of moisture in the atmosphere are both reduced by deforestation.

V.   Soil erosion, flooding, and landslides are also the consequences of deforestation. Surface water runoff, which moves far quicker than subterranean flows, is generated by deforested areas. Faster surface water transfer can result in flash flooding and more localized floods, limiting the amount of nutrients in the soil.

VI.   Reduced evapotranspiration, which reduces atmospheric moisture and, in some situations, lowers precipitation amounts, is a result of indiscriminate forest degradation.

VII.   Forests are being degraded ruthlessly, resulting in a loss of biodiversity and the extinction of numerous species. Deforestation has resulted in a degraded

environment with diminished biodiversity. Forests promote medicinal conservation while also supporting biodiversity by providing habitat for wildlife.

2.4.1.   Climatic Influence

2.4.2. Global warming is caused by the accumulation of carbon dioxide in the atmosphere[47]. Between 2015 and 2017, annual gross carbon dioxide emissions from the loss of forest cover in tropical nations averaged 4.8 gigatons(Figure 12)[48].
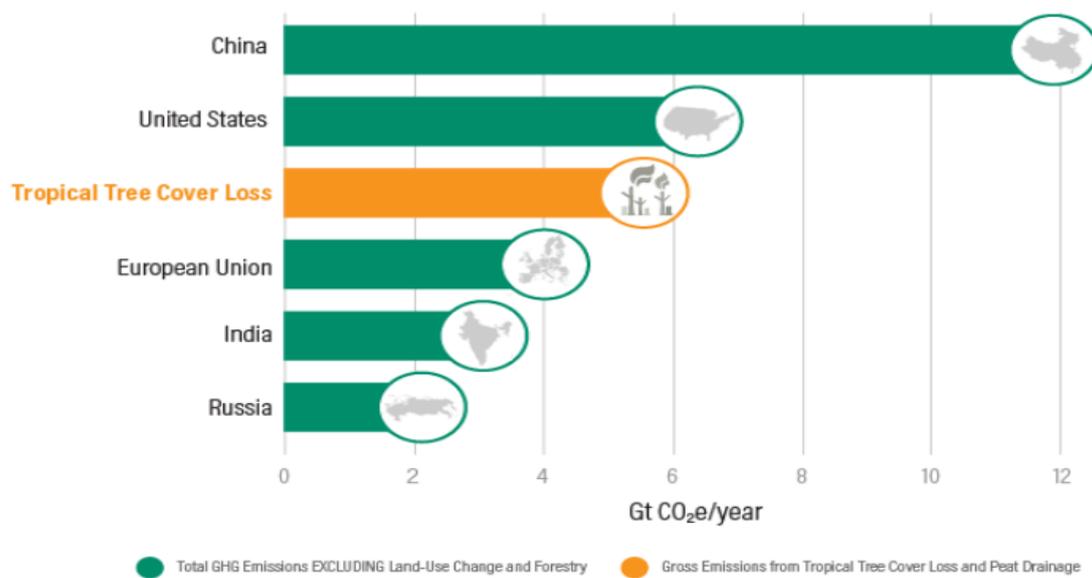
Figure 12 Annual gross carbon dioxide emissions from tree cover loss in tropical countries[48].

If tropical deforestation were a country, it would rank third in carbon dioxide-equivalent emissions, trailing only China and the United States. [48].

However, in Pakistan's future energy mix will be harmful to the environment[49]. According to projections, Pakistan's overall GHG emissions will rise from 347 million tons of CO2 equivalents (Mt CO2-eq) in 2011 to 4621 Mt CO2-eq in 2050. In Table 5 Emissions from Land use, land-use change, and forestry (LULUCF) is showing an increase from 10 (Mt CO2 eq) in 2010 to 35 (Mt CO2 eq) in 2050[49].

Table 5. Existing and future emissions of Pakistan[49].

Total Emissions	2011	2020	2030	2040	2050
GHG (Mt CO2eq)	347	557	1046	2156	4621
Energy	176	295	560	1250	2730
% Share	50.6	52.9	53.5	58.0	59.1
Agriculture	134	210	408	812	1765
% Share	38.7	37.7	39.0	37.7	38.2
Industry	20	30	52	61	75
% Share	5.8	5.4	5.0	2.8	1.6
LULUCF[a]	10	13	15	20	35
% Share	2.9	2.3	1.4	0.9	0.8
Waste	7	9	11	13	16
% Share	1.9	1.6	1.1	0.6	0.3

[a] LULUCF − Land use, land-use change, and forestry.

2.4.3. Soil Erosion

Clearing of ground vegetation in conjunction with timber harvesting, agricultural cultivation, mining, residential, and recreational development is a prevalent form of land-use change in humid tropical regions[50]. Soil erosion is a key indicator of forest deterioration. Soil erosion degrades water quality, pollutes watersheds with nutrients and sediments, and is both an indication and a cause of diminished soil fertility (and potentially, therefore, reduced forest productivity). It can also restrict access to the forest and obstruct the collection of products like timber in extreme cases[51].

The funding of the studies carried out by Jiabao, Pierre and Co. were that the precipitation pattern and runoff generation are governed by various geographic factors and anthropogenic activities, in addition to the temperature itself. For example, deforestation, which removes the protection afforded by the natural cover, can cause soil erosion and ecosystem disruption, affecting surface roughness, infiltration rates, and, ultimately, fast versus base flow[52].

Deforestation can also increase surface runoff rather than reduce it: as the forest deteriorates, soil water retention capacity is compromised, and base flow is reduced, resulting in more rain converted to surface runoff[53].
In another study to examine the effect of land use in headwater catchments on stream discharge, M. C. Roa, S. Brown, and Co. adopted a comparative catchment methodology[54]. During the study of the conversion of three catchment areas, it was observed that the area with a higher percentage of area with forest cover had less variability inflows, and the catchment with a higher percentage of area in wetlands had a slower decline inflow in the dry season[54]. For tropical ecosystems, evidence is shown for the infiltration trade-off theory, which claims that after forest removal, soil infiltration rates are lower and water losses by fast flow are greater than gains from reduced

evapotranspiration. This is consistent with the results of using the linear reservoir model, which demonstrates a faster water release for the least forested catchment[54].

In Pakistan, the estimated average soil erosion in Pakistan in 2005 was 1.79 ± 11.52 ton/ha/year(mean ± standard deviation at 95% confidence interval), which climbed to 2.47 ± 18.14 ton/ha/year in 2015[55]. In Azad Jammu & Kashmir, the rate of soil erosion has increased the most in the last ten years among seven administrative entities (2005 - 2015) followed by Khyber Pakhtunkhwa and Gilgit Baltistan province[55].

Table 6. Annual soil erosion estimation (mean ± standard deviation) in 2005 and 2015 at the national and Administrative Unit[55]

Administrative unit name	2005	2015
	Mean ± Standard deviation ton/ha/year	Mean ± Standard deviation ton/ha/
National scale	1.79 ± 11.52	2.47 ± 18.14
Azad Jammu & Kashmir	14.44 ± 35.70	28.03 ± 68.24
Balochistan	0.28 ± 1.88	0.26 ± 1.77
Gilgit-Baltistan	7.54 ± 20.25	9.06 ± 29.69
Islamabad Capital Territory	0.77 ± 2.22	1.57 ± 4.56
Khyber Pakhtunkhwa	8.73 ± 25.55	12.84 ± 39.88
Punjab	0.11 ± 1.22	0.17 ± 2.02
Sindh	0.02 ± 0.28	0.03 ± 0.35

Soil erosion increased in high altitudes according to the study period (2005-2015), possibly due to poor weathering of rocks, increased surface runoffs, landslides, deforestation, forest degradation, natural catastrophes, and other factors[55].
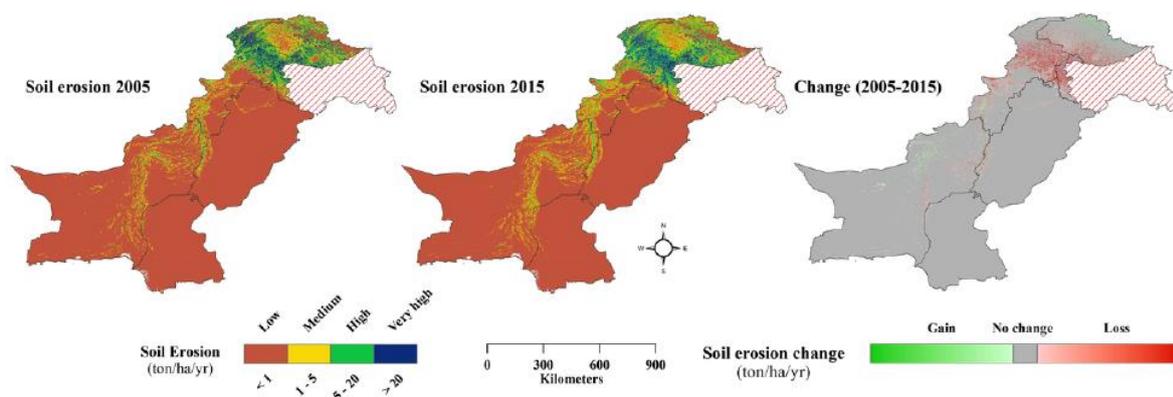
Figure 13 soil Erosion from 2005 to 2015 and soil Erosion change at altitude[55]

2.4.4. Loss of Biodiversity

Around 80% of all land-based species rely on forests for their survival. The biodiversity within forests has altered as forest cover has fluctuated through time[56]. After forest loss, local scale increases and declines in abundance, species richness, and temporal species replacement (turnover) were exacerbated by as much as 48 percent, according to a study by Gergana N., Isla, and Co[57]. Species at risk from land-use change, according to IUCN(International Union for Conservation of Nature) threat assessments[57].

Table 7 Changes in numbers of species in the Critically threatened and Endangered categories from 1996 to 2021[58]

Critically Endangered (CR)										
Year	Mammals	Birds	Reptiles	Amphibians	Fishes	Insects	Molluscs	Other invertebrates	Plants	Fungi & protists	TOTAL
2021	225	223	332	663	707	365	683	285	4,674	31	8,188
2020	221	223	324	650	666	347	682	282	4,337	30	7,762
2019	203	225	309	588	592	311	667	270	3,229	19	6,413
2018	201	224	287	550	486	300	633	252	2,879	14	5,826
2017	202	222	266	552	468	273	625	243	2,722	10	5,583
2016	204	225	237	546	461	226	586	211	2,506	8	5,210
2015	209	218	180	528	446	176	576	209	2,347	5	4,894
2014	213	213	174	518	443	168	576	205	2,119	2	4,631
2013	196	198	164	520	413	125	553	154	1,957	2	4,282
2012	196	197	144	509	415	119	549	132	1,821	2	4,084
2011	194	189	137	498	414	91	487	132	1,731	2	3,875
2010	188	190	106	486	376	89	373	132	1,619	2	3,561
2009	188	192	93	484	306	89	291	99	1,577	2	3,321
2008	188	190	86	475	289	70	268	99	1,575	2	3,242
2007	163	189	79	441	254	69	268	86	1,569	2	3,120
2006	162	181	73	442	253	68	265	84	1,541	2	3,071
2004	162	179	64	413	171	47	265	61	1,490	1	2,853
2003	184	182	57	30	162	46	250	61	1,276	1	2,249
2002	181	182	55	30	157	46	222	59	1,046	0	1,978
2000	180	182	56	25	156	45	222	59	1,014	0	1,939
1996/1998	169	168	41	18	157	44	257	57	909	0	1,820

Endangered (EN)										
Year	Mammals	Birds	Reptiles	Amphibians	Fishes	Insects	Molluscs	Other invertebrates	Plants	Fungi & protists	TOTAL
2021	542	460	588	1,060	1,108	730	587	351	8,593	87	14,106
2020	539	460	584	1,036	1,036	690	586	347	7,925	82	13,285
2019	505	461	565	964	868	571	564	344	5,727	60	10,629
2018	482	469	515	903	674	537	546	348	4,537	21	9,032
2017	476	461	484	869	676	461	547	340	4,123	18	8,455
2016	464	448	421	852	660	408	513	312	3,691	12	7,781
2015	481	416	361	810	614	305	503	311	3,510	11	7,322
2014	477	419	356	789	587	270	501	307	3,231	1	6,938
2013	447	397	329	783	530	247	486	224	3,009	1	6,453
2012	446	389	296	767	494	207	480	183	2,655	1	5,918
2011	447	382	284	764	477	169	417	183	2,564	1	5,688
2010	450	372	200	758	400	166	328	183	2,397	1	5,255
2009	449	362	150	754	298	151	245	164	2,316	1	4,890
2008	448	361	134	755	269	132	224	165	2,280	1	4,769
2007	349	356	139	737	254	129	224	96	2,278	1	4,563
2006	348	351	101	738	237	129	222	96	2,258	1	4,481
2004	352	345	79	729	160	120	221	82	2,239	1	4,328
2003	337	331	78	37	144	118	243	76	1,634	1	2,999
2002	339	326	79	37	143	118	236	77	1,291	0	2,646
2000	340	321	74	38	144	118	237	76	1,266	0	2,614
1996/1998	315	235	59	31	134	116	212	76	1,197	0	2,375

In a developing country like Pakistan, biodiversity risks are greater[59]. The northern Hindu Kush-Karakoram-Himalayas (HKH) mountain range in Pakistan, which is part of a

larger mountain arc stretching across South and Central Asia, is particularly important in terms of biodiversity, as it contains many rare and endangered species of flora and fauna, as well as some of the last viable populations of certain species such as the Deosai brown bear[60]. The region has different animals species such as Musk deer (Moschus chrysogaster) Snow leopard (Uncia uncia), Large mammals include the Astor markhor (Capra falconeri falconeri), Blue sheep (Pseudois nayaur), Himalayan black bear (Ursus thibetanus), Himalayan brown bear (Ursus arctos), Himalayan ibex (Capra ibex siberica), Ladakh urial (Ovis vigenei vigenei), Marco Polo sheep ((Uncia uncia)[61], In addition, the region's flora is diverse, and contain herbaceous plants (mainly of the Asteraceae family) in drier lowlands[62].

Furthermore, these mountains are home to around 350 kinds of plants, 230 species of birds, 54 species of mammals, 23 species of herpetofauna, and 23 species of herpetofauna. However, with more research, this could alter[60].

Habitat fragmentation owing to deforestation and shifting land use and subsistence hunting and fishing, human-wildlife conflicts, unsustainable wood, and peat harvesting, and fast-expanding tourism all threaten biodiversity in the HKH (Hindu Kush-Karakoram-Himalayas) region[63].

Table 8 Distribution of big mammals in districts of Hindu Kush-Karakoram-Himalayas (HKH) region of Northern[60]

Species & authority	Distribution (districts of HKH region)							Conservation Status*
	Ghizer	Gilgit	Hunza-Nagar	Diamer	Astor	Skardu/Ghanche	Chitral	
Blue sheep (*Pseudois nayaur*, Hodgson 1833)			+					LC
Common or Eurasian otter (*Lutra lutra*, Linnaeus 1758)	+	+	+	+	+	+	+	NT
Flare-horned or Astor markhor (*Capra falconeri falconeri*, Wagner 1839)	+	+	+	+	+	+	+	NT
Hill fox or Tibetan red fox (*Vulpes vulpes montana*, Pearson 1837)	+	+	+	+	+	+	+	LC
Himalayan or Asiatic black bear (*Ursus thibetanus*, Cuvier 1823)				+	+		+	VU
Himalayan brown bear (*Ursus arctos isabellinus*, Horsfield 1826)			+	+	+	+		CR
Himalayan ibex (*Capra sibirica*, Pallas 1776)	+	+	+	+	+	+	+	LC
Himalayan lynx (*Lynx lynx isabellinus*, Blyth 1847)	+	+	NA	NA	NA	+	+	VU
Himalayan or Alpine musk deer (*Moschus chrysogaster*, Hodgson 1839)	+	+		+	+		+	EN
Hyena (*Hyaena hyaena*, Linnaeus 1758)	+	+	NA	NA	+	NA	+	NT
Kashmir musk deer (*Moschus cupreus*, Grubb 1982)						+		EN
Ladakh urial (*Ovis orientalis vignei*, Blyth 1841)			+		+	+	+	VU
Leopard cat (*Prionailurus bengalensis*, Kerr 1792)	+	NA	NA	+	+	NA	NA	LC
Macro Polo sheep (*Ovis ammon polii*, Blyth 1841)			+					NT
Snow leopard (*Uncia uncia* syn. *Panthera unica*, Schreber 1775)	+	+	+	NA	+	+	+	EN
Tibetan gray wolf (*Canis lupus chanco*, Gray 1863)	NA	NA	+	NA	NA	NA	+	LC
Tibetan wild ass (*Equus kiang*, Moorcroft 1841)	NA	NA	+	NA	NA	NA	NA	LC

Note: *IUCN (International Union for the Conservation of Nature); Categories: CR = Critically Endangered (5), EN = Endangered (4), VU = Vulnerable (3), NT = Near Threatened (2), LC = Least Concern (1), DD = Data Deficient, NA = Not Available (information or data) and + = Presence of big mammal.

2.5. Reforestation Projects in Pakistan

2.5.1. Billion tree Tsunami Project

In 2014, the government of Khyber Pakhtunkhwa (KP) initiated the Billion Tree Tsunami Project to combat climate change. According to the Government of KPK's plan, the BTTAP (Billion Tree Tsunami Afforestation Project) aims to increase forest area by 20% to 22% by 2018[64]. The estimated number of tree saplings to be planted is 550 million, which will be planted in two phases, with 450 million saplings naturally produced in forest enclosures. The plant species that would be used in the plantation project are Walnut (Juglans), Aeasia Arabia, chir pine (Pinus roxburghii),palosa (Aesiasmodesta), Indian rosewood (Dalbergia sisoo), ziziphus, safeeda (eucalyptus)[64]. The government intends to put an additional 30,000 hectares of land under forest cover per year, according to the plan[65].

In figure 14, the area has been shown in which this project has been carried out in the province of KP.

Figure 14 Map of the BTTAP project Area Involving KP Districts, Pakistan[66]

2.5.2.   Ten Billion Trees Tsunami Programme- Phase-I

The Ten Billion Tree Tsunami Project is a federal government program designed to address the rapid changes that have occurred over the last decade. It is a project that will take four years to complete (2019-2023). This project is being carried out by Pakistan's Ministry of Climate Change, with assistance from provincial agencies such as the Provincial Forest institution and Wildlife Departments. On September 2nd, 2018, Pakistani Prime Minister Imran Khan officially launched this project[67].

In five years, the first phase would cost up to 2 billion. The key goal of this massive project is to restore Pakistan's forest sector and protect the country's wildlife. Even, to ensure that the protected areas are preserved. Also, assist in the promotion of eco-tourism, community engagement, and job development[67].

The estimated budget for this initiative is 109.59 billion dollars, with 15.59 billion dollars set aside for wildlife. Through this initiative, the COVID-19 pandemic forest and wildlife department were able to create green jobs for 84,609 people. The 430 million plantation target was reached, and a new 1 million plantation target is set until June 2021[67].

3. RESEARCH METHODOLOGY

3.1 Overview

This study aims to identify the drivers of deforestation and forest degradation, the agents of these drivers, and the necessary activities to reduce these drivers, based on analysis of local opinions in Pakistan. To observe the opinion of the local people in Pakistan regarding the effectiveness of Pakistan's current forest management system, as well as their views regarding the monitoring of the ongoing reforestation effort. Based on those results, Proposing policy recommendations for more sustainable forest management in Pakistan. A survey was created and distributed around Pakistan among people The questionnaire was delivered across Khyber Pakhtunkhwa via personal acquaintances and among forestry professionals, who subsequently passed it on to others. Personal contacts, as well as Facebook and WhatsApp groups, were utilized to distribute the questionnaire to people of all ages and occupations in other provinces (Sindh, Punjab, Baluchistan, and Gilgit Baltistan) to understand their perspective on Pakistan's forestry sector.

Furthermore, utilizing the above-mentioned links, the survey form was sent to about 500 individuals, and 171 responses were received. There were 9 responses that were incomplete or unrealistic which were discarded. The percentage of people that responded was around 35%.

Furthermore, people of different ages, backgrounds, and provinces were targeted. But it was largely educated individuals that responded. The reason for this could be due to their access to internet services in urban area. In addition, less participation from individual as compared to highly educated also points toward the fact that rural areas have a lower number of literate individuals as well as limited access to internet services.

The goals of the survey were defined as

1. To determine the extent to which indigenous peoples are aware of the environmental repercussions of deforestation.
2. To get the opinion of locals about the role of the Forest management system of Pakistan in reforestation and deforestation activities.
3. To analyse how satisfied residents are with the forest sector's monitoring procedures for the Billion Tree Tsunami initiative.
4. To understand how individuals perceive the primary factors of deforestation.
5. Based on an analysis of local perceptions in Pakistan, the measures required to reduce these drivers.

The distribution of the survey form was the next step. As a result, a Google form was created and distributed to people of various ages and backgrounds in Pakistan. Social media and personal contacts were all used to distribute the questionnaire survey. The information gathered was then analyzed in another section. The research methodology is shown in (figure 15).
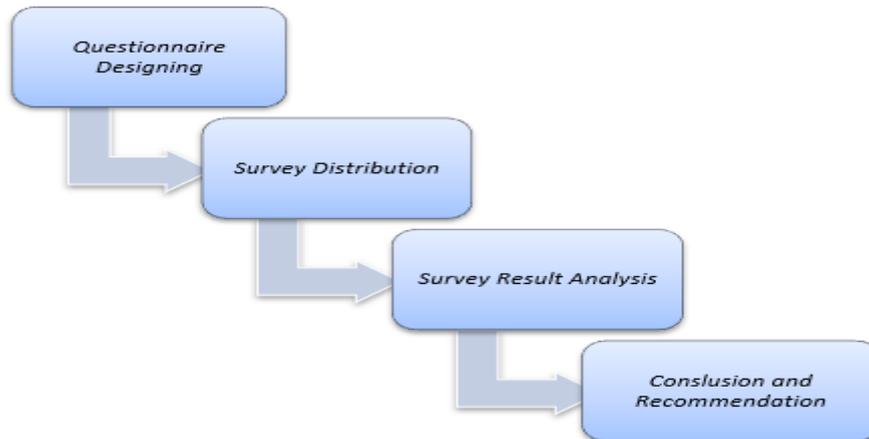
Figure 15 Research Methodology Process

Figure 15 represents the four processes associated with research methodology.

The first step is to generate a questionnaire. The concept of establishing the survey form was to gain a better understanding of public perceptions regarding the forestry sector in the region (Pakistan). To gain a better understanding of how forest-related institutions and other organizations operate in the region.

Furthermore, to establish what the general public in their location feels about the deforestation driver in the region. Finally, utilize the knowledge gained to make recommendations for the betterment and sustainable management of the forestry sector in the region.

In the second step, questionnaire was circulated to citizens via various platforms, including Facebook pages, WhatsApp groups, and personal acquaintances.

In third stage Survey result received were analysed to determine trends in forestry sector in the country through public disclosure.

Based on these results and the data available develop interpretations in the final step.

3.2 Developing Survey Questionnaire

The questionnaire was divided into two sections: one was designed to obtain demographic information about the respondents, and the second was comprised of major questions aimed at learning about the respondent's opinions to enhance forest management techniques and policies. In the first portion, five questions were connected to the respondents' demographic data, while the second half had ten questions.

People from various backgrounds and ages were contacted through email and social media platforms in Pakistan to meet the study's objectives. Beginning in April 2021, a total of 171 people participated in the survey. Considering the volume of responses, and time constrains the public response was satisfactory. Below is a list of the demographics of those that responded.

3.2.1. Participants Demographic Formation

The surveyee demographic information will be shown in this section of the report. The following questions were included in the demographic information of the respondents: Gender of the respondents, age group, education background, profession, and the province of residence.The first question concerned the participants' gender. Figure 16 below depicts the proportion of male and female survey respondents.

The chart below demonstrates the percentage of male and female respondents, and approximately 49.4 percent of responses were from male participants, while the percentage of female participants in the survey was 50.6 %.
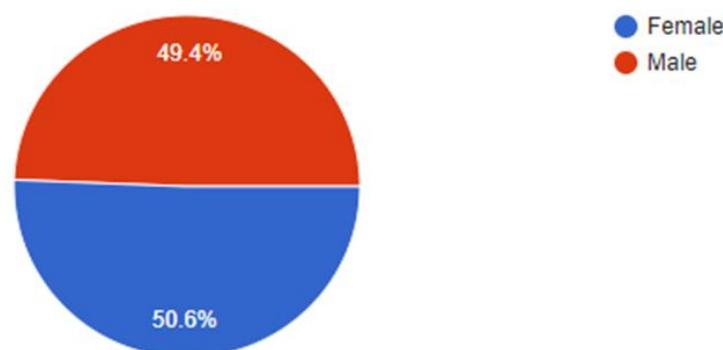
Figure 16 Gender of the Respondents

The respondents' age group was the subject of the study's second question. The survey included responses from people of all ages. The ages of the respondents are demonstrated in Figure 17. The age group 18-25 received the highest percentage of responses (32.7%), followed by 23.5 percent for those aged 25 to 35, and 24.7 percent for those aged 35 to 50. However, 19.1 percent of those aged 50 and above responded.

What is your age group?
162 responses

- 18-25
- 25-35
- 35-50
- 50 or Above
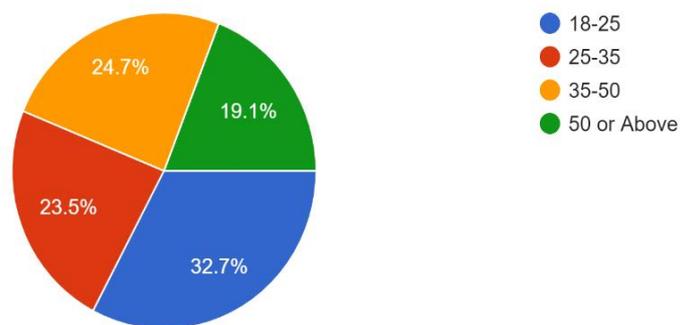
Figure 17 Age of the respondents

Furthermore, in the study, the third question was asked about the occupation of the respondents. Figure 18 represents the profession of the individual who participated in this study survey. The student response rate in the survey was 38.9%, which was the highest of all. A total of 18.5 percent of respondents were farmers. While businessmen responded to the survey, their responses accounted for only 11.1 percent of the total. The responses received from the`` other´´ category were 14.2 %. Lastly, the figure represents that there was an equal number of respondents, i.e. 8.6% from government officials and 8.6% from labor workers.

Primary occupation of respondent.
162 responses
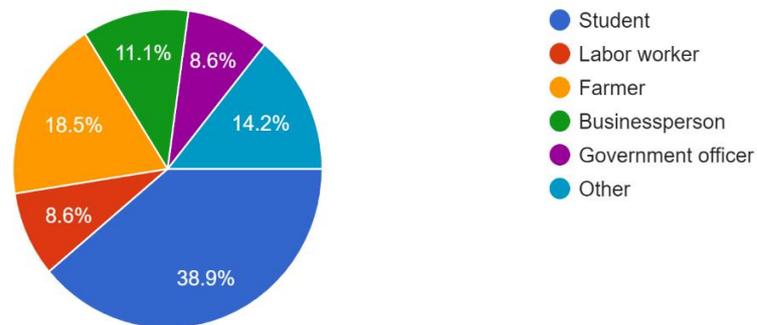
Figure 18 Occupation of the Respondent

The fourth question in the demographic section of this study was about the respondent's educational level. The poll drew responses from people with various levels of education. Figure 19 illustrates information about the respondents' educational backgrounds.

Level of education of respondent?
162 responses
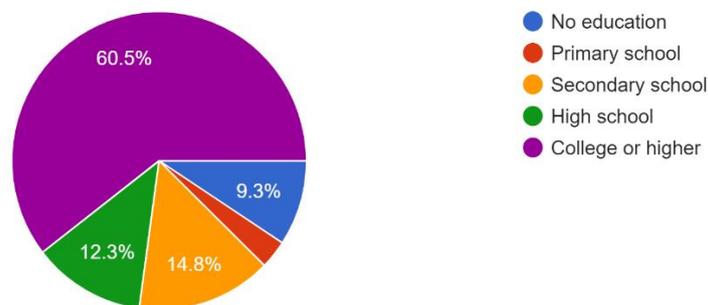
Figure 19. Education level of the respondent

As shown in the graph above, respondents with a college or higher education level made up most responses (60.5 percent). The second group of respondents, with an education level of Secondary School, accounted for 14.8 percent of the total. 12.3% of respondents had a high school education, while 9.3% had no education. However, only 3.1 percent of the precipitants with a primary education responded.

Finally, the fifth question was focused on the respondents' province. Figure 20 represents the details regarding the respondent's province of residence. Most of the responses

(35.8%) were from the province of Khyber Pakhtunkhwa (KP). Sindh accounted for 19.1% of the total number of respondents. In third place came responses from the Punjab province, which accounted for 18.5 percent of the total. However, 13.6 % of those who participated in the survey were from Baluchistan, and 13% of those who responded were from Gilgit Baltistan.

What is your resident province/state in Pakistan?
162 responses
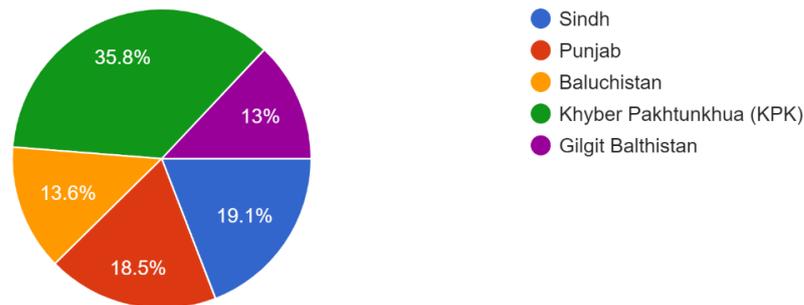
Figure 20. Province of residence of the respondent

3.2.2. Survey Main Questions

This section of the study focuses on the survey questions that were developed to find out what locals think about the forestry sector in Pakistan. To learn what indigenous peoples think about forest management in the country and to understand what issues need to be addressed and what measures need to be taken to ensure the long-term sustainability of the forests in the country. The following ten questions were developed to elicit responses from respondents to achieve long-term sustainability objectives.

Question No. 1: **How do you rate your knowledge regarding the environmental consequences of Deforestation?** The goal of adding this question to the survey is to collect respondents' opinions and knowledge on deforestation from various regions of the country, as well as to determine their level of awareness about the environmental implications of deforestation. It was a scale-based question marked from 1-5 (Highly unaware= 1, unaware= 2, Neutral = 3, Rather Aware = 4, Highly Aware = 5).

Question No. 2: **Do you think that conserving tropical forests can benefit Pakistan?** The objective of asking this question is to learn about the thoughts of survey participants from various provinces of Pakistan on whether tropical forest conservation and protection

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can benefit the country or not. It was also a one-to-five scale-based question (Strongly disagree = 1, Rather Disagree = 2, Neutral = 3, Rather agree = 4, Strongly agree = 5).

Question No. 3: **Do you have wood energy consumption in your residence for Cooking, Water, and Space heating?** The goal of the question is to see if locals are using wood energy as a source of energy. Pakistan is a developing country, most people in the country, especially in rural areas, do not have access to or can afford fuel. As a result, the question was posed to determine how many people use wood energy for domestic purposes. It was a general question with two options: yes or no.

Question No. 4: **In your opinion, do you believe that the increase in population and influx of land migrants resulted in deforestation in your region?** This question was designed to investigate the causes of deforestation in various parts of the country. To learn how the community feels about whether local population growth and land migration are contributing to deforestation in their area. The reason for raising this question is that Pakistan's population has been quickly increasing over time, and millions of Afghan refugees have arrived in Pakistan since 1980 because of Afghan wars. This question comprised of five options from 1 to 5 where (Strongly disagree= 1, Rather Disagree = 2, Neutral = 3, Rather agree = 4, Strongly agree = 5).

Question No. 5: **In your opinion, how do you rate current reforestation activities in your region?** This question was intended to gauge public opinion on a current reforestation project in their area. To learn how satisfied people are with plantation activities in different parts of the country. And to find out to which extent government is interested in forestry efforts in different regions and how the respondents feel about these reforestation efforts. It was a scale-based question marked from 1-5 where (Highly ineffective= 1, Rather ineffective = 2, Neutral = 3, Rather effective= 4, Highly effective = 5).

Question No. 6**: In your opinion, to what extent do you rate efforts (Voluntary pledges, Awareness campaigns) of local institutions, governing bodies to tackle deforestation and/or address forest degradation?**
The purpose of this question is to learn about residents' perceptions on the role of local departments and governing bodies in addressing deforestation issues. Through public disclosure understand the role of awareness initiatives such as seminars and rallies, as well as the allocation of volunteer funding to address deforestation. The goal is to get a sense of what people think about these commitments and campaigns in their neighbourhoods. It was likewise a scale-based question with (Highly ineffective = 1, Rather ineffective = 2, Neutral = 3, Rather effective = 4, Highly effective = 5).

Question No. 7: **In your observation, how do you rate current monitoring approaches for the Billion Tree Tsunami project? –** The question was asked to evaluate how competent the government was in managing the recently completed Billion Tree Tsunami initiative in the public's eye. In 2014, the KP (Khyber Pakhtunkhwa) government launched the Million Tree Tsunami Drive, which lasted until 2017. However, it is critical to keep track of how efficient and beneficial this initiative effort has been in the eyes of the different communities. It was also a scale-based question marked from 1-5 where (Highly ineffective= 1, Rather ineffective = 2, Neutral = 3, Rather effective= 4, Highly effective = 5).

Question No. 8: **In your opinion, to what extent do the absence of sound policies contributing to deforestation and forest degradation in your region?** The purpose of asking this question is to learn about the participants' perspectives on the role of ineffective policies in deforestation. To gain public opinion on how much deforestation and forest degradation has occurred from a lack of efficient policies, in addition to the presence of the various driver**.** It was also a scale-based question marked from 1-5 where (No Contribution = 1, low Contribution = 2, Neutral = 3, High Contribution = 4, very high-level Contribution= 5).

Question No. 9: **In your observation, which is the main driver of deforestation in your region? –** The goal of designing this question is to identify the main drivers of deforestation in the region. To analyse what the opinion of the respondents are regarding the driver of deforestation in their community. Commercial agriculture, cattle ranching, illegal timber logging, infrastructure construction, forest fires, firewood gathering, and other sources of deforestation were among the options given in this survey question.

Question No. 10: **In your opinion, what can be the most potential activity for addressing Deforestation in your region?** – The purpose of incorporating this question in the survey is to learn what people think about future deforestation-fighting actions. To get a sense of what the respondents think will help conserve and expand forest cover in the region, respondents were questioned what initiatives they think will help. Different potential activities option was given in the question which included Tree plantation Drives, Community Forest Management, Policy and Governance Reforms, Financial Incentives for agriculture, Build Infrastructure for Local employment.

4. Results and Analysis

The focus of this chapter is on the survey results. After distributing the survey questions to the public, 162 out of 171 responses were considered. Even though there was a high expectation for more responses. However, due to the lack of future interest shown by the people, the survey was limited to 162 people. The findings of the survey questionnaire and other analyses are presented in this section of the study.

4.1. Survey Questions General Analysis

4.1.1. Knowledge regarding the environmental consequences of Deforestation

As previously stated in the study, the purpose of asking this question is to determine the level of awareness among the indigenous people in the region about the environmental implications of deforestation. The responses were encouraging enough to materialize into outcomes. Figure 21. demonstrates that there has been a mixed response to having awareness about the environmental implications of deforestation.

Approximately 12.3 % and 22.8 % are Highly Unaware or unaware, respectively. Furthermore, 19.1 percent and 16 percent are Very Aware or Aware of the consequences of deforestation, respectively. Finally, 29.6 percent of respondents are undecided (Neutral) about the statement.

How do you rate your knowledge regarding the environmental consequences of Deforestation?
162 responses
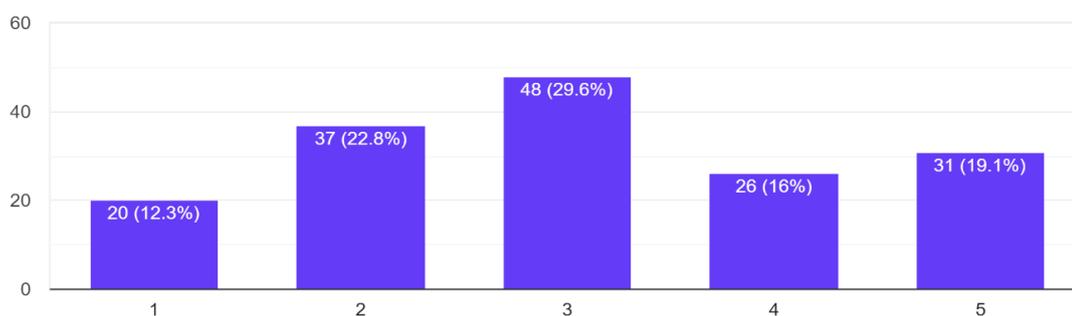
Figure 21. Question 1. Awareness level of Respondents regarding Environmental Consequences of Deforestation.

Gender-based analysis was performed for Figure 20 to better understand the responses to question 1. Male and female respondents who were highly unaware and unaware were 36.2 % and 35.1 %, respectively, while male and female respondents who were aware and highly unaware were 37.5 % and 33.7 %. However, 26.2 percent of men and 32.9 percent of women were undecided. (Figure 22)
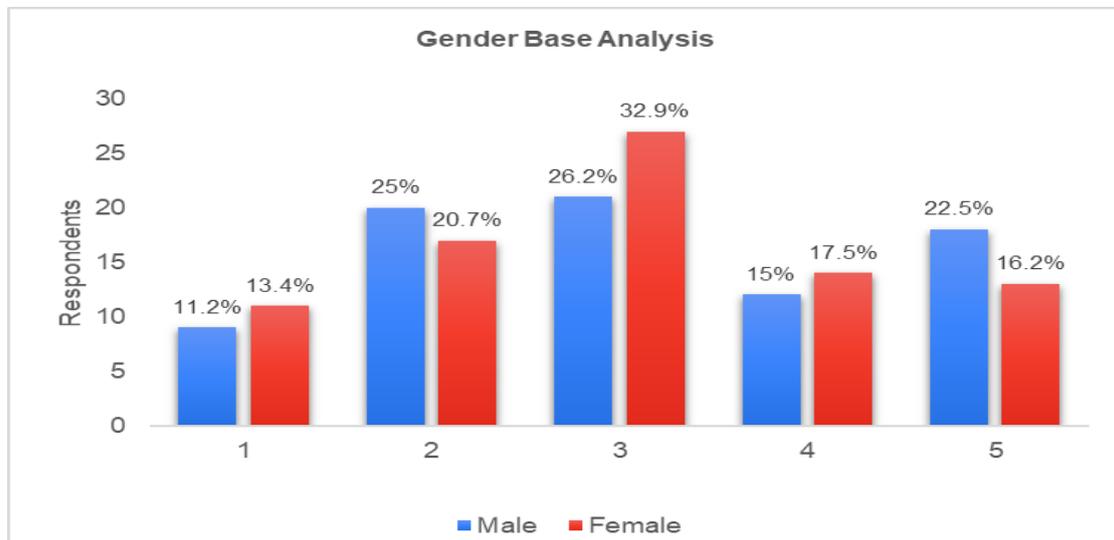
Figure 22. Gender Base Analysis of Question 1.

4.1.2. Attitudes towards tropical forest conservation and protection

The goal of creating this question was to examine how respondents felt about tropical forest conservation benefiting Pakistan. According to the responses in figure 23, most respondents believe that protecting tropical forests can benefit Pakistan. Most respondents (48.8 percent) strongly agree, while 37 percent agree, However, 4.9 % strongly disagree, and 1.9 % rather disagree that conserving tropical forests provides no benefits. Furthermore, only 7.4 percent of respondents were undecided. The overall impression is that most people support forest protection and expansion.

Do you think that conserving tropical forests can benefit Pakistan?
162 responses
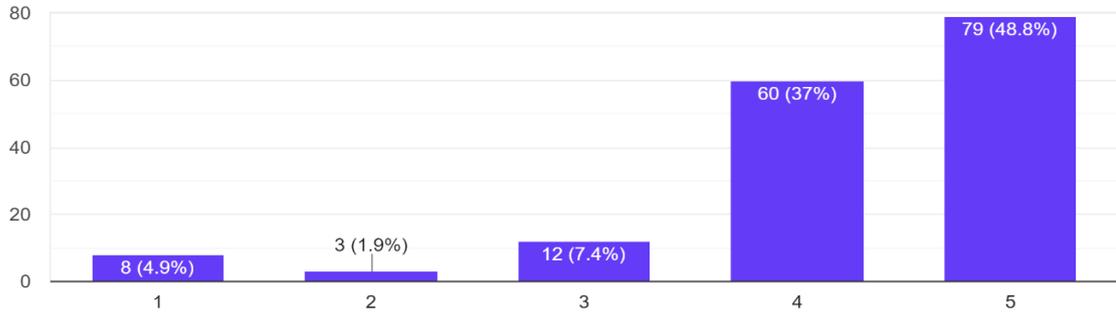
Figure 23. Respondent's Opinion Regarding Tropical Forests Benefits.
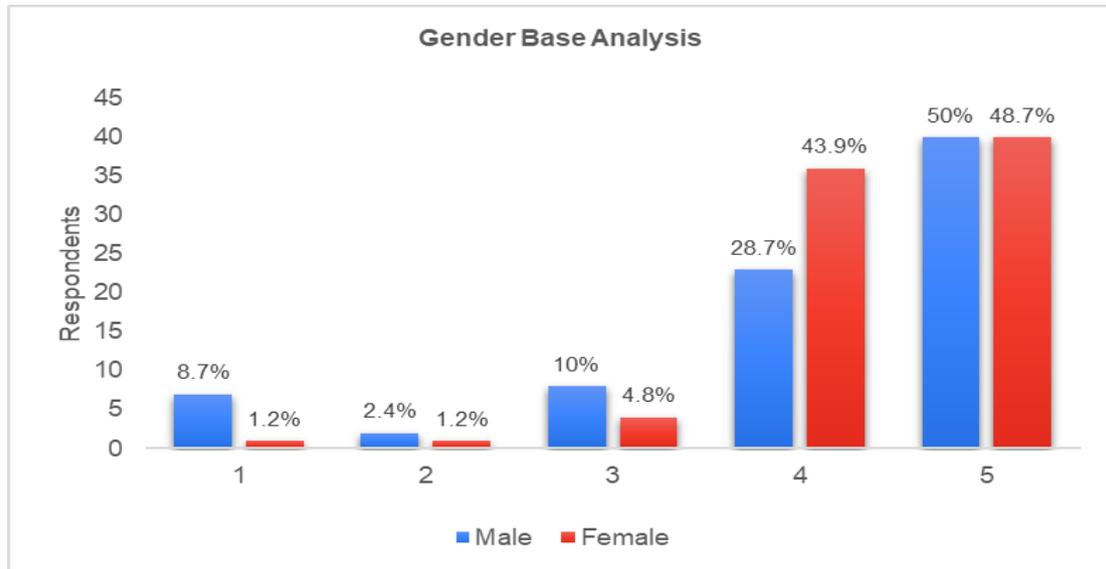
Figure 24 Gender Base Analysis of Question 2.

In the same way, the gender-based analysis of question 2 in figure 24 reveals that the majority of males respondents agree (28.7%) and strongly agree (50%) with the idea of tropical forest conservation in case of male while female participants in the survey stance, in this case, was 43.9% and 48.7% respectively. While males were 8.7% and 2.4 percent, respectively, who strongly disagreed and disagreed with this viewpoint, however, 1.2% females responded to strongly disagreed and disagreed. However, 10% of men and 4.8 % have a neutral stance.

4.1.3. **Attitude towards wood energy consumption in the region**

As stated in the study's literature review, wood consumption is high in developing countries. Pakistan is still in the early stages of its development. This question was designed to elicit local opinions on whether or not people use wood as a source of domestic fuel. Figure 25 shows that 57.4% of respondents agree that they use wood as a fuel resource for household purposes, whereas 42.6 percent claim they do not use wood for cooking, water heating, or space heating. As, survey result suggests that the majority of people utilize wood as a fuel source, as earlier mentioned Pakistan is a developing country with people having low purchasing power for alternative fuel sources, however, there could be other reasons as well.

Do you have wood energy consumption in your residence for Cooking, Water and Space heating?
162 responses
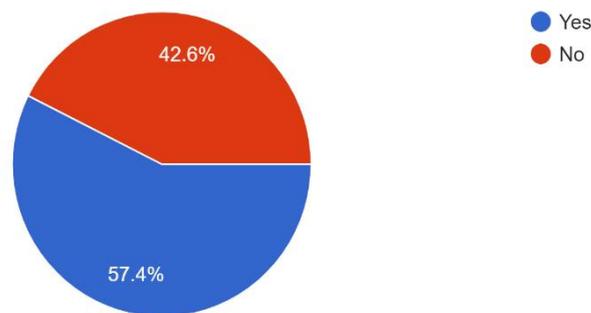
Figure 25. Use of wood for domestic purposes Results.

4.1.4. **Increasing Population and Migration impact on deforestation**

The respondent's perspective on the role of land migration and population growth in increasing deforestation was the subject of this question. In Figure 26 the majority of respondents (45.7 % agree and 31.5 % strongly agree) that these two variables are one of the causes of deforestation, according to the survey results. While 11.1 % were undecided. However, 4.3 %strongly disagree and 7.4 % strongly disagree with the notion that deforestation is caused by population growth and migration.

In your opinion, do you believe that the increase in population and influx of land migrants resulted in deforestation in your region?

162 responses
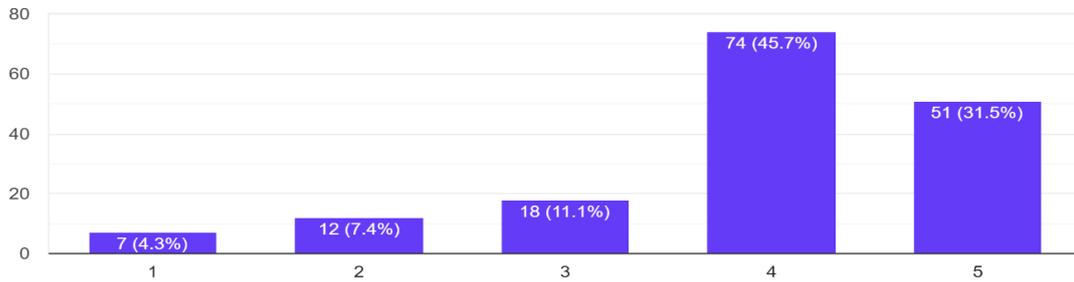
Figure 26. Role of Raising population and migration on Deforestation.
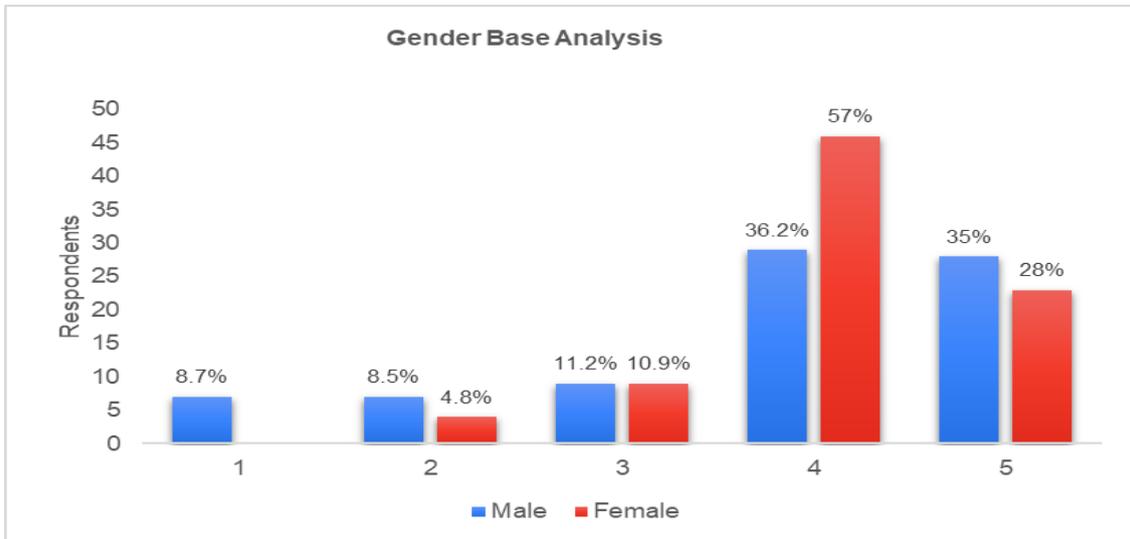
Figure 27 Gender Base Analysis of Question 4.

The figure 27 shows that 85% of females agree or strongly agree that population growth and migration have resulted in deforestation. 71.2 % of male respondents also selected the same option. And nearly 11% of participants were undecided. However, 8.7% and 8.5% male and 4.8% females, respectively, choose strongly disagree and disagree.

4.1.5. **Locals attitude towards reforestation efforts in the region**

As mentioned earlier, question 5 was a scale-based question which aimed at capturing the respondent's point of view regarding plantation activities or reforestation projects in their region. According to the findings of the poll (Figure 27), 17.9% and 27.2 % of respondents

believe that reforestation initiatives are highly ineffective or ineffective. In addition, 29.6% of respondents were undecided. While 14.8 % think it is effective, and 10.5 % think reforestation efforts in their area are quite effective (Figure 28). Most respondents, however, feel that the region's reforestation efforts are insufficient.

In your opinion, how do you rate current reforestation activities in your region?
162 responses
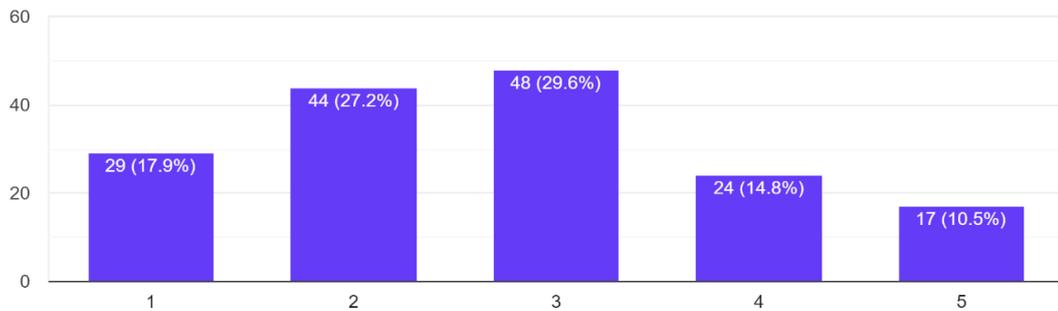
Figure 28. Reforestation Activities in the Region Poll Results.
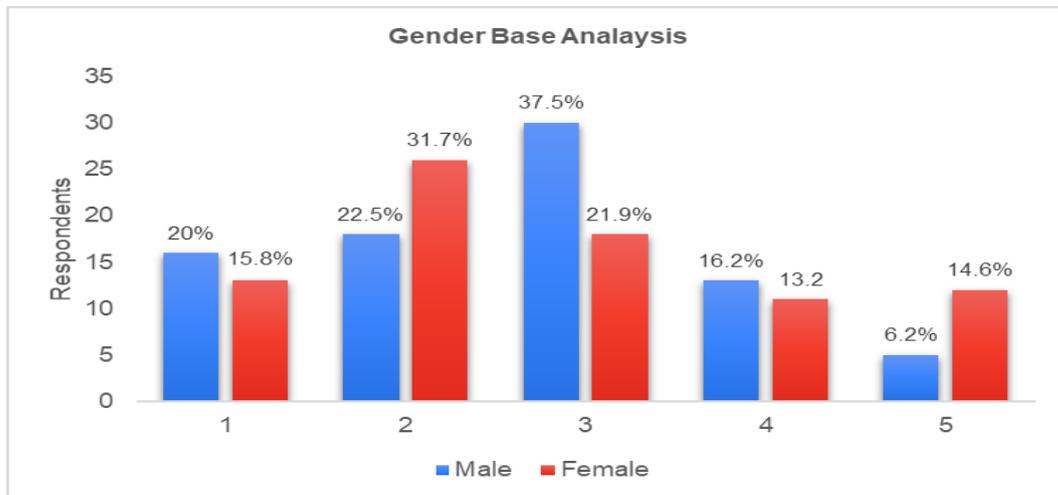
Figure 29 Gender Base Analysis of Question 5.

The gender-based analysis of question 5 reveals that most male respondents (37.5%) and female respondents (21.9%) had a neutral attitude toward this question. While 20% of male respondents and 22.5 % of female respondents believe that forestry activities are highly ineffective or ineffective, respectively, 15.8 % and majority 31.7 % of female respondents feel that reforestation initiatives are highly ineffective or ineffective. (Figure 29). Furthermore, 16.2% and 6.2% of male respondents considered reforestation efforts

36

highly effective while 13.2% and 14.6% of female respondents also choose the same options.

4.1.6. **Attitude towards the efforts of all concern bodies to tackle deforestation**

The objective of including this question in the survey is to better understand local perceptions on the role of local government and concerned bodies in addressing deforestation in different ways.

Figure 30 shows that 32.7 % and 10.5 % of respondents, respectively, consider these pledges and campaigns ineffective and highly ineffective. Whereas 21% feel that these efforts are effective, and 13% believe they are extremely effective. However, 22 % of the respondents have a neutral stance.

In your opinion, to what extent do you rate efforts(Voluntary pledges, Awareness campaigns) of local institutions, governing bodies to tackle deforestation and/or address forest degradation?
162 responses
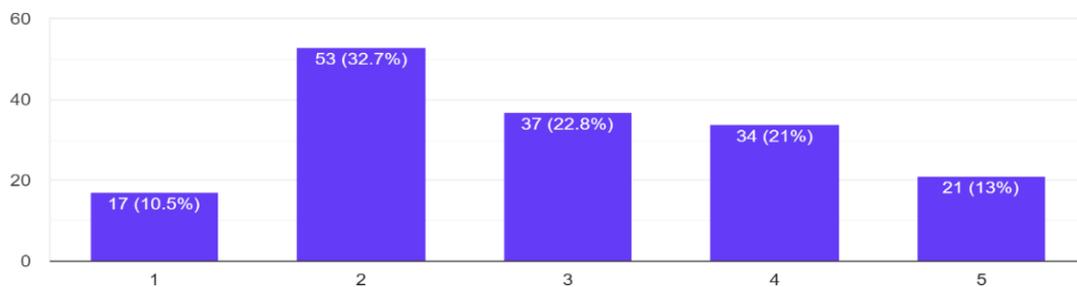
Figure 30. Efforts of Government and different bodies to Tackle deforestation Poll Results.
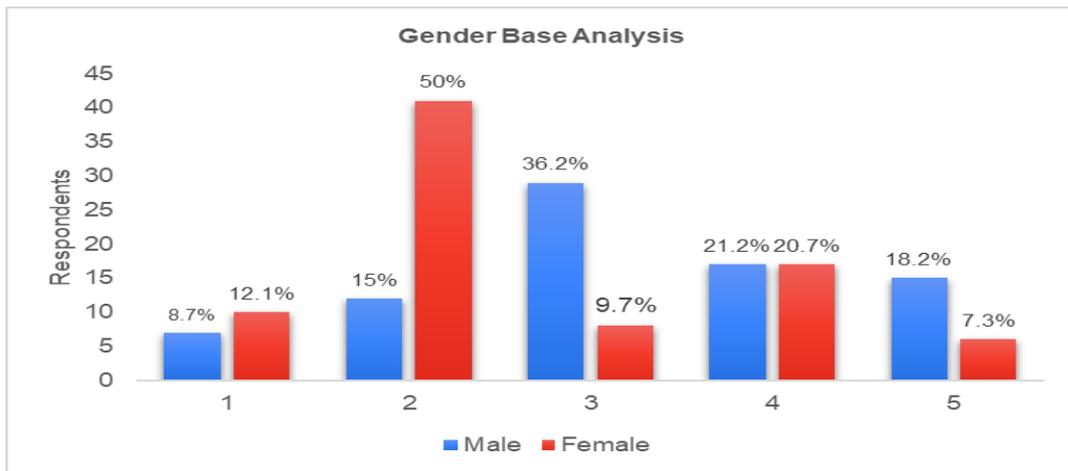
Figure 31 Gender Base Analysis of Question 6.

The goal of the gender-based analysis is to have a better understanding of each respondent's behaviour separately. The majority of female respondents (Figure 31) believe government and other institutions' efforts are either highly ineffective (12.1%) or ineffective (50%), whilst male participants had the same opinion 8.7% and 15%, respectively. However, male, and female responders who had opposing views that the efforts had been effective were 21.2% and 20.7%. In addition, 18.2 % of male and 7.3 % of female respondents selected the highly effective option. Most male participants, however, had a neutral regarding the question (36.2 %).

4.1.7. Monitoring approaches for the Billion Tree Tsunami project survey results

Just like the previous question, this was a scale-based question. This question was added to gather views on the billion-tree tsunami monitoring methods. In response to the question, around 34% of those surveyee feel that the monitoring methods are ineffective. Around 10.5 percent agree that it is extremely ineffective. Furthermore, 30.9 % have a neutral stance. Moreover, 13% believe monitoring measures are effective, while 11.7 % believe these approaches are highly effective. In general, most respondents feel that the monitoring methods are inadequate (Figure 32).

In your observation, how do you rate current monitoring approaches for Billion tree Tsunami project?
162 responses
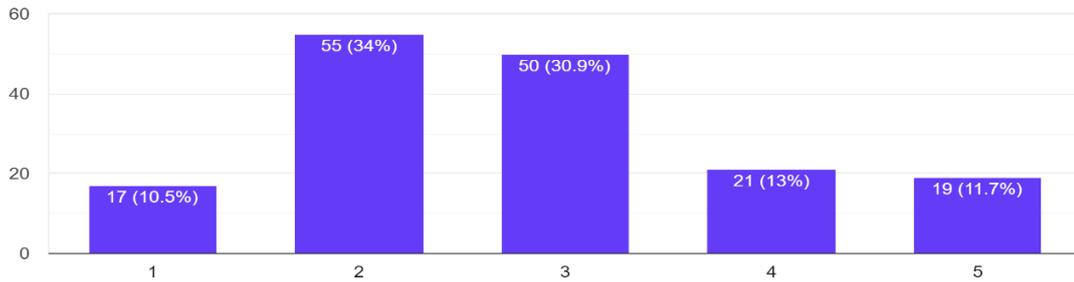
Figure 32. Respondents Opinion Regarding Billion Tree Tsunami Monitoring.
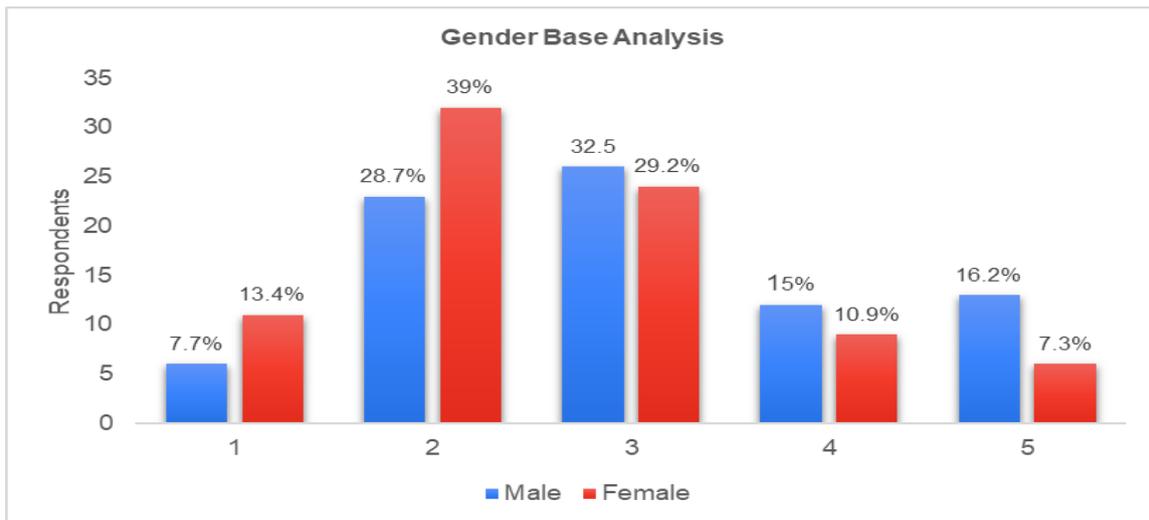
Figure 33 Gender Base Analysis of Question 7.

Figure 33 suggests that the vast majority of male and female respondents felt that monitoring is inefficient or highly ineffective (36.4 %) (52.3 %). However, the percentage of male and female participants who have a neutral opinion is significant, at 32.5 % and 29.2 %, respectively. Males and female favoured the effective and highly effective choice 15 %, 10.9 %, and 16.2 %, 7.3 % respectively.

4.1.8. **Attitude towards the role of sound policies in forest degradation**

The aim of including this question in the survey was to have a better understanding of how respondents thought about whether deforestation in the country was also influenced by a lack of effective policies. Figure 34 shows that 34% of respondents firmly believe that the lack of effective policies has a very high contribution to deforestation, while 24.1 % believe it has a high role. However, 13% of those polled oppose that lack of sound policies does not contribute to deforestation and forest damage. Furthermore, the limited contribution by lack of sound policies in deforestation was suggested by 14.2 % of responders. While 14.8 % have a neutral opinion.

In your opinion, to what extent do absence of sound policies contributing to deforestation and forest degradation in your region?
162 responses
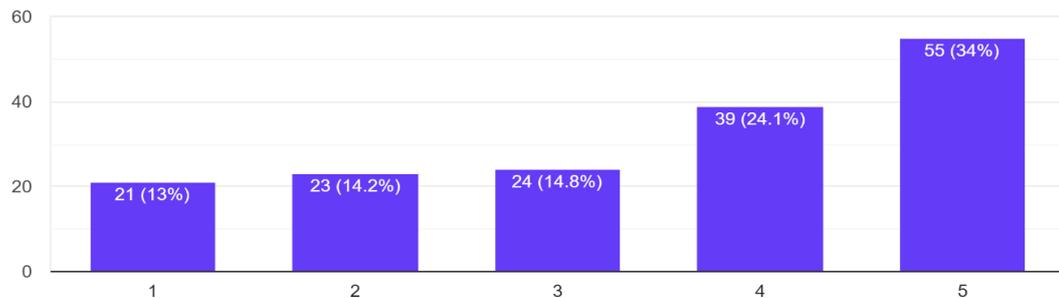
Figure 34 Respondents Position Concerning Absences of Sound Policies in the region
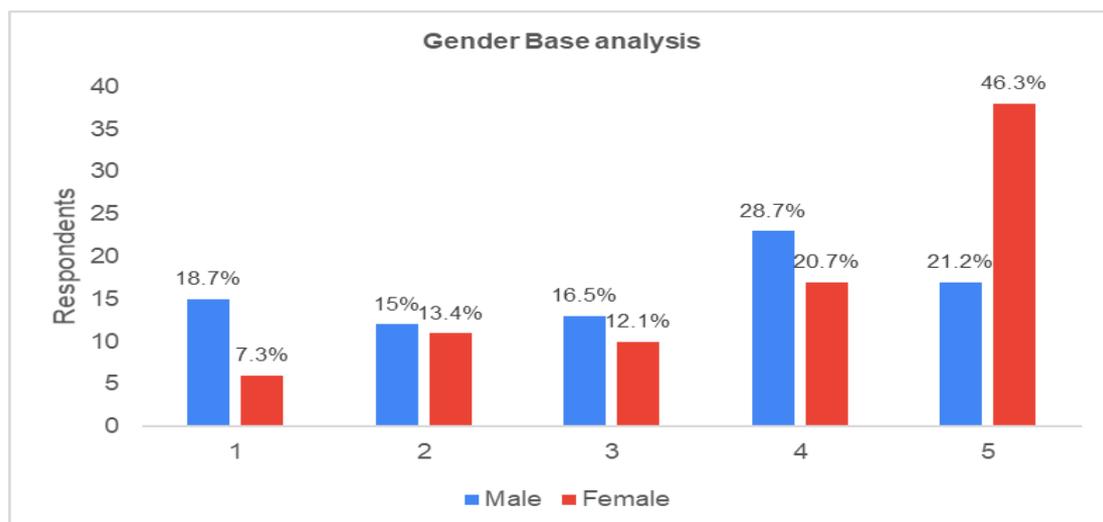
Figure 35 Gender Base Analysis of Question 8.

Figure 35 shows that the majority of females feel that deforestation is exacerbated by a lack of appropriate policies (46 percent) and (20.7%). While 21.2 percent of males believe it has a very high degree of contribution, 28.7% believe it has a high level of contribution. However, men were more likely than women to conclude that it makes no or only a minimum contribution.

4.1.9. **Public opinion toward main driver of deforestation**

The aim of including this question in the study is to gather responses regarding the driver of deforestation in the country. Illegal wood logging was considered by 49 % of the 162 participants as the primary cause of deforestation. Furthermore, 19.1 % of respondents believed that the usage of wood for domestic purposes was a driver of deforestation. Infrastructure development was blamed for deforestation by 11.1 % of respondents. Cattle ranching was also selected by 5.6 % of respondents as a driver of deforestation. 6.8% of those who responded selected Commercial Agriculture. Finally, 2.5 % believed deforestation was driven by forest fires. (Figure 36)

In your observation, which is the main driver of deforestation in your region?
162 responses
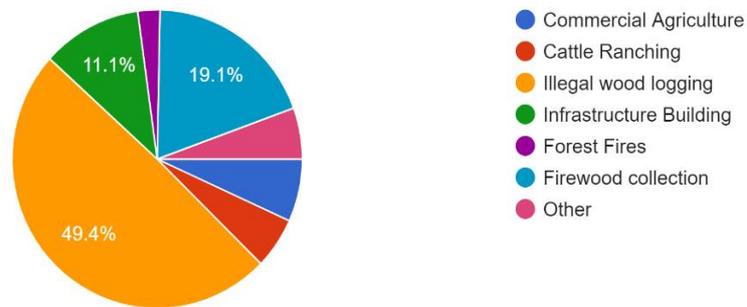
Figure 36 Driver of Deforestation Survey Results in the Region.
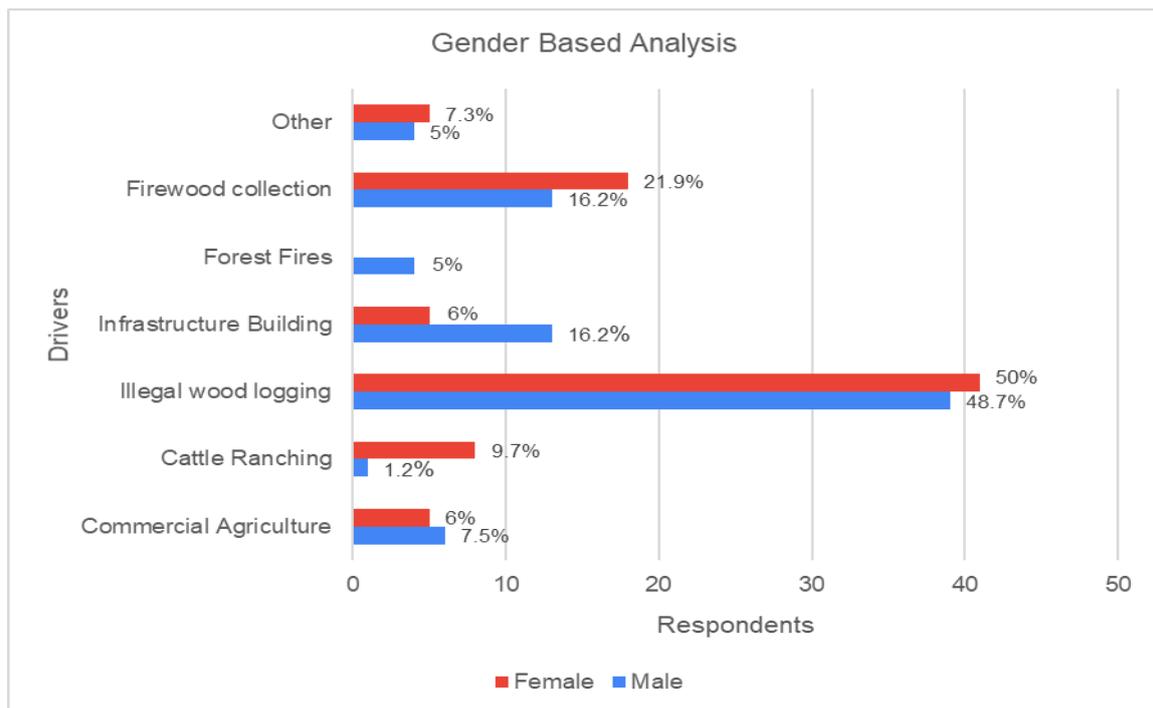
Figure 37 Gender Base Analysis of Question 9.

Illegal wood logging and firewood collecting appear to be the primary and secondary drivers of deforestation, according to the majority of female respondents in the poll. Similarly, male respondents have the same opinion. (See figure 37.) Male and female

respondents rated the remainder of the driver as not a serious threat to Pakistan's forestry sector.

4.1.10 Potential activity to address Deforestation in Locals perception

In your opinion, what can be the most potential activity for addressing Deforestation in your region?
162 responses
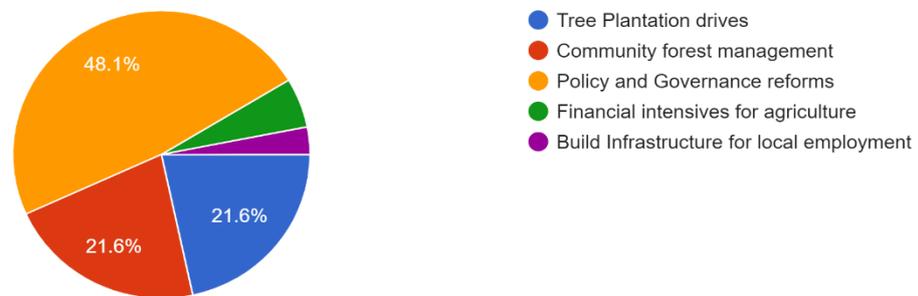
Figure 38 Responses Regarding Most Potential Activity to Address Deforestation.

Finally, the survey's last question was designed to determine what residents consider is the best way possible to address the issue of deforestation in their community. Most responses (48.1 %) in Figure 38 were in support of policy and governance improvements, suggesting that the majority of respondents were dissatisfied with forestry policies. 21.6 % of respondents, on the other hand, feel that community forest management and tree-planting campaigns were the possible way to tackle deforestation. Furthermore, 5.6 % believe that financial aid for agriculture is one of the solutions. Whereas, building infrastructure for local employment was favoured by 3.1% of respondents.
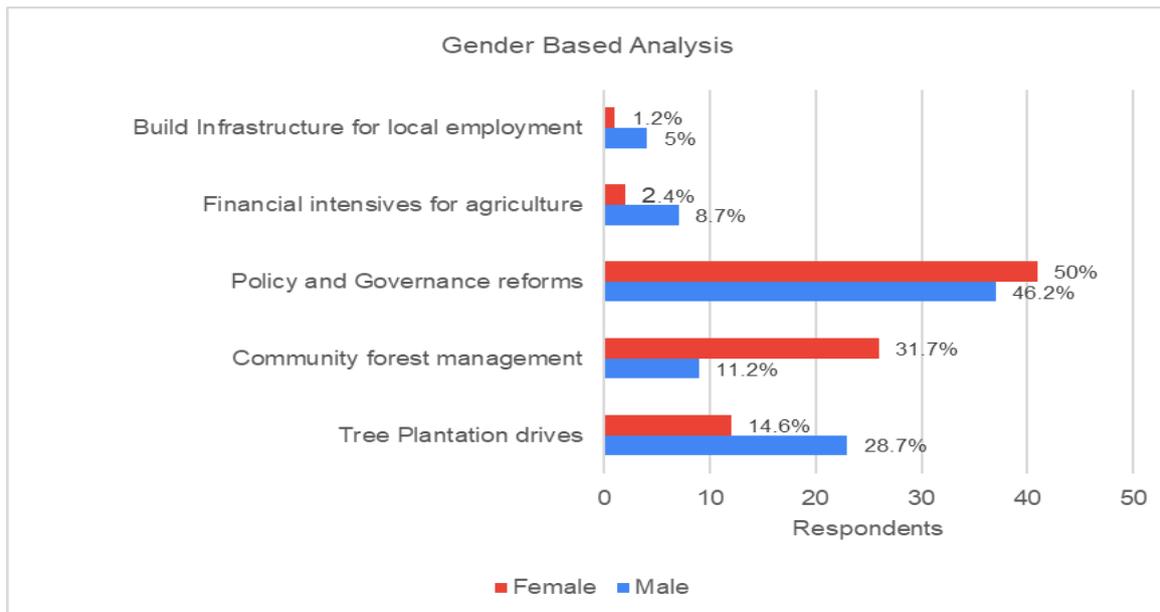
Figure 39 Gender Base Analysis of Question 10.

Question 10 Gender Base Analysis reveals that the majority of male and female respondents (45.2 % and 50 percent, respectively) consider policy and governance reforms as a possible solution to the deforestation problem. However, when it comes to secondary approaches, male and female respondents are split, with female respondents selecting Community Forest Management (31.7 %) and male respondents favouring Tree Planting Drives. (Figure 39)

4.2. Provincial Based Analysis

Further evaluation was carried out in this study to better understand the behaviour of the respondents at the province level. The graph below represents the participants' attitudes at the province level.

The Poll was mostly dominated by male respondents from the province of Khyber Pakhtunkhwa (KP). Their reliance on wood as a source of energy is significant (Figure 40). Furthermore, the male respondent from KP identified illegal wood logging as the primary cause of deforestation, while policy and governance reforms and tree plantation drives were suggested as potential solutions. Female respondents, on the other hand, had a mixed reaction to all of the questions.
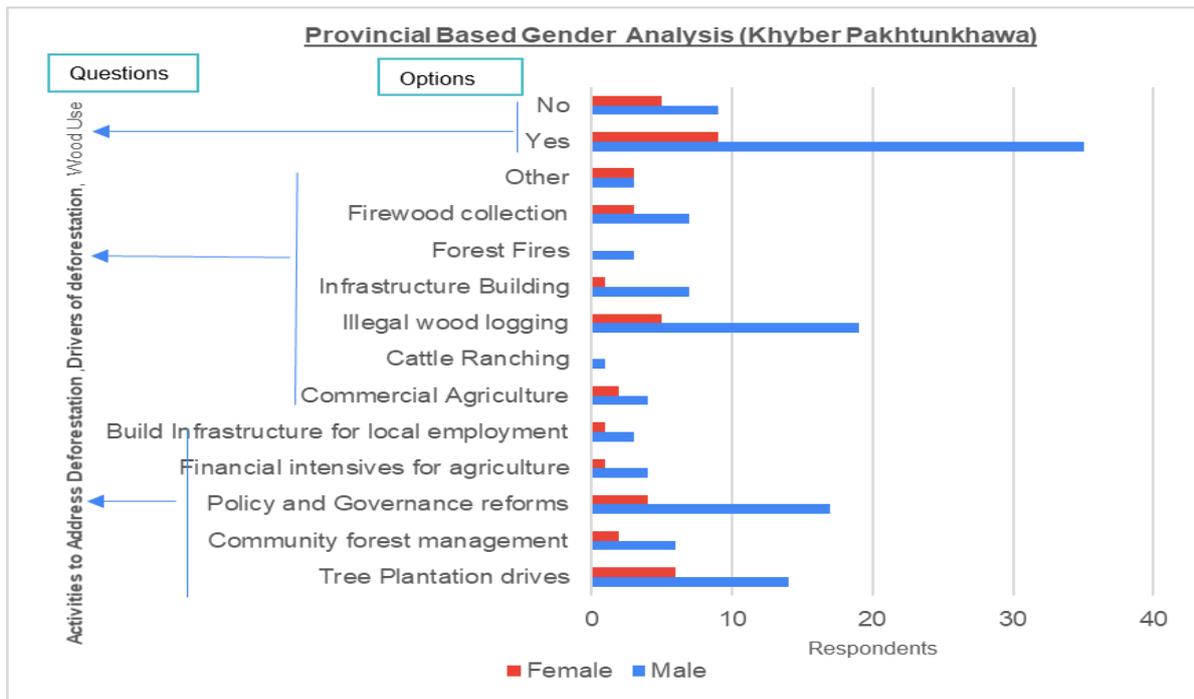
Figure 40. Attitude of Respondent toward Driver of Deforestation and its Solutions (Khyber Pakhtunkhwa).

Furthermore, both male and female respondents in Gilgit Baltistan Province participated actively in the poll (see Figure 41 below). In their region, most of the respondents feel that wood is heavily used for home purposes. Most respondents feel that deforestation was driven by firewood collecting and illegal timber logging. While, the majority of respondents, especially women, considered policy and governance reforms, as well as Community Forest Management, as potential solutions to deforestation. There were, however, other opinions as well.
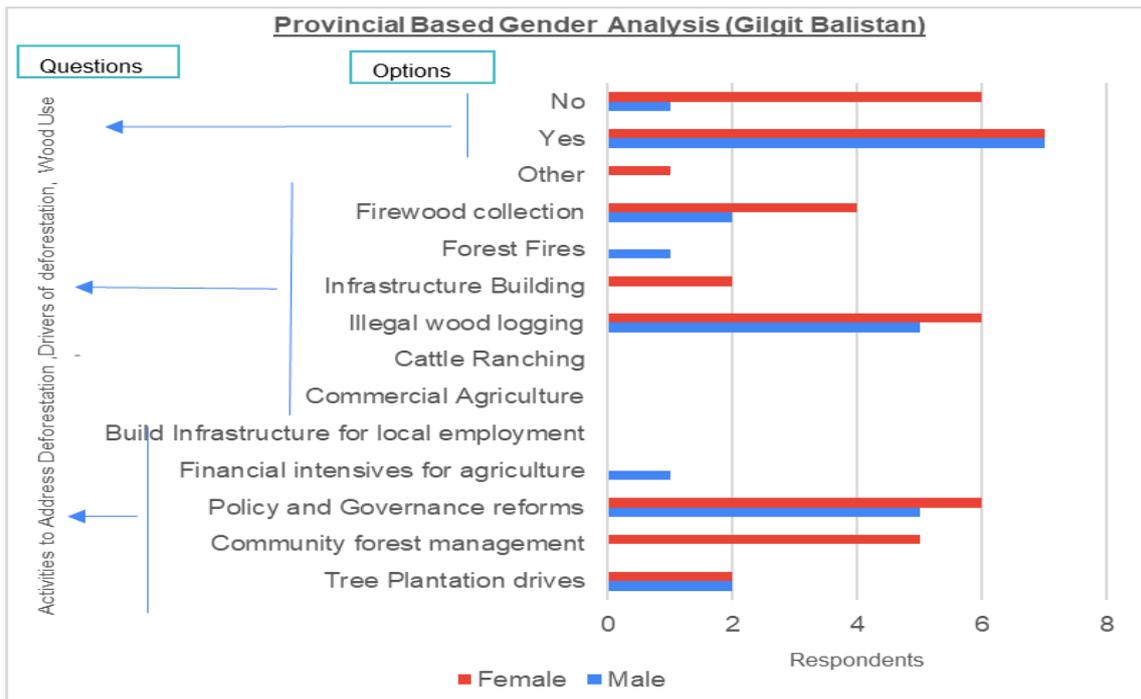
Figure 41 Provincial Based responses to Survey from Gilgit Baltistan.

Thirdly, in the survey, which was conducted in Punjab, the participation of male was slightly high than female respondents. Some participants thought that they use wood as a fuel resource. While others contradicted the statement. Male participants considered Infrastructure Building and illegal wood logging and the causes of deforestation. While efficient policy (Figure 42) was believed to be the possible solution to the problem by both genders.
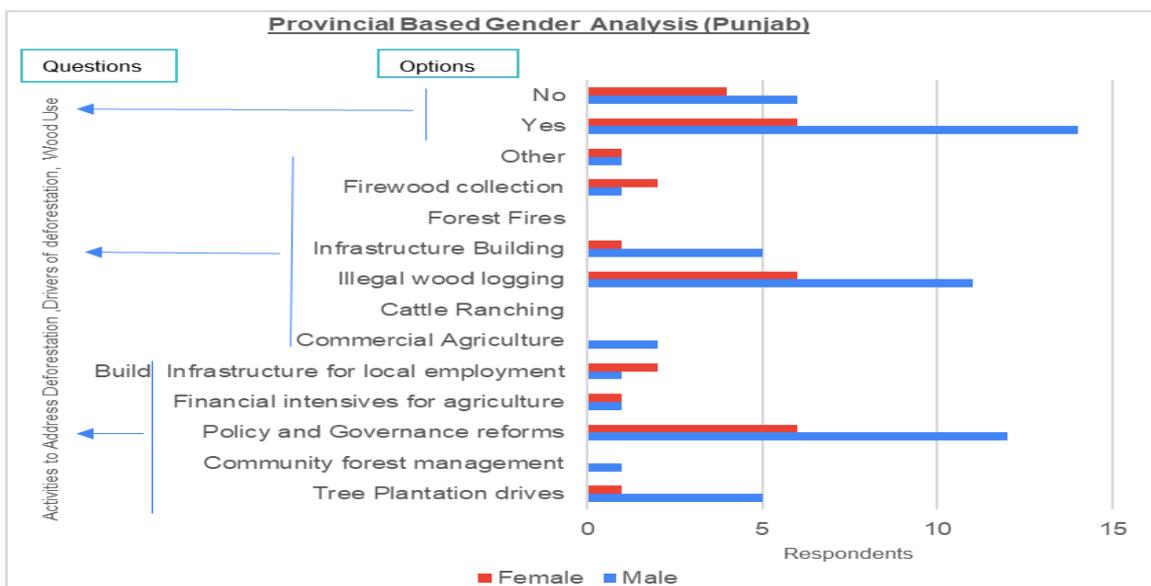
Figure 42 Gender-based survey results (Punjab)
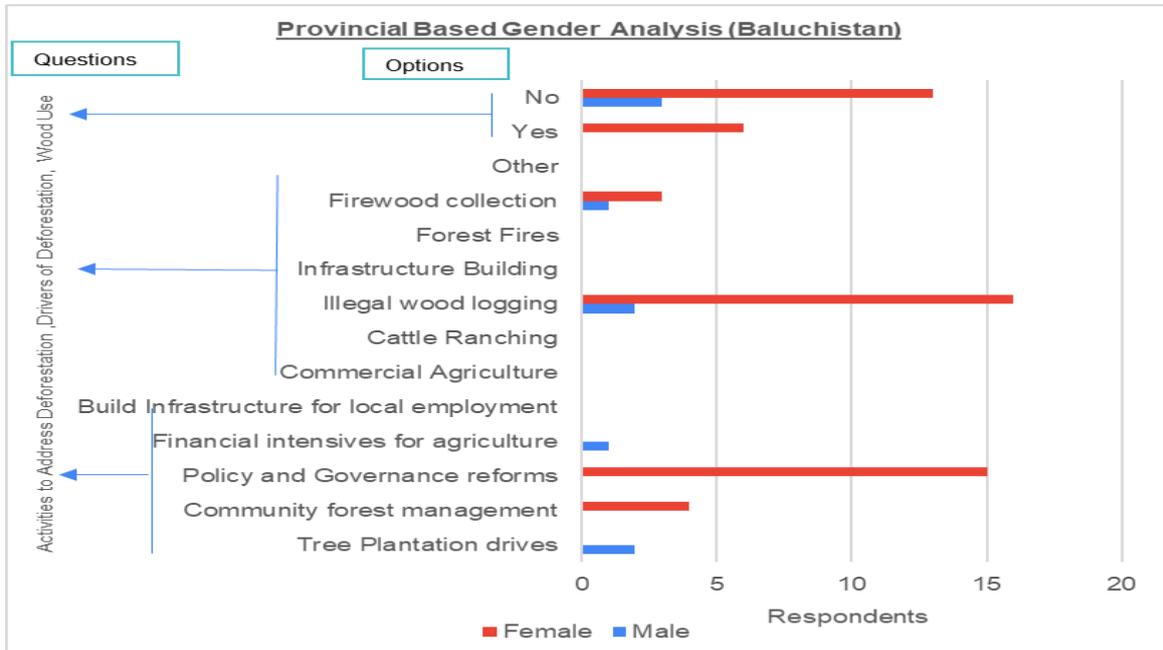
Figure 43 Baluchistan Province Gender-Based Survey Results.

This poll was overwhelmingly dominated by female respondents, as shown in Figure 43. In response to the widespread utilization of wood as a fuel source, most people avoided using fuel for home purposes. While the same trends were evident in the study results as well, with Illegal wood logging being cited as the primary source of deforestation. Policy reforms, on the other hand, were seen as a viable activity to combat deforestation.
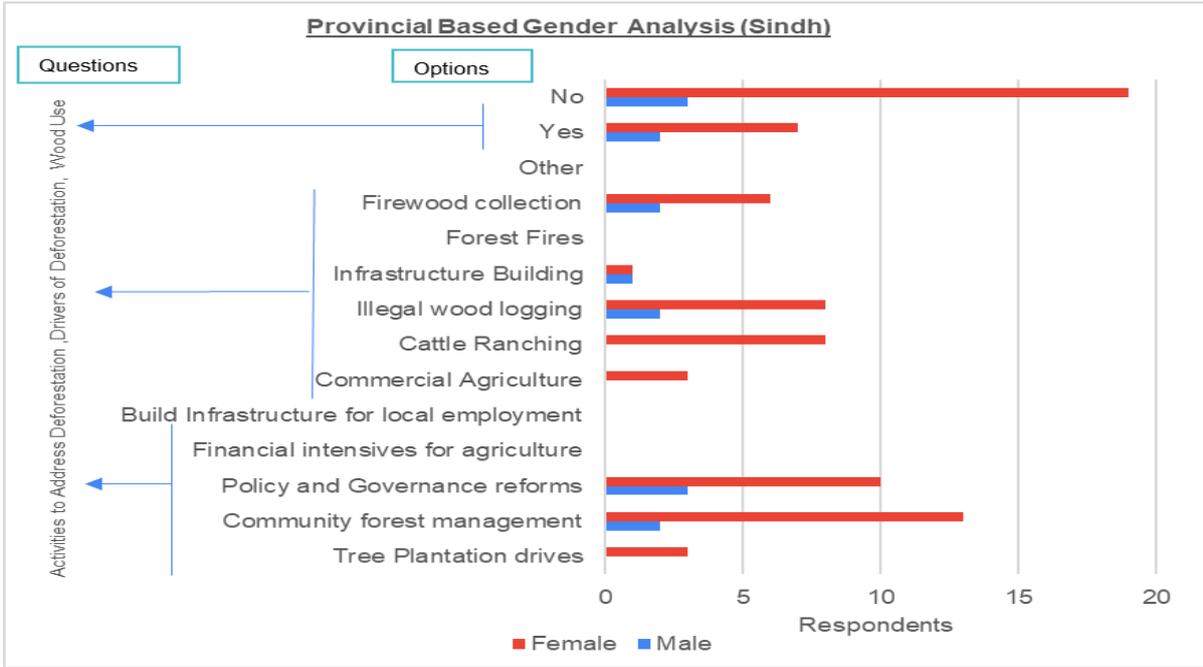
Figure 44. Sindh Province Gender-Based Survey Results.

Again, female respondents outnumbered male respondents in the Sindh survey. They do not utilize wood in their homes. Illegal wood logging is also the biggest danger to Sindh's natural resources, as per respondents. Furthermore, most participants feel that Community Forest Management (Figure 44) is the primary solution, whereas policy and governance improvements are viewed as a secondary solution to the problem.

4.3. Educational and age Based Analysis.

A detailed analysis of responses from highly educated respondents with mature age, highly educated respondents with a young age, and finally the attitude of respondents with no education toward the poll has been carried out to better understand the behaviour of the respondents. (Table 9–11). It is also worth noting that respondents who remain impartial in the poll figures are not counted in all remaining analysis.

Table 9. Respondents Attitude based on Varying age and education (Question 1 - 7)

Questions	How do you rate your knowledge regarding the environmental consequences of Deforestation		2 to 6	In your opinion, how do you rate Monitoring approaches for Billion tree Tsunami project?	
Options	Highly unaware+Unaware	Aware+HighlyAware		Highly Ineffective+Ineffective	Highly effective+effective
High school/College or Higher, Age=30-50 and 50+	6	17	Same Attitude	9	14
High school or Higher, Age=18-25 and 25-35	27	5	Same Attitude	15	8
No Education	12	5	Same Attitude	15	2

Most mature respondents (Age 35 to 50+) and those with a high school or higher degree in Table 9 have a good understanding of the environmental consequences of deforestation. Those with the same education level but who are young (18-25, 25-35) and those who are uneducated have less knowledge about the repercussions of deforestation.
Question 2-6, on the other hand, shows the same behaviour across all age groups and levels of education (Majority considers Forest been beneficial to the country, same about population been one of the reasons of deforestation, majority are not satisfied with reforestation activities and institutional performances).

Table 10 Respondents Behaviour toward Question 8 and 9 (age and education-wise)

Questions	8. To what extent do absence of sound policies contribute to deforestation and forest degradation in your region?		9. In your observation which one the main Driver of deforestation in the region?		
Options	No Contribution+negligable contribution	High Contribution+very high Contribution	Illegal wood logging	Firewood collection	Other Driver Responses *(Commercial Agriculture, Cattle Ranching, Forest Fires, Others)
High school/College or Higher, Age=30-50 and 50+	5	17	9	6	10
High school or Higher, Age=18-25 and 25-35	18	11	17	5	11
No Education	10	7	5	9	4

In addition, the majority of mature respondents with a high school or college qualification (Table 10) believe that lack of sound policy plays a critical role in the loss of forest cover, whereas young respondents with high education are divided on the above statement, with few in favor of the first statement, However, the majority of young respondents and those with no education disagree, believing that policies play no contribution in deforestation. Furthermore, respondents of mature age (35-50+) and young age (18-25, 25-35) viewed illegal timber logging as the primary cause of deforestation, whereas uneducated people chose the alternative of firewood collecting.

Table 11. age and education-wise Attitude toward Survey Question 10.

Questions	10. In your opinion, what can be the most potential activity for addressing Deforestation in your region?			
Options	Tree Plantation drives	Community forest management	Policy and Governance reforms	Financial intensives for agriculture + Build Infrastructure for local employment.
High school/College or Higher, Age=30–50 and 50+	2	8	8	0
High school or Higher, Age=18-25 and 25-35	8	3	15	7
No Education	1	12	4	2

Finally, highly educated mature age group respondents preferred Community Forest Management and Policy and Governance reforms, whereas highly educated young, aged individuals viewed Policy and Governance reforms as a potential solution to deforestation (Table 11). Uneducated participants, on the other hand, believe that community forest management is the way to go.

4.4. Occupation Base Analysis

The purpose of conducting occupation-based analysis is to understand the attitudes of respondents from various backgrounds. In Table 12 most of the respondents from various backgrounds agree or strongly agree that migration and population growth are the causes of deforestation. In response to a question about local institution awareness campaigns and the performance of local institutions, the majority of people believe they are ineffective or severely ineffective, with only students satisfied with their efforts.

Table 12. Analysis based on the occupation of the respondents.

Questions	In your opinion, do you believe that the increase in population and influx of land migrants resulted in deforestation in your region?		In your opinion, to what extent do you rate efforts (Voluntary pledges, Awareness campaigns) of local institutions, governing bodies to tackle deforestation and/or address forest degradation?	
Options	Strongly Disagree+ Disagree.	Strongly agree+ agree	Highly Ineffective+Ineffective	Highly effective+effective
Student	11	44	16	28
Labor worker	1	13	10	2
Businessperson	4	12	10	4
Farmer	2	26	21	5
Government officer	1	11	7	4
Other	0	19	6	12

Furthermore, to know the behaviour of respondents belongs to different backgrounds regarding the role of the absence of policies in deforestation and the driver of deforestation in the region as shown in Table 13 below. An individual having different background believes that the absence of sound policies in the region have contributed to deforestation. While students have mixed opinions with almost half of the respondents believe that the absence of sound policies has no role in deforestation.

As per the second question response, illegal timber logging is the primary cause of deforestation, according to students, farmers, government officials, and others. While a labor worker and businessperson have chosen the option of firewood and cattle ranching respectively.

Table 13 Attitude of the Professions towards question regarding the role of absence of sound policies and driver of deforestation

Questions	To what extent do absence of sound policies contribute to deforestation and forest degradation in your region?		In your observation which one the main Driver of deforestation in the region?				
Options	No Contribution +negliable contribution	High Contribution +very high Contribution	Illegal wood logging	Firewood Collection	Cattle Ranching	Infrastructu - re Building	Other Driver Responses (Commercial Agriculture, Forest Fires, Others)
Student	22	29	29	8	1	12	13
Labor worker	4	10	4	8	0	0	2
Businessperson	3	13	7	2	8	1	0
Farmer	5	24	23	4	1	1	1
Government officer	2	8	7	3	0	3	1
Other	8	10	10	6	0	3	4

Table 14 Occupation-based analysis.

Questions	In your opinion, what can be the most potential activity for addressing Deforestation in your region?			
Options	Tree Plantation drives	Community forest management	Policy and Governance reforms	Financial intensives for agriculture + Build Infrastructure for local employment.
Student	22	8	24	8
Labor worker	1	10	3	0
Businessperson	3	9	5	1
Farmer	0	7	15	8
Government officer	3	3	6	2
Other	9	1	11	2

Finally, a question was posed in the survey to get the opinion of the different professionals regarding the most useful activity to curb deforestation in their region. Community forest management, according to labor workers and Businesspersons, is the way forward. While Students, farmer government officers, and others considered Policy and Governance reforms as the potential solution to address deforestation.

5. Summary

This study focused on deforestation in Pakistan. Mainly focused on the identification of drivers which lead to deforestation, Efficiency, and management of policies related to forestry. The study sought the opinions of locals and targeted all the five provinces through the survey. In addition, through the literature review; the causes and effects of deforestation are identified.

The survey results showed that less than 50% of the people in Pakistan are not aware of the environmental consequences of deforestation. Furthermore, more than 80% of respondents believe that conserving tropical forests in Pakistan can benefit Pakistan. In addition, as the literature review showed that wood is also been consumed as a source of energy mostly in rural areas. However, survey results represent that above 57.4% of the residents are consuming wood for cooking, water, and space heating. Moreover, more than 80% of the respondents agree that an increase in population and influx of land migrants resulted in deforestation. In addition, regarding the current reforestation activities; about 50% of the respondents stated that current reforestation activities are not enough to address the issue. Similarly, most respondents believe that voluntary pledges and awareness campaigns from local institutions and governing bodies are not up to mark. Similarly, regarding the monitoring approaches for the Billion tree tsunami project; most respondents responded that monitoring approaches are not sufficient. Moreover, when identifying the main drivers of deforestation illegal wood logging, followed by commercial agriculture were considered the main driver of deforestation in Pakistan. Lastly, when identifying the most potential activity for addressing deforestation in Pakistan it was observed that policy and governance reforms can address the issue.

Furthermore, during gender-based analysis considering the awareness regarding the environmental consequences of deforestation, the same trend for both genders was observed (Figure 21). Furthermore, when it comes to the issue of population and migrant surge, the majority of women believe it contributes to deforestation (57% female agreed, 36% male agreed). Mostly, for most of the questions Trends are similar for both genders. However, regarding the absence of sound policies, mostly female strongly agree that absence of sound policies are leading to deforestation. In addition, regarding drivers of deforestation gender base analysis showed that mostly female believe that firewood collection and cattle ranching is the main driver of deforestation. However, more male as compared to females believe that infrastructure building is the main driver. Lastly, when identifying potential activities, the gender base analysis reveals that as compared to female mostly males believe that tree plantation drive can be a sufficient activity.

However, more female as compared to male believe that community forest management can be a potential activity.

In addition, individuals with high education and age (35-50+), as well as young people with high education and uneducated mindset, were studied. Most persons of mature age are aware of the environmental impacts of deforestation and believe that monitoring methods are quite effective. They also agree that a lack of sound policy has played a significant role in deforestation, and they see illegal wood logging as the primary deforestation driver, with community forest management and policy and governance reforms as potential solutions. Young age (18-35) and uneducated respondents were mainly unaware of the environmental consequences of deforestation. Furthermore, individuals from both groups believe that current monitoring methods for the Billion Tree Tsunami are ineffective. In response to the lack of a sound policy role in deforestation question, both uneducated and young respondents with a high level of education believe that policy has no role in deforestation, according to the survey. While young people have selected illegal wood logging as the primary cause of deforestation, uneducated participants have identified firewood collection as the primary cause. Finally, policy and governance improvements are seen as the solution to deforestation by young respondents, whereas community forest management is preferred by those with no education.

Furthermore, the behaviour of respondents from various Profession was identified. In response to the question of the impact of expanding population and land migration on deforestation, all experts agree that these two causes have played a part in deforestation. The same trend and attitude were noticed in the question about the role of lack of policy in deforestation, with everyone agreeing that the region's deforestation is due to a lack of appropriate policies. While the question asked about the main driver of deforestation, Farmer and others listed illegal wood logging as the primary cause, while labor and farmers have identified firewood collection as a source of deforestation, businessmen have cited cattle ranching as a source of deforestation. Finally, policy and governance reforms have been highlighted as a potential solution by students, farmers, government officials, and others, while labor and businessperson have opted for community forest management as a potential solution to deforestation.

Finally, the evaluation of this study based on survey results and literature review is that most people in Pakistan are not aware of especially the young age people (18-25, 25-35) and uneducated individuals, regarding the environmental consequences of deforestation. Local authorities in Pakistan rarely conduct awareness programs. As a result, it is recommended that effective awareness programs addressing the environmental consequences of deforestation be implemented. Furthermore, studies show that there are

insufficient policies in place to combat deforestation, hence it is suggested that sound and efficient policies be implemented to address the problem. Furthermore, the study discovered that wood is often used for domestic purposes, contributing to deforestation in rural regions. As a result, there should be a proper alternative. In addition, because illegal wood logging and firewood collection are the primary and secondary causes of deforestation, appropriate methods, and policies to address these issues should be implemented. Finally, the results of the survey imply that community forest management and policy reforms can help to combat deforestation. A proper monitoring system, on the other hand, should be in place.

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