Micro-level Study of Deforestation in Capital Territory of Pakistan

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Abstract
Wood products are better than artificial material, products when evaluating with environmental concerns, but our world's forests cannot be compromised for these products. As increasing demand for wood product leads to deforestation, more rapid tree cutting even without permits and cause threat to human health and wildlife. The current study estimates the percentage of wood cutting and gives a comparison of green cover for a period (2009-2016) in Margalla Hills National Park (MHNP), Islamabad. Scale and aftermath of wood harvesting is a major area of concern. The wood consumption by villagers of MHNP, the role of authorities and communities to safeguard MHNP and its effects are also studied by incorporating villagers and forest guards' point of view through questionnaire and interviews respectively. Forest cover of MHNP is reduced at high percentage due to deforestation and different land use pattern. It needs to be monitored and taken as the responsibility of government and public to protect forests.
Keywords: encapsulation of biodiversity, villagers' particulars, forest guards' particulars, responses

1. INTRODUCTION

Margalla Hills National Park is a national park located in Islamabad Capital Territory, Pakistan falling in the IUCN category V (protected landscape/seascape). The park includes the Margalla Hills, which forms the foothills of the Himalayas, along with Shakarparian Park and Rawal Lake. Established in 1980, Margalla Hills National Park covers approximately 17,386 hectares (67.13 mi^2). The land use/land cover mapping activity of the Margalla Hills National Park (MHNP) is carried out by the WWF-Islamabad team and the steps involved are discussed below.

The Margalla hills national park (MHNP) is in the foothills of Himalayas in Pakistan(Khalid *et al.* 2018). The total area covered by Margalla hills is 203.9 km^2 (CDA, Islamabad capital territory map). The capital city Islamabad is divided into zones where Margalla hills are in zone 3. (CDA, Islamabad capital territory map) (Figure 1)
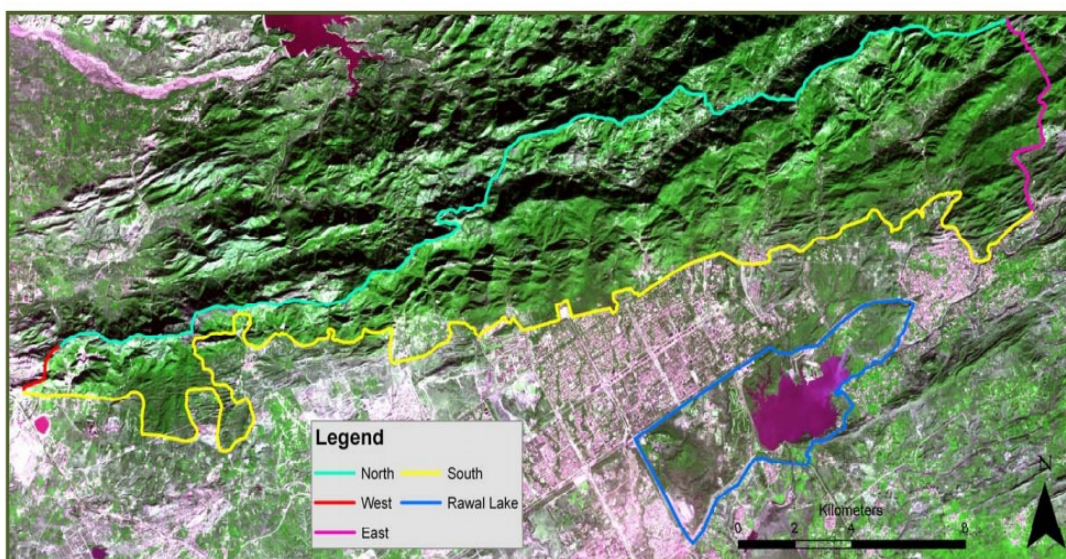
Figure 1 *Margalla Hills National Park (WWF-report 2009)*

A study on 'Illegal Logging and Related Timber Trade' reported that China depends upon all tropical forest regions and Russia for illegal timber whereas India depends on Southeast Asia. China consuming the illegal wood with a worth of USD (United States Dollar) 3295.7 million annually, Vietnam of USD 767.3 million, India of USD 596.5 million, EU of USD 453.9 million, Thailand of USD 101.4 million, USA (United States of America) of USD 88.2 million, South Korea of USD 22.4 million, Japan of USD 15.1 million, Malaysia of USD 12.1 million and Australia of USD 1.1 million(Maryudi 2016). Whereas Pakistan contributes about USD 782 million for illegal logging, annual illegal wood harvesting(Chiabai *et al.* 2011).

2.   LAND COVER CLASSIFICATION METHODOLOGY

Methodology for Processing of Classification of Margalla Hills National Park is done using Open Source software named "Quantum GIS (QGIS)" following the IPCC Good Practice Guidelines (GPG) & Global observation of Forest and Land Cover - FAO (GOFC-GOLD) (Figure 2).
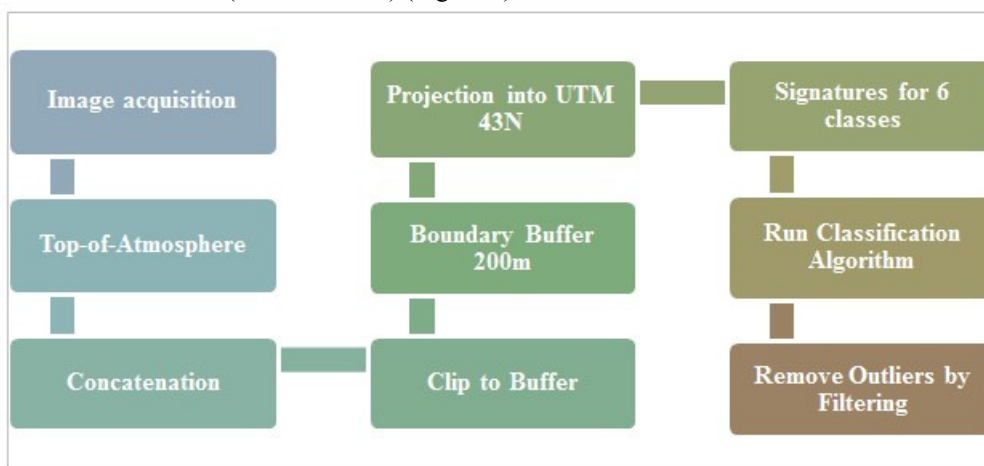

Figure 2 *Flowchart showing the method of classification*

The step-wise process is cumbersome but bears fine-tuned results. They can be summed up as follows:

2.1. Image acquisition

Freely available satellite imagery is downloaded from the NASA's US-Geological Survey website. As a search criterion, it is best to select search query of satellite imagery while browsing for the month's range September - November because the cloud-cover is the least and the results achieved are more accurate.

2.2. Pre-processing

Top-of-Atmosphere (ToA) correction is applied along with some histogram stretches to improve visual interpretation for analysis of the imagery. For the purpose of stacking the individual bands into one seamless raster file, we concatenate the visible (RGB) and Infrared (NIR, SWIR) bands.

The projection system of all datasets should be kept the same i.e. UTM Zone 43 in our case which corresponds to code 32643 of the EPSG Geodetic Parameter Dataset, a structured dataset of Coordinate Reference Systems and Coordinate Transformations, accessible through this online registry (www.epsg-registry.org). We clip the imagery to our MHNP boundary with a buffer of 200m circular radius.

2.3. Classification

Using the Semi-automated Classification Plugin (SCP), we create "Macro Class Ids" according to IPCC and Micro Class Ids" if any. The classes used are as given in Table 1.

Table 1 *IPCC harmonized classes*

Code	Class
1	Forest
2	Cropland
3	Grassland
4	Wetland
5	Settlements
6	Another land

We use several image composites along with freely viewable "Google Earth" or "Bing Imagery" as a reference to validate our classification. Taking the classifier sample sets of each class defined to train the classifier; we keep minimum pixel size for the samples defined to avoid class mixing.

The classification process needs to be run several times to achieve the desired quality of results using different algorithms as "Spectral Signatures Mapping" or "Nearest neighbourhood method" etc. The processing of each signature set takes several hours to run depending upon the capabilities of the system. For this step, it may be helpful to check the RMS errors that each signature samples are generating and then replacing them with better pixel samples with RMS error closer to 1 or less. Root Mean Square Error (RMSE) is the standard deviation of the residuals (prediction errors). In simple words, it tells you how concentrated the data is around the line of best fit.

The results can be checked by computing the raster statistics and are refined until the desired accuracy is achieved. As a final step, the achieved output may have some sinks or "Outliers" and these can be removed by applying filtering tools to the "Salt and Pepper" from the scene.

Figure 3 shows the focused map of Margalla Hills National park, the study area. The boundaries are labelled. Figure 4 shows the areas that were visited to conduct the questionnaire and interview survey.
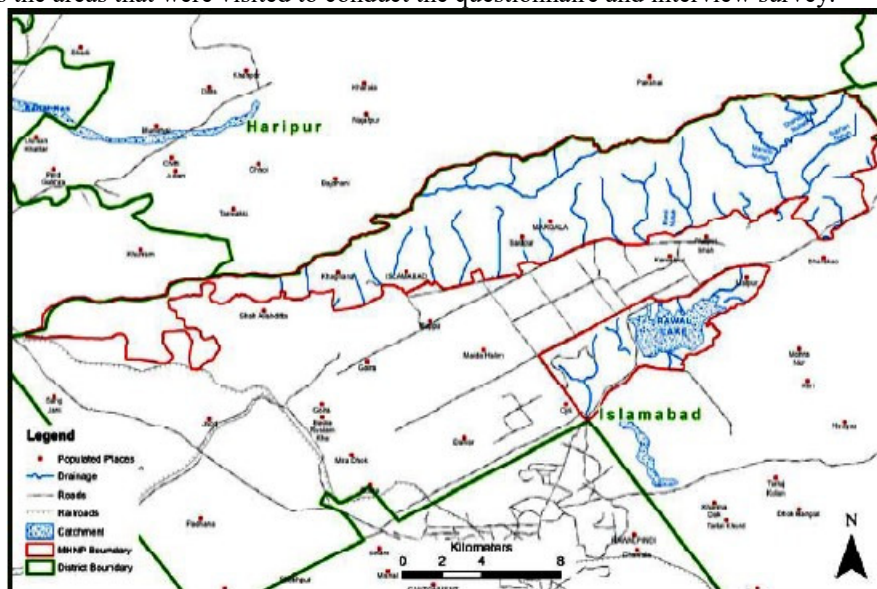

Figure 3 *Focused MHNP map/area, study area (WWF)*

Figure 4 *Location of villages visited of MHNP (red markers) (Google Maps)*

Table 2 shows the coordinates of selective households in Saidpur village, Table 3 shows the coordinates of selective households in Nurpur village, Table 4 shows the coordinates of selective households in Shahdara village and Table 5 shows the coordinates of selective households in Rumli village.

Table 2 *Selective Saidpur village coordinates for survey*

Saidpur Village coordinates		
Serial no.	Coordinates	Elevations
1	33.73157˚N, 073.03616˚E	630m
2	33.74025˚N, 073.06653˚E	637m
3	33.74061˚N, 073.06632˚E	638m
4	33.74111˚N, 073.06632˚E	641m
5	33.74152˚N, 073.06690˚E	642m
6	33.74164˚N, 073.06765˚E	642m
7	33.74257˚N, 073.06782˚E	647m
8	33.74353˚N, 073.06789˚E	646m
9	33.74477˚N, 073.06831˚E	645m
10	33.74522˚N, 073.06854˚E	645m
11	33.74026˚N, 073.06609˚E	623m
12	33.74008˚N, 073.06564˚E	621 m
13	33.74059˚N, 073.06764˚E	623m
14	33.74054˚N, 073.06825˚E	623m
15	33.74056˚N, 073.06912˚E	621m

Table 3 *Selective Nurpur village coordinates for survey*

Nurpur Village coordinates		
Serial no.	Coordinates	Elevations
1	33.74566˚N, 073.10509˚E	609m
2	33.74562˚N, 073.10236˚E	588m
3	33.74920˚N, 073.10236˚E	598m
4	33.74992˚N, 073.10554˚E	596m
5	33.75032˚N, 073.10651˚E	601m
6	33.75142˚N, 073.10720˚E	596m
7	33.75094˚N, 073.10785˚E	598m
8	33.75113˚N, 073.10867˚E	606m
9	33.74575˚N, 073.10509˚E	587m
10	33.74609˚N, 073.10564˚E	588m
11	33.74628˚N, 073.10638˚E	592m
12	33.74627˚N, 073.10708˚E	596m
13	33.74652˚N, 073.10872˚E	595m
14	33.74550˚N, 073.10878˚E	591m
15	33.74561˚N, 073.10938˚E	587m

Table 4 *Selective Shahdara village coordinates for survey*

Shahdara Village coordinates		
Serial no.	Coordinates	Elevation
1	33.74413˚N, 073.15845˚E	581m
2	33.75544˚N, 073.16597˚E	597m
3	33.76167˚N, 073.17166˚E	611m
4	33.76397˚N, 073.17242˚E	621m
5	33.76445˚N, 073.17304˚E	623m
6	33.76494˚N, 073.17371˚E	628m
7	33.76552˚N, 073.17425˚E	631m
8	33.76719˚N, 073.17384˚E	645m
9	33.77509˚N, 073.17392˚E	643m
10	33.77570˚N, 073.17339˚E	647m
11	33.77649˚N, 073.17290˚E	669m
12	33.77639˚N, 073.17112˚E	666m
13	33.77675˚N, 073.17043˚E	664m
14	33.77759˚N, 073.16967˚E	661m
15	33.77807˚N, 073.16933˚E	663m

Table 5 *Selective Rumli village coordinates for survey*

Rumli Village coordinates		
Serial no.	Coordinates	Elevations
1	33.75164˚N, 073.13718˚E	616m
2	33.75209˚N, 073.13554˚E	615m
3	33.75341˚N, 073.13596˚E	620m
4	33.75376˚N, 073.13599˚E	622m
5	33.75843˚N, 073.13442˚E	643m
6	33.76294˚N, 073.13531˚E	662m
7	33.76728˚N, 073.13540˚E	670m
8	33.76804˚N, 073.13530˚E	673m
9	33.76926˚N, 073.13493˚E	678m
10	33.76926˚N, 073.13462˚E	686m
11	33.76949˚N, 073.13475˚E	688m
12	33.76981˚N, 073.13483˚E	689m
13	33.77078˚N, 073.13463˚E	694m
14	33.77085˚N, 073.13482˚E	696m
15	33.77094˚N, 073.13523˚E	698m

3.   ENCAPSULATION OF BIODIVERSITY

3.1. Margalla Hills

The present biodiversity of Margalla Hills National Park is condensed into Tables include a list of mammals, reptiles, birds, amphibians, fish that are non-native species, tree species, shrub species, herb species.

3.1.1.   Mammals

The list of mammals in MHNP is given in Table 6.

Table 6 *Mammals in Margalla Hills*

Sr.No	Common Name	Scientific Name
1.	Asiatic Leopard	*Panthera purdus pardus*
2.	Wild Boar	*Sus scrofa*
3.	Golden Jackol	*Canis aureus*
4.	Rhesus Macaque	*Macaca mulatta*
5.	Gray Goral sheep	*Naemorhedus caudatus*
6.	Leopard Cat	*Prionailurus bengalensis*
7.	Barking deer	*Muntiacus muntjac*
8.	Chinkara gazelle	*azella bennettii*
9.	Red fox	*Vulpes vulpes*
10.	Pangolin	*Pholidota*
11.	Porcupine	*Erethizon dorsatum*
12.	Yellow-throated marten	*Martes flavigula*
13.	Fruit bats	*Chiroptera*
14.	Rhesus monkey	*Macaca mulatta*
15.	Urial	*Ovis aries vignei*
16.	Goral	*Nemorhaedus goral*
17.	Grey wolf	*Canis lupus*
18.	Striped hyaena	*Hyaena*

3.1.2.   Reptiles

The list of reptiles in MHNP is given in Table 7.

Table 7 *Reptiles in Margalla Hills*

Sr.No	Common Name	Scientific Name
1.	Russell's viper	*Daboia*
2.	Indian cobra	*Naja naja*
3.	Himalayan pit viper	*Gloydius himalayanus*
4.	Saw-scaled viper	*Echis*

3.1.3.   Birds

The list of birds in MHNP is given in Table 8.

Table 8 *Birds in Margalla Hills*

Sr.No	Common Name	Scientific Name
1.	Himalayan Griffon vulture	*Gyps himalayensis*
2.	Laggar falcon	*Falco jugger*
3.	Peregrine falcon	*Falco peregrinus*
4.	Kestrel	*Falco sparverius*
5.	Indian sparrowhawk	*Accipiter nisus*
6.	Egyptian vulture	*Neophron percnopterus*
7.	White-cheeked bulbul	*Pycnonotus leucotis*
8.	yellow vented bulbul	*Pycnonotus goiavier*
9.	Paradise flycatcher	*Terpsiphone*
10.	Black partridge	*Melanoperdix niger*
11.	Cheer Pheasant	*Catreus wallichii (extinct)*
12.	Golden oriole	*Oriolus oriolus*
13.	Spotted dove	*Spilopelia chinensis*
14.	Collared dove	*Streptopelia decaocto*
15.	Larks	*Alaudidae*
16.	Shrikes	*Laniidae*
17.	Wheatears	*Oenanthe*
18.	buntings	
19.	Kalij pheasant	*Lophura leucomelana*

20.	Black partridge	*Francolinus pondicerianus*
21.	Grey patridge	*Francolinus pondicerianus*
22.	Mallard ducks	*Anas platyrhynchos*
23.	Pintail ducks	*Anas acuta*
24.	Shoveler ducks	*Anas clypeata*
25.	Common coots	*Fulica atra*
26.	Pochard	*Netta rufina*
27.	Wigeon	*Anas penelope*
28.	Tufted Duck	*Aaytha fuligula*
29.	Common teal	*Aaytha crecca*
30.	Blue-winged teal	*Aaytha querquedula*
31.	Great crested grebe	*Podiceps cristatus*
32.	Great cormorant	*Phalacrocorax carbo*
33.	Little egret	*Egretta garzetta*
34.	Grey heron	*Ardea cinerea*
35.	White-tailed plover	*Vanellus leucurus*
36.	Black-headed gull	*Larus ridibundus*
37.	Gargany	*Aaytha crecca*
38.	Little grebe	*Tachybaptus ruficollis*
39.	Great Egrot	*Egretta alba*
40.	White-tailed plover	*Vanellus leucurus*
41.	Black-headed gull	*Larus ridibundus*

3.1.4. Amphibians
The list of amphibians in MHNP is given in Table 9.

Table 9 *Amphibians in Margalla Hills*

Sr. No	Common Name	Scientific Name
1.	Skittering frog	*Euphlyctis cyanophlyctis*
2.	Indian cricket frog/Marshy frog,	*Fejervarya limnocharis*
3.	Murree hill frog	*Nanorana vicina*
4.	Indian burrowing frog	*Sphaerotheca breviceps*
5.	Short-ant frog	*Microhyla ornate*
6.	Narrow-mouthed balloon frog,	*Uperodon systoma*
7.	Marbelled toad/Indus valley toad	*Duttaphrynus stomaticus*

3.1.5. Fish (non-native species)
The list of fish in MHNP is given in Table 10.

Table 10 *Fish in Margalla Hills*

Sr. No	Common Name	Scientific Name
1.	Snakehead	*Channa channa*
2.	*Bullseye snakehead* or great *snakehead*	*Channa marulius*
3.	Rahu fish	*Labio rohita*
4.	Carp	*Catla catla*
5.	Mirigala	*Carrhinus mrigala*
6.	Carp, Karpe, Karpfen, Gulfam	*Cyprinus carpio*
7.	Mozambique tilapia	*Tilapia mossambica*
8.	Mahseer	*Tor putitora*

3.1.6. Trees species
The list of tree species in MHNP is given in Table 11.

Table 11 *Tree species in Margalla Hills*

Sr. No	Common name	Scientific Name
1.	Sheesham	*Dalbergia sissoo*
2.	Phulai	*Acacia modesta*
3.	Jhar Beri	*Ziziphus nummularia*
4.	Chir pine tree	*Pinus roxburghii*
5.	Paper mulberry	*Broussonetia papyrifera*
6.	Gum Arabic tree	*Acacia nilotica*

3.1.7. Shrubs species
The list of shrubs species in MHNP is given in Table 12.

Table 12 *Shrub species in Margalla Hills*

Sr.No	Common Names	Scientific Name
1.	Broad *leaf hopbush*	*Dodonaea viscosa*
2.	Spanish flag, butterfly weed	*Lantana camara*
3.	Variegated Tropical Reed, Variegated Reed Grass	*Phragmites karka*
4.	Broadleaf Cat Tail	*Typha angustata*
5.	Sanatha	*Dodonaea viscosa*

3.1.8. Herb species
The list of herb species in MHNP is given in Table 13.

Table 13 *Herb species in Margalla Hills*

Sr. No	Common Name	Scientific Name
1	Bermuda Grass, Doobgrass	*Cynodon dactylon*

RESULTS AND DISCUSSION
3.2. VILLAGERS PARTICULARS

Table 14 *Villagers particulars*

Status	Description
Number of villages	4
Name of villages	Rumli, Shahdara, Nurpur and Saidpur
Number of households per village	15
Gender	Male and Female
Age	25-45
Education	Under matric to graduate
Class	Low class

3.3. VILLAGERS RESPONSES
The responses of households are condensed into graphs in percentage against the specified options. The purpose of this survey is to evaluate the villages and other household depending upon the wood of Margalla Hills National Park. Their dependency affecting biodiversity and role of authorities played to safeguard the MHNP. The responses to the household questionnaire are given in Figure 5.
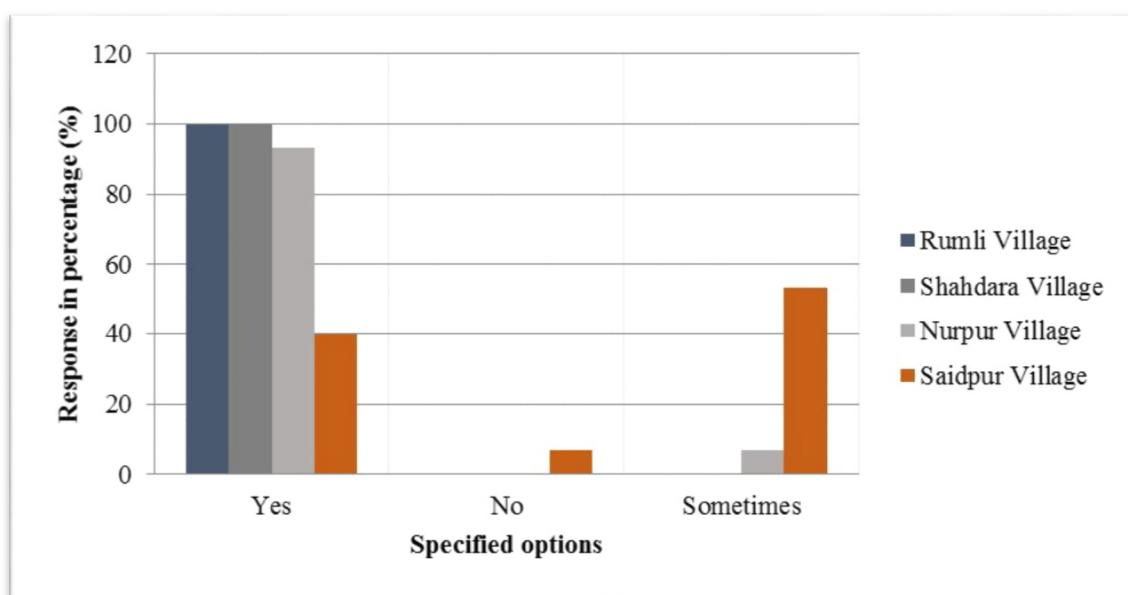

Figure 5 *Percentage of villagers depending on wood*

In Figure 5 the villagers' response in percentage against specified options is summarized for their dependency on wood. The three possibilities are "Yes", "No" and "Sometimes". 100% Rumli and Shahdara villagers favoured the option "Yes". 93.3% of Nurpur villagers favoured the option "Yes" and 6.7% favoured the option "Sometimes".

40% of the Saidpur villagers favoured the option "Yes", 6.7% favoured the option "No" and 53.3% favoured the option "Sometimes".

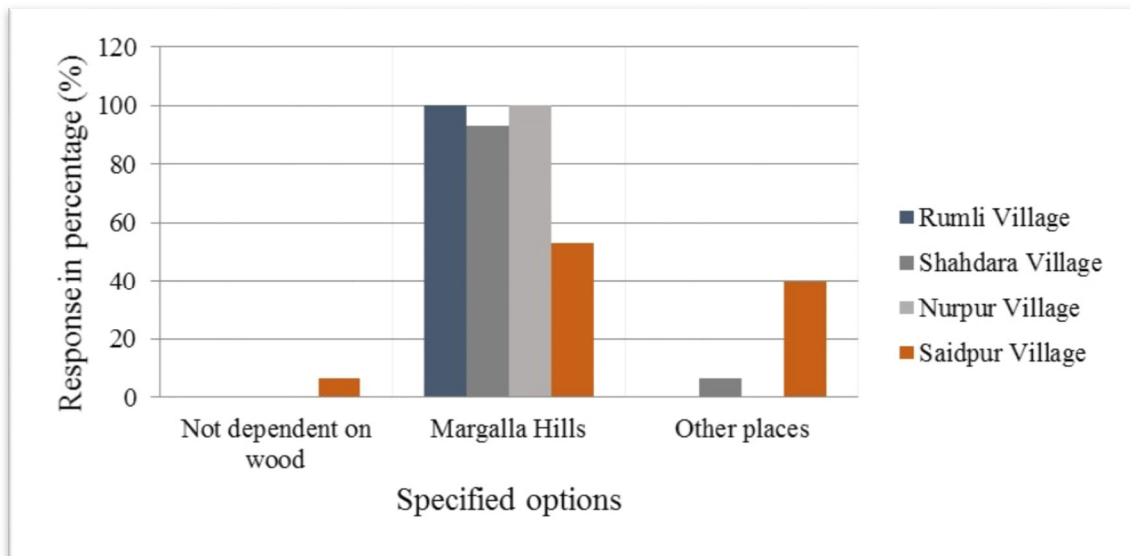The responses to the household questionnaire are given in Figure 6.

Figure 6 *Areas on which villagers depend on for wood*

In Figure 6 the villagers' response in percentage against specified options is summarized for areas on which villagers depend on for wood. The three possibilities are "Not dependent on wood", "Margalla Hills" and "Other places". 100% Rumli and Nurpur villagers favoured the option "Margalla Hills". 93.3% of Shahdara villagers favoured the option "Margalla Hills" and 6.7% villagers favoured the option "Other places". 53.3% of Saidpur villagers favoured the option "Margalla Hills", 6.7% villagers favoured the option "Not dependent on wood" and 40% villagers favoured the option "Other places". The responses to the household questionnaire are given in Figure 7.

Figure 7 *Wood dependency in kilograms per month*

In figure 7 the villagers' response in percentage against specified options is summarized for their wood dependency in kilograms per month. The four possibilities are "<80 kgs", "80-160 kgs", "160-240 kgs" and ">240 kgs". 20% Rumli villagers favoured the option ">240 kgs", 33.3% villagers favoured the option "160-240 kgs" and 46.7% of the villagers favoured the option "80-160 kgs". 93.3% of Shahdara villagers favoured the option ">240 kgs" and only 6.7% villagers favoured the option "<80 kgs". 26.7% of Nurpur villagers favoured the option ">240 kgs", 53.3% villagers favoured the option "160-240 kgs" and 20% villagers favoured the option "80-160 kgs". 26.7% Saidpur villagers favoured the option ">240 kgs", 6.7% villagers favoured the option "160-240 kgs", 33.3% villagers favoured the option "80-160 kgs" and 26.7% villagers favoured the option "<80 kgs". The

responses to the household questionnaire are given in Figure 8
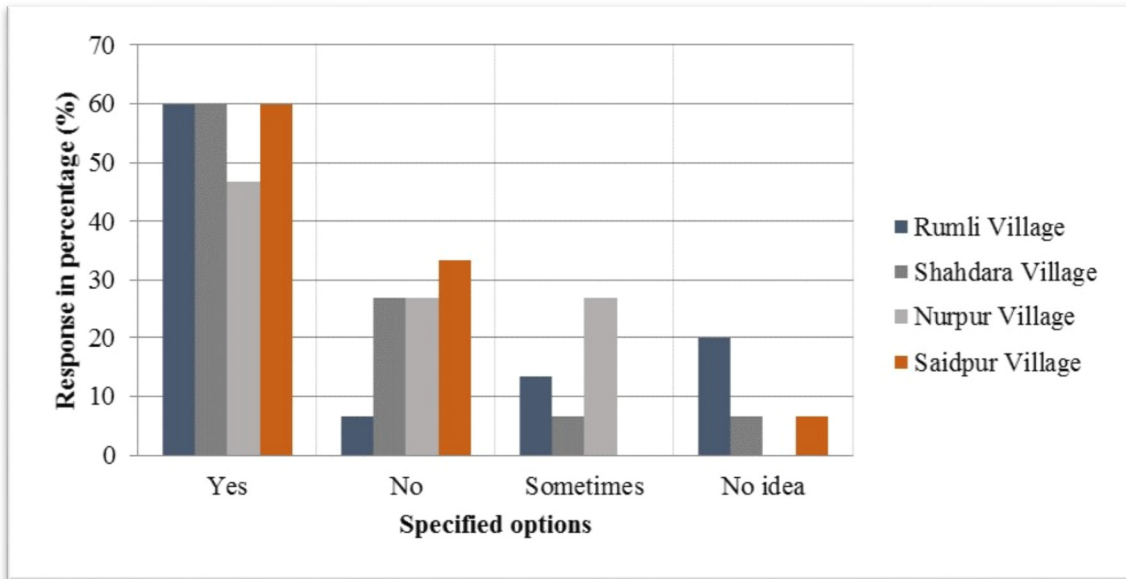

Figure 8 *Percentage of non-villagers cutting MHNP trees*

In Figure 8 the villagers' response in percentage against specified options is summarized for a percentage of non-villagers cutting MHNP trees. The four possibilities are "Yes", "No", "Sometimes" and "No idea". 60% Rumli villagers favoured the option "Yes", 6.7% villagers favoured the option "No", 13.3% villagers favoured the option "Sometimes" and 20% villagers favoured the option "No idea". 60% Shahdara villagers favoured the option "Yes", 26.7% villagers favoured the option "No", 6.7% villagers favoured the option "Sometimes" and 6.7% villagers favoured the option of "No idea". 46.7% of Nurpur villagers favoured the option "Yes", 26.7% villagers favoured the option "No" and 26.7% villagers favoured the option "Sometimes". 60% of Saidpur villagers favoured the option "Yes", 33.3% villagers favoured the option "No" and 6.7% villagers favoured the option "No idea".

The responses to the household questionnaire are given in Figure 9.
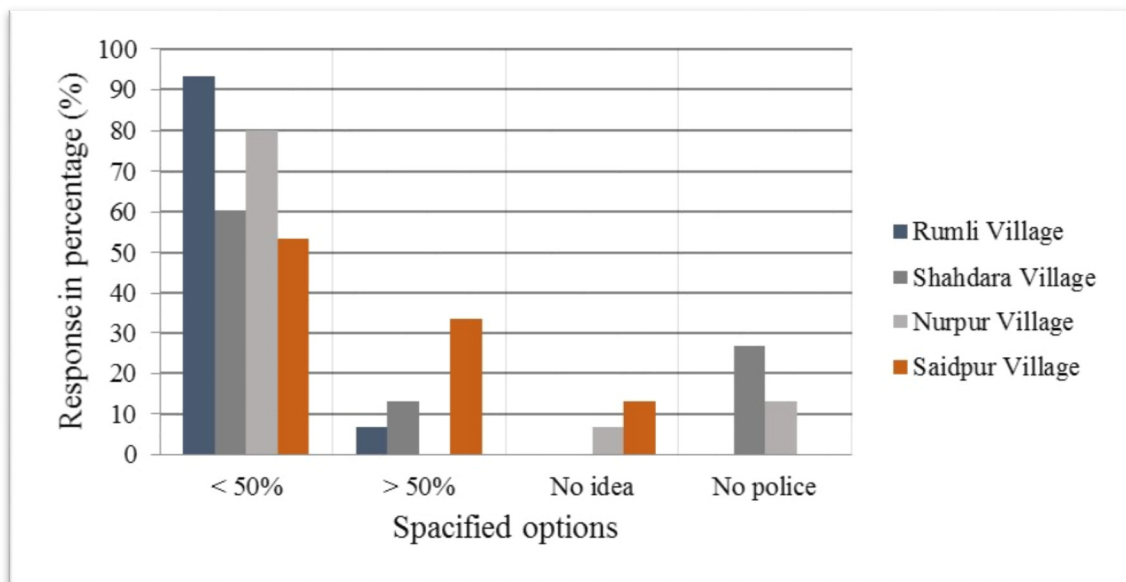

Figure 9 *Role of police in safeguarding MHNP*

In Figure 9 the villagers' response in percentage against specified options is summarized for the role of police in safeguarding MHNP. The four possibilities are "<50%", ">50%", "No idea" and "No police". 93.3% Rumli villagers favoured the option "<50%" and 6.7% villagers favoured the option ">50". 60% of Shahdara villagers favoured the option "<50%", 13.3% villagers favoured the option ">50%" and 26.7% villagers favoured the option "No police". 80% of Nurpur villagers favoured the option "<50%", 6.7% villagers favoured the option "No idea" and 13.3% villagers favoured the option "No police". 53.3% of Saidpur villagers favoured the option "<50%",

33.3% villagers favoured the option ">50%" and 13.3% villagers favoured the option "No idea". The responses to the household questionnaire are given in Figure 10.
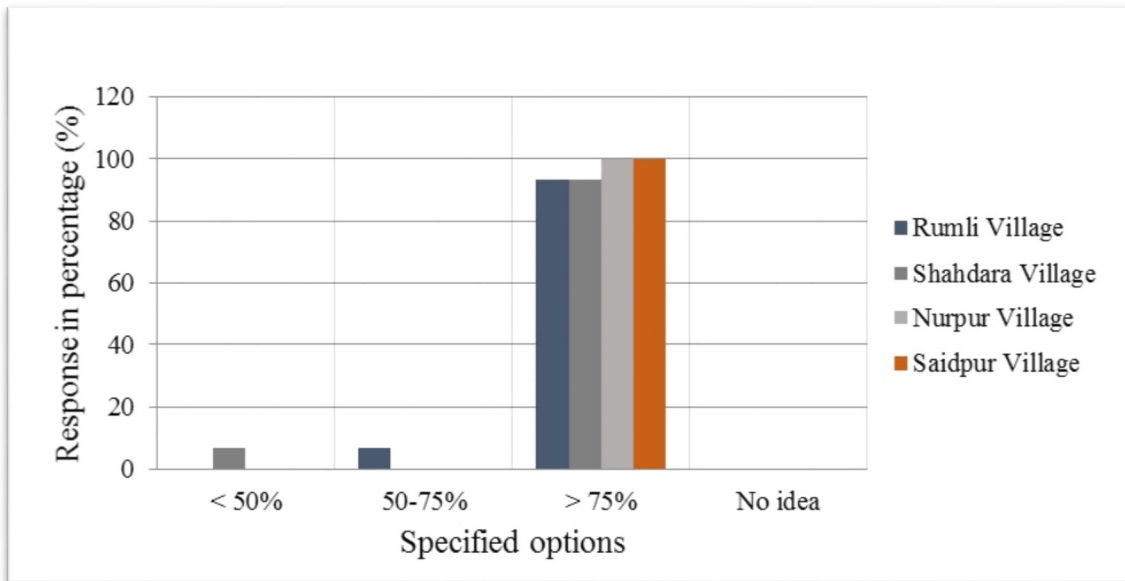

Figure 10 *Role of forest guards in safeguarding MHNP*

In figure 10 the villagers' response in percentage against specified options is summarized for the role of forest guards in safeguarding MHNP. The four possibilities are "<50%", "50-75%", ">75%" and "No idea". 93.3% Rumli villagers favoured the option ">75%" and only 6.7% villagers favoured the option "50-75%". 93.3% of Shahdara villagers favoured the option ">75%" and only 6.7% villagers favoured the option "<50%". 100% Nurpur and Saidpur villagers favoured the option ">75%".

The responses to the household questionnaire are given in Figure 11.
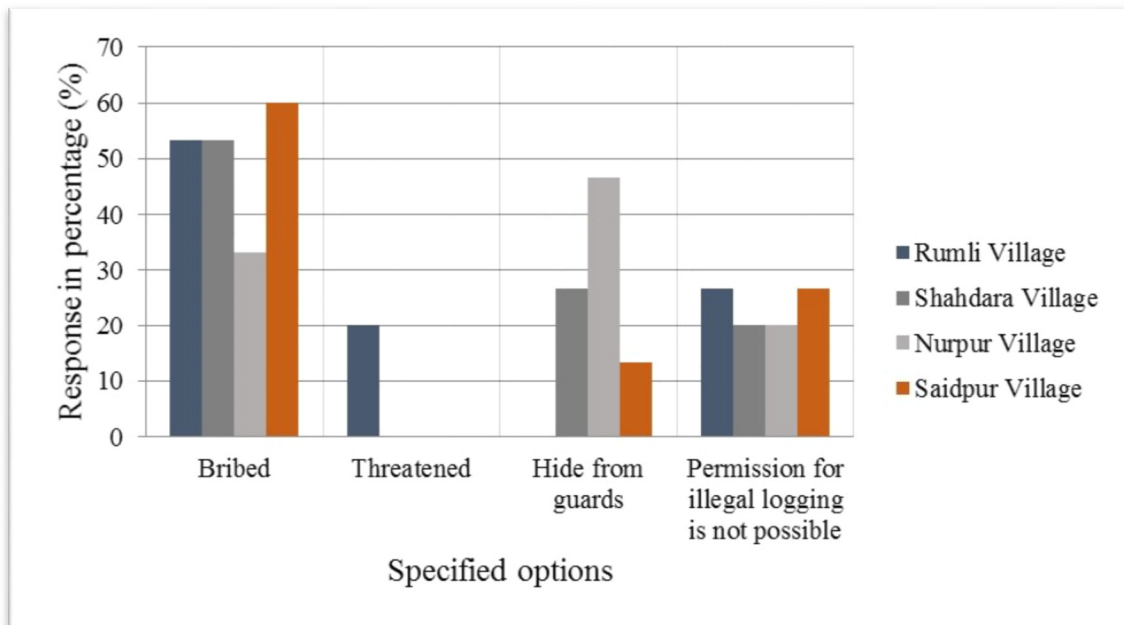

Figure 11 *Possibilities of illegal logging*

In Figure 11 the villagers' response in percentage against specified options is summarized for that how illegal logging is possible. Four possibilities are "Bribed", "Threatened", "Hide from guards" and "Permission for illegal logging is not possible". 53.3% of Rumli villagers favoured the option "Bribed", 20% favoured the option "Threatened" and 26.7% favoured the option "Permission for illegal logging is not possible". 53.3% of Shahdara villagers favoured the option "Bribed", 26.7% favoured the option "Hide from guards" and 20% villagers favoured the option "Permission for illegal logging is not possible". 33.3% of Nurpur villagers favoured the option "Bribed", 46.7% villagers favoured the option "Hide from guards" and 20% villagers favoured the option "Permission for

illegal logging is not possible". 60% of Saidpur villagers favoured the "Bribed", 13.3% villagers favoured the option "Hide from guards" and 26.7% villagers favoured the options "Permission for illegal logging is not possible".

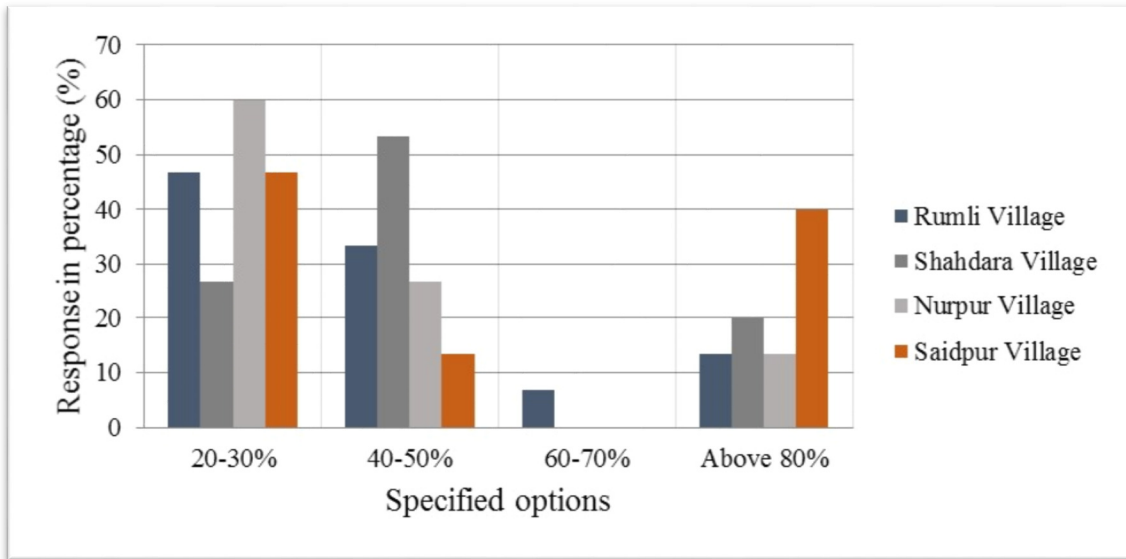The responses to the household questionnaire are given in Figure 12.

Figure 12 *Illegal logging in MHNP*

In Figure 12 the villagers' response in percentage against specified options is summarized for illegal logging in MHNP. The four possibilities are "20-30%", "40-50%", "60-70%" and "Above 80%". 46.7% Rumli villagers favoured the option "20-30%", 33.3% favoured the option "40-50%", 6.7% villagers favoured the option "60-70%" and 13.3% villagers favoured the option "Above 80%". 26.7% of Shahdara villagers favoured the option "20-30%", 53.3% favoured the option "40-50%" and 20% villagers favoured the option "Above 80%". 60% of Nurpur villagers favoured the option "20-30%", 26.7% villagers favoured the option "40-50%" and 13.3% villagers favoured the option "Above 80%". 46.7% of Saidpur villagers favoured the option "20-30%", 13.3% favoured the option "40-50%" and 40% favoured the option "Above 80%".

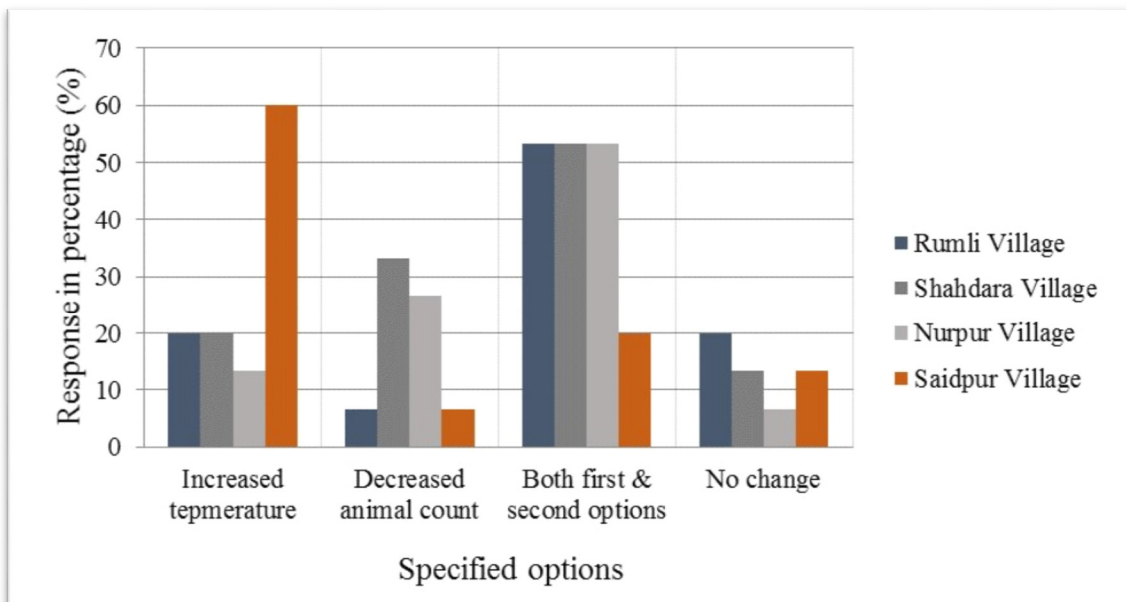The responses to the household questionnaire are given in Figure 13

Figure 13 *Change due to rapid tree cutting*

In Figure 13 the villagers' response in percentage against specified options is summarized for change due to rapid tree cutting. The four possibilities are "Increased temperature", "Decreased animal count", "Both first and second options" and "No change". 20% Rumli villagers favored the option "Increased temperature", 6.7% villagers

favoured the option "Decreased animal count", 53.3% villagers favoured the option "Both first and second options" and 20% villagers favoured the option "No change". 20% Shahdara villagers favoured the option "Increased temperature", 33.3% villagers favoured the option "Decreased animal count", 53.3% villagers favored the option "Both first and second option" and 13.3% villagers favored the option "No change". 13.3% Nurpur villagers favoured the option "Increased temperature", 26.7% villagers favoured the option "Decreased animal count", 53.3% villagers favored the option "Both first and second options" and 6.7% villagers "No change". 60% Saidpur villagers favoured the option "Increased temperature", 6.7% villagers favoured the option "Decreased animal count", 20% villagers favored the option "Both first and second option" and 13.3% villagers favoured the option "No change".

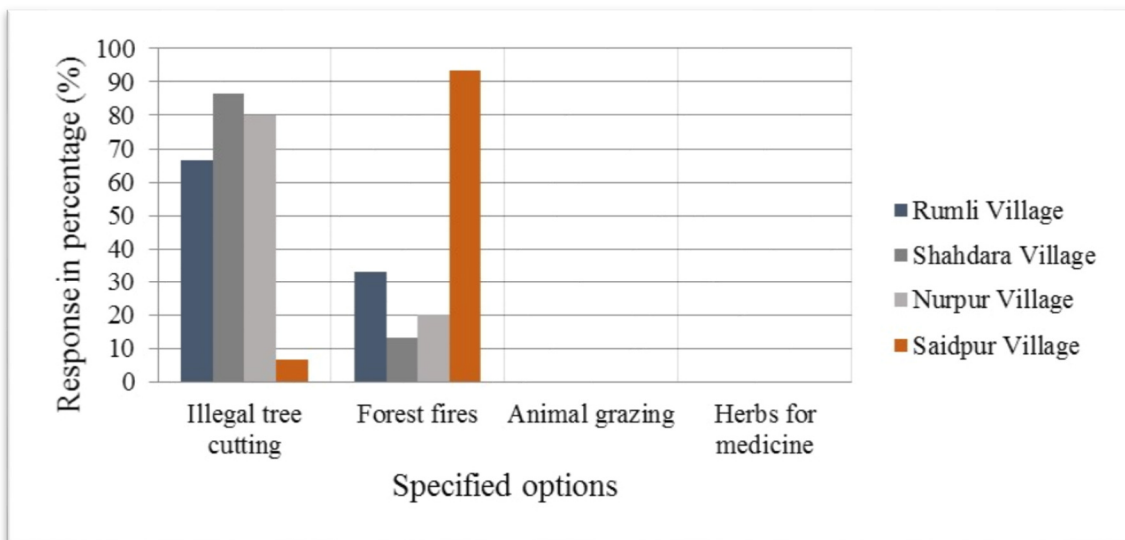The responses to the household questionnaire are given in Figure 14

Figure 14 *Activity responsible for MHNP tree decline*

In Figure 14 the villagers' response is summarized for activity responsible for MHNP tree decline. 66.7% Rumli villagers favoured the option "Illegal tree cutting" and 33.3% favoured the option "Forest fires". 86.7% of Shahdara villagers favoured the option "Illegal tree cutting" and 13.3% villagers favoured the option "Forest fires". 80% of Nurpur villagers favoured the option "Illegal tree cutting" and 20% villagers favoured the option "Forest fires". 6.7% Saidpur villagers favoured the option "Illegal tree cutting" and 93.3% villagers favoured the option "Forest fires".

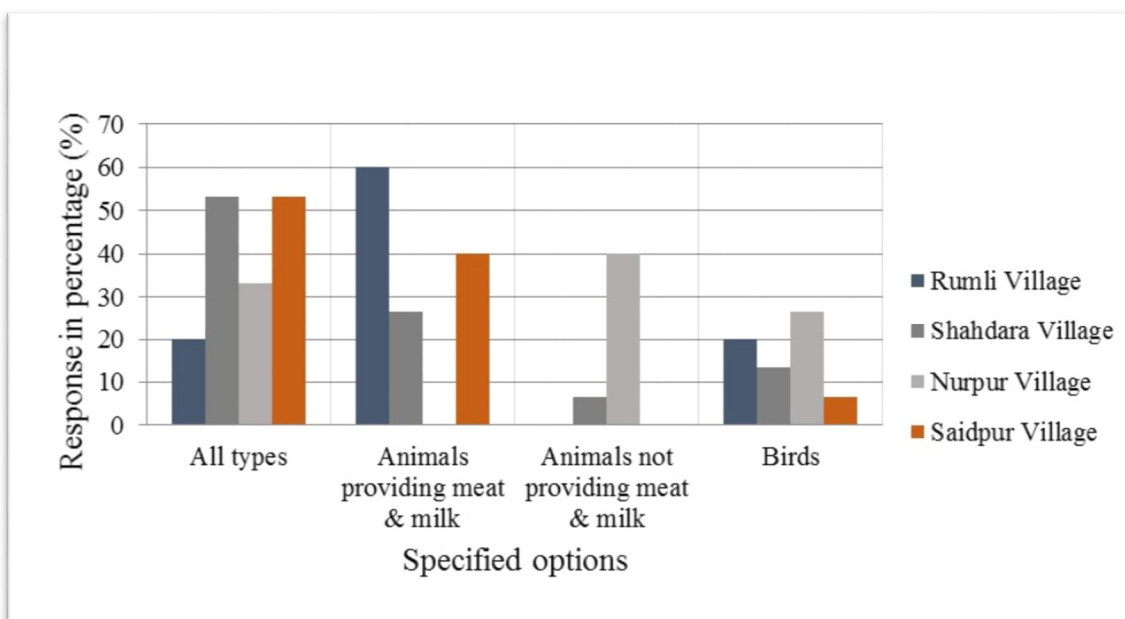The responses to the household questionnaire are given in Figure 15
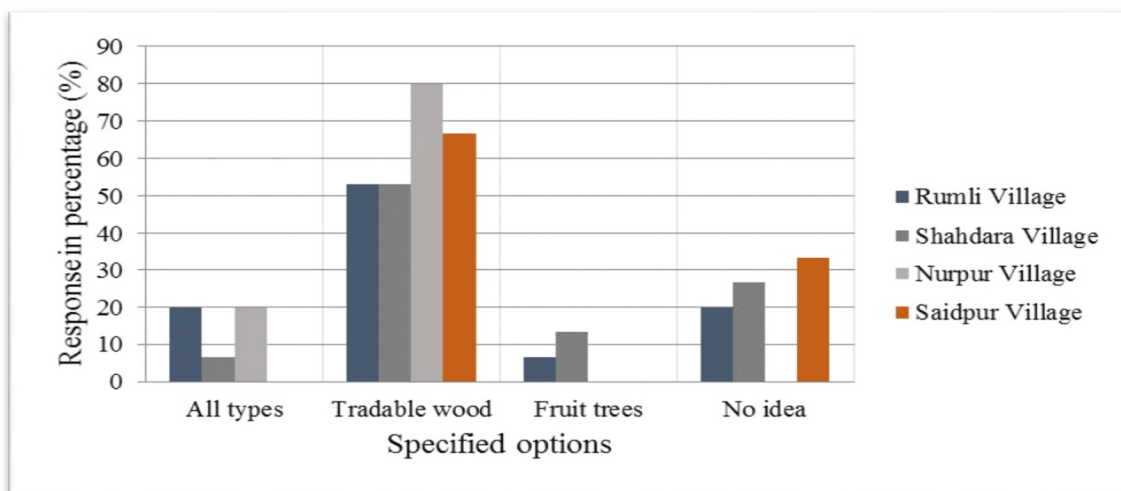

Figure 15 *Decline in animals of MHNP*

In Figure 15 the villagers' response in percentage against specified options is summarized for the decline in animals of MHNP. The four possibilities are "All types", "Animals providing meat and milk", "Animals not providing meat and milk" and "Birds". 20% of Rumli villagers favoured the option "All types", 60% villagers favoured the option "Animals providing meat and milk" and 20% villagers favoured the option "Birds". 53.3% Shahdara villagers favoured the option "All types", 26.7% villagers favoured the option "Animals providing meat and milk", 6.7% villagers favoured the option "Animals not providing meat and milk" and 13.3% villagers favoured the option "Birds". 33.3% of Nurpur villagers favoured the option "All types", 40% villagers favoured the option "Animals not providing meat and milk" and 26.7% villagers favoured the option "Birds". 53.3% of Saidpur villagers favoured the option "All types", 40% villagers favoured the option "Animals providing meat and milk" and 6.7% villagers favoured the option "Birds".

The responses to the household questionnaire are given in Figure 16.

Figure 16 *Decline in trees of MHNP*

In Figure 16 the villagers' response in percentage against specified options is summarized for the decline in trees of MHNP. The four possibilities are "All types", "Tradable wood", "Fruit trees" and "No idea". 20% Rumli villagers favoured the option "All types", 53.3% villagers favoured the option "Tradable wood", 6.7% villagers favoured the option "Fruit trees" and 20% villagers favoured the option of "No idea". 6.7% Shahdara villagers favoured the option "All types", 53.3% villagers favoured the option of "Tradable wood", 13.3% villagers favoured the option "Fruit trees" and 26.7% villagers favoured the option of "No idea". 20% of Nurpur villagers favoured the option of "All types" and 80% villagers favoured the option "Tradable wood". 66.7% of Saidpur villagers favoured the option "Tradable wood" and 33.3% villagers favoured the option of "No idea".

The responses to the household questionnaire are given in Figure 17
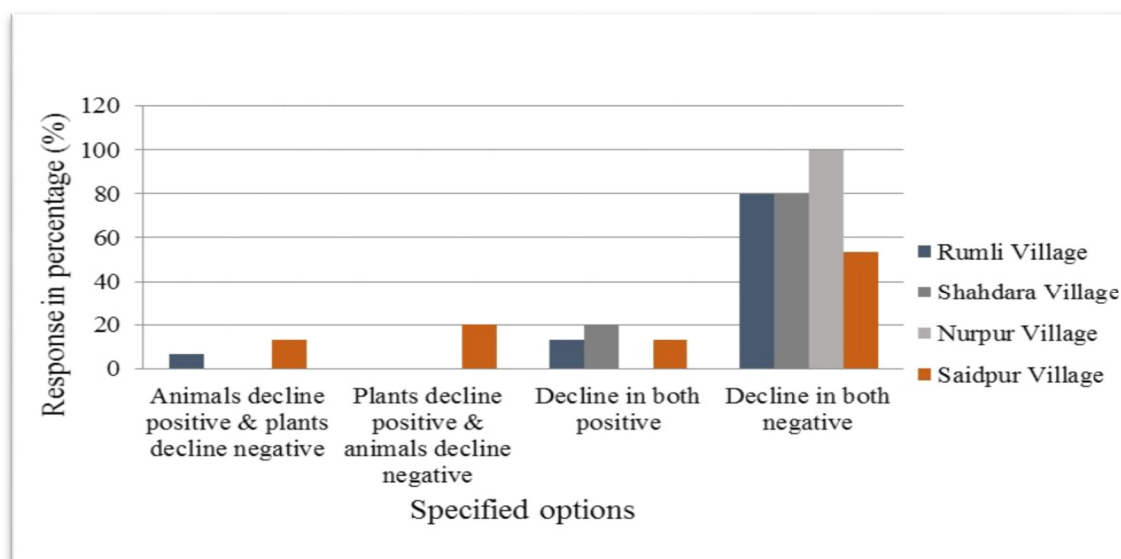

Figure 17 *Villagers' opinion about animals and plants importance*

In Figure 17 the villagers' response in percentage against specified options is summarized for villagers' opinion about animals and plants importance. The four possibilities are "Animals decline positive and plants decline negative", "Plants decline positive and animals decline negative", "Decline in both positive" and "Decline in both negative". 6.7% Rumli villagers favoured the option "Animals decline positive and plants decline negative", 13.3% villagers favoured the option "Decline in both positive" and 80% villagers favoured the option "Decline in both negative". 20% of Shahdara villagers favoured the option "Decline in both positive" and 80% villagers favoured the option "Decline in both negative". 100% of Nurpur villagers favoured the option "Decline in both negative". 13.3% Saidpur villagers favoured the option "Animals decline positive and plants decline negative", 20% villagers favoured the option "Plants decline positive and animals decline negative", 13.3% villagers favoured the option "Decline in both positive" and 53.3% villagers favoured the option "Decline in both negative".

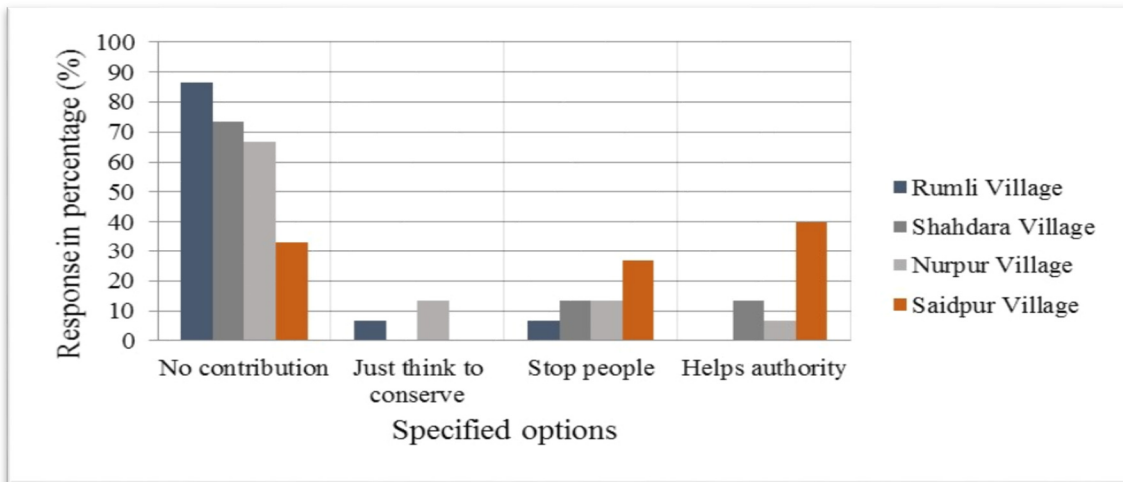The responses to the household questionnaire are given in Figure 18

Figure 18 *Role of community in safeguarding MHNP*

Figure 18 shows villagers' response to the role of community in safeguarding MHNP. 86.7% Rumli villagers favoured the option "No contribution", 6.7% favoured each option "Just think to conserve" and "Stop people". 73.3% of Shahdara villagers favoured the option "No contribution", 13.3% favoured each option "Stop people" and "Helps authority". 66.7% Nurpur villagers favoured "No contribution", 13.3% favoured the option "Just think to conserve", 13.3% favoured the option "Stop people" and 6.7% villagers favoured the option "Helps authority". 33.3% of Saidpur villagers favoured option "No contribution", 26.7% favoured "Stop people" and 40% favoured "Helps authority".

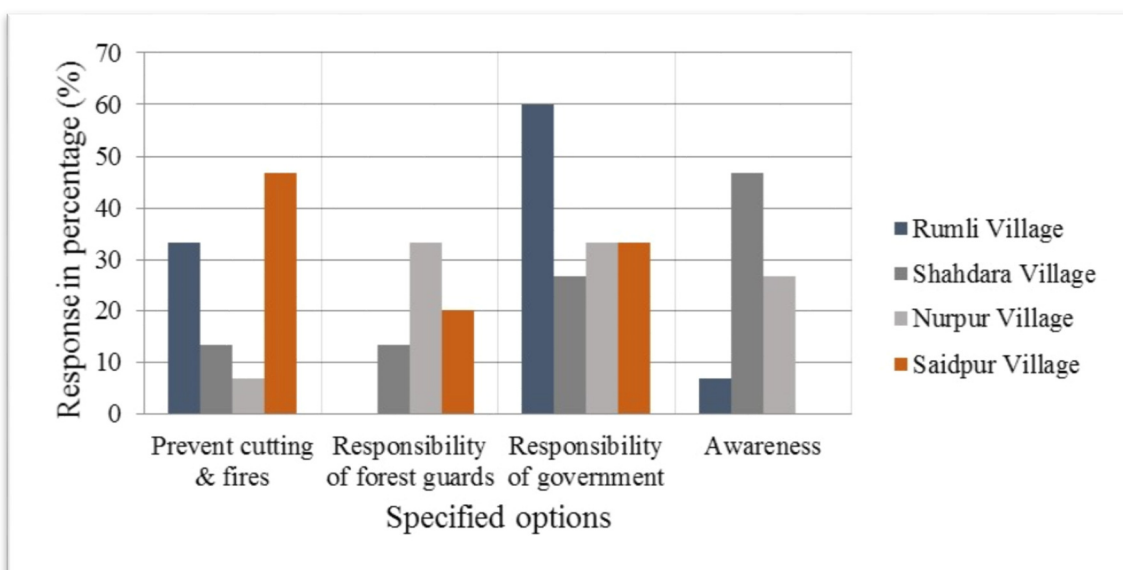The responses to the household questionnaire are given in Figure 19.

Figure 19 *How to conserve MHNP in future*

In Figure 19 the villagers' response is summarized for that how to conserve MHNP in future. 33.3% Rumli villagers favoured the option "Prevent cutting and fires", 60% villagers favoured the option "Responsibility of

government" and 6.7% villagers favoured the option "Awareness". 13.3% Shahdara villagers favoured the option "Prevent cutting and fires", 13.3% villagers favoured the option "Responsibility of forest guards", 26.7% villagers favoured the option "Responsibility of government" and 46.7% villagers favoured the option "Awareness". 6.7% Nurpur villagers favoured the option "Prevent cutting and fires", 33.3% villagers favoured the option "Responsibility of forest guards", 33.3% villagers favoured the option "Responsibility of government" and 26.7% villagers favoured the option "Awareness". 46.7% Saidpur villagers favoured the option to "prevent cutting and fires", 20% villagers favoured the option "Responsibility of forest guards" and 33.3% villagers favoured the option "Responsibility of government".

3.4. FOREST GUARDS PARTICULARS
The forest guard's particulars are given in Table 15.

Table 15 *Forest guard's particulars*

Status	Description
Number of guards	6
Gender	Male
Age	20-35
Education	Under matric to graduate
Monthly income	PKR 18000/- to 28000/-
Timings	8:00am-7:00pm

3.5. FOREST GUARDS RESPONSES
The responses of forest guards are given in the following Table 16.

Table 16 *Forest guard's responses*

Forest Guard	Response
1.	The area under his supervision is Saidpur Village and Trail 2. Mentioned that only one person that works with him. Salary is not sufficient for his needs. Difficulties faced during his job like people fighting with him often as he stops them from taking wood somewhere. Regarding Forest mafia, he mentioned about facing threats indirectly not directly. He did correspond to how once threaten him that they will kill him as he arrested one of their relative while taking wood to somewhere else. Mentioned that Government is not taking any part in respect to the protection of the forest. HWFP it is a private organization which is playing its part in protecting the forest. At first, deforestation was occurring at a massive scale, an unlimited number of trees used to cut down. Since he joined in August 2017 before it the level was uncontrollable but now it's in control. In regards to coming up with deforestation mentioned that reforestation activities did take place recently on trial 3. Through different ways people take wood mostly they carry it on their head. He wants the local people to cooperate with him along with other forest guards to stop deforestation and in enhancing forest conservation activities. He wants the Government to also play its role in proving better facilities to them.
2	Areas under his supervision are Saidpur Village and Trail-4. Mentioned that only one person that works with him. 6-7 family members are dependent upon him financially. During his duty hours he faces several difficulties like the common people of the area do not cooperate with them they cut trees from the national park, hunt animals etc. People usually try to give 2000 or 4000Rs to let their cars full of the illegally cut wood pass. His fellow member has been recently murdered by the hands of timber mafia. Recently IWMB has been established for the conservation and protection of MHNP but before that its protection comes under CDA. The NGO's working for the conservation of MHNP are WWF and HWF. They have ordered from the government to not let anyone cut trees from the national park, not even dry branches, but they let some poor people pick dry branches for their needs. Minister of Climate Change Authority started a campaign this February about a plantation in MHNP.

	If we go towards Shah Allah Ditta side the illegally extracted wood is usually transported on camels. His point of view in saving the MHNP was that local people of the area should cooperate with them. The people who are trying to sell illegally cut wood should be stopped and punished. The local people of the area should be given the availability of gas. IWMB should be given more facilities.
3	A place that comes under his supervision is Rata Hotar. Mentioned that only one person that works with him. Five people of his household financially dependent upon him. He did face threats from timber mafia. The government has made a department of CDA but he mentioned that they aren't playing any part. Instead of CDA private organizations like HWF plays its role in forest protection and SMEC foundation gave them instruments if we need any they donate them. Trees cut down are now in full control since this year but shrubs and branches did get cut down by people that are forest dependent. Forest fire events mostly occur due to people as CDA do take employees for firefighting for 3 months if they are late then people start a fire in the forest. For coming up with deforestation he mentioned that no reforestation activity has been taken place. In different ways trees are being taken from the place with small vehicles they cut trees in small pieces and take them and sometimes place inside seats and let a woman sit on the seat to act as a family car. He wants CDA forest department to play its full role and cooperate with them, he mentioned that they come late in case of penalty situations we can't stop people without giving a penalty or otherwise, he wants CDA to give them the rights of cutting penalty in case of forest cutting.
4	The area under his supervision is Trail-5 and its nearby area. Mentioned that only one person that works with him. 6-7 of his family members depends upon him for financial support. Whenever they try to stop people from cutting trees they often start fighting with them. Timber mafia he has lost his fellow member who was murdered on trail-6. Near Shahdara village he and his fellow guards have captured quite prominent personalities hunting wildlife which is prohibited in the national park, they started abusing them but still they file FIR against them. The government every year in the months of February and March do plantation in the national park. WWF and HWF are doing massive work in this area. Massive illegal Logging (deforestation) is taking place at Bari Imam, Rata Uttar, KalarKahar etc. One interesting reality he told was that people themselves put on huge fires because about 400 people are employed to finish the fire in this way people get employment and without thinking about the forests they are basically forced to do this act to support their families. "Green Pakistan" campaign was done by IWMB in collaboration with Climate Change Authority in February in which plantation was done. The transportation of wood is that it is mostly carried on the shoulders of the common people. And if the tree is big it is cut down into smaller pieces and then taken one by one. His point of view in saving national park was that the staff of IWMB should be increased so proper protection of national park is ensured. Forest Department should recognize their responsibilities like CDA forest guards should work in collaboration with us only than positive difference can occur.
5	The area under his supervision is Trail-4 and Log Jeewan, with him there is also another guard that guards that area. Many people are illegally extracting wood from the park and when they try to stop them from these people they start abusing them and even fight with us. He has heard of Timber Mafia but timber mafia has not till now encountered him. After the establishment of IWMB, a huge positive difference can be felt. According to him only Government is working for the safety of the national park and no NGO is involved in such a work (it seemed like he did not know about any NGO). Local people of the area don't have gas supplies and they depend on wood from MHNP to fulfil their daily needs. About one year ago Saidpur Mandi (containing extracted wood from MHNP) was very famous and people from many villages used to come and buy them. But now such activities have been controlled and a positive difference can be seen. There are many ways to transport the wood, the local people of area carry the wood on their

	shoulders whereas timber mafia they cut the tree then further cut it down into small pieces and roll them down from the backside of the hill then after some time obtain it from the bottom of the hill. His point of view in saving the national park was that their staff should be increased as they are very less in number for the protection of such a massive national park. With a force of adequate number, more improvement is sure to occur.
6	The area under his supervision is Trail-5 and Dar Chand. There are two more guards with him on duty. Control the local people of the area and educate them, their cooperation is the solution to all the problems. And fines should be obtained from people who are cutting trees. Women come from Golra Shareef to obtain wood for their daily needs we only allow them to pick dry branches. Once 4-5 forest guards including him were patrolling an area of MHNP which has congested trees and was very far from the community that they heard a gunshot, they were startled and after coming back to their senses noticed that their partner has been shot after which he died, it is said by many people that this was the work of timber mafia. When initially IWMB came into force they caught many hotels red-handed using wood extracted from MHNP. His point of view in saving MHNP was that encroachment is a menace it should not be done here. And people should be educated to not extract wood from MHNP.

3.6. PROBLEMS MENTIONED BY FOREST GUARDS

1. Timing Issues

Their duty hours are very long (it's a 24-hour job); in some situations (emergency situations) they are even called at night. Many of the forest guards were positive on this thought that they themselves should educate people about the importance of forests rather than punishing them so for that they themselves should be educated but their hectic routine makes it quite impossible to acquire education.

2. Lack of Guards

Lack of guards is another big issue which was noted during our study, as for a whole big area it's hard for just two people to check for the whole forest area. If the number of guards is increased then checking over the forest area can be done for effectively and efficiently. As it was quoted by most of them that if they patrol one area of their region mostly bad practices are done by (villagers or timber mafia) on another side, so it is advised that a number of guards should be increased for better protection of MHNP.

3. Monthly Income

Most of them have a monthly income ranging from 18 thousand to 28 thousand. With supporting at least 5 to 9 people at the home, it's hard for them to manage in such a salary. Many of them confessed that they are left with no choice but to do this job to support their large families. According to our study, many of them are forced to do this job just to support their families even if the salaries are low. Their salaries should be increased to encourage them to love their job and forests. If bonuses are given to them for capturing ones that are involved in timber cutting than they can work more effectively without financial threats. Other facilities like medical should also be given to them.

4. Issues they come across during duty hours

Lack of coordination among local people is one of the issues which most of them are facing. As local people do not listen to them much if they try to stop them from cutting trees. Many of them including us are of this point of view that the government should provide gas facilities to the local people this could make a huge difference and a percentage of deforestation could be decreased. A similar study conducted by Tanvir Ali, Babar Shahbaz and Abid Suleri which focused deforestation in Swat highlighting that 90% of the local people are involved in the decline in forests, major reason the unavailability of gas facilities. And the wood is being used in constructing houses.

Many of them reported that the people of the villages are poor and they are left with no choice but to cut trees and sell them for their living, so the government should be active to provide them with job opportunities.

Timber mafia is another serious threat which they came across for some timber mafia threatens them directly and indirectly, even threats to their life. Some of them have even lost their lives in this battle. Forest is also another issue which they mentioned. They should be given special training for weaponry use while dealing across such mafias and local people.

Many of them while protecting the National park came across many prominent personalities involved in some illegal practices. It is very hard to raise voice against them. Our society will only flourish and such activities will come to a halt when such personalities are also held responsible and punished.

Mysterious fires are also a threat to forests which are common here and can be controlled by proper management done by the forest department.

5.   Role of Government & NGOs

The government on its part has made a department of CDA which possess around 300 people and has more authority than IWMB in regards to charging credits from people that are cutting timber. They mentioned to us that private organization like HWF and WWF plays a more important role in corresponding to protecting forest and SMEC foundation which provides them with different instruments. Recently IWMB has been established for the protection of MHNP. So, it is being noted out that Government on his role has taken a part in making departments but strict check and balance needs to be taken.

6.   Afforestation activities

Everyone had a different point of view regarding afforestation activities some mentioned that such activities haven't taken place. Some mentioned that every spring plantation takes place, some mention that this year in February recently on trail-3, afforestation did happen by Climate change authority as a part of the campaign "Green Pakistan". If afforestation activities happen, it also requires maintenance. Local people should take equal part in such activities and should make it their responsibility in protecting forests.

7.   Means of Transportation of timber

Most of them mentioned that timber gets transported on head and shoulders of local people. In extreme cases, timber mafia cut trees in small pieces and then transports them through the vehicle. Sometimes they place timber inside seats and let a woman sit over to act as a family car. Many cut the trees and roll them down and then obtain it from the bottom. The extreme check should be placed to minimize such activities and police should perform their duties devotedly and sincerely.

3.7. FUELWOOD

Fuelwood is a vital element for most of the households in the villages of Margalla Hills National Park, Pakistan. The results of the survey showed that around 83-88% of the villagers depend on wood to meet their daily requirement as according to Jabeen work, 70-79% of households in Pakistan depend on fuelwood as the energy source(Jabeen *et al.* 2009). The wood consumption varies with climatic conditions, geography and the socio-economic status of the area.

The results showed that most of the villagers depend on the forested area of Margalla Hills Nation Park as they harvest the required wood themselves due to low economic status and the villagers that gather their fuelwood from other places told that they buy the wood from wood storage houses for fulfilling their need. It is discussed that the communities in the Himalayan Mountains face a serious shortage of energy sources because of their poor economic status (Khalid *et al.* 2015).

3.8. ILLEGAL CUTTING AND CORRUPTION

Ali and Benjaminsen explained that protected areas/forests are government property but all the rights to use are provided to local communities and commercial harvesting is restricted in protected areas(Ali and Benjaminsen 2004). As the result shows that the non-villagers cut the trees from MHNP and the non-villagers represent the timber mafia, cutting for their benefits. As the results show that a high level of corruption is involved in gaining wood from the MHNP (Volkmer and Sharif 2018) forestry sectors. According to the ministry of environment (2009), there is political interference to harvest wood illegally.

The G8 action programme on forests-Backgrounders (2002) stated that the developing nations are more involved in the illegal logging activities than the developed nations and Pakistan is one of the developing nations and practising high percentage of illegal logging. Moreover, the G8 action programme on forests is working with developing countries to prevent or reduce illegal logging activities. According to the G8 action programme on forests-Backgrounders (2002) involving public would help to make decisions to reduce illegal logging whereas the results of the study showed that the public or local people have no contributions.

3.9. CHANGES IN TEMPERATURE AND BIODIVERSITY

The results showed that the temperature is increasing and the number of species and individuals are decreasing as it is also discussed by Cochard (Cochard 2011) that the endemic species of the area can even lead to extinction if the deforestation activity gets common. According to Cochard, the climatic conditions may change locally due to the change in land use patterns and deforestation and forest fires may lead to increase in temperature, change the air movements, reducing atmosphere moisture and cloud formation.

3.10. MHNP COMPARISON 2009-2016

The comparison of the green cover of MHNP is shown in Table 17.

Table 17 *MHNP area comparison 2009-2016*

ID	Class	Area(ha) in 2009	Area(ha) in 2016
1	Forest	13,597	7,868
2	Cropland	219	1,234
3	Grassland	1,368	5518
4	Wetland	552	277.5
5	Settlements	1,259	589
6	Other land	391	1,899.5
	Total	17,386	17,386

3.10.1. Forest

Forest in the past used to be 13,597 and now its number is decreased to almost half in number that is 7,868. This indicates how the massive amount of deforestation activities corresponding to illegal logging are occurring.

3.10.2. Cropland

In past, our population was less so cropland area at that time was 219 and now the population has increased and a large area of forest has cleared out for agriculture so now cropland is 1,234. This change in land cover with the advantage of agricultural production has many effects like a change in temperature, changes in the water availability, decrease in rainfall, evaporation and soil water.

3.10.3. Grassland

In the past Grassland used to be 1,368 and now it's 5,518. Grassland has a direct relationship with the rainfall pattern in seasons when rainfall increases grassland increases.

3.10.4. Wetland

Wetlands in the past were 552 and now its number has decreased to 277.5. The decline in rainfall pattern due to rise in temperature can have negative consequences on this as well leading to having intense draughts and inundation periods.

3.10.5. Settlements

Settlements in the past used to be 1,259 and now it's 589. It's a good factor it denotes that control measures taken for encroachments in the National Park.

3.10.6. Other Land
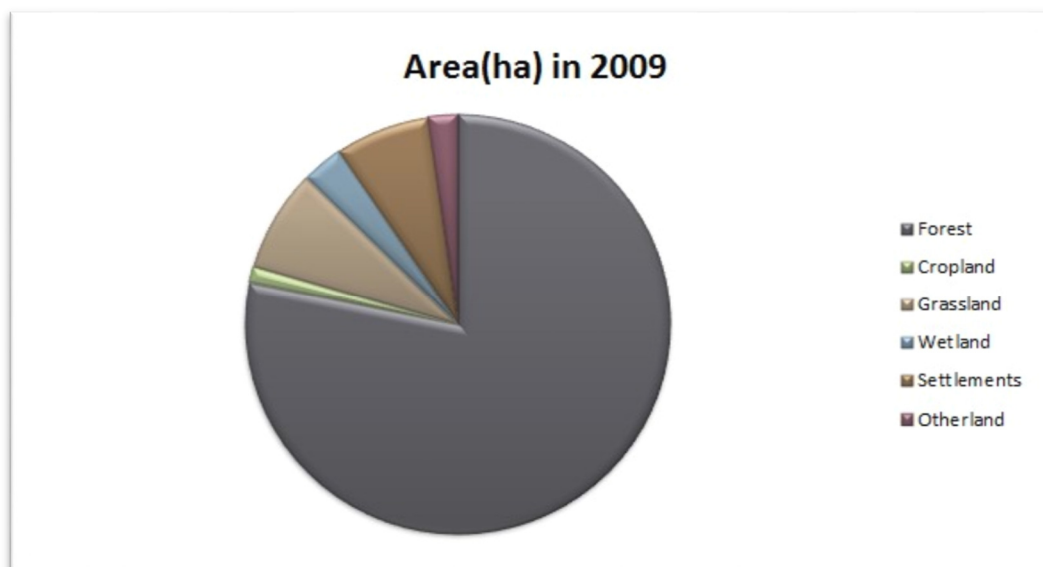
The number of other land use was 391 and now it's 1,899.5.
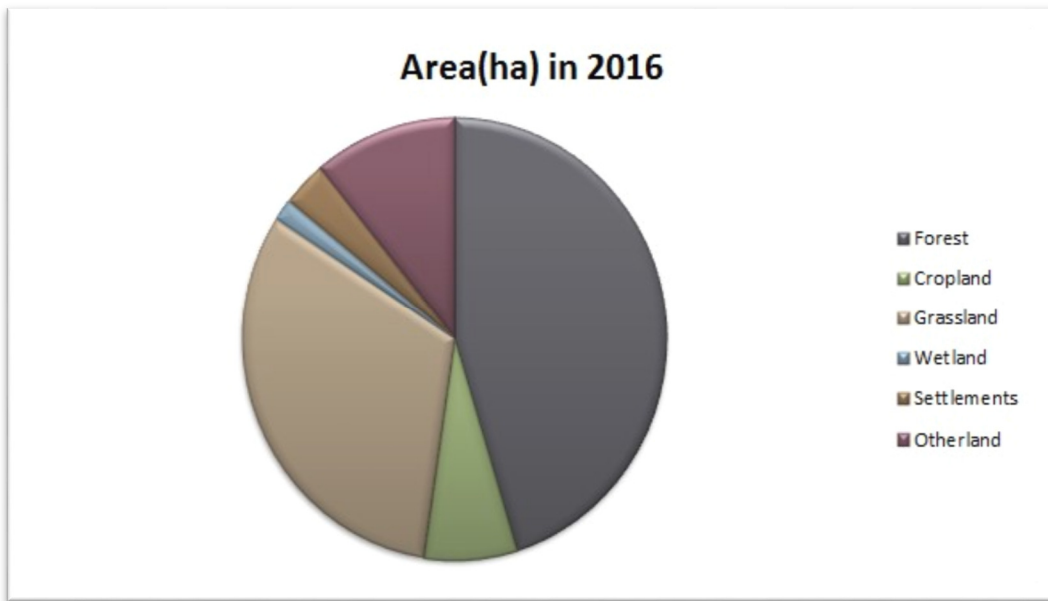

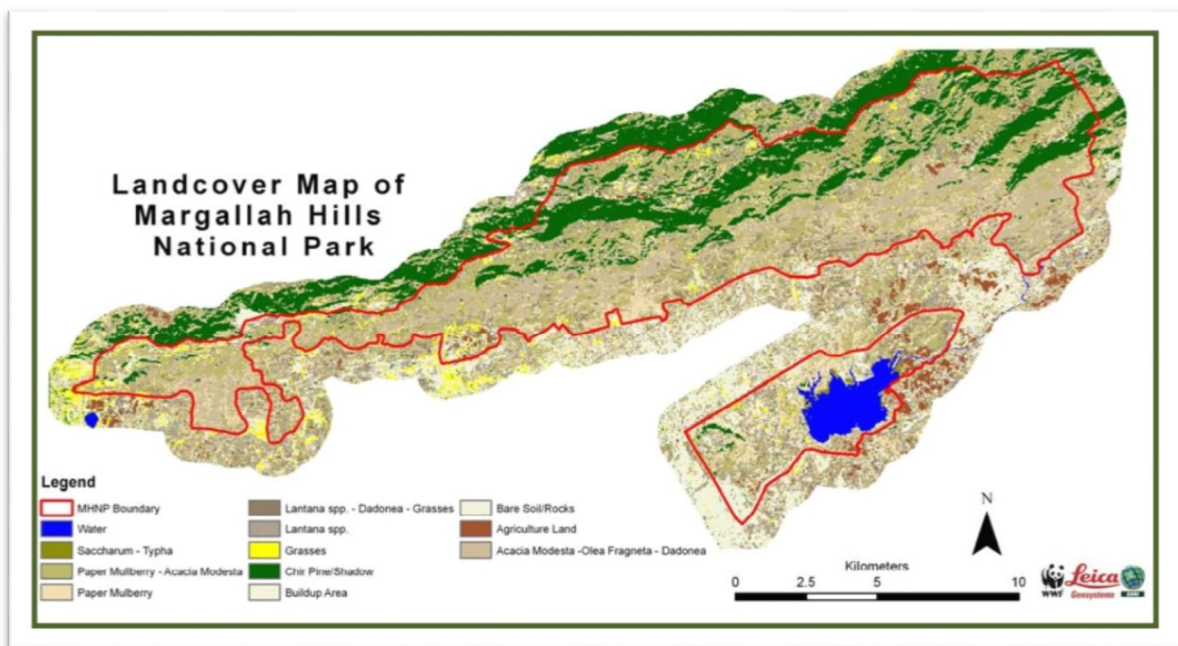Figure 20 *MHNP land use in 2009*

Figure 21 *MHNP land use in 2016*
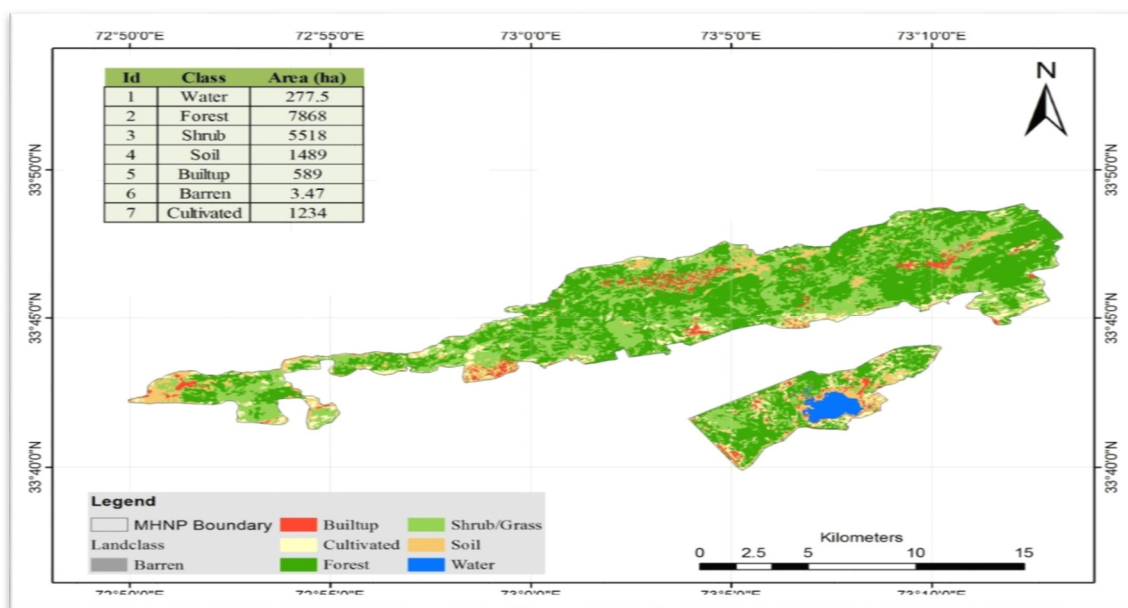
Figure 22 *Land cover MHNP 2009*

Figure 23 *Land cover MHNP 2016*

4.   CONCLUSIONS

High level of deforestation activities is carried out in Pakistan as it is one of the major problems and need to be concentrated to save forests. Due to the low income of the villagers they use wood as fuel for survival. The deforestation rate must be reduced if the villagers will be provided with an alternate source for survival such as gas facility. Forest crimes are practised at a high rate in MHNP through prominent bodies to poor villagers, the laws should be implemented on each and every person how practice acts against laws. The forest guards should be provided with weapons and give authority to trap the people who violate rules. The forested area of Margalla Hills National Park has reduced from 2009-2016 about 42%. Many of the species are extinct or endangered due to extensive deforestation activities and to control the extinction rate plans need to be developed. Awareness of the importance of forests should be given to the people who practice illegal activities. Afforestation activities should be a common practice and it should be maintained and cared for later.

Conflict of Interest

The authors declare that they have no conflict of interest.

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