INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 14, No. 6, p. 103-113, 2019
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Land cover change analysis and impacts of deforestation on the climate of District Mansehra, Pakistan

Dania Amjad[1], Sumaira Kausar[*2], Rana Waqar[3], Faiza Sarwar[4]

[1]*Department of Geography, Punjab University, Lahore, Pakistan*

[2]*Lecturer Punjab University, Lahore, Pakistan*

[3]*GIS Specialists, Al Jabar Sign Abu Dhabi, UAE*

[4]*Geography Department, Punjab University, Lahore, Pakistan*

Article published on June 30, 2019

Key words: GIS, Remote Sensing, Deforestation, Climate Change, Landcover Analysis, Landsat imagery, Temperature, Precipitation, Time Series Analysis, Supervised, Mansehra, Pakistan.

Abstract

In this study, district Mansehra, Pakistan was chosen as the study area. The main objectives of this research are to assess the extent and the changes in the rate of deforestation in Mansehra since past 20 years. It also examine the impacts of deforestation on the Climate by establishing and mapping the magnitude and rates of land cover changes that had occurred in the study area. Landsat satellite images were taken as secondary data and they were foremost for the classification process. Remote sensing data together with GIS techniques have made it conceivable to display and oversee remotely detected information in various scales. The images taken for classification are Landsat 5 TM for the year 1998 and 2008 and from Landsat 8 OLI/TIRS TM for the year 2017. Climatic data from 1988 to 2017 was collected from Pakistan Meteorological Department (PMD) of Mansehra District. The Forest Cover was 14% (601 Sq. Km) in 1998, 15% (668 Sq. Km) in 2008 and 5% (194 Sq. Km) in 2017. Taking everything together, anyway the results exhibit that some land cover types experienced extending rates and sizes of changes however in the others the inverse is legitimate, results revealed that the size and the rates of land cover changes for forest areas experienced an exceptional fluctuations in these 20 years. Maximum temperature of Mansehra increased at an alarming rate from 25.82°C in 1988 and 24.8°C in 1998 to 25.667°C in 2008 and 27.304°C in 2016 and 26.739°C in the year 2017. Mean minimum temperature showed fluctuation of 1° during these 30 years. In some years mean minimum temperature showed decrease from 12° to 11° and this change is not confined to a specific year. The rainfall was 5.129mm in 1988 and then rainfall increased from 3.6 mm in the year 1998 when there was 14% forest Cover to 4.8mm in 2008 when there was 15% Forest Cover but declined to 2.9mm in the year 2017 when there was only 5% forest left in Mansehra.

***Corresponding Author:** Sumaira Kausar ✉ sumaira.geog@pu.edu.pk

Introduction

Deforestation is the elimination of trees or clearing of plants or burning of forest on large scale for attaining all the local, regional and global requirements of the increasing population (Jonathan Lash, 1997). In 1990 the total forest cover of Earth surface was 30 percent but after that there was a decrease of 13 million hectors of the trees every year that means 78,000 square miles of the surface of forest has been removing annually for agricultural and other different purposes depending upon the type of location (P. Sellers. 1990). The rising temperature of Earth is a result of vast emission of greenhouse gasses in the atmosphere which is directly proportional to the cutting of trees because forests are the carbon sinkers. It is clear that the major contributions in the atmospheric concentrations of carbon dioxide and other greenhouse gasses like methane etc. is due to deforestation which is emerging as a huge demon of our society by leading towards extreme temperatures or global warming. In this study, District Mansehra, Pakistan was chosen which is located at elevation of 3200 feet (975.36 meters) and lies on the North Eastern District of N.W.F.P. Balakot, Mansehra, and Oghi.

According to Tenden P. 2013 in the communities of Ghana, Praaso and Dwease which are the three communities of Ashanti region the world has experienced a great loss of its forests. The main objectives of this survey was to study and examine the reasons why deforestation takes place and what are the impacts of deforestation and inquire into the conditions for local level sustainable forest management in Ghana because climate change is conventionally known to result specifically from deforestation and the situation at the local level is no exception. The world has experienced a great loss of its forests specifically in tropical areas which store 892 metric tons of carbon per hectare as a total amount and deforestation in tropical forests has significant impacts on climate. The two variables deforestation and environmental change is directly proportional to each other, this is illustrated by the negative impacts of deforestation of tropical forests because they are major carbon sinks and tropical deforestation is conventionally creating the long-term dangerous environmental consequences such as global warming, biodiversity loss and soil degradation which are often identified. In Ghana Excessive logging, bush burning, mining and quarrying, unsustainable agricultural practices, and settlement and related infrastructure construction are the major factors accounting for the loss of forests. The primary data in this study was taken from 110 respondents to present the empirical findings implored in the field from two communities Dwease with 60 respondents and Praaso with 50 respondents.

The secondary data was taken from Chief of Dwease, Assembly for Praaso, Assistant Direct Manager of Forestry Services Division and a Forest Guard based in Dwease. Landsat images of 2002 and 2004 were taken to check the differences in the forest cover. Additionally, field images were also taken to make this research authentic and structured questionnaires were prepared to be filled by 110 respondents in which sampling was random. The research findings revealed that how has deforestation influenced changes in local climate and impacts on the sustainable forest management.

The significance of this study was to determine the extent, negative impacts and causes of deforestation and giving strategies of sustainable forest management by Forest Service Division FSD, local leaders and people Mansehra is a land of forest and it's been several years that people are cutting down trees harshly in the region. There are many forests in the Mansehra and due to deforestation the climate is influencing to greater extent. Taking in to concern the importance of forests for global climate and the complexity of kinds of land cover in Mansehra, exploration of as well as working on other classification approaches that might produce better results can be done.

The research area could be explored more and future research could be prepared constructing on results of this study and refining its results, focusing on accurate delineation of dense forest area and even

sparsely forest areas. Individuals must know about the outcomes of proceeding with deforestation on the atmosphere. This study analyzes the change in temporal and spatial patterns of deforestation and how it is affecting the climate of Mansehra District.

Materials and methods

Materials and methods of the study encompassed the research design together with types of research methodology, data collection sources, and data processing software and image classification techniques in order to obtain the objectives of the study.

Research Methodology

Supervised classification technique was applied to estimate the forest cover, the images of Landsat 5 and 8, which is accessible from the USGS EROS, for 1998, 2008 and 2017 were utilized. For the acquiring satellite information for forest cover in Mansehra, Pakistan, the long stretches of September and October are viewed as the most reasonable as a result of minimal measure of cloud and snow cover amid this period. Forest area cannot be classified from Mid-October to November due to autumn season (because in this season the reflectance property of trees and chlorophyll concentration becomes weaker) and from December to May due to ice cover. The images taken for classification are Landsat 5 TM for the year 1998 and 2008 and from Landsat 8 OLI/TIRS TM for the year 2017. The weather data tabulation was done in Microsoft Excel and it was processed in SPSS Software to get Mean Annual values for Maximum Temperature, Minimum Temperature and Rainfall to get the required results by fulfilling research objectives. Besides this time series analysis was performed to detect the change in mean annual temperatures and rainfall. To link deforestation and climate change a graph having all the results altogether is also made. The data is presented in the form of pie charts, tables, graphs, Fig.s and maps.

Primary Data Sources

In order to detect changes in the forest cover ground truth verification was done. Field survey was conducted to monitor the change in forest-cover and the causes of deforestation in Mansehra District.

The reasons behind increased deforestation were also investigated by the residents of Mansehra. This was done by visiting different deforested areas along.

Secondary Data Sources

Landsat satellite images were taken as secondary data and they were foremost for the classification process. Remote sensing data together with GIS techniques have made it conceivable to display and oversee remotely detected information in various scales. Climatic data of Mansehra District from 1988 to 2017 was collected from Pakistan Meteorological Department (PMD), Lahore.

Data Processing

The data was processed in the following manner; by creating polygons on the satellite imagery, Training sites were recognized and marked, and for each type of cover these training sites are showing homogenous. There were many training stes along with the pre training samples for each type of land cover. This means that for six types of land cover there were pre six pure training samples.

The source of these training areas was a mix of conception and visualization of very high-resolution images that are easily available in Google Earth Pro and GPS based ground truth verification done from field surveys and the data gathered from earlier land cover reports. Initially, average values of training samples were demonstrated with elliptic boundaries over scatter plots of the different band combinations of spectral imagery.

When the gathered signatures were agreeably analyzed, different marks were united into one signature for a given type of land cover and utilized for the classification. Based on the spectral signature and preparation areas, the satellite data for the whole region brought about a map of land cover along with 6 classes. Essentially, satellite imagery for the years 1998 and 2008 and 2017 were additionally handled by a comparative methodology for the classification of notable datasets.

Results

According to the results, it has been revealed that there is an obvious change in the forest cover in Mansehra. This research has proved declining trend in forest covered area and warned for expected bad consequences. Remote sensing has provided a valuable contribution to document the land cover changes in the whole district of Mansehra, Pakistan. There is a huge increase in the Barren land and reduction in the Forest Cover from 1998-2017. Barren area has maintained an upward trend in its rates and magnitude of change, from 1998 to 2017. The logic behind this could lie in the assumptions that, as the population in an area increased the need for wood also increased and ultimately rate of deforestation also increased leading to expansion of barren land. Heterogeneous landscapes are successfully classified after spatial reclassification that exerts GIS functions, auxiliary data and image interpretation which was integrated in the digital classification process through on-screen digitizing, multiple zooming, and area of interest facility, recording and overlaying.

Land Cover Analysis 1998

In the Fig. 1, it can clearly observed that in the southern part of Mansehra in Kala Dhaka the grass land are of greater extent spreading all over the area. In Kala Dhaka the forest cover area can be seen in the western part. In the Oghi Tehsil built up areas are shown by the brown colour and this is only the part in the east side of the Oghi Tehsil where the built up areas are detected to much greater extent as compared to the other parts of Mansehra district. Most of the forest cover is located over Mansehra Tehsil. Much of the water bodies and ice are observed in the northern parts of Mansehra district which comprises of Balakot Tehsil. In the southern Balakot forest cover can also be seen. With regard to the Barren land it is spread all over the northern Mansehra. So in the year 1998 according to this classification Barren land has maintained an upward trend in the northern parts in its rates and magnitude whereas in the southern part grass land were found in abundant and in the central part of the Mansehra District forest cover is of greater extent spreading all over the area.

According to the Fig. 2, in the year 1998, the forest cover of Mansehra was 14% i.e. 601 Sq. Km and the grassland was 49% i.e. 2094 Sq. Km. The ice was 4% meaning having the areal expansion of 186 Sq. Km. The percentage of barren land was 32% covering the area of 1370 Sq. Km, the areal extension of water bodies for the year 1998 in Mansehra was 39 Sq. Km comprising 1% of the total land cover. Built up areas is yet another land cover type which is almost negligible comprising the area of 6 Sq. Km.

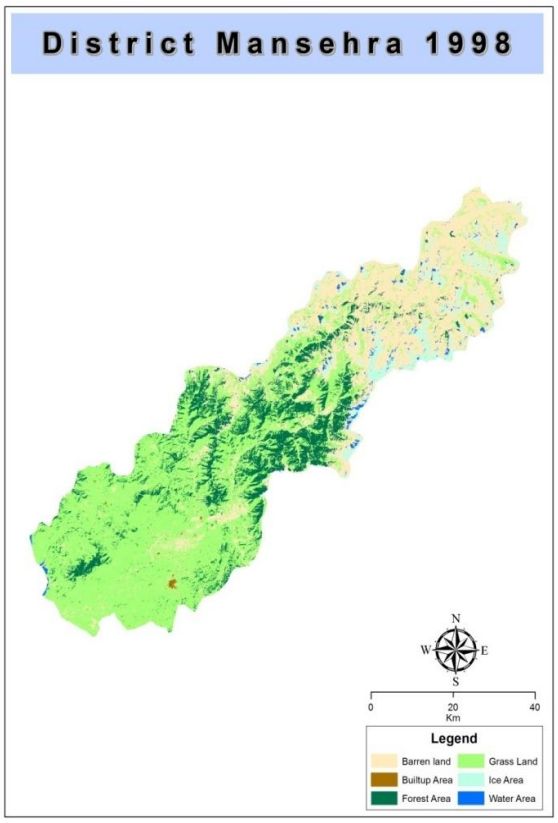

Fig. 1. Land Cover classification 1998.

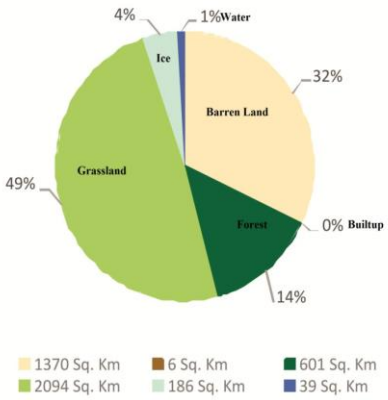

Fig. 2. Land Cover analysis 1998.

Land Cover Analysis 2008

Six types of Land Covers are classified in the following Fig

In the Fig. 3, it can clearly observed that 1% increase in the forest area is spread over the southern part of Mansehra in Kala Dhaka Tehsil where the grass lands are of greater extent spreading all over the area along with the Barren Land. In Kala Dhaka the barren area is present in the east SIDE whereas the forest cover area can be seen in the western part. In the Oghi Tehsil built up areas are shown by the brown colour and even after 10 years of gap this is only the part in the east side of the Oghi Tehsil where the built up areas are detected to much greater extent as compared to the other parts of Mansehra district. Most of the forest cover is located over Mansehra Tehsil that is also showing an upward trend towards Balakot Tehsil. Much of the water bodies and ice are observed in the northern parts of Mansehra district which comprises of Balakot Tehsil. In the southern Balakot forest cover can also be seen. With regard to the Barren land it is spread all over the northern Mansehra. So in the year 2008 according to this classification no clear changes were seen in this time period but only forest area increased to 15% from 14%. There was a decrease of 1% in the percentage of ice in the year 2008.

According to the Fig. 4, in the year 2008, the forest cover of Mansehra was 15% i.e. 668 Sq. Km and the grassland was 49% i.e. 2090 Sq. Km. The ice was 3% which has the areal expansion of 119 Sq. Km. The percentage of barren land was 32% covering the area of 1375 Sq. Km, the areal extension of water bodies for the year 2008 in Mansehra was 33 Sq. Km comprising 1% of the total land cover. Built up areas again comprising the area of 11 Sq. Km that is almost negligible.

Land Cover Analysis 2017

Six types of Land Covers are classified in the following Fig.

In the Fig. 5, there is a clear decrease in the forest cover of Mansehra according to the classification and ground truth verification. Forest cover reduced from 15% to 5% and it is a huge decline in the forest area (668-194 Sq. Km). There is a huge increase in Barren land especially in the Northern part over Balakot Tehsil. The barren Land increased from 32% in 1998 to 44% in 2017 which is not confined to a specific location. In Kala Dhaka the Barren area is present in the upper (northern) part whereas the Grass Land area can be seen in the south and south west part along with some built up area and water bodies. Built up areas are shown by the brown color and even after 10 years of gap there is no much increase in the built up areas. In 2017, some parts of Mansehra Tehsil and Oghi Tehsil are only the part in the whole Mansehra District where the built up areas are detected to much greater extent as compared to the other parts of Mansehra District. Most of the forest cover disappeared from Mansehra Tehsil that is also showing an upward trend towards Balakot Tehsil.

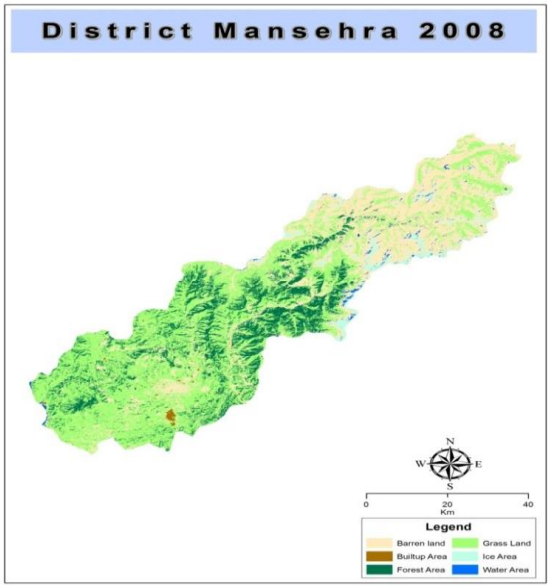

Fig. 3. Land Cover Classification 2008.

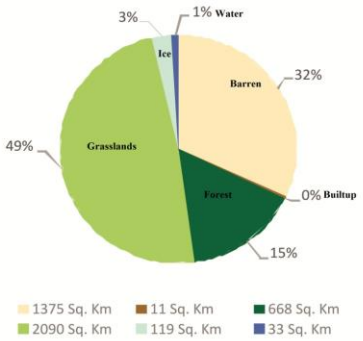

Fig. 4. Land Cover analysis 2008.

According to the Fig. 6, in the year 2017, the forest cover of Mansehra was 5% i.e. 194 Sq. Km and by comparing it with 1998 when forest cover was 14% i.e. 601 Sq. Km then a huge decrease in the forest cover can be clearly observed. The grassland was 48% i.e. 2050 Sq. Km. The ice was 3% which has the areal expansion of 126 Sq. Km. The percentage of barren land was 44% covering the area of 1899 Sq. Km, the areal extension of water bodies for the year 2008 in Mansehra was 8 Sq. Km comprising 0% of the total land cover. The rate of Built up areas increased to 16 Sq. Km.

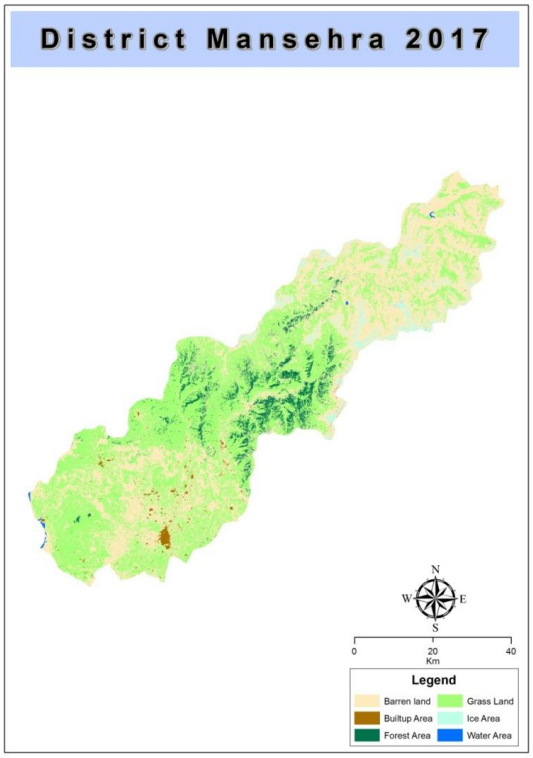

Fig. 5. Land Cover Classification 2018.

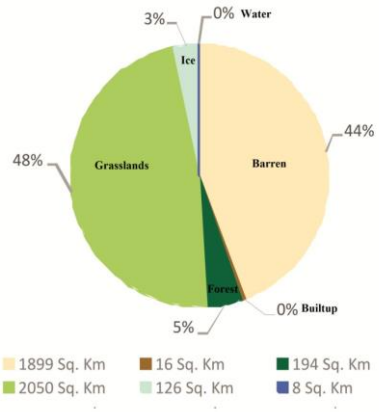

Fig. 6. Land Cover Analysis 2018.

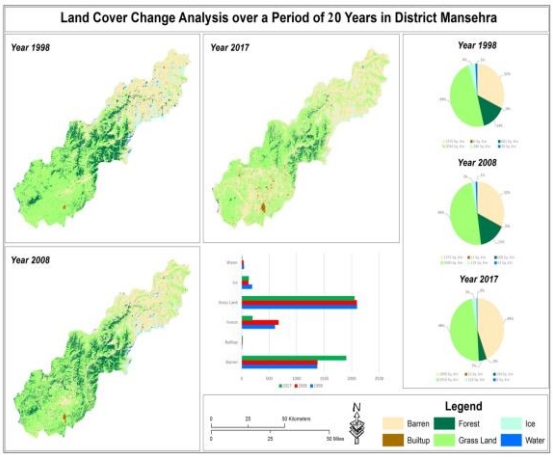

Fig. 7. Land Cover Change Analysis over a Period of 20 years in District Mansehra.

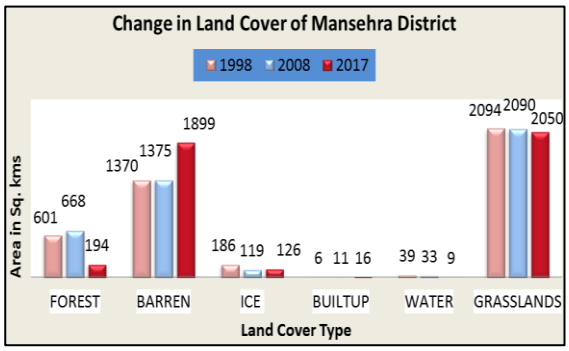

Fig. 8. Change in Land Cover of Mansehra.

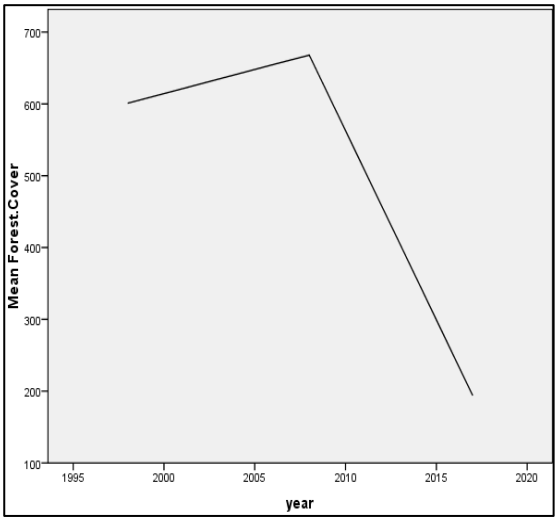

Fig. 9. Rate of Change in Forest Cover from 1998 to 2017 in Mansehra.

Climatic Impacts of Deforestation in Mansehra

In Mansehra, obvious changes in the Mean Maximum Temperature, Mean Minimum Temperature and Rainfall were seen during the time period of 1988-2017.

Mean Maximum Temperature

As per table 2, deforestation is the strong reason behind changing global temperatures the results of this research are also supported by the results of Carlos A. Nobre *etal* 1990 and Max Planck, 2009. Maximum temperature of Mansehra was 25.82°C in 1988 and increased at an alarming rate from 24.8°C in 1998 to 25.667°C in 2008 and 27.304°C in 2016 and 26.739°C in the year 2017. According to tes Fig. 10, the Mean Maximum Temperature is showing an upward trend during the 30 years in Mansehra District.

Table 1. Variation of six land cover types from 1998-2017 in Mansehra.

Land Cover Type	1998	2008	2017
Forests	14% (601 Sq. Km)	15% (668 Sq. Km)	5% (194 Sq. Km)
Barren	32% (1370 Sq. Km)	32% (1375 Sq. Km)	44% (1899 Sq. Km)
Ice	4% (186 Sq. Km)	3% (119 Sq. Km)	3% (126 Sq. Km)
Builtup	0% (6 Sq. Km)	0% (11 Sq. Km)	0% (16 Sq. Km)
Water	1% (39 Sq. Km)	1% (33 Sq. Km)	0% (9 Sq. Km)
Grasslands	49% (2094 Sq. Km)	49% (2090 Sq. Km)	48% (2050 Sq. Km)

Table 2. Mean Maximum Temperature.

Year	Mean Maximum Temperature in °C	Year	Mean Maximum Temperature in °C
1988	25.82	2003	25.1
1989	24.80	2004	26.0
1990	25.42	2005	25.4
1991	24.49	2006	25.8
1992	23.50	2007	26.4
1993	24.51	2008	25.7
1994	23.46	2009	25.7
1995	22.78	2010	25.6
1996	23.68	2011	26.0
1997	23.80	2012	25.1
1998	24.8	2013	25.7
1999	25.5	2014	25.5
2000	25.7	2015	25.4
2001	26.4	2016	27.3
2002	26.3	2017	26.7

Mean Minimum Temperature

According to the results of research shown n table 3, mean minimum temperature showed fluctuation of 1° during these 30 years. In some years mean minimum temperature showed decrease from 12° to 11° and this change is not confined to a specific year. According to the Fig. 11.

The Mean Maximum Temperature is showing fluctuations during the 30 years in Mansehra District.

Table 3. Mean Minimum Temperature.

Year	Mean Minimum Temperature in °C	Year	Mean Minimum Temperature in °C
1988	12.62	2003	12.0
1989	12.129	2004	13.3
1990	12.139	2005	12.0
1991	11.333	2006	12.2
1992	11.482	2007	11.8
1993	13.10	2008	12.1
1994	12.89	2009	12.0
1995	12.76	2010	12.1
1996	12.66	2011	12.5
1997	13.35	2012	11.0
1998	12.3	2013	12.2
1999	12.4	2014	11.5
2000	12.7	2015	11.9
2001	12.8	2016	12.2
2002	12.4	2017	12.4

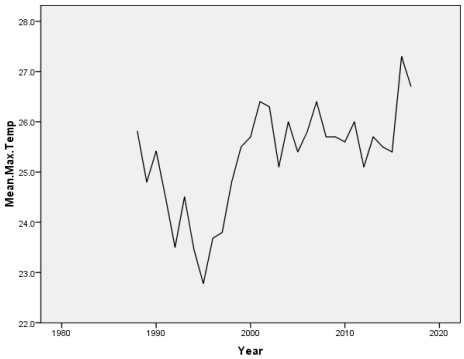

Fig. 10. Rate of Change in Maximum Temperature from 1988-2017 in Mansehra.

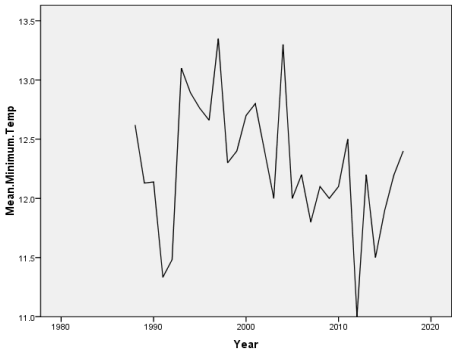

Fig. 11. Rate of Change in Minimum Temperature from 1988 to 2017 in Mansehra.

Mean Rainfall

As per table 4, The rainfall was 5.129mm in 1988 and then rainfall increased from 3.6mm in the year 1998 when there was 14% forest Cover to 4.8mm in 2008 when there was 15% Forest Cover but declined to 2.9mm in the year 2017 when there was only 5% forest left in Mansehra. According to the Fig. 12, the Mean Rainfall is showing a declining trend during the 20 years in Mansehra District.

Deforestation and Climate Change

In the Fig. 13, the forest area is shown in square kilometer on the left axis and the climatic data e.g., maximum tepmeratre (in Celsius), minimm temperatre (in Celsius), and rainfall (in mm) are shown on the right axis. The results have revealed that there is a strong and obvious link between deforestation and climate change in the district Mansehra, Pakistan.

Table 4. Mean Rainfall.

Year	Rainfall in mm	Year	Rainfall in mm
1988	5.129	2003	5.1
1989	3.676	2004	3.5
1990	5.595	2005	4.4
1991	5.598	2006	6.7
1992	5.142	2007	3.1
1993	3.662	2008	4.8
1994	4.303	2009	3.4
1995	3.64	2010	3.9
1996	3.859	2011	3.9
1997	3.665	2012	3.7
1998	3.6	2013	3.9
1999	4.1	2014	3.2
2000	4.0	2015	4.4
2001	3.7	2016	3.5
2002	3.4	2017	2.9

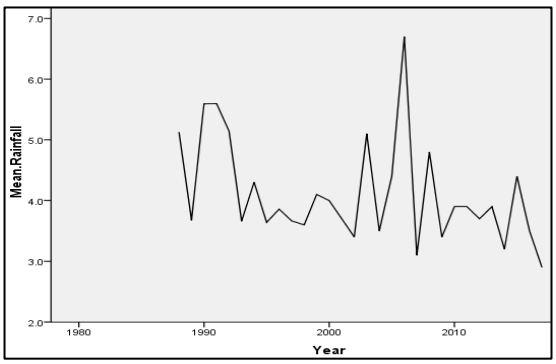

Fig. 12. Rate of Change in amount of rainfall from 1988 to 2017 in Mansehra.

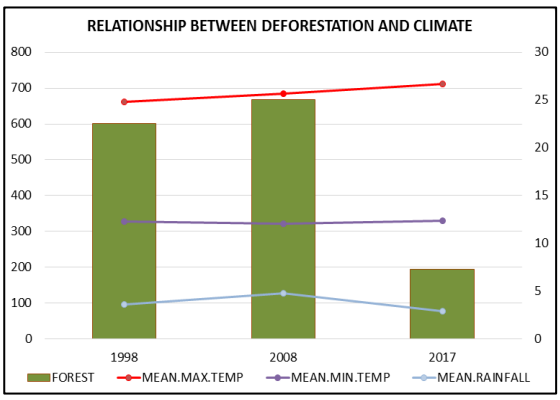

Fig. 13. Relation between deforestation and climate.

Discussion

According to the research done in 1990 by J. Shukla, P. Sellers, and C. Nobre extensive scale transformation of tropical woods into yearly yields or pastures could prompt changes in the atmosphere. In their study a coupled numerical model of the worldwide environment and biosphere (Center for Ocean-Land-Atmosphere GCM) was utilized to survey the impacts of Amazonian deforestation on the provincial and worldwide atmosphere. Their examination likewise discovered that when the Amazonian tropical woods were changed by damaged grass (field) in the model, there was a critical decline in the yearly evapo-transpiration (30% decrease), increment in the average surface temperature (about 2.5°C), overflow (20% decrease) and precipitation (25% decrease) in the locale. The contrasts between the two reproductions were most noteworthy amid the dry season. The deforested case was related with bigger diurnal variances of surface temperature and vapor pressure deficiency; such impacts have been seen in existing deforested arms in Amazonia. The determined decrease in precipitation was bigger than the determined decline in evapotranspiration, showing a more in the territorial dampness combination. There was additionally an expansion in the length of the dry season in the southern portion of the Amazon Basin, which could have genuine ramifications for the restoration of the tropical woods following enormous deforestation since rainforests just happen where the dry season is short or nonexistent. An experimental bioclimatic plan dependent on a coordinated soil dampness stretch file was utilized to infer the development of the savanna-forest boundary because of the reformed environmental change delivered by extensive scale deforestation (Carlos A. Nobre *etal.,* 1990).

According to the research done by Max Planck in 2009, between the pre-modern time and year 2000 it has been calculated that for the most part deforestation and non-renewable energy source emssions have caused an expansion in climatic carbon dioxide of 90ppm. By the end of this century, the projected range of carbon dioxide concentration will be 170-600 ppm above 2000 levels below the scale of discharge scenarios established for IPCC. Throughout the history, after comparing the maps of vegetation from satellite images to ground based information, it was estimated that there was 180-200 PgC cumulative carbon losses to atmosphere. 66% to 75% of the all out carbon misfortune is come about because of deforestation. In the wake of representing ocean response, by the end of this century carbon dioxide in the atmosphere can be reduced by 17-31 ppm if the most extreme measure of carbon will be sequestrated by worldwide afforestation and reforestation exercises somewhere in the range of 1995 and 2050 is 60-90 ppm. The figurings above depend on extraordinary and very impossible situations. As per IPCC recent projection of carbon dioxide emissions there will be 540-970 ppm atmospheric carbon dioxide in 2100, or increment of 170-600 ppm above 2000 levels (Max Planck, 2009).

Conclusion

According to the Fig. 7, though the results show that some land cover types experienced increasing rates and magnitudes of changes whereas in the others the converse is true, the overall observation made is that the magnitude and the rates of land cover changes for forest and barren land experienced a great fluctuations in these 30 years. It has been observed that deforestation is rising at an alarming rate in Mansehra District and it is closely linked with climate change. There was a major decline in the forest area i.e. it declined from 14% (601 Sq. Km) in 1998 to 5% (194 Sq. Km) in 2017 in the Northern Region of Pakistan, Mansehra. In Pakistan, energy is a vital factor for the social and economic development of the country because it improves the quality and standard of living. Therefore, the patterns of energy consumption in Pakistan are increasing with increasing population which is leading to increased deforestation and forest degradation. Drawing on field work, it was concluded that, the local residents of Mansehra mostly cook three times a day; breakfast and two major meals (lunch n dinner) in many households which is a major cause of deforestation as people cook food with the help of wood in the study

area. In many households, people also cook evening tea on woods and either collect fuel wood from the nearest forest or buy it from the markets, and a bundle of fuel wood is always available in the market by which it is clear that levels of wood consumption in Mansehra is higher resulting in forest degradation and subsequent deforestation. The average temperatures of the study area also fluctuate within 20 years as Mean Maximum temperature increased at an alarming rate from 24.786°C in 1998 to 27.304°C in 2016 and 26.739°C in the year 2017 and Mean Minimum Temperature showed fluctuation of 1° during these 20 years. In some years mean minimum temperature showed decrease from 12° to 11° and this change is not confined to a specific year. The rainfall increased from 3.6 mm in the year 1998 to 4.8mm in 2008 but declined to 2.9mm in the year 2017 when there was only 5% forest left in Mansehra.

Rate of increment is higher than rate of decrement during 1998 and 2017 in Mansehra. From the study it can be observed that most of the forest area in Mansehra District is converted in to barren land which was increased from 32% in 1998 to 44% in 2017 and it is not confined to a specific location. The land cover changes are spread throughout the District Mansehra and it is not confined to one specific location. From the discussion with residents it was concluded that the major cause of deforestation in Mansehra is the critical shortages of fuel wood in those areas where they have to purchase fuel wood and the prices are rising sharply which has turn out to be expensive for the poor households who continue to collect live wood by cutting and burning.

Acknowledgement

I owe immense thanks to many people whose assistance was indispensible in completing this research endeavor. First off all, I am very thankful to Allah Almighty, whose blessing made it possible for me to do this work successfully. I would like to express my deep and sincere gratitude to my research supervisors Miss Sumaira Gull and Dr. Faiza Sarwar who were always there for me no matter what or when even with their extremely busy schedule they really guided and directed me to make my research valuable. Words are inadequate to express my heartiest obligation and gratitude to Ms. Sumaira Gull and Dr. Faiza Sarwar for their enthusiastic guidance, vigorous attention and inquisitiveness throughout my research work. Finally, I must express my very profound gratitude to my parents, Mr. Amjad Iqbal Khan, Mrs. Riyasat Amjad and Mr. Amir Khan, Mrs Noshaba Amir for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

References

Ross W. Gorte & Pervaze Sheikh A. 2010. "Deforestation and Climate Change" Congressional Research Service.

Ghana, Peter Dok Tenden. 2013. "The Causes of and Impacts from Deforestation on Local Level Sustainable Forest Management in Ghana: a survey of Dwease and Praaso communities in the Ashanti region" Master's theses in Development Management University of Agder 2013.

Catrin Robertson. 2011. " Forest Transition or just Deforestation.?" Evidence from Brazil, A Masster Thesis.

Philip, Fearnside M. 1999. " Global Warming and Tropical Land Use Change: GHG Emissions from Biomass Burning, Decomposition and Soils in Forest Conversion, Shifting Cultivation and Secondary Vegetation" Research Gate **46(1),** 115-158.

Longobardi P, Montenegro A, Beltrami H, Eby M. 2016. "Deforestation Induced Climate Change: Effects of Spatial Scale." PLoS ONE **11(4),** e0153357.

Max Planck. 2002. "Maximum Impacts of Future Reforestation and Deforestation on Atmospheric CO_2." Global Change Biology **8(11),** 1047-1052.

Philip Fearnside M. 1997. "Greenhouse Gases from Deforestation in Brazilian Amazonia: Net Committed Emissions" **35(3),** 321-360.

Lauren Bennett. 2017. "Deforestation and Climate Change." Climate Institute.

Faisal Mueen, Khuram Shzad, Sawaid Abbas, Hamad Gillan And Birendra Bajracharya. 2016. "Mapping Deforestation and Forest Degradation Patters in Western Himalaya Pakistan" ***8(5),*** 385.

Arshad Ali, Somana Riaz. 2015. " Deforestation and its Impact on Climate Change, An Overview of Pakistan" **21(1),**51-60.

Muhammad Tariq. 2015. "An Overview of Deforestation Causes and its Environmental Hazards in KPK." Journal of Natural Sciences Research **5(1),** 2225-092.

DeJong BHJ, Hellier A, Castillo-Santiago MA, Tipper R. 2014. "Application of the 'CLIMAFOR' Approached to Estimate Base Line Carbon Emissions of a Forest Conservation Project in the SelvaLacandonaChiapas, Mexico" **10(2),** 265-2781.

Carlos Nobre, Piers Sellers A, Jagadish Shukla J. 1991" Amazonian Deforestation and Regional Climate Change". Journal of Climate **4(10).**

Karen Brien L.O. 2000. " Up Scaling Tropical Deforestation: Implications for Climate Change". Climatic Change **44(3),** 311-329.

Bernard Tinker P, John Ingram S, Sten Struwe I. 1996. "Effects of Slash-&Burn Agriculture and Deforestation on Climate Change". Agriculture, Ecosystems & Environment **58(1),** 13-22.

Polcher J, Laval K. 1993. " The Impact of African and Amazonian Deforestation on Tropical Climate". Journal of Hydrology **155(3,4),** 389-405.

David Werth and Roni Avissar. 2002 "The Local and Global Effects of Amazon Deforestation". Journal of Geographic Research Atmosphere **107(20),** 55-1,55-8.

Bala K, Caldiera M, Wickett TJ, Phillips D, Lobell B, Delire C, Mirin A. 2007. "Combined Climate and Carbon-Cycle Effects on Large Scale Deforestation". PNAS **104(16),** 6550-6555.

John Polcher. 1993. "The Statistical Study of the Impacts of Deforestation on Climate Using the LMD-GCM". Climate Dynamics **10(4,5),** 205-219.

Khalid Ahmad, Mohammad Shahbaz, AhmerQasim, Weilong. 2015. "The Linkages between Deforestation, Energy and Growth for Environmental Degradation". Ecological Indicators. **49,** 95-103.